AMERICAN FORK CITY COUNCIL
JUNE 10, 2025
CITY COUNCIL AGENDA – AMENDED*

Notice of Electronic Meeting
One or more City Council members may be physically absent from this meeting but may participate electronically.

The American Fork City Council will meet in a regular session on Tuesday, June 10, 2025, in the American Fork City Hall, 31 North Church Street, commencing at 7:00 p.m. The agenda shall be as follows:

PUBLIC HEARING

- Receive public comments on a code text amendment of Section 9.15.010, titled Public Disturbances.
- Receive public comments on the fiscal year ending June 30, 2026, city budgets.
- Receive public comments on the FY 2026 American Fork Municipal Officers compensation increases.

REGULAR SESSION

1. Pledge of Allegiance; Invocation by Council Member John; roll call.
2. Presentation of Manager of the Year Award to David Bunker.
3. Twenty-minute public comment period - limited to two minutes per person.
4. City Administrator's Report
5. Council Reports
6. Mayor's Report

COMMON CONSENT AGENDA

(*Common Consent* is that class of Council action that requires no further discussion or which is routine in nature. All items on the Common Consent Agenda are adopted by a single motion unless removed from the Common Consent Agenda.)

1. Approval of the April 22, 2025, city council minutes.
2. Approval of the May 6, 2025, work session minutes.
3. Approval of the May 13, 2025, city council minutes.
4. Approval of the May 20, 2025, work session minutes.
5. Approval of the authorization to release the Improvements Construction Guarantee in the amount of $99,349.50 and issue a Notice of Acceptance for the Walton Lane Townhomes construction of public improvements located at 841 East 700 South.
6. Approval of the authorization to release the Improvements Durability Retainer of $26,140.75 for 860 Place Plat B, located at 400 South 860 East.

7. Approval of an alcoholic beverage license for MMC American Fork LLC, DBA Mr. and Mrs. Crab Juicy Seafood & Bar, located at 466 North 900 West Suite C.
8. Ratification of city payments (May 21, 2025, to June 3, 2025) and approval of purchase requests over $50,000.

<u>ACTION ITEMS</u>

1. *Review and action on an ordinance approving a code text amendment for Section 9.15.010, known as Disturbing the Peace, and Section 9.15.020, known as Exemptions to Public Disturbances.
2. Review and action on an ordinance approving a code text amendment for Section 13.94.040, known as Storm Water System Design and Management Standards of the American Fork City Municipal Code.
3. Review and action on a resolution approving the FY2026 General Fee Schedule.
4. Consideration and action to enter into a closed session to discuss items described in Utah State Code 52-4-204 and 52-4-205.
5. Adjournment.

Dated this 9th day of June 2026.

/s/Terilyn Lurker
City Recorder

- In accordance with the Americans with Disabilities Act, the City of American Fork will make reasonable accommodations to participate in the meeting. Requests for assistance can be made by contacting the City Recorder at 801-763-3000 at least 48 hours in advance of the meeting.
- The order of agenda items may be changed to accommodate the needs of the City Council, staff, and the public.

REQUEST FOR COUNCIL ACTION
CITY OF AMERICAN FORK
JUNE 10, 2025

Department Public Works **Director Approval** *Sam Kelly*

AGENDA ITEM (Common Consent Agenda) - Consideration regarding authorization to release the Improvements Construction Guarantee in the amount of $99,349.50 and issue a Notice of Acceptance for the Walton Lane Townhomes construction of public improvements located at 841 East 700 South.

SUMMARY RECOMMENDATION The City Engineer recommends that the Improvements Construction Guarantee (ICG) be released. The improvements were found in a condition meeting City standards and specifications and in conformance with the approved project construction plans.

BACKGROUND Pursuant to the terms of Sections 17.9.100 and 17.9.304 of the City Development Code, the City Council may authorize the release of the ICG and issue a "Notice of Acceptance" of the project improvements. Following the issuance of the Notice of Acceptance, the City accepts ownership of the project improvements. The project will then enter the one (1) year Durability Testing Period as specified in section 17.9.400 of the City Development Code.

In issuing a Notice of Acceptance, the City Council finds that:

- The condition of the improvements are found to be satisfactory.
- All liens have been released, all outstanding fees paid, costs of administration paid, and reimbursement payments to prior developers (if any) have been made.
- The project clean-up is found to be satisfactory.

The City may request a current title report or other such measures or reports as deemed appropriate by the City as a means of determining the existence of any unreported liens or other claims upon the project. All financial information (if any) provided by the developer is attached. The Council may request additional information as deemed necessary.

BUDGET IMPACT Following the release of the ICG, there is a one (1) year Durability Testing Period wherein ten percent (10%) of the total ICG is held to ensure the durability of the constructed improvements.

SUGGESTED MOTION Move to accept the improvements and authorize the Mayor to execute the Notice of Acceptance for the Walton Lane Townhomes public improvements located at 841 East 700 South. To authorize the issuance of documents and/or payments to release the

Improvement Construction Guarantee (ICG). Commence the Durability Testing Period by retaining ten percent (10%) of the ICG. To find that the project improvements are in a condition meeting City ordinances, standards, and specifications and are in conformance with the approved project construction plans.

Note: With passage of the Common Consent Agenda items, the City Council will enact the motion and findings as noted in the "Suggested Motion" heading found above.

SUPPORTING DOCUMENTS

Walton Lane Townhomes final bond release for CC 6-10-25 (PDF)

NOTICE OF ACCEPTANCE / IMPROVEMENT COMPLETION ASSURANCE RELEASE AUTHORIZATION

The City Council of American Fork City, a Municipal Corporation and Body Politic in the State of Utah, hereby authorizes the release of the Improvement Completion Assurance WALTON LANE TOWNHOMES. The City Council accepts the improvements completed with the finding that said improvements are in a condition meeting City ordinances, standards, and specifications, are in conformance with the approved project construction plans, and all conditions for release as detailed in section 17.9.304 of the City Code have been satisfied.

The City Council hereby authorizes the issuance of a letter to the financial guarantee institution authorizing release of the Improvement Completion Assurance or to issue an authorized City check as appropriate for the type of guarantee provided, pursuant to the recommendation of staff and the receipt of reports, documents, and other correspondence. Upon issuance of this Notice of Acceptance, the Improvement Warranty Period shall commence as detailed in section 17.9.400 of the City Development Code. An amount totaling ten percent (10%) of the Improvement Completion Assurance funds will be held as the Improvement Warranty pursuant to the City Performance Guarantee ordinance.

Amount Released: $99,349.50

PASSED THIS 10TH DAY OF JUNE 2025

City Representative, American Fork City

ATTEST:

____
Terilyn Lurker, City Recorder

AMERICAN FORK 1853

BOND RELEASE REQUEST

Development Name: Walton Lane Townhomes

Development Address: 841 E 700 S, American Fork, UT 84003

*All outstanding fees must be paid prior to any release.

☐ Partial Improvement Assurance Release   ☑ Final Improvement Assurance Release   ☐ Improvement Warranty Release (10% Durability Release)

Description of Item	Quantity	Units	Unit Price	Total	Inspector Use Only Complete? Yes/No
				$ 99,349.50	
			Total	$ 99,349.50	

Bond Type: ☑ Cash Deposit   ☐ Escrow Account   ☐ Letter of Credit   ☐ Surety Bond

Please send check/bank letter to:

Name: Brighton Homes Utah, LLC

Bank (if applicable):

Address: 45 E Center Stree Ste 004

City: North Salt Lake   State: UT   Zip: 84054

Phone: Email: ap@buildwithbrighton.com

Signature: John Blocker   Date: 5/21/2025

City Official Use Only

☒ Fees paid and current

Administrative Signature: Jeri Gaungert   Date: 5-28-25

Inspector Signature: Dee Howard   Date: 05/27/2025

Name of Development: Walton Townhomes

Date		Date		Date		Date		Date		Date			
6/10/2025	Final												

Comments	Description of Item	Quantity	Unit	Unit Price	Total	Release #1	Amount Requested	Release #2	Amount Requested	Release #3	Amount Requested	Release #4	Amount Requested	Release #5	Amount Requested	Release #6	Am R	Balance
	SWPPP																	
	Concrete Washout Area	1	Each	$200.00	$200.00	1	$200.00		$0.00		$0.00		$0.00		$0.00			$0.00
	Silt Fence	1281	LF	$2.50	$3,202.50	1281	$3,202.50		$0.00		$0.00		$0.00		$0.00			$0.00
	Portable Toilet	2	Each	$130.00	$260.00	2	$260.00		$0.00		$0.00		$0.00		$0.00			$0.00
	Sediment Trap	13	Each	$600.00	$7,800.00	13	$7,800.00		$0.00		$0.00		$0.00		$0.00			$0.00
	Stabilized Staging Area	1107	SF	$2.00	$2,214.00	1107	$2,214.00		$0.00		$0.00		$0.00		$0.0			$0.00
	SWPPP Board	1	Each	$150.00	$150.00	1	$150.00		$0.00		$0.00		$0.00		$			$0.00
	Vehicle Tracking Control	2	LS	$500.00	$1,000.00	2	$1,000.00		$0.00		$0.00		$0.00					$0.00
	Notice Of Intent	1	Each	$100.00	$100.00	1	$100.00		$0.00		$0.00		$0.00					$0.00
	Notice Of Termination	1	Each	$100.00	$100.00	1	$100.00		$0.00		$0.00		$0.00					$0.00
	Storm Drain Maintenance Agreement	1	Each	$100.00	$100.00	1	$100.00		$0.00		$0.00		$0.00					$0.00
	CULINARY WATER																	
6" fire laterals included in this count, we have $35 unit cost	8" DI Culinary Water	970	LF	$35.00	$33,950.00	$970.00	$33,950.00		$0.00		$0.00		$0.00					$0.00
	8" Water Bend (45) w Thrust Blocks	2	Each	$600.00	$1,200.00	2	$1,200.00		$0.00		$0.00		$0.					$0.00
	8" Water Bend (90) w Thrust Blocks	3	Each	$650.00	$1,950.00	3	$1,950.00		$0.00		$0.00							$0.00
This doesn't include 6"x8" tees for fire laterals	8" Water Tee w Thrust Blocks	2	Each	$965.00	$1,930.00	2	$1,930.00		$0.00		$0.00							$0.00
	8" Gate Valve	3	Each	$1,545.00	$4,635.00	3	$4,635.00		$0.00		$0.00							$0.00
Cap will be needed at blowoff valve if project isn't finished	8" Culinary Cap	2	Each	$325.00	$650.00	2	$650.00		$0.00		$0.00							$0.00
We have $3200 unit price	Connect to Existing Water	2	Each	$900.00	$1,800.00	2	$1,800.00		$0.00		$0.00							$0.00
What does this include? 6" gate valves?	Fire Hydrant Assembly	3	Each	$6,000.00	$18,000.00	3	$18,000.00		$0.00		$0.00							$0.00
	Blowoff Assembly	1	Each	$1,375.00	$1,375.00	1	$1,375.00		$0.00		$0.00							$0.00
This doesn't include grade collars for 6" fire hydrant valves - included in FH assembly?	Water Valve Grade Collar	6	Each	$385.00	$2,310.00	6	$2,310.00		$0.00		$							$0.00
	Import Water Trench Backfill	980	Ton	$12.10	$11,858.00	980	$11,858.00		$0.00									$0.00
Add a line item for testing, cleaning, and inspections for the utilities	Testing, Cleaning, Inspections	1	LS	$2,500.00	$2,500.00	1	$2,500.00		$0.00									$0.00
	STORM DRAINAGE																	
Add this line item for SD in PUE on south side	12" RCP Storm Drain	49	LF	$33.00	$1,617.00	49	$1,617.00		$0.00									$0.00
Sidewalk on west side of west access	Sidewalk 4" Thick (4"untreated base course included)	112		$4.00	$448.00	112	$448.00		$0.0									$0.00
	CONSTRUCTION MANAGEMENT/MISC.																	

	Total		Amount Requested #1		Amount Requested #2		Amount Requested #3		Amount Requested #4		Amount Requested #5		Am R	Balance	
Improvement Completion Assurance	$99,349.50		$99,349.50		$0.00		$0.00		$0.00		$0.00		$0.00	**$0.00**	Available for Release
Improvement Warranty	$9,934.95													$9,934.95	Durability Period
TOTAL															

Total Fees

Total Bond & Fees $109,284.45

REQUEST FOR COUNCIL ACTION
CITY OF AMERICAN FORK
JUNE 10, 2025

AMERICAN FORK 18 53

Department Public Works **Director Approval** *Sam Kelly*

AGENDA ITEM Consideration regarding authorization to release the Improvements Durability Retainer of $26,140.75 for 860 Place Plat B, located at 400 South 860 East.

SUMMARY RECOMMENDATION The City Engineer recommends that the Improvements Durability Retainer be released. The improvements were found in a condition meeting City standards for workmanship and performance after one (1) year of service.

BACKGROUND Pursuant to the terms of Sections 17.9.100 and 17.9.403 of the City Development Code, the City Council may authorize the release of the Improvements Durability Retainer following the one (1) year durability testing period. The release is based on a finding that the quality of construction and materials have endured without evidence of unusual depreciation, wear, non-conformance of City standards or need for remedial action.

BUDGET IMPACT Following the release of the Improvements Durability Retainer, the City is responsible for all future maintenance and replacement costs for any publicly-owned property or improvement. In developments with Home-Owners or Unit-Owners Associations, all common area maintenance and replacement responsibilities will then fall to the Association. All privately-owned improvements will be the responsibility of the owner of the given parcel.

SUGGESTED MOTION Move to authorize the City Engineer to issue documents and/or payments to release the Improvements Durability Retainer of $26,140.75 for 860 Place Plat B. Find that the quality of construction and materials have endured without evidence of unusual depreciation, wear, non-conformance of City standards, or need for remedial action.

SUPPORTING DOCUMENTS

860 Place Plat B warranty bond release for CC 6-10-25 (PDF)

IMPROVEMENT WARRANTY RELEASE AUTHORIZATION

The City Council of American Fork City, a Municipal Corporation and Body Politic in the State of Utah, hereby authorizes the release of the Improvement Warranty for 860 PLACE PLAT B pursuant to the terms of Section 17.9.100 and 17.9.403 of the City Development Code, and pursuant to the recommendation of staff and the receipt of reports, documents, and other correspondence. The City Council finds that the quality of construction and materials have endured without evidence of unusual depreciation, wear, non-conformance to City standards, or need for remedial action.

The City Council hereby authorizes the City Engineer to issue a letter to the financial guarantee institution authorizing the release of the Improvement Warranty or to issue an authorized City check as appropriate for the type of guarantee provided.

Amount Released: $26,140.75

PASSED THIS 10 DAY OF JUNE 2025

City Representative, American Fork City

ATTEST:

Terilyn Lurker, City Recorder

BOND RELEASE REQUEST

Development Name: 860 Place Plat B

Development Address: 400 S 860 E

☐ Partial Release ☐ Final Release ☑ 10% Warranty Release

Description of Item	Quantity	Units	Unit Price	Total	Inspector Use Only Complete? Yes/No
Warranty Release					
			Total	$26,140.75	

Bond Type: ☐ Cash Deposit ☐ Escrow Account ☑ Letter of Credit ☐ Surety Bond

Please send check/bank letter to:

Name: Brady Mather

Bank (if applicable): Alta Bank

Address: 113 S Main St.

City: Alpine State: Utah ZIP: 84004

Phone: Email: brady.mather@altabank.com

Signature: [signature] Date: 4/4/2025

Inspector Use Only

Inspector Signature: [signature] Date: 05/12/2025

Form Number xxx-xx-xxx Approved for use by PW Director Date Apr 3 2018

Dari Faught 5-22-25

Name of Development: 860 Place Plat B

	Description of Item	Quantity	Unit	Unit Price	Total	Release #1	Amount Requested	Release #2	Amount Requested	Release #3	Amount Requested	Release #4	Amount Requested	Release #5	Amount Requested	Relea		Balance
						Date		Date		Date		Date		Date		Date		
						3/28/2024	Final											
		1	LS	$4,000.00	$4,000.00	1	$4,000.00		$0.00		$0.00		$0.00		$			$0.00
			LF	$52.50	$56,910.00	1084	$56,910.00		$0.00		$0.00		$0.00					$0.00
				3,250.00	$32,500.00	10	$32,500.00		$0.00		$0.00		$0.00					$0.00
					$36,623.70	45	$36,623.70		$0.00		$0.00		$0.					$0.00
							1.34		$0.00		$0.00							$0.00
									$0.00		$0.00							$0.00
											$0.00							$0.00
											$0.00							$0.00
											$0.00		$					$0.00
	As Builts Mylar & Disks	1	LS						00		$0.00		$0.00		$0.00			$0.00
	Testing, Cleaning, Inspections	1	LS						$0.00		$0.00		$0.00		$0.00			$0.00
	Subdivision Monument	2	Each						$0.00		$0.00		$0.00		$0.00		$0.00	$0.00
					$261,407.50		$261,407.50		$0.00		$0.00		$0.00		$0.00		$	$0.00 Available for Release
	10% Durability - retained at ICG r				$26,140.75													$26,140.75 Durability Period

ICG Amo

Street Lights

Fees $70.00

ADD landscaping, trees, irrigation system

Attachment: 860 Place Plat B warranty bond release for CC 6-10-25 (Durability Release)

REQUEST FOR COUNCIL ACTION
CITY OF AMERICAN FORK
JUNE 10, 2025

Department Recorder **Director Approval** *Terilyn Lurker*

AGENDA ITEM Approval of an alcoholic beverage license for MMC American Fork LLC, DBA Mr. and Mrs. Crab Juicy Seafood & Bar, located at 466 North 900 West Suite C.

SUMMARY RECOMMENDATION
The Business License Official recommends approval of the alcoholic beverage license.

BACKGROUND
This alcoholic beverage license is for MMC American Fork LLC, doing business as Mr. & Mrs. Crab Juicy Seafood & Bar, located at 466 North 900 West, Suite C.

BUDGET IMPACT
Application fee

SUGGESTED MOTION
Move to approve the alcoholic beverage license for MMC American Fork LLC located at 466 North 900 West, Suite C.

SUPPORTING DOCUMENTS

MMC American Fork - Alcoholic Beverage License(PDF)

American Fork

Printed: 06/05/2025

MMC American Fork LLC

06/04/2025 - 12/31/2025

3996303

Beer/Alcoholic Beverage Business License

62e283c0-4170-11f0-8580-9bad466a3486

General

Active

New

Application Review Status

Pre-Review	Not Reviewed	
Final-Review	Not Reviewed	06/04/2025

Fees

New Beer/Alcoholic Beverage Application Fee	$300.00
Subtotal	**$300.00**
Amount Paid	**$0.00**

Payments

There are no payments

Application Form Data

(Empty fields are not included)

Applicant First Name
LINYAN

Applicant Last Name
QIU

Phone Number

Email Address

Date of Birth

Age

Are you a US Citizen?
Yes

Social Security #
Reveal

Home Address (Street)

City

State

Zip

Previous Home Address

Name of Business to be Licensed
MMC American Fork LLC

DBA
MR & MRS CRAB JUICY SEAFOOD & BAR American Fork

Business Address
466 N 900 W STE C

City
AMERICAN FORK

State
UT

Zip
84003

Business Phone
(626) 327-7028

Type of American Fork City License
Alcoholic Beverage License

Type of DABC License Applying for
Restaurant-Full Service

Please upload a copy of County Health Permit

Health Permit Application Payment.pdf

Upload Local Consent Form

Local Consent Form.pdf

Signature

I hereby certify that I have complied with the requirements and possess the qualifications specified in the Alcoholic Beverage Control Act, and that all the information I have provided in this application is true.
I hereby certify that I have never been convicted of a felony, or any misdemeanor involving moral turpitude, or of any violation of any law or ordinance relating to alcoholic beverages, including DUI offenses.
I agree that if a license is issued, it shall be subject to suspension or revocation as provided in Chapter 5.08 of the American Fork City Code. I further agree to post any bonds required by the City pursuant to the terms of Chapter 5.08 of the City Code. No business license shall be transferred from one person to another, nor from one location to another.

LINYAN QIU - 06/04/2025 12:18 pm

REQUEST FOR COUNCIL ACTION
CITY OF AMERICAN FORK
JUNE 10, 2025

Department Recorder **Director Approval** *Terilyn Lurker*

AGENDA ITEM Review and action on an ordinance approving a code text amendment for Section 9.15.010, known as Disturbing the Peace, and Section 9.15.020, known as Exemptions to Public Disturbances.

SUMMARY RECOMMENDATION
Recommendation to approve the code text amendment.

BACKGROUND
The city desires to modify the regulations within Section 9.15.010 related to disturbing the peace due to the public demand for recreational and entertainment use of city parks, which includes playing sports before 7 a.m. There is also a need for maintenance to occur in or adjacent to residential zones before 7 a.m. The amendment also allows for an exemption to public disturbances for routine maintenance at the Fox Hollow Golf Course.

BUDGET IMPACT
NA

SUGGESTED MOTION
Move to adopt the ordinance approving amendments to Section 9.15.010 and 9.15.020 of the American Fork Municipal Code.

SUPPORTING DOCUMENTS

Distrubing the Peace.Ordinance Amendment.6.9.2025.Clean (DOCX)

ORDINANCE NO. __________

AN ORDINANCE AMENDING SECTION 9.15.010 AND SECTION 9.15.020 OF THE AMERICAN FORK MUNICIPAL CITY CODE

WHEREAS, the City is authorized to enact ordinances as are necessary and proper to promote the health, safety, morals, convenience, order, prosperity, and general welfare of American Fork City; and

WHEREAS, the City desires to modify regulations related disturbing the peace; and

WHEREAS, there is a public demand for recreational and entertainment use of city parks, including the playing of sports, before 7:00 a.m.; and

WHEREAS, there is a need for seasonal and periodic snow maintenance to occur in or adjacent to residential zones before 7:00 a.m; and

WHEREAS, the City finds that responsible recreational or entertainment activity may occur in city parks that are in or adjacent to residential zones between the hours of 10:30 p.m. and 6:00 a.m., when conducted with reasonable consideration for neighboring residents, and such does not inherently constitute a disturbance of the peace; and

WHEREAS, the City finds that for the performance of seasonal maintenance between the hours of 6:00 a.m. and 7:00 a.m to accommodate seasonal weather and maintenance issues in or adjacent to residential zones between the hours of 10:30 p.m. and 6:00 a.m., when conducted with reasonable consideration for neighboring residents, such does not inherently constitute a disturbance of the peace; and

WHEREAS, the unique and specific nature of the Fox Hollow Golf Course, which requires golf course maintenance to occur while the course is closed to the public, justifies an exemption to the rules and regulations related to disturbing the peace; and

WHEREAS, the City's Park Rules will need to be updated to conform with this Ordinance; and

WHEREAS, the adoption of this Ordinance will promote the public health, safety and welfare of the City.

NOW THEREFORE, be it ordained by the City Council of American Fork, Utah, that:

PART I
TEXT OF ORDINANCE

American Fork City Code Section 9.15.010 Disturbing The Peace and American Fork City Code Section 9.15.020 Exemption To Public Disturbances shall be amended as follows:

1. **SECTION ONE. Amendment.**

Sec 9.15.010 Disturbing The Peace

A. It is unlawful for any person to disturb the peace or quiet of another by loud or unusual noise or by tumultuous conduct or by threatening or yelling in a manner likely to incite another to violence.

B. It is unlawful for any person to cause noise that constitutes a public disturbance. It shall also be unlawful for any person in possession of real property to allow to originate from the property noise that constitutes a public disturbance. For purposes of this section, "public disturbance" shall be any sound which unreasonably disturbs or interferes with the peace, comfort or repose of owners or possessors of real property, including but not limited to sound which emanates from any of the following sound sources:
   1. Music, stereo or sound systems;
   2. Loud arguing or boisterous conduct;
   3. Construction work in or adjacent to a residential zone between the hours of ten-thirty p.m. and seven a.m.;
   4. Sports or other entertainment activities in or adjacent to a residential zone between the hours of ten-thirty p.m. and ~~seven~~ six a.m.
   ~~4.~~5. The use of machinery or motorized or power tools and equipment in or adjacent to a residential zone between the hours of ten-thirty p.m. and ~~seven~~ six a.m., except for specialized equipment used for seasonal maintenance and periodic snow removal~~;~~
   ~~5.~~6. The repetitive or continuous starting, testing or operation of a motor vehicle, including a motorcycle, in a residential zone.

C. Disturbing the peace is a Class C misdemeanor.

Sec 9.15.020 Exemptions To Public Disturbances

A. Sounds created by emergency activities or emergency vehicles; sounds giving warning of emergencies; and sounds associated with emergency work shall be exempt from the provisions of this chapter. "Emergency work" means work made necessary to restore property to a safe condition following a public calamity or work required to protect persons or property from an imminent exposure to danger.

B. Sounds created by parades, carnivals, special public social events, or special construction projects may be exempted from the noise provisions of this chapter. An exemption is granted by a permit from the mayor, or his administrative assistant with the mayor's approval, which must be in writing and shall describe:
   1. The special nature of the exempted event; and

2. The time period for which the exemption is in force. The permit shall be for one event only. The mayor or his administrative assistant may impose reasonable conditions on the issuance of a permit as necessary to protect the public peace and welfare. The permit may be withdrawn if the provisions thereof are violated.

C. Sounds created by routine maintenance at the Fox Hollow Golf Course that must be completed before opening to accommodate public access to the golf course.

D, Violations of the conditions of an exemption permit shall be a Class C misdemeanor.

2. **SECTION 2.** The City is hereby authorized to make any modification, changes, amendments and alternations to its Park Rules to conform to this Ordinance and take actions to conform to the City's policies and practices to conform to this Ordinance including but not limited to replacing signage at City Parks.

PART II

CONFLICTING ORDINANCES, SEVERABILITY, AND ADOPTION

SECTION 1. Conflicting Provisions. Whenever the provisions of this Ordinance conflict with the provisions of any other ordinance, resolution or part thereof, the more stringent shall prevail.

SECTION 2. Provisions Severable. This Ordinance and the various sections, clauses, and paragraphs are hereby declared to be severable. If any part, sentence, clause or phrase is adjudged to be unconstitutional or invalid, it is hereby declared that the remainder of the ordinance shall not be affected thereby.

SECTION 3. Effective Date. This Ordinance shall take effect upon its passage and publication as required by law.

PASSED AND ADOPTED BY THE CITY COUNCIL OF AMERICAN FORK CITY, STATE OF UTAH, ON THIS _____ DAY OF _______________________ 2025.

AMERICAN FORK CITY

Bradley J. Frost, Mayor

ATTEST:

____

CITY RECORDER

COUNCIL MEMBER	AYE	NAY	ABSTAIN	ABSENT
Staci Carroll	☐	☐		
Ryan Hunter	☐	☐		
Clark Taylor	☐	☐		
Tim Holley	☐	☐		
Ernie John	☐	☐		

REQUEST FOR COUNCIL ACTION
CITY OF AMERICAN FORK
JUNE 10, 2025

AMERICAN FORK 18 53

Department Recorder **Director Approval** *Terilyn Lurker*

AGENDA ITEM Review and action on an ordinance approving a code text amendment for Section 13.94.040, known as Storm Water System Design and Management Standards of the American Fork City Municipal Code.

SUMMARY RECOMMENDATION The staff would recommend approval. The Planning Commission recommended approval of this project at the March 19, 2025 meeting.

BACKGROUND The staff has initiated a Code Text Amendment to amend Section 13.94.040 of the American Fork City Municipal Code. The proposed amendment looks to:

- Add requirements related to individual lot detention and retention systems

- Clarify responsibility of property owners to prevent runoff from their property to neighboring properties

- Clarify geotechnical report requirements for infiltration designs.

BUDGET IMPACT N/A

SUGGESTED MOTION I move to adopt the ordinance approving the Code Text Amendment, amending Section 13.94.040, titled Storm Water System Design and Management Standards, with instructions to the City Recorder to withhold publication of the ordinance subject to all conditions identified in the public record of the March 19th, 2025, Planning Commission meeting have been met.

SUPPORTING DOCUMENTS

13.94.040 Storm Water System Design and Management Standards Revisions 2025-03 - Redlines (PDF)
Section 13.94.040 - Ordinance (DOCX)
13.94.040 Storm Water System Design and Management Standards Revisions 2025-03 - Updated (DOCX)
American Fork BMP Manual 2025 (PDF)
DWQ-2019-000161 (PDF)

Sec 13.94.040 Storm Water System Design And Management Standards

A. Irrigation ditches.
   1. All existing irrigation ditches located on the site or straddling a site property boundary shall be piped with a sufficiently-sized pipe and shall be coordinated with the water user and city engineer.
   2. Property owners are responsible for the protection of irrigation ditches per the relevant sections of this ordinance.
   3. Discharges to private ditches require written approval from the ditch owners and design shall comply with the terms of approvals and the storm water design standards and regulations and the land disturbance permit.
   4. Piping of ditches and modification to the diversion boxes require documented coordination with ditch owners or representative(s) but are not required to receive written approval of ditch owners. Design and coordination requirements shall comply with the storm water design standards and regulations and the land disturbance permit documents.

B. Storm water design and BMP manuals.
   1. Adoption. The municipality adopts as its storm water design and best management practices (BMPs) manuals the following publications, which are incorporated by reference in this chapter as if fully set out herein:
      a. American Fork City Storm Water Design Standards and Regulations.
      b. American Fork City Storm Water Master Plan.
      c. Other guidance document for Storm used in the administration of the American Fork City Storm Water Management Program.
      d. American Fork City Storm Water Technical Manual.
      ~~d.~~e. A Guide to Low Impact Development within Utah prepared for Utah Department of Environmental Quality Division of Water Quality and the BMPs included within this document as allowed and approved by the Public Works Department
   2. These manuals include a list of acceptable BMPs and include specific design performance criteria and operation and maintenance requirements for each storm water practice. The manuals may be updated and expanded from time to time at the discretion of the governing body of the city, upon the recommendation of the city engineer, based on improvements in engineering, science, monitory and local maintenance experience. Storm water facilities that are designed, constructed, and maintained in accordance with these BMP criteria will be presumed to meet the minimum water quality performance standards.

C. General performance criteria for storm water management. Unless granted a waiver or judged by the city engineer to be exempt, the following post construction performance criteria shall be addressed for storm water management at all sites:
   1. Design of storm drain systems in boundaries and discharges into an American Fork City storm drain system required direct supervision of a Utah Registered Professional Engineer, and shall carry the seal of the same supervising professional engineer.

2. All site designs shall control the peak flow rates of storm water discharge associated with design storms specified in this chapter or in the BMP manuals and reduce the generation of post construction storm water runoff to preconstruction levels or one-hundred-year historical runoff flow rates. These practices should seek to utilize pervious areas for storm water treatment and to infiltrate storm water runoff from driveways, sidewalks, rooftops, parking lots, and landscaped areas to the maximum extent practical to provide treatment for both water quality and quantity.
3. To protect stream channels from degradation, specific channel protection criteria shall be provided as prescribed in the BMP manuals.
4. Storm water discharges to critical areas with sensitive resources (i.e., cold water fisheries, swimming beaches, recharge areas, water supply reservoirs) may be subject to additional performance criteria, or may need to utilize or restrict certain storm water management practices.
5. Storm water discharges from "hot spots" may require the application of specific structural BMPs and pollution prevention practices.
6. Prior to or during the site design process, applicants for land disturbance permits shall consult with the city engineer to determine if they are subject to additional storm water design requirements.
7. The calculations for determining peak flows as found in the BMP manuals shall be used for sizing all storm water facilities.

D. Minimum control requirements.
1. Storm water discharge during all construction activities shall comply with the terms of the land disturbance permit, the storm water design standards and regulations, and/or requirements set forth by the International Building Code and the state of Utah UPDES requirements.
2. Storm water designs shall meet the multi-stage storm frequency storage requirements as identified in the BMP manuals unless the city engineer has granted the applicant a full or partial waiver for a particular BMP pursuant to Section 13.94.060 of this chapter.
3. Runoff rates from one lot to another shall not exceed pre-existing conditions, one-hundred-year historical runoff flow rates, or increase in such a manner that may unreasonably and unnecessarily cause greater harm than before.
4. All property owners shall manage and maintain both irrigation and stormwater on their own property to prevent any runoff from flowing onto adjacent parcels and lots.
~~3.~~5. Where individual lot detention or retention basins are proposed, a note shall be placed on the final plat recorded at the Office of the County Recorder, together with any prohibition or limitation to the excavation, removal or modification of the individual lot detention or retention basins without written approval from the City's Public Works Department. Excavation limitations resulting from development shall be attached to the lot as a condition of development approval. Any lot which has excavation limitations shall be identified on each lot on the final plat through the

placement of a symbol consisting of a capital E within a circle with a slash through the circle.

~~4.~~6. If hydrologic or topographic conditions warrant greater control than that provided by the minimum control requirements, the city engineer may impose any and all additional requirements deemed necessary to control the volume, flow velocity, timing, and rate of runoff.

E. Storm water management plan (SWMP) requirements. Property owners are responsible to manage storm water runoff and sediment, whether in conduit systems or on the surface, that traverse or originate on their property, unless this responsibility is relinquished through the terms and conditions of an easement. The storm water management plan (SWMP) shall include sufficient information to allow the city engineer to evaluate the environmental characteristics of the project site, the potential impacts of all proposed development of the site, both present and future, on the water resources, and the effectiveness and acceptability of the measures proposed for managing storm water generated at the project site. To accomplish this goal, the storm water management plan (SWMP) shall include the following:

1. Topographic base map. A one inch = one hundred feet topographic base map of the site which extends a minimum of two hundred fifty feet beyond the limits of the proposed development and indicates:
    a. Existing surface water drainage, including stream, ponds, culverts, ditches, sink holes, wetlands; and the type, size, elevation, etc., of nearest upstream and downstream drainage structures;
    b. Current land use, including all existing structures, locations of utilities, roads, and easements;
    c. All other existing significant natural and artificial features;
    d. Proposed land use with tabulation of the percentage of surface area to be adapted to various uses; drainage patterns, locations of utilities, roads, and easements; and the limits of clearing and grading;
    e. Proposed structural BMPs;
    f. A written description of the site plan and justification of proposed changes in natural conditions may also be required;
    g. Tabulations shall be provided for both existing and proposed land use and surface coverage materials, with specific types of permeability characteristics;
    h. When deemed necessary by the city engineer, the topographic base map and survey shall conform to the minimum levels established by the American Land and Title Association (A.L.T.A. Survey).
2. Calculations. Hydrologic and hydraulic design calculations for the pre-development, during construction, and post-development conditions for the design storms specified in the BMP manuals. These calculations must show that the proposed storm water management measures are capable of controlling runoff from the site in compliance with this chapter and the guidelines of the BMP manuals. Such calculations shall include:

a. A description of the design storm frequency, duration, and intensity where applicable;
b. Time of concentration;
c. Soil curve numbers or runoff coefficients, including assumed soil moisture conditions;
d. Peak runoff rates and total runoff volumes for each watershed area;
e. Infiltration rates verified by percolation tests or geotechnical reports, where applicable;
f. Culvert, storm water sewer, ditch, and/or other storm water conveyance capacities;
g. Flow velocities;
h. Data on the increase in rate and volume of runoff for the design storms referenced in the BMP manuals; and
i. Documentation of sources for all computation methods and field test results.

3. Soils information. If a storm water management control measure depends on the hydrologic properties of soils (e.g., infiltration basins), then a soils report shall be submitted. The soils report shall be based upon on-site boring logs or soil pit profiles survey reports. The number and location of required soil borings or soil pits shall be determined based on what is needed to determine the suitability and distribution of soil types present at the location of the control measure but shall follow these minimum requirements:
   a. A minimum of two borings for every subdivision or commercial site plan application.
   b. A minimum of one boring near each proposed sump location at least 18' deep.
   c. Sumps shall not be permitted within zones 1 and 2 of well protection zones as determined by the City.
   ~~3.~~d. Provide infiltration tests near the proposed sump locations.
4. Maintenance and repair plan. The design and planning of all storm water management facilities shall include detailed maintenance and repair procedures to ensure their continued performance. These plans will identify the parts or components of a storm water management facility that need to be maintained and the equipment and skills or training necessary. Provisions for the periodic review and evaluation of the effectiveness of the maintenance program and the need for revisions or additional maintenance procedures shall be included in the plan. A permanent elevation benchmark shall be identified in the plans to assist in the periodic inspection of the facility.
5. Landscaping plan. The applicant must present a detailed plan for management of vegetation at the site after construction is finished, including who will be responsible for the maintenance of vegetation at the site and what practices will be employed to ensure that adequate vegetative cover is

preserved. Where it is required by the BMP, this plan must be prepared by a registered landscape architect licensed in the state of Utah.

F. Maintenance easements. The applicant must ensure access to the site for the purpose of inspection and repair by securing all the maintenance easements needed. These easements must be binding on the current property owner and all subsequent owners of the property and must be properly recorded in the land record.

G. Maintenance agreement. The owner of the property to be served by an on-site storm water management facility must execute an inspection and maintenance agreement that shall operate as a deed restriction binding on the current property owner and all subsequent property owners. The maintenance agreement shall:

1. Assign responsibility for the maintenance and repair of the storm water facility to the owner of the property upon which the facility is located and be recorded as such on the plat for the property by appropriate notation.
2. Provide for a periodic inspection for the purpose of documenting maintenance and repair needs and ensure compliance with the purpose and requirements of this chapter. The property owner will arrange for this inspection to be conducted by a registered storm water inspector in the state of Utah who will submit a sealed report of the inspection to the city public works department. It shall also grant permission to the city to enter the property at reasonable times and to inspect the storm water facility to ensure that it is being properly maintained.
3. Provide that the minimum maintenance and repair needs include, but are not limited to: the removal of silt, litter, and other debris, the cutting of grass, grass cuttings and vegetation removal, and the replacement of landscape vegetation, in detention and retention basins, and inlets and drainage pipes and any other storm water facilities. It shall also provide that the property owner shall be responsible for additional maintenance and repair needs consistent with the needs and standards outlined in the BMP manuals.
4. Provide that maintenance needs must be addressed in a timely manner, on a schedule to be determined by the city engineer.
5. Provide that, if the property is not maintained or repaired within the prescribed schedule, the city public works department shall perform the maintenance and repair at its expense, and bill the same to the property owner. The maintenance agreement shall also provide that the city public works department's cost of performing the maintenance may be filed as a lien against the property.

H. Dedication. The municipality shall have the discretion to accept the dedication of any existing or future storm water management facility, provided such facility meets the requirements of this chapter, and includes adequate and perpetual access and sufficient areas, by easement or otherwise, for inspection and regular maintenance. Any storm water facility accepted by the municipality must also meet the municipality's construction standards and any other standards and specifications that apply to the particular storm water facility in question.

I. Sediment and erosion control plans. The applicant must prepare a sediment and erosion control plan for all construction activities that complies with Section 13.94.040(9) below.
The sediment and erosion control plan shall accurately describe the potential for soil erosion and sedimentation problems resulting from land disturbing activity and shall explain and illustrate the measures that are to be taken to control these problems.

The length and complexity of the plan is to be commensurate with the size of the project, the severity of the site condition, and the potential for off-site drainage. The plan shall be sealed by a registered professional engineer licensed in the state of Utah. The plan shall also conform to the requirements found in the BMP manuals and shall include at least the following:

1. Project description. Briefly describe the intended project and proposed land disturbing activity, including the number of units and structures to be constructed and infrastructures required.
2. A topographic map with contour intervals of two feet or less showing present conditions and proposed contours resulting from land disturbing activity.
3. All existing drainage ways, including intermittent and wet weather. Include any designated floodways or flood plains.
4. A general description of existing land cover. Individual trees and shrubs do not need to be identified.
5. Stands of existing trees as they are to be preserved upon project completion, specifying their general location on the property. Differentiation shall be made between existing trees to be preserved, trees to be removed, and proposed planted trees.
   Tree protection measures must be identified and the diameter of the area involved must also be identified on the plan and shown to scale. Information shall be supplied concerning the proposed destruction of exceptional and historic trees in setbacks and buffer strips, where they exist. Complete landscape plans may be submitted separately. The plan must include the sequence of implementation for tree protection measures.
6. Approximate limits of proposed clearing, grading, and filling.
7. Approximate flows of existing storm water leaving any portion of the site.
8. A general description of existing soil types and characteristics and any anticipated soil erosion and sedimentation problems resulting from existing characteristics.
9. Location, size, and layout of proposed storm water and sedimentation control improvements.
10. Proposed drainage network.
11. Proposed sizing for storm system piping, dewatering facilities, or other waterways.
12. Approximate flows leaving site after construction and incorporating water run-off mitigation measures. The evaluation must include projected effects

on property adjoining the site and on existing drainage facilities and systems. The plan must address the adequacy of outfalls from the development: When water is concentrated, what is the capacity of waterways, if any, accepting storm water offsite; and what measures, including infiltration, sheeting into buffers, etc., are going to be used to prevent the scouring of waterways and drainage areas off-site, etc.

13. The projected sequence of work represented by the grading, drainage, and sedimentation and erosion control plans as related to other major items of construction; beginning with the initiation of excavation and including the construction of any sediment basins or retention facilities or any other structural BMPs.
14. Specific remediation measures to prevent erosion and sedimentation run-off. Plans shall include detailed drawings of all control measures used. Stabilization measures, including vegetation and non-vegetation measures, both temporary and permanent, will be detailed. Detailed construction notes and a maintenance schedule shall be included for all control measures in the plan.
15. Specific details for the construction of rock pads, wash-down pads, and settling basins for controlling erosion; road access points; eliminating or keeping soil, sediment, and debris on streets and public ways at a level acceptable to the city engineer. Soil, sediment, and debris brought onto streets and public ways must be removed by the end of the work day by machine, broom, or shovel to the satisfaction of the city engineer. Failure to remove the sediment, soil, or debris shall be deemed a violation of this chapter.
16. Proposed structures. Location (to the extent possible) and identification of any proposed additional buildings, structures, or development on the site.
17. A description of on-site measures to be taken to recharge surface water into the ground water system through infiltration.
18. Future phasing plans and impervious areas if applicable.

ORDINANCE NO. __________________________

AN ORDINANCE AMENDING SECTION 13.94.040 TITLED STORM WATER SYSTEM DESIGN AND MANAGEMENT STANDARDS PROVIDING FOR THE ADOPTION AND ENFORCEMENT OF THE AMENDMENTS.

WHEREAS, American Fork City is authorized to enact ordinances as are necessary and proper to promote the health, safety, morals, convenience, order, prosperity, and general welfare of American Fork; and

WHEREAS, it is in the best interest and general welfare of residents of American Fork to amend Section 13.94.040 relating to the policy regarding storm water system design and management standards and

NOW THEREFORE, BE IT ORDAINED BY THE CITY COUNCIL OF AMERICAN FORK, UT as follows:

PART I

SECTION 1. Section 13.94.040 of the American Fork municipal code is hereby amended to read as follows:

Sec 13.94.040 Storm Water System Design And Management Standards

A. Irrigation ditches.
    1. All existing irrigation ditches located on the site or straddling a site property boundary shall be piped with a sufficiently-sized pipe and shall be coordinated with the water user and city engineer.
    2. Property owners are responsible for the protection of irrigation ditches per the relevant sections of this ordinance.
    3. Discharges to private ditches require written approval from the ditch owners and design shall comply with the terms of approvals and the storm water design standards and regulations and the land disturbance permit.
    4. Piping of ditches and modification to the diversion boxes require documented coordination with ditch owners or representative(s) but are not required to receive written approval of ditch owners. Design and coordination requirements shall comply with the storm water design standards and regulations and the land disturbance permit documents.

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c. Other guidance document for Storm used in the administration of the American Fork City Storm Water Management Program.
d. American Fork City Storm Water Technical Manual.
e. A Guide to Low Impact Development within Utah prepared for Utah Department of Environmental Quality Division of Water Quality and the BMPs included within this document as allowed and approved by the Public Works Department

2. These manuals include a list of acceptable BMPs and include specific design performance criteria and operation and maintenance requirements for each storm water practice. The manuals may be updated and expanded from time to time at the discretion of the governing body of the city, upon the recommendation of the city engineer, based on improvements in engineering, science, monitory and local maintenance experience. Storm water facilities that are designed, constructed, and maintained in accordance with these BMP criteria will be presumed to meet the minimum water quality performance standards.

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3. To protect stream channels from degradation, specific channel protection criteria shall be provided as prescribed in the BMP manuals.
4. Storm water discharges to critical areas with sensitive resources (i.e., cold water fisheries, swimming beaches, recharge areas, water supply reservoirs) may be subject to additional performance criteria, or may need to utilize or restrict certain storm water management practices.
5. Storm water discharges from "hot spots" may require the application of specific structural BMPs and pollution prevention practices.
6. Prior to or during the site design process, applicants for land disturbance permits shall consult with the city engineer to determine if they are subject to additional storm water design requirements.
7. The calculations for determining peak flows as found in the BMP manuals shall be used for sizing all storm water facilities.

D. Minimum control requirements.

1. Storm water discharge during all construction activities shall comply with the terms of the land disturbance permit, the storm water design standards and

regulations, and/or requirements set forth by the International Building Code and the state of Utah UPDES requirements.

2. Storm water designs shall meet the multi-stage storm frequency storage requirements as identified in the BMP manuals unless the city engineer has granted the applicant a full or partial waiver for a particular BMP pursuant to Section 13.94.060 of this chapter.
3. Runoff rates from one lot to another shall not exceed pre-existing conditions, one-hundred-year historical runoff flow rates, or increase in such a manner that may unreasonably and unnecessarily cause greater harm than before.
4. All property owners shall manage and maintain both irrigation and stormwater on their own property to prevent any runoff from flowing onto adjacent parcels and lots.
5. Where individual lot detention or retention basins are proposed, a note shall be placed on the final plat recorded at the Office of the County Recorder, together with any prohibition or limitation to the excavation, removal or modification of the individual lot detention or retention basins without written approval from the City's Public Works Department. Excavation limitations resulting from development shall be attached to the lot as a condition of development approval. Any lot which has excavation limitations shall be identified on each lot on the final plat through the placement of a symbol consisting of a capital E within a circle with a slash through the circle.
6. If hydrologic or topographic conditions warrant greater control than that provided by the minimum control requirements, the city engineer may impose any and all additional requirements deemed necessary to control the volume, flow velocity, timing, and rate of runoff.

E. Storm water management plan (SWMP) requirements. Property owners are responsible to manage storm water runoff and sediment, whether in conduit systems or on the surface, that traverse or originate on their property, unless this responsibility is relinquished through the terms and conditions of an easement. The storm water management plan (SWMP) shall include sufficient information to allow the city engineer to evaluate the environmental characteristics of the project site, the potential impacts of all proposed development of the site, both present and future, on the water resources, and the effectiveness and acceptability of the measures proposed for managing storm water generated at the project site. To accomplish this goal, the storm water management plan (SWMP) shall include the following:
   1. Topographic base map. A one inch = one hundred feet topographic base map of the site which extends a minimum of two hundred fifty feet beyond the limits of the proposed development and indicates:
      a. Existing surface water drainage, including stream, ponds, culverts, ditches, sink holes, wetlands; and the type, size, elevation, etc., of nearest upstream and downstream drainage structures;
      b. Current land use, including all existing structures, locations of utilities, roads, and easements;
      c. All other existing significant natural and artificial features;

   d. Proposed land use with tabulation of the percentage of surface area to be adapted to various uses; drainage patterns, locations of utilities, roads, and easements; and the limits of clearing and grading;
   e. Proposed structural BMPs;
   f. A written description of the site plan and justification of proposed changes in natural conditions may also be required;
   g. Tabulations shall be provided for both existing and proposed land use and surface coverage materials, with specific types of permeability characteristics;
   h. When deemed necessary by the city engineer, the topographic base map and survey shall conform to the minimum levels established by the American Land and Title Association (A.L.T.A. Survey).
2. Calculations. Hydrologic and hydraulic design calculations for the pre-development, during construction, and post-development conditions for the design storms specified in the BMP manuals. These calculations must show that the proposed storm water management measures are capable of controlling runoff from the site in compliance with this chapter and the guidelines of the BMP manuals. Such calculations shall include:
   a. A description of the design storm frequency, duration, and intensity where applicable;
   b. Time of concentration;
   c. Soil curve numbers or runoff coefficients, including assumed soil moisture conditions;
   d. Peak runoff rates and total runoff volumes for each watershed area;
   e. Infiltration rates verified by percolation tests or geotechnical reports, where applicable;
   f. Culvert, storm water sewer, ditch, and/or other storm water conveyance capacities;
   g. Flow velocities;
   h. Data on the increase in rate and volume of runoff for the design storms referenced in the BMP manuals; and
   i. Documentation of sources for all computation methods and field test results.
3. Soils information. If a storm water management control measure depends on the hydrologic properties of soils (e.g., infiltration basins), then a soils report shall be submitted. The soils report shall be based upon on-site boring logs or soil pit profiles survey reports. The number and location of required soil borings or soil pits shall be determined based on what is needed to determine the suitability and distribution of soil types present at the location of the control measure but shall follow these minimum requirements:
   a. A minimum of two borings for every subdivision or commercial site plan application.
   b. A minimum of one boring near each proposed sump location at least 18’ deep.
   c. Sumps shall not be permitted within zones 1 and 2 of well protection zones as determined by the City.

d. Provide infiltration tests near the proposed sump locations.

4. Maintenance and repair plan. The design and planning of all storm water management facilities shall include detailed maintenance and repair procedures to ensure their continued performance. These plans will identify the parts or components of a storm water management facility that need to be maintained and the equipment and skills or training necessary. Provisions for the periodic review and evaluation of the effectiveness of the maintenance program and the need for revisions or additional maintenance procedures shall be included in the plan. A permanent elevation benchmark shall be identified in the plans to assist in the periodic inspection of the facility.
5. Landscaping plan. The applicant must present a detailed plan for management of vegetation at the site after construction is finished, including who will be responsible for the maintenance of vegetation at the site and what practices will be employed to ensure that adequate vegetative cover is preserved. Where it is required by the BMP, this plan must be prepared by a registered landscape architect licensed in the state of Utah.

F. Maintenance easements. The applicant must ensure access to the site for the purpose of inspection and repair by securing all the maintenance easements needed. These easements must be binding on the current property owner and all subsequent owners of the property and must be properly recorded in the land record.

G. Maintenance agreement. The owner of the property to be served by an on-site storm water management facility must execute an inspection and maintenance agreement that shall operate as a deed restriction binding on the current property owner and all subsequent property owners. The maintenance agreement shall:

1. Assign responsibility for the maintenance and repair of the storm water facility to the owner of the property upon which the facility is located and be recorded as such on the plat for the property by appropriate notation.
2. Provide for a periodic inspection for the purpose of documenting maintenance and repair needs and ensure compliance with the purpose and requirements of this chapter. The property owner will arrange for this inspection to be conducted by a registered storm water inspector in the state of Utah who will submit a sealed report of the inspection to the city public works department. It shall also grant permission to the city to enter the property at reasonable times and to inspect the storm water facility to ensure that it is being properly maintained.
3. Provide that the minimum maintenance and repair needs include, but are not limited to: the removal of silt, litter, and other debris, the cutting of grass, grass cuttings and vegetation removal, and the replacement of landscape vegetation, in detention and retention basins, and inlets and drainage pipes and any other storm water facilities. It shall also provide that the property owner shall be responsible for additional maintenance and repair needs consistent with the needs and standards outlined in the BMP manuals.
4. Provide that maintenance needs must be addressed in a timely manner, on a schedule to be determined by the city engineer.
5. Provide that, if the property is not maintained or repaired within the prescribed schedule, the city public works department shall perform the maintenance and repair at its expense, and bill the same to the property owner. The maintenance

agreement shall also provide that the city public works department's cost of performing the maintenance may be filed as a lien against the property.

H. Dedication. The municipality shall have the discretion to accept the dedication of any existing or future storm water management facility, provided such facility meets the requirements of this chapter, and includes adequate and perpetual access and sufficient areas, by easement or otherwise, for inspection and regular maintenance. Any storm water facility accepted by the municipality must also meet the municipality's construction standards and any other standards and specifications that apply to the particular storm water facility in question.

I. Sediment and erosion control plans. The applicant must prepare a sediment and erosion control plan for all construction activities that complies with Section 13.94.040(9) below. The sediment and erosion control plan shall accurately describe the potential for soil erosion and sedimentation problems resulting from land disturbing activity and shall explain and illustrate the measures that are to be taken to control these problems.

The length and complexity of the plan is to be commensurate with the size of the project, the severity of the site condition, and the potential for off-site drainage. The plan shall be sealed by a registered professional engineer licensed in the state of Utah. The plan shall also conform to the requirements found in the BMP manuals and shall include at least the following:

1. Project description. Briefly describe the intended project and proposed land disturbing activity, including the number of units and structures to be constructed and infrastructures required.
2. A topographic map with contour intervals of two feet or less showing present conditions and proposed contours resulting from land disturbing activity.
3. All existing drainage ways, including intermittent and wet weather. Include any designated floodways or flood plains.
4. A general description of existing land cover. Individual trees and shrubs do not need to be identified.
5. Stands of existing trees as they are to be preserved upon project completion, specifying their general location on the property. Differentiation shall be made between existing trees to be preserved, trees to be removed, and proposed planted trees.
   Tree protection measures must be identified and the diameter of the area involved must also be identified on the plan and shown to scale. Information shall be supplied concerning the proposed destruction of exceptional and historic trees in setbacks and buffer strips, where they exist. Complete landscape plans may be submitted separately. The plan must include the sequence of implementation for tree protection measures.
6. Approximate limits of proposed clearing, grading, and filling.
7. Approximate flows of existing storm water leaving any portion of the site.
8. A general description of existing soil types and characteristics and any anticipated soil erosion and sedimentation problems resulting from existing characteristics.
9. Location, size, and layout of proposed storm water and sedimentation control improvements.
10. Proposed drainage network.

11. Proposed sizing for storm system piping, dewatering facilities, or other waterways.
12. Approximate flows leaving site after construction and incorporating water run-off mitigation measures. The evaluation must include projected effects on property adjoining the site and on existing drainage facilities and systems. The plan must address the adequacy of outfalls from the development: When water is concentrated, what is the capacity of waterways, if any, accepting storm water offsite; and what measures, including infiltration, sheeting into buffers, etc., are going to be used to prevent the scouring of waterways and drainage areas off-site, etc.
13. The projected sequence of work represented by the grading, drainage, and sedimentation and erosion control plans as related to other major items of construction; beginning with the initiation of excavation and including the construction of any sediment basins or retention facilities or any other structural BMPs.
14. Specific remediation measures to prevent erosion and sedimentation run-off. Plans shall include detailed drawings of all control measures used. Stabilization measures, including vegetation and non-vegetation measures, both temporary and permanent, will be detailed. Detailed construction notes and a maintenance schedule shall be included for all control measures in the plan.
15. Specific details for the construction of rock pads, wash-down pads, and settling basins for controlling erosion; road access points; eliminating or keeping soil, sediment, and debris on streets and public ways at a level acceptable to the city engineer. Soil, sediment, and debris brought onto streets and public ways must be removed by the end of the work day by machine, broom, or shovel to the satisfaction of the city engineer. Failure to remove the sediment, soil, or debris shall be deemed a violation of this chapter.
16. Proposed structures. Location (to the extent possible) and identification of any proposed additional buildings, structures, or development on the site.
17. A description of on-site measures to be taken to recharge surface water into the ground water system through infiltration.
18. Future phasing plans and impervious areas if applicable.

PART II
PROVISIONS AND ADOPTION

SECTION 1. Severability
The sections, paragraphs, sentences, clauses and phrases of this Ordinance are severable. If any such section, paragraph, sentence, clause, or phrase shall be declared invalid or unconstitutional by the valid judgment or decree of a Court of competent jurisdiction, such invalidity or

unconstitutionality shall not affect the validity of constitutionality of any of the remaining sections, paragraphs, sentences, clauses or phrases of this Ordinance.

SECTION 2. Amendments to be added to the City Code.
The City Council hereby directs that the provisions enacted by this ordinance shall be made and placed in the City Code.

SECTION 3. Effective Date
This ordinance shall take effect immediately upon its passage and publication as required by law.

PASSED AND ADOPTED BY THE CITY COUNCIL OF AMERICAN FORK, STATE OF UTAH, ON THIS _____ DAY OF _____________, 2025.

____
Bradley J. Frost, Mayor

ATTEST:

____
Terilyn Lurker, City Recorder

Sec 13.94.040 Storm Water System Design And Management Standards

A. Irrigation ditches.
   1. All existing irrigation ditches located on the site or straddling a site property boundary shall be piped with a sufficiently-sized pipe and shall be coordinated with the water user and city engineer.
   2. Property owners are responsible for the protection of irrigation ditches per the relevant sections of this ordinance.
   3. Discharges to private ditches require written approval from the ditch owners and design shall comply with the terms of approvals and the storm water design standards and regulations and the land disturbance permit.
   4. Piping of ditches and modification to the diversion boxes require documented coordination with ditch owners or representative(s) but are not required to receive written approval of ditch owners. Design and coordination requirements shall comply with the storm water design standards and regulations and the land disturbance permit documents.

B. Storm water design and BMP manuals.
   1. Adoption. The municipality adopts as its storm water design and best management practices (BMPs) manuals the following publications, which are incorporated by reference in this chapter as if fully set out herein:
      a. American Fork City Storm Water Design Standards and Regulations.
      b. American Fork City Storm Water Master Plan.
      c. Other guidance document for Storm used in the administration of the American Fork City Storm Water Management Program.
      d. American Fork City Storm Water Technical Manual.
      e. A Guide to Low Impact Development within Utah prepared for Utah Department of Environmental Quality Division of Water Quality and the BMPs included within this document as allowed and approved by the Public Works Department
   2. These manuals include a list of acceptable BMPs and include specific design performance criteria and operation and maintenance requirements for each storm water practice. The manuals may be updated and expanded from time to time at the discretion of the governing body of the city, upon the recommendation of the city engineer, based on improvements in engineering, science, monitory and local maintenance experience. Storm water facilities that are designed, constructed, and maintained in accordance with these BMP criteria will be presumed to meet the minimum water quality performance standards.

C. General performance criteria for storm water management. Unless granted a waiver or judged by the city engineer to be exempt, the following post construction performance criteria shall be addressed for storm water management at all sites:
   1. Design of storm drain systems in boundaries and discharges into an American Fork City storm drain system required direct supervision of a Utah Registered Professional Engineer, and shall carry the seal of the same supervising professional engineer.

2. All site designs shall control the peak flow rates of storm water discharge associated with design storms specified in this chapter or in the BMP manuals and reduce the generation of post construction storm water runoff to preconstruction levels or one-hundred-year historical runoff flow rates. These practices should seek to utilize pervious areas for storm water treatment and to infiltrate storm water runoff from driveways, sidewalks, rooftops, parking lots, and landscaped areas to the maximum extent practical to provide treatment for both water quality and quantity.
3. To protect stream channels from degradation, specific channel protection criteria shall be provided as prescribed in the BMP manuals.
4. Storm water discharges to critical areas with sensitive resources (i.e., cold water fisheries, swimming beaches, recharge areas, water supply reservoirs) may be subject to additional performance criteria, or may need to utilize or restrict certain storm water management practices.
5. Storm water discharges from "hot spots" may require the application of specific structural BMPs and pollution prevention practices.
6. Prior to or during the site design process, applicants for land disturbance permits shall consult with the city engineer to determine if they are subject to additional storm water design requirements.
7. The calculations for determining peak flows as found in the BMP manuals shall be used for sizing all storm water facilities.

D. Minimum control requirements.
1. Storm water discharge during all construction activities shall comply with the terms of the land disturbance permit, the storm water design standards and regulations, and/or requirements set forth by the International Building Code and the state of Utah UPDES requirements.
2. Storm water designs shall meet the multi-stage storm frequency storage requirements as identified in the BMP manuals unless the city engineer has granted the applicant a full or partial waiver for a particular BMP pursuant to Section 13.94.060 of this chapter.
3. Runoff rates from one lot to another shall not exceed pre-existing conditions, one-hundred-year historical runoff flow rates, or increase in such a manner that may unreasonably and unnecessarily cause greater harm than before.
4. All property owners shall manage and maintain both irrigation and stormwater on their own property to prevent any runoff from flowing onto adjacent parcels and lots.
5. Where individual lot detention or retention basins are proposed, a note shall be placed on the final plat recorded at the Office of the County Recorder, together with any prohibition or limitation to the excavation, removal or modification of the individual lot detention or retention basins without written approval from the City's Public Works Department. Excavation limitations resulting from development shall be attached to the lot as a condition of development approval. Any lot which has excavation limitations

shall be identified on each lot on the final plat through the placement of a symbol consisting of a capital E within a circle with a slash through the circle.

6. If hydrologic or topographic conditions warrant greater control than that provided by the minimum control requirements, the city engineer may impose any and all additional requirements deemed necessary to control the volume, flow velocity, timing, and rate of runoff.

E. Storm water management plan (SWMP) requirements. Property owners are responsible to manage storm water runoff and sediment, whether in conduit systems or on the surface, that traverse or originate on their property, unless this responsibility is relinquished through the terms and conditions of an easement. The storm water management plan (SWMP) shall include sufficient information to allow the city engineer to evaluate the environmental characteristics of the project site, the potential impacts of all proposed development of the site, both present and future, on the water resources, and the effectiveness and acceptability of the measures proposed for managing storm water generated at the project site. To accomplish this goal, the storm water management plan (SWMP) shall include the following:

1. Topographic base map. A one inch = one hundred feet topographic base map of the site which extends a minimum of two hundred fifty feet beyond the limits of the proposed development and indicates:
    a. Existing surface water drainage, including stream, ponds, culverts, ditches, sink holes, wetlands; and the type, size, elevation, etc., of nearest upstream and downstream drainage structures;
    b. Current land use, including all existing structures, locations of utilities, roads, and easements;
    c. All other existing significant natural and artificial features;
    d. Proposed land use with tabulation of the percentage of surface area to be adapted to various uses; drainage patterns, locations of utilities, roads, and easements; and the limits of clearing and grading;
    e. Proposed structural BMPs;
    f. A written description of the site plan and justification of proposed changes in natural conditions may also be required;
    g. Tabulations shall be provided for both existing and proposed land use and surface coverage materials, with specific types of permeability characteristics;
    h. When deemed necessary by the city engineer, the topographic base map and survey shall conform to the minimum levels established by the American Land and Title Association (A.L.T.A. Survey).
2. Calculations. Hydrologic and hydraulic design calculations for the pre-development, during construction, and post-development conditions for the design storms specified in the BMP manuals. These calculations must show that the proposed storm water management measures are capable of controlling runoff from the site in compliance with this chapter and the guidelines of the BMP manuals. Such calculations shall include:

a. A description of the design storm frequency, duration, and intensity where applicable;
b. Time of concentration;
c. Soil curve numbers or runoff coefficients, including assumed soil moisture conditions;
d. Peak runoff rates and total runoff volumes for each watershed area;
e. Infiltration rates verified by percolation tests or geotechnical reports, where applicable;
f. Culvert, storm water sewer, ditch, and/or other storm water conveyance capacities;
g. Flow velocities;
h. Data on the increase in rate and volume of runoff for the design storms referenced in the BMP manuals; and
i. Documentation of sources for all computation methods and field test results.

3. Soils information. If a storm water management control measure depends on the hydrologic properties of soils (e.g., infiltration basins), then a soils report shall be submitted. The soils report shall be based upon on-site boring logs or soil pit profiles survey reports. The number and location of required soil borings or soil pits shall be determined based on what is needed to determine the suitability and distribution of soil types present at the location of the control measure but shall follow these minimum requirements:
   a. A minimum of two borings for every subdivision or commercial site plan application.
   b. A minimum of one boring near each proposed sump location at least 18’ deep.
   c. Sumps shall not be permitted within zones 1 and 2 of well protection zones as determined by the City.
   d. Provide infiltration tests near the proposed sump locations.
4. Maintenance and repair plan. The design and planning of all storm water management facilities shall include detailed maintenance and repair procedures to ensure their continued performance. These plans will identify the parts or components of a storm water management facility that need to be maintained and the equipment and skills or training necessary. Provisions for the periodic review and evaluation of the effectiveness of the maintenance program and the need for revisions or additional maintenance procedures shall be included in the plan. A permanent elevation benchmark shall be identified in the plans to assist in the periodic inspection of the facility.
5. Landscaping plan. The applicant must present a detailed plan for management of vegetation at the site after construction is finished, including who will be responsible for the maintenance of vegetation at the site and what practices will be employed to ensure that adequate vegetative cover is

preserved. Where it is required by the BMP, this plan must be prepared by a registered landscape architect licensed in the state of Utah.

F. Maintenance easements. The applicant must ensure access to the site for the purpose of inspection and repair by securing all the maintenance easements needed. These easements must be binding on the current property owner and all subsequent owners of the property and must be properly recorded in the land record.

G. Maintenance agreement. The owner of the property to be served by an on-site storm water management facility must execute an inspection and maintenance agreement that shall operate as a deed restriction binding on the current property owner and all subsequent property owners. The maintenance agreement shall:

1. Assign responsibility for the maintenance and repair of the storm water facility to the owner of the property upon which the facility is located and be recorded as such on the plat for the property by appropriate notation.
2. Provide for a periodic inspection for the purpose of documenting maintenance and repair needs and ensure compliance with the purpose and requirements of this chapter. The property owner will arrange for this inspection to be conducted by a registered storm water inspector in the state of Utah who will submit a sealed report of the inspection to the city public works department. It shall also grant permission to the city to enter the property at reasonable times and to inspect the storm water facility to ensure that it is being properly maintained.
3. Provide that the minimum maintenance and repair needs include, but are not limited to: the removal of silt, litter, and other debris, the cutting of grass, grass cuttings and vegetation removal, and the replacement of landscape vegetation, in detention and retention basins, and inlets and drainage pipes and any other storm water facilities. It shall also provide that the property owner shall be responsible for additional maintenance and repair needs consistent with the needs and standards outlined in the BMP manuals.
4. Provide that maintenance needs must be addressed in a timely manner, on a schedule to be determined by the city engineer.
5. Provide that, if the property is not maintained or repaired within the prescribed schedule, the city public works department shall perform the maintenance and repair at its expense, and bill the same to the property owner. The maintenance agreement shall also provide that the city public works department's cost of performing the maintenance may be filed as a lien against the property.

H. Dedication. The municipality shall have the discretion to accept the dedication of any existing or future storm water management facility, provided such facility meets the requirements of this chapter, and includes adequate and perpetual access and sufficient areas, by easement or otherwise, for inspection and regular maintenance. Any storm water facility accepted by the municipality must also meet the municipality's construction standards and any other standards and specifications that apply to the particular storm water facility in question.

I. Sediment and erosion control plans. The applicant must prepare a sediment and erosion control plan for all construction activities that complies with Section 13.94.040(9) below.
The sediment and erosion control plan shall accurately describe the potential for soil erosion and sedimentation problems resulting from land disturbing activity and shall explain and illustrate the measures that are to be taken to control these problems.

The length and complexity of the plan is to be commensurate with the size of the project, the severity of the site condition, and the potential for off-site drainage. The plan shall be sealed by a registered professional engineer licensed in the state of Utah. The plan shall also conform to the requirements found in the BMP manuals and shall include at least the following:

1. Project description. Briefly describe the intended project and proposed land disturbing activity, including the number of units and structures to be constructed and infrastructures required.
2. A topographic map with contour intervals of two feet or less showing present conditions and proposed contours resulting from land disturbing activity.
3. All existing drainage ways, including intermittent and wet weather. Include any designated floodways or flood plains.
4. A general description of existing land cover. Individual trees and shrubs do not need to be identified.
5. Stands of existing trees as they are to be preserved upon project completion, specifying their general location on the property. Differentiation shall be made between existing trees to be preserved, trees to be removed, and proposed planted trees.
   Tree protection measures must be identified and the diameter of the area involved must also be identified on the plan and shown to scale. Information shall be supplied concerning the proposed destruction of exceptional and historic trees in setbacks and buffer strips, where they exist. Complete landscape plans may be submitted separately. The plan must include the sequence of implementation for tree protection measures.
6. Approximate limits of proposed clearing, grading, and filling.
7. Approximate flows of existing storm water leaving any portion of the site.
8. A general description of existing soil types and characteristics and any anticipated soil erosion and sedimentation problems resulting from existing characteristics.
9. Location, size, and layout of proposed storm water and sedimentation control improvements.
10. Proposed drainage network.
11. Proposed sizing for storm system piping, dewatering facilities, or other waterways.
12. Approximate flows leaving site after construction and incorporating water run-off mitigation measures. The evaluation must include projected effects

on property adjoining the site and on existing drainage facilities and systems. The plan must address the adequacy of outfalls from the development: When water is concentrated, what is the capacity of waterways, if any, accepting storm water offsite; and what measures, including infiltration, sheeting into buffers, etc., are going to be used to prevent the scouring of waterways and drainage areas off-site, etc.

13. The projected sequence of work represented by the grading, drainage, and sedimentation and erosion control plans as related to other major items of construction; beginning with the initiation of excavation and including the construction of any sediment basins or retention facilities or any other structural BMPs.
14. Specific remediation measures to prevent erosion and sedimentation run-off. Plans shall include detailed drawings of all control measures used. Stabilization measures, including vegetation and non-vegetation measures, both temporary and permanent, will be detailed. Detailed construction notes and a maintenance schedule shall be included for all control measures in the plan.
15. Specific details for the construction of rock pads, wash-down pads, and settling basins for controlling erosion; road access points; eliminating or keeping soil, sediment, and debris on streets and public ways at a level acceptable to the city engineer. Soil, sediment, and debris brought onto streets and public ways must be removed by the end of the work day by machine, broom, or shovel to the satisfaction of the city engineer. Failure to remove the sediment, soil, or debris shall be deemed a violation of this chapter.
16. Proposed structures. Location (to the extent possible) and identification of any proposed additional buildings, structures, or development on the site.
17. A description of on-site measures to be taken to recharge surface water into the ground water system through infiltration.
18. Future phasing plans and impervious areas if applicable.

American Fork
Preferred BMP List
For Permitted Construction Sites

Adopted January 1, 2025

Revised December 19, 2024

This is a living document addition, or removals will be updated to city website

Introduction

The operator is responsible for selecting effective site specific Best Management Practices (BMPs) for erosion and sediment control as well as pollution prevention operations according to the site's unique current conditions and the conditions that will occur throughout construction. A qualified person (as described in section 7.2 of the Construction General Permit, and section 4 of the Common Plan Permit) should evaluate the site to ensure the selected BMP is suitable and may need to consider a series of BMPs based on site conditions and construction operations. Conditions such as slope, proximity to water, soil type, infiltration rate, feasibility, etc should all be considered.

BMPs that do not meet their performance criteria can result in oversight authority notice of Storm Water Pollution Prevention Plan (SWPPP) violation(s) and potential enforcement.

Purpose

The purpose of the State Preferred BMP List is to meet the requirements of Utah Code 19-5-108.3. Each MS4 in the State of Utah will select which BMPs from this Preferred BMP List document are acceptable for use within that jurisdiction at permitted construction sites.

Applicability

This Preferred BMP List document shall be applicable to all sites that require regulation under the General Permit for Storm Water Discharges from Construction Activities (CGP) and the Common Plan Permit (CPP).

The USWAC Preferred BMPs are intended to be installed and maintained specifically as described. The operator or SWPPP agent is responsible for choosing BMPs that are applicable and will be effective at containing and managing the site's unique exposures and construction operations. The USWAC Preferred BMP List does not contain all BMPs for every situation or imply that all Preferred BMPs are agreeable to the operator.

When necessary, the operator or SWPPP agents may need to use BMPs not found in the USWAC BMP Preferred List. Where this is the case, a BMP Template is provided as the basis to describe the alternative BMP. In addition to BMPs not covered with the preferred list, the operator or SWPPP agents are invited to modify any of the USWAC BMPs to manage project exposures and operations. However, in both cases the alternative BMPs must be designed to satisfy or exceed the minimum performance criteria. The operator or SWPPP agents must submit modified or alternative BMPs to the oversight authority for review.

Stormwater pollution control requirements are intended to be proactive and implemented on a year-round basis. Appropriate pollution control includes both erosion control and sediment mitigation as well as track out controls, non-stormwater discharge and waste management, and material pollution BMPs. Some BMPs can be implemented as a stand-alone device while others can be combined to improve effectiveness and compliance.

Reporting

The CGP and CPP require operators to conduct inspections of storm water pollution prevention controls and keep record of these inspections. The GCP/CPP report requirements are to demonstrate that selected BMPs are effective at controlling sources of storm water pollution. The report must include actions taken to maintain, repair, or install new BMPs as needed to fulfill the pollution prevention plan created for the site. The DEQ has provided a SWPPP inspection form for operators to utilize to record this minimum information as well as record actions taken to correct issues. See SWPPP Inspection Form.

Utah State Code 19-05-108.3 requires that operators submit "electronic site inspections" which is defined as "geo-located and time-stamped photos taken, evaluated, and submitted electronically by the applicant to the municipal system." To guide the operator in fulfilling this additional requirement, an *Electronic Site Inspection Guide* document has been created and is accessible via the hyperlink and is found towards the bottom of the webpage.

It is important that the BMPs in the photos support the operator's SWPPP inspection report and represent the condition of each BMP. BMPs (either sourced from this preferred list or added by the operator or SWPPP agents) that do not meet the installation, maintenance and performance criteria specified must be corrected to achieve compliance with the site specific SWPPP and CGP/CPP. After the BMP is corrected, provide a description of how the BMP was corrected and the date the correction was made in the SWPPP Inspection report. Provide adequate geo-located and time-stamped photo(s) that support the correction action. If applicable, also address any deficiencies noted by the oversight authority within the established deadlines provided in the oversight inspection report. For guidance in which case corrective actions versus routine maintenance must be reported, refer to the CGP/CPP for specifications.

Acknowledgement

The creation of this USWAC Preferred BMP List would not have been possible without the support of the Utah Storm Water Advisory Committee and BMP Subcommittee. We take this opportunity to express gratitude to the MS4 Unification Committee who have been instrumental in the successful completion of this project.
And to many others who contributed their time and effort to the contents of this document, thank you!

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Template for Adding an Alternate BMP (Operator Version)

"Operators are invited to use an alternative BMP or modify a BMP from the USWAC Preferred List so long as the BMP has the same performance criteria or better as the preferred BMP. Any deviations from the preferred BMP installation and use parameters must be reviewed and accepted by the oversight authority."

[BMP # - Title]

Replace all blue text in brackets with BMP specific data. Then delete any remaining unnecessary blue instructional text.

[Insert the BMP detail drawing specific to the proprietary device you will use. It should illustrate the structure of the BMP, installation requirements, and any typical variances due to site conditions.]

[IMAGE]

APPLICATION

- [Describe specifically when and where this BMP will be used on site]

INSTALLATION/USE PROCEDURES

- [Describe how this BMP should be installed or how it should be practiced]
- [Describe further so that it is very clear, such as minimum length of structure, etc]

BMP MODIFICATION OR REPLACEMENT JUSTIFICATION

Use only one of the two following bullets

- This BMP is replacing or augmenting [list the preferred BMP that is being replaced] OR
- This BMP is being added and implemented as the conditions or operations cannot be adequately managed by a BMP from the USWAC Preferred List.

MAINTENANCE/MANAGEMENT

- [Add maintenance criteria for proper BMP performance]
- [Describe how the BMP should look or function during an inspection]
- [Describe when maintenance is necessary]
- [Describe when replacement is necessary]
- [Describe when no action is needed]

PERFORMANCE

- [Describe performance expectations of the alternative BMP. This includes how it protects water resources, manages hazards, and limits public complaints]

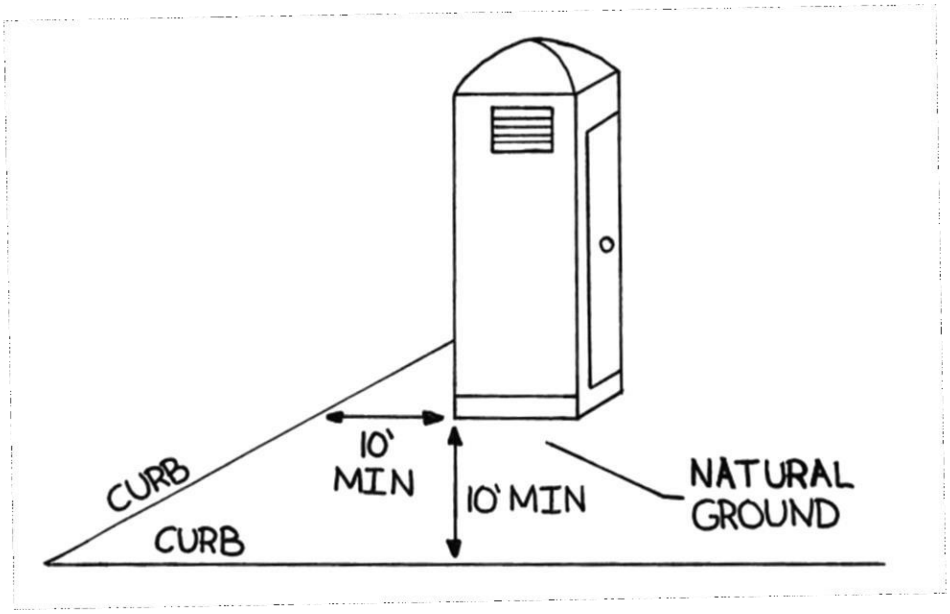
GENERAL

- [Include other information, direction, instruction, and BMP criteria that does not fit well into the other categories.]

REFERENCE

- [CGP and Federal Regulations sections, numbers, link to proprietary documentation, etc]

BMP 1- Portable Toilet on Pervious Surface



APPLICATION

- Provide temporary sanitary facilities when permanent facilities are too far from activities or are unavailable.

INSTALLATION/USE PROCEDURE

- Locate portable toilets away from waters of the state, and at least 10 feet from any storm water conveyance, inlet, curb and gutter, or conduit to a waterway.
- Wherever possible, locate portable toilet upon natural ground and not on impervious surfaces such as asphalt, concrete, or similar
- Prepare a level surface and provide clear access to the toilet(s) for servicing and for on-site personnel
- Wherever possible, locate a portable toilet next to track out pad or provide gravel access pad for maintenance pick up to reduce occurrence of mud track out by service provider.
- Secure portable toilets to prevent tipping e.g. stakes, tie downs, etc.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.
- Also see BMP 2- Portable Toilet on Pavement

MAINTENANCE/MANAGEMENT

- Portable toilets should be maintained in good working order by licensed service
- Portable toilets should be inspected daily to detect any leaks
- Damaged toilets must be repaired/replaced immediately
- All waste must be deposited in the sanitary sewer system for treatment with appropriate agency approval
- Implement spill BMP immediately upon spill incident
- If track out from the service provider occurs, debris must be removed as soon as practicable.

PERFORMANCE

- A portable toilet is expected to contain human waste with zero exposure to storm water.
- A successful portable toilet is clean, effective, and is processed by the appropriate licensed facility.

REFERENCE

- Construction General Storm Water Permit (CGP) 2.3.3(f)
- Common Plat Permit (CPP) 2.4.4

BMP 2- Pavement Mounted Portable Toilet

Picture for concept purpose only

APPLICATION

- Use portable toilets on pavement only for projects without pervious staging areas. Usually projects within existing right-of-ways.
- Do not install portable toilets on pavement when private property is expected to be used. Generally, portable toilets installed on pavement are not acceptable for commercial and residential projects.

INSTALLATION/USE PROCEDURE

- When near inlets, always locate portable toilets downstream of inlets. Identify on SWPPP BMP map.
- Place portable toilet on a surface no steeper than 2% grade.
- Attach portable toilet contractor illustrations, service and any maintenance information. For ground mount toilets provide each corner with 50# weights or as specified by the service contractor. For trailer mounted systems, provide a plan for securing the trailer as specified by the service contractor.
- Provide secondary containment. Submit for oversight authority review. A gutter dam BMP is a good choice.
- Obtain private or public right of way encroachment permit (or local equivalent) when required by the local authority.
- Attach a copy of the portable toilet manufacturer's maintenance literature.
- Ensure the spill prevention program includes containment materials and protocols for potential portable toilet spills.

- Ensure maintenance personnel and site workers involved in site operations understand BMP requirements.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Inspect BMP location corresponds with SWPPP BMP map. Locations are often dynamic for projects within right-of-ways.
- Inspect maintenance per manufacturer requirements
- Inspect for leaks and tank levels
- Inspect anti-tipping system

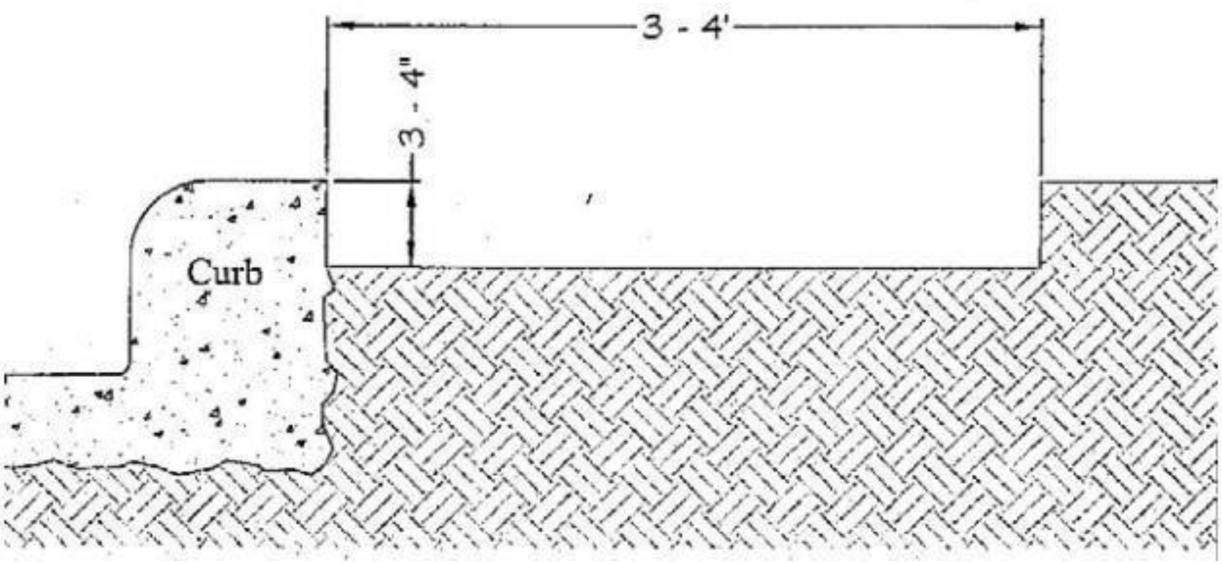
PERFORMANCE

- A portable toilet is expected to contain human waste with zero exposure to storm water.
- A successful portable toilet is clean, effective, and is processed by the appropriate licensed facility.

REFERENCE:

- CGP 2.3.3(f), 2.4.4
- CPP 2.4.4

BMP 3- Curb Sedimentation Trap



APPLICATION

- Use at project boundaries in which final grading is sloped towards pavement or roadways to retain sediment.
- Only applicable when the site is sloped towards the curb such that runoff overtops the curb
- Particularly useful for residential sites when major earth disturbing activities have ceased and final site stabilization (landscape installation) is pending.

INSTALLATION/USE PROCEDURE

- Excavate soil behind curb to a depth of 3-4 inches
- Extend the excavation 3-4 feet behind the curb to form a sediment trap
- Should not be installed on a slope that exceeds 5% as it may be ineffective and compromise the integrity of the curb
- Not suitable if underlying soil is expansive or collapsible, refer to the soils report.
- The sedimentation trap may be implemented behind a sidewalk instead of the curb
- The depth and width of the excavation may be increased if more sediment storage is necessary

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Inspect at least once every seven calendar days, or once every 14 calendar days and within 24 hours of the occurrence of a storm event of 0.5 inches or greater.
- Remove accumulated sediment when it reaches ½ height of original excavation.

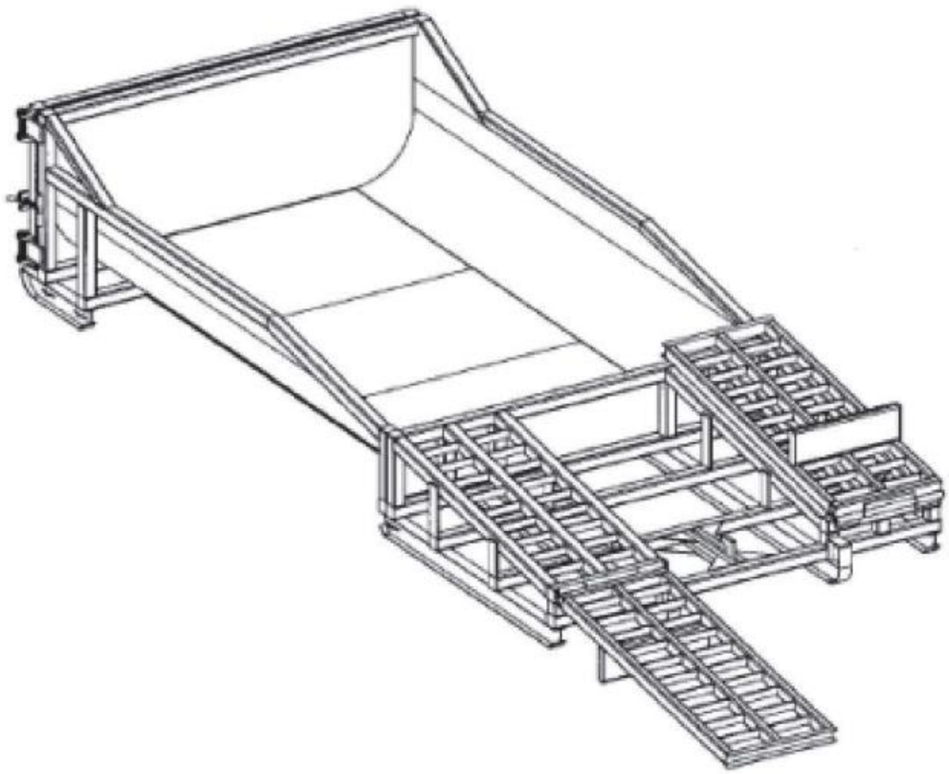
PERFORMANCE

- Sediment, or sediment laden water overtopping the curb, leaving the site, and entering the roadway constitutes BMP failure and must be corrected immediately.

REFERENCE

- CGP 2.2.3
- CPP 2.1.2

BMP 4- Concrete Washout Pan



*

*Picture for concept only, attach detail for chosen site specific wash out pan

APPLICATION

Concrete waste management is necessary on construction sites when:

- Concrete, grout, or mortar is used as a construction material.
- Concrete truck drums, chutes, and hoses, or other concrete equipment (e.g. hand tools, screeds, shovels, rakes, floats, trowels, and wheelbarrows) are washed on-site and it is not possible to dispose of all concrete wastewater and washout off-site (ready mix plant, etc.).
- Grout or mortar mixing stations are used.

INSTALLATION/USE PROCEDURES

- Locate pans next to track-out or parking pad or provide its own anti-track-out system and area for driver chassis washing. Attach illustration with dimensions. Reference other track-out BMPs as needed to manage site conditions.
- Install a sign at each washout location and identify on the SWPPP BMP map.
- Locate washout facilities a minimum of 50 feet from sensitive areas such as storm drains, open ditches, water bodies, wetlands, or where an infiltration feature will be installed. Protect downstream inlets.

- When the minimum distance from sensitive areas is not practicable, provide secondary containment and attach containment system specifications to this BMP.
- Empty excess concrete onto the ground near the pour site until only liquid cement remains on tools and equipment.
- Wash cement off of the chute, pump equipment, and tools directly into the washout pan.
- Ensure concrete truck operators and concrete transport/disposal service providers have the necessary support to protect water quality.
- The operator is expected to modify the concrete waste management system, location and capacity when necessary as site conditions and operations warrant.
- The operator shall oversee and enforce concrete waste management procedures.
- Educate employees, concrete suppliers, and subcontractors of these concrete waste management requirements. Discuss the concrete management techniques with concrete suppliers before any deliveries are made.
- Incorporate requirements for concrete waste management into concrete supplier and subcontractor agreements.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Washouts must be maintained to provide adequate holding capacity with one foot of freeboard.
- Washout pan must be cleaned, or additional pans provided and ready for use once the concrete washout pan is 70% full.
- Maintenance includes removal and disposal of hardened concrete and excess liquid or slurry. Excess liquid and slurry shall be pumped or evaporated prior to removal of solids.
    - Attach method of liquid disposal including licensed dumping location.
- Dispose of all materials in conformance with applicable federal, state, and local regulations.
    - Do not discharge liquid or slurry to waterways, storm drains or directly onto ground.
- Inspect washout pans at least weekly, and before and after each concrete operation. During extended wet weather conditions, ensure track out is not occurring.
    - Check overall condition and performance.
    - Check remaining capacity (% full)
    - If using prefabricated pan containers, check for leaks.
- Damaged or leaking washout facilities shall be addressed immediately.

PERFORMANCE

- Pans must be water-tight with sufficient volume plus 1 foot freeboard to meet concrete washout needs in between maintenance/service intervals. Attach concrete waste volume calculations and identify the number washout pans required.
- The performance expected of a wash out pan is to contain all pollutants associated with washout of concrete, slurry, mortar, and other products with no discharge at anytime during operations.

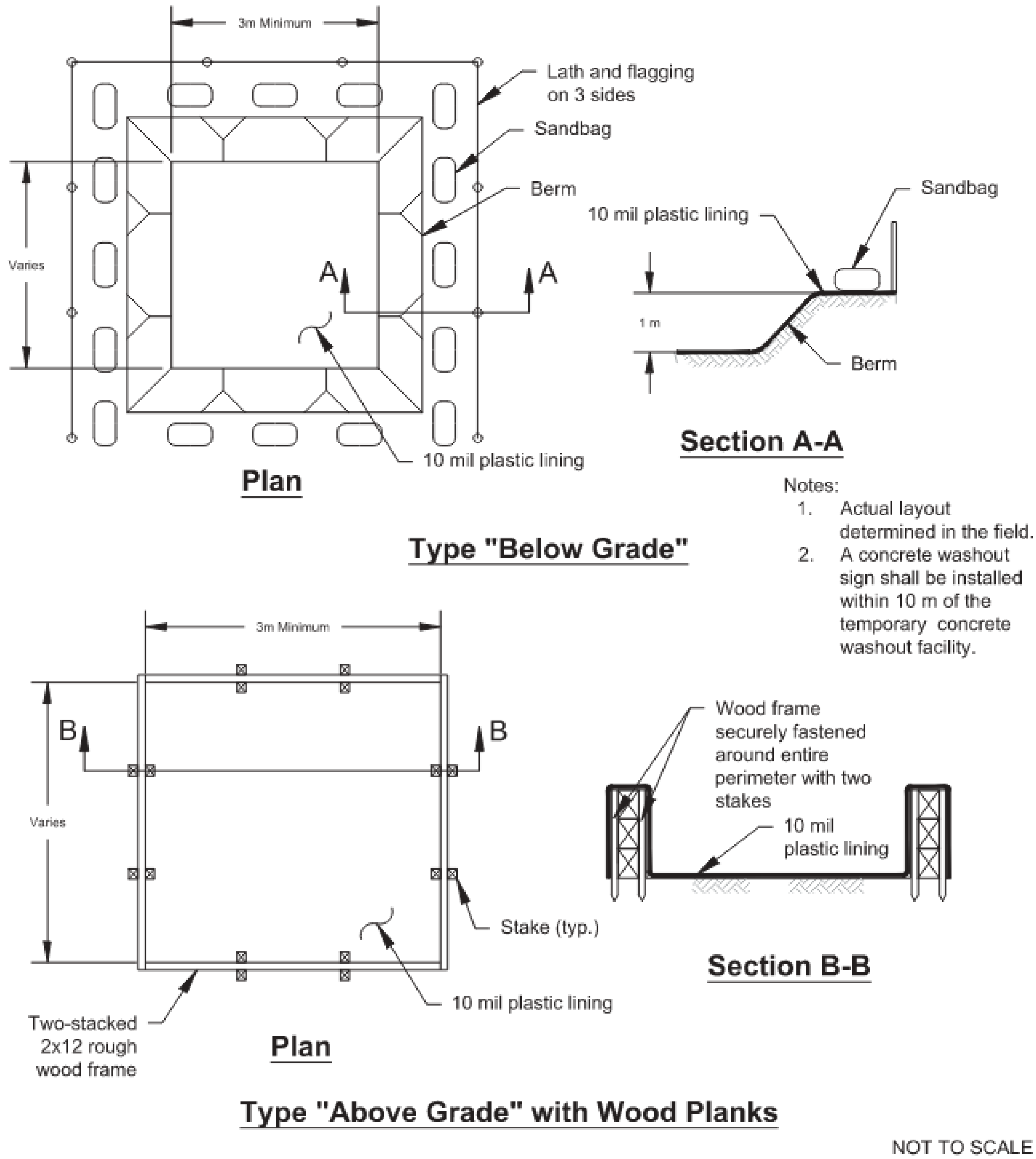
It is considered a concrete waste management failure when any of the following occur:

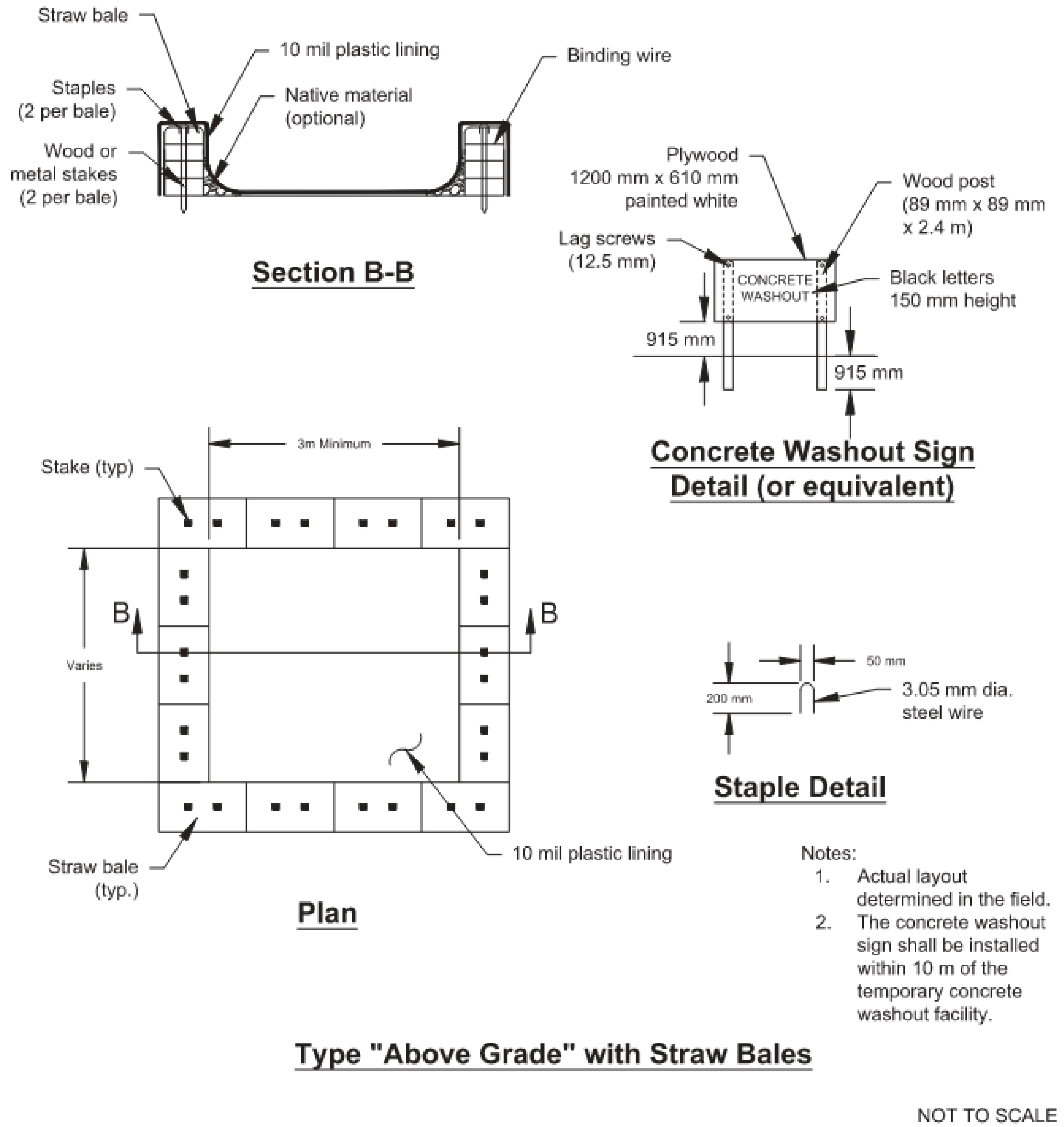
- There are leaks, overflows, or spills of concrete waste. The discharge of concrete washout waters is classified as a "Prohibited Discharge"
- Track-out associated with the concrete washout BMP operation.

REFERENCE

- CGP 2.3.4
- CPP 2.9.1

BMP 5- Concrete Washout Ground Fixed Systems



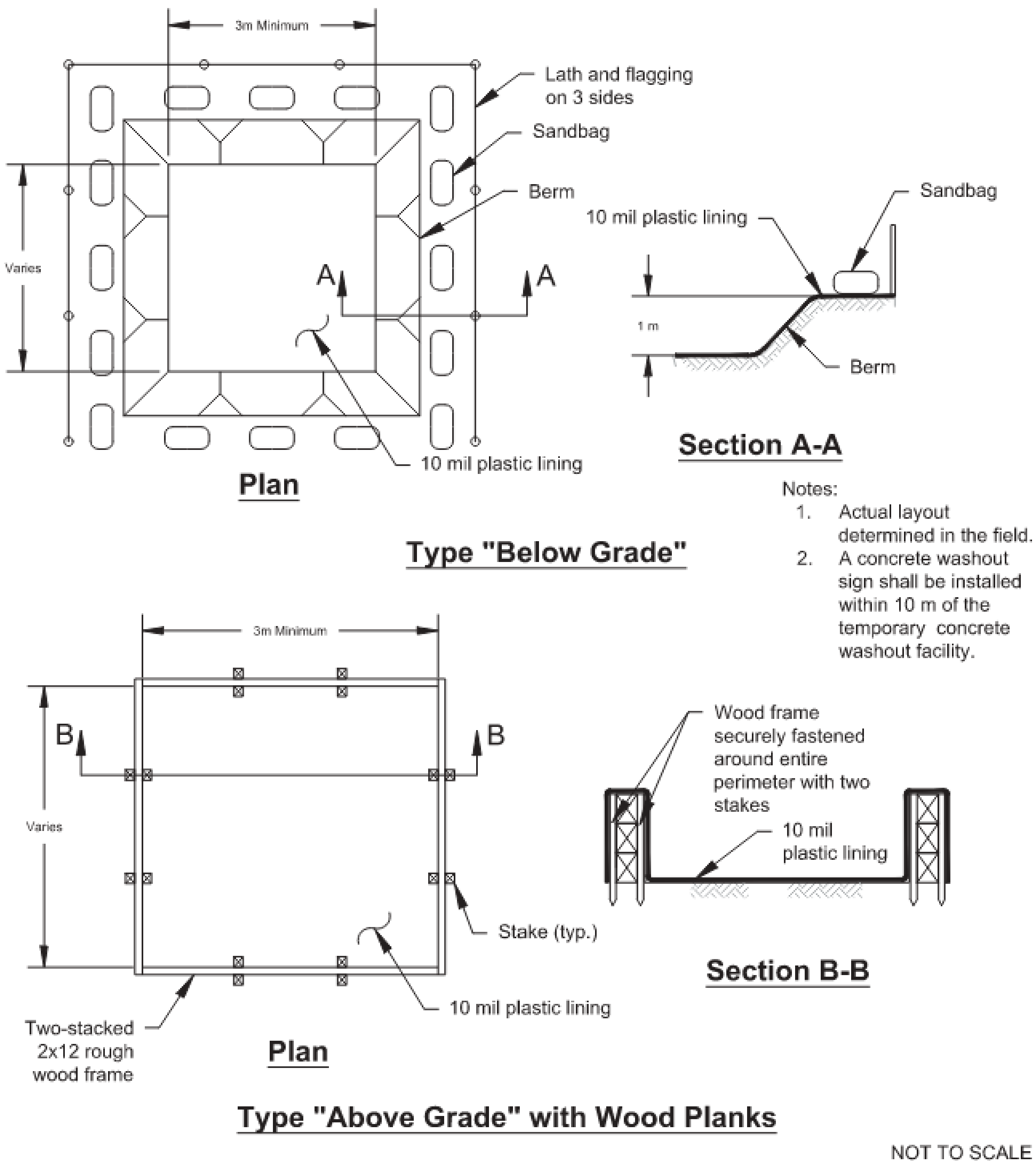

Straw bale
10 mil plastic lining
Binding wire
Staples
(2 per bale)
Native material
(optional)
Wood or
metal stakes
(2 per bale)
Section B-B
Plywood
1200 mm x 610 mm
painted white
Wood post
(89 mm x 89 mm
x 2.4 m)
Lag screws
(12.5 mm)
CONCRETE
WASHOUT
Black letters
150 mm height
915 mm
915 mm
Concrete Washout Sign
Detail (or equivalent)
3m Minimum
Stake (typ)
B
B
Varies
50 mm
200 mm
3.05 mm dia.
steel wire
Staple Detail
Straw bale
(typ.)
10 mil plastic lining
Plan
Notes:
1. Actual layout determined in the field.
2. The concrete washout sign shall be installed within 10 m of the temporary concrete washout facility.
Type "Above Grade" with Straw Bales
NOT TO SCALE

APPLICATION

Concrete waste management is necessary on construction sites when:

- Concrete, grout, or mortar is used as a construction material.
- Concrete truck drums, chutes, and hoses, or other concrete equipment are washed on-site and it is not possible to dispose of all concrete wastewater and washout off-site (ready mix plant, etc.).
- Grout or mortar mixing stations are used.

INSTALLATION/USE PROCEDURES



- The washout facility shall be watertight and impermeable.
- The washout facility may be a self-installed structure or a pre-fabricated structure
- For self-installed washout structures, the lining material shall be a minimum of 10-mil polyethylene sheeting and must be free of holes, tears, or other defects that compromise the impermeability of the material. Liner materials shall be installed in accordance with manufacturer's recommendations.
    - No seams in the plastic are allowed at the bottom of the washout. The soil base shall be prepared free of rocks or other debris that may cause tears or holes in the plastic lining material.
- Washout facilities shall be constructed and maintained with sufficient quantity and volume to contain all liquid and concrete waste generated by washout operations.
- On large sites with extensive concrete work, multiple washouts may be needed to provide adequate capacity.
- Locate pans next to track-out or parking pad or provide its own anti-track-out system and area for driver chassis washing. Attach illustration with dimensions. Reference other track-out BMPs as needed to manage site conditions.
- A sign shall be installed at each washout location.
- Install the washout at the location specified in the SWPPP.
- Locate washout facilities a minimum of 50 feet from sensitive areas such as storm drains, open ditches, water bodies, wetlands, or where an infiltration feature will be installed. Protect downstream inlets.
- When the minimum distance from sensitive areas is not practicable, provide secondary containment and attach containment system specifications to this BMP.
- Keep the washout areas away from other construction traffic and access areas to reduce the likelihood of accidental damage, spills, or tracking.
- Inspect and verify that concrete washout areas are in place prior to the commencement of concrete work.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- When materials are removed from ground fixed concrete washout systems, build a new structure; or, if the previous structure is still intact, inspect for signs of weakening or damage, and make any necessary repairs. Re-line the structure with new 10-mil polyethylene sheeting after each cleaning.
- Washouts must be maintained to provide adequate holding capacity with one foot of freeboard.
- Once the concrete washout system is 70% full, it is time to remove the existing waste material to allow further use or provide an additional washout facility.
- Maintenance includes removal and disposal of hardened concrete and excess liquid or slurry. Excess liquid and slurry shall be pumped or evaporated prior to removal of solids.

- Attach method of liquid disposal including licensed dumping location.
- Dispose of all materials in conformance with applicable federal, state, and local regulations.
    - Do not discharge liquid or slurry to waterways, storm drains or directly onto ground.
- Inspect ground fixed concrete washout systems at least weekly, and before and after each concrete operation. During extended wet weather conditions, ensure track out is not occurring.
    - Check overall condition and performance.
    - Check remaining capacity (% full)
    - Check for leaks
- Damaged or leaking washout facilities shall be addressed immediately.
- When concrete washout areas are no longer required for the work, the hardened concrete and containment system shall be removed and disposed of at a licensed waste facility. Attach information of disposal facility. Where concrete is recycled attach recycling facility information.
- Holes, depressions, or other ground disturbances caused by the removal of concrete washout areas shall be backfilled, repaired, and stabilized to prevent erosion.

PERFORMANCE

- The performance expected of a wash out pan is to contain all pollutants associated with washout of concrete, slurry, mortar, and other products with no discharge at any time during operations.

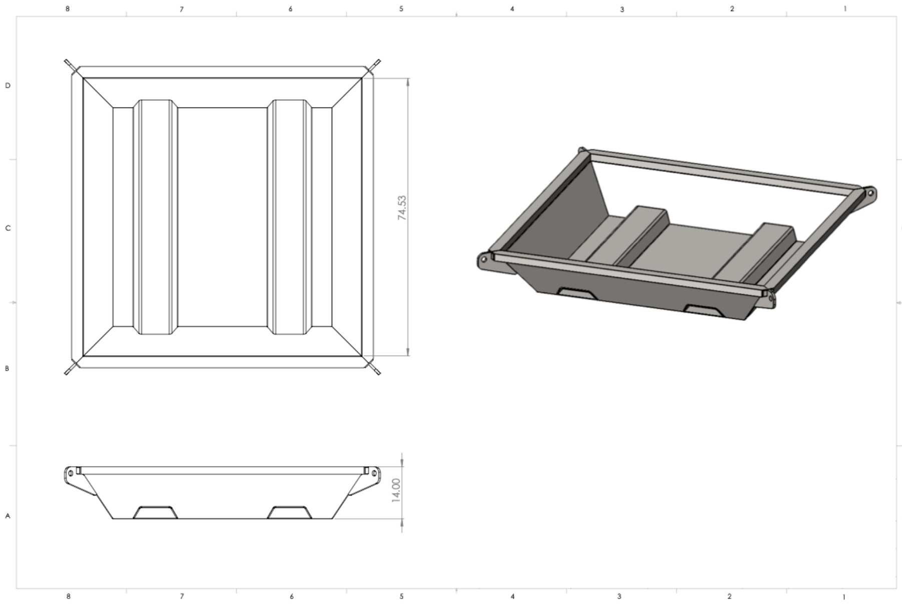
It is considered a concrete waste management failure when any of the following occur:

- There are rips, tears, or defects in the containment system
- Seepage overflows are observed or waste is outside of the containment system
- Track-out associated with the concrete washout BMP operation.

REFERENCE

- CGP 2.3.4,
- CPP 2.4.5, 2.9.1

BMP 6- Small Concrete Management Operations



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*Picture for concept purpose only

APPLICATION

- Use for small pours only. Usually for single lot residential homes or other minor projects where the washout volume is small and using a standard proprietary concrete washout pan system is not feasible.

INSTALLATION/USE PROCEDURES

- Small metal pan, plastic pools or equal portable watertight disposable container that can contain caustic materials. Attach dimensions of containers.
- Calculate concrete waste volume required. Attach calculations and identify the number of containment systems needed. Simply repeat this BMP for each day's concrete operation. Provide one additional container for redundancy.
- Maximize the capacity of the small containment system:
  - Empty excess concrete onto the ground near the pour site.
  - Wash cement off of the chute, pump equipment, and tools directly into the washout container.
- Place containers on a flat surface, near the track-out where there is enough room to wash the chassis and remove mud from the tires. Locate on the site BMP map.
- Containers are not allowed in roadway right of ways.
- Do not haul containers away until the waste concrete is set and all water has evaporated.
- Ensure the workforce is informed how to use your concrete management BMP.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.

- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Cover the containment system when not in use if a rain event is anticipated.
- Individual containers should no longer be used for washout once the volume capacity has reached 70% full. Utilize an additional container.
- This is a one time disposable BMP, typical maintenance is not necessary. Any exposed concrete washing and disposal operations are considered a BMP failure because the operation was not adequately anticipated and implemented.
- When the daily concrete management operation is completed simply repeat this BMP.

PERFORMANCE

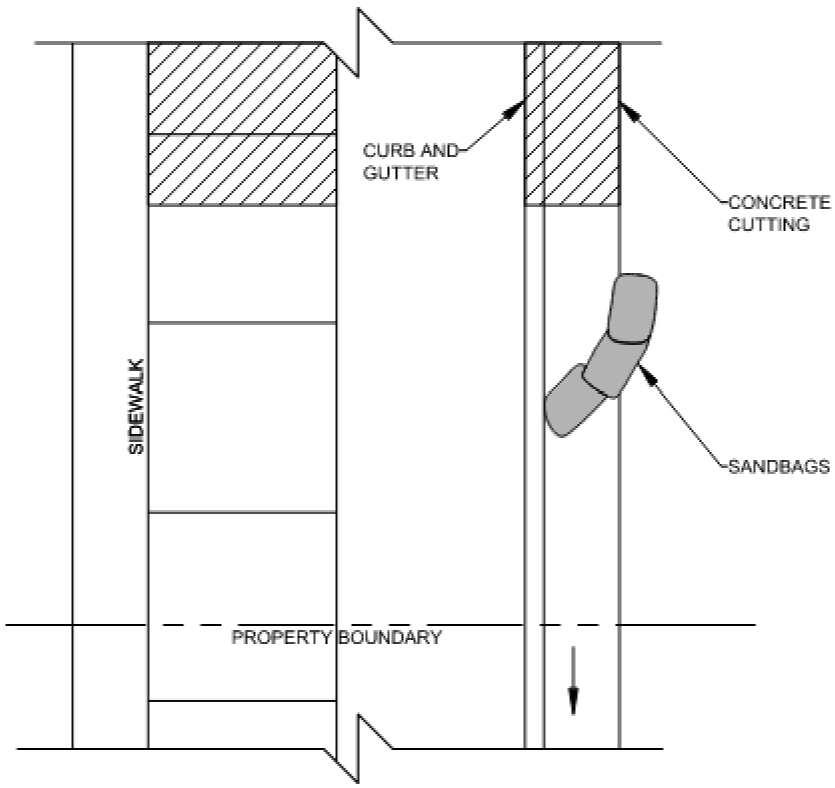
It is considered a concrete waste management failure when any of the following occur:

- Washout container overflows.
- Containers are hauled away prior to concrete set up and when liquid was not completely evaporated.
- When track-out results from washout container inadequate placement.
- When supply truck chassis are being washed outside of the containment system.

REFERENCE:

- CGP 2.3.4
- CPP 2.4.5, 2.9.

BMP 7- Pavement Saw Cutting-Wet



APPLICATION

- Use Pavement Saw Cutting-Wet BMP when cutting pavement with wet saw, especially in curb and gutter applications.
- Appropriate for use when dry cutting is not allowed or dust control is desired.

INSTALLATION/USE PROCEDURES

- Install 6" min diameter sand or gravel bags in a manner to contain slurry from moving downslope from the cutting operation. Double up bags as necessary.
- Install enough bags anticipating the volume of cut slurry.
- Schedule cutting during dry weather periods.
- Remove slurry at the end of day or prior to rain events whichever comes first. When wet conditions exist, mix slurry with dirt or other absorbing material and remove immediately.
  - Dump waste in concrete washout containment system.
  - Dry the waste in a contained area and dispose of waste in regular waste management container.
- Sweep until no more waste can be picked up with a square nose shovel.
- Do not use water to rinse slurry from the cutting operation area, dry clean up methods only as described above.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- BMP is installed and removed with each cutting operation, no maintenance is necessary.

PERFORMANCE

- Utilizing water during saw cutting is a great way to capture dust from cutting operations so that dust does not travel out of the cutting operation area nor pollute the air.
- Additionally utilization of this BMP will prevent high density opacity for nearby drivers and operators.
- Performance criteria to judge application success would be that airborne dust does not occur and slurry is contained and disposed per BMP.

It is considered a BMP failure when any of the following occur:

- The dam created with sand or gravel bags overflows
- Cutting operations are not cleaned up by the end of day or prior to wet conditions.
- Any waste material is not disposed per BMP or otherwise can contaminate water resources

REFERENCE:

- CGP 2.3.4
- CPP 2.9.1

BMP 8- Pavement Saw Cutting-Dry

APPLICATION

- Use for pavement cutting on directly connected pavements or where cutting dust can be washed to drainage systems, especially in curb and gutter applications.

INSTALLATION/USE PROCEDURES

- Schedule cutting during dry weather periods.
- Remove cutting dust immediately following the cutting operation.
- Sweep until no more waste can be picked up with a square nose shovel.
- Dispose of cutting dust in a concrete waste container or regular waste management container.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- BMP is installed and removed with each cutting operation, no maintenance is necessary.

PERFORMANCE

- BMP application success would be that dust is contained to the cutting operation area and disposed per BMP.

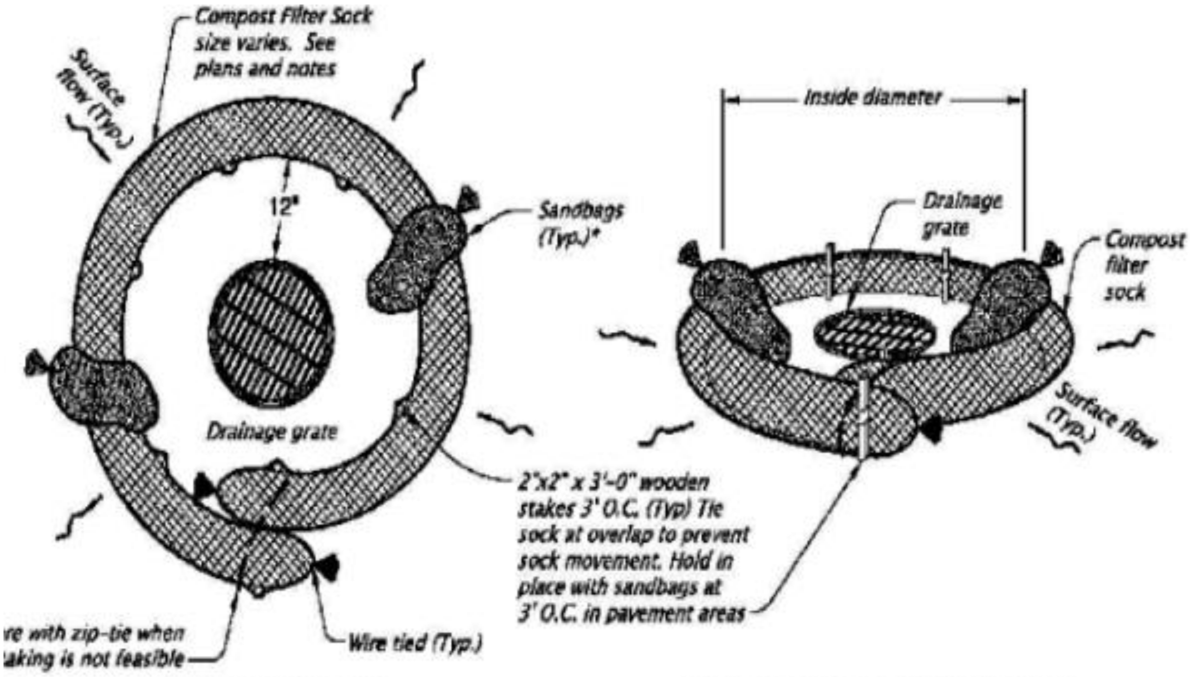
It is considered a BMP failure when any of the following occur:

- Cutting dust enters drainage systems
- Cutting operations are not cleaned up immediately following the cutting operation
- Any waste material is not disposed per BMP or otherwise can contaminate water resources

REFERENCE:

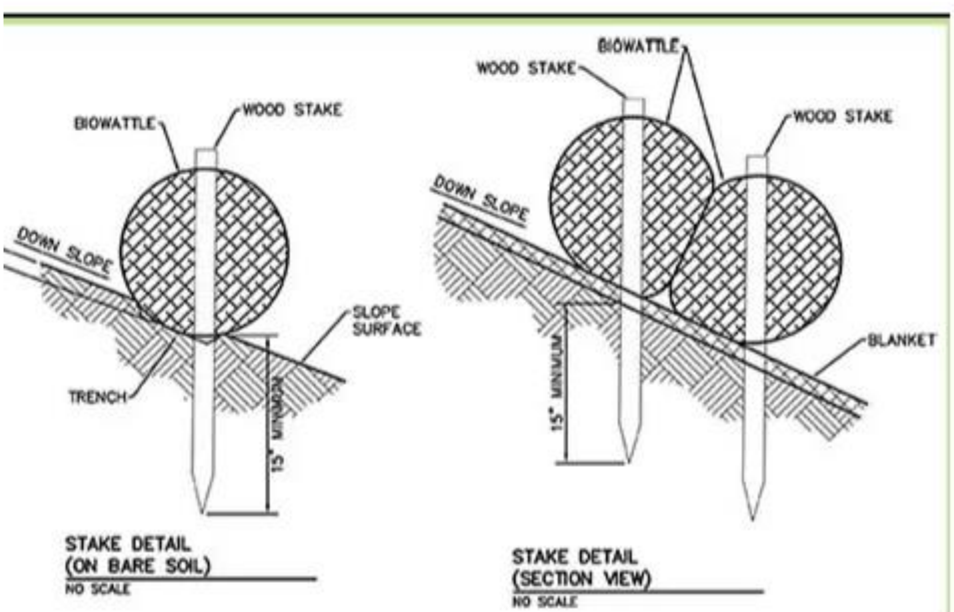
- CGP 2.3.4
- CPP 2.9.1

BMP 9- Area Drain Filtration



AREA DRAIN PLAN

AREA DRAIN PERSPECTIVE VIEW



APPLICATION

- Straw wattles or filter tubs are an open weave, mesh tube that is filled with a filter material (compost, wood chips, straw, coir, aspen fiber, or a mixture of materials) used to divert or filter stormwater.

- Straw wattles are a temporary BMP that can be used in the rough grading process of construction. Straw wattles and large filter sock can be used with or without storm drain inlet tops, but not ready for grading of roadway.
- Can be used for area drains until final stabilization is complete.

INSTALLATION/USE PROCEDURES

- On natural ground tubes shall be staked with 2 inch by 2 inch wooden stakes at a maximum spacing of 4 feet. Rebar or similar metal stakes may be used instead of wooden stakes. Filter tubes shall be embedded a minimum of two inches when placed on soil.
- Sand or rock bags shall be placed at a minimum, one foot from each end of the tube and at the middle of the tube.
- The end of tubes shall overlap a minimum of 18 inches when multiple tubes are connected to form a linear control along a contour or a perimeter.
- Straw wattles should wrap around the entirety of the storm drain to prevent sediment and other pollutants from entering the storm drain.
- Follow manufacturer's recommendations for staking or other methods of approved securement when used on pavement.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Check straw wattles material to make sure it has not become clogged with sediment or debris. Clogged filter tubes usually lead to standing water behind the filter tube after a rain event. Sediment shall be removed from behind the filter tube before it reaches half the height of the exposed portion of the tube.
- The straw wattles should be checked to ensure it is in continuous contact with the soil at the bottom of the embedment trench. Closely check for rill erosion that may develop under the filter tubes. Eroded spots must be repaired and monitored to prevent reoccurrence. If erosion under the tube continues, additional controls are needed.
- Any straw wattles destroyed by construction operations or UV degradation will need to be removed and replaced.

PERFORMANCE

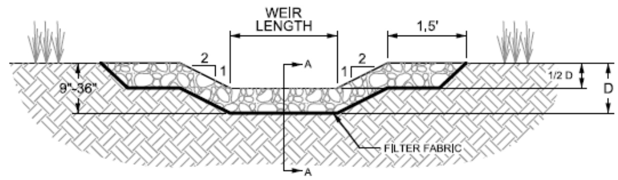
It is considered a BMP failure when any of the following occur:

- Damaged or not installed to the BMPs details or attached manufacturer illustrations
- Sediment depth around wattle exceeds maintenance tolerances.
- Opening or gaps in straw wattles.

REFERENCE

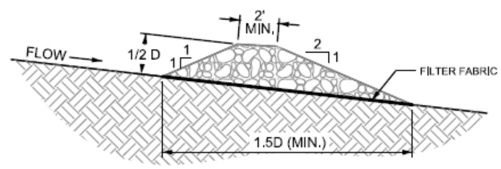
- CGP 2.2.10

BMP 10- Rock Check Dam for Channels



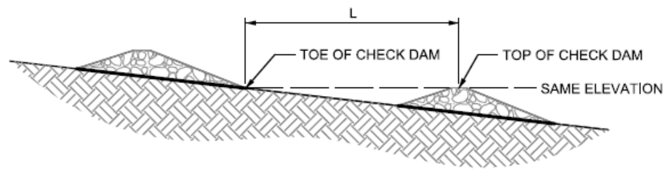
ROCK CHECK DAM VIEW LOOKING UPSTREAM

N.T.S.



CROSS SECTION A-A

N.T.S.



APPLICATION

- Check dams are used in swales and drainage ditches (including those along linear projects such as roadways).
- They can also be used in short swales down a steep slope to reduce velocities.
- Check dams shall not be used in live stream channels.
- Check dams should be installed before the contributing drainage area is disturbed, so as to mitigate the effects on the swale from the increase in runoff.
- If the swale itself is graded as part of the construction activities, check dams are installed immediately upon completion of grading to control velocities in the swale until stabilization is completed.

INSTALLATION/USE PROCEDURES

- Install rock check dam per illustrated detail. D=24” or less and install the center of the dam about 6” lower than the sides.
- Check dams should be used in conjunction with other sediment reduction techniques prior to releasing flow offsite.
- Use 4” or greater rock diameter and non-woven geotextile fabric under check dams of 12 inches in height or greater. When high flow rates and velocities are anticipated engineering is required.
- Dam height should be between 9 and 36 inches and less than one-third the depth of the channel
- Dams should be spaced such that the top of the downstream dam is at the same elevation as the toe of the upstream dam. On channel grades flatter than 0.4 percent, check dams should be placed at a distance that allows pools to form between each check dam.
- The top of the side of the check dam shall be a minimum of 12 inches higher than the middle of the dam. In addition, the side of the dams shall be embedded a minimum of 18 inches into the

side of the drainage ditch, swale or channel to minimize the potential for flows to erode around the side of the dam.

- Use geotextile fabric (of appropriate tensile strength, puncture rating and apparent opening size) under check dams of 12 inches in height or greater.
- Loose soil, wood chips, compost, and other floatable materials that are transportable during runoff should not be used to construct a check dam.

ALTERNATIVE DESIGN

- **Rock Check Dams:**
  - Stone shall be well graded with stone size ranging from 3 to 6 inches in diameter for a check dam height of 24 inches or less. The stone size range for check dams greater than 24 inches is 4 to 8 inches in diameter.
- **Rock Bag Check Dams:**
  - Rock bag check dams should have a minimum top width of 16 inches.
  - Minimum rock bag dam height of 12 inches would consist of one row of bags stacked on top of two rows of bag. The dam shall always be one more row wide than it is high, stacked pyramid fashion.
  - Bags should be filled with pea gravel, filter stone, or aggregate that is clean and free of deleterious material.
  - Sand bags shall not be used for check dams, due to their propensity to break and release sand that is transported by the concentrated flow in the drainage swale or ditch.
  - Bag material shall be polypropylene, polyethylene, polyamide or cotton burlap woven fabric, minimum unit weight 4-ounces-per-square-yard, Mullen burst strength exceeding 300-psi as determined by ASTM D3786, Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method, and ultraviolet stability exceeding 70 percent.
  - PVC pipes may be installed through the dam to allow for controlled flow through the dam. Pipe should be schedule 40 or heavier polyvinyl chloride (PVC) having a nominal internal diameter of 2 inches.
- **Sack Gabion Check Dams:**
  - Sack gabion check dams may be used in channels with a contributing drainage area of 5 acres or less.
  - Sack gabions shall be wrapped in galvanized steel, woven wire mesh. The wire shall be 20 gauge with 1 inch diameter, hexagonal openings.
  - Wire mesh shall be one piece, wrapped around the rock, and secured to itself on the downstream side using wire ties or hog rings.
  - Sack gabions shall be staked with ¾ inch rebar at a maximum spacing of three feet. Each wire sack shall have a minimum of two stakes.
  - Stone shall be well graded with a minimum size range from 3 to 6 inches in diameter.
- **Organic Filter Tube Check Dams:**
  - Organic filter tubes may be used as check dams in channels with a contributing drainage area of 5 acres or less.
  - Organic filter tubes shall be a minimum of 12 inches in diameter.
  - Filter material used within tubes to construct check dams shall be limited to coir, straw, aspen fiber and other organic material with high cellulose content. The material should be slow to decay or leach nutrients in standing water.

- Staking of filter tubes shall be at a maximum of 4 foot spacing and shall alternate through the tube and on the downstream face of the tube.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Inspect the check dam system each report period and after storm events.
- Remove silt when sediment accumulation reaches approximately 1/3 the height of the dam.
- Inspect for erosion beneath and around the check dam (particularly where the edge of the dam meets the side of the channel) and restore as needed each report period.
- If erosion continues to be a problem, modifications to the check dam or additional controls must be engineered.

PERFORMANCE

- Check dam systems are intended to perform as engineered up to .25” of rain fall
- Rock check dams are performing as intended if the drainage channel they are protecting does not develop deep erosive gulleys between dams and the dam itself is not being undercut by erosion or eroded to either side of the dam.
- Due to the minimal sediment capture capability of check dams, good performance will include accumulations of sediment on the upstream side of dams between maintenance intervals.

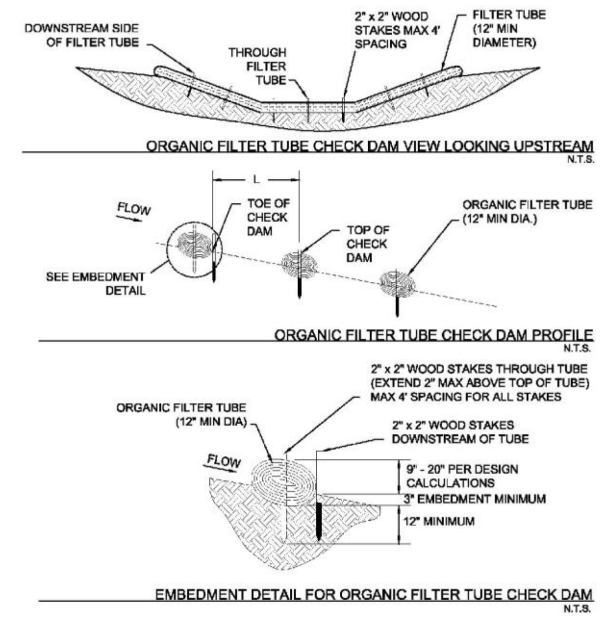
It is considered a BMP failure when any of the following occur:

- System not installed per illustrated detail, system not maintained, or system damaged by construction operations.
- Erosion damage resulting in variance from detail dimensions

REFERENCE

- U-CGP 2.2.11 – “Minimize erosion of constructed or natural site drainage feature channels and their embankments, outlets, adjacent streambanks, slopes, and downstream waters. Use erosion controls and velocity dissipation devices within and along the length of any constructed or natural site drainage feature channel and at any outlet to slow down runoff and minimize erosion.”

BMP 11- Straw Wattle Check Dam for Channels



APPLICATION

- Check dams are used in swales and drainage ditches (including those along linear projects such as roadways).
- They can also be used in short swales down a steep slope to reduce velocities.
- Check dams shall not be used in live stream channels.
- Check dams should be installed before the contributing drainage area is disturbed, so as to mitigate the effects on the swale from the increase in runoff.
- If the swale itself is graded as part of the construction activities, check dams are installed immediately upon completion of grading to control velocities in the swale until stabilization is completed.

INSTALLATION/USE PROCEDURE

- Dam height should be between 9 and 36 inches and less than one-third the depth of the channel
- Dams should be spaced such that the top of the downstream dam is at the same elevation as the toe of the upstream dam. On channel grades flatter than 0.4 percent, check dams should be placed at a distance that allows small pools to form between each check dam.
- The top of the side of the check dam shall be a minimum of 12 inches higher than the middle of the dam. In addition, the side of the dams shall be embedded a minimum of 18 inches into the side of the drainage ditch, swale or channel to minimize the potential for flows to erode around the side of the dam.
- Check dams should be used in conjunction with other sediment reduction techniques prior to releasing flow offsite.
- Use geotextile fabric (of appropriate tensile strength, puncture rating and apparent opening size) under check dams of 12 inches in height or greater.
- Loose soil, wood chips, compost, and other floatable materials that are transportable during runoff should not be used to construct a check dam.

ALTERNATIVE DESIGN

- See “Rock Check Dam for Channels”

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Inspect the check dam system each report period and after storm events.
- Remove silt when sediment accumulation reaches approximately 1/3 the height of the dam.
- Inspect for erosion beneath and around check dam (particularly where edge of the dam meets the side of the channel) and restore as needed each report period.
- If erosion continues to be a problem, modifications to the check dam or additional controls must be engineered.

PERFORMANCE

- Check dam systems are intended to perform as engineered up to .25” of rain fall
- Check dams are performing as intended if the drainage channel they are protecting does not develop deep erosive gulleys between dams and the dam itself is not being undercut by erosion or eroded to either side of the dam.
- Due to the minimal sediment capture capability of check dams, good performance will include accumulations of sediment on the upstream side of dams between maintenance intervals.

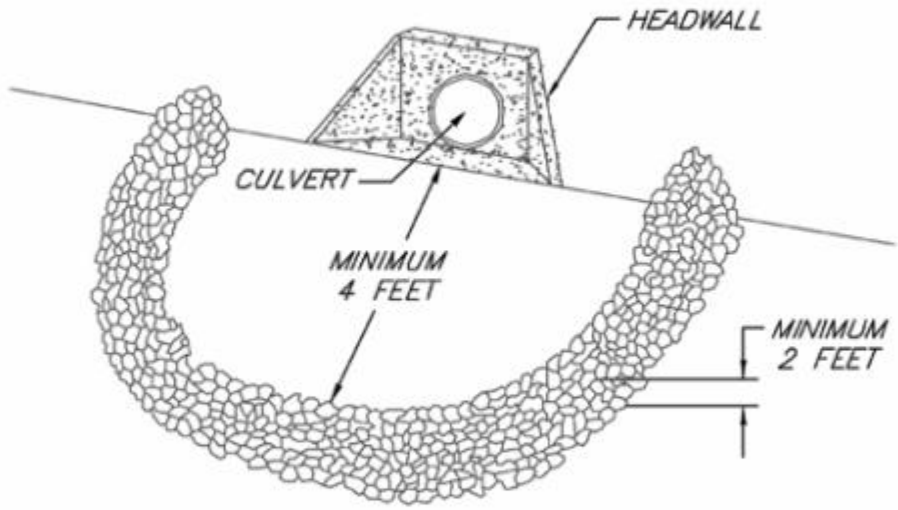
It is considered a BMP failure when any of the following occur:

- System not installed per illustrated detail, system not maintained, or system damaged by construction operations.
- Erosion damage resulting in variance from detail dimensions.

REFERENCE

- U-CGP 2.2.11 – “Minimize erosion of constructed or natural site drainage feature channels and their embankments, outlets, adjacent streambanks, slopes, and downstream waters. Use erosion controls and velocity dissipation devices within and along the length of any constructed or natural site drainage feature channel and at any outlet to slow down runoff and minimize erosion.”

BMP 12- Culvert Sediment Barrier



APPLICATION

A culvert inlet sediment barrier is a temporary rock barrier at a culvert inlet. The purpose of the barrier is to reduce the amount of sediment that enters the culvert by creating a small ponding area for the sediment to settle out.

- For use on a site with open culverts within the project area that are exposed to runoff.

INSTALLATION/USE PROCEDURES

- A geotextile should be placed between the stone barrier and the natural ground.
- Surround all sides of the culvert with Class II Channel Lining at a minimum of 4 feet from the culvert.
- The barrier must be designed to ensure that no bypasses occur up to 0.5” of rainfall
- Control the location of the sediment barrier spillway by placing an overflow notch at a selected location in the middle portion of the barrier.
    - The notch should be at least six inches lower than the rest of the barrier.
    - The downgradient portion of the overflow notch should be protected from erosion caused by potential spillover with Class II Channel Lining.
- The upstream face of the barrier should consist of smaller stone to decrease the flow rate through the stone.
- If a culvert inlet sediment barrier is intended to be used for long-term storm water management, design and installation must be approved by an accredited engineer.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.

- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Inspect the condition of the sediment barrier weekly and after every rainfall event greater than one-half inch. Erosion and scouring would necessitate barrier reinforcement.
- Remove sediment and/or debris when depth reaches one-half the height of the barrier.

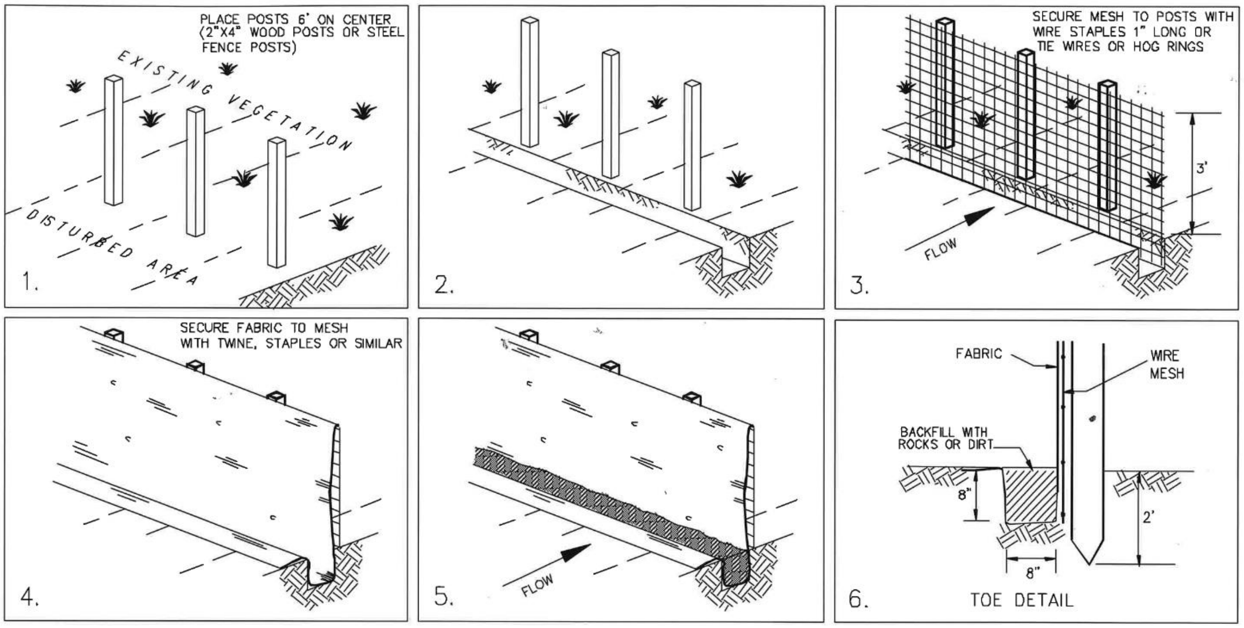
PERFORMANCE

- A culvert inlet sediment barrier is expected to utilize sediment deposition to the maximum extent possible before allowing runoff to enter the culvert.
- The overflow spillway should not compromise the capacity of the berm to slow the flow of the first half inch of rain

REFERENCE

- CGP 2.2.11
- CPP 2.3

BMP 13- Silt Fence



APPLICATION

A silt fence when properly installed and maintained can help mitigate the discharge of sediment in storm water runoff. It can be used in multiple applications such as:

- Downstream project boundaries
- Downstream side(s) of erodible stockpiled materials.
- Minor channels or slopes when calculations show runoff volumes will not exceed the anticipated volume capacity and strength of the system.

A silt fence is not intended for:

- Controlling large volumes of concentrated runoff. Use an alternative BMP
- Border control or limits of construction site only (i.e. not intended to fulfill the same purpose as construction fencing)

INSTALLATION/PROCEDURE/CALCULATIONS

- Install silt fence per detail dimensions, description and materials or -
- For proprietary systems attach all design, performance, installation, maintenance requirements and the proprietary BMP detail documents. All requirements of this BMP remain except for any differences necessary to achieve design performance.
- Install silt fence downstream of all necessary exposed boundaries as shown by the grading sheet, demolition map, phasing map, and or SWPPP BMP map, etc. Attach topographic maps for all construction phases to this BMP or reference where these maps are found in the SWPPP.
- Install silt fence along contours of the slope to maximize effectiveness.
- Overlap each fence segment in a series by at least 6 inches to prevent gaps.
- The end of the silt fence must be installed in a "J-hook" to treat runoff effectively. Flare the ends uphill to provide storage capacity of storm water runoff
- Attach engineering calculations for sites with steep slopes, for large areas clear of vegetation and when runoff rates or when runoff volumes behind fences will feasibly cause failure for

storm events less than 2yr 24hr intensities and volumes. In this case, engineering calculations are required or as allowed by oversight authority.
- Ensure all workers are trained on proper installation, maintenance, and inspection of silt fences.

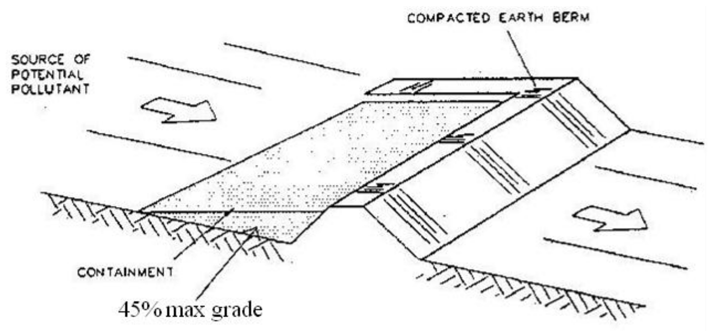
OPERATOR BMP MODIFICATION OR REPLACEMENT
- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT
- Inspect the silt fence prior to a forecasted rain event and during weekly inspections.
- Maintain or repair within the period given by the inspector following city and state code within the reporting period or prior to storm event.
- Inspect silt fence after storm events. Restore any fence damaged back to the installation requirements.
- Remove accumulated sediment when it reaches one-third fence height or as specified by proprietary system.

PERFORMANCE
- A silt fence allows water to pass trapping sediment behind. Runoff going around, under or over silt fence would indicate a silt fence system failure.
- A silt fence is expected to filter sediment for storm events less than 2yr 24hr storm events. Fence failures for events less than a 2yr 24hr storm feasibly means the silt fence was either designed, installed, was unmaintained, was damaged by construction operations or the silt fence was not the best BMP for the site exposure. When the area tributary to the fence results in runoff rates greater than silt fence design capability, provide conveyance swales and retention pond BMPs or as per other CGP options.

REFERENCE
- CGP 2.2.3, 2.2.5, 2.2.11, 2.2.12, 7.3.3

BMP 14- Earth Berm Barrier



APPLICATION

A temporary containment control constructed of compacted soil.

- Construct around waste and materials storage area.
- Construct around staging and maintenance areas.
- Construct around vehicle parking and servicing areas.

Not intended for erosion control.

INSTALLATION/USE PROCEDURES

- Construct an earthen berm downhill of the area to be controlled. The berm should surround fueling facilities and maintenance areas on three sides to provide containment.
- Berm needs to be a minimum of 1 foot tall by 1 foot wide and be compacted by earth moving equipment.
- The berm should be protected from heavy equipment traffic through signage or training

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Observe daily for any non-stormwater discharge.
- Look for runoff bypassing ends of berms eroding, or breaching.
- Repair or replace damaged areas of the berm and remove accumulated sediment.
- Recompact soil around the berm as necessary to minimize erosion rates.

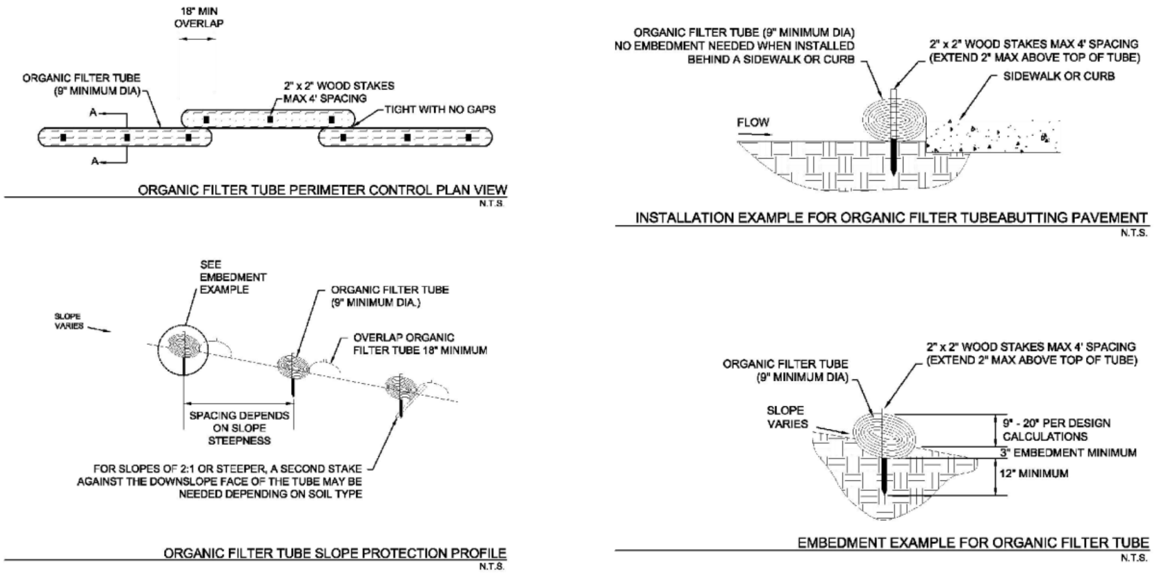
PERFORMANCE

- An earthen berm should be able to contain incidental spills in the area that it is installed while the spill control plan in the SWPPP is being put into effect.

REFERENCE

- CGP 2.2.11
- CPP 2.3

BMP 15- Filter Tubes on Slopes



APPLICATION

Filter tubes are also called fiber rolls, fiber logs, wattles, mulch socks, and/or coir rolls. The tubes can be filled with organic material (compost, wood chips, straw, coir, aspen fiber, or a mixture of materials) or geosynthetic material. Though filter tubes have many uses, this BMP focuses on slope management.

- If the tubes will be left onsite as part of the final stabilization plan (such as in Arid and Semi-Arid areas with exceptions to final stabilization timeline requirements) they must be constructed of 100 percent biodegradable jute, coir, sisal or similar natural fiber or 100 percent UV photodegradable plastic, polyester or geosynthetic material.
- Filter tubes can be used to treat sheet flow over a short distance and can be used on steep slopes as both sediment and erosion control.
- Filter tubes work by detaining flow and capturing sediment as a linear control along the contours of a slope, or as a perimeter control down-slope of a disturbed area (when appropriately sized).
- Filter tubes are most effective with coarse to silty soil types; additional controls may be needed to remove fine silts and clays suspended in stormwater.

INSTALLATION/USE PROCEDURES

- Filter tubes should be installed along the contour.
- Tubes shall be staked with 2 inch by 2 inch wooden stakes at a maximum spacing of 4 feet. Rebar or similar metal stakes may be used instead of wooden stakes.
- When placed on pavement, sand or rock bags shall be placed abutting the down-slope side of the tubes to prevent runoff from dislodging the tubes. At a minimum, bags shall be placed one foot from each end of the tube and at the middle of the tube.
- Filter tubes shall be embedded a minimum of three inches when placed on soil. Placement on rock shall be designed as placement on pavement.
- The end of tubes shall overlap a minimum of 18 inches when multiple tubes are connected to form a linear control along a contour or a perimeter.

- Loose mulch material shall be placed against the log on the upstream side to facilitate contact with the ground.
- The last 10 feet (or more) at the ends of a line of tubes shall be turned upslope to prevent bypass by stormwater. Additional turned-upslope lengths of tubes may be needed every 200 to 400 linear feet, depending on the traverse slope along the line of tubes.
- The most common sizes of tubes are 6 to 24 inches in diameter; however, tubes are available in sizes as small as 4 inches and up to 36 inches in diameter. The designer shall specify a diameter based on the site application. Tubes less than 8 inches in diameter when filled will require more frequent maintenance if used.
- When using manufactured tubes, the manufacturer's recommendations for diameter and spacing based on slope, flow velocities, and other site conditions shall be followed and documented in a site's SWPPP.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Organic filter tubes should be inspected regularly each inspection period.
- The filter tube should be checked to ensure that it is in continuous contact with the soil at the bottom of the embedment trench. Closely check for rill erosion that may develop under the filter tubes. Eroded spots must be repaired and monitored to prevent reoccurrence. If erosion under the tube continues, additional controls are needed.
- Staking shall be checked to ensure that the filter tubes are not moving due to stormwater runoff. Repair and re-stake slumping filter tubes. Tubes that are split, torn or unraveling shall be repaired or replaced.
- Check the filter tube material to make sure that it has not become clogged with sediment or debris. Clogged filter tubes usually lead to standing water behind the filter tube after the rain event. Sediment shall be removed from behind the filter tube before it reaches half the height of the exposed portion of the tube.

PERFORMANCE

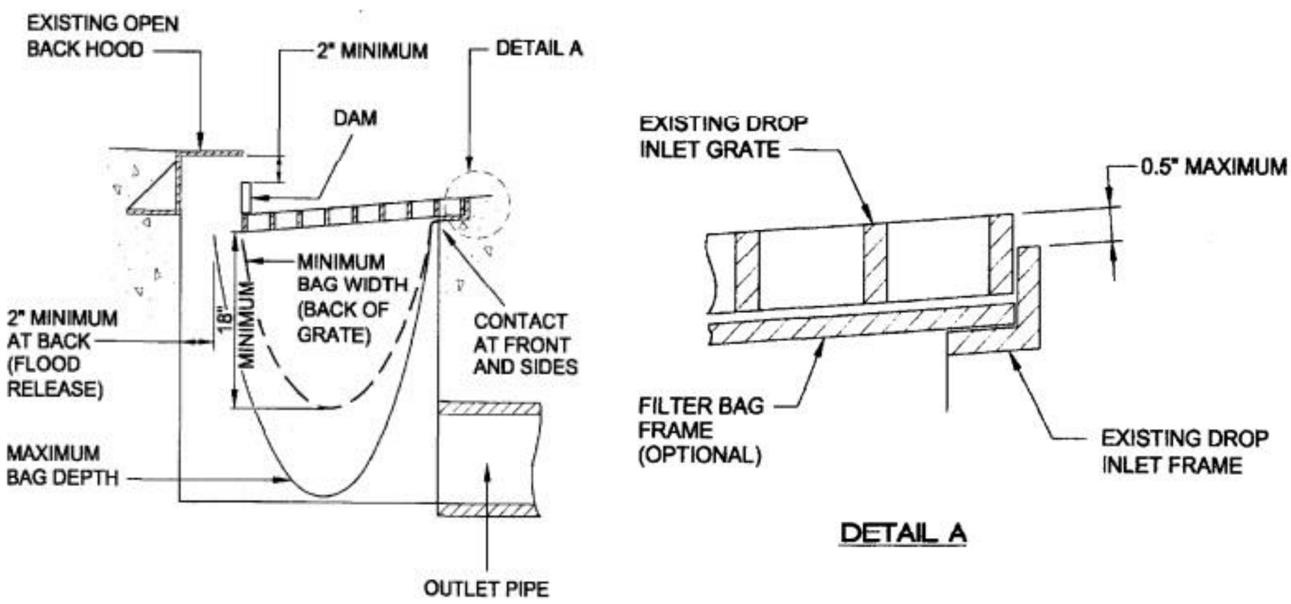
- Organic filter tubes are performing as intended if sheet flow of runoff is passing over or through the barrier and not simply around it, bypassing the control.
- Additionally, performance is achieved if the filter tube barrier is effectively minimizing the off-site discharge of sediment from the drainage area it is controlling and does not develop erosive rills/gullies between filter tubes and the tubes are not being undercut by erosion or eroded to either side of the barrier.
- Due to the relatively smaller sediment capture capability of these filter tubes, as compared to taller barriers, good performance will include accumulations of sediment on the upstream side of filter tubes until maintenance occurs, which will likely require more frequent maintenance.

REFERENCE

- CGP 2.2.3, 2.2.5, 2.2.11

- CPP 2.3

BMP 16- Drop Inlet Bag with Overflow



[Picture for concept purpose only]

APPLICATION

- Use drop inlet bag BMPs with overflow systems at roadway sag locations. Note, these BMP can be appropriate on collector roadways when inspections show success at preventing surface ponding. Note, the local municipality will need to evaluate the traffic risk on a case by case basis.
- Use drop inlet bag BMPs when other surface inlet BMPs like sand bags are less feasible due to high traffic in the area.

INSTALLATION/USE PROCEDURES

- Attach drop inlet bag proprietary manufacturer installation and maintenance detail literature to this BMP. Provide drop inlet bag system designed for inlet type needed, e.g. open face, not open face gutter, etc.
- Install the drop inlet bag system in accordance with the manufacturer literature.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Inspect and maintain if necessary every report period. Empty and dispose of debris accumulations when the bag capacity has reached 50% full or before the bag becomes unmanageable or ineffective.
- Inspect the unit prior to and after storm events. Large storm events will scour sediment from almost all roadway inlet BMPs, therefore regular maintenance is the best management practice.
- Remove and dispose of any sediment found inside the inlet box resulting from BMP failure or resulting during maintenance operations.
- Conduct any maintenance required by the drop inlet bag manufacturer.
- In collector roadways or other locations oversight authority requires, check during storm events and prevent hazardous driving conditions.

PERFORMANCE

- A drop inlet bag is expected to prevent debris and large sediment particles from entering a storm drain.
- Minor ponding should be expected, but the overflow would prevent excessive ponding
- A drop inlet bag should not allow the accumulated debris to fall into the structure it is protecting at anytime both during maintenance and removal. The design and installation specifications should support this ideal.

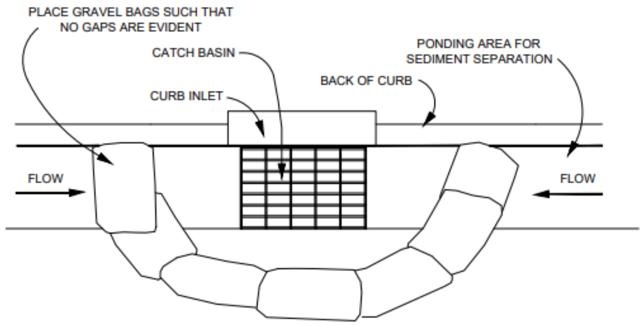
It is considered a BMP failure when any of the following occur:

- System not installed or maintained to installation and operation requirements
- System not installed and maintained to manufacturer requirements
- Sediment scour resulting from irregular maintenance.
- Sediment left in inlet following maintenance.
- Excessive ponding resulting from irregular maintenance or blocked overflow.

REFERENCE

- Construction General Storm Water Permit (CGP) 2.2.10
- Common Plan Permit (CPP) 2.1.3

BMP 17- Gravel Bag Curb Inlet Protection



PLAN VIEW

APPLICATION

- The purpose of placing gravel bags around an inlet or other runoff receiving area is to slow the flow of water to allow sediment deposition to be maximized before runoff enters the inlet or other receiving area.
- Ideal for areas near storm drains, curb inlets, and other drainage structures.
- Not intended for high-flow areas without additional support measures.
- Do not use on collector roadways and where the control could create safety concerns such as hydroplaning.

INSTALLATION/USE PROCEDURES

- Ensure the bags are properly positioned to maximize the area available for ponding.
- Use appropriate types of inlet protection based on site-specific conditions.
- Install inlet protection measures that remove sediment from discharges prior to entry into any storm drain inlet that carries storm water flow from your site to surface water of the state, provided you have authority to access the storm drain inlet.
- This BMP is designed for 1/4" (~2yr 10min intensity) rain storm events.
- Train SWPPP inspection and maintenance team

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Regularly inspect and maintain the system to ensure proper function.
- If repairs are needed, repair the system as soon as practicable.
- Inspect inlet protection before and after storm events or other large volume runoff events.

- Remove accumulated sediment and debris when deposits are ⅓ the height of the gravel bag barrier.
- Ensure a clear area around inlet protection devices to facilitate inspections and maintenance.
- Check during storm events and prevent hazardous surface water driving conditions.

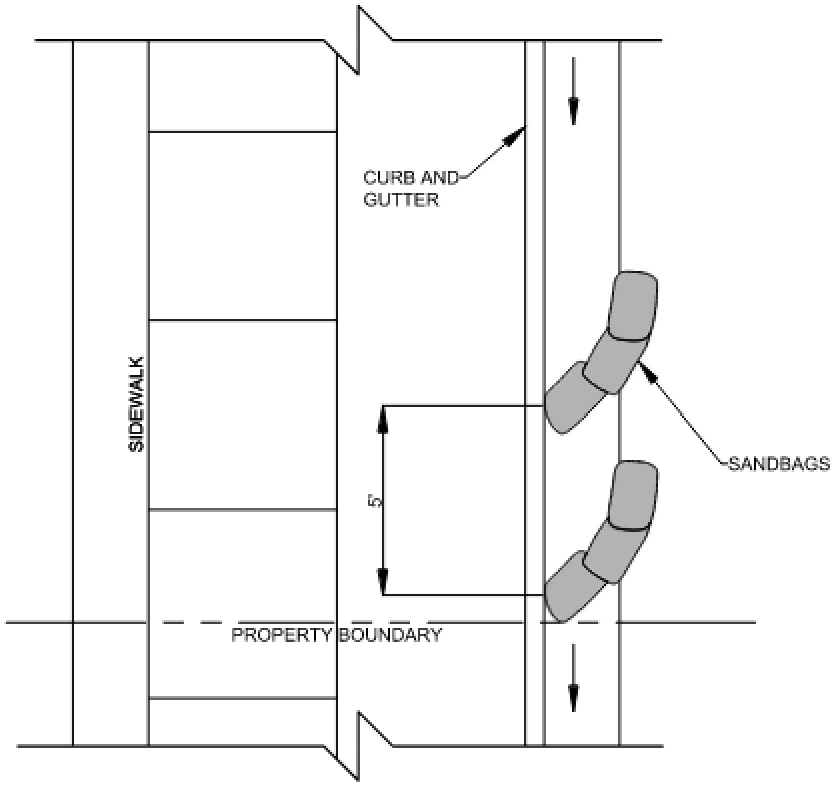
PERFORMANCE

- Inlet protection is considered effective if it mitigates target pollutants from entering the stormwater system.
- Inlet protection system resulting in spill over during an event less than 1/4”(~2yr 10min intensity) of rain is considered a failure.

REFERENCE

- CGP-2.2.10
- CPP- 2.1.3

BMP 19- Gutter Dam



APPLICATION

- This BMP allows sediment laden storm water to be filtered by the gutter dam minimizing sediment from reaching downstream inlets.
- This BMP allows for runoff by-pass during intense storm events but when adequately maintained can minimize sediment by-pass common with many inlet cover only BMPs. Inlet cover only BMPs should have secondary containment built in or coupled with downstream BMPs to contain sediment and debris by-pass.
- Use Gutter Dam BMP when the project is expected to contain its impact from other operators downstream BMPs. This is a common concern between operators when multiple independent builders are building homes in the same subdivision.
- Warning: This BMP is easily damaged by vehicles that park along the curb and gutter, and by snow removal operations.

INSTALLATION/USE PROCEDURES

- Install 6" min dia sand or gravel bags. Double up bags as necessary.
- Install upstream of inlets.
- This gutter dam system is working when the first dam is holding more sediment than the downstream dams. When the sediment collection is about the same then something is wrong.
- This system can scour out easily and needs regular maintenance to be effective.
- Inform subcontractors and suppliers of the gutter dams placement to roadside parking from damaging the sand or gravel bags.
- Train SWPPP inspection and maintenance team

- This BMP is designed for 1/4” (~2yr 10min intensity) rain storm events.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Anticipate significant storm events, repair damage and remove sediment deposits prior to storm events that could scour sediment deposits from the gutter dam.
- Inspect, remove sediment and repair gutter dam regularly during the report period and following each storm event.
- Following storm events the first dam should have more sediment than the downstream dams. When inspection shows failure persists, even with regular maintenance, a third dam should be installed. If the gutter dam system does not perform as intended, a different or additional BMP is warranted.
- Bring awareness to workforce and suppliers parking near the gutter dam.
- Check during storm events and prevent driving hazardous resulting from surface water conditions.

PERFORMANCE

- A gutter dam system is expected to slow the flow of runoff in the gutter to allow for sediment deposition. Erosion control of non-stabilized sediment should be used in conjunction with a gutter dam system. This BMP should be utilized as a secondary control to erosion control BMPs.

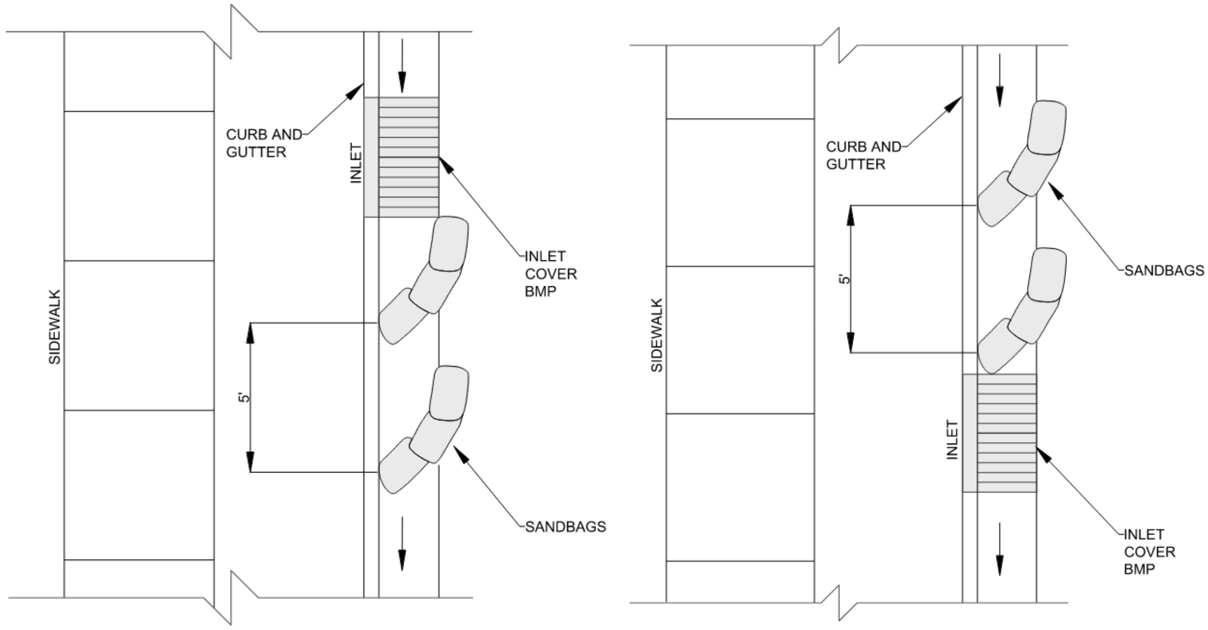
It is considered a BMP failure when any of the following occur:

- When storm events less than ¼” of rain results in significant scour an alternative BMP is warranted.
- When regular damage occurs to the gutter dam system due to traffic or snow operations an alternative BMP is warranted.
- When sediment deposits are equal to or greater in the downstream dam following storm events of 1/4” or less, the BMP is not adequate and warrants a different BMP.

REFERENCE:

- CGP 2.2.10
- CPP 2.1.3

BMP 20- Inlet Filter with Gutter Dam Combo



APPLICATION

- This BMP allows sediment laden storm water to be filtered by inlet cover and the gutter dam. Installing the gutter dam on the downstream end of the inlet will increase filter effectiveness and reduce sediment and debris by-pass. This configuration can reduce passing higher volumes downstream.
- This BMP allows for runoff by-pass during intense storm events but when adequately maintained can minimize sediment reaching storm water inlets. Inlet cover only BMPs should have secondary containment built in.
- Use Inlet Filter Gutter Dam Combo BMP for at grade inlets.
- Warning: This BMP is easily damaged by vehicles that park along the curb and gutter, and by snow removal operations.

INSTALLATION/USE PROCEDURES

- Install 6" min dia sand or gravel bags. Double up bags as necessary.
- Install upstream of inlets.
- This gutter dam system is working when the first dam is holding more sediment than the downstream dams. When the sediment collection is about the same then something is wrong.
- This system can scour out easily and needs regular maintenance to be effective.
- Inform subcontractors and suppliers of the gutter dams placement to roadside parking from damaging the sand or gravel bags.
- Train SWPPP inspection and maintenance team
- This BMP is designed for 1/4" (~2yr 10min intensity) rain storm events.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Anticipate significant storm events, repair damage and remove sediment deposits prior to storm events that could scour sediment deposits from the gutter dam.
- Inspect, remove sediment and repair gutter dam regularly during the report period and following each storm event. Check for out of place or broken bags, and torn or punctured fabric.
- Following storm events the first dam should have more sediment than the downstream dams. When inspection shows failure persists, even with regular maintenance, a third dam should be installed. If the gutter dam system does not perform as intended, a different or additional BMP is warranted.
- Inspect for sediments and remove with shovel and broom or vacuum tools.
- When fabric removal or replacement results in sediment dropping into the inlet, use hydro vacuum machinery or safely remove by other means
- Bring awareness to workforce and suppliers parking near the gutter dam.
- Check during storm events and prevent driving hazardous resulting from surface water conditions.

PERFORMANCE

- A gutter dam system is expected to slow the flow of runoff in the gutter to allow for sediment deposition. Erosion control of non-stabilized sediment should be used in conjunction with a gutter dam system. This BMP should be utilized as a secondary control to erosion control BMPs.

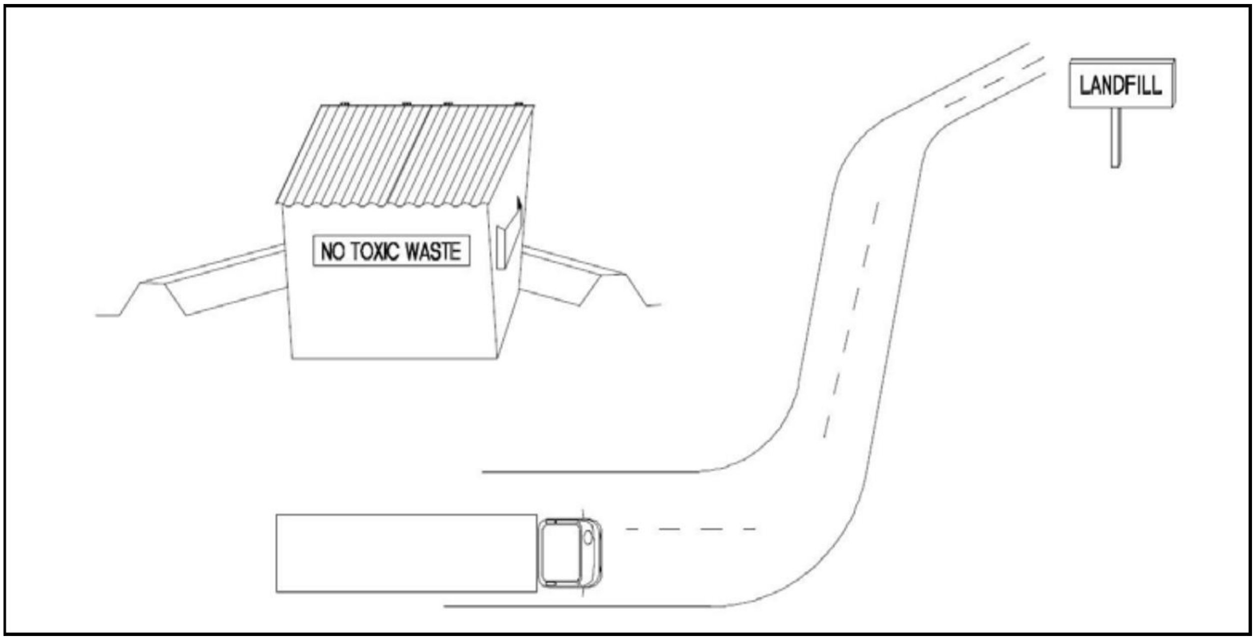
It is considered a BMP failure when any of the following occur:

- When storm events less than ¼” of rain results in significant scour an alternative BMP is warranted.
- When regular damage occurs to the gutter dam system due to traffic or snow operations an alternative BMP is warranted.
- When sediment deposits are equal to or greater in the downstream dam following storm events of 1/4” or less, the BMP is not adequate and warrants a different BMP.

REFERENCE:

- CGP 2.2.10
- CPP 2.1.3

BMP 21- Solid Waste Management



APPLICATION

- This BMP is necessary when construction activities generate solid waste that needs to be collected and disposed of properly to prevent environmental contamination.
- Use this BMP when: The site generates solid waste, including packaging materials, scrap construction materials, masonry products, timber, pipe and electrical cuttings, plastics, styrofoam, concrete, demolition debris; and other trash or building materials that could potentially contaminate stormwater if not managed correctly.

INSTALLATION/USE PROCEDURES

- **Selection Criteria**: Use durable, watertight containers (e.g., dumpster, trash receptacle) that are appropriately sized for the volume of waste generated on-site.
- **Placement**: position dumpsters on a flat, stabilized surface, away from storm drains and water bodies. Identify these locations on the site plan.
- **Usage**: ensure all construction waste is placed inside the dumpster. Do not overfill; waste should not extend beyond the sides or top of the dumpster. Do not dispose of liquids in this BMP. Most dumpsters and garbage trucks are not water tight.
- **Containment:** Provide containment or cover for waste that is blowable or that can leach nutrients, metals, pesticides, herbicides, oil, grease, bacteria, or other pollutants.
- **Segregation:** separate hazardous waste from non-hazardous waste and use appropriately labeled and secured containers for hazardous materials.
- Locate on parking pad or next to track-pad to prevent track-out when servicing. Show location on site BMP map.
- Do not install in roadways without approval of local municipality. This usually means obtaining a local right-of-way encroachment permit or equal to stage dumpsters in right-of-ways.
- Train workforce.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Ensure the workforce is informed about proper waste disposal procedures and the importance of maintaining the integrity of waste management BMPs.
- Operator is expected to modify the solid waste management system, location and capacity when necessary as site conditions and operations warrant.
- Inspect dumpsters for leaks, damage, and proper cover.
- Collect any trash around the construction site daily and deposit it in the waste container at designated collection areas.
- Arrange for regular waste removal to a licensed facility often enough to prevent overfilling.
- Contain and clean up spilled waste or overflow immediately.

PERFORMANCE

A solid waste management BMP is considered effective if:

- All construction and domestic waste generated is contained
- No incidents of dumpster overflow or leaks
- No visible waste or debris around the construction site or dumpster area

REFERENCE

- CGP 2.3.3 (e).

BMP 22- Chemical/Hazardous Materials Management

APPLICATION

- Use Chemical/Hazardous Materials Management BMP when chemicals or hazardous materials are used or stored at the construction site.

INSTALLATION/USE PROCEDURES

- Store chemicals and/or other hazardous materials in sealed, clearly labeled containers.
- Safety Data Sheets (SDS) specific to each chemical must be accessible on site.
- When chemicals/hazardous materials are not in use, store materials in such a way that they are not exposed to stormwater or runoff. (covered and off the ground)
- Storage and use areas must be located away from waters of the state, sensitive areas, and storm water conveyance systems
- Submit illustration or detail for secondary containment system when secondary containment and/or cover is required (containers more than 55 gallons); such as drip pan, spill containment pallets, or spill berm with impermeable liner.
- Attach a spill plan and provide a spill kit in good working condition sufficient to address small spills and protect water quality.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Train employees and subcontractors in chemical/hazardous materials BMPs.
- Regularly inspect the chemical storage area and the construction site for evidence of spills
- Spills must be properly cleaned up with dry clean up methods only.
- For spills that occur on permeable surfaces, remove contaminated material before leaching occurs and dispose according to manufacturer's recommended method of disposal and in compliance with Federal, State, Tribal, and local requirements
- Large spills must be documented and reported according to Section 2.3.6 of the CGP.
- Keep ample supplies of spill cleanup materials on-site and perform any repairs necessary to contain chemicals appropriately immediately.
- Dispose of expired or used up hazardous materials in accordance with the manufacturer's recommended method of disposal and in compliance with Federal, State, Tribal, and local requirements

PERFORMANCE

- This BMP is expected to contain chemical/hazardous materials in such a way that it cannot pollute the environment.
- No pollutants are allowed to reach storm water conveyance systems or waters of the state

REFERENCE

- CGP 2.3.3

BMP 23- Onsite Equipment Fueling

APPLICATION

- Use when fixed onsite fueling tanks are planned.

INSTALLATION/USE PROCEDURES

- Locate fueling operations a minimum of 50 feet from receiving waters, constructed or natural site drainage features, and storm drain inlets. If infeasible due to site constraints, store containers as far away from these features as the site permits. If site constraints prevent you from storing containers 50 feet away from the features identified, you must document in your SWPPP the specific reasons why the 50-foot setback is infeasible.
- Store fuels in sealed, clearly labeled containers.
- Containers must be covered and/or have secondary containment (curbing, spill berms, dikes, spill containment pallets, double-walled storage tank)
- Submit illustration or detail for secondary containment of fuel containers and secondary containment used during active fueling (drip pan, drop cloth, etc)
- Discourage topping-off of fuel tanks.
- Carry out all Federal and State requirements regarding stationary above ground storage tanks. (40 CF Sub. J) Avoid mobile fueling of mobile construction equipment around the site; rather, transport the equipment to designated fueling areas.
- Create and attach a Spill Plan specific to the project.
- If you fuel many vehicles or pieces of equipment, consider using an off-site fueling station. These areas are better equipped to handle fuel and spills properly.
- Provide a copy of your off site written policy to the oversight authority for review

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Fuel equipment in designated areas only
- Train employees and subcontractors in proper fueling and cleanup procedures.
- Regularly check for leaks and damage including but not limited to: tanks, hoses, and secondary containment.
- Keep ample supplies of spill cleanup materials on-site and perform any repairs necessary to contain fuel appropriately immediately.
- If spill occurs, use dry clean up methods and dispose of spill clean up materials to a proper licensed facility.
- Large spills must be documented and reported according to Section 2.3.6 of the CGP.

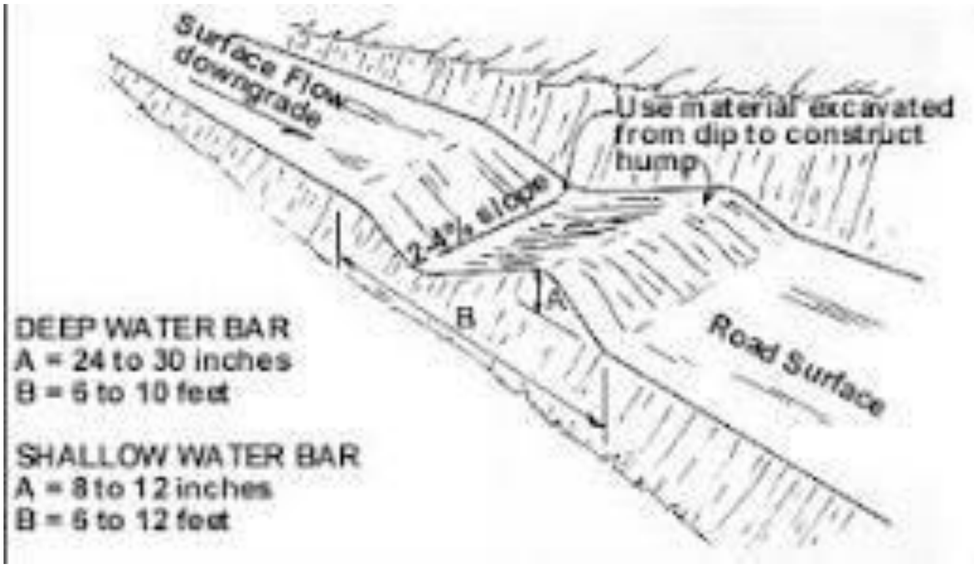
PERFORMANCE

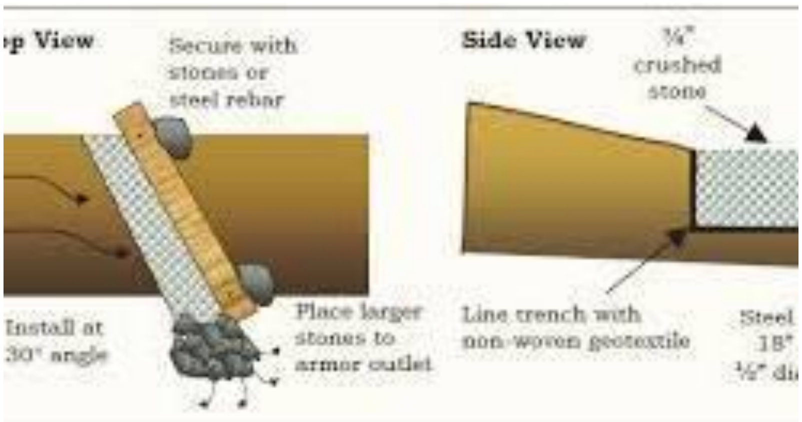
- Onsite equipment fueling BMPs are expected to protect stormwater to the extent that no fuel, oil, or solvents are allowed to pollute waters of the state or storm water conveyances.

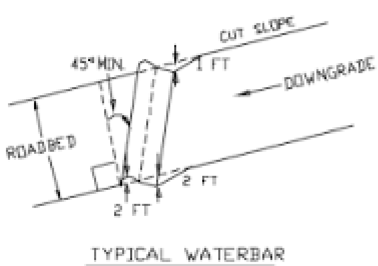
REFERENCE

- CGP 2.3.1

BMP 24- Water Bars







APPLICATION

Water Bars may be used as a means of erosion control when:

- Clearing right-of-way and construction of access for power lines, poplins, and other similar installations that often require long narrow rights-of-way over sloping terrain.
- Disturbance and compaction promote gully formation in these cleared strips by increasing the volume and velocity of runoff
- Gully formation may be especially severe in tire tracks and ruts. To prevent gullying, runoff can often be diverted across the width of the right-of-way to undisturbed areas by using small predesigned diversions generally referred to here as water bars.

INSTALLATION/USE PROCEDURES

- Give special consideration to each outlet area individually, as well as to the cumulative effect of added diversions. Use gravel to stabilize the diversion where significant vehicular traffic is anticipated.
- Design the height of the Water Bar with the slope in mind to effectively divert the volume needed.
- Design the base width of the ridge with the slope and volume of water diverted in mind.
- Locate well-vegetated and stable areas to use natural drainage systems and to discharge into well-vegetated stable areas.
- During a rain event ensure that the installed Water Bars are effective in diverting the runoff away from the road, or path and that the discharge areas are effective at handling the volume of water being diverted.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Periodically inspect right-of-way diversions for wear and after every heavy rainfall for erosion damage.
- Immediately remove sediment from the flow area and repair the dike.
- Check outlet areas and make timely repairs as needed.
- When permanent road drainage is established and the area above the temporary right-of-way diversion is permanently stabilized, remove the dikes and fill the channel to blend with the natural ground, and appropriately stabilize the disturbed area.

PERFORMANCE

It is considered a Water Bar management failure when any of the following occurs:

- Water is not being properly diverted from the intended area.
- Sediment is built up in diverted flow areas and needs to be maintained.

REFERENCE

2.1, 2.2, 2.3

BMP 25- Portable Sediment Tank

APPLICATION

- This BMP is necessary when construction activities generate significant amounts of sediment-laden water that needs to be managed to prevent environmental contamination.
- Use this BMP when: The site requires the temporary storage and treatment of sediment-laden water due to construction activities such as excavation, dewatering, or stormwater runoff collection.

INSTALLATION/USE PROCEDURES

- **Placement:** position the portable sediment tank (frac tank) on a flat, stabilized surface, away from storm drains and water bodies. Identify these locations on the site plan.
- **Connection:** ensure all hoses and connections are secure and leak-free. Properly connect the inlet and outlet hoses to direct sediment-laden water into the tank.
- **Filling:** gradually fill the tank with sediment-laden water, allowing sediments to settle out. Avoid overfilling the tank.
- **Sediment removal:** periodically remove accumulated sediments from the tank according to proprietary specifications to maintain capacity and effectiveness. Follow appropriate disposal methods for the removed sediments.
- **Discharge:** discharge the treated water in compliance with local regulations, ensuring that it meets the required water quality standards.
- **Training:** ensure the workforce is informed about the correct operation and maintenance procedures for portable sediment tank (frac tank).

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Inspect the portable sediment tank (frac tank) and associated equipment for leaks, damage, and proper functioning.
- Ensure that sediment levels are monitored and sediments are removed as needed to maintain tank capacity.

- Applicant is expected to modify the portable sediment tank system, location and capacity when necessary as site conditions and operations warrant.

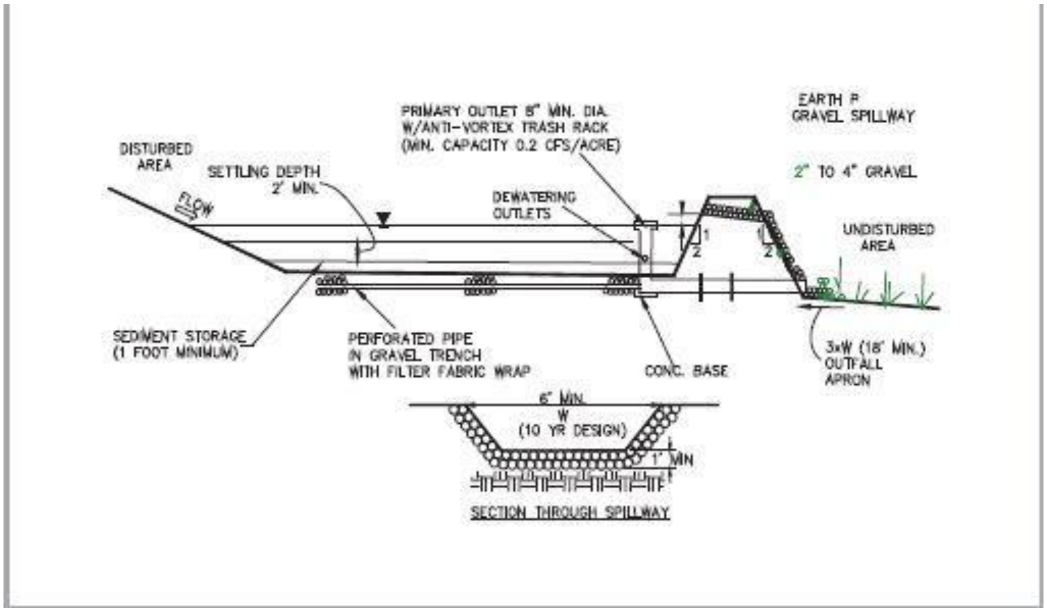
PERFORMANCE

- Ensure that the discharge from the frac tank meets local, state, and federal water quality standards for sediment and turbidity. Any discharge with visible sediment or cloudiness constitutes failure and requires immediate corrective action.
- Any leak or spill around the tank area indicates BMP failure.
- Sediment within the tank must be kept below the manufacturer's recommended level.

REFERENCE

- CGP 2.2.12, 7.3.5, A.2.4

BMP 26- Sediment Basin



APPLICATION

Sediment basins serve as treatment devices which can be used on a variety of project types. They are normally used in construction projects where:

- Large areas of land drain to the basin
- At the outlet of disturbed watersheds 10 acres or larger
- At the outlet of smaller watersheds as necessary
- Where post construction basins will be located
- for disturbed upstream drainage areas of 5 acres or more

INSTALLATION/USE PROCEDURES

- Determine the number of basins needed. In some cases, it is more effective to have multiple smaller basins versus one large basin. This is particularly important in areas with larger-grained sediments. In addition, potential damage from basin failure can be minimized by using multiple smaller basins, versus one large basin.
- Whenever possible, construct the sedimentation basins before clearing and grading work begins.
- Construct sediment basins at locations that are accessible for cleanout.
- Situate the basin or impoundment outside of any water of the state and any natural buffers.
- Design the basin or impoundment to avoid collecting water from wetlands or high ground water.
- Design the basin or impoundment to provide for either:
    - (1) The calculated volume of runoff from the 2-year, 24-hour storm; or
    - (2) 3600 cubic feet per acre drained.
- Utilize outlet structures that withdraw water from near the surface of the sediment basin or similar impoundment, unless infeasible.
- Use erosion controls and velocity dissipation devices to prevent erosion at inlets and outlets.
- Sediment basins and ponds must be installed only within the property limits where failure of the structure would not result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities.

- Sediment basins and ponds are attractive to children and can be very dangerous. Local ordinances regarding health and safety must be adhered to. If fencing of the pond is required, the type of fence and its location should be shown on the Stormwater Pollution Prevention Plan (SWPPP).
- Because of additional detention time, sediment basins may be capable of trapping smaller sediment particles than traps. However, they are most effective when used in conjunction with other BMPs such as seeding or mulching.
- Sediment basins can be converted to permanent structures after completion of the construction project. Remove all excess sediment from the basin. The containment volume must meet the design specifications of the approved plan set. The inside of a permanent sediment basin should be stabilized to meet local and UPDES requirements.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Inspect after each rainfall event and at a minimum as part of any regularly scheduled inspections.
- Repair any damage to the berm, spillway, sidewalls and outlet structures or mechanisms.
- Remove accumulated sediment to maintain at least one-half of the design capacity and conduct all other appropriate maintenance to ensure the basin or impoundment remains in effective operating condition.
- Check outlet for sedimentation/erosion of downgradient area and remediate and/or install downgradient BMPs as necessary.

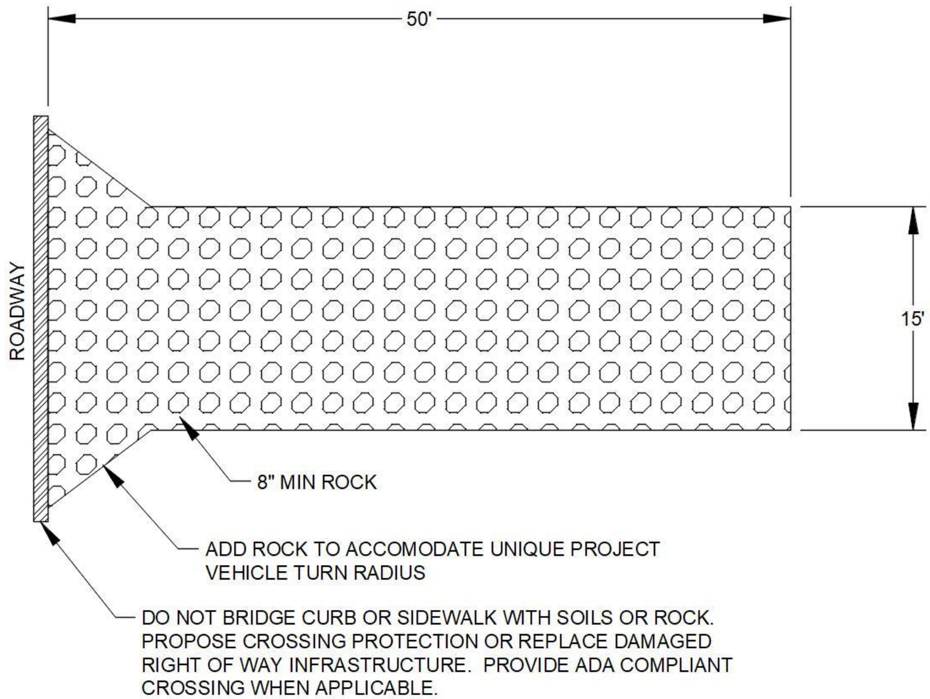
PERFORMANCE

- Sediment basins are at best only 70-80 percent effective in trapping sediment which flows into them. Therefore, they should be used in conjunction with erosion control practices such as temporary seeding, mulching, diversion dikes, etc. to reduce the amount of sediment flowing into the basin.
- A type of outlet being used with increasing frequency is the floating skimmer. Some early tests indicate that the skimmer (which draws water only from the surface) might be more effective at retaining sediment in the basin than the standard riser and barrel configuration.

REFERENCE

- CGP 2.2.12, 7.3.5
- Drainage Design Manual for City
- Salt Lake County Best Management Practices for Construction Activities

BMP 27- Rock Track Out Pad



APPLICATION

- Use this BMP when vehicles and equipment operations require egress from the project property to decrease the amount of debris leaving the site via vehicle tracking.
- Particularly applicable in wet conditions in which sediment sticks more easily to tires/tracks.

INSTALLATION/USE PROCEDURE

- Determine the ingress/egress location(s) allowed by the oversight authority and show them on the site plan.
- Use 8" rock for the track out pad at a minimum depth of 8" and use dimensions described in the illustration above.
- Workforce and subcontractors must utilize the track out pad when leaving the construction site.
- Move vehicles forward and in reverse until mud is removed from tires.
- Stop, for rocks wedged in dual tires and remove any unremoved mud and wedged rocks.
- Ensure the workforce is trained regarding track-out BMP requirements.
- Use of Sweeping BMP is still usually necessary at the end of the day at minimum.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Rake, refresh or wash rock as necessary when space between rocks is inundated with mud.
- Add, extend or replace rock as necessary to achieve performance criteria results.
- Train workforce when BMP improper use is recognized.
- When sediment, rock, or gravel track out occurs due to BMP failure or misuse, debris must be removed from roadways according to the CGP criteria.
    - Street clean-up operations are separate from this Rock Track Out Pad BMP, but necessary to address unacceptable track out that may occur.

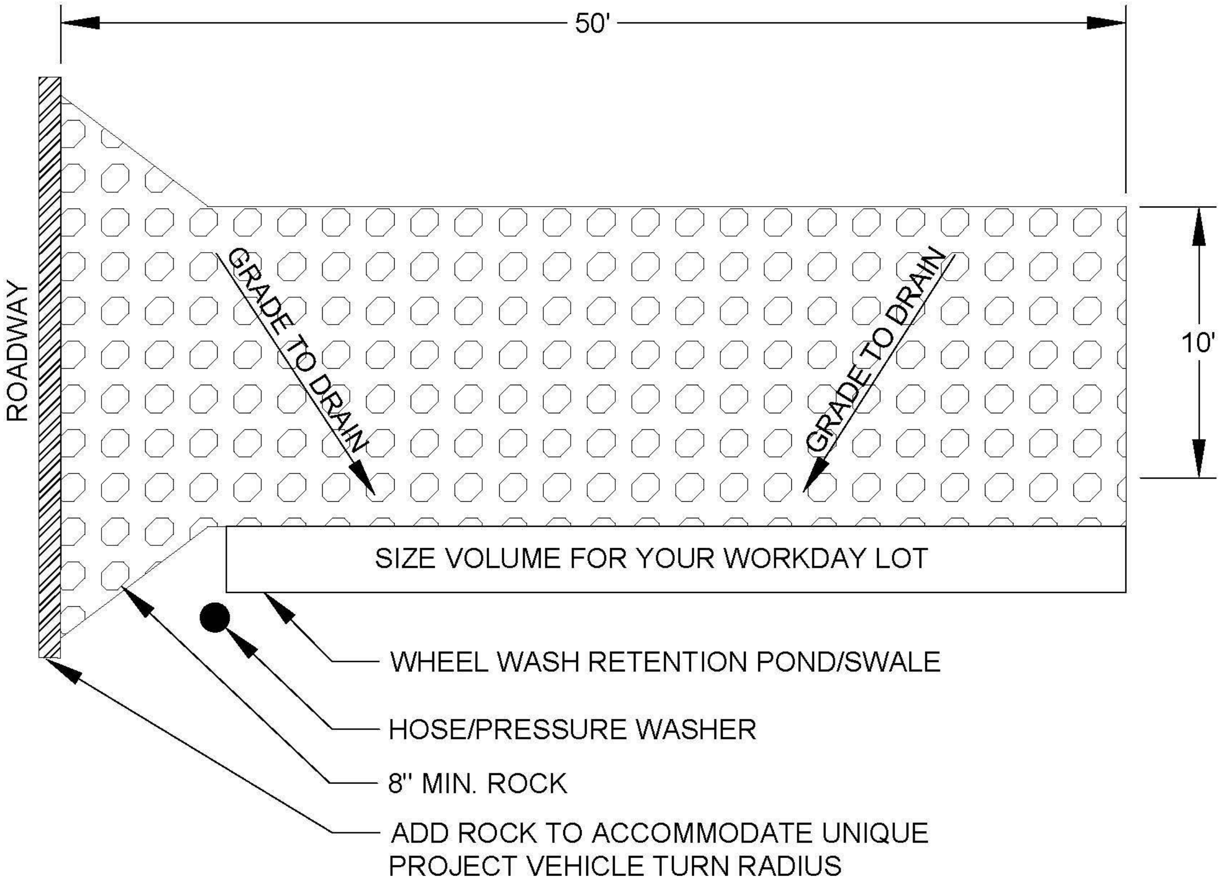
PERFORMANCE:

- Slick conditions, slurry, mud chucks, rocks, gravel, water quality risk and driver hazards constitute BMP failure and require immediate sufficient action.
- Light tracking is expected and requires regular maintenance but not usually immediate action. Light tracking is defined as minor residual dirt that can't be picked up by a square nose shovel.
    - Remove/sweep prior to unsafe and wet conditions or end of workday, whichever is first.

REFERENCE:

- CGP 2.2.4, 5.1, 5.2.1
- CPP 2.4.1

BMP 28- Wheel Wash



APPLICATION

- Use this BMP when vehicles and equipment operations require egress from the project property to decrease the amount of debris leaving the site via vehicle tracking.
- Use wheel wash BMP when mud needs to be removed from tires.
- Wheel washes are a logical redundant option during very wet conditions when other wheel agitation type tire mud management systems are not effective.

INSTALLATION/USE PROCEDURE

- Determine the ingress/egress location(s) allowed by the oversight authority and show them on the site plan.
- Do not bypass the wheel wash area when track out prevention is necessary.
- Wash all wheels with a hose or pressure washer provided. Pull forward as necessary to remove all mud from tires and tread.
- Check for rocks wedged in dual tires and remove.
- Identify the necessary retention volume needed for wash waters and attach to this BMP.
- Ensure the workforce is trained regarding track-out BMP requirements.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.

- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Rake or wash rock as necessary when BMP is not working.
- Remove pond/swale sedimentation at 50% capacity.
- Expand the wash water basin as necessary to contain the retention volume required.
- Do not wash wheels anywhere on site except at the designed wheel wash area that has a retention pond to retain and treat wash waters.
- Train workforce when BMP improper use is recognized.
- When sediment, rock, or gravel track out occurs due to BMP failure or misuse, debris must be removed from roadways according to the CGP criteria.
    - Street clean-up operations are separate from this wheel wash BMP, but necessary to address unacceptable track out that may occur.

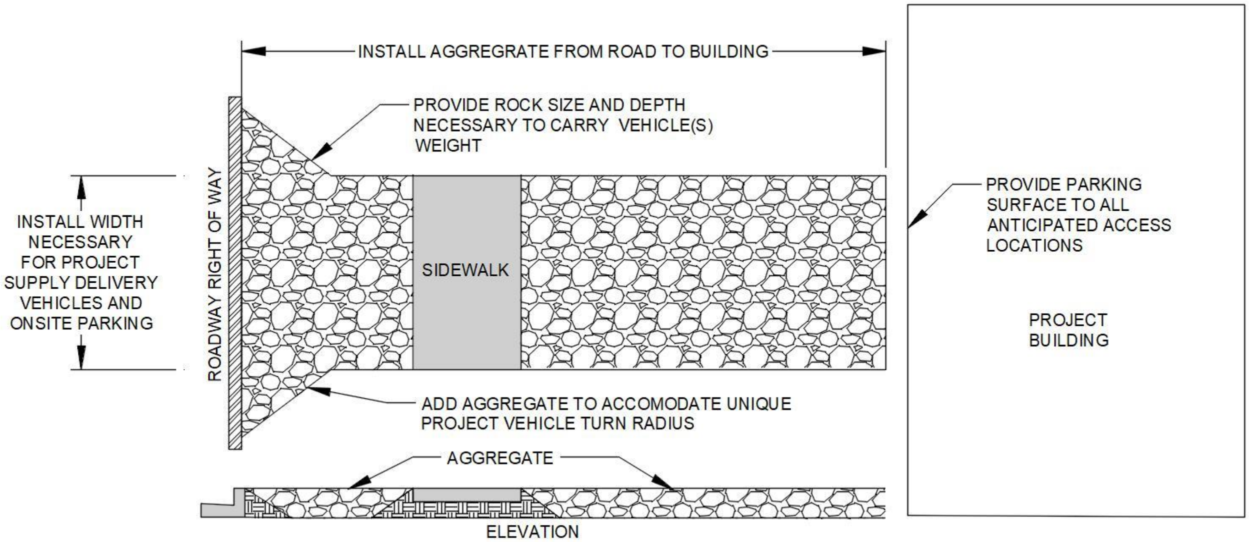
PERFORMANCE:

- The Wheel Wash BMP is expected to greatly minimize the risk of excessive track out onto roadways and also utilizes sediment deposition in the wash water retention pond.
- Slick conditions, slurry, mud chucks, rocks, gravel, water quality risk and driver hazards constitute BMP failure and require immediate sufficient action.
- Light tracking is expected and requires regular maintenance but not usually immediate action. Light tracking is defined as minor residual dirt that can’t be picked up by a square nose shovel.
    - Remove/sweep prior to unsafe and wet conditions or end of workday, whichever is first.

REFERENCE:

- CGP 2.2.4, 5.1, 5.2.1
- CPP 2.4.1

BMP 29- Parking Pad & Supplier Access



APPLICATION

- Use a parking pad for supply delivery vehicles, tool drop off and onsite project parking etc.
- Use this BMP to *prevent* mud from sticking to tires. This BMP will not remove mud sticking to tires.

INSTALLATION/USE PROCEDURES

- Determine where supplies and tools need to be delivered or dropped off and show the delivery area on the site plan. Coordinate with oversight authority for any prohibited access locations.
- Do not drive beyond the parking pad.
- Size pad to accommodate project supply vehicles and any necessary onsite parking. Attach illustration of specific dimensions for the parking pad and gravel/rock specific to the project needs with this BMP detail.
- Ensure the workforce is trained regarding proper use and maintenance of the parking/delivery pad.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Refresh parking/access pad as necessary when BMP is not effective at preventing mud from sticking to tires.
- Add, extend or replace rock as necessary to achieve performance criteria results.
- Train workforce when BMP improper use is recognized.

- When sediment, rock, or gravel track out occurs due to BMP failure or misuse, debris must be removed from roadways according to the CGP criteria.
    - Street clean-up operations are separate from this Parking Pad BMP, but necessary to address unacceptable track out that may occur.

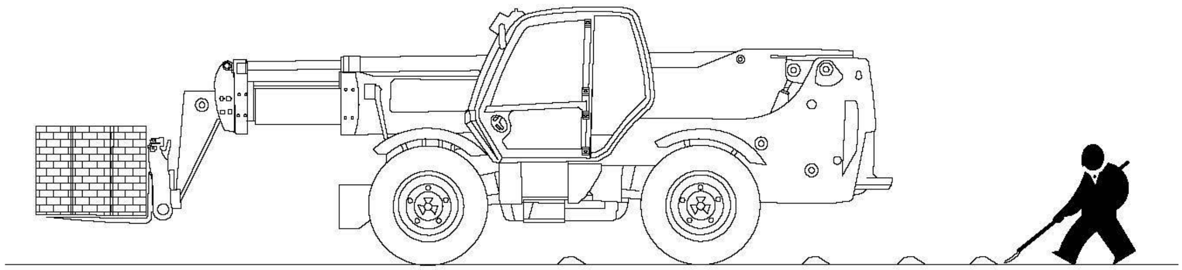
PERFORMANCE

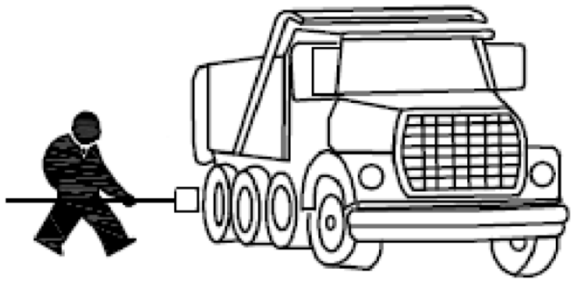
- The parking pad and supplier access gravel pad is expected to reduce vehicle contact with exposed sediment on site.
- In addition, it also acts as a visual marker for suppliers to know where to make deliveries, increasing work site operation efficiency.
- Slick conditions, slurry, mud chucks, rocks, gravel, water quality risk and driver hazards constitute BMP failure and require immediate sufficient action.

REFERENCE:

- CGP 2.2.4, 5.1, 5.2.1
- CPP 2.4.1

BMP 30- Manual Mud Removal





APPLICATION

- Use this BMP when vehicles and equipment operations require egress from the project property during wet conditions resulting in mud sticking to vehicle tires and tracks.
- Use this BMP when non-regular egress is necessary or using the primary track out BMP is not practical for an unusual situation.
- Use this BMP as a redundant BMP when the primary track out BMP(s) is not working.
- Use this BMP for short transfer of vehicles for short distances, e.g. across the street.

INSTALLATION/USE PROCEDURES

- Stop before exiting the site and use a square nose shovel or stiff broom to remove mud from tires and remove mud tracks when applicable.
  - When manually removing mud on pavement, shovel and sweep with each track out occurrence and always perform this BMP when incidents are upstream of inlets.
- Check for and remove rocks wedged in dual tires.
- Ensure the workforce is trained regarding mud removal and clean up of trackout BMP requirements.
- Use of Sweeping BMP is still usually necessary at the end of day minimum.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- When removing mud from tires or tracks on pavement sweep prior to wet conditions or end of day, whichever comes first.
- Train workforce when BMP improper use is recognized.
- When sediment, rock, or gravel track out occurs due to BMP failure or misuse, debris must be removed from roadways according to the CGP criteria.
    - Street clean-up operations are separate from this Manual Mud Removal BMP, but necessary to address unacceptable track out that may occur.

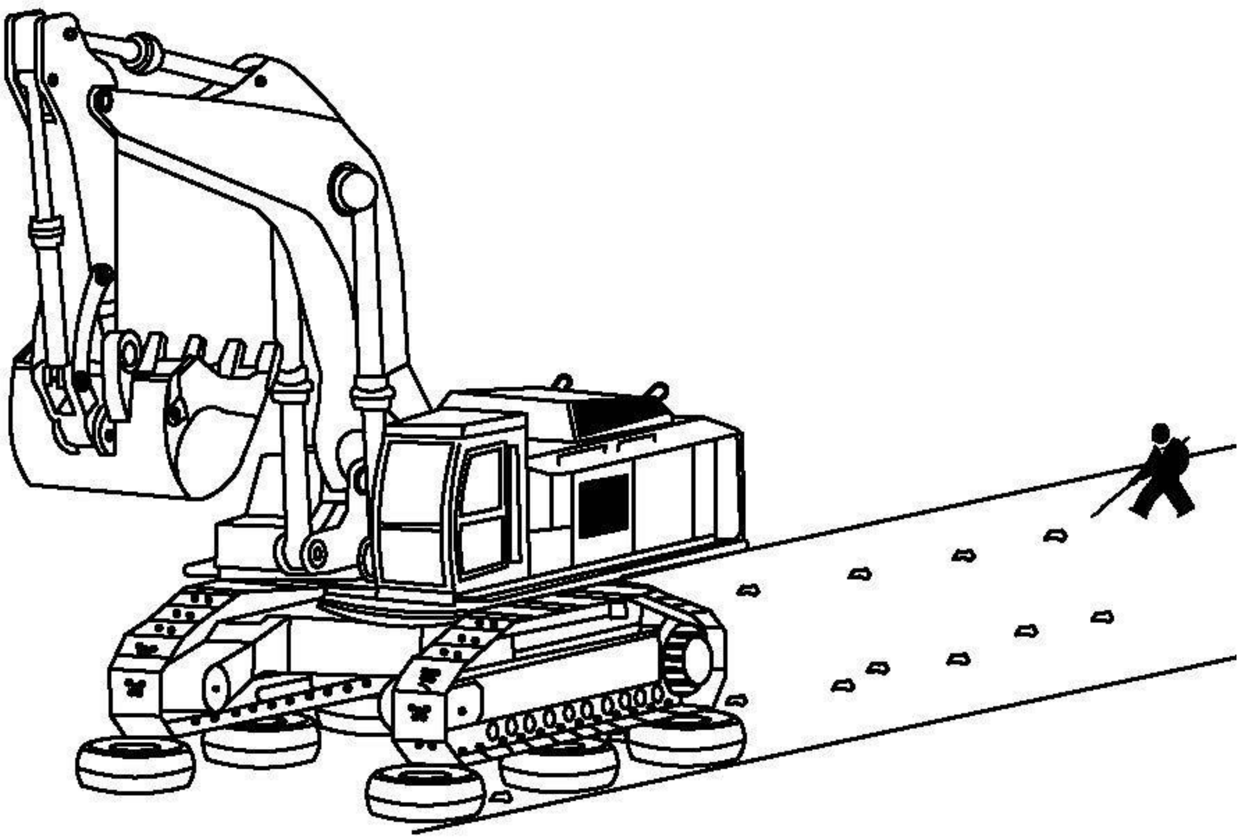
PERFORMANCE:

- Slick conditions, slurry, mud chucks, rocks, gravel, water quality risk and driver hazards constitute BMP failure and require immediate sufficient action.
- Light tracking is expected and requires regular maintenance but not usually immediate action. Light tracking is defined as minor residual dirt that can't be picked up by a square nose shovel.
    - Remove/sweep prior to unsafe and wet conditions or end of workday, whichever is first.

REFERENCE:

- CGP 2.2.4, 5.1, 5.2.1
- CPP 2.4.1

BMP 31- Track Vehicle Crossing



APPLICATION

- Use when track vehicle road crossing for multiple project sites is planned.
- It is not practical to remove mud from most tracked construction equipment. Even track washing is usually impractical.

INSTALLATION/USE PROCEDURES

- When road crossings are short distances, remove clumps with a square nose shovel and broom at each crossing. The clumps will be compacted to the road reducing vacuum sweeper effectiveness.
- When distant crossings are necessary, scraping or track washing BMPs are usually necessary. A machinery bucket blade can also work but follow up with a vacuum operated sweeper is also necessary.
- Protect roadway infrastructure from vehicle tracks. Placing tires beneath tracks is usually effective. Decide the track buffer method and attach your plan to this BMP.
- Ensure the workforce is trained regarding track-out BMP requirements.
- Use of Sweeping BMP is still usually necessary at the end of day minimum.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Regular sweeping is usually necessary daily. Shovels are intended to remove the dirt/mud clumps but will not move residual slurry that collects over multiple days.
- Train workforce when BMP improper use is recognized.
- When sediment, rock, or gravel track out occurs due to BMP failure or misuse, debris must be removed from roadways according to the CGP criteria.
    - Street clean-up operations are separate from this Track Vehicle Crossing BMP, but necessary to address unacceptable track out that may occur.

PERFORMANCE

- Slick conditions, slurry, mud chucks, rocks, gravel, water quality risk and driver hazards constitute BMP failure and require immediate sufficient action.
- Light tracking is expected and requires regular maintenance but not usually immediate action. Light tracking is defined as minor residual dirt that can't be picked up by a square nose shovel.
    - Remove/sweep prior to unsafe and wet conditions or end of workday, whichever is first.

REFERENCE

- CGP 2.2.4, 5.1, 5.2.1
- CPP 2.4.1

BMP 32- Street Sweeping

APPLICATION

- A Sweeping BMP is necessary to address the immediate safety, water quality and complaint issues that exist resulting from vehicle track out.
- Sweeping BMPs do not eliminate the requirement for egress track out BMPs, but are necessary to compensate for the practical limitations of most egress track out BMPs.

INSTALLATION/USE PROCEDURES

- Use vacuum type sweeping machinery.
- Anticipate end of day sweeping or multiple times a day as needed. The better the egress track out BMP the less sweeping operations are necessary.
- A Square nose shovel and broom are also always a good roadway sediment and debris removal option.
- Identify the sweeper hopper licensed dump location. Attach dump location information to this BMP.
- Ensure the workforce is trained regarding track-out BMP requirements.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Employ sweeping operations at the end of the workday and as necessary.
- Train workforce when BMP improper use is recognized.

PERFORMANCE:

- Slick conditions, slurry, mud chucks, rocks, gravel, water quality risk and driver hazards constitute BMP failure and require immediate sufficient action.
- Light tracking is expected and requires regular maintenance but not usually immediate action. Light tracking is defined as minor residual dirt that can't be picked up by a square nose shovel.
  - Remove/sweep prior to unsafe and wet conditions or end of workday, whichever is first.

REFERENCE:

- CGP 2.2.4, 5.1, 5.2.1
- CPP 2.4.1

BMP 33- Fugitive Dust Control Plan

APPLICATION

- Dust control applies to any bare earth on the project that is at risk of being picked up by wind erosion.
- Dust suppression is necessary for all areas where vegetation is removed.
- A good BMP for dust management is to minimize and phase vegetation removal. See Phase Clearing BMP.

INSTALLATION/USE PROCEDURES

- Attach a copy of the Fugitive Dust Control Plan and DAQ permit information
- Attach a copy of the Dust Control Plan Tools and details for suppression, including but not limited to equipment information, methods, and responsible party (inhouse or subcontracted)
- Attach a list of all dust generating operations, including but not limited to; vehicle traffic, dirt processing, load and haul, brick mason operations, etc.
- Ensure the workforce is trained regarding track-out BMP requirements.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Implement Fugitive Dust Control plan per DAQ permit.
- Train workforce when BMP improper use is recognized.

PERFORMANCE:

- UAC section R307-309-5. Typically this means no greater than 10% opacity at property boundaries.
- Any neighbor complaints warrants reevaluation of the effectiveness of the dust control plan and/or an inspection by the oversight authority.

REFERENCE:

- UAC section R307-309-5
- CGP 2.2.6
- CPP 2.2.6

BMP 34 - Vegetation Removal Phasing

APPLICATION

- Erosion and dust suppression is necessary for all areas where vegetation is removed.
- Apply vegetation removal management to minimize dust and erosion risk. Many large projects can benefit from this BMP.

INSTALLATION/USE PROCEDURES

- Attach a copy of phasing maps showing no disturbance areas for each phase. A vegetated buffer can also be utilized to provide erosion control along the outskirts of the project area.
- Ensure the workforce are informed regarding no disturbance areas.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Train workforce when encroachment into no disturbance areas are found. Update no disturbance maps and SWPPP document as relevant.
- Address encroachment exposures and add or amend BMPs to compensate for the exposure as necessary.

PERFORMANCE:

- Encroachment of no disturbance phasing plan areas constitutes BMP non-compliance.

REFERENCE:

- UAC section R307-309-5
- CGP 2.2.2, 2.2.9, 2.2.6, 7.3.2.f
- CPP 2.2.14

BMP 35 - Final Stabilization

APPLICATION

- Construction projects considered completed that will have bare, unimproved, erodible surfaces
- Projects with temporary exposed surfaces exceeding the CGP cover and time limits.
- A Final Stabilization Plan is necessary for all projects. The final stabilization CGP goal is when the final landscape plan achieves surface stabilization of 70% uniformly distributed cover by either finish grade mulch or established vegetation.

INSTALLATION/USE PROCEDURES

- Attach a copy of the final landscaping plan, including but not limited to vegetation establishment periods.
- Attach a copy temporary vegetation, including but not limited to temporary seed plan, chemical treatment of erodible surfaces, erosion control blankets, etc,
- Provide a list of all the SWPPP erosion, operation and fugitive dust BMPs that must remain in place through the final stabilization installation and establishment period.
- Ensure the workforce is informed of the final stabilization BMP requirements.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is expected to submit a site specific final stabilization plan attached to this BMP. This may include: Proprietary system literature, illustrations, any operation procedures and maintenance required to achieve storm water pollution prevention and final stabilization.

MAINTENANCE/MANAGEMENT

- Ensure all other SWPPP containment BMPs are installed, maintained and inspected throughout the installation of the final landscaping infrastructure and vegetation establishment period.
- Train workforce when final stabilization plan and site BMP non-containment is recognized.

PERFORMANCE:

A Final Stabilization Plan is not effective when any of the following occurs:

- Erosion occurs beyond the disturbance boundary or sediment is leaving the site.
- A pollutant risk to water quality is present.
- Fugitive dust opacity exceeds DAQ Permit requirements which is usually opacity exceeding 10% at the property boundary.
- Any neighbor complaints warrants an inspection.

REFERENCE:

- UAC section R307-309-5
- CGP 2.2.6, 2.2.14, 2.2.14.a, 7.3.5.b
- CPP 2.2.14, 8.2.1

BMP 36 - Stockpile Management

APPLICATION

- Projects where topsoil is stripped and will be reused at a later phase
- Projects where any natural materials must be stored on site for use throughout the project
- Projects which have an offsite stockpile area

INSTALLATION/USE PROCEDURES

- Provide staging/storage area location(s) on the BMP map.
- For offsite storage yard or stockpiles that are used in conjunction with the project, include appropriate storm water pollution prevention controls and BMPs in the SWPPP and show the location on the site map
- Provide stockpile toe BMP when sediment is not adequately contained by other boundary BMPs. Reference other boundary BMPs managing the stockpile exposure risk.
- Ensure the workforce is informed of stockpile management requirements.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Ensure all other sediment control BMPs are installed, maintained and inspected throughout storage, staging, and topsoil redistribution operations.
- Train workforce when non-containment is recognized.
- If stockpile is not being actively used, cover it and/or provide containment so that runoff cannot enter sensitive areas, waters of the state, or storm water conveyances.

PERFORMANCE:

Successful stockpile management occurs when:

- Storage areas are noted on the SWPPP documentation and are up to date
- Stockpiles are covered and/or contained with little to no contaminated runoff leaving the area

REFERENCE:

- CGP 2.2.8 7.3.3
- CPP 2.2.5, 7.3.3, 2.2.14

BMP 37 - Construction Dewatering Retention

APPLICATION

- Project where waterline system commissioning is necessary
- A DEQ Dewatering permit is not required when full retention is provided onsite. Note, groundwater warranted dewatering operations usually do not qualify for a DEQ Dewatering Permit waiver. The exposure period and amount of groundwater results in uncertain volume calculations.

INSTALLATION/USE PROCEDURES

- Provide a retention location on BMP map.
- Provide a simple detail of retention pond and operation volume necessary for full retention of anticipated dewatering volume. Attached copy of volume calculations to this BMP.
- Ensure the workforce is informed of the CGP dewatering BMP requirements.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Inspect following dewatering operation and ensure volume exists for any subsequent dewatering operations.
- Train workforce when non-containment is recognized.

PERFORMANCE:

- Any uncontained dewatering volume constitutes BMP failure.

REFERENCE:

- CGP 1.2.2, 1.2.4, 2.3.7, 7.3.4
- CPP 1.2.4, 2.2.7

BMP 38 - Construction Dewatering Water Truck

APPLICATION

- Project where waterline system commissioning is necessary
- A DEQ Dewatering permit is not required when dispersing water onsite. Note, groundwater warranted dewatering operations usually do not qualify for a DEQ Dewatering Permit waiver. The exposure period and amount of groundwater results in uncertain volume calculations.

INSTALLATION/USE PROCEDURE

- Pump hyperchlorinated water to water truck and use for dust suppression. Attach operation details.
- Show dispersal areas on BMP site map. Not allowed on impervious surfaces are directly connected to inlets or other waterways
- Ensure the workforce is informed of the CGP dewatering BMP requirements.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Train workforce when non-containment is recognized.

PERFORMANCE:

- Any uncontained dewatering volume constitutes BMP failure.

REFERENCE:

- CGP 1.2.2, 1.2.4, 2.3.7, 7.3.4
- CPP 1.2.4, 2.3.7

BMP 39 - Construction Dewatering DEQ Permit Required

APPLICATION

- Projects where groundwater is anticipated or other dewatering operation volumes would exceed available space for onsite retention.
- Project where pressure system and waterline commissioning is necessary
- Projects where groundwater warranted dewatering operations are anticipated.

OPERATION PROCEDURE

- Provide dewatering operation location(s) on BMP map.
- Attach a copy of the DEQ Dewatering Permit to this BMP.
- Attach a copy of all permit required inspection, monitoring requirements, operator prepared BMPs or proprietary systems and chemical treatment methods.
- Ensure the workforce is informed of the DEQ permit dewatering BMP requirements.

OPERATOR BMP MODIFICATION OR REPLACEMENT

- Operator is invited to propose an alternative BMP or modify this preferred BMP. The proposed BMP must match or exceed performance requirements as this preferred BMP. Any deviations from this preferred BMP must be reviewed and accepted by the oversight authority.
- Submit BMP modifications or replacements to the oversight authority for review; including but not limited to; Proprietary system literature, modified illustrations, any operation procedures and maintenance adjustments, etc.

MAINTENANCE/MANAGEMENT

- Ensure proprietary system, inspection, monitoring maintenance and application methods are followed.
- Train workforce when non-containment is recognized.

PERFORMANCE:

- Any uncontained dewatering volume constitutes BMP failure.
- Any DEQ Dewatering Permit non-compliance.

REFERENCE:

- CGP 1.2.2, 1.2.4, 2.3.7, 7.3.4
- CPP 2.2.3

UTAH DEPARTMENT *of* ENVIRONMENTAL QUALITY
WATER QUALITY

A Guide to Low Impact Development within Utah

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Division of Water Quality

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epg Sustainable Solutions. Thriving Environments.

Summary of Changes

August 2020	
Description of Changes	**Impacted Sections**
Updated definition of Redevelopment	*The 80th Percentile Volume*
Updated V_{goal} calculations to reflect new definition of Redevelopment	*The 80th Percentile Volume*
Updated the Commercial land use example as an example of Redevelopment	*Land Use Examples*
Replaced 90th percentile NOAA storm depths with permittee-submitted 80th percentile storm depths	*Appendix A 80th Percentile Storm Depths*
Updated Storm Water Quality Report Template	*Appendix B Storm Water Quality Report Template*
Updated BMP drawing notes to indicate treatment options	*Appendix C LID BMP Fact Sheets*
Added a Minimize Impervious Area fact sheet	*Appendix C LID BMP Fact Sheets*
Replaced 90th percentile storm depth text and calculations with 80th percentile storm depth	Throughout manual
Replaced many uses of '90th percentile storm depth' with 'project volume retention goal' to allow for option of using the predevelopment hydrologic condition as the retention goal.	Throughout manual
Minor spelling, grammatical, and formatting updates	Throughout manual

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Introduction

Purpose

This manual is to be used as a reference and guide for incorporating low impact development (LID) storm water approaches into new development and redevelopment projects. It helps planners and designers in selecting appropriate practices to incorporate in their site design as well as municipal separate storm sewer system (MS4) program managers in evaluating LID practices and determining what is most appropriate for their storm water programs. The information contained in this guidance complies with the goals of the federal Clean Water Act (CWA) "to reduce the discharge of pollutants to the maximum extent practicable."

This manual provides background and technical information on LID best management practices (BMPs), maintenance practices, selection of appropriate plant materials, methods to retain the project volume retention goal (see *The 80th Percentile Volume*), and other relevant information needed to assist decision makers, planners, designers, and reviewers in making the best possible decisions for their storm water programs and developments while complying with Utah's Division of Water Quality (DWQ) storm water permit requirements.

Users of this manual are encouraged to seek out innovative and effective methods in addition to those discussed here to accommodate site-specific conditions and to achieve the key principles of LID and meet permit requirements. A wide array of LID approaches is presented; however, as with any environmental discipline for any development, site-specific decisions from qualified personnel will always be required. While the LID BMPs presented are widely used, local climate, soil conditions, vegetation, and other factors must be considered to determine what will work best within the project location.

Low Impact Development

LID refers to engineered systems, either structural or natural, that use or mimic natural processes to promote infiltration, evapotranspiration, and/or reuse of storm water as close to its source as possible to protect water quality and aquatic habitat. LID practices at the regional and site-specific level preserve, restore, and create green space using soils, vegetation, and rainwater harvesting techniques. These systems and practices are referred to as BMPs.

Green infrastructure (GI) includes LID practices but is a broader practice that also includes ecological services and approaches such as "filtering air pollutants, reducing energy demands, mitigating urban heat islands, sequestering and storing carbon, enhancing aesthetics and property values, and preserving and creating natural habitat functions." (United States Environmental Protection Agency, 2012)

Key LID Principles

- Mimic natural processes
- Promote infiltration, evapotranspiration, harvest/reuse
- Manage storm water close to source
- Site design planning at project conception

Urban development has historically resulted in increased impervious surfaces, vehicle use, and other human activities that introduce pollutants and create adverse hydrologic conditions detrimental to water quality. In the past, the goal of traditional storm water management was to convey these flows offsite as directly as possible (*Figure 1*), giving little to no consideration to preserving open spaces or creating pervious areas where rainfall could be managed on-site. Flood control infrastructure such as storm drains have been used to convey runoff and discharge it to a receiving surface water. Polluted runoff degrades the quality of the receiving water, impacting aquatic life and dependent ecosystems. Incorporating LID practices reduces the impact of development on natural waterways and watersheds and provides practical as well as aesthetic benefits. Other benefits include reduced construction costs by conveying runoff through vegetated swales instead of through pipes. Pavers or other pervious surfaces can reduce the size of an on-site basin by retaining runoff within a subsurface storage layer and bioretention areas can provide retention and treatment to improve water quality before discharging. These types of designs also enhance the aesthetics of the development and are viewed favorably by the public.

LID practices are not limited to long-term post-construction controls. Site design practices such as preserving natural areas and reducing the size and connectivity of impervious surfaces are examples of LID practices at the site planning stage that will result in improved water quality. City leaders, engineers, developers, and other stakeholders are encouraged to incorporate LID practices into project planning to maximize the effectiveness of their LID strategy and minimize negative impacts on water quality.

Figure 1: Impervious parking lot with no pervious areas or storm water quality features

Extensive research and educational materials have been developed to assist in the understanding and implementation of LID practices. See the US Environmental Protection Agency (EPA) website on LID for an overview of LID concepts: https://www.epa.gov/nps/urban-runoff-low-impact-development.

Projects Covered by the Manual

The guidance provided in this manual is intended for all projects where the long-term management of storm water is required. New development and redevelopment projects within a permitted MS4 that disturb one acre or more, including projects less than one acre that are part of a larger common plan of development or sale which collectively disturbs land greater than or equal to one acre, have specific LID requirements that must be met as part of DWQ's storm water program. As of July 1, 2020, the following requirements apply for new development and redevelopment projects:

New Development: New development projects must manage rainfall on-site and prevent the off-site discharge of the precipitation from all rainfall events less than or equal to the 80^{th} percentile rainfall event or a predevelopment hydrologic condition, whichever is less.

Redevelopment: If a redevelopment project increases the impervious surface by greater than 10%, the project shall manage rainfall on-site, and prevent the off-site discharge of the net increase in the volume associated with the precipitation from all rainfall events less than or equal to the 80^{th} percentile rainfall event.

All projects are encouraged to consider LID practices including projects for permitted non-traditional MS4s such as universities, medical centers, and prisons.

Storm Water Integration

Long-Term Storm Water Management at the Jurisdictional Level

Successful integration of LID features and green infrastructure requires that jurisdictions be able to provide technical and planning guidance to stakeholders. Storm water master plans and technical guidance documents will assist stakeholders in developing their planning approach and design process

Organizational structures vary widely but implementation of long-term storm water quality requirements typically fall within the duties of the public works, utilities, engineering, maintenance, and/or land development groups. It may become necessary to have staff dedicated to storm water management as the jurisdiction develops ordinances, land development standards, storm water master plans, and review processes.

Familiarity with permit requirements is imperative to succeed at implementation. Dedication to achieve and maintain compliance with permit requirements is necessary for a successful and functioning storm water management program. Restraints to success; such as competing interests, budgetary constraints, lack of inter-departmental communication, and lack of support within the jurisdiction, must be addressed or they will jeopardize implementation at the program level, the planning level, and ultimately at the project level.

Impaired Waters

Permittees should be aware of receiving waters within their jurisdiction that have been listed as having impairments on the State's 303(d) list and those that have been identified as requiring or have an approved Total Maximum Daily Load (TMDL). Project sites near these waters may have additional restrictions and require more attention. An interactive map identifying such waters can be found at the DWQ website: https://enviro.deq.utah.gov/

Ordinances

Ordinances should be adopted or modified that promote or mandate LID principles and green infrastructure for development within the jurisdiction. Ordinances should be developed that:

- Promote and preserve open spaces
- Help meet density goals by specifying building footprint, height limits, and setbacks that allow for the proper placement of LID BMPs
- Include an LID analysis as part of the site plan review
- Allow for the use of pervious surfaces within parking lots within parking code
- Encourage clustering development to increase green space within developments
- Address any public safety concerns relating to LID practices
- Allow vegetation appropriate to the BMP being used (See *Vegetation Selection* for specific information relating to the goals and benefits of selecting appropriate vegetation)
- Address maintenance agreements that:
    - Determine final ownership of the BMP (if not the MS4)
    - Require a maintenance schedule, list of activities, and identify the responsible party
    - Allow the municipality to access BMPs for inspections and/or maintenance
    - Provide a method of resolution should violation of the maintenance agreement occur

Examples of ordinances related to storm water maintenance and maintenance agreements templates may be found at the following links:

- EPA – Urban Runoff: Model Ordinances for Stormwater Control: https://www.epa.gov/nps/urban-runoff-model-ordinances-stormwater-control
- Utah Storm Water Advisory Committee – Long-Term Stormwater Management Agreement: https://uswac.files.wordpress.com/2018/09/uswac-long-term-stormwater-management-agreement-template.docx

Creating zoning ordinances and providing incentives that promote LID will lay the groundwork for LID implementation. A gap analysis of existing codes will determine if existing codes are preventing LID principles from being implemented.

A gap analysis is a systematic approach to reviewing ordinances to determine how LID practices can be written into city codes. The results of the gap analysis will identify the objective, a reference to specific codes or standards, and give recommendations for how the code can be modified (*Table 1*).

Table 1: Example parking lot runoff gap analysis results.

Objective	Code	Summary of Impediment
Determine if rain gardens, bioretention cells, and other bioretention devices are permitted within parking areas.	*ORD 04-13.b* Vegetation within parking lots shall be within raised areas and protected by curbs.	The existing code does not permit storm water flows within parking lots to sheet flow into bioretention or vegetated areas.

An example of a gap analysis template for Small MS4s within California was based on a requirement for permittees to review local planning and permitting processes and identify gaps or impediments to effective implementation of post-construction requirements. Landscaping is directly identified as a priority in the permit. The gap analysis identifies five areas related to the conservation and creation of landscapes (AHBL, 2017):

1. Vegetation conservation
2. Open space management
3. Rooftop runoff
4. Open space/cluster development
5. Street and parking lot standards

The full gap analysis template can be found here: https://www.casqa.org/sites/default/files/downloads/20171109_gap_analysis_user_guide.pdf.

Ordinances within Utah

A review of current ordinances within Utah reveals that some cities have created or modified codes to address LID (*Table 2*). Ordinances range from general descriptions of implementation to entire sections dedicated to storm water ordinances and design criteria. Examples of some of these are provided in the following table.

Table 2: LID ordinances within Utah

City	Category	Ordinance
Spanish Fork	Land Use	15.4.16.085.F. Grades *"...The minimum grade allowed for any City street is zero-point forty-five (0.45) percent. The City Engineer or his/her designee may allow a minimum grade of zero-point thirty-five (0.35) percent if the roadway has incorporated Low Impact Development (LID) systems. The maximum grade allowed for any private driveway is 12%."*
Spanish Fork	Utilities	13.16.040.E. *"All site designs shall implement LID principles as defined in this Chapter and in the BMP Manual. Runoff rates from one lot to another may not exceed pre-existing conditions as defined by the City, nor in such a manner that may unreasonably and unnecessarily cause more harm than formerly."*
Spanish Fork	Utilities	13.16.080. Waivers "*Every applicant shall provide for post construction stormwater management as required by this Chapter, unless a written request to waive this requirement is filed and approved. Requests to waive the stormwater management plan requirements shall be submitted to the City SWMP Administrator for approval.* *For post construction, minimum requirements for stormwater management may be waived in whole or in part upon written request of the applicant, provided that at least one of the following conditions applies:* *1. It can be demonstrated that the proposed development is not likely to impair attainment of the objectives of this Chapter.* *2. Alternative minimum requirements for on-site management of stormwater discharges have been established in a stormwater management plan that has been approved by the City Engineer.* *3. Provisions are made to manage stormwater by an off-site facility. The off-site facility must be in place and designed to provide the level of stormwater control that is equal to or greater than that which would be afforded by on-site practices. Further, the facility must be operated and maintained by an entity that is legally obligated to continue the operation and maintenance of the facility.*

City	Category	Ordinance
Moab*	Zoning	17.80.050.10. *"Parking lots shall incorporate methods for storm water management utilizing low impact development (LID) techniques including, but not limited to:* *a. End-of-island bioretention cell(s) with underdrain(s) and landscaping;* *b. Bioretention cells or biofiltration swales located around the parking perimeter;* *c. Breached curb drainage inlets (or curb cuts) in the end-of-island bioretention cells and bioretention strips to collect runoff; or* *d. Bioretention cells installed between lines of parking stalls to increase the total treatment surface area of these systems."*
Salt Lake City	Public Services	Chapter 17.75 through 17.91 address storm water quality ordinances. 17.75.200.C. *"Purposes and Objectives: In view of the foregoing, the purposes and objectives of this chapter through chapter 17.91, inclusive, of this title are to:* *1. Provide for and maintain a stormwater sewer system for collecting and disposing of stormwater runoff;* *2. Establish the inspection, surveillance and monitoring procedures, and all related rules and regulations, necessary to regulate discharges into the stormwater sewer system, and to establish the legal authority to enforce compliance with such rules and regulations; and* *3. Provide fair, equitable and nondiscriminatory rates and charges which will generate sufficient revenues to construct, operate, improve, and maintain the stormwater sewer system at a level commensurate with stormwater sewer management needs. It shall be the policy of the city that present and future costs of operating the stormwater sewer system shall be fairly allocated among the various users of the stormwater sewer system through the establishment of rates and charges based upon such factors as the intensity of development of the parcel; the types of development on the parcel; the amount of impervious surface on the parcel; the cost of maintenance, operation, repair and improvements of the various parts of the system; the quantity and quality of the runoff generated; and other factors which present a reasonable basis for distinction, and which will allow for management of the stormwater sewer system in a manner that protects the public health, safety and welfare. (Ord. 53-07 § 5, 2007)"*

City	Category	Ordinance
Logan	Public Services	13.14.200.A. *"All site designs shall control the peak flow rates of storm water discharge associated with design storms specified in this chapter or in the BMP manual and reduce the generation of postconstruction storm water runoff volumes and water quality to preconstruction levels. These practices should seek to utilize pervious areas for storm water treatment and to infiltrate storm water runoff from driveways, sidewalks, rooftops, parking lots, and landscaped areas to the maximum extent practical to provide treatment for both water quality and quantity. Other low impact development (LID) methods are also encouraged."*

*Not a permitted MS4

Retrofitting Programs

A retrofit program is the structured evaluation of existing development to identify possible improvements to infrastructure with the goal of creating and improving the design of storm water practices and improving water quality. A retrofit program may require dedicated funding for development and implementation. Note that permitted MS4s are required to develop a ranking of control measures to determine those best suited for retrofits. Retrofits can be completed on both public and private properties. Retrofits on private property require coordination and approval from the property owner and may require encouragement through financial incentives to be accepted.

Figure 2: Potential curb cut location that could be retrofitted into a swale

Retrofit programs include activities such as adding curb cuts that allow runoff of impervious surfaces to enter vegetated areas. *Figure 2* shows an existing development that has a slightly depressed, curbed, vegetated area that is surrounded by impervious surfaces. If allowable after considering grading of the site, potential conflicts with the existing utilities, and the environmental sensitivity of receiving waters, a curb cut or multiple curb cuts at the upstream end of the swale to allow parking lot storm water runoff to be conveyed through it would be considered a retrofit. Project site parameters such as the contributing drainage area, imperviousness, 80th percentile volume, water quality flow, and the swale's geometry should be analyzed to determine the impact of the retrofit. Additional analysis would be needed to determine the potential contributing drainage area if a curb cut were to be made at the upstream end. *Figure 3* shows the curb of a parking lot island that has been retrofitted to allow storm water runoff to be retained within the island.

Figure 3: Retrofitted island curb within parking lot

A common need among all programs is prioritizing where retrofit efforts should be focused based on geography and environmental needs. The following factors identified in the Utah 2016 General Permit for Discharges from Small MS4s (UTR090000) must be considered in prioritizing:

- Proximity to waterbody
- Status of waterbody to improve impaired waterbodies and protect unimpaired waterbodies
- Hydrologic condition of the receiving waterbody
- Proximity to sensitive ecosystem or protected area
- Any upcoming sites that could be further enhanced by retrofitting storm water controls

The general steps below can be used in the development of a retrofit program:

1. Identify local need and capacity for storm water retrofitting. Include an evaluation of watersheds in the MS4 that are 303(d) listed or have TMDLs associated with them.
2. Identify potential locations within the MS4 including publicly owned properties, right-of-way, easements, culverts, and existing detention practices that lack adequate storm water practices or are undergoing modifications in the near future.
3. Visit potential project locations to verify current conditions and identify potential retrofit BMP options.
4. Create an inventory of potential locations with site sketches, photos, and basic hydraulic calculations.
5. Based on the permittee's developed ranking of control measures, evaluate retrofit options for factors like performance, cost, community support, property ownership, and feasibility.
6. Model water quality benefits for chosen retrofitting option to determine most cost-effective approach. Online models are available that give users multiple options and associated costs.
    a. Green Values Storm Water Management Calculator: http://greenvalues.cnt.org/calculator/calculator.php
    b. EPA's National Stormwater Calculator: https://www.epa.gov/water-research/national-stormwater-calculator
7. Once the most cost-effective and environmentally beneficial option is determined and funds are obtained, move the project to the design and construction phase. Allow time for sites surveys, permitting, bidding, and specifications.

The LID BMPs described in this manual can be used to retrofit existing sites in addition to the control measures described below.

Curb Cuts

Identify areas where introducing a curb cut will result in flows being diverted from gutters into vegetated areas. A curb cut detailing a depression within the curb may be needed to ensure that flows do not bypass the curb cut. Regrading of the vegetated receiving area and inlet protection may be necessary on the downstream side of the cut.

Dual-Purpose Basins

Retrofitting the outlet structure of a flood control basin creates a dual-purpose basin that accommodates flood control flows and the 80^{th} percentile volume (*Figure 4*). Determine the 80^{th} percentile volume of the contributing drainage area and provide an outlet near the bottom of the structure that releases the 80^{th} percentile volume within an acceptable drawdown time. Modification of the outlet structure can be as simple as adding orifices to a pipe riser or could require design of a new outlet structure.

Perform infiltration testing (or obtain from project plans) within the basin to determine the infiltration rate of the soils within the basin. If infiltration rates are appropriate for retention, the detention basin will also function as an infiltration basin.

Figure 4: Multi-stage overflow outlet with trash screen

Trash Capture Devices

Trash collection devices are installed as in-line systems or end-of-pipe systems to prevent large solids from entering a receiving water or basin. In-line systems require more design effort and expense for retrofitting but end-of-pipe systems such as that seen in *Figure 5* are easier to install retroactively to a pipe end section depending on the end section configuration.

Linear radial devices are in-line or end-of-pipe trash collection devices that can be installed either within the pipe or at the end of a pipe prior to discharging to a basin or receiving water. The EPA provides additional information about the use of linear radial devices: https://www.epa.gov/trash-free-waters/clean-water-act-and-trash-free-waters.

Figure 5: End-of-pipe trash netting

Alternative Compliance and Credit Systems

Alternative Compliance Options

Municipalities may choose to adopt alternative options that provide water quality benefits either on-site or off-site. Off-site treatment is only considered when it is technically infeasible to retain the project volume retention goal within the project limits as required for permitted MS4s. This is done within the project limits, within the watershed or subwatershed of the project, or on a regional level. If retention of the project volume retention goal is technically infeasible for a project, possible alternative compliance measures include:

- Implementation of BMPs that provide water quality treatment such as bioswales, filter strips, etc.
- Proprietary water quality treatment devices.
- The creation of off-site retention areas within the original project's subwatershed that is sized for the volume unable to be captured.
- Establishment of a credit system that allows for the tracking of volume reduction and pollutant reduction throughout the municipality's jurisdiction.

Spanish Fork's Municipal Code (13.16.080) which is cited within the example ordinances (*Table 2*), allows requests to be submitted to waive post construction storm water requirements.

Credit Systems and Alternative Compliance Programs

In its simplest form, a credit system is a database of projects that documents project volume retention goals and the actual volume retained. This applies to pollutant reduction goals as well. Regional BMPs can be used within the credit system. Additional runoff at one project location can be retained to account for runoff that may have been technically infeasible to retain at other project locations.

A few examples of credit systems and other alternative compliance programs are briefly explained below. Links to additional credit systems in use throughout the country are found below the examples in *Table 3*.

Minnesota Pollution Control Agency

The state of Minnesota credit system quantifies storm water runoff volume and pollutant reduction. Every cubic foot of the design storm that is captured is counted as a credit. Pollutant removal is counted as 1 credit based on the unit of measurement for the pollutant. For example, if a BMP removes 10 pounds of phosphorus per year, it is counted as 10 credits. Multiple credits can be claimed for each BMP depending on its function. A bioretention area that removes multiple pollutants can claim credit for the volume reduction and the reduction of any pollutants (Kieser & Associates, LLC, 2009).

Credits can be used towards the following:

- To meet a TMDL waste load allocation
- To meet the Minimal Impact Design Standards performance goal
- To provide incentive to site developers to encourage the preservation of natural areas
- To reduce costs associated with BMPs
- To supplement the Minnesota Pollution Control Agency Construction General Permit or be used for projects not covered under the CGP
- As part of the financial evaluation under a local storm water utility program

San Diego County

San Diego County implements an Alternative Compliance program that is implemented in areas that are unable to retain 100% of the required retention volume on-site. There may be several reasons why the volume cannot be handled on-site including poorly infiltrating soils, high groundwater, and concerns with pollutant mobilization. San Diego County has identified the following measures for alternative compliance (California Regional Water Quality Control Board San Diego Region, 2015):

- Stream or riparian area rehabilitation
- Retrofitting existing infrastructure for storm water retention or treatment
- Groundwater recharge projects
- Regional BMPs
- Water supply augmentation projects
- Floodplain preservation through land purchase

Los Angeles County

Los Angeles County also implements an Alternative Compliance program. Los Angeles County has identified the following measures for alternative compliance (California Regional Water Quality Control Board Los Angeles Region, 2016):

- On-site biofiltration
- Offsite infiltration
- Groundwater replenishment projects
- Offsite retrofitting projects
- Regional storm water mitigation programs

If using biofiltration, the county requires the project to treat 1.5 times the volume retention goal that cannot be retained on-site. Offsite infiltration requires a project to retain the portion of the project's volume retention goal that is unable to be retained on-site as well as reduce pollutant loads from the runoff. Groundwater replenishment projects are required to intercept the volume retention goal not retained on-site through infiltration, bioretention, or groundwater replenishment BMPs. These projects are required to be located in the same sub-watershed as the development. For retrofitting projects, developers are required to retain the volume retention goal not retained on-site through BMP measures at a site with similar land uses. The regional storm water mitigation program option allows permittees to create a program for handling runoff on a regional or sub-regional scale.

Table 3: Nationwide storm water programs using credit systems.

State or Local Storm Water Guidance Document	Web Link
Vermont Storm Water Management Manual	https://dec.vermont.gov/sites/dec/files/wsm/stormwater/docs/Permitinformation/2017%20VSMM_Rule_and_Design_Guidance_04172017.pdf
Minnesota Stormwater Manual	https://www.pca.state.mn.us/water/minnesotas-stormwater-manual
Philadelphia Storm Water Management Guidance Manual	https://www.pwdplanreview.org/manual-info/guidance-manual
New Jersey Storm Water Best Management Practices Manual	https://www.njstormwater.org/bmp_manual2.htm
Maryland Storm Water Design Manual	https://mde.maryland.gov/programs/Water/StormwaterManagementProgram/Pages/index.aspx
Georgia Storm Water Management Manual	https://atlantaregional.org/natural-resources/water/georgia-stormwater-management-manual/
Pennsylvania Storm Water Best Management Practices Manual	http://www.depgreenport.state.pa.us/elibrary/GetFolder?FolderID=4673
Ontario Storm Water Management Planning and Design Manual	https://www.ontario.ca/document/stormwater-management-planning-and-design-manual-0
Storm Water Management Manual for Western Washington	https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/stormwater-permittee-guidance-resources/stormwater-manuals

Source: Center for Watershed Protection

Storm Water at the Project Level

Incorporating LID principles at the planning stages of a development will increase the likelihood that they will be able to be integrated into the site (*Figure 6*). If LID is considered late in the design, it becomes more expensive to implement due to costs associated with redesign of the site layout, additional geotechnical studies, or coordination with community councils, watershed management groups, or other state or federal agencies. Integration of LID principles should be done by qualified engineers who understand the goals of the project, the requirements within the municipality's jurisdiction, and the design criteria for the BMPs.

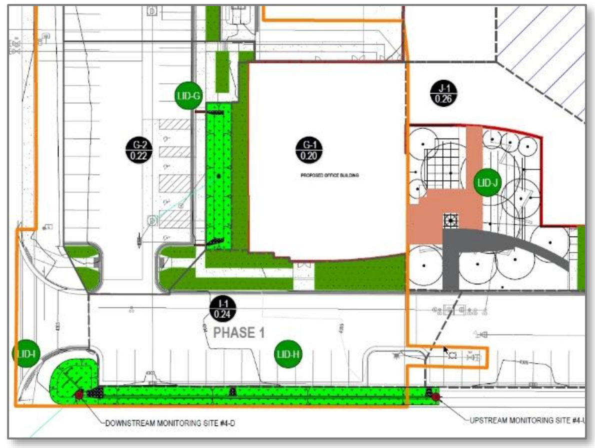


Figure 6: LID BMPs shown in site plans

Collaboration among a project's stakeholders for including LID principles should occur as part of the regular project development, as would be the case for other design elements like grading, utilities, and flood control. As the design progresses, project meetings should include discussion on the storm water elements of the project to ensure that water quality requirements are being met and that the LID approach is functional and compatible with the site's hydrologic and hydraulic design. Additional meetings and coordination to address design details and/or conflicts should be expected. A list of potential project team members who will be involved in the coordination and/or design of LID features is presented in *Table 4*.

Table 4: LID project team.

Jurisdiction/Permittee		**Site Designer/Developer/Architect**
MUNICIPALITY	NON-TRADITIONAL MS4s	Project Manager
Storm Water Coordinator	Storm Water Coordinator	Civil Engineers
Environmental Compliance	Environmental Compliance	Geotechnical Engineers
City Engineer	Facilities Director	Lead Architect
Public Works	Project Coordinator	Landscape Architects
Utilities	Utilities	Landscape Engineers
Planner	Planner	Environmental Engineers
Maintenance	Maintenance	
Landscaping	Landscaping	

Site Considerations

Gather subsurface, geotechnical, topographical, and any other technical information about the site to incorporate into the site design. Site conditions will dictate an appropriate LID approach by revealing opportunities and limitations.

Soils

Soil characteristics will determine if certain LID approaches are feasible. Soils that are classified as Hydrologic Soil Group 'A' are generally acceptable for bioretention and infiltration BMPs. 'B' soils may be marginal for infiltration and bioretention. 'C' and 'D' soils generally have limited capacity for bioretention and infiltration. For a planning level analysis of the Hydrologic Soil Groups, the Web Soil Survey developed by the National Cooperative Soil Survey can be used: https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx. For design, geotechnical reports should determine if the existing soils are acceptable.

Groundwater

Infiltration BMPs should not be utilized within areas of shallow groundwater as it may lead to flooding of the BMP or introduction of pollutants into the groundwater. Measurements should be taken at each BMP location to determine the depth to the historical high groundwater level. The following groundwater resources are available for planning level decision making:

Hydrogeology of Recharge Areas and Water Quality of the Principal Aquifers along the Wasatch Front and Adjacent Areas, Utah – A snapshot of the overall hydrogeology within the Wasatch Front area of Utah. https://pubs.usgs.gov/wri/1993/4221/report.pdf

Groundwater Conditions in Utah, Spring of 2017 – An annual report on groundwater conditions within Utah. https://ut.water.usgs.gov/publications/GW2017.pdf

Utah Active Water Level Network, USGS – Active monitoring of groundwater wells throughout the state. https://groundwaterwatch.usgs.gov/StateMap.asp?sa=UT&sc=49

Project sites with contaminated groundwater may not be appropriate for infiltration due to the potential for mobilizing the contamination into new areas. Coordinate with jurisdictions or watershed management groups to identify areas with contaminated groundwater to determine the level of concern it presents.

Existing drainage patterns

Drainage patterns will be readily evident for any redevelopment project either from visual observation or from plan sets. Determine the constraints introduced by the existing storm drain network such as pipe capacity and inlet and outlet elevations. For new development projects, determine the existing drainage patterns as determined by the site's topography. It is more likely that the site's pre-development hydrology can be mirrored if the design maintains the original drainage patterns and paths.

Existing pervious areas and vegetation

If existing pervious areas can support bioretention or already provide bioretention, maintain them or otherwise make them a part of the site design. Taking advantage of natural depressions or areas of vegetation is an ideal and cost-effective alternative to grading and design. Preserve existing trees and other vegetation on-site when possible.

Site Design Practices

Storm water treatment and retention is most effective when done close to its source. Site design practices accomplish this by taking advantage of approaches that are aimed at reducing the overall impact of the development. These approaches to reducing the impact of storm water should be considered during projects' planning phases and their use should be evaluated as design progresses. These practices should be prioritized because they will reduce the project's retention requirement by introducing pervious areas and they will reduce storm water pollutants.

Reduction of Impervious Surfaces

Reducing impervious surfaces, preserving pervious surfaces, or creating pervious surfaces provides multiple benefits to storm water quality. From a storm water quality standpoint, the potential for treatment is higher for runoff that lands on the pervious surface instead of on an impervious surface. Pervious surfaces with healthy soils will infiltrate more runoff from frequent storms. From a design standpoint, increasing the pervious area decreases the total runoff from the site. Pervious surfaces also provide the opportunity to add shade trees or other types of vegetation that will increase the aesthetic appeal of the site. For more information, see the Minimize Impervious Area fact sheet.

Disconnected Impervious Areas

The practice of connecting impervious areas to the storm drain network is ubiquitous as traditional designs encouraged the removal of runoff as quickly as possible. This practice leads to increased runoff volume from rain events and increased peak flows. Treatment of runoff is virtually nonexistent as it is conveyed from rooftop to sidewalk to parking lot to catch basin to receiving water, taking with it all the pollutants it encounters in its path. Disconnecting impervious areas by introducing pervious areas or rerouting flows from impervious surfaces (*Figure 7*) slows down flows and reduces the volume discharged to the downstream storm drain network or removes it entirely. Treatment is also provided through bioretention and biofiltration.

Figure 7: Downspout disconnected from parking lot

Curb Cuts

Curb cuts can be part of a site plan or be introduced as part of a retrofit program. Curb cuts are a simple way to convey flows from an impervious surface to a pervious surface (*Figure 8*). Roadways and parking lots are prime locations to investigate whether curb cuts can be used to divert flows from a traditional storm drain network to a pervious area or a bioswale, bioretention or infiltration area, or another type of BMP.

Figure 8: Curb cuts to a rock lined swale.

Additional site design practices

- Preserving natural areas
- Site reforestation
- Stream and shoreline buffers
- Open space design
- Disconnecting rooftop and impervious discharges and distributing runoff
- Soil compost amendments
- Grass channels
- Storm water landscaping
- Reducing impervious cover in site design
    - Narrower streets and sidewalks
    - Smaller cul-de-sacs
    - Shorter driveways
    - Smaller parking lots

Documentation

MS4s are required to review and document that a project's LID approach and design are consistent with the permittee's requirements and other project developers may wish to document design parameters. A template for documentation is provided in *Appendix B*. The storm water quality report template provides jurisdictions a sample of project documentation that ensures consistent design and verifies compliance with LID considerations and retention requirements. The report template may be used during a project's design and review process and be required as part of a project's submittal documents to ensure that water quality requirements have been met. The review process may differ between municipalities, and the template can be altered as needed by the user. Sample text is highlighted.

The 80th Percentile Volume

LID Impact on Hydrology

Storm water programs have focused on the goal of mimicking predevelopment hydrologic conditions over the last several decades as municipal and department of transportation (DOT) storm water programs have increased their efforts to comply with the Federal Clean Water Act of 1972 and their associated MS4 permits. LID BMPs, green infrastructure practices, and retention of the 80th percentile volume or of the predevelopment hydrologic condition are tools and requirements that are used to accomplish this goal.

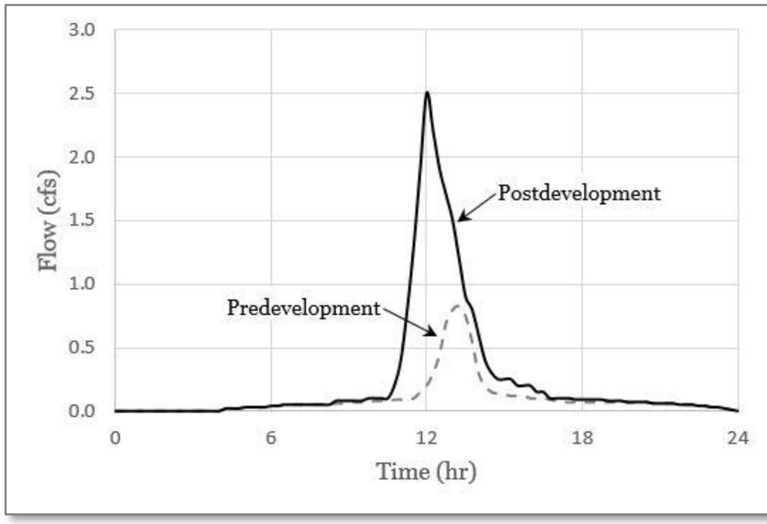


Figure 9: Typical hydrologic impact of development on-site hydrology.

More frequent peak flows, higher peak flows, and higher runoff volumes are well-documented hydrologic impacts of urbanization and development due to an increase in impervious surfaces (D.B. Booth, 1997; Konrad & Booth, 2002) (*Figure 9*).

Traditional approaches to storm water management that remove runoff from a site by quickly conveying flows to a storm drain network are also effective in protecting life and property and should be implemented in tandem with low impact design principles. Within Utah, discharges are typically limited to between 0.1 cfs and 0.2 cfs per acre.

An LID approach to site development produces a hydrologic condition that more closely mimics the pre-development hydrologic condition. Peak flows are reduced and are less frequent (*Figure 10*); runoff volume is also reduced (WEF Press, 2012).

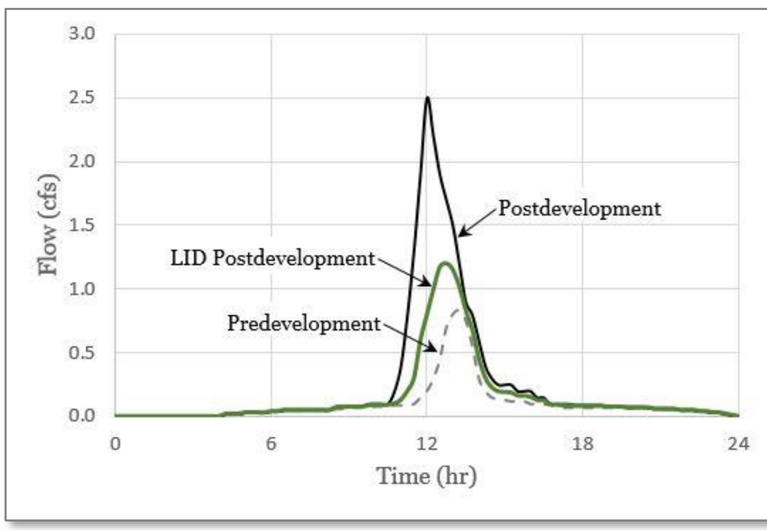


Figure 10: General post development hydrograph with LID.

Developing the 80th Percentile Volume

Project Volume Retention Goal, V_{goal}

V_{goal} for New Development: The volume of runoff generated within the project's limits of disturbance over a 24-hour period during the 80th percentile storm event or a predevelopment condition, whichever is less.

Attachment: DWQ-2019-000161 (Section 13.94.040 Storm Water System Design and Management Standards)

V_{goal} for Redevelopment: For a redevelopment project that results in a net increase in impervious surface greater than 10%, V_{goal} is the net increase in volume between the existing condition and the proposed condition generated by the 80th percentile storm event over a 24-hour period.

Water Quality Volume, WQV – The volume of runoff generated within a BMP's drainage area over a 24-hour period during the 80th percentile storm event.

The following steps may be used to determine the project volume retention goal and the water quality volume.

Step 1: 80th Percentile Depth

Method 1

A table of 80th percentile storm depths can be found in *Appendix A*. These values have been determined by the permittees.

Method 2

Planners and developers should verify with the MS4 before determining an 80th percentile with this method.

Determine the 80th percentile precipitation depth.

1. Obtain long-term daily rainfall data from the following sources:
    a. National Oceanic and Atmospheric Administration (NOAA): https://www.ncdc.noaa.gov/cdo-web/datatools/selectlocation; or
    b. Reliable historical local data; or
    c. Any other reliable data source.
2. Sort data low to high.
3. Remove snowfall and small precipitation events (≤0.1 inch).
4. Use the Excel PERCENTILE function to calculate the 80th percentile rainfall depth.

A more in-depth discussion on determining the 80th percentile precipitation depth is found here: https://documents.deq.utah.gov/water-quality/stormwater/DWQ-2019-004584.pdf.

A reliable record of historical precipitation data should meet the following conditions:

1. Come from an active rain gage;
2. Have at least 30 years of data;
3. Have 90% data coverage for the period of record.

Step 2: Imperviousness

To determine the project's volume retention goal, determine the imperviousness within the disturbance limits of the project. To determine the water quality volume of a BMP's drainage area, determine the imperviousness of the drainage area. The imperviousness of the BMP drainage area will include any off-site impervious areas that are part of the BMP's drainage area.

Project imperviousness = Post-development impervious area / Project's disturbance limits

BMP imperviousness = Post-development impervious area within BMP drainage area / BMP drainage area

Step 3: Volumetric Runoff Coefficient

Determine the volumetric runoff coefficient (R_V).

The volumetric runoff coefficient (also referred to as just the 'runoff coefficient') is a calculation of the percentage of rainfall that results in surface runoff. Runoff coefficients for small, frequent storms, such as for the 80th percentile, are not equivalent to runoff coefficients for large, less-frequent storms such as the 10-yr event and greater that are used with the Rational Method. The effects of infiltration, retention, and interception are increased for the smaller storm events compared to the larger events. Because of this, runoff coefficients for smaller storms are numerically smaller than for larger storms.

In 1983 data from over 50 sites nationwide was evaluated as part of the Nationwide Urban Runoff Program (NURP) (Driscoll, 1983). From these sites, mean and median R_V values were calculated and compared to the site's imperviousness. This research led to the following conclusions that are also discussed by Schueler who did additional analysis of the NURP sites:

1. "Most of the variation in mean R_V among sites can be attributed to differences in the level of urbanization, and in particular, to the site imperviousness."
2. "R_V's were found to be relatively consistent at individual sites and were only weakly correlated with storm-related variables such as precipitation volume, intensity, and duration."
3. "The runoff coefficient could serve as a reliable estimator of runoff volumes, given an initial estimate of rainfall volume." (Schueler, Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs, 1987)

Various coefficients for smaller storms have also been developed using national datasets and through local research. Municipalities are encouraged to research these and other runoff coefficients or develop their own in determining which method to use within their jurisdiction for use with the 80th percentile storm. Deciding on a single runoff coefficient methodology for a jurisdiction will simplify the design and review process.

Development of a runoff coefficient is done by monitoring the runoff volume produced from a storm event. The runoff coefficient is the ratio between the monitored runoff volume and the total precipitation volume expressed in the following equation and will vary depending on land use and imperviousness of the measured area:

$$R_V = \frac{V_R}{V_P}$$

Where:

R_V = Volumetric runoff coefficient, unitless

V_R = Monitored runoff volume, cf

V_P = Total precipitation volume, cf

The total precipitation volume can be determined using the following equation:

$$V_P = \frac{dA}{12}$$

Where:

d = Precipitation depth, in.

A = Drainage area, sf

It is not the intent of this manual or the Division of Water Quality to recommend specific methodologies. An in-depth summary of runoff coefficients used throughout the country by municipalities and DOTs was developed by the California Department of Transportation (Caltrans) and published as a Technical White Paper titled *Runoff Coefficient Evaluation for Volumetric BMP Sizing*. It can be found here: http://www.dot.ca.gov/design/hsd/guidance/CTSW-TM-15-312_03_01-Runoff_Coeff_for_Vol_BMP_Sizing.pdf. This white paper specifically discusses Method 1 in more detail.

For all the equations presented below, *i* represents the percent of imperviousness of the drainage area in decimal format (0.0 – 1.0).

Method 1 – Reese method

Comparing the imperviousness of 44 nationwide sites to their respective calculated volumetric runoff coefficient, a simple linear regression equation was created to estimate the volumetric runoff coefficient for small urban catchments. Land uses for these sites were classified as residential, mixed, commercial, industrial, and urban open and nonurban (Schueler, Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs, 1987). Outliers were removed from this dataset by Reese to derive the equation below. Removing outliers from the dataset reduces the impact of erroneous measurements (Reese, 2006).

$R_V = 0.91i - 0.0204$

Method 2 – Hydrologic soil groups

Regression equations for runoff coefficient equations were derived based on imperviousness and the NRCS hydrologic soil groups for the 2-year event as presented in *Table 5* (Guo, 2013).

Table 5: Runoff coefficient equations based on the NRCS Soil Group.

NRCS Soil Group

A	B	C/D
$R_{V\text{-}A} = 0.84i^{1.302}$	$R_{V\text{-}B} = 0.84i^{1.169}$	$R_{V\text{-}C/D} = 0.83i^{1.122}$

Method 3 – Granato method

This runoff coefficient is calculated based on a two-line regression model of the runoff coefficient developed by the United States Geological Survey (USGS). This method of developing the runoff coefficient was developed to assist DOTs and contractors to estimate long-term volume reduction for highway projects and has been adopted for use by UDOT. Additional information relating to this runoff coefficient and its applicability can be found in NCHRP Report 792.

$R_V = 0.225i + 0.05;$ when $i < 0.55$

$R_V = 1.14i - 0.371;$ when $i \geq 0.55$

Step 4: 80th Percentile Volume

Calculate the 80th percentile volume using the following equations for V_{goal} or WQV.

$$V_{goal} = R_V dA \quad \text{or} \quad WQV = R_V dA$$

Where:

V_{goal} and WQV = 80th percentile volume, cf

R_V = Volumetric runoff coefficient, unitless

d = 80th percentile storm depth, ft (convert from inches to feet if required)

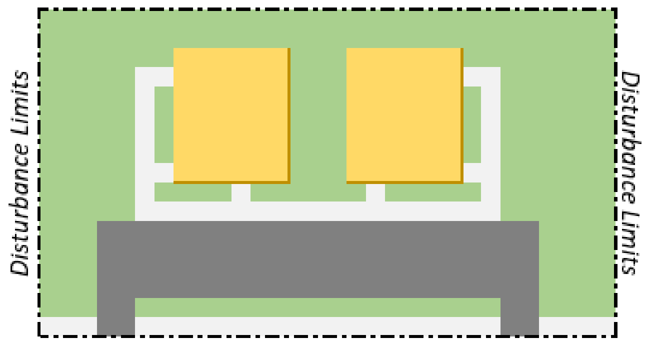
A = Project area or BMP drainage area, sf

The images on the following page show how V_{goal} and WQV are related. Examples from local case studies and different land uses further demonstrate the usage of these equations. See *Land Use Examples* and *Local Case Studies*.

V_{goal}

New Development

V_{goal} is the volume generated from the 80th percentile storm event over the entire project site or a predevelopment hydrologic condition, whichever is less.



$V_{goal} = R_V dA$

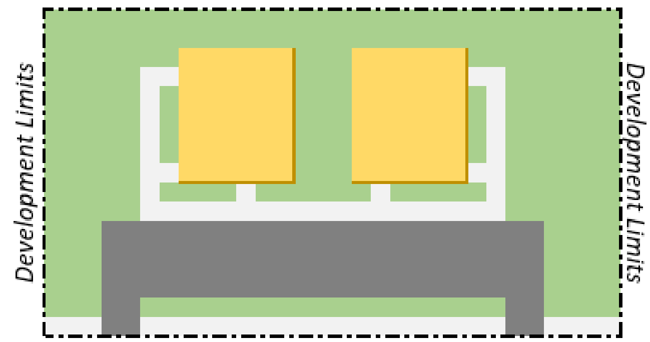
R_V = Volumetric runoff coefficient (based on the project's total area)

d = 80th percentile storm depth, ft

A = Project area, sf

Redevelopment

V_{goal} is the net volume increase generated from the 80th percentile storm event over the project area when the increase in impervious surface is greater than 10%.



Proposed Redevelopment
(Impervious surface increase > 10%)

$V_{goal} = V2 - V1$

$V_2 = R_V dA$

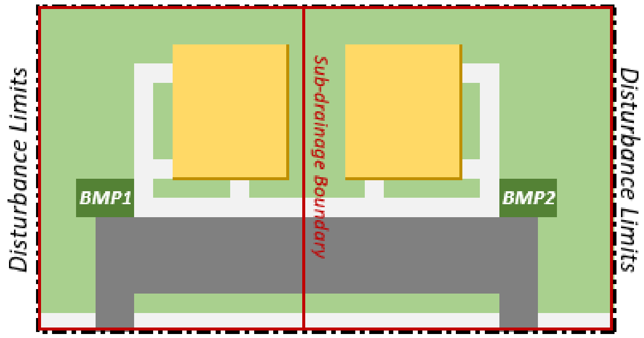
- Volume generated by the 80th percentile storm depth for the proposed project condition.

$V_1 = R_V dA$

- Volume generated by the 80th percentile storm depth for the existing project condition.

Water Quality Volume, WQV

The WQV is the 80th percentile volume of the sub-drainage area for each BMP.



Within the sub-drainage area boundaries, WQV is the 80th percentile volume based on the BMP's drainage area, the imperviousness of the BMP's drainage area, and the 80th percentile storm depth.

WQV = $R_V dA$

R_V = Volumetric runoff coefficient (based on the sub-drainage area's imperviousness)

d = 80th percentile storm depth, ft

A = Sub-drainage area, sf

LID BMPs

Introduction

LID BMPs are long-term structures, graded features, or practices that are designed to retain and/or treat runoff close to its origin after construction is complete. Guidance is given in the following areas:

- **Fact Sheets:** The preface and fact sheets contain information on: pollutant removal effectiveness, design criteria, calculation methods, sample calculations, evaluating BMP effectiveness, technical infeasibilities, water quality concerns, a designer checklist, vegetation selection, installation, installation costs, maintenance, maintenance activities, maintenance costs, and a cross-sectional figure.
- **Treatment Trains:** A description of the use and benefits of treatment trains.
- **Proprietary Devices:** A discussion on manufactured devices that have been designed specifically for storm water quality.
- **LID BMP Selection:** How 303(d) listed impairments, TMDLs, and existing and planned land uses should be used to inform the selection of BMPs. Three flow charts are shown for BMP selection based on site conditions and design criteria.
- **Vegetation Selection:** Description of the role of vegetation and guidance on plant selection for BMPs.
- **Land Use Examples:** Hypothetical developments showing a site plan for residential, commercial, and industrial land uses and how an LID approach improves storm water quality.
- **Local Case Studies:** Examples of existing sites within Utah that have implemented LID practices.
- **Additional Local LID Implementation:** An overview four additional LID sites that investigated pollutant removal, vegetation performance, and the relationship between observed runoff coefficients and rain depth, storm duration, and intensity.

LID BMP Fact Sheets

DWQ has developed fact sheets for 12 LID BMPs. These provide guidance for the more common BMPs; however, BMP selection should not be limited to those on this list. They can be found in *Appendix C*.

LID BMP Type	Fact Sheet ID	LID BMP Category
Minimize Impervious Area	SD-1	Site Design
Rain Garden	BR-1	Bioretention
Bioretention Cell	BR-2	
Bioswale	BR-3	
Vegetated Strip	BR-4	
Tree Box Filter	BR-5	

LID BMP Type	Fact Sheet ID	LID BMP Category
Green Roof	BR-6	
Pervious Surfaces	PS-1	Pervious Surfaces
Infiltration Basin	ID-1	Infiltration Devices
Infiltration Trench	ID-2	
Dry Well	ID-3	
Underground Infiltration Galleries	ID-4	
Harvest and Reuse	HR-1	Harvest and Reuse

Where possible, information that is relevant to all BMPs has been summarized below in this preface instead of repeating identical information in each fact sheet.

Preface to Fact Sheets

Pollutant Removal Effectiveness

Pollutant removal effectiveness is determined from various sources and provides general guidance (Taylor & Barrett, 2014; Filterra Bioretention, 2018; Minnesota Pollution Control Agency, 2018; WERF, 2016; Charlesworth, Beddow, & Nnadi, 2017; APWA, 2012). Many factors contribute to a BMP's pollutant removal effectiveness such as infiltration capacity, climate, vegetation selection, and maintenance practices. Careful collection and analysis of monitoring data is the only definitive method of determining actual pollutant removal for any BMP.

Primary Functions

The BMP's primary functions are listed as a quick reference. Bioretention is the process by which soils and plants remove pollutants from runoff after it has entered the soil. Volume retention describes the BMP's ability to retain runoff and contribute to groundwater recharge. Biofiltration is the process by which pollutants are removed as surface flows interact with grasses, and other vegetation.

Design Criteria

The design criteria for each BMP are based on generally accepted designs. The maximum and minimum ranges are meant to provide a starting point for jurisdictions to develop their own standards, details, and designs. They are not prescriptive. Deviation from the design criteria in these fact sheets is acceptable and encouraged if alternative designs are supported by sound engineering practice, research, or have been shown through past experience to be effective.

Calculation Methods

BMPs are sized for the water quality volume and/or the water quality flow of the BMP's contributing drainage area. The following equations are used for the BMPs in the fact sheets.

Manning's Equation

Applicable BMPs: *Bioswale*, and *Vegetated Strip*

$$Q = \frac{1.49}{n} A R^{\frac{2}{3}} \sqrt{S}$$

Where:

Q = Flow rate, cfs

n = Manning's roughness coefficient, unitless

A = Cross-sectional area of flow, sf

R = Hydraulic radius, sf/ft

S = Longitudinal slope, ft/ft

Continuity Equation

Applicable BMPs: *Bioswale*, and *Vegetated Strip*

$$Q = AV$$

Where:

Q = Flow rate, cfs

A = Cross-sectional area of flow, sf

V = Flow velocity, ft/s

Storage volume within a media with a known porosity

Applicable BMPs: *Rain Garden*, *Bioretention Cell*, *Pervious Surfaces*, *Infiltration Basin*, and *Infiltration Trench*

$$V_{storage} = nV$$

Where:

$V_{storage}$ = Volume of runoff available for storage within media, cf

n = Media porosity, unitless

V = Volume of media layer, cf

Drawdown time

Applicable BMPs: *Rain Garden*, *Bioretention Cell*, *Pervious Surfaces*, *Infiltration Basin*, and *Infiltration Trench*

$$t = \frac{(D_T n_W + d)}{k}$$

Where:

t = Drawdown time, hrs

D_T = Total depth of soil matrix, in

n_W = Weighted average porosity of soil matrix based on soil layer depth

d = Ponding depth, in

k = Design infiltration rate of existing soil or soil matrix, in/hr

---

Minimum footprint area

Applicable BMPs: *Rain Garden*, *Bioretention Cell*, *Infiltration Basin*, and *Infiltration Trench*

$$A_{min} = \frac{12xSFxWQV}{kt}$$

Where:

12 = Conversion factor (inches to feet)

SF = Safety factor

WQV = Water quality volume, cf

k = Design infiltration rate of existing soil or soil matrix, in/hr

t = Drawdown time, hr

Water quality outlet elevation

Applicable BMPs: *Rain Garden*, *Bioretention Cell*, and *Infiltration Basin*

$$Ele_{WQ} = \frac{WQV}{A_{bottom}}$$

Where:

Ele_{WQ} = Elevation of the water quality volume above basin bottom where overflow is provided, ft

WQV = Water quality volume, cf

A_{bottom} = Area of basin bottom, sf*

*Although stage storage calculations may determine the water quality elevation, using the basin bottom will yield a conservative value.

Volume Reduction

For retention BMPs, the volume reduction is inherent in the sizing of the BMP. For example, a rain garden that is designed to retain 1,000 cf is said to have a volume reduction of 1,000 cf. Volume reduction calculations for bioswales and vegetated strips, however, may not be as simple to quantify due to the variable design considerations such as longitudinal slope, flow rate, and infiltrating capacity of the soils. The information below summarizes a few tools that have been developed by either national research groups or municipalities that may be considered for use.

It is not the intent of this manual to give guidance on the use of these tools or to discuss their applicability at length. Jurisdictions are encouraged to review and apply these tools as deemed appropriate or to develop their own. Jurisdictions are also encouraged to monitor the volume reduction of their own bioswales and vegetated strips to gain a more precise understanding of performance within their jurisdiction to be able to make better informed design level and planning level decisions.

Urban Drainage Flood Control District, Colorado – UD-BMP v3.07

An Excel spreadsheet developed by the Urban Drainage Flood Control District. A multivariable Storm Water Management Model (SWMMM) analysis determines volume reduction based on the user's input of the BMP's drainage area characteristics such as imperviousness and soil type.

The tool can be found by clicking on the link for UD-BMP v3.0 here: https://udfcd.org/software.

City of Stockton, California – Stormwater Quality Control Criteria Plan Volume Reduction Calculator

An Excel spreadsheet developed by the City of Stockton and the County of San Joaquin. User input determines pre- and post-project volume runoff to determine the expected volume reduction.

The spreadsheet can be downloaded by clicking on the link for the Stormwater Quality Control Criteria Plan Volume Reduction Calculator found here:
http://www.stocktongov.com/government/departments/municipalUtilities/utilStorm.html.

NCHRP 25-41 – Volume Performance Tool V.1.0 for Windows

An Excel spreadsheet developed by the National Cooperative Highway Research Program (NCHRP) that allows users to define site characteristics and drainage area characteristics and determine an estimate of the volume reduction percentage for various BMP types. Applicability of this tool is limited to projects within urban highway environments.

The tool can be downloaded by clicking on the link for the .ISO CD-ROM Image found here:
http://www.trb.org/Main/Blurbs/172415.aspx.

Sample Calculations

The sample calculations provide one working configuration of a planning level design for each type of BMP. For example, the sample calculations in the rain garden fact sheet assume that the soils infiltrate and that there are no subsurface constraints. However, if a rain garden is required to be lined, an underdrain design and detention time may need to be considered. Different approaches beyond what is shown in the examples might be required and alternate calculation methods are acceptable if they are supported by sound engineering practice, research, or have been shown through experience to be effective.

Consider the following assumptions when reviewing the sample calculations:

- The examples use hypothetical jurisdictional requirements and design criteria to show their role in BMP design. An example may state that the jurisdiction requires 6 inches of freeboard for a BMP, but jurisdictions are encouraged to develop and implement their own design standards.
- The examples have been prepared with the assumption that the BMPs are for water quality purposes only. It is assumed that upstream bypasses have been provided for larger storm events or that overflow structures within the BMP are provided.
- The examples state which method of determining the volumetric runoff coefficient is used for the sole purpose of showing the calculations for the methods discussed in this manual. It is not intended to be an endorsement of a methodology for each BMP type. The appropriate use of runoff coefficients will be determined by jurisdictions.

See *Step 3: Volumetric Runoff Coefficient* in *Developing the 80th Percentile Volume* for additional information.

Evaluating BMP Effectiveness

To evaluate the performance of a BMP, it is necessary to know its purpose for the developed site and to understand the goals for the BMP's watershed. Visiting BMPs during storm events is a highly valuable method for determining if the BMP is functioning as expected. If the BMP is part of a monitoring program, analysis of monitoring data will reveal if it is performing as designed.

To gain a basic understanding of whether the BMP is functioning properly, performing as expected, and meeting regulatory goals several general questions should be asked that can be applied to all BMPs. Answers to these questions may provide guidance on how to remedy any functionality or treatment issues that arise. The below questions, along with additional considerations specific to each BMP that can be found within the fact sheets, can be used during BMP inspections.

Site-Specific Considerations

1. Are flows reaching the BMP?
    a. If not, flows have been interrupted and runoff is not being retained or treated by the BMP.
2. Is standing water present at or upstream of the BMP?
    a. If yes, the BMP may be clogged, groundwater may be entering the BMP, or the storm drain network may be backing up. Standing water can cause mosquito problems.
3. Is sediment collecting at the upstream end before entering the BMP?
    a. Sediments will ideally be captured in pretreatment (forebay, sump, bioswale, etc.). If significant amounts of sediment are visibly accumulating prior to entering the BMP (either along a curb or within a vegetated area), they should be removed to prevent them from eventually entering the BMP.
4. Does the BMP overflow during large storm events?
    a. If yes, this could indicate that the designated overflow point is clogged, and it should be immediately corrected.
5. Have changes to the site altered the quantity or quality of runoff that drains to the BMP?
    a. If yes, the drainage area to the BMP may be larger than the original design, and the BMP will be undersized for its new drainage area.
6. Is the BMP within a jurisdiction's database and is it being regularly maintained by the responsible party?
    a. If no, the BMP will likely fail. See the individual BMP fact sheets for specific maintenance activities that will prolong the lifespan of the BMP.
7. Has the public raised concerns about the BMP?
    a. If yes, address concerns or, if no modification is necessary, provide education on BMP functions and protective measures that are in place.

Watershed Specific Considerations

1. Is the BMP located within a 303(d) listed watershed, and does the watershed have an approved TMDL?
    - If yes, prioritizing the BMP for monitoring should be considered.
2. Was the BMP designed to address specific TMDL approved impairments?

   - If yes, monitoring will provide data to support the BMP's performance.
3. Has upstream and downstream monitoring equipment been set up for the BMP, and is it functioning?
   - If yes, analyze data of the monitored parameters to determine the BMP's effectiveness.
4. Does monitoring data show that targeted pollutants are being removed?
   - If no, investigate further to determine causes for the BMP's inability to remove the targeted pollutants.

Technical Infeasibilities

It may be technically infeasible to install BMPs at the project site. When this is the case, the site is not required to retain the full project volume retention goal; however, an MS4 may require that an alternative compliance option be utilized (See *Alternative Compliance and Credit Systems*). Technical infeasibilities will be related to depth to the historical high groundwater, soil conditions, project boundaries, economic factors, or other reasons. Possible technical infeasibilities have been categorized below by BMP type.

General Infeasibilities

- Insufficient project space
- Inadequate maintenance access
- Public safety concerns or BMP is unable to be designed in a way that is compatible with jurisdiction's safety standards
- Insufficient head to allow for proper BMP drainage
- Utility conflicts that cannot be resolved

Bioretention/Infiltration/Detention

- High groundwater that does not allow for the minimum separation between the bottom of the BMP and the water table. Infiltration may also exacerbate existing downstream groundwater concerns.
- Poorly infiltrating soils
- Proximity to structures that may result in compromising geotechnical, foundation, or structural integrity (though detention may still be an option with an impermeable liner)
- Steep slopes that may be compromised by infiltration

Pervious Surfaces

- Pervious surface would not provide sufficient load bearing strength for heavy loads
- Storage beneath pervious surface would threaten the stability of adjacent subgrades

Harvest and Reuse

- There are no opportunities for reuse within the contributing drainage area
- A harvest and reuse system cannot be practically designed without significant impact on the project

Water Quality Concerns

General Concerns

Negative impacts on water quality from the construction and maintenance of LID BMPs can generally be avoided in the development's design phases. On the planning level, water quality degradation can be avoided by considering the proximity of BMPs to environmentally sensitive areas such as landfills, areas with known groundwater contamination, and wellhead protection areas. Retention at these locations is not advised, as it has the potential to mobilize contaminated groundwater and degrade down-gradient groundwater or drinking water quality. Pollutants can become concentrated within the soils at BMP locations, which may further exacerbate existing groundwater contamination. Installing BMPs without consideration to geotechnical conditions such as high groundwater and poor soils can lead to a failed BMP that results in degraded water quality that in turn interacts with groundwater and receiving waters. Compaction of soils at the bottom of a BMP or within a soil matrix that is meant to infiltrate will likely result in standing water, vector issues, or algae. Poorly maintained BMPs will result in many possible modes of failure such as standing water, vector issues, algae, flooding, failed soils, or other issues which will compromise the integrity of groundwater or adjacent receiving waters.

Designer Checklist

The designer checklist provided on each BMP fact sheet may be used by those who are designing or reviewing the design decisions that were made for each BMP. Engineering judgment should be used for all design decisions and LID approaches. Consider including information from the designer checklist in the Storm Water Quality Report.

Vegetation

Ensuring that vegetation remains healthy will increase the likelihood that the BMP remains aesthetically pleasing and performs as expected. See *Vegetation Guidance by BMP Type* for additional information.

Installation

LID BMPs should be taken offline during construction so that flows within its drainage area do not enter the BMP until construction is complete. They should not be used as construction BMPs. Use as a construction BMP can compromise functionality and decrease lifespan. They should not be allowed to become compacted during construction.

Typical installation activities for each BMP can be found within each BMP fact sheet.

Installation Costs

Refer to each BMP fact sheet for a general list of construction items. The Green Values National Stormwater Calculator summarizes BMP construction costs and can be found here: http://greenvalues.cnt.org/national/cost_detail.php. Costs will vary.

Maintenance

Proper maintenance will significantly improve the functionality of the BMP and increase its life span. Maintenance activities typically include semiannual (Spring and Fall) inspections but may be required more often such as shortly after construction or after significant storm events. Documentation of maintenance activities is encouraged to provide a record of inspection frequency, maintenance activities, and associated costs.

Maintenance agreements between the municipalities and the final owner of the BMP (if not the MS4) should identify key maintenance elements such as: transfer of BMP ownership; a description of maintenance activities and who is expected to perform them (owner, municipality, other); and, a method of resolution should violation of the maintenance agreement occur.

A description of typical maintenance considerations for each BMP type is given below.

Bioretention/Infiltration/Detention/Harvest and Reuse

- Inspect for sediment buildup or pollutant accumulation within or upstream of BMP and remove if present. Inspection of underground systems may require an access port such as a manhole.

- Inspect for and remove trash and debris.
- Determine cause of any standing water within BMP and remediate.
- Ensure that vegetation is established and maintained.
- If underdrains have been installed, ensure that they are functioning properly.
- If irrigation system has been installed, ensure that it is functioning properly.
- For green roofs, additional inspection of the roof structure may be required.

Pervious Surfaces

- Inspect for clogging of pervious surfaces
  - Vacuum or sweep the pavement to remove sediment and debris.
  - Power wash if necessary. Prior to power washing, downgradient inlets (if present) need to be protected to prevent sediments from entering storm drain system.
- Inspect for depressions. Depressions will indicate that the subsurface layers are failing or have failed. Regrading may be required.

Maintenance Activities

Detailed descriptions of maintenance activities, inspection frequencies, actions that can be taken to resolve maintenance issues, and the general level of effort associated with maintenance activities can be found in each BMP fact sheet.

In determining the inspection effort, the following descriptions were used:

Low – Visual inspection only required to make determination of possible required maintenance activity.

Medium – Visual inspection and other physical activity is required, such as opening an observation or a manhole lid; or, visual inspection and training is required, such as identifying invasive species, to make determination of possible required maintenance activity.

High – Visual inspection, physical activity, and training is required to make determination of possible required maintenance activity.

Maintenance Costs

Maintenance costs are tied to maintenance activities. Inspection of BMPs requires either an on-site presence that is tasked with performing the inspections or a designated person or persons who must visit the BMP to perform the inspection. In either case, the inspector(s) will need to be trained to make correct determinations of the next maintenance activity (if any) for any given maintenance issue that is required to remedy a failing or poorly maintained BMP (*Figure 11*). Permittees are required and private owners are encouraged to track operations and maintenance activities and associated costs.

Figure 11: Standing water after a rain event at a bioretention BMP.

In general, the following items are considered when considering maintenance costs: inspection frequency, inspection duration, crew size, machinery costs, and remediation. Remediation costs will vary widely based on the action required.

The Green Values National Stormwater Calculator summarizes a range of BMP maintenance costs and can be found here: http://greenvalues.cnt.org/national/cost_detail.php.

Figures

The figures for each BMP show a general cross-section that is a starting point for site-specific design. Use of these figures is appropriate for planning level design. For project design, the level of detail, the layout, and cross-sections for the selected BMPs should meet the municipality's CAD and design standards and include all information required for construction.

Treatment Trains

Treatment trains are a configuration of BMPs in series designed to achieve a pollutant reduction goal or a volume retention goal. Treatment trains are commonly used when a BMP can provide pretreatment to a downstream BMP. An example of this is shown in *Figure 12* at a site that is under development where a swale will provide pretreatment for the downstream dry well. Another scenario where a treatment train may be appropriate is when additional BMPs are needed to adequately provide volume retention. A scenario where this applies is where a rain garden has insufficient space to retain the entire water quality volume, but there is available space for an upstream bioswale that can provide additional retention. Site design practices can also be part of a treatment train (WEF Press, 2012).

Figure 12: A vegetated swale that will provide pretreatment for a dry well.

Treatment trains that keep runoff on-site have been found to be more effective. For this reason, BMPs that provide physical, chemical, and biological treatment are good candidates as these processes occur within BMPs that are designed to capture runoff. Pollutant reduction primarily occurs within the most upstream BMP. This is due to the theory of irreducible pollutant concentrations. Irreducible pollutant concentrations occur because of the BMP's inability to adsorb and degrade pollutants beyond a certain concentration (Schueler, Irreducible Pollutant Concentrations Discharged from Stormwater Practices: The Practice of Watershed Protection, 2000). Treatment train configuration should be considered carefully based on the water quality goals and targeted pollutants at the site.

Figure 13: Proprietary tree box filter

Proprietary Devices

Proprietary devices, such as tree box filters (*Figure 13*), media filters, and underground chambers use proprietary designs, soil mixes, aggregates, and other technologies to accomplish volume retention and storm water treatment.

Consideration of proprietary devices, as with other LID BMPs, should occur at the planning level. These devices function well in highly urbanized areas where there is limited room for other treatment options. Drainage areas with high imperviousness will require that the device have a larger footprint. A common design criterion for the size of the proprietary devices is the flow-through rate and are often referred to as flow-through devices.

These devices and technologies are typically designed with the help of the manufacturer. An approved list of vendors, devices, or other technologies may be written into a municipality's storm water management plan. Manufacturers will also be able to provide maintenance activities and inspection frequencies associated with the device. Discussion of specific proprietary devices within this manual does not constitute an endorsement of the device; nor does exclusion of a device constitute a lack of endorsement. Municipalities are responsible for determining which devices and technologies to use within their jurisdiction at the planning or project level.

Tree Box Filters
Tree box filters are typically contained within a concrete vault if being designed as a flow-through device. The vault bottom is removed if it is decided that infiltration is an appropriate function of the filter. See the *Tree Box Filter* fact sheet for additional information.

Underground Detention or Retention
Underground systems, such as chambers, are installed beneath project surfaces that already serve a function, such as parking, when there is limited space within the project limits to provide above ground detention or retention. These systems can be designed for flood control volumes or for the project volume retention goal. See the *Underground Infiltration Galleries* fact sheet for additional information.

Engineered Soils
Engineered soils can be manufactured soil mixes or mixes that are known by a jurisdiction to perform as desired. They can be used to achieve various water quality goals such as pollutant removal, volume storage, or supporting vegetation when existing soils may not be adequate. They are composed of proprietary and non-proprietary materials such as crushed stone, soil, clay, rock, sand, or other proprietary materials developed by the manufacturer.

Others
Aggregate composition, concrete pavers, grass pavers, pervious concrete mixes, permeable asphalt mixes, hydrodynamic separators, and snouts are all examples of types of proprietary devices and technologies. Jurisdictions are encouraged to seek out and determine which devices are appropriate for their projects.

LID BMP Selection

Selection of BMPs is based on many factors. At the planning level, receiving waters, 303(d) impairments, TMDLs, land use, and watershed management plans will play a role in determining which BMPs are most appropriate. At the project level, project limits, groundwater, contaminated soils or groundwater, poorly draining soils, and connections to the storm drain network are all variables that will guide the project team toward BMP selection. The following sections provide tables and charts that can be used to assist in the selection of appropriate BMPs.

BMPs Categorized by 303(d)/TMDL

Table 6 summarizes pollutants that are included on the 303(d) list of impairments or that have approved TMDLs within at least one watershed in Utah along with BMPs that are effective at addressing the pollutant. In general, all BMPs are effective at addressing one or more pollutant impairments but special considerations should be taken into account as shown by footnotes provided at the end of the table. Specific BMPs are not identified for categories in which pollutant removal effectiveness is not rated.

Table 6: BMP types rated for the removal of pollutants that are either 303(d) listed or have approved TMDLs within Utah.

Pollutant	Category	BMP Type
E. coli	Bacteria	All
Total Coliform		
Dissolved Oxygen	Dissolved Oxygen	All[1]
Total Dissolved Solids	Dissolved Solids	BMPs that prevent erosion of sediments
Cadmium	Metals	All
Zinc		
Aluminum, Dissolved	Metals (Dissolved)	All
Arsenic, Dissolved		
Cadmium, Dissolved		
Copper, Dissolved		
Iron, Dissolved		
Lead, Dissolved		
Mercury, Dissolved		
Zinc, Dissolved		
Ammonia	Nutrients	All[2]
Boron		
Boron, Total		
Nitrate as N, Total		
Selenium		
Selenium, Dissolved		
Total Ammonia		
Total Phosphorus		
Observed/Expected (OE) Species Bioassessment	OE Bioassessment	All
pH	pH	All[1]
Gross Alpha	Radioactivity	BMPs that prevent erosion of sediments
Radium		
Sediments/TSS	Sediment	All
Temperature	Temperature	BMPs that incorporate shading and promote infiltration

[1]Improving dissolved oxygen levels and pH values are tied to nutrient reduction.
[2]BMPs may increase nutrients in the effluent if fertilizer is used.

BMPs Categorized by Land Use

Residential, commercial, industrial, and agricultural land uses produce unique assemblages of pollutants. Sediments, pet waste, fertilizers and pesticides are common pollutants in residential areas. Pollutants in commercial and industrial land uses vary depending on site activities. Landscaping, outdoor storage, metal roofs, food, and animal waste products will determine which pollutants may be expected. *Table 7* summarizes expected pollutants by land use.

Table 7: Expected pollutants by common land uses.

Land Uses	Expected Pollutants				
	Sediment	Nutrients	Metals	Bacteria	Oil/Grease
Residential	Y	Y	N	Y	Y
Commercial	Y	Y	N	N	Y
Industrial	Y	N	Y	N	Y
Transportation	Y	Y	Y	Y	Y
Landscaped Areas	Y	Y	N	N	N
Agriculture	Y	Y	N	Y	N

BMP Selection Flow Charts

Selection of LID BMPs is determined by site constraints. There may be geotechnical constraints that govern BMP selection such as shallow groundwater or poor soils, which could rule out the possibility of retention. When retention is not feasible, treatment of runoff can still be accomplished. Treatment can be achieved by creating soil layers or adding amendments to existing soils through which runoff will travel to remove pollutants. Impermeable liners may need to surround the soil layers to prevent groundwater intrusion or to protect adjacent structures. Underdrains should also be considered to allow the BMP subsurface to drain. An example of this would be a rain garden used at a project with high groundwater that has been designed with soil layers, underdrains, and an impermeable liner. Treatment is still achieved but retention does not occur.

Three flow charts have been developed to assist in the selection of appropriate BMPs. The flow charts guide the user through the general BMP evaluation and selection process. Ultimately, BMP selection will be site-specific; BMP recommendations contained within the flow chart do not necessarily rule out consideration of other BMPs.

Flow Chart 1: Retention vs Treatment

Based on site conditions, determine if retention or treatment will be used.

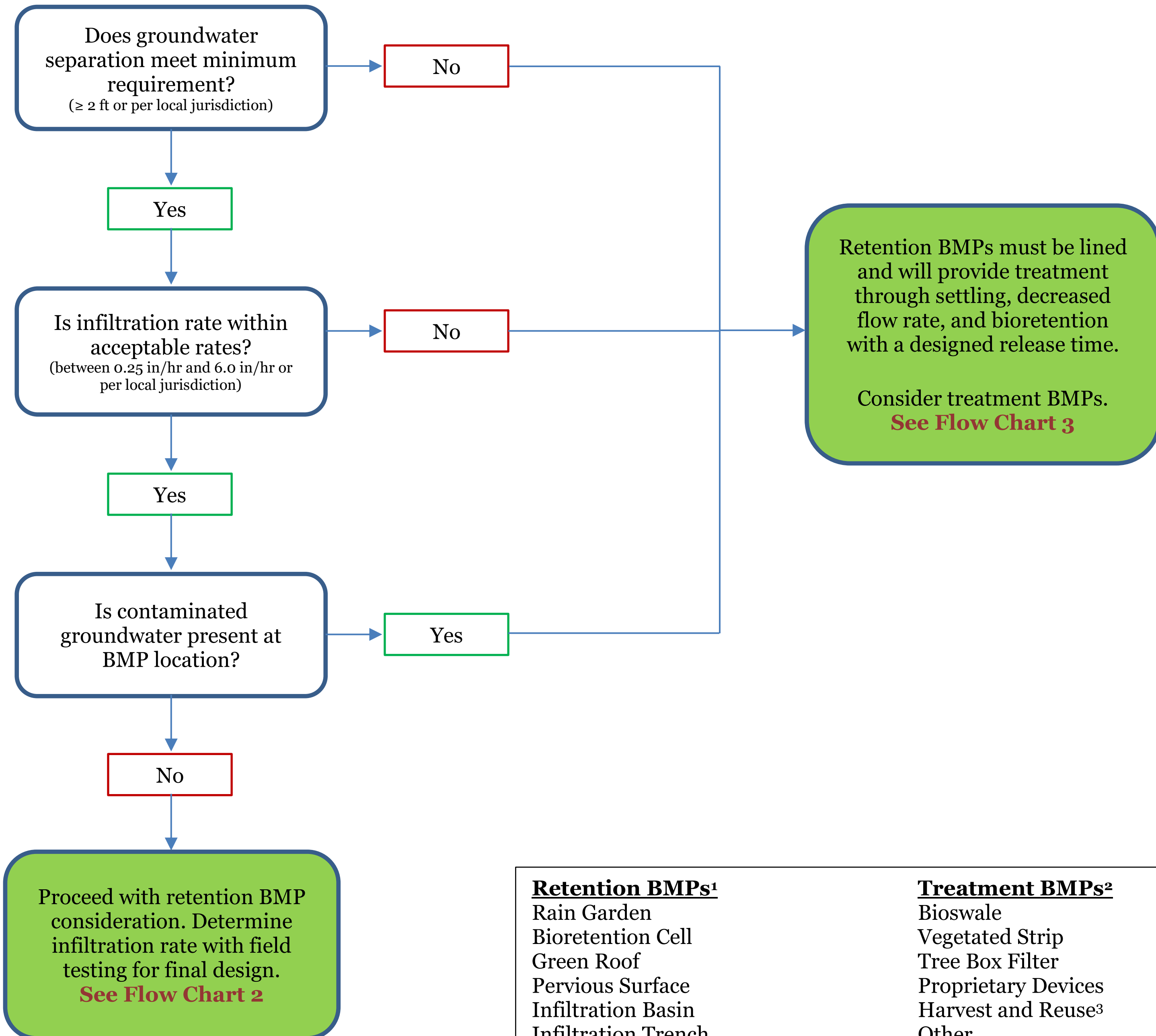
Flow Chart 2: Retention BMP Selection

Determine which BMPs will provide retention based on the design criteria and technical criteria of each BMP.

Flow Chart 3: Treatment BMP Selection

Determine which BMPs will provide treatment based on the design criteria and technical criteria of each BMP.

Flow Chart 1: Retention vs Treatment

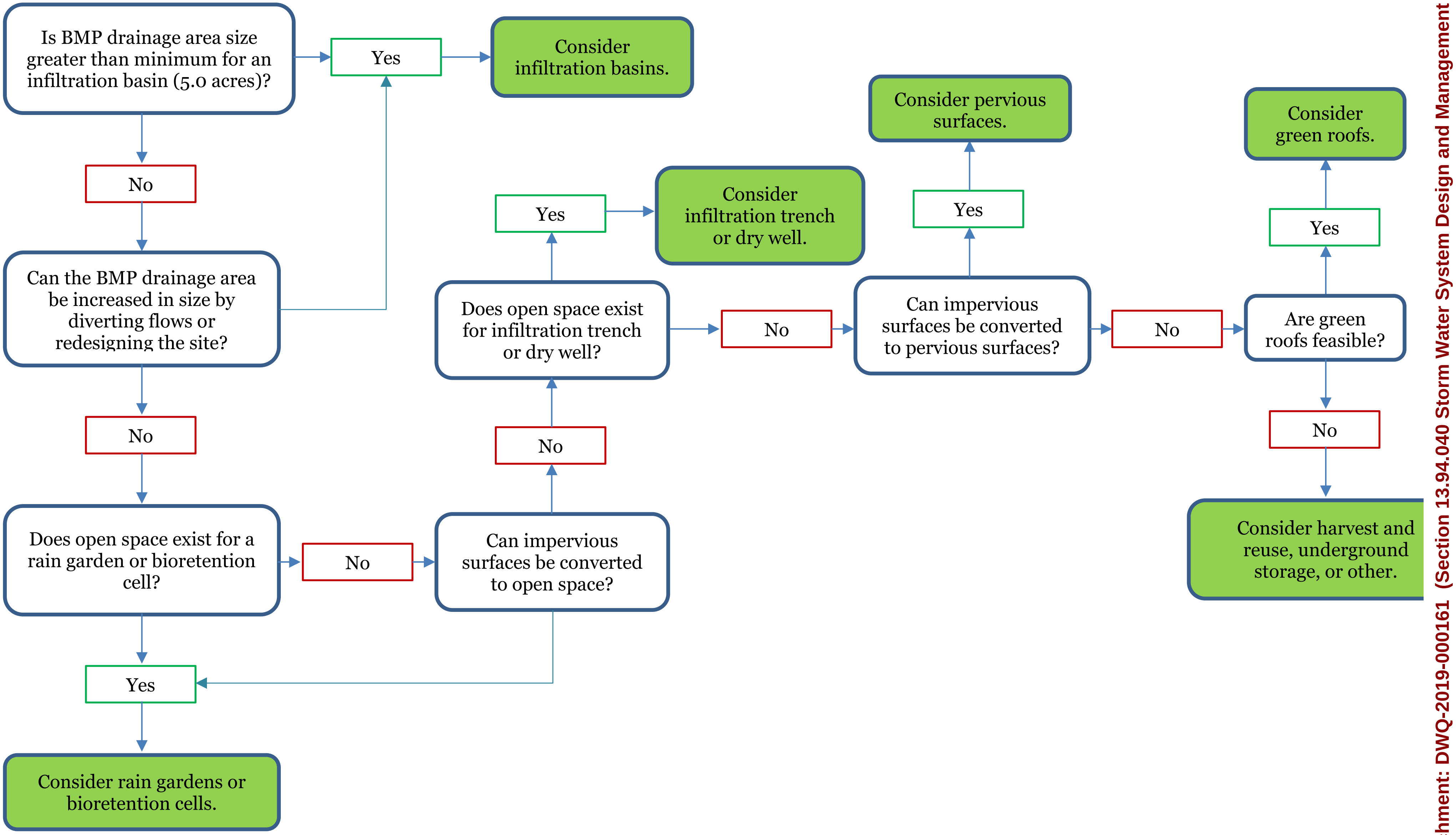


Retention BMPs[1]	Treatment BMPs[2]
Rain Garden	Bioswale
Bioretention Cell	Vegetated Strip
Green Roof	Tree Box Filter
Pervious Surface	Proprietary Devices
Infiltration Basin	Harvest and Reuse[3]
Infiltration Trench	Other
Underground Infiltration Galleries	
Dry Well	
Proprietary Devices	
Harvest and Reuse[3]	
Other	

[1]When retention BMPs are infeasible, they may still provide treatment by using impermeable liners and underdrains.
[2]Bioswales may function as retention devices if soils permit and if a raised outlet is provided.
[3]Harvest and Reuse may be considered a retention BMP or a treatment BMP depending on the application.

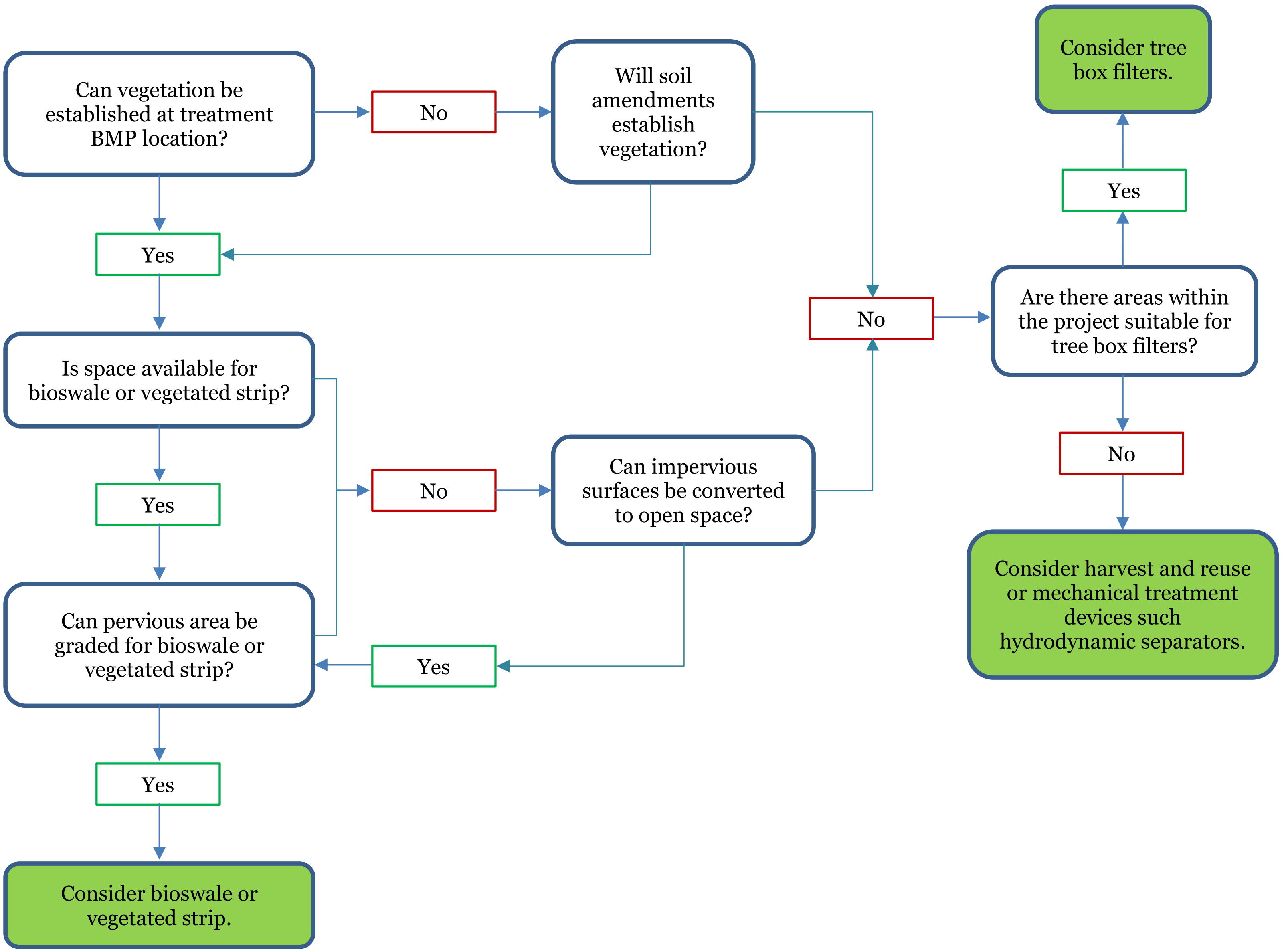
Flow Chart 2: Retention BMP Selection

Note: BMP recommendations contained within this flow chart does not necessarily rule out consideration of other BMPs.



Flow Chart 3: Treatment BMP Selection

Note: BMP recommendations contained within this flow chart does not necessarily rule out consideration of other BMPs.



Vegetation Selection

Benefits of Using Vegetation in BMPs

Vegetation plays a vital role in the viability of BMPs. In conjunction with engineered systems, they reduce pollutants through plant uptake, protect soils from further erosion, increase percolation rates, provide habitat for wildlife, increase aesthetic appeal of BMPs, contribute to mental health, and reduce heat retention.

Pollutant Reduction

Phytoremediation is another benefit of plant use in BMPs. Plants, can uptake pollutants through their root systems and utilize the contaminants to promote vegetative growth above ground, thereby removing the pollutants from soils and water. Generally, this method is more cost effective than other engineered approaches, which may create secondary contaminated waste that must be treated and disposed of in special landfills and through expensive treatment systems. Furthermore, when appropriate plants are selected, it does not have a negative impact on the plant itself as the nutrients are utilized for proper growth and functions of the plant. In conjunction with microbes, they break down otherwise harmful pollutants and either minimize pollutants to acceptable levels or reduce them altogether.

The percent of vegetative coverage has a direct impact on the pollutant reduction performance of the BMP. During a 2-year monitoring study of roadside vegetation by the Caltrans Division of Environmental Analysis, it was found that a minimum coverage of at least 65% was needed for pollutant reduction to occur, but that there was a significant decrease in pollutant reduction below 80% (Caltrans Division of Environmental Analysis, 2003). This result is consistent with similar studies that have led to minimum vegetative requirements for various permittees nationwide that range from 65% to 80%.

Protect Soils from Erosion

Soil erosion occurs when soil is removed through the action of wind and water at a greater rate than it is formed. Plants prevent soil erosion by providing protective cover, slowing down runoff and holding the soil in place. As raindrops fall directly on the soil the impact displaces small particles of soil causing erosion. Plants and plant litter protect the soil from the effects of raindrop impact. Vegetation that completely covers the soil and intercepts all falling raindrops on or close to the surface are the most effective in controlling soil erosion. Additionally, by slowing down runoff, fewer soil particles are carried downstream and surface water can soak into the soil. Plant cover also protects soil against wind erosion. A lack of wind breaks, such as trees, shrubs, and groundcovers, allows the wind to further displace soil particles for longer distances, increasing abrasion and erosion. Furthermore, plant roots help to bind the soil, reducing wind and water displacement. Roots also help to stabilize embankments and slopes, limiting the risk of landslides.

Mulch also adds additional protection from erosion, especially in newly seeded areas. Like vegetation, mulch protects the ground from wind and water erosion while seeds germinate and reduces the loss of soil moisture which, if not maintained, makes the soil more susceptible to wind erosion.

Increase Percolation Rates

Plant litter, root systems, and the microbes associated with the soil environment increase percolation rates through soils. This occurs due to increased air pockets within the soil created as roots expand and contract and decomposed vegetative material is incorporated into the soil. Additionally, the use of water by the plants as they grow draws water through the soil to the roots and increases the permeability of soil over time through constant microscopic movement within the soil itself. Together, these processes create voids in the soil structure allowing water to freely move through the soil either into plant roots for uptake or down into the groundwater below.

Provide Habitat for Wildlife

Vegetation plays a vital role in the quality of wildlife habitat. Plants offer wildlife food, shelter, water, and space needed to exist. Edge areas, especially where water occurs, offers secluded places for wildlife to forage without disturbing the BMPs. When wider habitat areas are provided, especially along edges, they provide a haven for wildlife. Furthermore, when wildlife occupies the area they contribute to vegetation distribution and help to control growth.

Increase Aesthetics

Form, line, color, and texture are the basic visual components of art, and their combination provides visual interest and aesthetic appeal. A good mix of plants with their varied physical characteristics adds beauty and aesthetics to the landscape. Some plants may have more value as a visual element in the landscape based on their physical characteristics. Some characteristics are more visually dominant and have a higher visual value, some are more functionally dominant, and some dominate simply by size. Upright forms, bright colors and coarse textures are dramatic and have high visual impact. Low or prostrate forms, dull colors and fine textures are calm and have low visual impact. The visual value of all plants is dependent on the distance from which they are viewed, the time of year, the quality of light, the adjacent plants, and the plants' health.

Creatively using vegetation within BMPs reduces negative visual impacts of the BMP, makes them more visually pleasing, and increases acceptance of BMP practices within urbanized areas, especially where residential areas are involved. Each plant must be considered individually when selecting plants for a composition, but the entire composition takes on greater importance than the individual plants. For this reason, it is important to think about how the characteristics of each plant will relate to the plant or hardscape next to it.

Contribute to Mental Health

Plants generally have a positive influence on mental health. In increasingly urbanized and developed areas, they provide respite and a sense of connectivity to nature.

Reduce Heat Retention

Vegetation also can mitigate the effect of heat islands created by development. By increasing areas for plants to grow, including within BMPs, increased shade is provided. The added shade combined with evapotranspiration naturally occurring from plants creates a cooling effect. Furthermore, trees and vines planted near buildings help to provide shade and insulation to existing buildings which provide a cooling effect and helps to mitigate cooling costs associated with urban living. One study that analyzed cost savings in Ft Collins, CO, Cheyenne, WY, Bismarck, ND, Berkeley, CA, and Glendale, AZ showed that a net savings of $30-$90 per tree ($40-$120 when adjusted for inflation) was achieved by planting trees in urban environments. (McPherson, Simpson, Peper, Maco, & Xiao, 2005).

Coordinating with a local Utah State University extension or a local nursery can help ensure appropriate plants are chosen for a project.

Vegetation Considerations

In choosing plant species for LID, several considerations need to be made to ensure establishment and long-term plant health. Factors that should be considered include: adaptability of plants to the site conditions, water consumption requirements, soil types, the ability to withstand air and soil pollutants, and heat and cold tolerances.

Site Conditions

When selecting vegetation for LID sites, it is critical to consider the needs of the plants and match them to the current and future site conditions. As the landscape transforms into a built environment, it is important to understand that the minimum and maximum temperatures will change, and microclimates will be created. As the heat index increases, evapotranspiration rates will also increase. Reflected heat off pavement, concrete, and glass can also burn plants. Furthermore, natural drainage patterns are altered as buildings and infrastructure are developed changing the soil structure and porosity, nutrient availability, and availability of water. Therefore, plants selected must be adaptable to and be tolerant of the changing site conditions. Their ability to improve water, soil and air quality and reduce the heat island effect caused by development should also be considered. Species native to the project area are often better suited to current site conditions; however, plant materials adapted to the changing site conditions may also be a good choice.

Water Requirements

In the arid environment of Utah, it is critical that plants are drought tolerant. This not only helps reduce plant stress, but conserves water. Plants that are not well adapted to the region will tend to be more stressed and therefore, require more water, nutrient supplements, and overall management. The use of additional fertilizer to aid stressed plants can contribute to water pollution. Plants that are not suitable to more arid environments are generally not a good choice for Utah landscapes.

Many municipalities have landscape ordinances that require minimum vegetative cover or percentages of trees and shrubs. In most cases, these landscape ordinances do not preclude the use of native or water wise vegetation. Additional planning and careful selection may be needed to meet these and any other aesthetic requirements.

Fluctuation in soil moisture conditions is also a critical consideration. Typically, plants that can tolerate wide fluctuations in soil moisture, including saturated conditions with standing water, are good choices for basins, swales, bioretention cells, rain gardens, and tree box filters while plants needing good drainage are better suited to basin slopes and upland areas.

Soil

Some plants prefer growing in consistently moist soils while others prefer dry soil with only intermittent changes in moisture levels. Also, the soil's alkalinity, salinity and soil structure are important factors. For example, plants that tend to do well in dry, shallow, rocky soils with a higher tolerance for salt buildup will tend to do better in rooftop gardens compared to plants that prefer acidic bog-like conditions that are better suited to a bioretention cell or rain garden.

Another factor to consider is the soil's structure as it impacts the root system of plants. Plants with shallow surface roots would not be an appropriate choice for areas that may be inundated with heavy flows of surface water, while those with deep taproots would be a better choice.

Plants that have a proven ability to tolerate soil compaction, increased heat, and reduced air flow are best suited for landscape strips. Parking lots along streets require plants that can produce strong tap roots, especially for trees which may otherwise blow over in wind gusts.

It is also important to consider the soil in relation to microbes and plant material, especially for tree box filters and bioretention cells. Plants, soil, and microbes work symbiotically in these situations to alter or reduce the quantity of pollutants collected in storm water and rain water. Some of the nutrients are utilized directly by the plants and soil microbes reducing them to acceptable levels. Selecting plants that are effective at pollutant reduction will ensure that the pollutants are not toxic to the plants.

Air Quality

Plant tolerance to air pollution is another important consideration. Some plants thrive in higher carbon pollutant environments, for example, while others may experience stunted growth. Air pollutants to consider include: carbon monoxide, ground-level ozone, lead, sulfur dioxide, particulate matter, and nitrogen dioxide.

Heat and Cold Tolerance

In addition to soil and water considerations, heat and cold tolerances of plants should be considered. The map of plant hardiness zones in *Appendix D* identifies areas by the lowest annual minimum temperature. Plants associated with each zone are identified in *Appendix E* and are generally tolerant of the coldest temperatures in the area. The other consideration is heat tolerance of plants, which in drier and hotter desert regions is equally important and can be detrimental to plant health. This information can be found using the American Horticultural Society Heat Zone Map for the United States (http://www.ahsgardening.org/gardening-resources/gardening-maps/heat-zone-map). The map identifies the average number of days a specific area experiences extreme heat. Also, it is important to consider the reflectivity of surfaces such as buildings and sidewalks on leaves and bark. Highly reflective surfaces tend to increase the ambient temperature around plants and can injure them to the point of plant death.

A plant selection matrix containing appropriate trees, grasses, shrubs, and groundcover for the LID BMPs covered in this manual is provided in *Appendix E*.

If applicable to the site, vegetation for BMPs should meet the following conditions:

- Vegetation is adapted to the local climate, considering seasonal temperature ranges and average rainfall, exposure to direct sun, frost, wind, and desired irrigation practices.
- Plants selected are tolerant of weather conditions at the specific site such as extreme high and low temperatures, strong winds, sun, and snow. (*Appendix E* contains a matrix of example plants identified by climate zones within Utah and BMPs for each.)
- Vegetation is tolerant of varied moisture conditions (wet and dry).
- Plants are adaptable to varying soil types and conditions.
- Species are non-invasive for the area and site conditions (will not readily spread by air, seed transport, or root invasion).
- Flora is resistant to wildlife foraging such as deer, elk, and rabbits and local pests and diseases.
- Vegetation provides habitat value and linkages to larger open spaces on the fringe of urban developments.
- Site maintenance requirements (e.g., invasive root growth, pruning, thinning, dead-heading), site accessibility, and the ability of the property owner to maintain the specific vegetation is feasible.
- Vegetation adheres to local design criteria such as height limitations and approved plant lists.
- Plants are readily available in local or regional nurseries.
- Flora has an attractive appearance and aesthetic value.
- Vegetation is appropriate for the type of pollution present and desired pollutant removal.

Vegetation Guidance by BMP Type

Bioretention/Bioswales/Infiltration/Detention

Typically, bioretention BMPs receive greater pollution due to storm runoff from streets and roadways; and these BMPs receive water after every storm event. As a result, they require plants that:

- Have a greater ability for nutrient uptake and pollutant neutralization.
- Can survive in boggy and moist soils.
- Tolerate salt or other de-icing agents.

Infiltration Basins

Infiltration basins generally hold water for longer periods of time; however, only the bottom of the basins hold the standing water. Plants located in the bottom of the basin must be able to tolerate standing water for several days, while plants located on the side slopes must be able to tolerate drier conditions. Select plants in infiltration basins that:

- Withstand being covered with water for up to 72 hours.
- Reduce the need for supplemental irrigation and maintenance.
- Do not require additional fertilization and thereby reduce polluted runoff potential.

Vegetated Strips

Vegetated strips are typically small and have limited planting space, so selection must consider the overall size in conjunction with safety requirements. Select plants that:

- Do not require additional fertilization and thereby reduce polluted runoff potential.
- Tolerate environmental factors such as reflective pavements and building materials, salt or other de-icing agents, and air pollution at the site.
- Withstand trampling and vandalism in urban conditions.

Green Roofs

Plant material selection should be based on factors determined by the type of green roof desired, structure itself, as well as the long-term maintenance the owner is able to provide. Typical green roof vegetation ranges from low-growing succulent plants (e.g., Sedums) or groundcovers (characteristic of extensive green roofs) to an assortment of native grasses, shrubs, and trees (more typical of intensive green roofs). Plants of the genus Sedum (family Crassulaceae), which are low-growing succulents, are often used for green roofs because of their resistance to wind, frost, drought, and fire. A mix of Sedum and other succulent plants is recommended because they possess many of the recommended attributes. Herbs, forbs, grasses, and other low groundcovers may also be used but typically require more irrigation and maintenance. Use of native vegetation is preferred though some natives may not thrive in the rooftop environment; thus, a mix of approximately 80% Sedum/succulent plants and 20% native plants generally recognized for their hardiness is recommended, particularly for extensive green roofs (Velazquez, 2005). Select plants that:

- Grow in a shallow and porous substrate (i.e., grasses, perennials and groundcovers are suited to roofs with a substrate of 3-7 inches minimum).
- Root system depth requirements matches depth of substrate (i.e., plants with a deeper and more extensive root system such as shrubs and some trees require 48 inches of substrate minimum depth).
- Drought tolerant and able to exist with minimal and infrequent watering, especially once established.
- Able to withstand higher wind speeds.
- Tolerant of full-sun conditions.
- Fire resistant.
- High salinity tolerance.
- Lower maintenance requirements since access is limited.

- Are primarily non-deciduous to provide adequate foliage cover year-round and reduce erosion potential.
- Have good regenerative qualities (i.e., perennial or self-sowing).
- Are low maintenance (i.e., no fertilizers, pesticides, or herbicides, little or no mowing or trimming).
- Have growth patterns allowing vegetation to thoroughly cover the soil (at least 90% surface area coverage should be achieved within 2 years).
- Are compatible with the aesthetic preferences of the owner and future building occupants who may utilize the roof as a green space.

Steps to Selecting Vegetation for BMPs

To identify vegetation for specific sites and BMPs, consider the following steps:

1. Consider consulting with a landscape architect and/or horticulturalist to assist in the appropriate selection and design for each BMP in conjunction with other professionals such as engineers and architects.
2. Identify the hardiness zone(s) at the site.
3. Identify which BMPs will be used.
4. Determine if there are any microclimates within the site that need to be considered.
5. Identify plants that will best work for the BMP based on the hardiness zone and site's microclimates (See *Appendix E Utah Plant Selection Matrix by Climate Zone and BMP* for more information.)
6. Develop a landscape plan that considers site conditions, erosion protection, pollutant mitigation, human use of and interaction with the site, creation of wildlife habitat, aesthetics, and site and BMP maintenance.

Land Use Examples

The following examples show possible implementations of LID BMPs for three land use types: residential, commercial, and industrial. Figures in the examples are conceptual and as such are not to scale and do not show details for final design. New development is shown for the residential and industrial examples; redevelopment is shown for the commercial example.

Residential LID (New Development) **Residential Development**

Development size: 6.61 ac

Imperviousness: 0.51

Volumetric runoff coefficient: 0.38

80^{th} percentile storm depth: 0.50 in

Hydrologic soil group: B

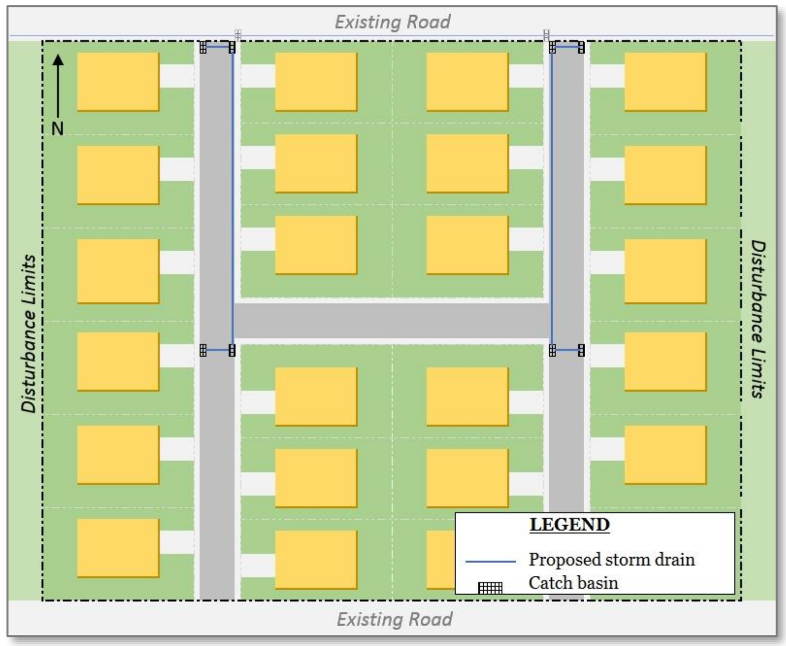


Figure 14: Proposed residential development.

A 6.61-acre residential development (*Figure 14*) is proposed. The development includes 24 homes, three new 30-foot wide roads, and sidewalks. The site is graded such that runoff will flow to the north. Catch basins and pipes are proposed as shown to connect to the existing storm drain network that runs east to west on the south side of the existing road north of the development.

With the given plan, the site's imperviousness is 51%. Assuming the jurisdiction of this development determines the volumetric runoff coefficient based on the hydrologic soil group and the site's imperviousness (See *Step 3: Volumetric Runoff Coefficient*), R_V is calculated to be 0.38. Using the 80^{th} percentile storm depth of 0.50 inches, the volume retention goal of the site is 4,600 cf.

To manage this volume, the design team decided to implement several LID strategies. First, the total impervious surface was reduced by narrowing all roads by 10 feet, which was the minimum roadway width per city guidelines. This resulted in a reduction of impervious area by 0.28 acres, which reduced the site's total imperviousness to 48%. The volume retention goal was recalculated to be 4,254 cf.

To retain the 4,254 cf, rain gardens, bioswales, pervious surfaces, and a dry well were strategically placed to capture the volume retention goal (*Figure 15*).

Revised LID Design

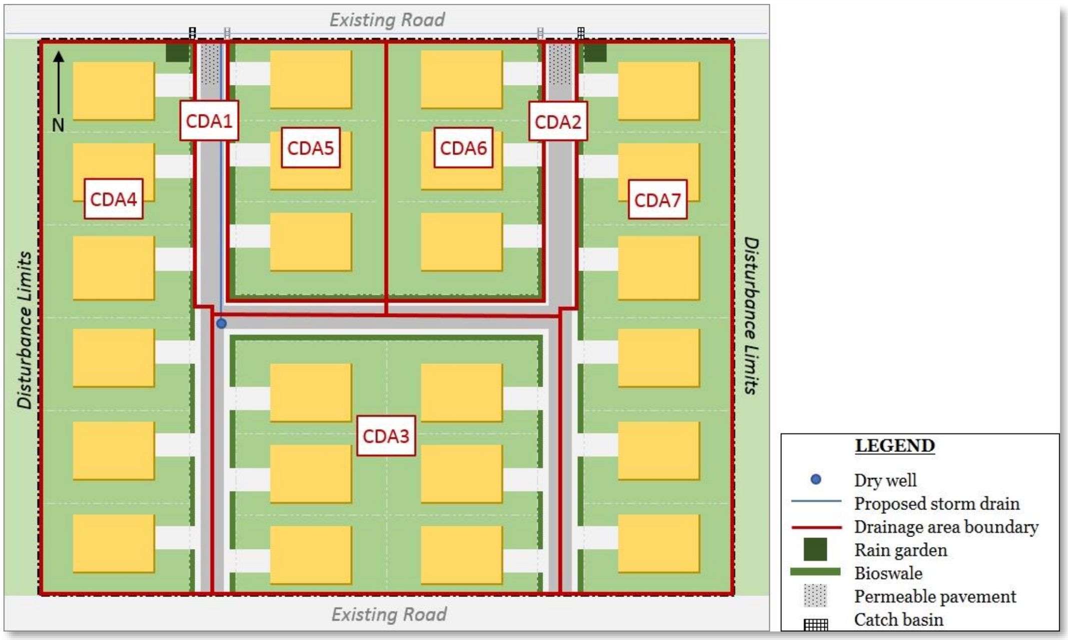


Figure 15: LID approach to residential development.

Contributing Drainage Area	LID BMP Type	Water Quality Volume, WQV (cf)	Runoff Captured (cf)	Percent of WQV Captured	Equivalent Storage Depth (in)	Notes
CDA1	Permeable Pavement	317	320	100%	6	-
CDA2	Permeable Pavement	317	320	100%	6	-
CDA3	Bioswale/Dry Well	1130	703* (bioswale) 452 (dry well)	100%	12 (bioswale)	6 ft x 16 ft dry well
CDA4	Bioswale/Rain Garden	870	238* (bioswale) 638 (rain garden)	100%	6 (bioswale) 24 (rain garden)	-
CDA5	Bioswale	375	410*	100%	14	-
CDA6	Bioswale	375	410*	100%	14	-
CDA7	Bioswale/Rain Garden	870	238* (bioswale) 638 (rain garden)	100%	6 (bioswale) 24 (rain garden)	-
	Total	4254	4367	100%		

*33% of water quality volume is assumed to infiltrate into bioswales. See *Volume Reduction* for further discussion on swale infiltration.

By narrowing the roads and introducing LID BMPs, the design team was able to capture 100% of the project's volume retention goal. This approach has also reduced the number of catch basins and linear feet of pipe required for the storm drain network (provided flood control consideration has also been incorporated into the design).

Commercial LID (Redevelopment)

Commercial Development

Development size: 1.84 ac

Existing Impervious Area: 1.56 ac

Volumetric runoff coefficient: 0.75

80th percentile storm depth: 0.50 in

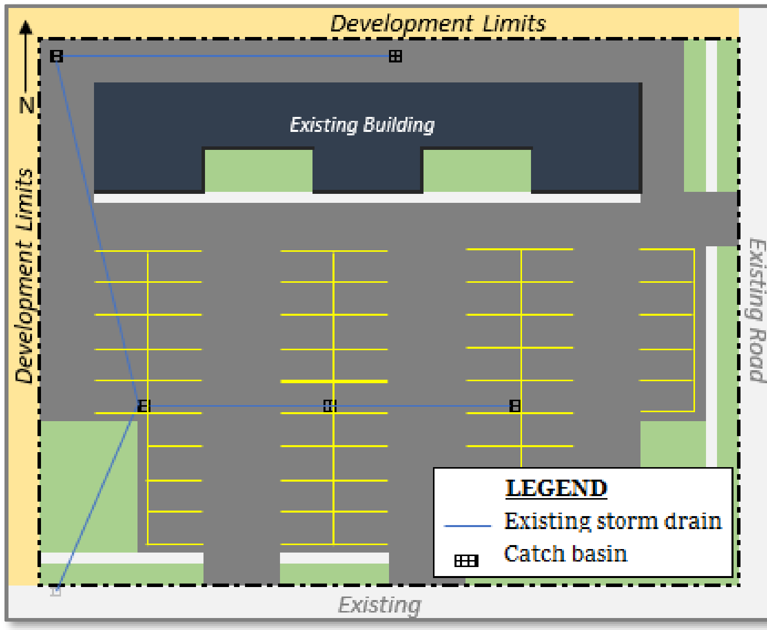


Figure 16: Existing commercial development.

An existing 1.84-acre commercial development (*Figure 16*) will be redeveloped to increase the size of the commercial building and the parking lot footprint. The development currently includes a 0.24-acre building, 1.32 acres of parking and sidewalk (1.56 total impervious acres), and 0.27 acres of pervious area. The imperviousness of the site is 85%. The storm drain network conveys flows to a catch basin at the southwest corner of the site.

The developer plans to increase the footprint of the building and increase parking capacity (*Figure 17*). This will increase the site's impervious area by 16% to 1.81 acres. Because this increase is greater than 10%, the project is required to prevent the off-site discharge of the net increase in the volume associated with the precipitation from all rainfall events less than or equal to the 80th percentile rainfall event. This net volume increase is the project's volume retention goal.

These calculations assume the jurisdiction permitted the project to use the Reese method of determining the runoff coefficient due to its applicability for urban development (see *Step 3: Volumetric Runoff Coefficient*). Using the 80th percentile storm depth of 0.50 inches, the net volume increase is summarized below:

Reese method of determining the runoff coefficient: $R_V = 0.91i - 0.0204$

Existing 80th percentile volume

$R_V = 0.91\,(0.85) - 0.0204 = 0.75$

80th percentile volume = $R_V dA = (0.75)\,(0.50''/12)\,(1.84 \text{ ac})\,(43{,}560 \text{ sf/ac}) = 2{,}516$ cf

Proposed 80th percentile volume

$R_V = 0.91\,(0.98) - 0.0204 = 0.87$

80th percentile volume = $R_V dA = (0.87)\,(0.50''/12)\,(1.84 \text{ ac})\,(43{,}560 \text{ sf/ac}) = 2{,}905$ cf

Volume Retention Goal, V_{goal}

V_{goal} is the net volume increase: V_{goal} = 389 cf

To retain this volume, the design team added a bioretention cell to one of the parking lot's drainage areas (*Figure 16*).

Water Quality Volume within the bioretention cell's drainage area based on the 80th percentile storm event:

Contributing drainage area: 0.37 ac

Impervious area: 0.36 ac

Imperviousness: 0.97

R_V = 0.91 (0.97) – 0.0204 = 0.86

WQV = $R_V dA$ = (0.86) (0.50"/12) (0.37 ac) (43,560 sf/ac) = 584 cf

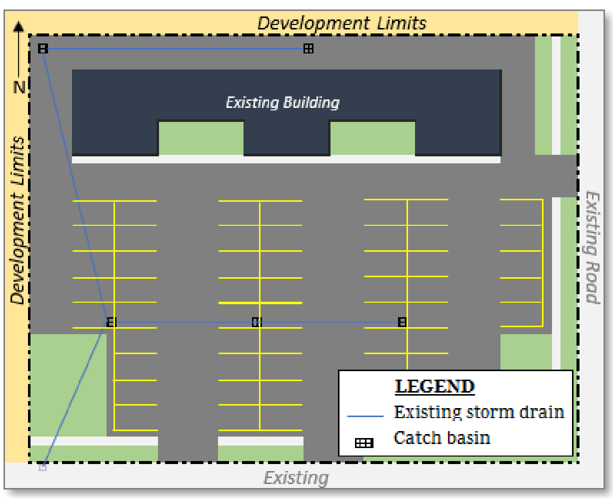
The water quality volume of this drainage area is greater than V_{goal}. The bioretention cell only needs to be sized for V_{goal}. In *Figure 16*, the bioretention area is 5' x 135'. The calculations below show that the storage depth of the bioretention cell needs to be at least 7" (0.58 ft) to retain V_{goal}.

Bioretention cell storage depth:

Bioretention cell footprint: 5' x 135' = 675 sf

V_{goal} = 389 cf

Storage depth = 389 cf / 675 sf = 0.58 ft



(Figure 16. Shown for comparison.)

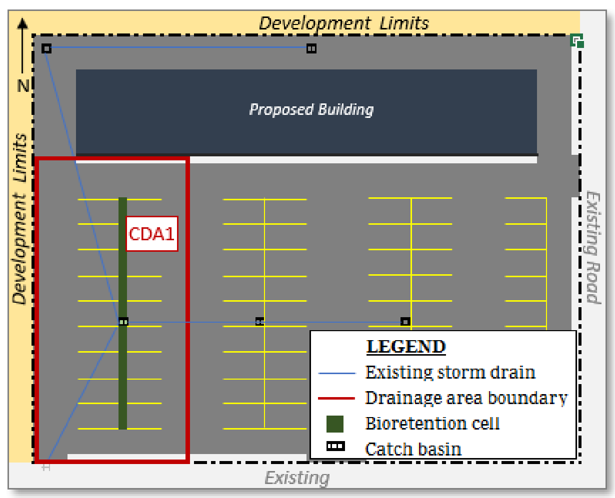


Figure 17: Bioretention cell within the redevelopment's project limits.

Development Size: 2.64 ac

Imperviousness: 94%

Volumetric runoff coefficient: 0.83

80th percentile storm depth: 0.50 in

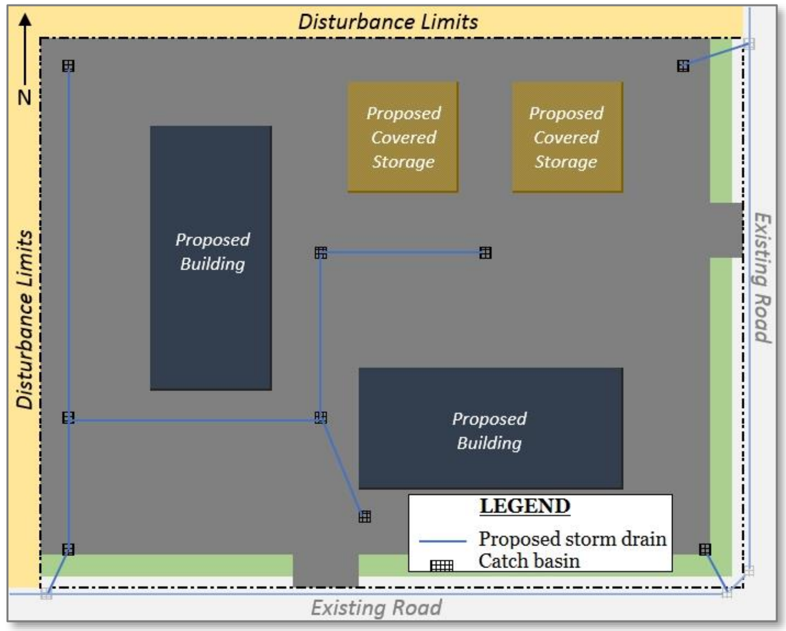


Figure 18: Proposed industrial development.

A 2.64-acre industrial development (*Figure 18*) is proposed. Two new buildings and two covered storage areas are also proposed. The current site will have 0.32 acres of pervious area adjacent to the new sidewalk. There are three connection points to the storm drain network.

With the given plan, the site's imperviousness is 94%. Assuming the jurisdiction of this development adopted the Reese method of determining the runoff coefficient due its applicability for urban development, R_V is calculated to be 0.83 (see *Step 3: Volumetric Runoff Coefficient*). Using the 80th percentile storm depth of 0.50 inches, the volume retention goal of the site is 4,000 cf.

Upon reevaluating the design of the site and subsurface site conditions, two LID features were determined to be appropriate: two infiltration basins and two infiltration trenches (*Figure 19*). Altering the grading design created four contributing drainage areas to the basins and trenches which have overflow connections to the existing catch basins. Pervious areas were also increased. Inclusion of these features results in a reduction of impervious area by 0.18 acres, which reduced the site's total imperviousness to 87%. The volume retention goal was recalculated to be 3,705 cf.

The LID features proposed will capture the volume retention goal.

Revised LID Design

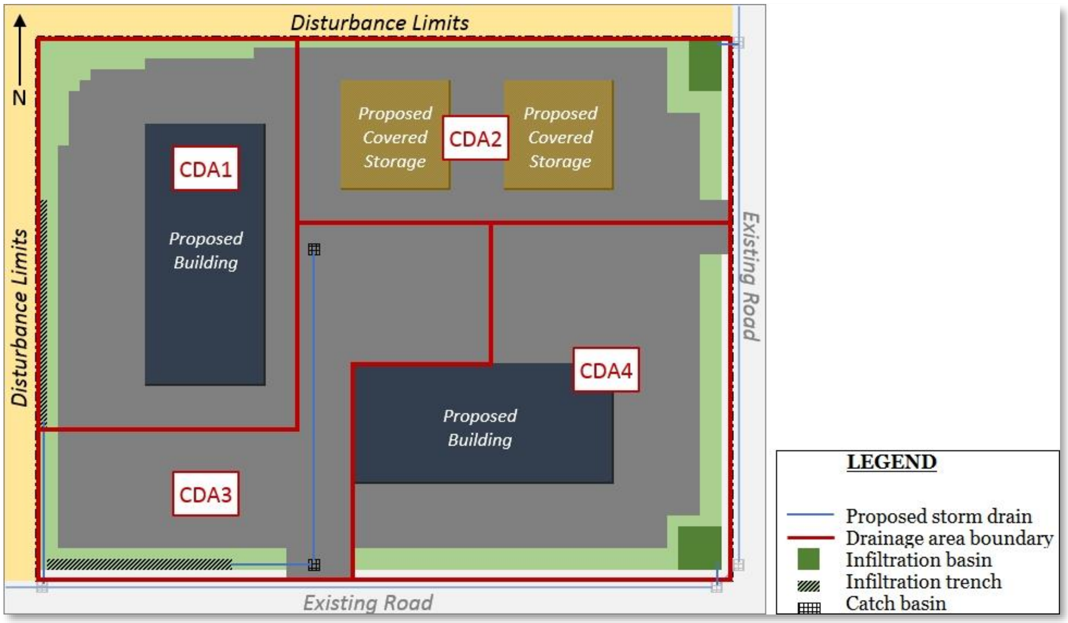


Figure 19: LID approach to industrial development.

Contributing Drainage Area	LID BMP Type	Water Quality Volume, WQV (cf)	Runoff Captured (cf)	Percent of WQV Captured	Equivalent Storage Depth (in)	Notes
CDA1	Infiltration Trench	975	975	100%	18	4 ft width
CDA2	Infiltration Basin	791	791	100%	-	Infiltration rate = 2 in/hr Safety factor = 1.33 Drawdown time = 24 hrs Footprint = 263 sf
CDA3	Infiltration Trench	801	801	100%	18	4 ft width
CDA4	Infiltration Basin	1129	1053	93%	-	Infiltration rate = 2 in/hr Safety factor = 1.33 Drawdown time = 24 hrs Footprint = 375 sf
	Total	3696	3620	98%		

Due to utility conflicts at the southeast corner of this site, the infiltration basin within CDA4 was not able to be sized for the full project volume retention goal. This is still an acceptable implementation of the 80th percentile retention requirement because retention of 100% of the 80th percentile volume was not possible. LID practices were still successful at this site such as the removal of pipe. Additional water quality measures appropriate for an industrial site such as an oil/water separator are not shown in this example but must be used if necessary. Flood control considerations should be considered for final design.

Local Case Studies

Preface to Case Studies

The following case studies are examples of LID features that were designed with the purpose of collecting urban storm water. They are significant because they demonstrate that within Utah's semiarid climate, bioretention and LID approaches can be successfully implemented. Two of the sites are within Salt Lake County and one is in Grand County.

The sites discussed are:

- Bioretention Area at Mountview Park in Cottonwood Heights

  A bioretention area within a large park captures runoff from parking lots within the park and from a nearby residential area.

- Various LID BMPs at the Sandy City Public Works facility

  Rain gardens, bioswales, vegetated swales, concrete pavers, and permeable asphalt detain and treat runoff from a public works facility.

- Permaculture Garden at Utah State University Moab

  As part of a landscaping renovation at the campus, impervious areas are converted to infiltrating swales and increased pervious surfaces that sustains various plant life.

Note that each of these projects was designed and constructed prior to adoption of the 80th percentile storm water retention requirement. As part of the evaluation of these sites, calculations using methods from the previous section were performed to determine whether the sites would be able to successfully retain the 80th percentile storm depth for the BMPs' drainage areas. The bioretention area at Mountview is undersized for the 80th percentile storm depth. The BMPs at the Sandy City Public Works were designed with the 90th percentile storm volume in mind and four of the nine BMPs were able to be sized for the full water quality volume. Approximate calculations for the 80th percentile storm volume for the Utah State University Moab site were also made.

Bioretention **Mountview Park – Cottonwood Heights**

Location: 40.6274°, -111.8449°

Contributing Drainage Area: 18.86 ac

Imperviousness: 65% (approx.)

Bioretention Footprint: 2,470 sf

Soil Type: A (Web Soil Survey)

Figure 20: Bioretention area at Mountview Park.

This bioretention area is one of two constructed by The University of Utah for research purposes in the Spring of 2012 to determine if bioretention is a feasible option in Utah's semiarid climate (Heiberger, 2013). The bioretention area at Mountview Park remains intact (*Figure 20*); however, the other bioretention site that was constructed on The University of Utah campus has been removed.

The bioretention area is approximately 2,470 sf and has a depth of 4 ft. There are two layers within the bioretention area: the top layer is 2 feet of native backfill soil; the bottom layer is 2 feet of a subsurface reservoir layer composed of Utelite 3/4" medium grade aggregate with a porosity of 53%. Utelite aggregate was selected due to its filtering and planting applications. The porosity of the top layer is 0.25, resulting in a storage capacity of 1,235 cf. The reservoir layer allows for storage of up to 2,620 cubic feet. The total storage capacity is 3,853 cf.

The nearest rain gage with reliable historical data is the Cottonwood Weir rain gage. Its 80th percentile storm depth is 0.65 inches. The drainage area's total imperviousness is approximately 65%. The runoff coefficient was determined to be 0.57. The water quality volume for this drainage area would be 25,360 cf. which means that the existing bioretention area is undersized for the water quality volume.

Location: 40.5924, -111.9091

Contributing Drainage Area: 7.98 ac

Imperviousness: 93.9%

Soil Types: C & D (Web Soil Survey)

80th Percentile Storm Depth: 0.77 in

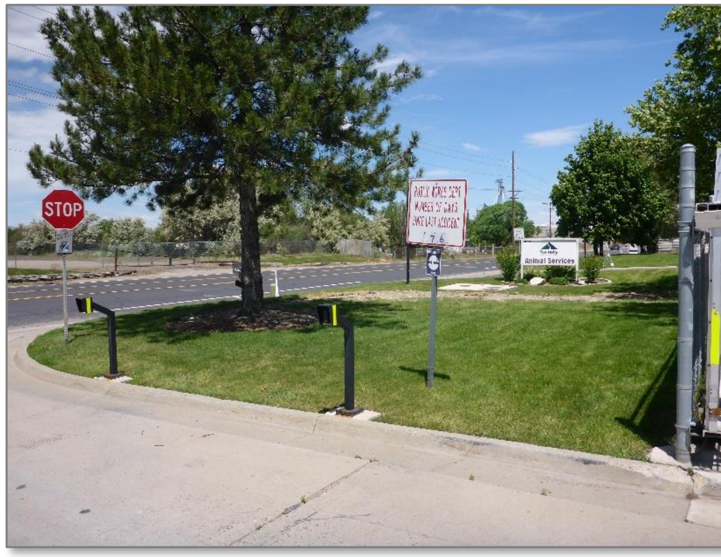


Figure 21: Proposed rain garden location.

In the winter of 2017, 60% of the Sandy City Public Works facility was destroyed by a large fire. Sandy City decided to do a full redesign and take a multi-phased approach to rebuilding the entire site. Construction is currently ongoing (*Figure 21*).

An LID approach to the site was incorporated into the design and several LID features such as bioswales, rain gardens, and bioretention cells were designed. The Granato method of determining the runoff coefficient (R_V = 1.14i-0.371 when $i \geq 55\%$) was used (Taylor & Barrett, 2014) due to the heavy transportation use at a public works site. The project's total volume retention goal was 15,600 cf. Due to various infeasibilities and to maintain the functional purpose of the site, it was not possible for the proposed BMPs to capture the full retention volume. Some drainage areas within the site were unable to retain or treat any storm water.

Shallow groundwater and poor soils limited infiltration opportunities, and it was decided that all BMP areas would have impermeable liners and underdrain systems. For this reason, all BMPs except for the bioswales were designed as detention devices that provided treatment of runoff instead of retaining it on-site. Outlet structures connecting to the storm drain network were designed to release within an acceptable drawdown time. Treatment at the various BMPs was accomplished through a combination of settling, filtration through vegetation, and bioretention through the BMPs' soil layers. Some retention will be accomplished through the bioswales and could be quantified through monitoring.

A full list of the site's BMPs and a few characteristics of each are given in *Table 8* below.

Table 8: LID BMP characteristics designed for the Sandy City Public Works facility.

LID BMP Type	Subsurface Sections	Underdrain	Drainage Area (ac)	WQV (cf)	BMP's Treated Volume (cf)
Rain Garden 1 (lined)	Engineered Soil Coarse Sand Pea Gravel Open Graded Stone	Yes	0.34	737	737
Bioswale 1	Engineered Soil	Yes	0.07	141	27
Bioswale 2	Engineered Soil	Yes	1.23	2309	1469
Rain Garden 2 (lined)	Engineered Soil Coarse Sand Pea Gravel Open Graded Stone	Yes	0.15	280	280
Bioswale 3	Engineered Soil	Yes	0.42	800	366
Rain Garden 3 (lined)	Engineered Soil Coarse Sand Pea Gravel Open Graded Stone	Yes	0.41	885	541
Vegetated Swale	Native backfill	No	0.65	1291	140
Concrete Pavers	AASHTO No. 8 AASHTO No. 57 Drain Rock	Yes	0.13	55	55
Permeable Asphalt	AASHTO No. 8 AASHTO No. 57	Yes	0.13	55	55
			Total Volume (cf)	6553	3670

Four of the nine BMPs were able to be sized for their water quality volume. Treatment was provided for 56% of the total water quality volume of all BMPs. Although the volume retention goal for the entire site was 15,600 cf and all drainage areas were evaluated for their retention potential, many of the drainage areas were deemed to be infeasible for various reasons. Lack of available open space, constraints imposed by the downstream storm drain network, and groundwater restricted five of the BMPs from being able to be sized for the full water quality volume. This site would meet the 80th percentile requirement by retaining runoff to the maximum extent practicable.

Figure 22: Construction progress of permaculture garden.

Location: 38.5700°, -109.5526°

Soil Type: C

In 2014, as part of a campus-wide landscaping redesign, it was decided that portions of the parking areas of Utah State University Moab would undergo a renovation to capture rainfall and create a thriving, productive micro-riparian area. With the removal of a few parking spaces and the conversion of previously unused impervious areas, two permaculture gardens were created that now support vegetation and are aesthetically pleasing areas that benefits the public while retaining rainfall that is reintroduced to the soil instead of conveying directly to catch basins. Each garden contains bioretention systems and bioswales (*Figure 22*) that collect runoff from the adjacent parking lots and down drains from nearby buildings.

Although the permaculture garden was not specifically designed for targeted pollutants, it is worth noting that the garden is located just over one mile away from the Colorado River at the confluence of Mill Creek and Pack Creek. Both creeks are listed for 303(d) impairments including dissolved oxygen, E. coli, dissolved selenium, temperature and total dissolved solids. A monitoring program would reveal the effectiveness of the bioretention and bioswales at removing these pollutants.

The nearest rain gage with a reliable historical record is Arches National Park HQS, which has an 80th percentile storm depth of 0.43 inches. With an estimated contributing drainage area of 1.0 acre and a runoff coefficient determined to be 0.89, the volume retention goal for the permaculture garden would be 1,389 cf.

Additional Local LID Implementation

Daybreak, South Jordan

Daybreak is a mixed-use development located in South Jordan, Utah in the southwest corner of Salt Lake County. The area for the development is planned to contain more than 20,000 residential units.

A variety of techniques were used to mitigate the effects of urbanization on storm water runoff quality. Among the LID techniques used in the community are bioswales, dry wells, constructed wetlands, infiltration trenches, infiltration basins, and detention basins. The community also stipulates that 40% of residential lots and 68% of common open spaces consist of native, drought resistant plants. This strategy is designed to be able to retain the 100-year storm event.

Researchers conducted a water quality monitoring study on the development to determine the effectiveness of the green infrastructure design. One sub-watershed utilized a series of bioswales while the other sub-watershed deployed traditional storm water management techniques. Several constituents were monitored for water quality including nitrogen, phosphorus, suspended solids, and heavy metals. The sub-watershed with bioswales showed significantly reduced runoff volumes as well as large reductions in constituent and heavy metal concentrations when compared to the traditional storm water sub-watershed. A promising finding of the study was that first flush concentrations of copper were reduced, which is significant due to its removal difficulty and the proximity of copper mines in the area. Reductions of other metals during the first flush are listed below. (Yang, Li, Wall, Blackmore, & Wang, 2015)

Total suspended solids, TSS: 92% reduction

Total Nitrogen, TN: 87% reduction

Total Phosphorus, TP: 92% reduction

Zinc, Zn: 96% reduction

Lead, Pb: 96% reduction

Copper, Cu: 82% reduction

Utah State University Research Sites

Utah State University is currently conducting research on the effectiveness of LID techniques on storm water pollutant removal and nutrient uptake. Several LID techniques are being monitored including bioswales, planter boxes, dry wells, bioretention, vegetated filter strips, and membrane roofs at two sites in Logan and one site in Salt Lake City (Dupont, McLean, Peralta, Null, & Jackson-Smith, 2017). The following pollutants are being monitored:

Total Nitrogen, TN	Dissolved Organic Carbon, DOC	Nickel, Ni
Total Dissolved Nitrogen, TDN	Electrical Conductivity, EC	Copper, Cu
Total Phosphorus, TP	pH	Zinc, Zn
Total Dissolved Phosphorus, TDP	Aluminum, Al	Arsenic, As
Nitrate, NO3-N	Chromium, Cr	Cadmium, Cd
Ammonia, NH3-N	Iron, Fe	Lead, Pb

A summary of whether the monitored constituent levels decreased (D) or increased (I) is provided in *Table 9*. Reasons for the increases in pollutant concentrations are uncertain and are currently being investigated. Of particular concern to the researchers is the mobilization of arsenic, although levels are still significantly lower than drinking water standards. In general, the use of organic matter and fertilizer to establish a BMP's vegetation is a typical reason for increases in nitrogen and phosphorus concentrations. BMP sites that are experiencing increases in pollutant concentrations should be inspected or further analyzed to eliminate the introduction of pollutants.

Site 1: Bioswale (Logan). Lysimeter measurements taken at depths of 6 inches and 24 inches depths.

Site 2: Bioswale (Logan). Lysimeter measurements taken at depths of 12 inches and 20 inches.

Site 3: Media Filter Layer below Bioretention Cell (Salt Lake City).

Site 4: Dry Well (Logan).

Site 5: Vegetated Parking Strip (Logan).

Table 9: Summary of monitored constituents at five sites.

Monitored Constituent	Site 1	Site 2	Site 3		Site 4	Site 5	
			UteLite Expanded Shale	Pea Gravel		4 ft Sump Sample	6 ft Sump Sample
TN	I	D	D	D	D	I	I
TDN	I	I	D	I	D	D	NC
TP	I	I	NC	NC	D	D	D
TDP	I	I	D	I	D	I	D
NO3-N	D	D	I	I	D	I	D
NH3-N	D	I	D	D	D	I	I
DOC	NM	NM	D	D	D	I	D
EC	I	I	I	I	D	D	D
pH	I	I	I	I	I	D	NC
Al	NM	D	I	I	D	D	I
Cr	NM	D	I	I	D	I	D
Fe	NM	D	I	I	D	I	I
Ni	NM	I	I	I	D	I	I
Cu	NM	D	I	D	D	I	D
Zn	NM	I	D	D	D	I	D
As	NM	I	I	I	D	I	D
Cd	NM	I	I	I	D	D	D
Pb	NM	D	D	I	D	I	D

D = decrease; I = increase; NC = no change; NM = not monitored

Green Meadows, Logan

The Green Meadows subdivision in Logan, Utah is one of Utah State University's research sites. The subdivision is a relatively new settlement with houses first being constructed in the early 2000s. The western end of the subdivision borders the Logan River which is in the Bear River watershed. A water quality management plan was established for the watershed in 1995 and found that the Logan River had relatively good water quality. As of 2016 it was listed on the 303d report by the Utah DWQ as having impairment for total phosphorus with a TMDL approved by the EPA.

Utah State University used the subdivision for a case study on the effectiveness of vegetative species within bioretention cells. The study focused on biomass production and water quality improvement to measure the effectiveness of the vegetation. Laboratory tests were conducted with simulated frequency and duration rainfall events to measure biomass production and pollutant removal. Field tests were conducted at the site to generate water quality improvement effectiveness data. Citric acid was added at the field site to simulate a possible increase in nutrient and metal uptake.

The USU study found that common reed and sedges were optimal plants for the area to improve storm water quality. The field site showed significant retention and infiltration capacities throughout the study and 100% pollutant removal from storm water runoff. Maximum nutrient and metal removal was shown to be possible at the site if there was no discharge from the bioretention cells. In tests with added citric acid, metal solubility was increased in the runoff but no enhanced metal uptake was observed. (Dupont & McLean, Optimizing Stormwater BMP Performance, 2018)

Northern Utah Runoff Coefficients

Additional research at Utah State University evaluated runoff coefficients at four sites in northern Utah. Monitoring of dozens of rain events took place from 2015 to 2017. Runoff coefficients were derived by dividing the cumulative rainfall by the cumulative runoff values for the rain events at each site. The sites are identified as 1400 N, 1300 N, 1000 N, and 800 N.

Data from the sites was statistically analyzed to determine relationships between the observed runoff coefficients and rain depth, storm intensity, and storm duration. Statistical significance (p values) and R squared values (the strength of the relationship between the runoff coefficient and the other parameters) were calculated. At the 1400 N site and 1300 N sites, the relationships between the runoff coefficient and all three parameters were found to be insignificant. The 1000 N site showed no statistical significance between the runoff coefficient and the storm intensity but did show significance between the runoff coefficient and storm duration. The 800 N site showed statistical significance between the runoff coefficient and both the storm duration and the storm intensity. Although general trends do come out in the data (increased rain depth results in higher runoff coefficients) R squared values were generally low due to the scattered nature of the data (Velásquez, 2018).

The range of imperviousness from these four sites is limited. The 1400 N and 1300 N sites were approximately 90% impervious and the 1000 N and 800 N sites were both approximately 65%. Jurisdictions will encounter a wider variation of imperviousness for their developments. Developing regression equations for runoff coefficients based on the 80th percentile storm depth that use the imperviousness as the control variable may be simpler to apply jurisdiction-wide to projects since imperviousness will be the parameter with the greatest variability. See *Step 3: Volumetric Runoff Coefficient* for more information on runoff coefficient equations that may be appropriate for use on a jurisdictional level.

Appendix A 80th Percentile Storm Depths

Facility Operator Name (MS4)	80th Percentile Storm Depth (in)	Facility Operator Name (MS4)	80th Percentile Storm Depth (in)
Cache County	0.47	Bluffdale	0.49
Hyde Park City Corp	0.50	Cottonwood Heights	0.58
Hyrum City Corporation	0.50	Draper	0.43
Logan	0.50	Herriman	0.50
Millville City Corp	0.47	Holladay	0.52
Nibley City Corporation	0.47	Midvale	0.50
North Logan City Corporation	0.60	Millcreek	0.55
Providence City Corporation	0.47	Municipal Service District (MSD)	0.55
River Heights City Corporation	0.50	Murray	0.46
Smithfield City Corporation	0.50	Riverton City	0.50
Utah State University (USU)	0.48	Salt Lake City	
Wellsville City Corporation	0.48	Salt Lake County	0.55
Bountiful City	0.60	Sandy	0.50
Centerville City Corporation	0.50	South Jordan	0.46
Clearfield City Corporation	0.50	South Salt Lake	0.60
Clinton City Corporation	0.48	University Of Utah**	1.00
Davis County Public Works	0.61" above Pine View Canal 0.48" below Pine View Canal	Veterans Affairs Medical Cente	0.55
Farmington City	0.49	West Jordan	0.46
Fruit Heights City Corp	0.45	West Valley City	0.46
Hill Air Force Base**	0.80	Park City	0.50
Kaysville City	0.48	Summit County	0.50
Layton City Corporation	0.45	Alpine City	0.53
North Salt Lake	0.60	American Fork City	0.50
South Weber City Corporation	0.43	Cedar Hills City	0.50
Sunset City	0.50	Eagle Mountain	0.40
Syracuse City Corp	0.47	Highland City Corporation	0.50
West Bountiful City	0.50	Lehi City Corporation	0.50
West Point City	0.50	Lindon City	0.50
Woods Cross City Corp	0.48	Mapleton City Corporation	0.55

Facility Operator Name (MS4)	80th Percentile Storm Depth (in)	Facility Operator Name (MS4)	80th Percentile Storm Depth (in)
Brigham City Corporation	0.54	Orem	0.50
Farr West City Corp	0.43	Payson City	0.46
Harrisville City Corporation	0.43	Pleasant Grove City	0.50
Hooper City Corporation	0.48	Provo City Storm Water Service District	.44 to .50 (depending on location)
Marriott-Slaterville City Corp	0.43	Salem City Corporation	0.55
North Ogden City Corporation		Saratoga Springs	0.41
Ogden City	0.48 (Harrison Blvd. to west) 0.62 (Harrison Blvd. to east)	Spanish Fork City**	0.9 Worst 25 Year Storm
Perry City Corporation	0.54	Springville City Corp	0.50
Plain City Corporation	0.48	Utah County	depth varies from 0.23 to 0.55, contact Utah County 801-851-8602
Pleasant View City Corporation	0.43	Vineyard	0.50
Riverdale City	0.50	Ivins City Corporation	0.44
Roy City Corporation	0.50	Santa Clara City Corp	0.44
South Ogden City Corporation		St. George	0.44
Uintah City Corporation	0.43	Washington City	0.44
Washington Terrace City Corp	0.43	Elk Ridge	0.52
Weber County	West: 0.60 East: 0.50	Taylorsville	0.45
Weber State University	0.52	Utah State Prison	TBD
West Haven City	0.49	Woodland Hills	0.50

**indicates the MS4 is using a storm depth different than the 80th percentile

Appendix B Storm Water Quality Report Template

Storm Water Quality Report – Template

This is an example of how the suggested report template is completed. Text highlighted in yellow is project specific information. A blank word document of this template can be found here: https://documents.deq.utah.gov/water-quality/stormwater/DWQ-2018-013750.docx

Date: 9/1/2019

Project Name: Garden Valley Condominiums

Project ID: 999999

Design Engineer: John Doe, PE

Is the project within a watershed that is 303(d) listed? Yes

If yes:

Name of receiving water(s): Little Cottonwood Creek-2

Listed Impairment(s): pH; Cadmium, Dissolved; Copper, Dissolved

Does the watershed that has an approved TMDL? Yes

If yes:

Approved TMDL(s): Zinc

I have reviewed the storm water quality design and find this report to be complete, accurate, and current.

Project Manager

[name], Project Manager

Storm Water Coordinator

[name], Designate Storm Water Coordinator

Maintenance

[name], Head of Maintenance

[stamp required at final design phase]

Landscaping

[name], Landscape Architect or Equivalent

Project Information

80th Percentile Storm Depth (in): 0.55

New Development

Area of Land Disturbance (ac): 3.7

Project Impervious Area (ac): 2.9

Project Imperviousness (%): 78

Project Volumetric Runoff Coefficient, R_V: 0.69

80th Percentile Volume (cf): 5,110

Predevelopment Hydrologic Condition (cf): 6,200

Project Volume Retention Goal, V_{goal} (cf): 5,110

Redevelopment

Existing Project Impervious Area (ac): ______

Proposed Project Impervious Area (ac): ______

Change in Impervious Area (%): ______

If change in impervious area > 10%:

Existing Project Conditions

Imperviousness (%): ______

Volumetric Runoff Coefficient, R_V: ______

80th Percentile Volume, V_1 (cf): ______

Proposed Project Conditions

Imperviousness (%): ______

Volumetric Runoff Coefficient, R_V: ______

80th Percentile Volume, V_2 (cf): ______

$V_{goal} = V_2 - V_1 =$ ______

Subsurface Information

Groundwater

Depth to Groundwater (ft): 17 ft

Historical High Depth to Groundwater if known (ft): 9 ft

Source: Project groundwater monitoring

Groundwater Contamination at Site: None

Soil Information

Infiltration Rate (in/hr): 1.5 in/hr

Hydrologic Soil Group: A

Source: Project geotechnical report

Soil Contamination at Site: None

Drinking Water

Within Drinking Water Source Area Protection: ____No___

Additional Relevant Site Information

LID Drainage Areas

Add additional rows as needed.

Contributing Drainage Area	Area (ac)	Impervious Area (ac)	Imperviousness (%)	Volumetric Runoff Coefficient, R_V	Water Quality Volume, WQV (cf)
CDA 1	0.90	0.50	0.56	0.49	872
CDA 2	0.75	0.45	0.60	0.53	787
CDA 3	0.80	0.80	1.00	0.89	1421
CDA 4	1.25	1.15	0.92	0.82	2038
				Total WQV (cf)	5118

LID BMP Design

Add additional rows as needed.

Contributing Drainage Area	LID BMP Type	Water Quality Volume, WQV (cf)	Runoff Retained (cf)	Percent of Runoff Captured (%)
CDA1	Rain Garden	900	872	100
CDA 2	Infiltration Basin	800	787	100
CDA 3	Bioretention Cell	1450	1421	100
CDA 4	Bioretention Cell	2100	2038	100
		Total Volume Retained (cf)	5118	100

Percent of V_{goal} captured by LID BMPs: _100_%

If 100% of V_{goal} is not captured, document and provide narrative of technical infeasibilities and/or alternate compliance measures below:

Describe additional storm water quality measures incorporated into the site:

Appendix C LID BMP Fact Sheets

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Minimize Impervious Area — *SD-1*

Pollutant Removal Effectiveness

Pollutant removal will vary based on the development's land use category. Refer to *Table 7* to determine pollutants that are to be expected for residential, commercial, industrial, transportation, landscaped, and agricultural land uses.

Minimize the amount of impervious surface at a development by reducing the footprint of impervious features or replacing impervious material with pervious alternatives. When appropriate and as permitted by jurisdiction and development standards, consider the use of pervious materials such as pavers, pervious pavement, or porous concrete for roads, parking lots, sidewalks, driveways, and other design elements that typically account for large portions of a site's impervious surfaces. If reduction of impervious surfaces was not accounted for during the initial design phases, review the plans to identify opportunities to reduce impervious areas. If development standards do not currently allow for narrower roads or pervious materials, work with the appropriate agencies to discuss how to effectively integrate these practices while maintaining functionality of the site and public safety.

Strategies

- Minimize roadway width as much as jurisdictional standards will allow
- Reduce width of parking spots
- Reduce sidewalk widths
- Incorporate *Pervious Surfaces*
- Shared driveways
- One-way streets

Benefits

- Reduce pollutant runoff
- Improve development aesthetic
- Reduce retention volume requirement

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WATER QUALITY

Rain Garden

BR-1

Pollutant Removal Effectiveness

Pollutant	Effectiveness
Sediment	High
Nutrients	High
Metals	High
Bacteria	High
Oil/Grease	High

Rain gardens are shallow bioretention areas with engineered or native soils. A variety of plants are used to increase infiltration and nutrient uptake including trees, shrubs, grasses, and other plants suitable for the climate. Rain gardens may be designed with various layers of soil, sand, and aggregate. They may also be designed with the existing soils at the site if the soils are expected to adequately infiltrate, support vegetation, and remove pollutants. They can be topped with a wood or rock mulch, any organic material, or other landscaping features. Performance is increased with high carbon soils. Sand and aggregate layers below the soil layers may provide filtration and storage. Rain gardens are usually well-received by the public for their aesthetic qualities.

Slopes leading to the garden bottom are gentle or steep based on site constraints, such as within urban areas. Ponding depths are typically between 1 to 18 inches. Underdrains and impermeable liners are necessary when subsurface concerns exist such as proximity to a structure, poorly infiltrating soils beneath the cross-section of the garden, or groundwater concerns. When a rain garden must be lined, its volume retention function is eliminated, pollutant removal effectiveness is diminished, and it functions primarily as a detention device; however, it still provides treatment through biofiltration. A bypass mechanism either within the rain garden or upstream of the rain garden should be considered for flood events.

Primary Functions	
Bioretention	Yes
Volume Retention	Yes
Biofiltration	Yes

Design Criteria

Refer to *Design Criteria* in the *Preface to Fact Sheets* for discussion of design criteria parameters.

Parameter	Min. Value	Max. Value	Notes
Depth to Historical High Groundwater	2 ft	No maximum	-
Side Slopes	No minimum	3H:1V	-
Ponding Depth	No minimum	18 in	-
Drawdown Time	12 hours	72 hours	24 to 48 hours preferred. Drawdown time may also depend on local mosquito abatement regulations.
Design Infiltration Rate	0.25 in/hr	6 in/hr	Field testing required for final design. Infiltration rate should be low enough to allow biofiltration processes to occur. During design, infiltration rate, drawdown time, and the soil matrix depth will be directly related.
Freeboard	No minimum	No maximum	Freeboard per jurisdiction standards. For public safety, consider requiring freeboard and a minimum 6-inch embankment when ponding depth is greater than 6 inches.

Calculation Methods

Rain garden design is governed by the water quality volume. The general design steps are:

1. Calculate the water quality volume.
2. Determine the geometry of the rain garden.
3. Based on the rain garden geometry and the porosity of the soil layers, determine the ponding depth and soil matrix depth required to hold the water quality volume.
4. Calculate the drawdown time.
5. Calculate the water quality outlet elevation.

Sample Calculations

Refer to *Calculation Methods* in the *Preface to Fact Sheets* for discussion on the equations used.

A site has 1,500 sf of available open space at the downstream end of a parking lot. The parking lot and an adjacent pervious surface constitute one drainage area that is 0.75 ac in size. The total imperviousness of the drainage area is 0.80. The jurisdiction has a maximum drawdown time of 48 hours and uses a safety factor of 1.5 for water quality design.

Given

Contributing drainage area: 0.75 ac

Imperviousness: 0.80

80th percentile storm depth: 0.55 in

Design infiltration rate: 1.75 in/hr

Determine

The footprint and depth of a rain garden that can retain the water quality volume.

Calculations

Volumetric runoff coefficient, R_V (See *Sample Calculations*)

$R_V = 0.91i - 0.0204$ (Reese method)

$R_V = 0.91(0.80) - 0.0204$

$R_V = 0.71$

Water quality volume, WQV (See *Developing the 80th Percentile Volume*)

$WQV = R_V dA$

WQV = (0.71)(0.55 in)(0.75 ac)(43,560 sf/ac) / (12 in/ft)

WQV = 1,063 cf

Minimum footprint, A_{min} (See *Minimum footprint area*)

A_{min} = (12)(Safety Factor)(WQV) / kt

A_{min} = (12)(1.50)(1,063 cf) / (1.75 in/hr)(48 hrs)

A_{min} = 228 sf

The water quality volume will infiltrate into the existing soil in 48 hours if the rain garden bottom is 228 square feet. However, this does not mean that the rain garden bottom is required to be 228 square feet. A larger footprint with a faster drawdown time may be acceptable and reduce the depth required to retain the water quality volume.

A rain garden with a bottom footprint of 1,063 sf and a 12-inch ponding depth will retain the water quality volume. If a safety factor is desired, it should be accounted for by multiplying the water quality volume by the safety factor.

Rain Garden Effectiveness

Effective rain gardens provide an aesthetically pleasing method for retaining and treating storm water. Visiting rain gardens during rain events will reveal if the garden is draining properly. Rain gardens are performing properly if they are retaining their design volume and treating runoff. Creating and following through on maintenance guidelines are critical to ensuring that a rain garden remains functional.

There are many possible indications that a rain garden has failed or is near failure, such as: ponding beyond the design ponding depth during small storm events, drawdown time exceeds design drawdown time, larger than expected sediment buildup within or upstream of the rain garden, irregular settling of the rain garden bottom creating standing water, sloughing of side slopes, excessive and unmaintained vegetation, lack of vegetation, and no maintenance or no record of maintenance. Although this is not an all-inclusive list, being aware of these items will assist in determining what steps need to be taken to remediate a failing rain garden.

Designer Checklist

If the answer to these questions corresponds to a response box that is red, the BMP should either not be used or additional measures need to be taken to address the issue.

	Yes	No
Does groundwater meet the minimum separation requirement?	☐	☐
Is there available right-of-way, property, or easement?	☐	☐
Is the design infiltration rate within acceptable rates?	☐	☐
Is contaminated groundwater present?	☐	☐
Is the drainage area to the rain garden less than 5 acres? (If no, consider an infiltration basin or subdividing to create smaller drainage areas.)	☐	☐
Do utility conflicts make installation of the rain garden technically infeasible?	☐	☐
Do geotechnical conditions exist that would compromise the stability of the rain garden or surrounding structures?	☐	☐
Does the rain garden provide storage for 100% of the water quality volume? (If no, it may still be appropriate to construct the rain garden if it is technically infeasible to capture 100% of the water quality volume.)	☐	☐
Does an overflow outlet structure or bypass mechanism exist?	☐	☐

Vegetation

Refer to *Vegetation Guidance by BMP Type*.

Installation

Excavation

Rain gardens, like other BMPs whose functionality is dependent on infiltration, will fail if proper care is not taken during excavation and construction. Excavators and heavy machinery should not be used within the rain garden area if infiltration is expected to occur through the rain garden bottom. Additional excavation beyond the rain garden's footprint may be required depending on site conditions to provide soil stability or to be able to tie-in to the surrounding grade.

Activities During Construction

Avoid using heavy machinery within the rain garden footprint during construction as doing so will compact the soils and diminish their infiltrating capabilities. Light machinery and even walking within the rain garden's footprint will also compromise infiltration. Compaction of native soils or backfill below the rain garden subsoils is acceptable if doing so does not prevent infiltration from occurring.

Flows During Construction

Flows during construction should be diverted away from the rain garden to prevent construction site sediment from clogging soils. Scheduling installation of the rain garden shortly after excavation will minimize the impact of unnecessary storm water flows from entering the excavated area. The introduction of unwanted sediment can be prevented by placing fiber rolls or silt fences around the rain garden perimeter during construction.

Additional Guidance

- Require certificates of compliance to verify that construction items meet specification requirements.
- Follow landscaping guidance to ensure that vegetation establishes after installation.

Installation Costs

The following cost items are typically associated with rain garden construction.

- Excavation
- Grading
- Fine grading
- Granular borrow fill
- Landscaping and vegetation
- Top layer
- Engineered soil
- Coarse sand
- Crushed gravel
- Open graded stone
- Geotextile fabric
- Outlet structure or upstream bypass structure (for larger storm events)
- Observation wells
- Curb and gutter
- Impermeable liner (if needed)
- Underdrain system (if needed)
- Irrigation system (if needed)

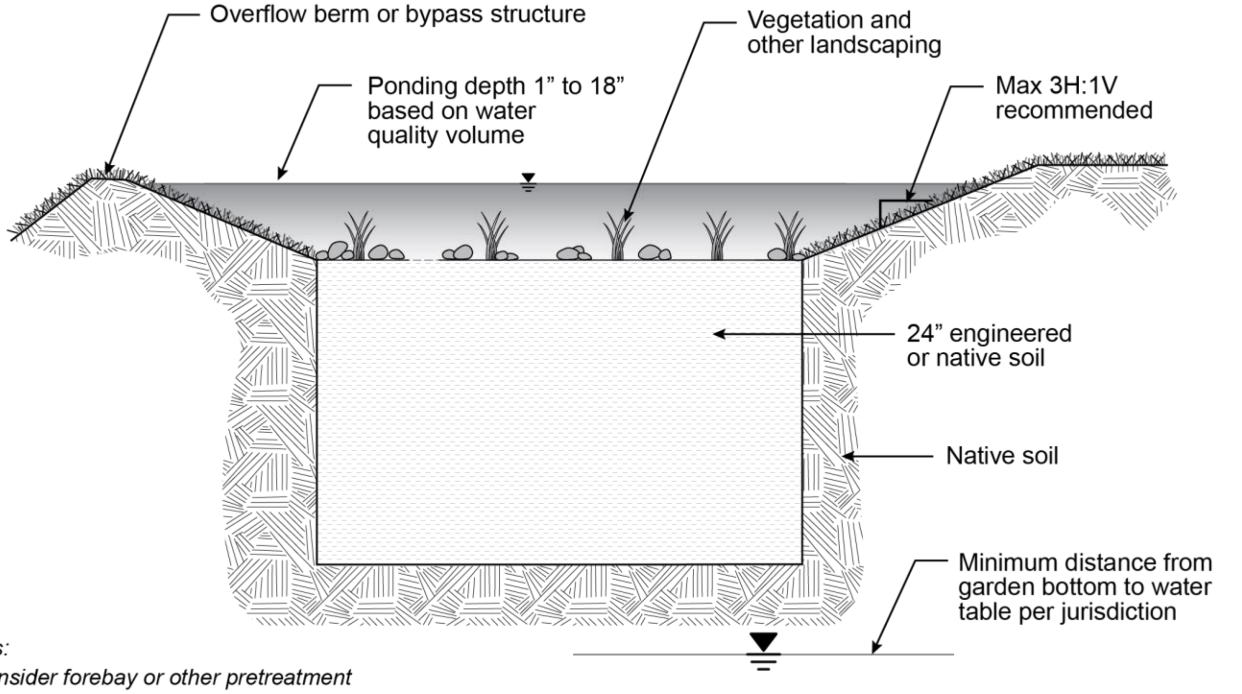
Maintenance

Refer to *Maintenance* and *Maintenance Costs* in the *Preface to Fact Sheets* for general information related to maintenance of bioretention BMPs.

Maintenance Activities

Inspection	Inspection/Maintenance Frequency	Maintenance Activity	Effort
Inspect for adequate vegetative coverage, and impaired or failing vegetation.	Semiannual (Spring, Fall)	Reseed/replant barren spots. Notify the engineer if failing vegetation persists.	Low
Inspect side slopes for erosion, rilling, and sloughing.	Semiannual (Spring, Fall)	Regrade side slope if sloughing does not impact slope stability. Notify the engineer if side slope stability has been compromised and is affecting the functionality of the basin.	Low
Inspect for trash and debris within basin and at inlet and outlet structures.	Semiannual (Spring, Fall) or as needed	Remove and dispose of trash and debris.	Low
Inspect for large deposits of sediment on basin bottom indicating soil clogging.	Semiannual (Spring, Fall) or as needed	Remove and dispose of built up sediment when buildup causes reduction in size of	Low

Inspection	Inspection/Maintenance Frequency	Maintenance Activity	Effort
		basin or if buildup results in standing water. Notify the engineer in the case of standing water as it may indicate clogging within the basin's soil layers.	
Inspect for standing water within rain garden or within observation well.	Semiannual (Spring, Fall) or as needed	Notify the engineer for further inspection.	Medium
Inspect for failure of additional features such as underdrains or irrigation systems.	Semiannual (Spring, Fall) or as needed	Repair as needed.	Medium

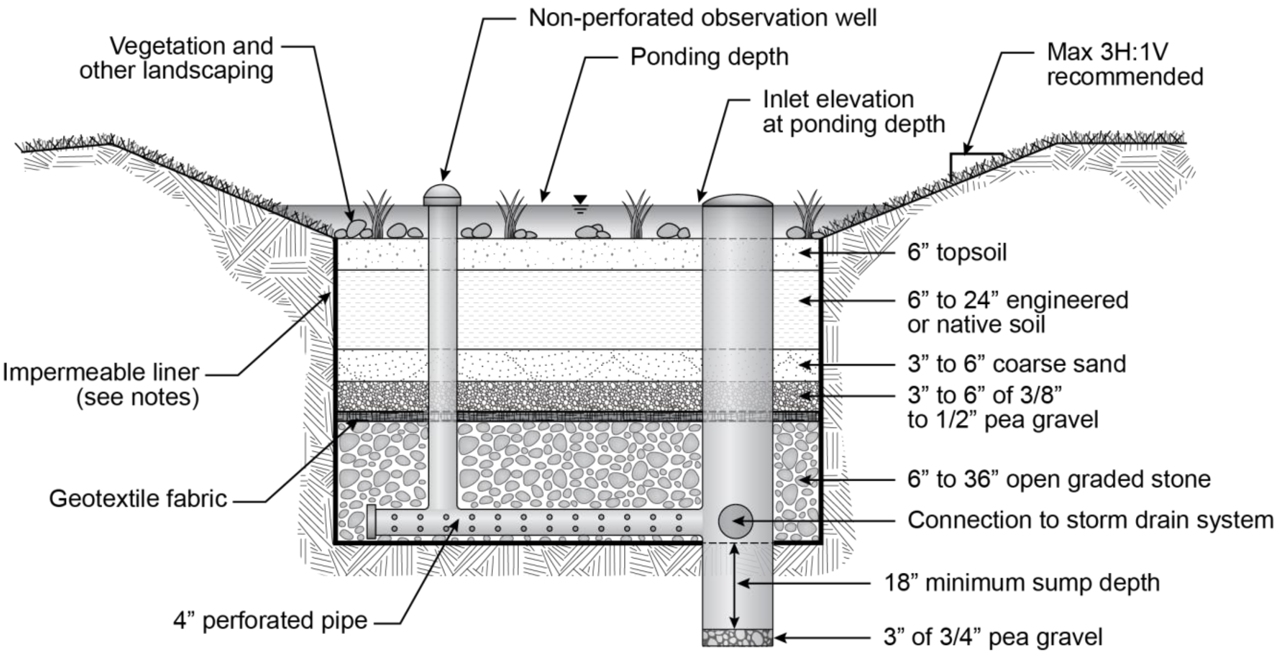


Notes:

- *Consider forebay or other pretreatment*
- *Consider upstream bypass for large storm events*

Rain Garden in Native or Engineered Soils

Not to scale



Notes:

- *Impermeable liner around all sides and bottom of rain garden if groundwater concerns exist*
- *Dimensions shown may vary based on site conditions*
- *Consider forebay or other pretreatment*
- *This treatment option may be considered when infiltration is infeasible*

Rain Garden with Underdrain System

Not to scale

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Bioretention Cell

BR-2

Pollutant Removal Effectiveness

Pollutant	Effectiveness
Sediment	High
Nutrients	High
Metals	High
Bacteria	High
Oil/Grease	High

Bioretention cells are shallow bioretention areas with engineered soil. They typically differ from rain gardens by having a delineation such as a curb, wall, or other distinct boundary. Similar to a rain garden, a variety of plants are used to increase infiltration and nutrient uptake including trees, shrubs, grasses, and other plants suitable for the climate. They may be designed with native soils or various layers of soil, sand, and aggregate. They can be topped with a wood or rock mulch, any organic material, or other landscaping features. Performance is increased with high carbon soils. Sand and aggregate layers below the soil layers provide filtration and storage.

Ponding depths are usually between 1 to 18 inches. In areas with high foot traffic, it may be necessary to provide a safety bench of soil within the cell and a minimum side slope leading to the cell bottom. Underdrains and impermeable liners are necessary when subsurface concerns exist such as proximity to a structure, poorly infiltrating soils, or groundwater concerns. When a bioretention cell must be lined, its volume retention function is eliminated, its pollutant removal effectiveness is diminished, and it functions primarily as a detention device; however, it still provides treatment through biofiltration. A bypass mechanism either within the bioretention cell or upstream of the cell should be considered for flood events.

Primary Functions	
Bioretention	Yes
Volume Retention	Yes
Biofiltration	Yes

Design Criteria

Refer to *Design Criteria* in the *Preface to Fact Sheets* for discussion of design criteria parameters.

Parameter	Min. Value	Max. Value	Notes
Depth to Historical High Groundwater	2 ft	No maximum	-
Ponding Depth	No minimum	18 in	-
Drawdown Time	12 hours	72 hours	24 to 48 hours preferred. Drawdown time may also depend on local mosquito abatement regulations.
Design Infiltration Rate	0.25 in/hr	6 in/hr	Field testing required for final design. Infiltration rate should be low enough to allow biofiltration processes to occur. During design, infiltration rate, drawdown time, and the soil matrix depth will be directly related.
Freeboard	No minimum	No maximum	Freeboard per jurisdiction standards. For public safety, consider requiring freeboard and a minimum 6-inch embankment when ponding depth is greater than 6 inches.

Calculation Methods

Bioretention cell design is governed by the water quality volume. The general design steps are:

1. Calculate the water quality volume.
2. Determine the geometry of the bioretention cell.
3. Based on the bioretention cell geometry and the porosity of the soil layers, determine the ponding depth and soil matrix depth required to hold the water quality volume.
4. Calculate the drawdown time.
5. Calculate the water quality outlet elevation.

Sample Calculations

Refer to *Calculation Methods* in the *Preface to Fact Sheets* for discussion on the equations used.

A drainage area within a proposed roadway will be one-third of an acre with 90% imperviousness. It is proposed that three bioretention cells be placed within the drainage area creating three sub-drainage areas. Each sub-drainage area has the same imperviousness and 'A' soils are present.

Given

Contributing drainage area: 0.11 ac

Imperviousness: 0.90

Storm depth: 0.45 in

Design infiltration rate: 1.60 in/hr

Determine

The footprint and depth of the bioretention cells that can retain the water quality volume.

Calculations

Volumetric runoff coefficient, R_V (See *Sample Calculations*)

$R_{V\text{-}A} = 0.84i^{1.302}$ (R_V based on hydrologic soil group)

$R_{V\text{-}A} = 0.84(0.90)^{1.302}$

$R_V = 0.73$

Water quality volume, WQV (See *Developing the 80th Percentile Volume*)

WQV = (0.73)(0.45 in) (0.11 ac)(43,560 sf/ac) / (12 in/ft)

WQV = 131 cf

Minimum footprint, A_{min} (See *Minimum footprint area*)

A_{min} = (12)(1.50)(131 cf) / (1.60 in/hr)(48 hrs)

A_{min} = 31 sf

The water quality volume will infiltrate into the existing soil in 48 hours if the footprint area of all bioretention cells is 31 square feet. However, this does not mean that the bioretention cell footprint is required to be 31 square feet. A larger footprint with a faster drawdown time is acceptable and will reduce the depth required to retain the water quality volume.

If the bioretention cell were to require an engineered soil layer, the design below with a bottom footprint of 200 sf will retain the water quality volume. If a safety factor is desired, it should be accounted for by multiplying the water quality volume by the safety factor.

Layer	Thickness, in	Porosity	Storage Volume, cf
Ponding	2	1.0	33.3
Top Soil	6	0.25	25
Engineered Soil	6	0.25	25
Coarse Sand	3	0.35	17.5
Pea Gravel	3	0.25	17.5
Aggregate Storage	4	0.4	26.7
Total	24 (soil layers)	0.37 (soil layers weighted)	133 (includes ponding)

Bioretention Cell Effectiveness

Effective bioretention cells provide an aesthetically pleasing method for retaining and treating storm water. Inspecting bioretention cells during rain events will reveal if the cell is draining properly. Bioretention cells are performing properly if they are retaining their design volume and treating runoff. Creating and following through on maintenance guidelines are critical to ensuring that a bioretention cell remains functional.

There are many possible indications that a bioretention cell has failed or is near failure, such as: ponding beyond the design ponding depth during small storm events, drawdown time exceeds design drawdown time, larger than expected sediment buildup within or upstream of the cell, excessive and unmaintained vegetation, lack of vegetation, obstructions at the inlet and outlet locations, and no maintenance or no record of maintenance. Although this is not an all-inclusive list, being aware of these items will assist in determining what steps need to be taken to remediate a failing bioretention cell.

Designer Checklist

If the answer to these questions corresponds to a response box that is red, the BMP should either not be used or additional measures need to be taken to address the issue.

	Yes	No
Does groundwater meet the minimum separation requirement?	☐	☐ (red)
Is there available right-of-way, property, or easement?	☐	☐ (red)
Is the design infiltration rate within acceptable rates?	☐	☐ (red)
Is contaminated groundwater present?	☐ (red)	☐
Is the drainage area less than 5 acres? (If no, consider an infiltration basin or subdividing to create smaller drainage areas.)	☐	☐ (red)
Do utility conflicts make installation of the bioretention cell technically infeasible?	☐ (red)	☐
Do geotechnical conditions exist that compromise the stability of the bioretention cell or surrounding structures?	☐ (red)	☐
Does the bioretention cell provide storage for 100% of the water quality volume? (If no, it may still be appropriate to construct the bioretention cell if it is technically infeasible to capture 100% of the water quality volume.)	☐	☐ (red)
Does an overflow outlet structure or bypass mechanism exist?	☐	☐ (red)

Vegetation

Refer to *Vegetation Guidance by BMP Type*.

Installation

Excavation

Bioretention cells, like other BMPs whose functionality is dependent on infiltration, will fail if proper care is not taken during excavation and construction. Excavators and heavy machinery should not be used within the excavated area if infiltration is expected to occur through the bioretention cell bottom. Additional excavation beyond the footprint may be required depending on site conditions to provide soil stability or to be able to tie-in to the surrounding grade.

Activities During Construction

Avoid using heavy machinery within the bioretention cell footprint during construction as doing so will further compact the soils and diminish their infiltrating capabilities. Light machinery and even walking within the bioretention cell's footprint will also compromise infiltration. Compaction of native soils or backfill below the bioretention cell subsoils is acceptable if doing so does not prevent infiltration from occurring.

Flows During Construction

Flows during construction should be diverted away from the bioretention cell to prevent construction site sediment from clogging soils. Scheduling installation of the bioretention cell shortly after excavation will minimize the impact of unnecessary storm water flows from entering the excavated area. The introduction of unwanted sediment can be prevented by placing fiber rolls or silt fences around the bioretention cell perimeter during construction.

Additional Guidance

- Require certificates of compliance to verify that construction items meet specification requirements.
- Follow landscaping guidance to ensure that vegetation establishes after installation.

Installation Costs

The following cost items are typically associated with bioretention cell construction.

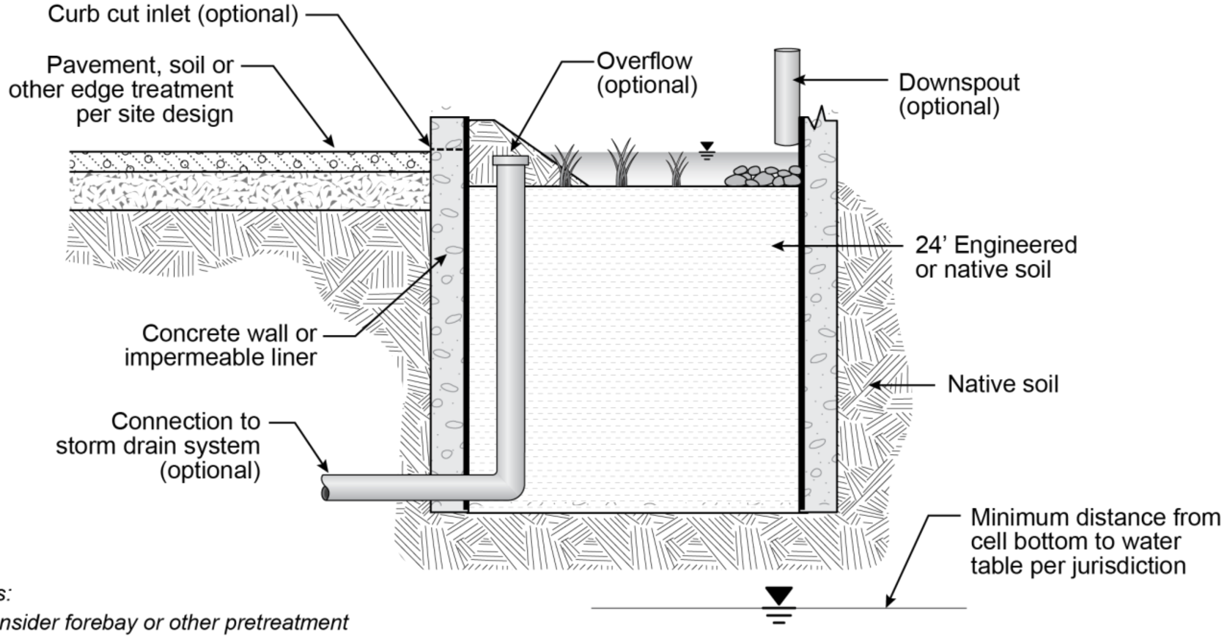
- Excavation
- Landscaping and vegetation
- Top layer
- Engineered soil
- Coarse sand
- Crushed gravel
- Open graded stone
- Geotextile fabric
- Outlet structure or upstream bypass structure (for larger storm events)
- Observation wells
- Curb and gutter
- Impermeable liner (if needed)
- Underdrain system (if needed)
- Irrigation system (if needed)

Maintenance

Refer to *Maintenance* and *Maintenance Costs* in the *Preface to Fact Sheets* for general information related to maintenance of bioretention BMPs.

Maintenance Activities

Inspection	Inspection/Maintenance Frequency	Maintenance Activity	Effort
Inspect for adequate vegetative coverage, and impaired or failing vegetation.	Semiannual (Spring, Fall)	Reseed/replant barren spots. Notify the engineer if failing vegetation persists.	Low
Inspect for trash and debris within basin and at inlet and outlet structures.	Semiannual (Spring, Fall) or as needed	Remove and dispose of trash and debris.	Low
Inspect for large deposits of sediment on bottom indicating soil clogging.	Semiannual (Spring, Fall) or as needed	Remove and dispose of built up sediment when buildup causes reduction in size of basin or if buildup results in standing water. Notify the engineer in the case of standing water as it may indicate clogging within the basin's soil layers.	Low
Inspect for standing water within bioretention cell or within observation well.	Semiannual (Spring, Fall)	Notify the engineer for further inspection.	Medium
Inspect for failure of additional features such as underdrains or irrigation systems.	Semiannual (Spring, Fall)	Repair as needed.	Medium

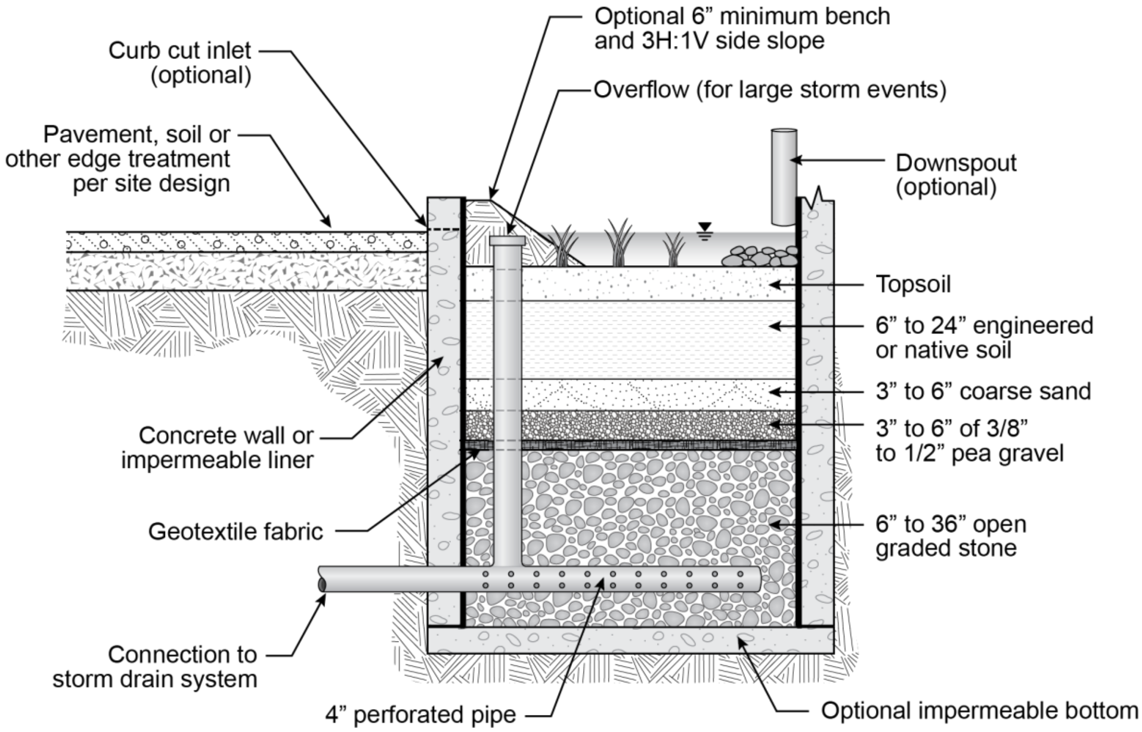


Notes:

- *Consider forebay or other pretreatment*
- *Consider upstream bypass for large storm events*

Bioretention Cell in Native or Engineered Soils

Not to scale



Notes:

- *Overflow elevation must be below elevation of inlet (curb cut, downspout, or other per site design)*
- *Dimensions shown may vary based on site conditions*
- *Consider forebay or other pretreatment*
- *This treatment option may be considered when infiltration is infeasible*

Bioretention Cell with Underdrain System

Not to scale

UTAH DEPARTMENT of ENVIRONMENTAL QUALITY
WATER QUALITY

Bioswale

BR-3

Pollutant Removal Effectiveness

Pollutant	Effectiveness[1]
Sediment	Medium
Nutrients	Medium
Metals	Medium
Bacteria	Medium
Oil/Grease	High

[1]Removal effectiveness is increased for all pollutants as retention increases.

Bioswales are vegetated open channels designed to convey and treat storm water runoff. They are appropriate when it is desirable to convey flows away from structures or as an alternate conveyance method to pipes, concrete channels, or curbed gutters. Bioswales reduce peak flow rates, reduce flow velocities, filter storm water pollutants, and can also reduce runoff volume through infiltration.

The primary functions of bioswales are bioretention and treatment through biofiltration. Conveying runoff through bioswales allows the runoff to be filtered through two processes: bioretention through a native or engineered soil matrix and biofiltration through the above ground vegetation.

Although volume retention may be accomplished within the native soil or a subsoil matrix of engineered soil and gravel layers, retention is not its primary function. However, retention volumes may be determined by designing ponding areas within the swale or creating check dams. There is research to support the quantification of infiltration when runoff is simply conveyed through the swale (no ponding) but design parameters vary widely. Monitoring bioswales for volume reduction is the most reliable source for future estimates of expected reduction.

Primary Functions	
Bioretention	Yes
Volume Retention	Some
Biofiltration	Yes

Design Criteria

Refer to *Design Criteria* in the *Preface to Fact Sheets* for discussion of design criteria parameters.

Parameter	Min. Value	Max. Value	Notes
Length	Based on hydraulic residence time	No maximum	-
Longitudinal Slope	0.50%	5%	Underdrain recommended below minimum slope
Bottom Width	No minimum	No maximum	-
Side Slope	No minimum	3H:1V	Per jurisdiction requirements
Flow Velocity	No minimum	1.0 ft/s	Maximum permissible shear stress may also dictate maximum flow velocity
Flow Depth	No minimum	2/3 vegetation height	Flow depths greater than vegetation height will bypass the biofiltration processes
Freeboard	No minimum	No maximum	Per jurisdiction requirements
Vegetation Coverage	≥ 65%		Biofiltration is significantly reduced when vegetation coverage is less than 65%
Hydraulic Residence Time	5 min	No maximum	-

Calculation Methods

Bioswale design is governed by the water quality flow. The general design steps are:

1. Calculate the water quality flow.
2. Determine the geometry of the bioswale's cross-section.
3. Determine the flow depth.
4. Determine volume retention within bioswale, if any.
5. Check flow velocity and hydraulic residence time.

Sample Calculations

Refer to *Calculation Methods* in the *Preface to Fact Sheets* for discussion on the equations used.

During the planning phase of a city roadway project it has been decided to remove curbs and instead allow one acre of runoff to sheet flow into a 500 ft bioswale. There are 15 feet of available right-of-way between the edge of pavement and the project limits. A 4-foot sidewalk is also proposed to be within the right-of-way. The city has a requirement that there be no slopes greater than 6H:1V within five feet of the edge of pavement. The city's storm water requirements state that the 2-yr, 6-hr intensity must be used in determining the water quality flow rate. Per city standards, 6 inches of freeboard will be required above the water quality flow depth.

<u>Given</u>

Contributing drainage area: 1.0 ac

Imperviousness: 0.85

80^{th} percentile storm depth: 0.55 in

2-yr, 6-hr storm intensity: 0.16 in/hr

Design Goals

Determine an acceptable swale bottom width and flow depth. Design a soil matrix and determine the volume of runoff that is expected to infiltrate into the bioswale.

Calculations

Volumetric runoff coefficient, R_V (See *Sample Calculations*)

$R_V = 1.14i - 0.371$ (Granato method when i ≥ 0.55)

$R_V = 1.14(0.85) - 0.371$

$R_V = 0.60$

Water quality flow, WQF

$WQF = R_V iA$

WQF = (0.60)(0.16 in/hr)(1.0 ac)

WQF = 0.10 cfs

Flow depth, y_d (See *Manning's Equation*)

The project team has decided that a 2-foot bottom width will be used for the bioswale. Per city standards, 6 inches of freeboard will be required above the water quality flow depth. Other design information for the bioswale includes:

Longitudinal slope: 2.0%

Side slopes: 3H:1V

Determine the flow depth during the design storm event by setting Manning's equation equal to the WQF and solving the equation for the flow depth, y_d. This calculation is made easier using a goal seek function within a spreadsheet.

y_d = 1.8 in

Velocity, v (See *Continuity Equation*)

The city requires that flows remain below 1 ft/s to prevent scouring of the bioswale bottom. With the flow depth known, the continuity equation can be used to determine the flow velocity. The cross-sectional area is calculated to be 0.37 sf.

v = Q/A

v = (0.10 cfs) / (0.37 sf)

v = 0.26 ft/s

Minimum swale length, L_{min}

The city also requires a 5-minute minimum hydraulic residence time to achieve the maximum desired biofiltration. Using the velocity, a minimum swale length can be determined.

L_{min} = (0.26 ft/s)(300 s)

L_{min} = 79 ft

Any portion of the runoff that enters the swale within 79 ft of the downstream end of the swale will not receive the optimal treatment.

With 6 inches of freeboard and a side slope of 3H:1V, the top width of the bioswale is 6.00 ft. With 15 feet of available right-of-way, 6 of which are available for the swale, at the planning level there is adequate space for the bioswale. If needed, the swale's top width could be narrowed by decreasing the bottom width, which would also result in a deeper flow depth.

Water quality volume, WQV (See *Developing the 80th Percentile Volume*)

WQV = (0.60)(0.55 in)(1.0 ac)(43,560 sf/ac) / (12 in/ft)

WQV = 1,194 cf

Volume Reduction

The swale will also include check dams that are 6 inches high to increase the volume retention. With a longitudinal slope of 2%, a 6-inch check dam will create a triangular pool that is 25 ft long before overtopping the check dam. The volume retained behind the check dam is calculated with the bottom width, the check dam height, and the length of the check dam pool.

$V_{check\ dam}$ = (2 ft)(25 ft)(0.5 ft) / 2

$V_{check\ dam}$ = 12.50 cf

If the check dams are spaced every 50 feet, 10 check dams are possible, and the total volume retained by the check dams will be 125 cf.

Additional volume retention can be achieved in any ponding areas that are designed into the swale.

Although methodologies have been developed to determine volume retention within a bioswale, the current body of research varies widely and jurisdictions are encouraged to exercise engineering judgment (See *Volume Reduction*).

A conservative design for the soil matrix below the swale will allow for the maximum possible percentage of the water quality volume to be captured. For flood control purposes, zero infiltration may be assumed to prevent downstream piping from being undersized if the bioswale's volume reduction is overestimated. Accounting for the ten check dams, the soil matrix below will provide storage for the remaining portion of the water quality volume (1,182 cf). Whether the full remaining volume is captured can be determined by monitoring the bioswale for volume retention.

Layer	Thickness, in	Porosity	Storage Volume, cf
Engineered Soil	12	0.25	250
Coarse Sand	3	0.35	87.5
Pea Gravel	3	0.25	62.5
Aggregate Storage	20	0.4	667
Total	52 (soil layers)	0.35 (soil layers weighted)	1067 (includes ponding)

Bioswale Effectiveness

Bioswales are effective when they can accomplish their design goals of conveying flows to a downstream receiving structure, BMP, or other receiving area. Flows through the swale should be relatively steady and uniform during a rain event unless retention areas and check dams are part of the swale design. Established vegetation with adequate coverage is an indication of a healthy bioswale along with minimal sediment and lack of invasive vegetation.

Designer Checklist

If the answer to these questions corresponds to a response box that is red, the BMP should either not be used or additional measures need to be taken to address the issue.

	Yes	No
If longitudinal slope is less than minimum, can an underdrain be installed?	☐	☐ (red)
If an underdrain is needed, is sufficient hydraulic head available for proper drainage?	☐	☐ (red)
Do flows result in a shear stress greater than the maximum permissible for selected vegetation?	☐ (red)	☐
Do utility conflicts make installation of the bioswale technically infeasible?	☐ (red)	☐
Will the bioswale provide conveyance for larger storm events? (If yes, the geometry of the bioswale will need to accommodate the larger events.)	☐	☐
Is the bioswale providing pretreatment for a downstream BMP?	☐	☐
Is the bioswale connecting directly to the storm drain network? (If yes, the outlet structure elevation will need to be determined.)	☐	☐

Vegetation

Refer to *Vegetation Guidance by BMP Type*.

Installation

Excavation

Bioswale construction is a relatively straightforward process of excavating the swale's subsurface trench prior to backfilling with any underdrain system, open graded stone, engineered soil, and geotextile fabric. Additional excavation beyond the swale's footprint may be required depending on site conditions to provide soil stability or to be able to tie-in to the surrounding grade.

Activities During Construction

Crews should avoid stepping within the trench except when necessary as doing so will compact the native soil that is expected to infiltrate runoff.

Flows During Construction

Flows during construction should be diverted away from the bioswale to prevent construction site sediment from clogging soils and to prevent erosion of the swale bed. Scheduling installation of the bioswale shortly after excavation will minimize the impact of unnecessary storm water flows from entering the excavated area. The introduction of unwanted sediment can be prevented by placing fiber rolls or silt fences around the bioswale perimeter during construction. Creating the upstream inlet or connection should be the last construction activity before flows are permitted to be conveyed as designed through the bioswale.

Additional Guidance

- Require certificates of compliance to verify that construction items meet specification requirements.
- Follow landscaping guidance to ensure that vegetation establishes after installation.

Installation Costs

The following cost items are typically associated with bioswale construction.

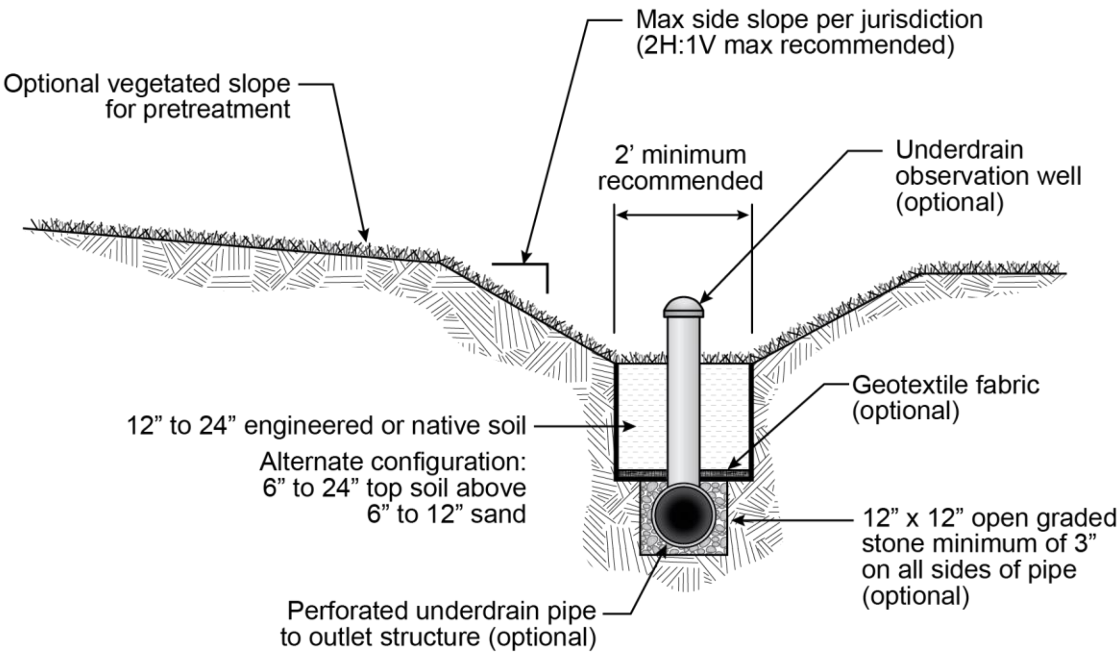
- Excavation
- Grading
- Fine grading
- Granular borrow fill
- Landscaping and vegetation
- Top layer
- Engineered soil
- Open graded stone
- Geotextile fabric
- Impermeable liner
- Outlet structure or upstream bypass structure (for larger storm events)
- Observation wells
- Underdrain system (if needed)
- Outlet protection such as riprap or other (if needed)

Maintenance

Refer to *Maintenance* and *Maintenance Costs* in the *Preface to Fact Sheets* for general information related to maintenance of bioretention BMPs.

Maintenance Activities

Inspection	Inspection/Maintenance Frequency	Maintenance Activity	Effort
Inspect for adequate vegetative coverage, and impaired or failing vegetation.	Semiannual (Spring, Fall)	Reseed/replant barren areas. Notify engineer if issue persists.	Low
Inspect side slopes for erosion, rilling, and sloughing.	Semiannual (Spring, Fall)	Regrade side slope if slope stability is not affected by sloughing. Notify engineer if stability is affecting basin functionality.	Low
Inspect for standing water within bioswale or within observation well.	Semiannual (Spring, Fall)	Notify engineer for further inspection.	Medium
Inspect for trash and debris at inlet and outlet structures.	Prior to mowing, at least semiannually	Remove trash and debris.	Low
Inspect vegetation height.	As needed	Mow swale as needed.	Low



Notes:

- *Engineered soil may improve filtration*
- *Underdrain recommended for longitudinal slopes < 1%*
- *Optional items shown for use of underdrain*
- *Dimensions shown may vary based on site conditions*
- *Use of underdrain system may be considered when infiltration is infeasible*

Bioswales

Not to scale

UTAH DEPARTMENT *of* ENVIRONMENTAL QUALITY
WATER QUALITY

Vegetated Strip

BR-4

Pollutant Removal Effectiveness

Pollutant	Effectiveness[1]
Sediment	High
Nutrients	Medium
Metals	Medium
Bacteria	High
Oil/Grease	High

[1]Removal effectiveness is increased for all pollutants as retention increases.

Vegetated strips are designed to receive and treat sheet flow from adjacent surfaces. This is accomplished by slowing runoff velocity to allow for pollutants and sediments to settle and by filtering out pollutants in the vegetation before entering the storm sewer system. Vegetated strips are best utilized for storm water treatment from roads, parking lots, and other impervious surfaces.

Primary Functions	
Bioretention	Yes
Volume Retention	Some
Biofiltration	Yes

The primary functions of vegetated strips are bioretention and biofiltration. Bioretention within a vegetated strip occurs as runoff enters the soil and pollutants are removed through physical, chemical, and biological processes. Similar biofiltration processes occur to provide treatment when runoff passes through the strip's vegetation. Biofiltration is significantly reduced when vegetation coverage is less than 65%. In arid locations a gravel strip may be used as a substitute for the vegetated strip. The lack of vegetation will cause biofiltration and bioretention to be greatly reduced; however, the runoff velocity will still be decreased and allow for pollutants and sediments to settle out. Volume retention through infiltration will also occur as runoff enters the gravel's void spaces.

Attachment: DWQ-2019-000161 (Section 13.94.040 Storm Water System Design and Management Standards)

Design Criteria

Refer to *Design Criteria* in the *Preface to Fact Sheets* for discussion of design criteria parameters.

Parameter	Min. Value	Max. Value	Notes
Length (direction of flow travel)	15 ft	No maximum	-
Longitudinal Slope	No minimum	4H:1V	Per jurisdiction requirements
Flow Velocity	No minimum	1.0 ft/s	Maximum permissible shear stress may also dictate maximum flow velocity
Flow Depth	No minimum	2/3 vegetation height	Flow depths greater than vegetation height will bypass the biofiltration processes
Freeboard	No minimum	No maximum	Per jurisdiction requirements
Vegetation Coverage	≥ 65%		Biofiltration is significantly reduced when vegetation coverage is less than 65%

Calculation Methods

Vegetated strip design is governed by the water quality flow. The general design steps are:

1. Calculate the water quality flow.
2. Determine the flow depth.
3. Check flow velocity.

Sample Calculations

Refer to *Calculation Methods* in the *Preface to Fact Sheets* for discussion on the equations used.

A roadway project is proposing to widen a road that is near a canal. Due to high groundwater and poor soils, retention on-site is not feasible. Treatment is still an option, however, and the design team has decided to establish vegetation within the twenty feet between the edge of pavement and the canal. The city's storm water requirements state that the 2-yr, 2-hr intensity must be used in determining the water quality flow rate.

<u>Given</u>

Contributing drainage area: 0.25 ac

Imperviousness: 1.00

2-yr, 2-hr storm intensity: 0.318 in/hr

<u>Design Goals</u>

Determine that the flow depth will be less than 1 inch.

<u>Calculations</u>

Volumetric runoff coefficient, R_V (See *Sample Calculations*)

$R_{V\text{-}A} = 0.84i^{1.302}$ (R_V based on hydrologic soil group)

$R_V = 0.84(1.0)^{1.302}$

$R_V = 0.84$

Water Quality Flow, WQF

$WQF = R_V iA$

$WQF = (0.84)(0.318 \text{ in/hr})(0.25 \text{ ac})$

$WQF = 0.067 \text{ cfs}$

There is available right-of-way for a 300-foot long strip that is 20 feet wide. The embankment side slope is 10H:1V which corresponds to a 10% longitudinal slope for the vegetated strip.

Flow depth, y_d (See *Manning's Equation*)

Calculation of the flow depth is typically done using Manning's equation setting the equation equal to the water quality flow and solving for the flow depth.

$y_d = [(nQ)/1.49LS^{0.5}]^{0.6}$

$y_d = [(0.2)(0.071 \text{ cfs}) / (1.49)(300 \text{ ft})(0.02)^{0.5}]^{0.6}$

$y_d = 0.04 \text{ in}$

Velocity, v (See *Continuity Equation*)

The city requires that flows remain below 1 ft/s to prevent scouring of the strip bottom. With the flow depth known, the cross-sectional area is calculated to be 1.10 sf.

$v = Q/A$

$v = 0.067 \text{ cfs} / 1.10 \text{ sf}$

$v = 0.06 \text{ ft/s}$

Volume Reduction

Although methodologies have been developed to determine volume retention within a bioswale, the current body of research varies widely and jurisdictions are encouraged to exercise engineering judgment (See *Volume Reduction*).

Vegetated Strip Effectiveness

Vegetated strips are effective when they can accomplish their design goals of conveying sheet flow to the receiving area. Flows through the vegetated strip should be relatively steady and uniform during a rain event and should not create rilling or other visible signs of erosion. Established vegetation with adequate coverage is an indication of a healthy vegetated strip along with minimal sediment and lack of invasive vegetation.

Designer Checklist

If the answer to these questions corresponds to a response box that is red, the BMP should either not be used or additional measures need to be taken to address the issue.

	Yes	No
Is the vegetated strip length greater than or equal to the minimum required length?	☐	☐

Do flows result in a shear stress greater than the maximum permissible for selected vegetation?	☐	☐
Is the vegetated strip providing pretreatment for a downstream BMP?	☐	☐
Is the slope in the direction of flow less than or equal to the jurisdiction's standards?	☐	☐

Vegetation

Refer to *Vegetation Guidance by BMP Type*.

Installation

Vegetated strips can be installed as part of normal construction activities. An appropriate grass such as turf sod should be installed per specifications. If additional vegetation such as shrubs or bushes will be used within the strip, follow landscaping guidance to ensure that vegetation establishes after installation. To maximize infiltration performance, minimize use of heavy machinery.

Additional Guidance

- Require certificates of compliance to verify that construction items meet specification requirements.

Installation Costs

The following cost items are typically associated with bioswale construction.

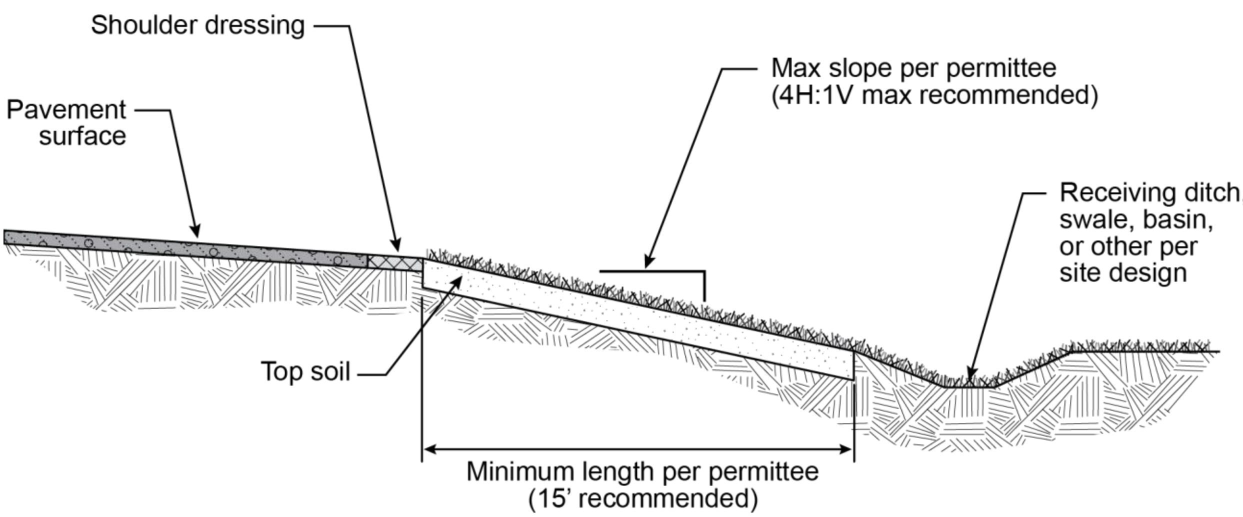
- Grading
- Landscaping and vegetation
- Topsoil
- Engineered soil
- Shoulder dressing upstream of vegetated strip

Maintenance

Refer to *Maintenance* and *Maintenance Costs* in the *Preface to Fact Sheets* for general information related to maintenance of bioretention BMPs.

Maintenance Activities

Inspection	Inspection/Maintenance Frequency	Maintenance Activity	Effort
Inspect upstream end of vegetated strip for sediment buildup that may be impeding sheet flow.	Semiannual (Spring, Fall) or as needed	Remove and dispose of sediment buildup.	Low
Inspect grass length.	As needed	Mow strip as needed.	Low
Inspect for erosion, rilling, and sloughing.	Semiannual (Spring, Fall)	Regrade side slope if slope stability is not affected by sloughing. Notify engineer if stability is affecting basin functionality.	Low
Inspect for adequate vegetative coverage, and impaired or failing vegetation.	Semiannual (Spring, Fall) or as needed	Reseed/replant barren areas. Notify engineer if issue persists.	Low



Notes:

- *Dimensions shown may vary based on site conditions*

Vegetated Strips

Not to scale

UTAH DEPARTMENT of ENVIRONMENTAL QUALITY
WATER QUALITY

Tree Box Filter

BR-5

Source: Montgomery County, Maryland Department of Environmental Protection

Pollutant Removal Effectiveness

Pollutant	Effectiveness
Sediment	High
Nutrients	Medium
Metals	Medium
Bacteria	High
Oil/Grease	High

Tree box filters are bioretention systems that are appropriate in urban drainage areas where space is limited. An underground concrete vault contains the soil matrix that provides bioretention and has a grated top where vegetation grows. Tree box filters are typically designed as flow-through devices, meaning that they do not retain storm water but rather allow flows to pass through them. However, a bottomless concrete vault will function as a bioretention system that provides infiltration into the native soils. Manufacturers have developed proprietary designs for tree box filters, but they may also be designed.

The primary functions of tree box filters are bioretention and treatment. Runoff from the contributing drainage area enters the tree box through an inlet where bioretention occurs. Storm water is treated by the physical, chemical, and biological processes that occur within the mulch, soil matrix, and plant roots.

Primary Functions	
Bioretention	Yes
Volume Retention	Varies[1]
Biofiltration	Yes

[1]Volume retention may be achieved with a bottomless vault.

Design Criteria

Refer to *Design Criteria* in the *Preface to Fact Sheets* for discussion of design criteria parameters. Tree box filters may be proprietary devices; follow manufacturer specifications to determine design criteria on a case-by-case basis.

Parameter	Min. Value	Max. Value	Notes
Depth to Historical High Groundwater	2 ft	No maximum	May be less than 2 feet if tree box filter has impermeable bottom.
Ponding Depth	No minimum	12 in	-
Drawdown Time	12 hours	72 hours	24 to 48 hours preferred. Drawdown time may also depend on local mosquito abatement regulations.
Design Infiltration Rate	0.25 in/hr	6 in/hr	Field testing required for final design. Infiltration rate should be low enough to allow biofiltration processes to occur. During design, infiltration rate, drawdown time, and the soil matrix depth will be directly related.

Calculation Methods

Tree box filters are typically sized based on their water quality flow but may be sized for their water quality volume when being designed for retention. Both design approaches are dependent on the contributing drainage area and imperviousness. A larger contributing drainage area will require a larger tree box filter.

Tree Box Filter Effectiveness

Tree box filters are effective when they maintain their bioretention and biofiltration capabilities. Proper inspection and maintenance of tree box filters will ensure that the chemical and biological processes that treat runoff perform optimally. Qualified inspection crews are necessary to determine if soils and vegetation are healthy.

The tree box must be able to function hydraulically. Flows must be able to pass through the filter without backing up or maintenance will be required.

Designer Checklist

If the answer to these questions corresponds to a response box that is red, the BMP should either not be used or additional measures need to be taken to address the issue.

	Yes	No
Is there adequate space for a tree box filter?	☐	☐
Is there sufficient hydraulic head for tree box filter to connect to storm drain network?	☐	☐
If retention is desired, will the design infiltration rate permit a reasonable drawdown time?	☐	☐
If retention is desired, is depth to the historical high groundwater from the filter bottom greater than the jurisdiction's minimum separation requirement?	☐	☐

Vegetation

Refer to *Vegetation Guidance by BMP Type*.

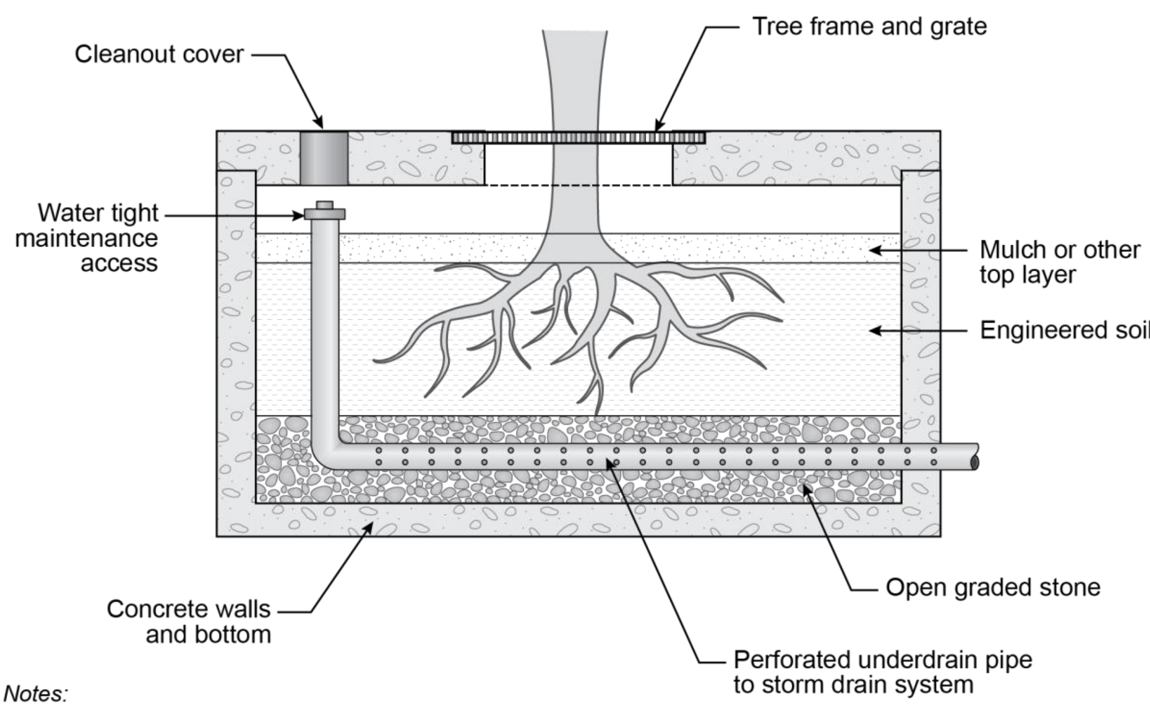
Maintenance

Refer to *Maintenance* and *Maintenance Costs* in the *Preface to Fact Sheets* for general information related to maintenance of bioretention BMPs.

Maintenance Activities

Proper maintenance of tree box filters will be per the manufacturer's specifications, but it typically includes the following:

Inspection	Inspection/Maintenance Frequency	Maintenance Activity	Effort
Inspect for trash and debris within tree box filter and at inlet and outlet structures.	Semiannual (Spring, Fall) or as needed	Remove trash, debris and sediment.	Low
Inspect performance.	Semiannual (Spring, Fall)	Replenish media filter layer with new mulch.	Medium
Inspect for invasive species.	Semiannual (Spring, Fall)	Prune and weed filter box.	Medium



Notes:
- *Dimensions shown may vary based on site conditions*
- *A bottomless design may allow for infiltration*
- *This treatment option may be considered when infiltration is infeasible*

Tree Box Filters

Not to scale

UTAH DEPARTMENT of ENVIRONMENTAL QUALITY
WATER QUALITY

Green Roof

BR-6

Pollutant Removal Effectiveness

Pollutant	Effectiveness[1]
Sediment	High
Nutrients	Medium[2]
Metals	High
Bacteria	High
Oil/Grease	-

[1]Removal effectiveness is increased for thicker soil layers.
[2]Use of organic matter to establish vegetation may increase nutrient leaching.

A green roof is a vegetated system that is designed to retain and treat rooftop runoff. The primary functions of green roofs are bioretention, volume retention, and filtration. Green roofs capture storm water within the pore space of the soil and vegetation and the moisture is then released through evapotranspiration.

Green roofs can be classified as either extensive or intensive systems. Extensive systems are those in which the soil media is up to 6 inches in depth and support smaller grasses and other vegetative species that do not have deep root systems. Intensive systems are those that support root systems greater than 6 inches such as those from trees and bushes.

The design of green roofs should be done with the coordination of qualified landscaping, structural, and maintenance teams. Vegetation selection and the proper maintenance of vegetation are critical items in the overall performance and functionality of the green roof. The integrity of the roof structure must also be accounted for as large volumes of plants, soils, water, and the weight of the green roof structure will create additional loads on the building.

Primary Functions	
Bioretention	Yes
Volume Retention	Yes
Biofiltration	Yes

Design Criteria

Refer to *Design Criteria* in the *Preface to Fact Sheets* for discussion of design criteria parameters.

Parameter	Extensive	Intensive	Notes
Drawdown Time	12 hours	12 hours	-
Growth Media Depth	< 6 in	6+ in	-
Vegetation	Low growing, low water-use vegetation such as Sedum, herbs, grasses, and perennials	More complex gardens including the species listed for extensive green roofs, but also incorporating trees and shrubs.	-
Load	12-54 lb/sf	72+ lb/sf	-
Roof Slope	5:1 maximum	5:1 maximum	-
Access	Required for maintenance	Required for maintenance	-
Irrigation	Simple irrigation. Only needed during droughts and plant establishment if well designed.	Complex irrigation	-
Drainage	Simple drainage system	Complex drainage system	-

Calculation Methods

Green roof design is governed by the water quality volume; however, special consideration must also be given to vegetation selection and proper installation with the assistance of a landscape architect or other qualified person. Special consideration must also be given to the structural design of the roof, with the assistance of a structural engineer. Neither of those considerations are considered in this discussion of calculation methods. For the purposes of determining if the green roof retains the water quality volume, the general design steps are:

1. Calculate the water quality volume.
2. Determine the porosity of the engineered soil used within the green roof and the retention volume within the soil.
3. Determine the required footprint to retain the water quality volume.

Sample Calculations

Refer to *Calculation Methods* in the *Preface to Fact Sheets* for discussion on the equations used.

An extensive green roof system will be designed for a new building with a roof that is 0.37 acres. The entire roof will drain to the green roof. It was decided that an extensive green roof system with a 6-inch soil matrix will be used. Determine the footprint that will be needed to capture the water quality volume.

Given

Roof area: 0.37 ac

80^{th} percentile storm depth: 0.55 in

Porosity of engineered soil: 0.25

Determine

Determine the footprint of the green roof.

Calculations

The footprint can be determined through iterative calculations. After iterative calculations, it was found that a footprint of 3,405 square feet will capture the water quality volume.

Pervious area (green roof footprint): 3,405 sf (0.078 ac)

Imperviousness of rooftop: 0.79

Volumetric runoff coefficient, R_V (See *Sample Calculations*)

$R_V = 0.91i - 0.0204$ (Reese method)

$R_V = 0.91(0.79) - 0.0204$

$R_V = 0.70$

Water quality volume, WQV (See *Developing the 80th Percentile Volume*)

WQV = (0.70)(0.55 in)(16,117 sf) / (12 in/ft)

WQV = 517 cf

Determine the equivalent storage depth of the engineered soil.

$d_{equivalent}$ = (0.6 in)(0.25)

$d_{equivalent}$ = 1.5 in

Determine the required footprint of the green roof to capture the water quality volume.

Footprint = WQV / $d_{equivalent}$

Footprint = 517 cf / ((1.5 in)/(12 in/ft))

Footprint = 4,121 sf

Green Roof Effectiveness

Green roofs provide an aesthetically pleasing method for retaining and treating storm water runoff. Healthy plants and soils are indications that the green roof is performing as expected. Excessive drainage through the soil layer may be an indication that the soils and vegetation are not retaining runoff; consequently, the evaporation and transpiration processes are not occurring. Qualified horticulturists and/or green roof contractors should be involved in determining the health and effectiveness of the green roof.

Designer Checklist

If the answer to these questions corresponds to a response box that is red, the BMP should either not be used or additional measures need to be taken to address the issue.

	Yes	No
Has a landscape architect been involved in the vegetation selection?	☐	☐
Has a structural engineer been involved in the green roof design?	☐	☐
Are maintenance crews trained and aware of maintenance responsibilities?	☐	☐

Does the green roof provide storage for 100% of the water quality volume? (If no, it may still be appropriate to construct the green roof if it is technically infeasible to capture 100% of the water quality volume.)	☐	☐
Will the green roof partially cover or fully cover the roof?	-	-
Will the green roof be extensive or intensive?	-	-

Vegetation

Refer to *Vegetation Guidance by BMP Type*.

Installation

Green roof installation should be done with proper oversight from qualified environmental or green roof specialists. Any requirements related to working on rooftops should be followed. During construction, vegetation and the growth media should be protected from erosion until vegetation has been established.

Additional Guidance

- Require certificates of compliance to verify that construction items meet specification requirements.

Installation Costs

The following cost items are typically associated with rain garden construction.

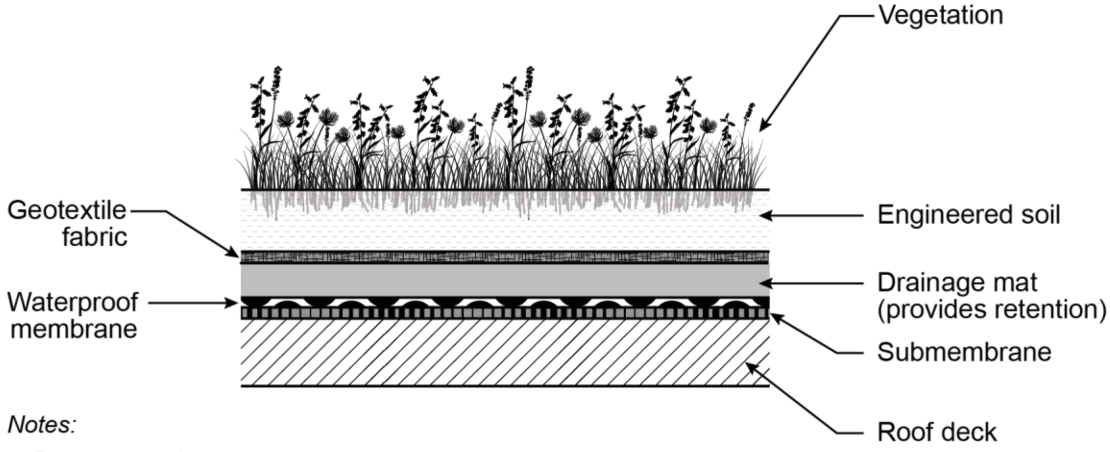
- Vegetation and landscaping expertise
- Horticulturist expertise
- Structural expertise

Maintenance

Refer to *Maintenance* and *Maintenance Costs* in the *Preface to Fact Sheets* for general information related to maintenance of green roofs.

Maintenance Activities

Inspection	Inspection/Maintenance Frequency	Maintenance Activity	Effort
Inspect weed growth.	2-4 weeks during growing season	Remove weeds before they flower.	High
Inspect fertilization.	Annually	Apply fertilizer in accordance with manufacturer recommendations. Avoid hottest/driest parts of the year.	Medium
Inspect water retention.	Semiannual (Spring, Fall) or as needed	If natural precipitation is not adequate for vegetation, water plants.	High



Notes:

- *Dimensions shown may vary based on site conditions*

Green Roof

Not to scale

UTAH DEPARTMENT of ENVIRONMENTAL QUALITY
WATER QUALITY

Pervious Surfaces

PS-1

Pollutant Removal Effectiveness

Pollutant	Effectiveness[1]
Sediment	High
Nutrients	High
Metals	High
Bacteria	High
Oil/Grease	High

[1]Pollutant removal may occur in the pervious surface or the subsurface.

Pervious surfaces such as permeable pavement, concrete pavers, pervious concrete, modular open pavers, and other types of pervious surfaces provide structural support for light vehicle or pedestrian traffic while also providing open space for storm water infiltration.

The primary function of pervious surfaces is volume retention, but some filtration is possible depending on the type of paver and subsurface selected. A modular open paver that, when installed, provides a certain percentage of pervious area in the form of grass, will allow for filtration processes to occur. Another source of filtration is the choker layer directly beneath the pervious surface.

The subsections beneath the pervious surface are typically a choker layer composed of small gravel and a storage layer of larger rock beneath. Underdrains may be required if existing soils do not adequately infiltrate.

Primary Functions	
Bioretention	Yes[1]
Volume Retention	Yes
Biofiltration	Some

[1]Bioretention occurs in the subsurface and not within the pervious surface.

Design Criteria

Refer to *Design Criteria* in the *Preface to Fact Sheets* for discussion of design criteria parameters.

Parameter	Min. Value	Max. Value	Notes
Drain Time	12 hours	72 hours	-
Design Infiltration Rate	0.25 in/hr	6 in/hr	Field testing required for final design.
Depth to Historical High Groundwater	2 ft	No maximum	-

Calculation Methods

Pervious surface design is governed by the water quality volume. The general design steps are:

1. Calculate the water quality volume.
2. Determine the required thickness of the subsection layers given their porosity and the footprint of the pervious surface area.

Sample Calculations

Refer to *Calculation Methods* in the *Preface to Fact Sheets* for discussion on the equations used.

A development in the planning phase will have a 0.90-acre parking lot. It is proposed that the parking lot be graded so that runoff is conveyed towards stalls that will be constructed with permeable asphalt.

<u>Given</u>

Contributing drainage area: 0.90 ac

Imperviousness: 0.95

80^{th} percentile storm event: 0.48 in

Design infiltration rate: 0.5 in/hr

<u>Design Goals</u>

Determine an acceptable area size and depth of the permeable asphalt section.

<u>Calculations</u>

Volumetric runoff coefficient, R_V (See *Sample Calculations*)

$R_V = 1.14i - 0.371$ (Granato method when $i \geq 0.55$)

$R_V = 1.14(0.95) - 0.371$

$R_V = 0.71$

Water quality volume, WQV (See *Developing the 80th Percentile Volume*)

WQV = (0.71)(0.48 in)(0.90 ac)(43,560 sf/ac) / (12 in/ft)

WQV = 1,113 cf

A permeable asphalt area that is 15 ft x 140 ft (2,100 sf) with the following properties will retain the water quality volume and will have an acceptable drawdown time. See *Storage volume within a media with a known porosity* for guidance on determining storage within soils.

Layer	Thickness, in	Porosity	Storage Volume, cf
Permeable Asphalt	4	0.2	140
Choker Layer	4	0.4	280
Aggregate Storage	10	0.4	700
Total	18	0.36 (weighted)	1120

Drawdown time, t

t = Equivalent storage depth / Design infiltration rate

Weighted porosity, $n_W = 0.36$

Equivalent storage depth = (18 in)(0.37)

Equivalent storage depth = 6.4 in

t = (6.4 in) / (0.5 in/hr)

t = 12.80 hrs

Pervious Surface Effectiveness

Pervious surfaces are effective when runoff from the design storm depth can enter the porous spaces of the pervious surface and successfully infiltrate into the native soil or drain through an underdrain system. Visual inspection of the pervious surface can reveal reasons for failure: for example, sediment-laden sheet flows that are conveyed to the pervious surface, or a down drain might be introducing organic material. Both scenarios are likely to contribute to clogging within the porous spaces of the pervious surface or within the sublayers.

Designer Checklist

If the answer to these questions corresponds to a response box that is red, the BMP should either not be used or additional measures need to be taken to address the issue.

	Yes	No
Will an underdrain system be required?	☐	☐
If an underdrain is needed, is there sufficient head for the underdrain system to drain?	☐	☐
Has the proposed pervious surface performed successfully in similar climate conditions?	☐	☐

Installation

Excavation

Pervious surfaces will fail if proper care is not taken during excavation and construction. Excavators and heavy machinery should not be used if infiltration is expected to occur through the underlying soils beneath the pervious surface's subsection.

Activities During Construction

Avoid using heavy machinery on the revealed soil during construction. Crews should avoid unnecessarily walking on the underlying soils when possible. Compaction of native soils or backfill below the pervious surface subsoils is acceptable if doing so does not prevent infiltration from occurring.

Flows During Construction

Flows during construction should be diverted away from the exposed underlying soil to prevent erosion. Scheduling installation of the pervious surface within a short time span after excavation will minimize the impact of unnecessary storm water flows from entering the excavated area. The introduction of unwanted sediment and storm water flows can be prevented by placing fiber rolls or silt fences around the excavated perimeter during construction.

Additional Guidance

- Require certificates of compliance to verify that construction items meet specification requirements.

Installation Costs

The following cost items are typically associated with construction of pervious surfaces.

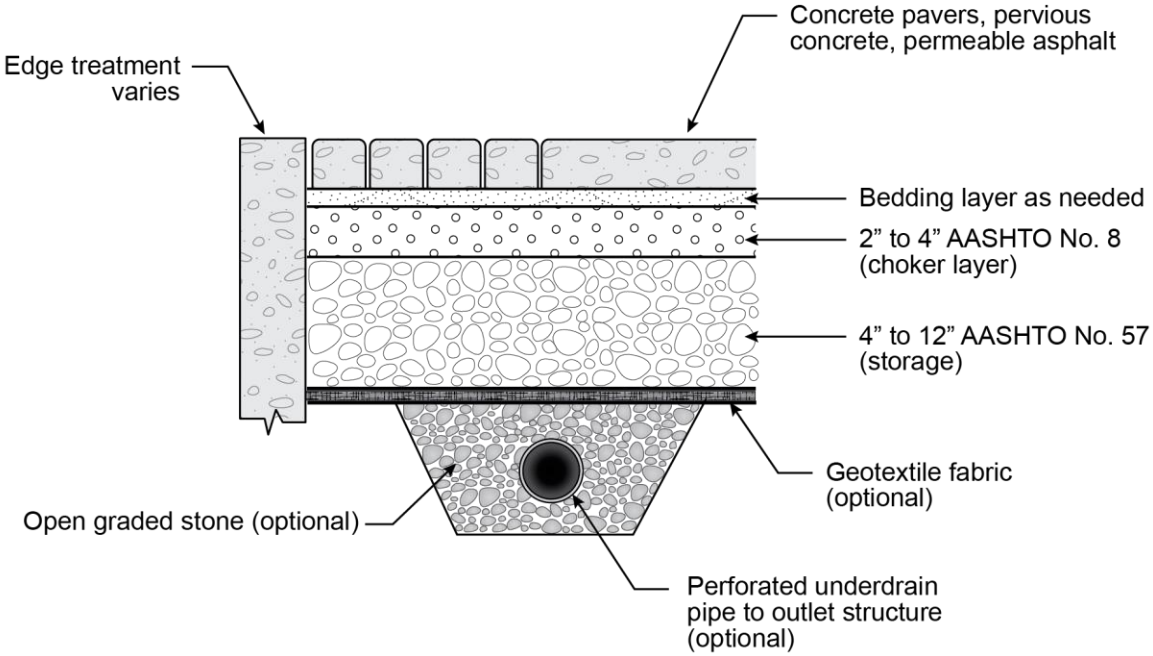
- Excavation
- Grading
- Fine grading
- Pervious surface
- Top layer
- Engineered soil
- Choker layer
- Open graded stone
- Geotextile fabric
- Impermeable liner
- Observation wells (if needed)
- Underdrain system (if needed)

Maintenance

Refer to *Maintenance* and *Maintenance Costs* in the *Preface to Fact Sheets* for general information related to maintenance of pervious surfaces.

Maintenance Activities

Inspection	Inspection/Maintenance Frequency	Maintenance Activity	Effort
Inspect for sediment accumulation.	Semiannual (Spring, Fall)	Use vacuum sweeper followed by pressure washing.	Medium
Inspect for weed growth.	Semiannual (Spring, Fall)	Remove weeds.	Low
Inspect for standing water on surface or within observation well (if used).	Semiannual (Spring, Fall)	Notify engineer for further inspection.	Low
Inspect surface for deterioration.	Annual	Notify engineer for further inspection.	Low
Inspect exfiltration and drainage performance.	As needed, at least annually	Notify engineer for further inspection.	Medium



Notes:

- *Optional items shown for use of underdrain*
- *Dimensions shown may vary based on site conditions*
- *Use of underdrain system may be considered when infiltration is infeasible*

Pervious Surfaces

Not to scale

UTAH DEPARTMENT of ENVIRONMENTAL QUALITY
WATER QUALITY

Infiltration Basin

ID-1

Pollutant Removal Effectiveness

Pollutant	Effectiveness
Sediment	High
Nutrients	High
Metals	High
Bacteria	High
Oil/Grease	High

Infiltration basins are shallow depressions that use existing soils to retain and provide treatment for storm water runoff. Infiltration basins function by capturing and infiltrating runoff over a specified drawdown time.

The primary functions of infiltration basins are bioretention, volume retention, and filtration. The existing soils remove pollutants through physical, chemical, and biological processes before the storm water reaches the groundwater. Filtration occurs as runoff interacts with grass and other vegetation within the basin and as runoff infiltrates through the soil.

Primary Functions	
Bioretention	Yes
Volume Retention	Yes
Biofiltration	Yes

Infiltration basins are typically designed for larger drainage areas where it may be impractical for a BMP such as a bioretention area that requires more maintenance of specialized vegetation over a larger area.

Pretreatment of runoff may take place in a forebay that will allow for particulate settling. Forebays are typically sized for a percentage of the water quality volume; typically ranging from 10% to 25%.

Design Criteria

Refer to *Design Criteria* in the *Preface to Fact Sheets* for discussion of design criteria parameters.

Parameter	Min. Value	Max. Value	Notes
Water Quality Volume	0.1 ac-ft (4356 cf)	No maximum	-
Freeboard	1 ft		-
Overflow Spillway Length	3 ft spillway length		-
Invert Slope	0% (flat basin bottom)		-
Interior Side Slopes	No minimum	3H:1V	-
Drawdown Time	24 hours	72 hours	48 hours recommended
Design Infiltration Rate	0.25 in/hr	6 in/hr	Field testing required for final design.
Depth to Historical High Groundwater	2 ft	No maximum	-

Calculation Methods

Infiltration basin design is governed by the water quality volume. The general design steps are:

1. Calculate the water quality volume.
2. Determine the geometry of the infiltration basin.
3. Based on the basin geometry, determine the ponding depth required to hold the water quality volume.
4. Calculate the drawdown time.

Calculate the water quality outlet elevation.

Sample Calculations

Refer to *Calculation Methods* in the *Preface to Fact Sheets* for discussion on the equations used.

A 13.50-acre highway development routes all of its storm water to a single infiltration basin. A safety factor of 1.50 is required for infiltration design within the jurisdiction. Adjacent soils are ‘A’ and are part of the drainage area.

<u>Given</u>

Contributing drainage area: 13.50 ac

Imperviousness: 0.65

80th percentile storm depth: 0.50 in

Soil infiltration rate: 1.35 in/hr

<u>Design Goals</u>

Determine the bottom footprint of the infiltration basin and the elevation of the water quality outlet above the basin bottom.

<u>Calculations</u>

Volumetric runoff coefficient, R_V (See *Sample Calculations*)

$R_{V\text{-}A} = 0.84i^{1.302}$ (R_V based on hydrologic soil group)

$R_{V\text{-}A} = 0.84(0.65)^{1.302}$

$R_V = 0.48$

Water quality volume, WQV (See *Developing the 80th Percentile Volume*)

WQV = (0.48)(0.50 in)(13.50 ac)(43,560 sf/ac) / (12 in/ft)

WQV = 11,761 cf

Minimum footprint, A_{min} (See *Minimum footprint area*)

A_{min} = (12)(1.50)(11,761 cf) / (1.35 in/hr)(48 hrs)

A_{min} = 3,267 sf

The water quality volume will infiltrate into the existing soil in 48 hours if the infiltration basin bottom is 3,267 square feet. However, this does not mean that the infiltration basin bottom is limited to 3,267 square feet.

Water quality elevation, Ele_{WQ}

The elevation of a water quality outlet above the basin bottom is determined by assuming that infiltration occurs only through the bottom of the basin and not through the sides.

Ele_{WQ} = WQV / A_{min}

Ele_{WQ} = 11,761 cf / 3,267 sf

Ele_{WQ} = 2.94 ft

Infiltration Basin Effectiveness

Effective infiltration basins take advantage of open spaces for retaining and treating storm water. Established vegetation with adequate coverage is an indication of a healthy infiltration basin along with minimal sediment and lack of invasive vegetation. Side slopes should be stable and show little to no signs of erosion or rilling. Slope sloughing is an indication that geotechnical remediation is needed.

During the design storm event, infiltration basins should, at most, pond up to the water quality outlet. After the rain event, runoff within the basin should infiltrate through the bottom soils within the design drawdown time.

Designer Checklist

If the answer to these questions corresponds to a response box that is red, the BMP should either not be used or additional measures need to be taken to address the issue.

	Yes	No
Does groundwater meet the jurisdiction's minimum separation requirement?	☐	☐
Is there available right-of-way, property, or easement for the infiltration basin?	☐	☐
Is contaminated groundwater present at the infiltration basin location?	☐	☐
Is the water quality volume above the 4,356 cf threshold?	☐	☐

Does the infiltration basin provide storage for 100% of the water quality volume? (If no, it may still be appropriate to construct the infiltration basin if it is technically infeasible to capture 100% of the water quality volume.)	☐	☐
Do utility conflicts make installation of the infiltration basin technically infeasible?	☐	☐
Do geotechnical conditions exist that compromise the stability of the infiltration basin or surrounding structures?	☐	☐
Does an overflow outlet structure or bypass mechanism exist?	☐	☐
Is a fence required?	☐	☐

Vegetation

Refer to *Vegetation Guidance by BMP Type*.

Installation

Excavation

Installation of infiltration basins is a relatively straightforward process of excavation and grading; however, the basin will fail if proper care is not taken during construction. Excavators and heavy machinery should not be used within the basin area to avoid soil compaction.

Activities During Construction

Avoid using heavy machinery within the infiltration basin footprint during construction as doing so will compact the soils and diminish their infiltrating capabilities. Installation of an outlet structure may require machinery.

Flows During Construction

Flows during construction should be diverted away from the infiltration basin to prevent construction site sediment from clogging soils. Seeding or laying turf sod should occur within a short time span after excavation to minimize the impact of unnecessary storm water flows from entering the basin area. The introduction of unwanted sediment can be prevented by placing fiber rolls or silt fences around the basin perimeter during construction.

Additional Guidance

- Require certificates of compliance to verify that construction items meet specification requirements.
- Follow landscaping guidance to ensure that vegetation establishes after installation.

Installation Costs

The following cost items are typically associated with infiltration basin construction.

- Excavation

- Grading

- Outlet structure or upstream bypass structure (for larger storm events)

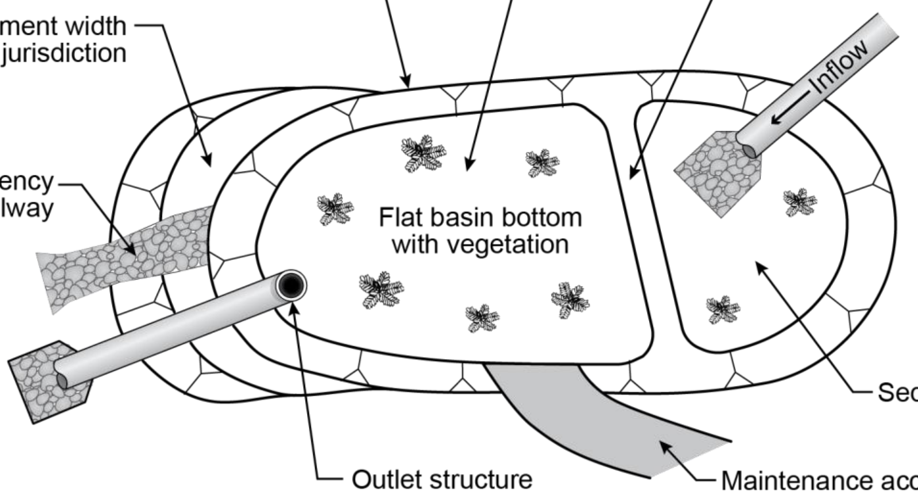
- Forebay and associated items: outlet protection, forebay wall, and connection between forebay and main bay.

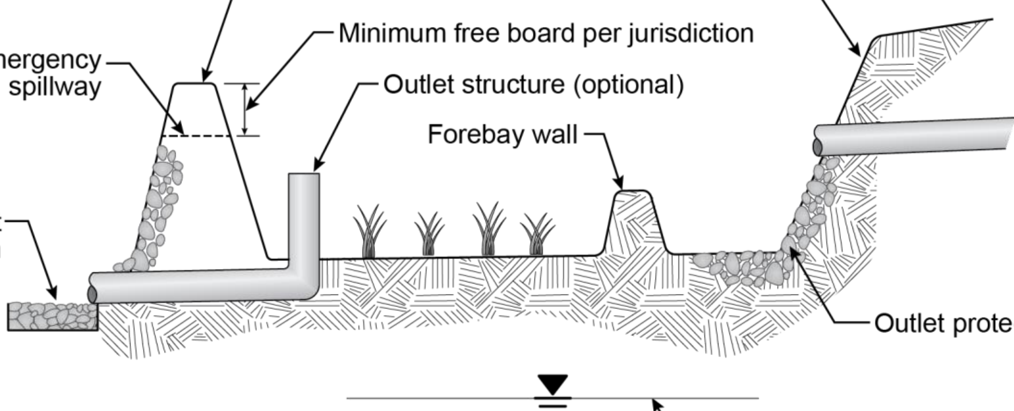
Maintenance

Refer to *Maintenance* and *Maintenance Costs* in the *Preface to Fact Sheets* for general information related to maintenance of infiltration BMPs.

Maintenance Activities

Inspection	Inspection/Maintenance Frequency	Maintenance Activity	Effort
Inspect for trash and debris at inlet and outlet structures.	Semiannual (Spring, Fall) or as needed	Remove and dispose of trash and debris.	LOW
Inspect grass length.	As needed	Mow basin grass.	LOW
Inspect pre-treatment diversion structures for sediment build-up.	Semiannual (Spring, Fall)	Remove and dispose of sediment buildup.	LOW
Inspect topsoil for sediment buildup.	Semiannual (Spring, Fall) or as needed	Remove sediment.	LOW
Inspect for standing water above trench or within observation well (if used).	Semiannual (Spring, Fall)	Notify engineer for further inspection.	LOW





Notes:

- *Dimensions shown may vary based on site conditions*
- *Forebay connection type to main bay will vary: outlet pipe, gabion wall, notched concrete wall, and others are acceptable*
- *Consider upstream bypass for large storm events*

Infiltration Basin

Not to scale

UTAH DEPARTMENT of ENVIRONMENTAL QUALITY
WATER QUALITY

Infiltration Trench

ID-2

Source: NHDES Soak Up the Rain

Pollutant Removal Effectiveness

Pollutant	Effectiveness
Sediment	High
Nutrients	High
Metals	High
Bacteria	High
Oil/Grease	High

Infiltration trenches are linear excavations that are backfilled with a combination of gravel, open graded stone, and sand layers that provide storage within the pore space of the specified layers. Although typically linear, infiltration trenches can be any shape provided that the footprint and depth are sized to retain the water quality volume.

The primary function of infiltration trenches is volume retention. The trench is designed such that the water quality volume is retained and stored within the gravel and sand layers. Depending on the design of the trench, pollutant removal occurs via filtration as runoff passes through an initial pea gravel layer and ultimately through the bottom sand layer. A geotextile fabric is also recommended along the sidewalls of the trench and under the pea gravel layer.

Primary Functions	
Bioretention	Yes[1]
Volume Retention	Yes
Biofiltration	Some

[1]Bioretention occurs in subsurface and not within the trench.

Design Criteria

Refer to *Design Criteria* in the *Preface to Fact Sheets* for discussion of design criteria parameters.

Parameter	Min. Value	Max. Value	Notes
Depth of Trench	2 ft	No maximum	Maximum depth determined by jurisdiction.
Longitudinal Trench Slope	0%	1%	-
Width	2 ft	No maximum	-
Drawdown Time	12 hours	72 hours	-
Design Infiltration Rate	0.25 in/hr	6 in/hr	Field testing required for final design.
Depth to Historical High Groundwater	2 ft	No maximum	-

Calculation Methods

Infiltration trench design is governed by the water quality volume. The general design steps are:

1. Calculate the water quality volume.
2. Determine the trench footprint.
3. Based on the trench geometry, porosity of the trench layers, and ponding depth (if any), determine the trench depth.
4. Calculate the drawdown time.

Sample Calculations

Refer to *Calculation Methods* in the *Preface to Fact Sheets* for discussion on the equations used.

A proposed park will have a concrete plaza that is 0.40 acres. Runoff from the plaza will flow towards a pervious area. To meet the jurisdiction's retention requirement, the design team proposes to install an infiltration trench adjacent to the plaza.

Given

Contributing drainage area: 0.40 ac

Imperviousness: 1.00

80^{th} percentile storm depth: 0.65 in

Design Goals

Determine that the geometry of an infiltration trench that will retain the water quality volume.

Calculations

Volumetric runoff coefficient, R_V (See *Sample Calculations*)

$R_V = 0.91i - 0.0204$ (Reese method)

$R_V = 0.91(1.0) - 0.0204$

$R_V = 0.89$

Water quality volume, WQV (See *Developing the 80th Percentile Volume*)

WQV = (0.89)(0.70 in)(0.40 ac)(43,560 sf/ac) / (12 in/ft)

WQV = 840 cf

There are 100 linear feet adjacent to the plaza that are available for the infiltration trench. Based on the grading at the trench, ponding above the trench will not occur. A trench that is 4.5 ft wide with the following properties will be able to retain the water quality volume. See *Storage volume within a media with a known porosity* for guidance on determining storage within soils.

Layer	Thickness, in	Porosity	Storage Volume, cf
Pea Gravel	4	0.25	37.5
Open Graded Stone	52	0.4	780
Sand Layer	6	0.15	33.8
Total	66	0.37 (weighted)	851

The equivalent storage depth of the water quality volume within the 4,500-sf infiltration trench is:

d = 851 cf / 4,500 sf

d = 1.9 ft

d = 23 in

Drawdown time, t

The infiltration rate of the surrounding soils is 1.5 in/hr.

t = Equivalent storage depth / infiltration rate

t = 23 in / 1.5 in/hr

t = 15 hrs

Infiltration Trench Effectiveness

Effective infiltration trenches take advantage of limited or narrow spaces where bioretention areas or infiltration basins are impractical. Visible sediment buildup on the top layer of the trench could be an indication that clogging is present within the trench or that runoff is simply passing over the trench and not being captured. Although some vegetation intrusion or organic debris is likely not a concern, proper grooming and maintenance will contribute to a trench's extended life-span.

During the design storm event, runoff should be conveyed toward and enter the trench per the design plans. Recent new construction, regrading, or resurfacing within the contributing drainage area should be noted as it may impact flow paths or the introduction of new pollutants.

Designer Checklist

If the answer to these questions corresponds to a response box that is red, the BMP should either not be used or additional measures need to be taken to address the issue.

	Yes	No
Does groundwater meet the jurisdiction's minimum separation requirement?	☐	☐
Is the infiltration rate of the existing soils within acceptable rates?	☐	☐
Is contaminated groundwater present at the infiltration trench location?	☐	☐
Do utility conflicts make installation of the infiltration trench technically infeasible?	☐	☐
Do geotechnical conditions exist that compromise the stability of the infiltration trench or surrounding structures?	☐	☐
Does the infiltration trench provide storage for 100% of the water quality volume? (If no, it may still be appropriate to construct the infiltration trench if it is technically infeasible to capture 100% of the water quality volume.)	☐	☐
Does an overflow outlet structure or bypass mechanism exist, if needed?	☐	☐

Vegetation

Vegetation is not typical for an infiltration trench.

Installation

Excavation
Excavation for infiltration trenches is typically linear but alternate geometries are possible. During excavation, light machinery should be used to avoid excessive compaction.

Activities During Construction
Avoid using heavy machinery within the infiltration trench footprint during construction as doing so will compact the soils and diminish their infiltrating capabilities.

Flows During Construction
Flows during construction should be diverted away from the infiltration trench to prevent construction site sediment from clogging soils. The introduction of unwanted sediment can be prevented by placing fiber rolls or silt fences around the trench perimeter during construction.

Additional Guidance
- Require certificates of compliance to verify that construction items meet specification requirements.

Installation Costs

The following cost items are typically associated with infiltration trench construction.

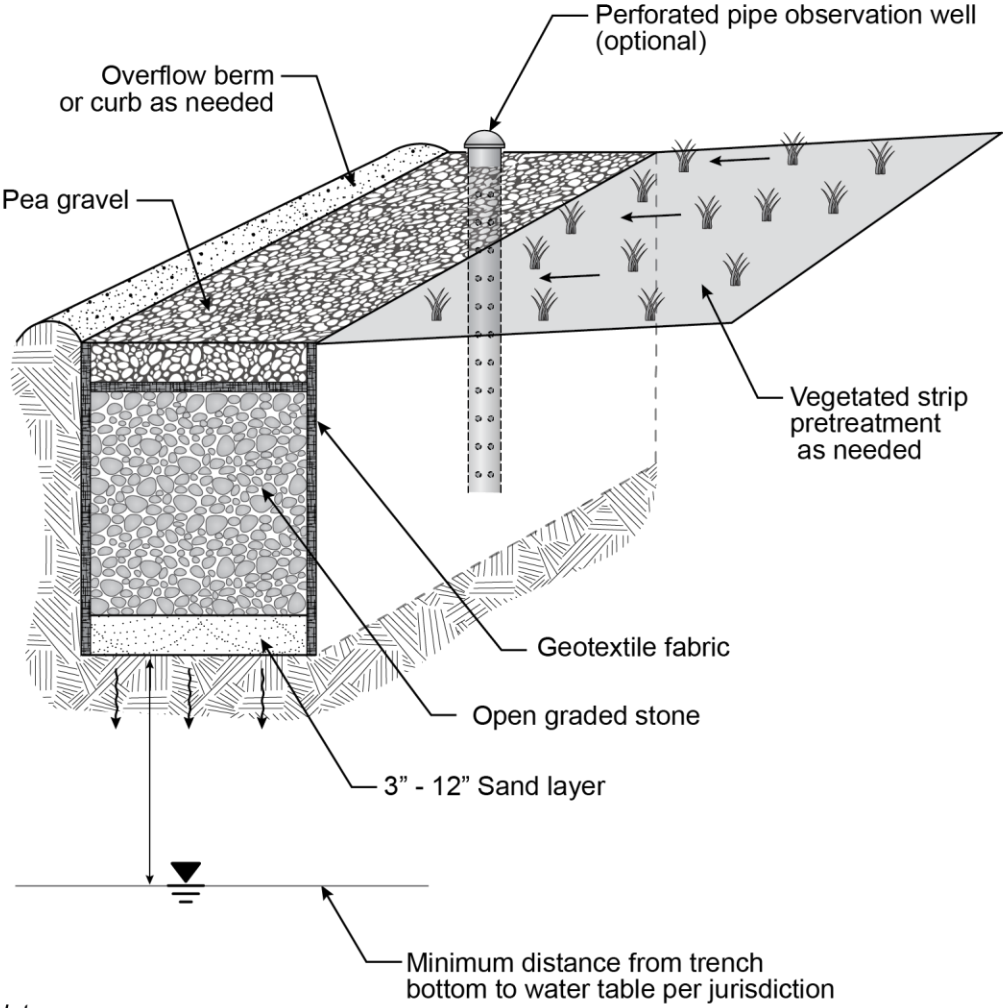
- Excavation
- Landscaping and vegetation
- Pea gravel
- Open graded stone
- Sand layer
- Geotextile separator

Maintenance

Refer to *Maintenance* and *Maintenance Costs* in the *Preface to Fact Sheets* for general information related to maintenance of infiltration BMPs.

Maintenance Activities

Inspection	Inspection/Maintenance Frequency	Maintenance Activity	Effort
Inspect for trash and debris at inlet and outlet structures.	Semiannual (Spring, Fall) or as needed	Remove and dispose of trash and debris.	LOW
Inspect grass length, if any, on top of trench.	As needed	Mow trench grass.	LOW
Inspect pre-treatment diversion structures for sediment buildup.	Semiannual (Spring, Fall) or as needed	Remove and dispose of sediment build up.	LOW
Inspect tree growth near trench.	Semiannual (Spring, Fall)	Remove trees in vicinity of the trench.	LOW
Inspect for standing water above trench or within observation well.	Semiannual (Spring, Fall)	Notify engineer for further inspection.	LOW



Notes:

- *Dimensions shown may vary based on site conditions*

Infiltration Trench

Not to scale

UTAH DEPARTMENT *of* ENVIRONMENTAL QUALITY
WATER QUALITY

Dry Well *ID-3*

Pollutant Removal Effectiveness

Pollutant	Effectiveness
Sediment	High
Nutrients	High
Metals	High
Bacteria	High
Oil/Grease	High

Dry wells are underground storage areas that are sized to retain the water quality volume and infiltrate runoff into the existing soils.

The primary functions of dry wells are bioretention and volume retention. Bioretention does not occur within the dry well but occurs in the native soils immediately surrounding the dry well.

Dry wells contribute to aquifer recharge and as such classify as a subclass of Underground Injection Control (UIC) Class V wells. Refer to the DWQ website on storm water drainage wells (link below) for more information relating to the UIC Program.

Primary Functions	
Bioretention	Yes
Volume Retention	Yes
Biofiltration	No

Storm Water Drainage Wells: https://deq.utah.gov/legacy/programs/water-quality/utah-underground-injection-control/drainage-wells/index.htm

Design Criteria

Refer to *Design Criteria* in the *Preface to Fact Sheets* for discussion of design criteria parameters.

Parameter	Min. Value	Max. Value	Notes
Depth to Historical High Groundwater	2 ft	No maximum	-
Drawdown Time	24 hours	72 hours	-
Building Setback	10 ft	No maximum	-
Design Infiltration Rate	0.25 in/hr	6 in/hr	Field testing required for final design.

Calculation Methods

Dry well design is governed by the water quality volume. The general design steps are:

1. Calculate the water quality volume.
2. Determine the dry well geometry.
3. Determine the drawdown time.

Sample Calculations

Refer to *Calculation Methods* in the *Preface to Fact Sheets* for discussion on the equations used.

A drywell is proposed at the downstream end of a swale that is being proposed adjacent to a new road.

Given

Contributing drainage area: 0.72 ac

Imperviousness: 0.40

80th percentile storm depth: 0.54 in

Infiltration rate of surrounding soil: 3 in/hr

Design Goals

Determine the dry well geometry required to hold the water quality volume.

Calculations

Volumetric runoff coefficient, R_V (See *Sample Calculations*)

$R_V = 0.225i + 0.05$ (Granato method when $i < 0.55$)

$R_V = 0.225(0.40) + 0.05$

$R_V = 0.14$

Water quality volume, WQV (See *Developing the 80th Percentile Volume*)

WQV = (0.14)(0.54 in)(0.72 ac)(43,560 sf/ac) / (12 in/ft)

WQV = 198 cf

A dry well that has a 6 ft diameter and is 7 ft deep will hold 198 cf.

For a conservative estimate at the planning stage, the dry well's drawdown time is based on the infiltration rate of the surrounding soil and ignores the effects of the pressure head within the dry well. A more detailed determination of the drawdown should be done for final design.

Drawdown time, t

t = Dry well depth / infiltration rate

t = (7 ft)(12 in/ft) / 3 in/hr

t = 28 hrs

Dry Well Effectiveness

Effective dry wells optimize infiltrating soils within limited space to retain storm water runoff while not introducing stability concerns to nearby development or structures. The design storm volume within a functioning dry well will drawdown within the design time and leave no standing water inside of the well. Pretreatment should be provided prior to entering the dry well and the pretreatment method should be determined based on the expected pollutants. Entry to the dry well should be unobstructed and free of debris that will restrict flows from entering.

Designer Checklist

If the answer to these questions corresponds to a response box that is red, the BMP should either not be used or additional measures need to be taken to address the issue.

	Yes	No
Does groundwater meet the jurisdiction's minimum separation requirement?	☐	☐
Is the infiltration rate of the existing soils within acceptable rates?	☐	☐
Is contaminated groundwater present at the dry well location?	☐	☐
Do utility conflicts make installation of the dry well technically infeasible?	☐	☐
Do geotechnical conditions exist that compromise the stability of the dry well or surrounding structures?	☐	☐
Is pretreatment provided upstream of or within the dry well?	☐	☐

Installation

Excavation
Excavate area in which dry well will be placed.

Activities During Construction
Take proper safety measures to cover the excavated dry well area before putting the dry well in place. If the dry well is designed to infiltrate through the well bottom, place and level gravel within the excavation to provide a foundation for the well structure.

Flows During Construction
Flows during construction can enter the dry well if the grated manhole lid contains a filtering material.

Additional Guidance

- Require certificates of compliance to verify that construction items meet specification requirements.
- Obtain a permit through the UIC Program

Installation Costs

The following cost items are typically associated with dry well construction.

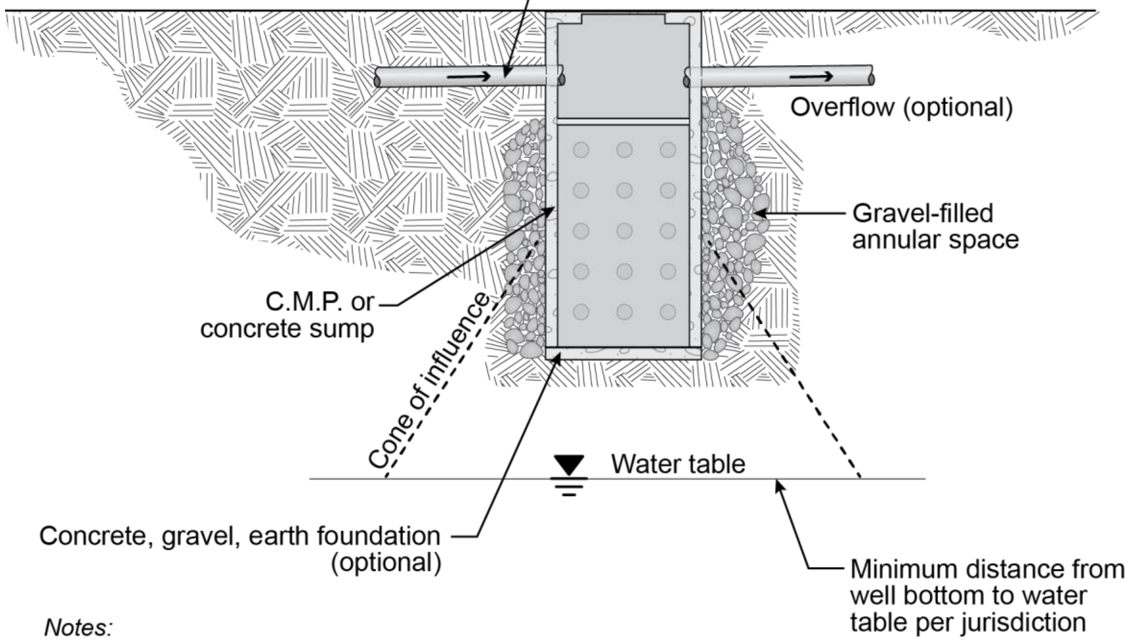
- Excavation
- Dry well
- Permit application fees for Class V Injection Wells
- Gravel-filled annular space surrounding dry well
- Pretreatment upstream of dry well
- Overflow connection to downstream system
- Gravel foundation (optional)

Maintenance

Refer to *Maintenance* and *Maintenance Costs* in the *Preface to Fact Sheets* for general information related to maintenance of dry wells.

Maintenance Activities

Inspection	Inspection/Maintenance Frequency	Maintenance Activity	Effort
Inspect water depth.	Initially after every major storm, then annually.	Remove and dispose of built up sediment when buildup causes reduction in detention capacity. Notify the engineer.	Medium
Inspect inlet for obstructions.	Semiannual (Spring, Fall) or as needed	Remove obstructions.	Low
Inspect structural elements.	As determined by jurisdiction.	Repair or reconstruct deficient structural components.	Medium



Notes:

- *Dimensions shown may vary based on site conditions*

Dry Well

Not to scale

UTAH DEPARTMENT of ENVIRONMENTAL QUALITY
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Underground Infiltration Galleries ID-4

Source: StormTech

Pollutant Removal Effectiveness

Pollutant	Effectiveness
Sediment	High
Nutrients	High
Metals	High
Bacteria	High
Oil/Grease	High

Underground storage devices are proprietary alternatives to above ground storage when space at the project site is limited. They may be sized for the 80th percentile volume similar to how they are sized for flood control volumes. When underground storage is used for water quality, its primary functions are bioretention as runoff infiltrates into the underlying soil and volume retention. They are constrained by subsurface conditions such as depth to the historical high groundwater, soil infiltration rates, and other site-specific constraints that prevent infiltration. Designing underground storage devices is done with the assistance of the device manufacturer.

Primary Functions	
Bioretention	Yes
Volume Retention	Yes
Biofiltration	No

Pretreatment for underground systems will vary. Pretreatment removes sediment that will potentially clog elements of the underground system such as geotextile fabrics or bedding layers. If the manufacturer does not include a pretreatment system as part of the device, it may be necessary to design a separate pretreatment system such as a settling basin upstream before entering the underground system.

Underground systems are typically modular and allow for configurations that range from large areas such as would be needed underneath a parking lot to linear installations like within a park strip or underneath a bioswale.

Design Criteria

Underground storage devices are proprietary devices; follow manufacturer specifications to determine design criteria on a case-by-case basis.

Calculation Methods

Underground storage device design is governed by the water quality volume (when sizing for the water quality event). It is not uncommon for manufacturers to provide sizing tools based on the desired storage volume. The general design steps are:

1. Calculate the water quality volume.
2. Determine manufacturer's recommendations given the water quality volume and other site conditions.

Underground Infiltration Effectiveness

With regular maintenance and inspection, it can be determined if the underground system is performing as expected. As part of the design process, determine how the system will be inspected. Possible inspection methods include the use of observation wells or structural vaults at tie-in locations with the site's storm drain network. Inspect for any soil displacement or movement at the perimeter of the system and any depressions above the system.

Designer Checklist

If the answer to these questions corresponds to a response box that is red, the BMP should either not be used or additional measures need to be taken to address the issue.

	Yes	No
Does groundwater meet the jurisdiction's minimum separation requirement?	☐	☐ (red)
Is the infiltration rate of the existing soils within acceptable rates?	☐	☐ (red)
Is contaminated groundwater present?	☐ (red)	☐
Do utility conflicts exist that make installation of the device technically infeasible?	☐ (red)	☐
Do geotechnical conditions exist that compromise the stability of the device or surrounding structures?	☐ (red)	☐
Is pretreatment provided upstream of or within the underground storage device?	☐	☐ (red)
Is the soil bearing capacity of the underlying soil sufficient for the system?	☐	☐ (red)
Will the underground system support the expected loads above it?	☐	☐ (red)

Installation

Excavation

Excavate the footprint of the underground system.

Activities During Construction

Avoid using heavy machinery within the excavated footprint during construction as doing so will compact the soils and diminish their infiltrating capabilities. Avoid using heavy machinery on top of the underground system as well. Follow all installation guidelines from the manufacturer.

Flows During Construction

Flows during construction should be diverted away from the excavated area to prevent construction site sediment from clogging soils.

Additional Guidance

- Follow all manufacturer's requirements.

Installation Costs

The following cost items are typically associated with installation of underground storage systems.

- Excavation
- Geotextile fabric
- Underground storage devices
- Aggregate (bedding, overlay, other as needed)
- Observation wells
- Pretreatment upstream of system (if not provided)

Maintenance

Underground systems are typically designed with accessible pretreatment areas such as a manhole. Refer to manufacturer's guidelines.

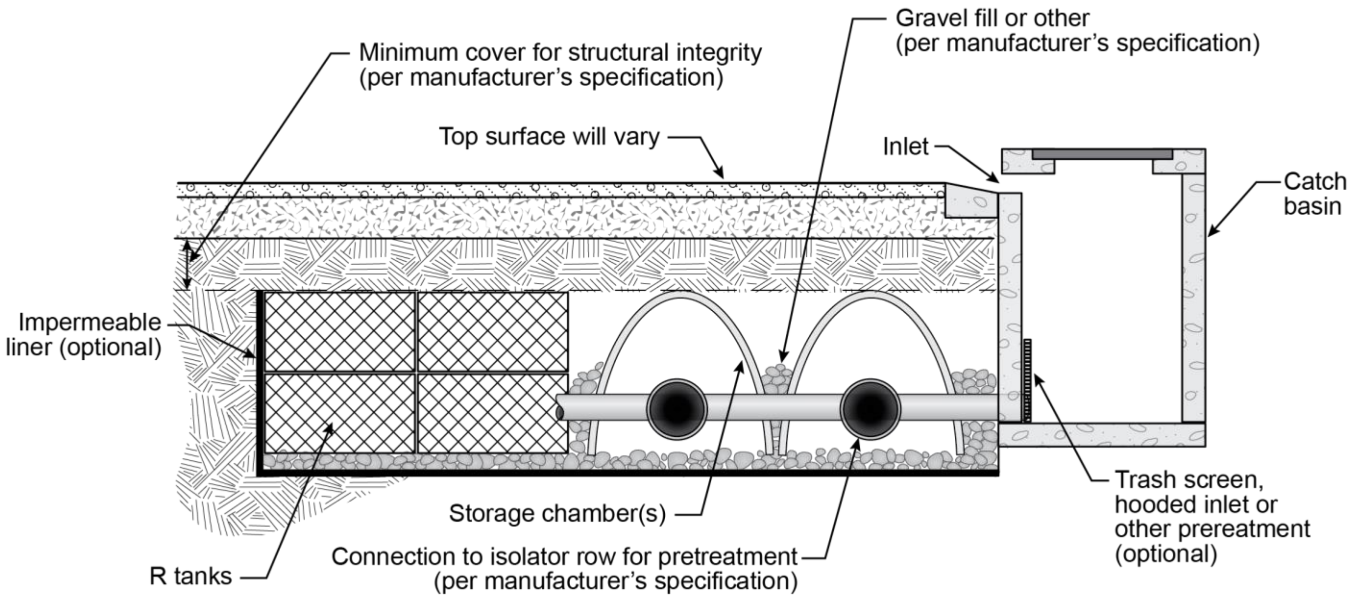
Maintenance Activities

Typical maintenance activity includes removal of sediment or debris within the pretreatment area. High pressure washing of geotextile fabrics or replacement of filter fabrics may also be needed. Refer to manufacturer's guidelines for specific activities and frequency of inspections.

Manufacturers

The following table of manufacturers is for reference only and does not constitute an endorsement.

Manufacturer	Device Type(s)	URL
StormTech	Chambers	http://www.stormtech.com/
ACF Environmental	Chambers R Tanks	https://www.acfenvironmental.com
ConTech	Chambers	https://www.conteches.com



Notes:

- *Configurations will vary*
- *Impermeable liner around undergroundsystem if groundwater concerns exist*
- *If impermeable liner is used, provide outlet to prevent standing water*

Underground Infiltration Gallery

Not to scale

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WATER QUALITY

Harvest and Reuse

HR-1

Pollutant Removal Effectiveness

Pollutant removal will vary based on the ultimate use of the harvested runoff.

Harvest and reuse refers to any type of runoff collection system that captures rainfall, stores it temporarily, and reuses it for irrigation, landscaping, or other non-potable uses. Harvest and reuse systems inherently retain the volume of runoff that it captures. Depending on the subsequent use after being captured, they also provide bioretention and filtration to the released runoff.

Harvest and reuse systems may be used in lieu of directly connecting rooftop drains to storm sewer systems; where downdrains discharge to impervious surfaces and the opportunity for irrigation or landscaping exists; as part of a home owner's irrigation plan; or for any other non-potable purpose where storm water is determined to be acceptable such as vehicle or machinery washing.

As of 2010, Utah's legislative code 73-3-1.5 requires that if more than 100 gallons of rainwater (13.4 cf) are captured, it must be registered through the Utah Division of Water Rights (https://waterrights.utah.gov/forms/rainwater.asp). The code also limits the total capture to 2,500 gallons (334.2 cubic feet). See the code for additional requirements.

Primary Functions	
Bioretention	Varies
Volume Retention	Yes
Biofiltration	Varies

Design Criteria

Design criteria for harvest and reuse devices or systems will vary widely. The governing principles of harvest and reuse are based on the system's function and capacity. For example, a rain barrel that provides occasional irrigation to a flower bed should be appropriately sized for the 80th percentile volume and be able to release the volume within an appropriate time that does not flood out the flower bed. A larger harvest and reuse system, such as an underground detention vault or above ground pond will be required to meet geotechnical or structural design criteria. The applications of harvest and reuse systems are endless; specific design criteria should be determined on a case-by-case basis with site-specific consideration.

Calculation Methods

Harvest and reuse systems are governed by the water quality volume. The general design steps are:

1. Calculate the water quality volume.
2. Size device for the water quality volume.

Sample Calculations

Refer to *Calculation Methods* in the *Preface to Fact Sheets* for discussion on the equations used.

A commercial development will have two buildings with roofs that are 2,500 square feet each. Rain barrels that will release to flower beds will be included as part of the design. Each roof is considered one drainage area.

Given

Contributing drainage area: 2,500 sf

Contributing drainage area: 0.057 ac

Imperviousness: 1.00

80th percentile storm depth: 0.55 in

Design Goals

Capture all runoff from the 80th percentile storm within rain barrels.

Calculations

Volumetric runoff coefficient, R_V (See *Sample Calculations*)

$R_V = 0.91i - 0.0204$ (Reese method)

$R_V = 0.91(1.0) - 0.0204$

$R_V = 0.89$

Water quality volume, WQV (See *Developing the 80th Percentile Volume*)

WQV = (0.89)(0.55 in)(0.057 ac)(43,560 sf/ac) / (12 in/ft)

WQV = 102 cf

WQV = 763 gallons

If 55-gallon rain barrels are used, 14 rain barrels will be needed for each roof and the capture will need to be registered with the Division of Water Rights.

Harvest and Reuse Effectiveness

The effectiveness of a harvest and reuse system is dependent on its use. Detention devices should be free of standing water to prevent stagnation and vector concerns. Systems that provide irrigation or that are part of landscaping features should be inspected regularly to ensure proper performance.

Designer Checklist

If the answer to these questions corresponds to a response box that is red, the BMP should either not be used or additional measures need to be taken to address the issue.

	Yes	No
Will stagnation of runoff be prevented by frequent release of the harvested runoff?	☐	☐
Does quantity of harvested runoff require registration with the Division of Water Rights?	☐	☐

Installation

Installation of harvest and reuse systems will vary depending on its use. Rain barrels can simply be connected to a down drain. More complicated systems require additional coordination.

Depending on the quantity of runoff being harvested, it will be necessary to register the detention device with the Division of Water Rights.

Installation Costs

The following cost items are typically associated with harvest and reuse systems.

-Detention device

-Upstream connection to detention device

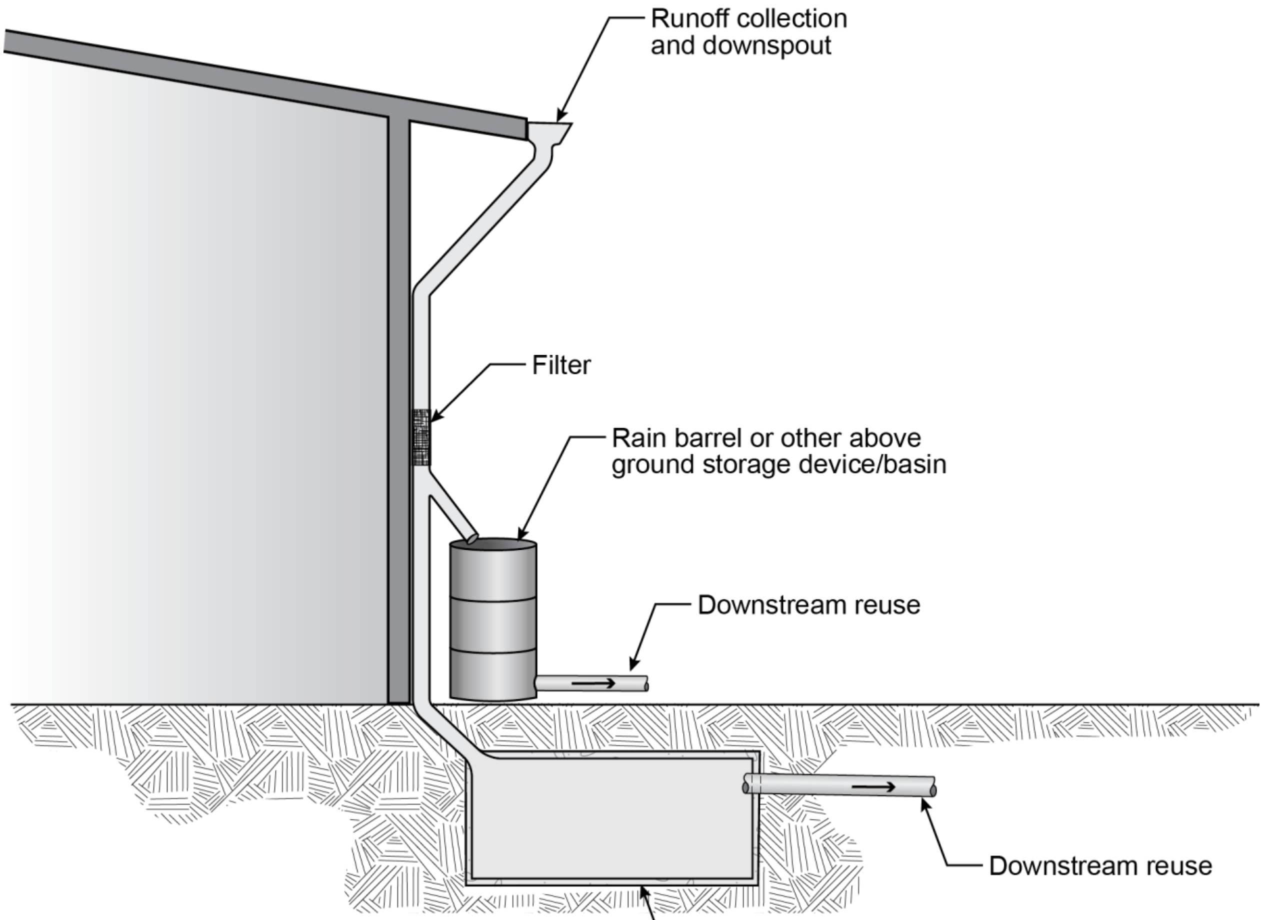
-Other items will be dependent on site-specific use

Maintenance

Refer to *Maintenance* and *Maintenance Costs* in the *Preface to Fact Sheets* for general information related to maintenance of harvest and reuse systems.

Maintenance Activities

Inspection	Inspection/Maintenance Frequency	Maintenance Activity	Effort
Inspect for mosquitos.	Semiannual (Spring, Fall)	Implement larvicide or other remediation.	Low
Inspect harvesting device for leaking.	Semiannual (Spring, Fall)	Replace harvesting device.	Low
Inspect condition of system components.	Semiannual (Spring, Fall)	Replace and repair components.	Medium



Notes:

- *Configurations and applications may vary*

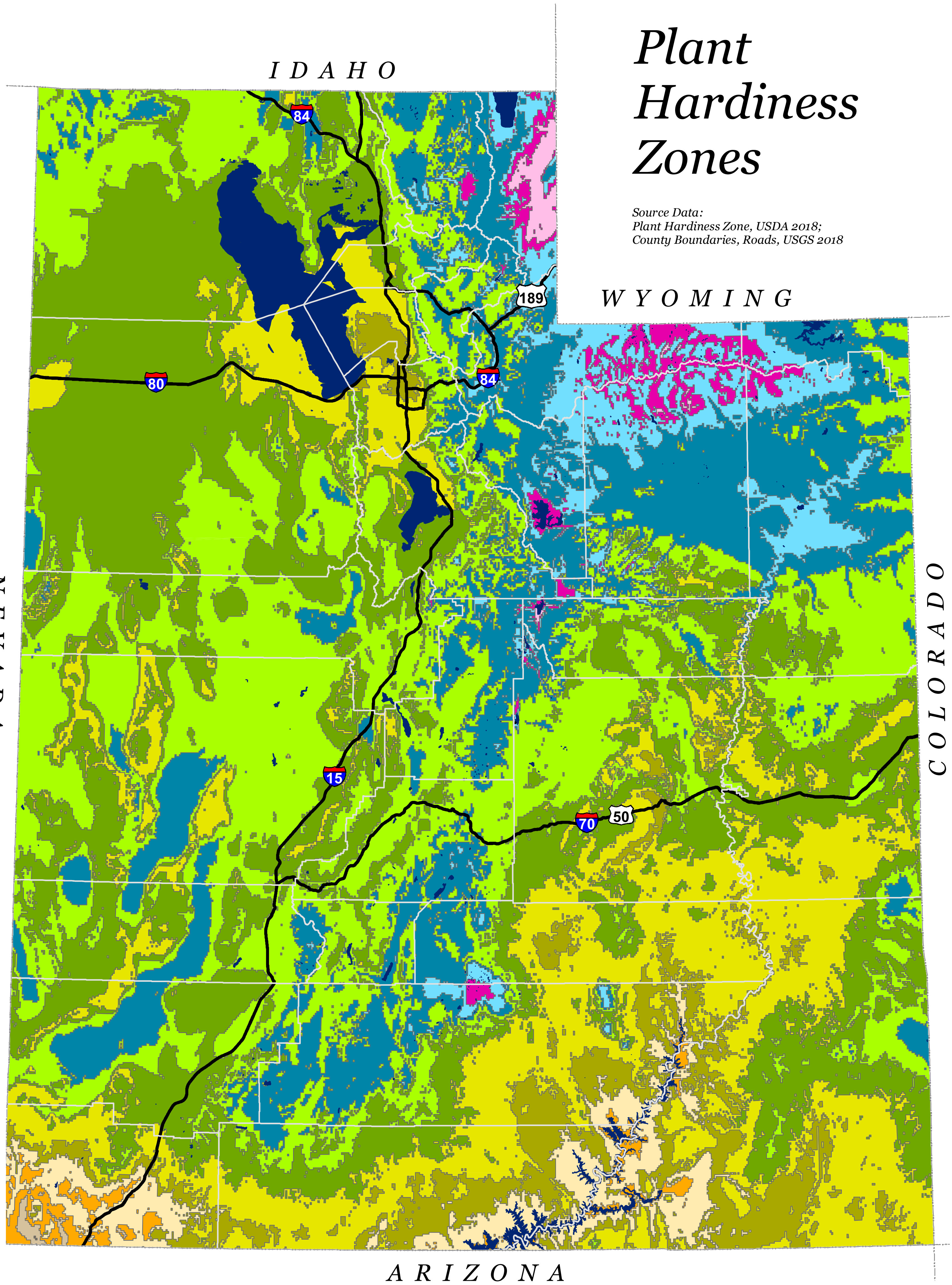
Harvest and Reuse

Not to scale

Appendix D Utah Plant Hardiness Zones

Plant Hardiness Zones

Source Data:
Plant Hardiness Zone, USDA 2018;
County Boundaries, Roads, USGS 2018



HARDINESS ZONE

3b: -35 to -30 F
4a: -30 to -25 F
4b: -25 to -20 F
5a: -20 to -15 F
5b: -15 to -10 F
6a: -10 to -5 F
6b: -5 to 0 F
7a: 0 to 5 F
7b: 5 to 10 F
8a: 10 to 15 F
8b: 15 to 20 F
9a: 20 to 25 F
9b: 25 to 30 F
Lake/Pond

0 12.5 25 50 75 100
Miles

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Michael Baker INTERNATIONAL

epg

Appendix E Utah Plant Selection Matrix by Climate Zone and BMP

Plants		Zones													Best Management Practices (BMPs)							
Trees		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Basin Upland	Swales	Strips	Bioretention Cells/ Rain Gardens	Tree Box Filters	Green Roofs
Acer campestre	Hedge Maple		x	x	x	x	x	x	x	x	x	x					x		x			
Acer campestre 'Carnival'	Carnival Hedge Maple		x	x	x	x	x	x	x	x	x	x					x		x			
Acer ginnala	Amur Maple	x	x	x	x	x	x	x	x	x	x						x	x		x	x	
Acer glabrum	Rocky Mountain Maple				x	x	x	x	x	x	x	x	x	x			x	x	x	x		
Acer grandidentatum	Bigtooth Maple	x	x	x	x	x	x	x	x	x	x	x					x					
Acer grandidentatum 'Schmidt'	Rocky Mountain Glow Maple		x	x	x	x	x	x	x	x	x	x					x					
Acer griseum	Paperbark Maple		x	x	x	x	x	x	x	x	x	x					x					
Acer microphyllum	Big Leaf Maple						x	x	x	x					x	x		x		x		
Acer negundo 'Sensation'	Sensation Boxelder		x	x	x	x	x	x									x		x		x	
Acer palmatum sp.	Japanese Maples				x	x	x	x	x	x	x	x					x		x			
Acer palmatum "Garnet"	Garnet Japanese Maple				x	x	x	x	x	x	x	x	x	x			x					
Acer palmatum 'Bloodgood'	Bloodgood Japanese Maples				x	x	x	x	x	x	x	x					x					
Acer palmatum 'Trompenburg'	Trompenburg Japanese Maple				x	x	x	x	x	x	x	x					x					
Acer platanoides	Norway Maple		x	x	x	x	x	x	x	x							x		x			
Acer platanoides 'Columnare'	Columnar Norway Maple		x	x	x	x	x	x	x	x							x		x			
Acer platanoides 'Crimson Sentry'	Crimson Sentry Norway Maple	x	x	x	x	x	x	x	x	x							x		x			
Acer pseudoplatanus 'Esk Sunset' ESKIMO SUNSET	Eskimo Sunset Sycamore Maple'				x	x	x	x	x	x	x	x					x					
Acer pseudoplatanus 'Spaethii'	Purple Sycamore Maple				x	x	x	x	x	x	x	x	x	x			x		x			
Acer pseudoplatanus 'Tunpetti' REGAL PETTICOAT	Regal Petticoat Sycamore Maple		x	x	x	x	x	x	x	x	x	x	x	x			x		x			x
Acer rubrum	Red Maple	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Acer saccharinum	Silver Maple		x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	
Acer tataricum	Tatarian Maple	x	x	x	x	x	x	x	x	x	x	x					x	x		x	x	
Acer tataricum ssp. Ginnala	Amur Maple	x	x	x	x	x	x	x	x	x	x	x					x		x			
Acer tataricum 'GarAnn' PP 15,023	HOT WINGS® Tatarian maple		x	x	x	x	x	x	x	x	x	x	x	x			x	x		x	x	
Acer x feemanii 'Jeffersred'	Autumn Blaze Maple	x	x	x	x	x	x	x	x	x	x	x					x	x	x	x	x	
Aesculus hippocastanum	Horsechestnut	x	x	x	x	x	x	x	x	x	x	x					x	x	x	x		
Aesculus x arnoldiana 'Autumn Splendor'	Autumn Splendor Horse Chestnut		x	x	x	x	x	x	x	x								x	x	x		
Alnus incana sp. Tenufolia	Thinleaf Alder	x	x	x	x	x											x		x			
Alnus rubra	Red Alder		x	x	x	x											x		x			
Alnus sinuata	Sitka Alder		x	x	x	x											x		x	x		
Amelanchier arborea	Serviceberry		x	x	x	x	x	x	x	x	x	x	x	x			x					
Amelanchier laevis 'Spring Flurry'	Spring Flurry Serviceberry	x	x	x	x	x	x	x											x			
Betula alleghaniensis	Yellow Birch	x	x	x	x	x	x	x									x					
Betula nigra	River Birch		x	x	x	x	x	x	x	x	x	x	x	x		x		x	x	x		
Betula occidentalis	Water Birch	x	x	x	x	x									x	x	x	x	x	x	x	
Betula papyrifera	Paper Birch	x	x	x	x	x	x	x							x	x	x	x	x	x	x	
Betula pendula	Silver Birch	x	x	x	x	x	x	x							x	x	x	x	x	x	x	
Betula pubescens	White Birch	x	x	x	x	x	x	x							x	x	x	x	x	x	x	
Carpinus betulus 'Fastigiata'	Pyramidal European Hornbeam		x	x	x	x	x	x	x	x	x	x							x	x		
Carpinus caroliniana	American Hornbeam	x	x	x	x	x	x	x	x	x	x	x	x	x		x						
Carya cordiformis	Bitternut Hickory		x	x	x	x	x	x	x	x	x	x	x	x			x					
Carya glabra	Pignut Hickory		x	x	x	x	x	x	x	x	x	x	x	x			x					
Carya illinoinensis	Pecan				x	x	x	x	x	x	x	x	x	x	x	x		x		x		
Carya ovata	Shabgark Hickory		x	x	x	x	x	x	x	x	x	x					x					
Carya lacinosa	Shellbark Hickory				x	x	x	x	x	x	x	x					x					
Catalpa speciosa	Catalpa				x	x	x	x	x	x	x	x	x	x			x	x	x			x
Celtis occidentalis	Common Hackberry		x	x	x	x	x	x	x	x	x	x	x	x			x	x		x	x	
Celtis occidentalis 'Prairie Pride'	Prairie Pride Hackberry	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	
Celtis tenuifolia	Dwarf Hackberry				x	x	x	x	x	x	x	x	x	x			x					
Cercis canadensis	Eastern Redbud				x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	
Cercis canadensis 'Forest Pansy'	Forest Pansy Redbud				x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	
Cercis canadensis 'Ruby Falls'	Ruby Falls Redbud						x	x	x	x	x	x	x	x			x	x	x	x	x	
Cercis canadensis 'The Rising Sun'	Rising Sun Redbud				x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	
Cercis occidentalis	Western Redbud						x	x	x	x	x	x	x	x		x	x		x			
Chilopsis linearis	Desert Willow								x	x	x	x	x	x		x	x		x			
Citrus limon	Lemon												x	x								x
Corylus colurna	Turkish Filbert			x	x	x	x	x	x	x							x	x	x			
Cotinus coggygria 'Grace'	American Smoke Tree, Grace				x	x	x	x	x	x	x	x								x		
Cotinus coggygria 'Royal Purple'	Royal Purple Smoketree				x	x	x	x	x	x	x	x								x		
Crataegus arnoldiana	Arnold Hawthorn				x	x	x	x	x	x	x	x	x	x			x	x				
Crataegus crusgalli	Cockspur Hawthorn		x	x	x	x	x	x	x	x	x	x					x					

Attachment: DWQ-2019-000161 (Section 13.94.040 Storm Water System Design and Management Standards)

Plants		Zones													Best Management Practices (BMPs)							
Trees		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Basin Upland	Swales	Strips	Bioretention Cells/ Rain Gardens	Tree Box Filters	Green Roofs
Crataegus crusgalli var. inermis	Thornless Cockspur Hawthorn		x	x	x	x	x	x	x	x	x	x					x					
Crataegus douglasii	Black/ Douglas Hawthorn		x	x	x	x	x	x									x		x	x		
Crataegus laevigata	English Hawthorn		x	x	x	x	x	x	x	x	x	x					x	x	x			
Fraxinus pennsylvanica	Green Ash	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x		
Ginkgo biloba	Maidenhair Tree	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x		
Ginkgo biloba 'Fairmount'	Fairmount Ginkgo				x	x	x	x	x	x	x	x			x	x	x	x	x	x		
Ginkgo biloba 'PNI 2720'	Princeton Sentry Ginkgo	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x		
Gleditsia triacanthos 'Impcole' IMPERIAL	Imperial Honeylocust		x	x	x	x	x	x	x	x	x	x					x	x	x	x		
Gleditsia triacanthos 'Imperial'	Imperial Honey Locust		x	x	x	x	x	x	x	x	x	x					x	x	x	x		
Gleditsia triacanthos 'Shademaster'	Shademaster Honeylocust				x	x	x	x	x	x	x	x			x	x	x	x	x	x		
Gleditsia triacanthos 'Skyline'	Skyline Honelocust	x	x	x	x	x	x	x	x	x	x	x					x	x	x	x		
Gleditsia triacanthos var. inermis 'Suncole'	Sunburst Honey Locust	x	x	x	x	x	x	x	x	x	x	x					x	x	x	x		
Gymnocladus dioica	Kentucky Coffeetree				x	x	x	x	x	x	x	x	x	x			x			x		
Juglans nigra	Black Walnut				x	x	x	x	x	x	x	x	x	x			x			x		
Koelreuteria paniculate	Golden Raintree				x	x	x	x	x	x	x	x	x	x			x		x	x		
Lagunaria pattersonii	Norfolk Island Hibiscus												x	x		x						
Laurus nobilis	Sweet Bay										x	x	x	x								x
Liquidambar styraciflua	Sweet Gum				x	x	x	x	x	x	x	x	x	x	x	x		x		x		
Liriodendron tulipifera 'Aureomarginatum'	Majestic Beauty Tulip Tree				x	x	x	x	x	x	x	x	x	x		x						
Liriodendron tulipifera 'Fastigiatum'	Columnar Tulip Tree				x	x	x	x	x	x	x	x	x	x			x					
Maackia amurensis	Amur Maackia	x	x	x	x	x	x	x	x	x									x			
Magnolia grandiflora	Souhthern Magnolia								x	x	x	x	x	x	x	x			x	x		
Magnolia virginiana	Sweet Bay Magnolia				x	x	x	x	x	x	x	x	x	x	x	x		x		x		
Malus pumila 'Obelisk' STARK CRIMSON SPIRE	Stark Crimson Spire Apple		x	x	x	x	x	x	x	x	x	x	x	x			x	x				
Malus pumila 'Tuscan' STARK EMERALD SPIRE	Stark Emerald Spire Apple		x	x	x	x	x	x	x	x	x	x	x	x			x	x				
Malus sargentii 'Tina'	Tina Sargent Crabapple		x	x	x	x	x	x	x	x	x	x					x	x				
Malus 'Adams'	Adams Crabapple		x	x	x	x	x	x	x	x	x	x	x	x			x	x				
Malus 'Prairifire'	Prairifire Crabapple				x	x	x	x	x	x	x	x					x	x				
Malus 'JFSKW213MZ'	Raspberry Spear Upright Crabapple		x	x	x	x	x	x	x	x							x	x				
Malus 'JFS-KW5' ROYAL RAINDROPS	Royal Raindrops Crabapple		x	x	x	x	x	x	x	x	x	x	x	x			x	x				
Malus 'Royalty'	Royalty Crabapple				x	x	x	x	x	x	x	x					x	x				
Malus 'Spring Snow'	Spring Snow Crabapple				x	x	x	x	x	x	x	x					x	x				
Malus 'Weepcanzam'	Candied Apple Crabapple		x	x	x	x	x	x	x	x	x	x					x	x				
Morus alba	White Mulberry	x	x	x	x	x	x	x	x	x	x	x	x	x		x		x	x			
Morus alba 'Chaparral'	Chaparral Weeping Mulberry		x	x	x	x	x	x	x	x	x	x						x	x			
Morus alba 'Kingan'	Kingan Mulberry				x	x	x	x	x	x	x	x	x	x				x	x			
Nyssa sylvatica	Black Gum	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	
Olea europaea 'Swan Hill'	Swan Hill Olive										x	x	x	x			x		x			x
Olea europaea 'Tolley's Upright'	Tolley's Upright Olive										x	x	x	x			x		x			x
Ostrya virginiana	Hop-Hornbeam	x	x	x	x	x	x	x	x	x	x	x	x	x			x					
Platanus occidentalis	Sycamore		x	x	x	x	x	x	x	x	x	x	x	x	x	x		x		x		
Platanus racemosa	Western Sycamore						x	x	x	x	x	x	x	x		x	x					
Platanus x acerifolia	London Plane Tree (American Sycamore)		x	x	x	x	x	x	x	x	x	x				x		x		x		
Platanus x hispanica	London Plane Tree		x	x	x	x	x	x	x	x	x	x				x				x		
Populus angustifolia	Narrowleaf Cottonwood	x	x	x	x	x	x	x	x	x	x	x					x		x	x		
Populus fremontii	Fremont Cottonwood		x	x	x	x	x	x							x	x	x	x	x	x		
Populus tremuloides	Quaking Aspen	x	x	x	x	x	x	x									x	x	x	x		
Populus trichocarpa	Black Cottonwood		x	x	x	x	x	x									x	x	x	x		
Prunus americana	American Plum	x	x	x	x	x	x	x	x	x	x	x				x	x	x				
Prunus armeniaca 'Moongold'	Moongold Apricot		x	x	x	x	x	x	x	x	x	x				x		x				
Prunus armeniaca 'Tilton'	Tilton Apricot		x	x	x	x	x	x	x	x	x	x	x	x		x		x				
Prunus cerasifera 'Krauter Vesuvius'	Krauter Vesuvius Cherry Plum				x	x	x	x	x	x	x	x	x			x		x				
Prunus cerasifera 'Pissardii'	Pissard's Cherry Plum				x	x	x	x	x	x	x	x	x	x		x		x				
Prunus laurocerasus 'Chestnut Hill'	Chestnut Hill Cherry Laurel						x	x	x	x	x	x	x	x		x		x				
Prunus maackii	Amur Chokecherry	x	x	x	x	x	x	x								x	x	x				
Prunus nigra 'Princess Kay'	Princess Kay plum			x	x	x	x	x	x	x	x	x	x	x		x		x				
Prunus padus	Bird Cherry	x	x	x	x	x	x	x								x		x	x			
Prunus persica 'Elberta'	Elberta Dwarf Peach				x	x	x	x	x	x	x	x	x	x		x		x				
Prunus persica 'Hale Haven'	Hale Haven Dwarf Peach			x	x	x	x	x	x	x	x	x				x		x				
Prunus persica var. nectarina 'Red Gold'	Red Gold Nectarine				x	x	x	x	x	x	x	x	x	x		x		x				
Prunus salicina 'Santa Rosa'	Santa Rosa Plum						x	x	x	x	x	x	x	x		x		x				

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Plants		Zones													Best Management Practices (BMPs)							
Trees		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Basin Upland	Swales	Strips	Bioretention Cells/ Rain Gardens	Tree Box Filters	Green Roofs
Prunus virginiana	Chokecherry	x	x	x	x	x	x	x	x	x						x	x	x	x	x		
Prunus virginiana 'Scubert'	Canada Red Chokecherry	x	x	x	x	x	x	x	x	x						x		x		x		
Prunus x blireana	Blireana Plum			x	x	x	x	x	x	x	x	x				x		x				
Prunus x cerasifera 'Cripoizam'	Crimson Pointe Flowering Plum		x	x	x	x	x	x	x	x	x	x	x	x		x		x				
Pyrus calleryana 'Chanticleer'	Chanticleer Flowering Pear				x	x	x	x	x	x	x	x	x	x					x			
Quercus alba	White Oak	x		x	x	x	x	x	x	x	x	x	x	x			x					
Quercus bicolor	Swamp White Oak	x	x	x	x	x	x	x	x	x	x	x				x	x	x	x	x		
Quercus gambelii	Gambel Oak		x	x	x	x	x	x	x	x	x	x			x	x	x	x				
Quercus imbricaria	Shingle Oak																x					
Quercus macrocarpa	Bur Oak	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x		x		
Quercus muehlenbergii	Chinkapin Oak				x	x	x	x	x	x							x					
Quercus palustris	Pin Oak		x	x	x	x	x	x	x	x	x	x				x	x					
Quercus prinoides	Dwarf Chinkapin Oak	x	x	x	x	x	x	x	x	x	x	x					x					
Quercus robur	English Oak				x	x	x	x	x	x	x	x					x	x				
Quercus robur f. fastigiata	Columnar English Oak				x	x	x	x	x	x	x	x					x	x	x			
Quercus rubra	Northern Red Oak				x	x	x	x	x	x	x	x					x	x	x			
Quercus undulata	Wavyleaf Oak				x	x	x	x	x	x	x	x					x	x				
Quercus 'Clemson' HERITAGE	Heritage Oak		x	x	x	x	x	x	x	x	x						x	x				
Robinia 'Purple Robe'	Purple Robe Locust	x	x	x	x	x	x	x	x	x	x	x							x	x		
Salix alba	White Willow		x	x	x	x											x	x		x		
Salix amygdaloides	Peachleaf Willow		x	x	x	x											x	x	x	x		
Salix lasiandra	Pacific Willow	x	x	x												x	x	x		x		
Salix nigra	Black Willow	x	x	x	x	x											x	x		x		
Salix sitchensis	Sitka Willow		x	x	x												x	x		x		
Salix prolixa	Mackenzie Willow		x	x	x	x											x	x		x		
Sambucus coerulea	Blue Elderberry		x	x	x	x	x	x									x	x		x		
Sambucus racemosa 'SMNSRD4' LEMONY LACE	Lemony Lace Elderberry	x	x	x	x	x	x	x	x	x										x		
Sambucus racemosa 'Sutherland Gold'	Sutherland Gold Elderrberry	x	x	x	x	x	x	x	x	x	x	x								x		
Shepherdia argentea	Silver Buffaloberry	x	x	x	x	x	x	x									x			x		
Sophora japonica 'Halka'	Millstone Japanese Pagoda Tree				x	x	x	x	x	x	x	x							x			
Sophora japonica 'Regent'	Regent Japanese Pagodatree				x	x	x	x	x	x	x								x			
Sorbus aucuparia	European Mountain Ash	x	x	x	x	x	x	x									x					
Syringa reticulata 'Ivory Silk'	Ivory Silk Tree Lilac	x	x	x	x	x	x	x	x	x									x			
Syringa vulgaris 'Sensation'	Sensation Lilac	x	x	x	x	x	x	x	x	x										x		
Taxodium distichum	Bald Cypress		x	x	x	x	x	x	x	x	x	x	x	x						x	x	
Taxodium distichum 'Shawnee Brave'	Shawnee Brave Bald Cypress		x	x	x	x	x	x	x	x	x	x	x	x					x	x	x	
Tilia americanna	American Linden	x	x	x	x	x	x	x	x	x	x	x					x					
Tilia cordata 'Greesnspire'	Greenspire Linden		x	x	x	x	x	x	x	x	x	x					x		x			
Tilia tomentosa	Silver Linden		x	x	x	x	x	x	x	x	x	x							x	x		
Tilia tomentosa 'Sterling'	Sterling Silver Linden		x	x	x	x	x	x	x	x	x								x	x		
Ulmaus parvifolia 'Emer II' ALLEE	Allee Lacebark Elm		x	x	x	x	x	x	x	x	x	x	x	x					x			x
Ulmus pumila	Siberian Elm		x	x	x	x	x	x	x	x	x	x	x	x			x	x		x		x
Ulmus x 'Morton' ACCOLADE	Accolade Elm			x	x	x	x	x	x	x	x	x	x	x					x			
Ulmus 'Frontier'	Frontier Elm				x	x	x	x	x	x	x	x	x	x					x			
Ulmus 'Homestead'	Homestead Elm	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x		
Zelkova serrata	Japanese Zelkova				x	x	x	x	x	x	x	x							x			
Zelkova serrata 'Green Vase'	Green Vase Zelkova				x	x	x	x	x	x	x	x	x						x			
Zelkova serrata 'Kiwi Sunset'	Kiwi Sunset Zelkova				x	x	x	x	x	x	x	x							x			
Zelkova serrata 'Village Green'	Village Green Zelkova				x	x	x	x	x	x	x	x							x			
Conifers																						
Cedrus libani 'Beacon Hill'	Beacon Hill Cedar of Lebanon						x	x	x	x							x					
Juniperus osteosperma	Utah Juniper	x	x	x	x	x	x	x	x	x							x	x	x			x
Juniperus scopulorum 'Blue Arrow'	Blue Arrow Juniper		x	x	x	x	x	x	x	x	x	x	x	x			x	x		x		x
Juniperus scopulorum 'Skyrocket'	Skyrocket Juniper	x	x	x	x	x	x	x	x	x	x	x					x	x		x		x
Juniperus scopulorum 'Woodward'	Woodward columnar juniper	x	x	x	x	x	x	x	x	x	x	x	x	x			x			x		x
Juniperus virginiana 'Blue Arrow'	Blue Arrow Eastern Red Cedar		x	x	x	x	x	x	x	x	x	x	x	x			x	x				x
Juniperus virginiana 'Hillspire'	Hillspire Eastern Red Cedar	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x				x
Picea pungens	Colorado Spruce	x	x	x	x	x	x	x	x	x	x	x					x	x				
Picea pungens 'Baby Blue Eyes'	Baby Blue Eyes Spruce	x	x	x	x	x	x	x	x	x							x					
Picea pungens 'Hoopsii'	Hoop's Blue Spruce	x	x	x	x	x	x	x	x	x							x					
Picea pungens 'Iseli Fastigiate'	Iseli Fastigiate Spruce	x	x	x	x	x	x	x	x	x	x	x					x					

Plants		Zones													Best Management Practices (BMPs)							
Trees		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Basin Upland	Swales	Strips	Bioretention Cells/ Rain Gardens	Tree Box Filters	Green Roofs
Picea pungens 'Mesa Verde'	Mesa Verde Spruce	x	x	x	x	x	x	x	x	x	x	x					x					
Picea pungens 'The Blues'	The Blues Blue Spruce																x					
Picea pungens var. glauca 'MonWal'	Sparkler Colorado Blue Spruce	x	x	x	x	x	x	x	x	x	x	x					x					
Pinus mugo	Mugo Pine	x	x	x	x	x	x	x	x	x							x	x		x		x
Pinus mugo fastigiata 'Wells Dolly's Choice'	Wells Dolly's Choice Mugo Pine	x	x	x	x	x	x	x	x	x										x		
Pinus mugo 'Carsten's Wintergold'	Carsten's Wintergold Mugo Pine	x	x	x	x	x	x	x	x	x							x	x		x		x
Pinus mugo 'Jakobsen'	Pinus mugo 'Jakobsen'	x	x	x	x	x	x	x	x	x							x	x		x		x
Pinus nigra	Austrian Pine				x	x	x	x	x	x	x	x					x			x		
Pinus nigra 'Arnold Sentinel'	Arnold Sentinel Austrian Pine		x	x	x	x	x	x	x	x	x	x								x		
Pinus ponderosa	Ponderosa Pine	x	x	x	x	x	x	x	x	x							x	x		x		
Pinus strobus 'Blue Shag'	Blue Shag Eastern White Pine		x	x	x	x	x	x	x	x	x	x					x	x				
Pinus sylvestris	Scots Pine	x	x	x	x	x	x	x	x	x	x	x								x		
Pseudotsuga menziesii	Douglas Fir		x	x	x	x	x	x									x					
Thuja occidentalis	American Arbovitae	x	x	x	x	x	x	x	x	x					x	x	x	x	x	x	x	
Thuja occidentalis 'Hetz Midget'	Hetz Midget Arborvitae	x	x	x	x	x	x	x	x	x					x	x	x			x		

Plant Select, 2018; Conservation Garden Park, 2018; Charter Township of Canton, 2006; USDA-Natural Resources Conservation Service, 2000; Missouri Botanical Garden, 2018;

Plants For A Future, 2018; Monrovia, 2018; Growing Green Guide, 2018; Central Coast Low Impact Development Initiative; San Francisco Water Power Sewer, 2016

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Plants		Zones													Best Management Practices (BMPs)							
Shrubs		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Basin Upland	Swales	Strips	Bioretention Cells/ Rain Gardens	Tree Box Filters	Green Roofs
Alnus rugosa	Speckled Alder	x	x	x	x	x	x	x								x						
Amelanchier alnifolia	Saskatoon Serviceberry	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x		x		
Amelanchier alnifolia 'Obelisk'	Standing Ovation Serviceberry	x	x	x	x	x	x	x	x	x	x	x						x		x		
Arctostaphylos x coloradensis	Panchito Manzanita			x	x	x	x	x	x	x	x	x				x						
Arctostaphylos x coloradensis 'Chieftain'	Chieftain Manzanita				x	x	x	x	x	x	x	x				x						
Aronia arbutifolia 'Brilliantissima'	Brilliant Red Chokeberry		x	x	x	x	x	x	x	x	x	x	x	x						x	x	
Aronia melanocarpa var. elata	Black Chokeberry		x	x	x	x	x	x	x	x	x	x	x	x		x				x	x	
Artemisia filifolia	Sand Sagebrush		x	x	x	x	x	x	x	x	x	x								x		
Artemisia nova	Black Sagebrush	x	x	x	x	x	x	x												x		
Atriplex canescens	Four-Wing Saltbrush						x	x	x	x	x	x	x	x			x	x		x		
Baccharis pilularis	Coyote Brush										x	x	x	x		x	x		x			
Berberis aquifolium	Barberry				x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	
Berberis aquifolium repens	Creeping Oregon Grape				x	x	x	x	x	x	x	x			x	x		x	x	x	x	
Berberis thunbergii f. atropurpurea	Japanese Barberry		x	x	x	x	x	x	x	x	x	x				x		x	x			
Berberis thunbergii f. atropururea 'Atropurpurea Nana'	Crimson Pygmy Japanese Barberry		x	x	x	x	x	x	x	x	x	x						x	x			
Berberis thunbergii f. atropurpurea 'Golden Ring'	Golden Ring Japanese Barberry		x	x	x	x	x	x	x	x	x	x	x	x				x	x			
Berberis thunbergii f. atropurpurea 'Helmond Pillar'	Helmond Pillar Japanese Barberry		x	x	x	x	x	x	x	x	x	x						x	x			
Berberis thunbergii f. atropurpurea 'Rose Glow'	Rose Glow Japanese Barberry		x	x	x	x	x	x	x	x	x	x						x	x			
Berberis thunbergii 'Goruzam'	Golden Ruby Barberry		x	x	x	x	x	x	x	x	x	x						x	x			
Berberis thunbergii 'Maria'	Sunjoy Gold Pillar Japanese Barberry		x	x	x	x	x	x	x	x	x	x						x	x			
Berberis thunbergii 'Orange Rocket'	Orange Rocket Barberry		x	x	x	x	x	x	x	x	x	x	x	x				x	x			
Berberis thunbergii 'Pygruzam'	Pygmy Ruby Japanese Barberry		x	x	x	x	x	x	x	x	x	x						x	x			
Betula pumila	Bog Birch	x	x	x	x	x	x	x	x	x	x	x	x	x		x						
Buxus microphylla 'Golden Triumph'	Golden Triumph Boxwood				x	x	x	x	x	x	x	x	x	x								x
Buxus microphylla 'Green Gem'	Boxwood 'Green Gem'		x	x	x	x	x	x	x	x	x	x	x	x								x
Callistemon 'Little John'	Little John Dwarf Bottlebrush										x	x	x	x			x		x			x
Caragana arborescens	Siberian Peashrub	x	x	x	x	x	x	x	x	x	x	x					x	x		x		x
Caragana arborescens 'Pendula'	Weeping Pea Shrub	x	x	x	x	x											x	x		x		x
Caragana frutex 'Globosa'	Globe Peashrub	x	x	x	x	x	x	x	x	x	x	x								x		
Caryopteris x clandonensis 'Dark Knight'	Dark Knight Bluebeard						x	x	x	x	x	x	x	x						x		
Caryopteris x clandonensis 'Heavenly Blue'	Heavenly Blue Bluebeard				x	x	x	x	x	x	x	x	x	x						x		
Caryopteris x clandonensis 'Korball'	Blue Balloon Caryopteris				x	x	x	x	x	x	x	x	x	x						x		
Caryopteris x clandonensis 'Janice'	Lil Miss Sunshine Bluebeard				x	x	x	x	x	x	x	x	x	x						x		
Caryopteris x clandonensis 'MiniBleu'	Petit Bleu Bluebeard				x	x	x	x	x	x	x	x	x	x						x		
Ceanothus americanus	New Jersey Tea		x	x	x	x	x	x	x	x	x	x				x	x					
Celtis occidentalis	Common Hackberry		x	x	x	x	x	x	x	x	x	x	x	x					x	x	x	
Cephalanthus occidentalis	Buttonbush				x	x	x	x	x	x	x	x	x	x	x	x		x		x		
Chrysothamnus (Ericameria) nauseosus var. nauseosus	Baby Blue Rabbitbrush		x	x	x	x	x	x	x	x	x	x	x	x						x		
Cornus alba 'Cream Cracker'	Cornus alba 'Cream Cracker'	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x		x		
Cornus alba 'Elegantissima'	Variegated Red Twig Dogwood	x	x	x	x	x	x	x	x	x	x	x					x	x		x		
Cornus amomum	Silky Dogwood				x	x	x	x	x	x	x	x				x						
Cornus foemina	Gray Dogwood										x	x	x	x			x					
Cornus sanguinea 'Midwinter Fire'	Midwinter Fire Dogwood				x	x	x	x	x	x							x	x		x	x	
Cornus sericea	Red Twig Dogwood	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x		x	x	
Cornus sericea 'Baileyi'	Bailey Red Twig Dogwood	x	x	x	x	x	x	x	x	x	x	x					x	x		x	x	
Cornus sericea 'Budd's Yellow'	Budd's Yellow Dogwood	x	x	x	x	x	x	x	x	x							x	x		x	x	
Cornus sericea 'Cardinal'	Cardinal Red Twig Dogwood	x	x	x	x	x	x	x	x	x	x	x					x	x		x	x	
Cornus sericea 'Farrow'	Artic Fire Dogwood	x	x	x	x	x	x	x	x	x							x	x		x	x	
Cornus sericea 'Flaviramea'	Yellow Twig Dogwood	x	x	x	x	x	x	x	x	x	x	x					x	x		x	x	
Cornus sericea 'Isanti'	Isanti Red Twig Dogwood	x	x	x	x	x	x	x	x	x	x	x					x	x		x	x	
Cornus sericea 'Kelseyi'	Kelsey's Dwarf Red Twig Dogwood	x	x	x	x	x	x	x	x	x	x	x					x	x		x	x	
Cornus stolonifera 'Neil Z' PUCKER UP	Pucker Up Red Twig Dogwood	x	x	x	x	x	x	x	x	x	x	x				x		x		x	x	
Corylus americana	American Filbert		x	x	x	x	x	x	x	x	x	x	x	x			x					
Cotinus coggygria 'Ancot' GOLDEN SPIRIT	Smoke Tree, 'Golden spirit'			x	x	x	x	x	x	x								x	x	x		
Cotoneaster adpressus 'Little Gem'	Little Gem Cotoneaster				x	x	x	x	x	x	x	x								x		
Cotoneaster apiculatus	Cranberry Cotoneaster				x	x	x	x	x	x	x	x								x		
Cotoneaster divaricatus	Spreading Cotoneaster		x	x	x	x	x	x	x	x										x		
Cotoneaster integerrimus	European Cotoneaster	x	x	x	x	x											x	x		x		
Cotoneaster racemiflorus var. soongoricus	Sungari redbead cotoneaster	x	x	x	x	x	x	x	x	x	x	x								x		
Cotoneaster x suecicus 'Coral Beauty'	Coral Beauty Cotoneaster			x	x	x	x	x	x	x										x		
Fallugia paradoxa	Apache Plume		x	x	x	x	x	x	x	x	x	x								x		
Forestiera neomexicana	New Mexico Privet		x	x	x	x	x	x	x	x	x	x	x	x						x		
Forsythia x 'Meadlowlark"	Meadowlark Forsythia	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x				
Hamamelis virginiana	Witch Hazel	x	x	x	x	x	x	x	x	x	x	x					x					
Helianthemum 'Ben Ledi'	Ben Ledi Sun Rose		x	x	x	x	x	x	x	x	x	x	x	x						x		

Plants		Zones													Best Management Practices (BMPs)							
Shrubs		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Basin Upland	Swales	Strips	Bioretention Cells/ Rain Gardens	Tree Box Filters	Green Roofs
Helianthemum 'Ben More'	Ben More Sun Rose				x	x	x	x	x	x	x	x	x	x						x		
Helianthemum 'Cheviot'	Cheviot Sun Rose		x	x	x	x	x	x	x	x	x	x	x	x						x		
Helianthemum 'Dazzler'	Dazzler Sun Rose		x	x	x	x	x	x	x	x	x	x	x	x						x		
Helianthemum 'Henfield Brilliant'	Henfield Brilliant Sun Rose		x	x	x	x	x	x	x	x	x	x	x	x						x		
Helianthemum 'Raspberry Ripple'	Raspberry Ripple Sun Rose		x	x	x	x	x	x	x	x	x	x	x	x						x		
Helianthemum 'Rhodanthe Carneum'	Rhodanthe Carneum Sun Rose		x	x	x	x	x	x	x	x	x	x	x	x						x		
Helianthemum 'St. Mary's'	St Mary's Sun Rose		x	x	x	x	x	x	x	x	x	x	x	x						x		
Helianthemum 'Wisley Primrose'	Wisley Primrose Sun Rose		x	x	x	x	x	x	x	x	x	x	x	x						x		
Holodiscus discolor	Oceanspray				x	x	x	x	x	x	x	x	x	x		x			x			
Ilex verticillata	Winterberry (Michigan Holly)	x	x	x	x	x	x	x	x	x	x	x	x	x		x						
Juniperus chinensis 'Daub's Frosted'	Daub's Frosted Juniper		x	x	x	x	x	x	x	x	x	x	x	x								x
Juniperus chinensis 'Kaizuka'	Kaizuka Juniper				x	x	x	x	x	x	x	x	x	x								x
Juniperus chinensis 'Spearmint'	Spearmint Juniper	x	x	x	x	x	x	x	x	x	x	x	x	x								x
Juniperus communis	Common Juniper	x	x	x	x	x	x	x														x
Juniperus communis 'Repanda'	Juniperus communis 'Repanda'	x	x	x	x	x	x	x	x	x	x	x	x	x								x
Juniperus horizontalis 'Bar Harbor'	Bar Harbor Juniper	x	x	x	x	x	x	x	x	x	x	x	x	x								x
Juniperus horizontalis 'Blue Chip'	Blue Chip Juniper	x	x	x	x	x	x	x	x	x	x	x	x	x								x
Juniperus horizontalis 'Hughes'	Hughes Juniper	x	x	x	x	x	x	x	x	x	x	x	x	x								x
Juniperus horizontalis 'Monber'	Icee Blue Juniper	x	x	x	x	x	x	x	x	x	x	x	x	x								x
Juniperus horizontalis 'Wiltonii'	Blue Rug Juniper	x	x	x	x	x	x	x	x	x	x	x	x	x								x
Juniperus osteosperma	Utah Juniper	x	x	x	x	x	x	x	x	x												x
Juniperus sabina 'Buffalo'	Buffalo Juniper	x	x	x	x	x	x	x	x	x	x	x										x
Juniperus sabina 'Skandia'	Skandia Juniper		x	x	x	x	x	x	x	x												x
Juniperus scopulorum	Rocky Mountain Juniper		x	x	x	x	x	x	x	x	x	x	x	x								x
Juniperus scopulorum 'Gray Gleam'	Gray Gleam Juniper		x	x	x	x	x	x	x	x												x
Juniperus scopulorum 'Skyrocket'	Skyrocket Juniper	x	x	x	x	x	x	x	x	x	x	x										x
Juniperus scopulorum 'Tabletop'	Tabletop Juniper	x	x	x	x	x	x	x	x	x												x
Juniperus x pfitzeriana 'Monsan'	Sea of Gold Juniper	x	x	x	x	x	x	x	x	x	x	x	x	x								x
Juniperus × pfitzeriana 'Sea Green'	Sea Green Juniper	x	x	x	x	x	x	x	x	x	x	x	x	x								x
Lindera benzoin	Spicebush		x	x	x	x	x	x	x	x	x	x	x	x			x					
Lonicera korolkowii 'Floribunda'	BLUE VELVET® honeysuckle	x	x	x	x	x	x	x	x	x	x	x					x	x				
Lonicera maackii	Amur Honeysuckle	x	x	x	x	x	x	x	x	x	x	x					x	x				
Lonicera nitida 'Lemon Beauty'	Lemon Beauty Box Honeysuckle								x	x	x	x	x	x								x
Lonicera periclymenum 'Winchester'	Winchester Honeysuckle				x	x	x	x	x	x	x	x	x	x								x
Lonicera x brownii 'Dropmore Scarlet'	Dropmore Scarlet Trumpet Honeysuckle		x	x	x	x	x	x	x	x	x	x	x	x								x
Mahonia aquifolium 'Compacta'	Dwarf Oregon Grape		x	x	x	x	x	x	x	x	x	x	x	x				x	x	x		
Mahonia repens	Creeping Mahonia, Oregon Grape				x	x	x	x	x	x	x	x						x	x	x		
Maireana sedifolia	Pearl Bluebush										x	x	x	x								x
Nandina domestica 'Nana'	Nandina						x	x	x	x	x	x	x	x			x		x			x
Pentaphylloides floribunda	Shrubby Cinquefoil				x	x	x	x									x	x		x		
Philadelphus coronarius 'Aureus'	Golden Mock Orange				x	x	x	x	x	x	x	x	x	x	x	x		x		x		
Philadelphus lewisii 'Blizzard'	Blizzard Mock Orange	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x		
Philadelphus lewisii 'Cheyenne'	Cheyenne Mock Orange	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x		
Philadelphus lewisii 'PWY01S'	CHEYENNE® mock orange	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
Physocarpus opulifolius	Nine Bark	x	x	x	x	x	x	x	x	x	x	x					x					
Physocarpus opulifolius 'Amber Jubilee'	Amber Jubilee Ninebark	x	x	x	x	x	x	x	x	x	x	x					x					x
Physocarpus opulifolius 'Dart's Gold'	Dart's Gold Ninebark	x	x	x	x	x	x	x	x	x							x					x
Physocarpus opulifolius 'Diabolo'	Diabolo Ninebark	x	x	x	x	x	x	x	x	x							x					x
Physocarpus opulifolius 'Nanus'	Dwarf Ninebark	x	x	x	x	x	x	x	x	x	x	x	x	x			x					x
Physocarpus opulifolius 'Nugget'	Nugget Ninebark	x	x	x	x	x	x	x	x	x	x	x					x					x
Physocarpus opulifolius 'Seward'	Summer Wine Ninebark	x	x	x	x	x	x	x	x	x	x	x					x					x
Physocarpus opulifolius 'POIPD2'	Petite Plum Ninebark	x	x	x	x	x	x	x	x	x	x	x					x					x
Physocarpus opulifolius 'SMPOTW'	Tiny Wine Ninebark	x	x	x	x	x	x	x	x	x	x	x					x					x
Pinus mugo	Mugo Pine	x	x	x	x	x	x	x	x	x										x		
Pinus mugo 'Big Tuna'	Big Tuna Mugo Pine	x	x	x	x	x	x	x	x	x										x		
Pinus mugo 'Mops'	Mops Mugo Pine	x	x	x	x	x	x	x	x	x										x		
Pinus mugo 'Slowmound'	Slowmound Mugo Pine	x	x	x	x	x	x	x	x	x										x		
Pittosporum tobira	Mock Orang												x	x		x	x		x			x
Potentilla fruticosa 'Gold Drop'	Gold Drop Shrubby Cinquefoil	x	x	x	x	x	x	x	x	x						x	x			x		
Potentilla fruticosa 'Goldfinger'	Goldfinger Shrubby Cinquefoil	x	x	x	x	x	x	x	x	x						x	x			x		x
Potentilla fruticosa 'McKay's White'	McKay's White Shrubby Cinquefoil	x	x	x	x	x	x	x	x	x						x	x			x		
Potentilla fruticosa 'Monsidh'	Frosty Shrubby Cinquefoil	x	x	x	x	x	x	x	x	x						x	x			x		
Prunus besseyi	Western Sand Cherry		x	x	x	x	x	x	x	x	x	x				x	x					
Prunus besseyi 'Pawnee Buttes'	Pawnee Buttes Western Sand Cherry		x	x	x	x	x	x	x	x	x	x				x	x					
Prunus besseyi 'P011S'	PAWNEE BUTTES® sand cherry	x	x	x	x	x	x	x	x	x	x	x				x	x					

Attachment: DWQ-2019-000161 (Section 13.94.040 Storm Water System Design and Management Standards)

Plants		Zones													Best Management Practices (BMPs)							
Shrubs		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Basin Upland	Swales	Strips	Bioretention Cells/ Rain Gardens	Tree Box Filters	Green Roofs
Prunus glandulosa 'Sinensis'	Dwarf Flowering Almond				x	x	x	x	x	x	x	x				x	x					
Prunus virginiana	Chokecherry	x	x	x	x	x	x	x								x	x	x				x
Prunus x cistena	Purple-Leaf Sand Cherry	x	x	x	x	x	x	x	x	x	x	x				x	x					
Purshia tridentata	Antelope Bitterbrush				x	x	x	x	x	x	x	x	x	x						x		
Ribes aureum	Golden Currant	x	x	x	x	x	x	x									x	x		x		
Ribes cereum	Wax Currant		x	x	x	x														x		
Rhamnus frangula 'Columnaris'	Tallhedge Buckthorn	x	x	x	x	x	x	x	x	x	x									x		
Rhamnus frangula 'Ron Williams'	Fine Line Buckthorn	x	x	x	x	x	x	x	x	x	x									x		
Rhus aromatica	Fragrant Sumac	x	x	x	x	x	x	x	x	x	x	x	x	x			x					
Rhus aromatica 'Gro-Low'	Grow-Low Sumac	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x				x
Rhus glabra	Smooth Sumac	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x		x		
Rhus glabra 'Laciniata'	Cutleaf Smooth Sumac	x															x	x		x		
Rhus trilobata	Three-Leaf Sumac		x	x	x	x	x	x	x	x	x	x					x	x	x	x		x
Rhus trilobata 'Autumn Amber'	Autumn Amber Sumac		x	x	x	x	x	x	x	x	x	x					x	x	x	x		x
Rhus typhina 'Bailtiger'	Tiger Eyes Sumac		x	x	x	x	x	x	x	x	x	x					x	x	x			
Ribes aureum	Golden Currant	x	x	x	x	x	x	x	x	x						x	x	x	x	x		x
Ribes cereum	Wax Currant		x	x	x	x											x	x	x			
Rosa palustris	Swamp Rose		x	x	x	x	x	x	x	x	x	x	x	x		x						
Rosa woodsii	Woods' Rose		x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x		
Rosmarinus officinalis 'Arp'	Arp Rosemary						x	x	x	x	x	x	x	x								x
Rosmarinus officinalis 'Huntington Carpet'	Huntington Carpet Rosemary										x	x	x	x								x
Salix bebbiana	Bebb's Willow		x	x	x	x											x	x		x		
Salix boothii	Bebb's Willow		x	x	x	x											x	x		x		
Salix drummondiana	Drummond Willow	x	x	x													x	x		x		
Salix exigua	Coyote Willow	x	x	x													x	x		x		
Salix geyeriana	Geyer Willow	x	x	x													x	x		x		
Salix lemmonii	Lemmon Willow	x	x	x													x	x		x		
Salix lutea	Yellow Willow	x	x	x													x	x		x		
Salix planifolia	Planeleaf Willow	x	x	x													x	x		x		
Salix scouleriana	Scouler Willow		x	x	x	x	x	x									x	x		x		
Salvia clevelandii	Cleveland Sage								x	x						x	x		x			
Salvia leucophylla	Purple Sage						x	x	x	x	x	x	x	x		x	x		x			
Salvia spathacea	Hummingbird Sage										x	x	x	x		x	x		x			
Sambucus canadensis	Elderberry	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x					
Sambucus mexicana	Western Elderberyy						x	x	x	x	x	x	x	x		x	x		x			
Sambucus nigra 'EIFFEL 1'	Black Tower Elderberry		x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	
Sambucus nigra 'Eva'	Black Lace Elderberry		x	x	x	x	x	x	x	x					x	x	x	x	x	x	x	
Sambucus nigra 'Gerda' x	Black Beauty Elderberry		x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	
Sambucus nigra f. laciniata	Cutleaf Elderberry		x	x	x	x	x	x	x	x	x	x	x	x	x	x				x	x	
Shepherdia argentea	Silver Buffaloberry	x	x	x	x	x	x	x									x	x	x			x
Spirea alba	Meadowsweet	x	x	x	x	x	x	x	x	x						x	x					
Spirea x vanhouttei	Vanhoutte Spirea	x	x	x	x	x	x	x	x	x	x	x					x	x				
Symphoricarpos albus	Snowberry	x	x	x	x	x	x	x	x	x					x	x	x	x	x	x		
Symphoricarpos x chenaultii 'Hancock'	Hancock Coralberry		x	x	x	x	x	x	x	x										x		
Syringa vulgaris 'Charles Joly'	Charles Joly Lilac	x	x	x	x	x	x	x	x	x							x	x				
Syringa vulgaris 'Président Grévy'	President Grevy Lilac	x	x	x	x	x	x	x	x	x							x	x				x
Syringa vulgaris 'Sensation'	Sensation Lilac	x	x	x	x	x	x	x	x	x							x	x				
Taxus cuspidata 'Monloo' EMERALD SPREADER	Emerald Spreader Japanese Yew		x	x	x	x	x	x	x	x										x		
Viburnum dentatum	Arrowwood	x	x	x	x	x	x	x	x	x	x	x					x					
Viburnum dentatum 'Ralfph Senior' AUTUMN JAZZ	Autum Jazz Viburnum	x	x	x	x	x	x	x	x	x	x	x					x					
Viburnum lentago	Nannyberry	x	x	x	x	x	x	x	x	x	x	x	x			x						
Viburnum trilobum	American Highbush Cranberry	x	x	x	x	x	x	x	x	x						x						
Viburnum x burkwoodii	Burkwood Viburnum				x	x	x	x	x	x	x	x	x							x		

Plant Select, 2018; Conservation Garden Park, 2018; Charter Township of Canton, 2006; USDA-Natural Resources Conservation Service, 2000; Missouri Botanical Garden, 2018;

Plants For A Future, 2018; Monrovia, 2018; Growing Green Guide, 2018; Central Coast Low Impact Development Initiative; San Francisco Water Power Sewer, 2016

Plants		Zones													Best Management Practices (BMPs)							
Grasses		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Basin Upland	Swales	Strips	Bioretention Cells/ Rain Gardens	Tree Box Filters	Green Roofs
Acorus calamus	Sweet Flag		x	x	x	x	x	x	x	x	x	x	x	x		x				x		
Acorus gramineus	Grassy-Leaved Sweet Flag						x	x	x	x	x	x	x	x	x	x		x		x		
Agropyron spp.	BioNative Wheatgrass Mix		x	x	x	x	x	x	x	x							x	x	x			
Agrostis sp.	Redtop Bentgrass	x	x	x	x	x	x	x							x	x	x	x	x	x	x	
Andropogon gerardii	Big Blue Stem		x	x	x	x	x	x	x	x	x	x	x	x						x		
Andropogon gerardii 'PWIN01S'	WINDWALKER® big bluestem				x	x	x	x	x	x	x	x								x		
Bouteloua gracilis	Blue Grama	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x
Bouteloua gracilis 'Blonde Ambition'PP 22,048	Blonde Ambition grama grass		x	x	x	x	x	x	x	x	x	x	x	x				x	x	x		x
Buchloë dactyloides	Buffalo Grass	x	x	x	x	x	x	x	x	x	x	x	x	x				x	x	x		x
Buchloë dactyloides 'Cody'	Cody Buffalo Grass	x	x	x	x	x	x	x	x	x	x	x	x	x				x	x	x		x
Buchloë dactyloides 'Legacy'	Legacy Buffalo Grass	x	x	x	x	x	x	x	x	x	x	x	x	x				x	x	x	x	x
Calamagrostis x acutiflora 'Avalanche'	Avalanche Feather Reed Grass		x	x	x	x	x	x	x	x	x	x	x	x								x
Calamagrostis x acutiflora 'Eldorado'	Eldorado Feather Reed Grass		x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x
Calamagrostis x acutiflora 'Karl Foerster'	Karl Foerster Feather Reed Grass		x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x
Calamagrostis x acutiflora 'Overdam'	Overdam Feather Reed Grass				x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x
Calamagrostis brachytricha	Korean feather reed grass		x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x
Carex 'Silver Sceptre'	Silver Scepter Sedge				x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	
Carex albula	Frosty Curlse Sedge								x	x	x	x	x	x								x
Carex buchananii	Fox Red Curly Sedge			x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x
Carex dolichostachya 'Kaga Nishiki'	Gold Fountains Sedge				x	x	x	x	x	x	x	x	x	x								x
Carex elata 'Aurea'	Bowles Golden Sedge		x	x	x	x	x	x	x	x	x	x	x	x								x
Carex glauca	Blue Sedge				x	x	x	x	x	x	x	x	x	x								x
Carex lacustris	Common Lake Sedge				x	x	x	x	x	x										x		
Carex lurida	Bottlebrush Sedge	x	x	x	x	x	x	x	x	x	x	x				x						
Carex morrowii 'Aurea-variegata'	Variegated Japanese Sedge				x	x	x	x	x	x	x	x	x	x								x
Carex morrowii 'Ice Dance'	Ice Dance Japanese Sedge				x	x	x	x	x	x	x	x	x	x								x
Carex oshimensis 'Everlite' Plant Patent #28,568	EverColor Everlite Variegated Sedge				x	x	x	x	x	x	x	x	x	x								x
Carex phyllocephala 'Sparkler'	Sparkler Sedge								x	x	x	x	x	x								x
Carex siderosticha 'Banana Boat'	Banana Boat Creeping Sedge				x	x	x	x	x	x	x	x	x	x								x
Carex stricta	Common Tussock Sedge	x	x	x	x	x	x	x	x	x	x	x					x					
Carex testacea	Orange New Zealand Sedge						x	x	x	x	x	x	x	x								x
Carex vulpinoidea	Brown Fox Sedge	x	x	x	x	x	x	x	x	x						x	x					
Cephalanthus occidentalis	Buttonbush				x	x	x	x	x	x	x	x	x	x						x		
Cynodon dactylon	Bermuda Grass								x	x	x	x	x	x	x	x	x	x	x	x	x	x
Decodon verticillatus	Swamp Loosestrife	x	x	x	x	x	x	x	x	x	x	x	x	x						x		
Deschampsia cespitosa 'Northern Lights'	Northern Lights Tufted Hair Grass		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Deschampsia cespitosa var. vivipara	Tufted Hair Grass		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Elocharis palustris	Creeping Spike Rush	x	x	x	x	x	x	x	x	x	x	x			x	x		x		x	x	
Elodea canadensis	Common Waterweed		x	x	x	x	x	x	x	x	x	x	x	x						x		
Elymus canadensis	Canadian Wild Rye	x	x	x	x	x	x	x	x	x	x	x				x	x					
Eriogonum caespitosum	Mat Buckwheat		x	x	x	x	x	x	x	x	x	x	x	x						x	x	
Festuca spp.	BioMeadow Fine Fescue Mix		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Festuca arundinacea	Dwarf Tall Fescue				x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x
Festuca arundinacea 'Bolero'	BioTurf Dwarf Fescue Mix				x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x
Festuca arundinacea 'Bonsai'	Bonsai Dwarf Tall Fescue				x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x
Festuca glauca	Blue Fescue		x	x	x	x	x	x	x	x	x	x	x	x			x	x		x	x	x
Festuca glauca 'Boulder Blue'	Border Blue Fescue		x	x	x	x	x	x	x	x	x	x	x	x			x	x		x		x
Festuca glauca 'Elijah Blue'	Elijah Blue Fescue		x	x	x	x	x	x	x	x	x	x						x	x	x		x
Glyceria striata	Fowl Manna Grass	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Helictotrichon sempervirens	Blue Oat Grass		x	x	x	x	x	x	x	x	x	x	x	x				x	x	x		x
Hibiscus laevis	Halberd-Leaved Rose Mallow		x	x	x	x	x	x	x	x	x	x	x	x						x		
Imperata cylindrica 'Rubra'	Japanese Blood Grass				x	x	x	x	x	x	x	x	x	x						x	x	
Juncus effusus	Common Rush		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Koeleria macrantha 'BarKoel' TURTLETURF	Turtleturf Prairie Junegrass		x	x	x	x	x	x	x	x	x	x	x	x	x	x		x		x	x	
Lomondra longifolia 'LM300' Plant Patent #15,420	Breeze Dwarf Mat Rush										x	x	x	x								x
Miscanthus x giganteus	Giant Chinese Silver Grass		x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x		x
Miscanthus 'Purpurascens'	Flame Grass		x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x		x
Miscanthus sacchariflorus	Silver Banner Grass				x	x	x	x	x	x	x	x	x	x			x	x	x	x		x
Miscanthus sinensis 'Adagio'	Adagio Maiden Grass				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x

Attachment: DWQ-2019-000161 (Section 13.94.040 Storm Water System Design and Management Standards)

Plants		Zones													Best Management Practices (BMPs)							
Grasses		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Basin Upland	Swales	Strips	Bioretention Cells/ Rain Gardens	Tree Box Filters	Green Roofs
Miscanthus sinensis 'Cabaret'	Cabaret Japanese Silver Grass				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Miscanthus sinensis 'Gold Bar'	Gold Bar Maiden Grass				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Miscanthus sinensis 'Gracillimus'	Gracillimus Maiden Grass				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Miscanthus sinensis 'Graziella'	Graziella Maiden Grass				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Miscanthus sinensis 'Silberfeder' SILVER FEATHER	Silver Feather Maiden Grass		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Miscanthus sinensis 'Strictus'	Porcupine Grass				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Miscanthus sinensis 'varigatus'	Variegated Maiden Grass				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Miscanthus sinensis 'Punktchen' LITTLE DOT	Little Dot Maiden Grass				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Miscanthus sinensis 'Morning Light'	Morning Light Maiden Grass				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Miscanthus sinensis 'Yaku Jima'	Yaku Jima Maiden Grass				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Miscanthus sinensis 'Zebrinus'	Zebra Grass				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Muhlenbergia rigens	Deer Grass						x	x	x	x	x	x	x	x		x	x	x	x			
Nasella tenuissima	Mexican Feather Grass						x	x	x	x	x	x	x	x								x
Panicum virgatum	Switch Grass				x	x	x	x	x	x	x	x	x	x		x	x		x			
Panicum virgatum 'Dallas Blues'	Dallas Blues Switch Grass				x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	
Panicum virgatum 'Cloud Nine'	Cloud Nine Switch Grass				x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	
Panicum virgatum 'Heavy Metal'	Heavy Metal Switch Grass				x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	
Panicum virgatum 'Prairie Sky'	Prairie Sky Switch Grass		x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	
Panicum virgatum 'Rotstrahlbusch'	Red Switch Grass				x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	
Panicum virgatum 'Shenandoah'	Shenandoah Switch Grass				x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	
Panicum virgatum 'Strictum'	Upright Switch Grass		x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	
Pennisetum alopecuroides 'Little Bunny'	Little Bunny Dwarf Fountain Grass						x	x	x	x	x	x	x	x						x	x	
Pennisetum alopecuroides 'Moudry'	Black Flowering Fountain Grass				x	x	x	x	x	x	x	x	x	x						x		
Pennisetum orientale 'Karley Rose'	Karley Rose Oriental Fountain Grass				x	x	x	x	x	x	x	x								x		
Poa pratensis	BioBlue Kentucky Bluegrass Mix				x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x
Schizachyrium scoparium	Little Bluestem				x	x	x	x	x	x	x	x	x	x						x	x	x
Schizachyrium scoparium 'Blaze'	Blaze Little Bluestem		x	x	x	x	x	x	x	x	x	x	x	x						x	x	x
Schizachyrium scoparium 'MinnblueA'	Blue Heaven Little Bluestem	x	x	x	x	x	x	x	x	x	x	x	x	x								x
Schizachyrium scoparium 'Prairie Blues'	Prairie Blues Little Bluestem		x	x	x	x	x	x	x	x	x	x	x	x						x	x	x
Schizachyrium scoparium 'Standing Ovation' PP25,202	Standing Ovation little bluestem	x	x	x	x	x	x	x	x	x	x	x								x	x	x
Scirpus atrovirens	Dark Green Rush	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x					
Spartina pectinata	Prairie Cordgrass		x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	
Sporobolus airoides	Alkali Sacaton		x	x	x	x	x	x	x	x	x	x	x	x						x	x	
Sporobolus wrightii	Giant sacaton				x	x	x	x	x	x	x	x								x	x	
Sporobolus wrightii 'Windbreaker'	Windbreaker Giant Sacaton				x	x	x	x	x	x	x	x	x	x						x	x	

Plant Select, 2018; Conservation Garden Park, 2018; Charter Township of Canton, 2006; USDA-Natural Resources Conservation Service, 2000; Missouri Botanical Garden, 2018;

Plants For A Future, 2018; Monrovia, 2018; Growing Green Guide, 2018; Central Coast Low Impact Development Initiative; San Francisco Water Power Sewer, 2016

Plants		Zones													Best Management Practices (BMPs)							
Perennials		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Basin Upland	Swales	Strips	Bioretention Cells/ Rain Gardens	Tree Box Filters	Green Roofs
Achillea millefolium 'Lilac Beauty'	Lilac Beauty Yarrow	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x			x
Achillea millefolium 'Little Susie'	Little Susie Yarrow	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x			x
Achillea millefolium 'Paprika'	Paprika Yarrow	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x			x
Achillea millefolium 'Pink Grapefruit'	Pink Grapefruit Yarrow	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x			x
Agalinus tenuifolia	Slender False Foxglove	x	x	x	x	x	x	x	x	x	x	x	x	x			x					
Agastache 'Blue Fortune'	Blue Fortune Hyssop				x	x	x	x	x	x	x	x	x	x								x
Agastache 'Desert Sunrise'	Desert Sunrise Hummingbird Mint				x	x	x	x	x	x	x	x	x	x								x
Agastache 'Kudos Gold'	Kudos Gold Dwarf Hummingbird Mint				x	x	x	x	x	x	x	x	x	x								x
Agastache 'Pink Pop'	Pink Pop Hummingbird Mint				x	x	x	x	x	x	x	x	x	x								x
Agastache 'Pstessene'	CORONADO® Red hyssop				x	x	x	x	x	x	x	x	x	x								x
Agastache 'Summer Glow'	Giant Hyssop				x	x	x	x	x	x	x	x	x	x								x
Agastache aurantiaca	Orange Hummingbird Mint				x	x	x	x	x	x	x	x	x	x								x
Agastache aurantiaca 'Apricot Sprite'	Apricot Sprite Hyssop				x	x	x	x	x	x	x	x	x	x								x
Agastache aurantiaca 'Coronado'	Coronado Hummingbird Mint				x	x	x	x	x	x	x	x	x	x								x
Agastache aurantiaca 'P012S'	CORONADO® hyssop				x	x	x	x	x	x	x	x	x	x								x
Agastache cana 'Sinning' PP 13,673	SONORAN SUNSET® hyssop				x	x	x	x	x	x	x	x	x	x								x
Agastache foeniculum 'Golden Jubilee'	Golden Jubilee Hyssop		x	x	x	x	x	x	x	x	x	x										x
Agastache rupestris	Sunset hyssop			x	x	x	x	x	x	x	x	x	x	x								x
Agastache x 'Blue Boa'	Blue Boa Hummingbird Mint				x	x	x	x	x	x	x	x	x	x								x
Angelica atropurpurea	Great Angelica		x	x	x	x	x	x	x	x							x					
Aguilegia caerulea	Rocky Mountain Columbine	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x		x	x	
Aquilegia formosa	Western Columbine	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x		x	x	
Aquilegia McKana Group	McKana Hybrid Columbine	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x		x	x	
Allium schoenoprasum	Chives		x	x	x	x	x	x	x	x	x	x										x
Armeria maritima 'Bloodstone'	Bloodstone Thrift	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x		x	x	x
Armeria maritima 'Cotton Tail'	Cotton Tail Thrift	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x		x	x	x
Armeria maritima 'Düsseldorfer Stolz' DUSSELDORF PRIDE	Dusseldorf Pride Thrift	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x		x	x	x
Armeria maritima 'Rubifolia'	Red Leaf Thrift	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x		x	x	x
Armeria maritima 'Splendens'	Splendens Common Thrift	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x		x	x	x
Asarum caudatum	Wild Ginger								x	x	x	x	x	x	x	x		x		x	x	
Asclepias incarnata	Swamp Milkweed	x	x	x	x	x	x	x								x	x					
Ceratostigma plumbaginoides	Blue Plumbago				x	x	x	x	x	x	x	x	x	x								x
Coreopsis tripteris	Tall Coreopsis	x	x	x	x	x	x	x	x	x	x	x					x					
Delosperma cooperi 'Eye Candy' Patent Applied For	Eye Candy Ice Plant								x	x	x	x	x	x								x
Delosperma cooperi 'Jewel of Desert'	Jewel of Desert Ice Plant				x	x	x	x	x	x	x	x	x	x								x
Delosperma cooperi 'Jewel of the Desert Garnet'	Jewel of the Desert Garnet Icepant				x	x	x	x	x	x	x	x	x	x								x
Delosperma cooperi 'Jewel of the Desert Topaz'	Jewel of the Desert Topaz Ice Plant				x	x	x	x	x	x	x	x	x	x								x
Delosperma cooperi 'Perfect Orange' Plant Patent Applied For	Perfect Orange Ice Plant								x	x	x	x	x	x								x
Delosperma cooperi 'WOWDOY3' Plant Patent #25,600	Wheels of Wonder Orange Wonder Ice Plant				x	x	x	x	x	x	x	x	x	x								x
Delosperma cooperi 'WOWDRW5' Plant Patent #25,572	Wheels of Wonder Violet Wonder Ice Plant				x	x	x	x	x	x	x	x	x	x								x
Eupatorium maculatum	Spotted Joe-Pye Weed		x	x	x	x	x	x	x	x	x	x					x					
Eupatorium perfoliatum	Common Boneset	x	x	x	x	x	x	x	x	x	x	x				x	x					
Euphorbia rigida	Spurge								x	x	x	x	x	x			x					x
Gentiana andrewsii	Bottle Gentian	x	x	x	x	x	x	x	x	x							x					
Guara lindheimeri	Bee Blossom				x	x	x	x	x	x	x	x	x	x								x
Helenium autumnale	Sneezeweed	x	x	x	x	x	x	x	x	x	x	x				x	x					
Heuchera micrantha var. diversifolia 'Palace Purple'	Palace Purple Coral Bells		x	x	x	x	x	x	x	x	x	x	x	x		x			x			
Iris virginica shrevei	Blue Flag Iris				x	x	x	x	x	x	x	x	x	x		x	x			x		
Lavandula angustifolia	English Lavendar				x	x	x	x	x	x	x	x				x	x	x				x
Lavandula angustifolia 'Armtipp01' Plant Patent #24,827	Big Time Blue English Lavender				x	x	x	x	x	x	x	x	x	x		x	x					x
Lavandula angustifolia 'Betty's Blue'	Betty's Blue Lavender						x	x	x	x	x	x	x	x		x	x					x
Lavandula angustifolia 'Granny's Bouquet'	Granny's Bouquet Lavender		x	x	x	x	x	x	x	x	x	x				x	x	x				x
Lavandula angustifolia 'Hidecote'	Hidcote True Lavender				x	x	x	x	x	x	x	x				x	x	x				x
Lavandula angustifolia 'Lavance Purple'	Lavance Purple Lavender				x	x	x	x	x	x	x	x	x	x		x	x	x				x
Lavandula angustifolia 'Munstead'	Munstead Lavender				x	x	x	x	x	x	x	x				x	x	x				x
Lavandula angustifolia 'Thumbelina Leight'	Thumbelina Leigh English Lavender				x	x	x	x	x	x	x	x	x	x		x	x					x
Lavandula angustifolia 'Pastor's Pride'	Pastor's Pride Lavender				x	x	x	x	x	x	x	x	x	x		x	x					x
Lavandula angustifolia 'Wee One'	Wee One dwarf English lavender				x	x	x	x	x	x	x	x	x	x		x	x	x				x

Plants		Zones													Best Management Practices (BMPs)							
Perennials		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Basin Upland	Swales	Strips	Bioretention Cells/ Rain Gardens	Tree Box Filters	Green Roofs
Lavandula x ginginsii 'Goodwin Creek Gray'	Goodwin Creek Gray Lavender								x	x	x	x	x	x		x	x					x
Lavandula x intermedia 'Provence'	Provence French Lavender				x	x	x	x	x	x	x	x	x	x		x	x					x
Lobelia siphilitica	Great Blue Lobelia		x	x	x	x	x	x	x	x	x	x	x	x			x					
Ludwigia alternifolia	Seedbox		x	x	x	x	x	x	x	x	x	x				x	x					
Mimulus cardinalis	Scarlet Monkey Flower								x	x	x	x	x	x		x			x			
Mimulus ringens	Mondey Flower	x	x	x	x	x	x	x	x	x	x	x				x						
Nepeta 'Psfike' PP 18,904	LITTLE TRUDY® catmint		x	x	x	x	x	x	x	x	x	x	x	x								x
Nepeta racemosa 'Blue Wonder'	Blue Wonder Catmint															x	x					x
Nepeta x faassenii 'Junior Walker'	Junior Walker Catmint					x	x	x	x	x	x	x	x	x		x	x					x
Nepeta x faassenii 'Novanepjun' Plant Patent #23,074	Junior Walker Catmint				x	x	x	x	x	x	x	x	x	x		x	x					x
Nepeta x faassenii 'Walker's Low'	Walker's Low Catmint		x	x	x	x	x	x	x	x	x	x	x	x		x	x					x
Ocimum basilicum 'Boxwood'	Boxwood Basil												x	x								x
Ocimum basilicum 'Fino Verde'	Fino Verde Basil												x	x								x
Origanum distamnus	Dittany of Crete								x	x	x	x	x	x								x
Origanum vulgare	Oregano		x	x	x	x	x	x	x	x	x	x							x			x
Peltandra virginica	Arrow Arrum				x	x	x	x	x	x	x	x	x	x		x	x					
Penstemon 'Dark Towers'	Dark Towers Penstemon				x	x	x	x	x	x	x	x				x						
Penstemon 'Midnight Blue'	Midnight Blue Penstemon			x	x	x	x	x	x	x	x	x				x						
Penstemon x 'Coral Baby'	Coral Baby penstemon				x	x	x	x	x	x	x	x				x						
Penstemon barbatus 'Elfin Pink'	Elfin Pink Penstemon		x	x	x	x	x	x	x	x	x	x				x						
Penstemon barbatus 'Navigator'	Navigator Penstemon		x	x	x	x	x	x	x	x	x	x				x						
Penstemon digitalis 'Husker Red'	Husker Red Penstemon	x	x	x	x	x	x	x	x	x	x	x				x						
Penstemon fruticosus 'Purple Haze'	Purple Haze Penstemon				x	x	x	x	x	x	x	x				x						
Penstemon grandiflorus 'P010S'	PRAIRIE JEWEL® penstemon	x	x	x	x	x	x	x	x	x	x	x	x	x		x						
Penstemon grandiflorus 'Prairie Jewel'	Prairie Jewel Penstemon	x	x	x	x	x	x	x	x	x	x	x	x	x		x						
Penstemon heterophyllus 'Margarita BOP'	Margarita BOP Penstemon						x	x	x	x	x	x	x	x		x						
Penstemon linarioides ssp. coloradoensis 'P014S'	SILVERTON® bluemat penstemon		x	x	x	x	x	x	x	x	x	x	x	x		x						
Penstemon mensarum	Grand Mesa beardtongue	x	x	x	x	x	x	x	x	x	x	x	x	x		x						
Penstemon pseudospectabilis	Desert beardtongue				x	x	x	x	x	x	x	x	x	x		x						
Penstemon rostriflorus	Bridges' penstemon			x	x	x	x	x	x	x	x	x				x						
Penstemon x mexicali 'Carolyn's Hope' PPAF	Carolyn's Hope pink penstemon			x	x	x	x	x	x	x	x	x				x						
Penstemon x mexicali 'Pike's Peak Purple'	Pike's Peak Purple Beardtongue															x						
Penstemon x mexicali 'Psmyers'	SHADOW MOUNTAIN® penstemon			x	x	x	x	x	x	x	x	x				x						
Penstemon x mexicali 'PWIN02S'	WINDWALKER® garnet penstemon			x	x	x	x	x	x	x	x	x				x						
Penstemon x mexicali 'P007S'	PIKES PEAK PURPLE® penstemon			x	x	x	x	x	x	x	x	x				x						
Penstemon x mexicali 'P008S'	RED ROCKS® penstemon			x	x	x	x	x	x	x	x	x				x						
Physotegia virginiana	Obedient Plant	x	x	x	x	x	x	x	x	x	x	x	x	x			x					
Pontederia cordata	Pickerel Weed	x	x	x	x	x	x	x	x	x	x	x	x	x		x						
Pycnanthemum muticum	Mountain Mint		x	x	x	x	x	x	x	x							x					
Pycanthemum virginianum	Common Mountain Mint	x	x	x	x	x	x	x	x	x							x					
Rudbeckia laciniata	Wild Golden Glow	x	x	x	x	x	x	x	x	x	x	x	x	x		x						
Rosa rugosa	Pink Rugosa Rose	x	x	x	x	x	x	x	x	x	x	x	x	x								x
Rumex sanguineus ssp. sanguineus	B+B392loody Sorrel/ Red Dock						x	x	x	x	x	x	x	x								x
Sagittaria latifolia	Common Arrowhead				x	x	x	x	x	x	x	x	x	x		x	x					
Salvia microphylla x greggii 'EGGBEN001' Plant Patent #24,152	Heatwave Glitter Sage						x	x	x	x	x	x	x	x								x
Salvia microphylla x greggii 'EGGBEN003' Plant Patent #24,155	Heatwave Glimmer Sage						x	x	x	x	x	x	x	x								x
Salvia microphylla x greggii ''EGGBEN004' Plant Patent #24154	Heatwave Sparkle Sage						x	x	x	x	x	x	x	x								x
Salvia microphylla x greggii 'EGGBEN005' Plant Patent #24,151	Heatwave Blaze Sage						x	x	x	x	x	x	x	x								x
Salvia nemorosa 'Blue Marvel'	Blue Marvel Sage		x	x	x	x	x	x	x	x	x	x	x	x								x
Salvia nemorosa 'Rose Marvel' Plant Patent Applied For	Rose Marvel Salvia			x	x	x	x	x	x	x	x	x	x	x								x
Santolina virens	Green Lavender Cotton										x	x	x	x								x
Santolina virens 'Lemon Fizz'	Lemon Fizz Lavender Cotton								x	x	x	x	x	x								x
Sedum 'Cherry Tart' Plant Patent #24,603	Sunsparkler Cherry Tart Stonecrop		x	x	x	x	x	x	x	x	x	x	x	x								x
Sedum '17-03' Pink Plant Patent Applied For	Purple Crush Stonecrop		x	x	x	x	x	x	x	x	x	x	x	x								x
Sedum album chloroticum 'Baby Tears'	Baby Tears Stonecrop		x	x	x	x	x	x	x	x	x	x	x	x								x
Sedum aldolphii	Golden Sedum										x	x	x	x								x
Sedum oreganum	Oregon Stonecrop	x	x	x	x	x	x	x	x	x	x	x	x	x								x
Sedum spathulifolium	Broadleaf Stonecrop		x	x	x	x	x	x	x	x	x	x	x	x		x	x					x

Attachment: DWQ-2019-000161 (Section 13.94.040 Storm Water System Design and Management Standards)

Plants		Zones													Best Management Practices (BMPs)							
Perennials		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Basin Upland	Swales	Strips	Bioretention Cells/ Rain Gardens	Tree Box Filters	Green Roofs
Sedum spurium 'Bronze Carpet'	Bronze Carpet Stonecrop	x	x	x	x	x	x	x	x	x	x	x	x	x								x
Sedum spurium 'Schorbuser Blut'	Dragon's Blood Stonecrop	x	x	x	x	x	x	x	x	x	x	x	x	x								x
Sedum rupestre 'Variegated'	Variegated Stonecrop	x	x	x	x	x	x	x	x	x	x	x	x	x								x
Sedum x cremnosedum 'Little Gem'	Little Gem Stonecrop										x	x	x	x								x
Sidalcea 'Party Girl'	Party Girl Prairie Mallow				x	x	x	x	x	x						x	x		x			
Silphium perfoliatum	Cup Plant	x	x	x	x	x	x	x	x	x	x	x	x	x			x					
Sisyrinchium 'Devon Skies'	Devon Skies Blue-Eyed Grass								x	x	x	x	x	x								x
Sisyrinchium angustifolium 'Lucerne'	Lucerne Blue-Eyed Grass				x	x	x	x	x	x	x	x	x	x								x
Solidago rugosa 'Fireworks'	Fireworks Goldenrod		x	x	x	x	x	x	x	x	x	x	x	x			x					
Stachys byzantina 'Helen von Stein'	Helen von Stein Lamb's Ear		x	x	x	x	x	x	x	x	x	x				x	x		x			
Stachys byzantina 'Primrose Heron'	Primrose Heron Lambs Ear		x	x	x	x	x	x	x	x	x	x				x	x		x			
Symphyotrichum novae-angliae	New England Aster		x	x	x	x	x	x	x	x	x	x					x					
Symphyotrichum puniceum	Swamp Aster	x	x	x	x	x	x	x	x	x	x	x	x	x			x					
Thymus argenteus 'Hi Ho Silver'	Hi Ho Silver Thyme				x	x	x	x	x	x	x	x	x	x								x
Thymus pseudolanuginosus	Woolly Thyme				x	x	x	x	x	x	x	x				x	x		x			x
Thymus serpyllum	Creeping Thyme					X	X	X	X	X	X	X	X	X								x
Thymus serpyllum 'Elfin'	Elfin Thyme					X	X	X	X	X	X	X	X	X								x
Thymus serpyllum 'Pink Chintz'	Pink Chintz Thyme				X	X	X	X	X	X	X	X	X	X								x
Thymus vulgaris	English Thyme				x	x	x	x	x	x	x	x	x	x								x
Typha latifolia	Broadleaf Cattail	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x		x		
Verbena hastata	Blue Verain	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	
Vernonia fasciculata	Common Ironweed		x	x	x	x	x	x	x	x	x	x	x	x		x	x					
Zizia aurea	Golden Alexander	x	x	x	x	x	x	x	x	x	x	x					x					

Plant Select, 2018; Conservation Garden Park, 2018; Charter Township of Canton, 2006; USDA-Natural Resources Conservation Service, 2000; Missouri Botanical Garden, 2018;

Plants For A Future, 2018; Monrovia, 2018; Growing Green Guide, 2018; Central Coast Low Impact Development Initiative; San Francisco Water Power Sewer, 2016

Plants		Zones													Best Management Practices (BMPs)							
Groundcovers		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Basin Upland	Swales	Strips	Bioretention Cells/ Rain Gardens	Tree Box Filters	Green Roofs
Ajuga x 'Toffe Chip' Plant Patent # 18,805	**Toffe Chip Carpet Bugle**		x	x	x	x	x	x	x	x	x	x	x	x								x
Campanula 'Samantha'	Samantha Bellflower				x	x	x	x	x	x	x	x	x	x								x
Diachondra repens	Diochondra								x	x	x	x	x	x	x	x		x		x	x	x
Delosperma 'Strong Red'	Strong Red Ice Plant								x	x	x	x	x	x								x
Delosperma coperi 'Jewel of Desert Garnet' Plant Patent #23, 471	Jewel of Desert Garnet Ice Plant				x	x	x	x	x	x	x	x	x	x								x
Delosperma coperi 'Jewel of Desert Moonstonet' Plant Patent #23, 49	Jewel of Desert Moonstone Ice Plant				x	x	x	x	x	x	x	x	x	x								x
Juniperus horizontalis 'Bar Harbor'	Bar Harbor Juniper	x	x	x	x	x	x	x	x	x	x	x								x		x
Juniperus horizontalis 'Hughes'	Hughes Juniper	x	x	x		x	x	x	x	x	x	x	x	x						x		x
Juniperus horizontalis 'Plumosa Compacta'	Compact Plumosa Juniper	x	x	x	x	x	x	x	x	x	x	x	x	x								x
Juniperus horizontalis 'Prince of Wales'	Prince of Wales Juniper	x	x	x	x	x	x	x	x	x	x	x	x	x								x
Juniperus horizontalis 'Youngstown'	Youngstown Andorra Juniper	x	x	x	x	x	x	x	x	x	x	x	x	x								x
Juniperus sabina 'Buffalo'	Buffalo Juniper	x	x	x	x	x	x	x	x	x	x	x										x
Juniperus sabina 'Skandia'	Skandia Juniper		x	x	x	x	x	x	x	x												x
Nepeta racemosa 'Walker's Low'	Walker's Low Catmint		x	x	x	x	x	x	x	x	x	x	x	x						x	x	
Nepeta sibirica 'Souvenir d' André Chaudron'	Souvenir d Andre Chaudron Catmint	x	x	x	x	x	x	x	x	x	x	x	x	x						x	x	x
Nepeta x faassenii 'Select Blue'	Select Blue Catmint		x	x	x	x	x	x	x	x	x	x	x	x						x	x	
Nepeta 'Psfike'	Little Trudy Catmint		x	x	x	x	x	x	x	x	x	x	x	x						x	x	
Teucrium chamaedrys 'Prostratum'	Compact Creeping Germander				x	x	x	x	x	x	x	x	x	x						x		
Veronica armeria	Thyme-leaf Speedwell		x	x	x	x	x	x	x	x	x	x	x	x						x		x
Veronica liwanensis	Turkish veronica	x	x	x	x	x	x	x	x	x	x	x	x	x						x		x
Veronica 'Reavis'	CRYSTAL RIVER® veronica	x	x	x	x	x	x	x	x	x										x		
Veronica x 'P018S'	SNOWMASS® blue-eyed veronica	x	x	x	x	x	x	x	x	x	x	x	x	x						x		

Plant Select, 2018; Conservation Garden Park, 2018; Charter Township of Canton, 2006; USDA-Natural Resources Conservation Service, 2000; Missouri Botanical Garden, 2018;

Plants For A Future, 2018; Monrovia, 2018; Growing Green Guide, 2018; Central Coast Low Impact Development Initiative; San Francisco Water Power Sewer, 2016

Plants		Zones													Best Management Practices (BMPs)							
Vines		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Basin Upland	Swales	Strips	Bioretention Cells/ Rain Gardens	Tree Box Filters	Green Roofs
Aristolochia californica	Pipe Vine										x	x	x	x		x		x				
Campsis radicans f. flava	Yellow Trumpetvine				x	x	x	x	x	x	x	x	x	x						x		
Clematis ligusticifolia	Western White Clematis				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
Vitis labrusca 'Concord'	Concord Grape				x	x	x	x	x	x	x	x					x	x	x	x		
Vistis labrusca 'Niagara'	Niagara Grape				x	x	x	x	x	x	x	x					x	x	x	x		
Vitis labrusca 'Niagara'	Niagara Grape				x	x	x	x	x	x	x	x					x	x	x	x		
Vitis 'Himrod'	Himrod Grape				x	x	x	x	x	x	x	x					x	x	x	x		
Vistis 'St. Theresa'	St. Theresa Grape				x	x	x	x	x	x	x	x					x	x	x	x		
Vitis x 'St. Theresa Seedless'	St. Theresa seedless grape		x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x		

Plant Select, 2018; Conservation Garden Park, 2018; Charter Township of Canton, 2006; USDA-Natural Resources Conservation Service, 2000; Missouri Botanical Garden, 2018;

Plants For A Future, 2018; Monrovia, 2018; Growing Green Guide, 2018; Central Coast Low Impact Development Initiative; San Francisco Water Power Sewer, 2016

Plants		Zones													Best Management Practices (BMPs)							
Cacti & Succulents		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Basin Upland	Swales	Strips	Bioretention Cells/ Rain Gardens	Tree Box Filters	Green Roofs
Aloe 'Carmine'	Retro Succulents Carmine Aloe												x	x								x
Aloe 'Donnie'	Retro Succulents Donnie Aloe												x	x								x
Aloe 'Guido'	Retro Succulents Guido Aloe												x	x								x
Aloe 'Pink Blush'	Pink Blush Aloe												x	x								x
Aloe 'Sal'	Retro Succulents Sal Aloe												x	x								x
Asclepias speciosa Torr.	Showy Milkweed				x	x	x	x	x	x	x	x	x	x	x	x		x		x	x	
Echeveria agavoides 'Lipstick'	Lipstick Echeveria												x	x								x
Echeveria elegans	Mexican Snowball												x	x								x
Echeveria imbricata	Blue Rose Echeveria												x	x								x
Echeveria setosa	Firecracker Echeveria												x	x								x
Echeveria shaviana	Mexican Hens Echeveria												x	x								x
Echeveria 'Black Prince'	Black Prince Echeveria												x	x								x
Echeveria 'Perle von Nurnberg'	Perle von Nurnberge Echeveria												x	x								x
Echeveria 'Ruffles'	Ruffles Echeveria												x	x								x
Hesperaloe parviflora	Red yucca				x	x	x	x	x	x	x	x	x	x								x
Hesperaloe parviflora 'Perpa'	Brakelights Red Yucca				x	x	x	x	x	x	x	x	x	x								x
Hesperaloe parviflora 'Yellow'	Yellow Yucca				x	x	x	x	x	x	x	x	x	x								x
Sempervivum arachnoideum 'Cebenese'	Cebenese Cobweb Houseleek		x	x	x	x	x	x	x	x	x	x	x	x								x
Sempervivum tectorum ssp. greenii	Greenii Hens and Chicks		x	x	x	x	x	x	x	x	x	x	x	x								x
Sempervivum 'Jade Rose'	Jade Rose Hens and Chicks		x	x	x	x	x	x	x	x	x	x	x	x								x
Sempervivum 'Royal Ruby'	Royal Ruby Hens and Chicks		x	x	x	x	x	x	x	x	x	x	x	x								x
Sempervivum ' Silver King'	Silver King Houseleek		x	x	x	x	x	x	x	x	x	x	x	x								x
Yucca filamentosa	Adam's Needle				x	x	x	x	x	x	x	x	x	x						X		
Yucca filamentosa 'Bright Edge'	Bright Edge Yucca		x	x	x	x	x	x	x	x	x	x	x	x						X		

Plant Select, 2018; Conservation Garden Park, 2018; Charter Township of Canton, 2006; USDA-Natural Resources Conservation Service, 2000; Missouri Botanical Garden, 2018;

Plants For A Future, 2018; Monrovia, 2018; Growing Green Guide, 2018; Central Coast Low Impact Development Initiative; San Francisco Water Power Sewer, 2016

Appendix F References

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REQUEST FOR COUNCIL ACTION
CITY OF AMERICAN FORK
JUNE 10, 2025

Department Recorder **Director Approval** *Terilyn Lurker*

AGENDA ITEM Review and action on a resolution approving the 2025-2026 General Fee Schedule.

SUMMARY RECOMMENDATION
Staff would recommend approval of the proposed fee schedule.

BACKGROUND
On an annual basis staff reviews the fee schedule and proposes suggested changes to the fee schedule. Each department was asked to look at the existing fees and charges to ensure they are appropriate and fair. The fees are based on cost recovery or state legislative action.

The proposed fee schedule was reviewed during the work session on May 20, 2025. No changes to the proposed fees were requested.

BUDGET IMPACT
See attached fee schedule.

SUGGESTED MOTION
I move to approve the resolution establishing the Fiscal Year 2025-2026 General Fee Schedule.

SUPPORTING DOCUMENTS

06.10.25 - Resolution Fee Schedule adoption (DOC)
2026 FEE SCHEDULE Redlined Effective 07.01.25 (PDF)

RESOLUTION NO. _______________

A RESOLUTION OF THE CITY OF AMERICAN FORK FOR THE PURPOSE OF ESTABLISHING A GENERAL SCHEDULE OF THE FEES CHARGED BY THE CITY

WHEREAS, the Mayor and City Council of American Fork finds and declares that it is desirable and in the public interest to pass a single Resolution for the purposes of establishing and setting forth a general schedule of the most common fees charged by the City of American Fork;

NOW, THEREFORE, THE CITY COUNCIL OF THE CITY OF AMERICAN FORK, UTAH, RESOLVES AS FOLLOWS:

The following Resolution is hereby enacted, entitled "General Fee Schedule:"

GENERAL FEE SCHEDULE

Section 1. General Fee Schedule Established**.** The following is an enactment listing the specific fees for the city shown in the General Fee Schedule shall be effective July 1, 2025:

Section 2. All fees and charges not listed in this Resolution which are contained in or promulgated pursuant to any current resolutions shall remain in full force and effect, unless and until duly modified.

Section 3. All fees and charges contained in any current resolutions inconsistent herewith, are hereby repealed to the extent of the inconsistency, but in all other respects such resolutions shall remain in full force and effect.

Section 4. This Resolution is to be construed to be consistent with any all State, County, and Federal laws and regulations concerning the subject matter hereof. If any section, sentence, clause or phrase of this Resolution is held invalid by any court of competent jurisdiction, then said ruling shall not affect the validity of the remaining portions.

PASSED by the American Fork City Council this 10 day of June 2025.

ATTEST:

____
Bradley J. Frost, Mayor

____
Terilyn Lurker, City Recorder

AMERICAN FORK CITY
General Fee Schedule

AMERICAN FORK CITY
ADOPTED FEE SCHEDULE - Effective July 1, 2025
Exhibit A

#	TAXES			Proposed	Justification
1	Adopt		Set by Resolution		
2	Telecom				
3	Franchise Ta				
4	Energy Sales/Use Taxes		6.0%		
5					
6	LICENSES, PERMITS, AND FEES				
7					
8	Administration and Miscellaneous			Proposed	Justification
9	Advertising Costs		Actual Cost		
10	Chicken Permit				
11	Violation as assessed by Enforcem				
12	Dog Licenses (North Utah Valley Animal S				
13	GRAMA Requests (Non-Police or Non-Fire re				
14	As per UCA 63G-2-202, the cost of staff time manipulating, packaging, summarizing, tailoring determined by the City Administrator.				
15	Note: The city will not copy onto personal thumb driv				
16	Candidate Filing Fee				
17	Failure to file Conflict of Interest Disclosure Statement fine for E				
18	Copies				
19	8.5" x 11" - Black and White				
20	8.5" x 11" - Color				
21	11" x 17" - Black and White				
22	11" x 17" - Color				
23	Agendas, Blank Forms				
24	History Books				
25	Early History of American Fork				
26	The Growing Years				
27	Recording Fees				
28	Facility Rentals				
29	Old City Hall, Senior Center				
30	Old City Hall, Senior Center Resident				
31	Old City Hall, Senior Center Non-Resident				
32	Facility Refundable Rental Deposit Old City Hall, Senior Center (in addition to rental fee)				
33	Veteran's Hall				
34	Veteran's Hall - Veteran's Events				
35	Veteran's Hall Half Day (up to 4 hours) Resident	$			
36	Veteran's Hall Half Day (up to 4 hours) Non-Resident	$			
37	Veteran's Hall Half Day (full day) Resident	$	175		
38	Veteran's Hall Half Day (full day) Non-Resident	$	245.00		
39	Facility Refundable Rental Veteran's Hall (in addition to rental fee)	$	50.00		
40	Stop Payment on Checks Fee	$	25.00		
41	Insufficient Funds Fee	$	25.00		
42	Credit Card Processing Fees				
43	All credit card payments other than utility payments		3%		
44	Utility Credit Card or EFT per Transaction charge	$	1.00		

AMERICAN FORK CITY

ADOPTED FEE SCHEDULE - Effective July 1, 2025

Exhibit A

Administration and Miscellaneous (Continued)		Proposed	Justification
	$ -		
or Tower (per event, per hour)	$ 300.00		
Senior Center Fees		**Proposed**	**Justification**
	$ 12.00		
per year Non-Resident	$ 36.00		
Business Licenses		**Proposed**	**Justification**
occupations with impacts)	$ 40.00		
Vendors - per company (if a business license is needed) Fire Inspection Fee	$ 100.00		

AMERICAN FORK CITY
ADOPTED FEE SCHEDULE - Effective July 1, 2025
Exhibit A

	Cemetery	Proposed	Justification
91			
92			
93			
94			
95			
96			
97			
98			
99			
100			
101			
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103			
104			
105			
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114			
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118			
119			
120			
121			
122			
123			
124			
125			
126			
127			
128	y back lots at the present day lot purchase price (less perpetual care)		

AMERICAN FORK CITY

ADOPTED FEE SCHEDULE - Effective July 1, 2025

Exhibit A

129	**Fire Department Fees**			**Proposed**	**Justification**
130	**At ction system plans may be sent to an independent pre-approved 3rd				
131	GRAMA R				
132	As per UC manipulating, determined by th				
133	Note: The city will n				
134	Standard Reports				
135	1st 10 pages				
136	Each additional page				
137	Fire Marshall Review (per hour)				
138	Automatic Fire Protection System**				
139	In house plan review				
140	<100 heads				
141	101-199 heads				
142	200-299 heads				
143	>300 heads - base fee plus $.50 per head				
144	Fire Alarm Systems** (Fees are for In-house Plan reviews only)				
145	Plan Review				
146	New System				
147	Remodel				
148	Additional Floors				
149	Commercial Hood System**				
150	Plan Review each hood per hour				
151	Reimbursed for material replacement, plus $50 per hour per firefighter				
152				**Proposed**	**Justification**
153	Fire Inspections associated with Business Licenses (unless specifically identified below)				
154	Day Care/Residential Non-Ambulatory Care Facility Fire Inspection				
155	Initial Business Inspection (non specified)				
156	3rd and subsequent fire inspections				
157	Specific Assessments for Fire Inspections				
158	Assembly Inspections - A-1 and A-2				
159	Commercial Day Care/Pre-school				
160	Residential Day Care/Pre-school	$			
161	Nursing Homes/Assisted Living	$			
162	Firework Sales - per location + temporary membrane structure permit if necessary	$			
163	Special Amusement Building	$	100.		
164	Hospitals	$	-		
165	Stop Work Removal	$	500.00		
166	Installation without a permit	$	500.00		
167	*Each additional day the violation continues without proper permitting or attempting to acquire				
168	2nd Inspection due to non-compliance inspection	$	125.00		
169	Third inspection due to non-compliance. Fine is to follow written warning	$	500.00		

AMERICAN FORK CITY

ADOPTED FEE SCHEDULE - Effective July 1, 2025

Exhibit A

170	**Fire Inspections/Enforcement (continued)**		**Proposed**	**Justification**
171		$ 500.00		
172				
173				
174				
175				
176				
177				
178				
179				
180				
181				
182				
183				
184	spection - submitted to 3rd party	$ 60.00		
185	**Fire Permits**		**Proposed**	New Category to simplify schedule
186		$ 20.00		
187				
188				
189				
190				
191				
192				
193				
194				
195				
196				
197				
198				
199				
200				
201				
202				
203				
204				
205				
206				
207	rbon Refinery - conducted on an annual basis	$ 500.00		
208	**Fire Operations**		**Proposed**	**Justification**
209		Actual Cost		
210				
211				
212				
213				
214				
215	h succeeding false alarm (per call)	$ 500.00		

AMERICAN FORK CITY

ADOPTED FEE SCHEDULE - Effective July 1, 2025

Exhibit A

Fire Operations (continued)		Proposed	Justification
each succeeding false alarm (per call)	$ 250.00		
Ambulance		**Proposed**	**Justification**
Ambulance fees will comply with the fees set forth by the State of Utah Bureau of EMS and may vary annually.			
Library Fees		**Proposed**	**Justification**
	Replacement Cost		
er session, up to 2 hours) for non-American Fork City Library Card holders	$ 1.00		

AMERICAN FORK CITY

ADOPTED FEE SCHEDULE - Effective July 1, 2025

Exhibit A

246	**Police Department Fees**			Proposed	Justification
247	Acciden				
248	Residen				
249	Non Reside				
250	GRAMA Requests (				
251	As per UCA 63G-2-2 manipulating, packagin determined by the City Adm				
252	Note: The city will not copy ont				
253	Standard Reports				
254	1st 10 pages				
255	each additional page				
256	CD Media Files - photograph, audio, visual				
257	Fingerprints - Wednesday and Thursday, 8 a.m. to 11 a.				
258	Residents				
259	Non Residents				
260	Alarm License				
261	False Alarm Penalty (per calendar year)				
262	First two (2) false alarms				
263	Third through fifth false alarms (per call)				
264	Sixth and each succeeding false alarm (per call)				
265	Reinstatement of suspended alarm permit				
266	Late fees (base fee plus 12% APR until paid in full)				
267	Civil Penalty - uses, maintains, operates without a permit				
268	Civil Penalty - all other violations (per day of violation)				
269	Initial Landlord Permit Fee (see business license fees)				
270	Annual Landlord Permit Fee - Renewal (see business license fees)				
271	Animal Traps Usage (refundable deposit)				
272	Weekly Charge (after first week)	$	10.00		
273					
274					
275				Proposed	Justification
276	Printed maps and copies				
277	8.5" x 11" - Black and White	$	0.25		
278	8.5" x 11" - Color	$	0.50		
279	11" x 17" - Black and White	$	0.50		
280	11" x 17" - Color	$	1.00		
281	Credit Card Processing Fees		3%		
282	(all credit card payments other than utility payments)				

AMERICAN FORK CITY
ADOPTED FEE SCHEDULE - Effective July 1, 2025
Exhibit A

283	Impact Fees			Proposed	Justification
284	Culinar				
285	3/4" me				
286	1" meter				
287	1.5" meter				
288	2" meter				
289	3" meter				
290	4" meter				
291	6" meter				
292	8" meter				
293	Fire Impact Fees				
294	Single Family Residential - per unit				
295	Multiple Family Residential - per unit				
296	Non-Residential - per 1,000 square feet				
297	Non-Residential Apparatus Fee - per 1,000 square fee				
298	Parks and Recreation Impact Fees				
299	Single Family Residential - per unit				
300	Multiple Family Residential - per unit				
301	Police Impact Fee				
302	Single Family Residential - per unit				
303	Multiple Family Residential - per unit				
304	Non-Residential - per 1,000 square feet				
305	Pressurized Irrigation Impact Fee				
306	Single Family Residential - per irrigated square feet				
307	Multiple Family Residential - per irrigated square feet				
308	Non-Residential - per irrigated square feet				
309	Sanitary Sewer Impact Fees - based on water meter size				
310	3/4" meter				
311	1" meter				
312	1.5" meter				
313	2" meter	$			
314	3" meter	$	8		
315	4" meter	$	14,00		
316	6" meter	$	27,999.79		
317	8" meter	$	44,801.34		
318	Storm Drain Impact Fee				
319	Single Family Residential - per gross square feet	$	0.1536		
320	Multiple Family Residential - per gross square feet	$	0.1536		
321	Non-Residential - per gross square feet	$	0.1536		

AMERICAN FORK CITY
ADOPTED FEE SCHEDULE - Effective July 1, 2025
Exhibit A

			Proposed	Justification
322	**Impact Fees (continued)**		Proposed	Justification
323	TSSD ermit but paid to TSSD)	As adopted by TSSD		
324	TSSD Se			
325	Roads Impa			
326	Single Fam			
327	Multiple Fami			
328	Single Family Re			
329	Multiple Family Res			
330	Non-TOD Mixed Use			
331	ITE Trips Peak PM Trips x % Entering x % Primary Trip x Final ITE PM Peak Hr Adjusted Trips x Cost per Trip ($5,723.06) = Base Non-Residential Impact Fee x Internal-Internal Trips (85%) = Final Non-Residential Mixed Use Impact Fee Outside of the TOD Areas			
332				
333				
334				
335				
336	Non-TOD Other Non-Residential			
337	ITE Trips Peak PM Trips x % Entering x % Primary Trip x Final ITE PM Peak Hr Adjusted Trips x Cost per Trip ($5,723.06) = Base Non-Residential Impact Fee			
338				
339				
340				
341				
342	TOD (All Non-Residential)			
343	ITE Trips Peak PM Trips x % Entering x % Primary Trip x Final ITE PM Peak Hr Adjusted Trips x Cost per Trip ($5,723.06) = Base Non-Residential Impact Fee x TOD Trip Reduction (84%) x Internal-Internal Trips (85%) = Final Non-Residential Impact Fee in the TOD Area			
344				
345				
346				
347				
348			Proposed	Justification
349	Water - residential and non-residential - based on water meter size			
350	0.750 inch			
351	1.000 inch			
352	1.500 inch			
353	2.000 inch			
354	3.000 inch			
355	4.000 inch			
356	6.000 inch			
357	Sewer - residential and non-residential			
358	Pressurized Irrigation - residential and non-residential - based on water meter size			
359	0.750 inch			
360	1.000 inch			
361	1.500 inch	$		
362	2.000 inch	$		
363	3.000 inch	$ 1		
364	4.000 inch	$ 3,06		
365	6.000 inch	$ 4,950.		
366	Meter Reset Fee (Charged per incident a meter is not ready for set up)	$ 80.00		

Attachment: 2026 FEE SCHEDULE Redlined Effective 07.01.25 (FY 2026 General Fee Schedule)

AMERICAN FORK CITY

ADOPTED FEE SCHEDULE - Effective July 1, 2025

Exhibit A

Row	Development Fees		Proposed	Justification
368	***Gener***			
369	Performa			
370	Right-of-Way			
371	~~Asphalt cut (~~			
372	~~Asphalt cut (per~~			
373	~~Traffic Control fees~~			
374	~~Base fee (includes first~~			
375	~~Barricading roads base fee~~			
376	~~Local road sidewalk closures (~~			
377	~~Arterial or collector sidewalk clos~~			
378	~~Arterial or collector shoulder/bike lan~~			
379	~~Bike path closure (per day)~~			
380	Road Cut Fee (does not include hourly inspectio			
381	Age Of Roadway:			
382	0-2 Years			
383	2-5 Years			
384	5 Plus Years			
385	Road Bore Fee			
386	Age Of Roadway:			
387	0-2 Years			
388	2-5 Years			
389	5 Plus Years			
390	Length of Bore:			
391	0-50 Feet			
392	51-300 Feet			
393	300 plus Feet			
394	Local Street Lane Closure (Lane/day/block) - first 8 hours free			
395	Collector Street Lane Closure (Lane/day/block) - first 8 hours free			
396	Arterial Street Lane Closure (Lane/day/block) - first 8 hours free			
397	Sidewalk or Bike Lane (day/block) - first 8 hours free			
398	Construction Water (base fee plus $3.50 per 1,000 gallons)	$ 250.00		
399	Usage rate per 1,000 gallons	$ 3.50		
400	Construction Water (hydrant use) deposit	$ 1,500.00		
401	Water share conveyance (per share, if surface water)	$ 500.00		

AMERICAN FORK CITY
ADOPTED FEE SCHEDULE - Effective July 1, 2025
Exhibit A

	Development Fees (continued)		Proposed	Justification
402	**Development Fees (continued)**		Proposed	Justification
403				
404				
405				
406				
407				
408				
409				
410				
411				
412				
413				
414				
415				
416				
417				
418				
419				
420				
421				
422				
423				
424				
425				
426				
427				
428	review (each additional after 4)	$50		
429	**Development Services**			
430				

AMERICAN FORK CITY
ADOPTED FEE SCHEDULE - Effective July 1, 2025
Exhibit A

431	**Residential Building Division Fees**		**Proposed**	**Justification**
432	Carpo	Based on ICC Valuation Table		
433	Garage			
434	Unfinished B			
435	Finished Basem			
436	Main Level			
437	2nd Level			
438	Plan Review			State code 10-9a-510 allows 65% of the building permit fee for plan review. A percentage allows for balanced plan review fees based on house valuation. A set fee is unfair to the smaller home builder/owner. The percentage fee offers a more equitable approach to cover the different volume of work required by staff in plan reviews and inspections. Effective 5/7/25 per state code.
439	Identical Plan Review Fee			State code 10-9a-541 allows 30% of the building permit fee for identical plan review. Identical plan review required to be allowed by state code 10-9a-541. Effective 5/7/25 per state code.
440	**At the discretion of the Development Services & Public Wo be sent to an independent pre-approved 3rd party engineering c division's choosing for review and/or consultation. An administrativ plans to include Site and Building Plan or Plans review. Any 3rd party re expenses and must be paid before any inspections will occur or occupancy allowed. Prior to review or inspection, applicants shall agree in writing to add cost estimates prior to hourly rates being incurred.			
441	Once plan review has been initiated, the plan review fee is non-refundable.			
442	Expedited Review Fee (in addition to regular plan review fee)			
443	Plan Revision Fee per hour			
444	Reinspection Fee per unit			
445	Electrical Meter Change Out			
446	Temporary Power			
447	Occupancy Fee - Residential			
448	Temporary Certificate of Occupancy - Residential			
449	Construction Water (residential)	$		
450	Inspection Cancellation Fee per unit (Cancellation Fee for Any Scheduled Inspection)	125.00		
451			**Proposed**	**Justification**
452	Reinspection Fee per unit	$ 175.00		
453	Inspection Cancellation Fee per unit (Cancellation Fee for Any Scheduled Inspection)	$ 125.00		
454	Plan Revision Fee per hour	$ 100.00		
455	Electrical Meter Change out	$ 100.00		
456	Temporary Power	$ 100.00		
457	Up Front Partial Plan Review Fee - New Commercial	$ 1,000.00		
458	The complete plan review fee are 65% of the building permit fee based on current ICC valuation tables.			

AMERICAN FORK CITY

ADOPTED FEE SCHEDULE - Effective July 1, 2025

Exhibit A

	Commercial Building Division Fees (continued)		Proposed	Justification
459				
460	odel	$ 500.00		
461				
462				
463				
464				
465				
466				
467				
468				
469				
470				
471				
472	Fee per hour charge	$ 100.00		
473	**Other Building Division Fees**		**Proposed**	**Justification**
474		$ 75.00		
475				
476				
477				
478				
479				
480				
481				
482				
483				
484				
485				
486				
487				
488				
489				
490				
491				
492				
493	*nder Building Inspection Fees are not inclusive. Other fees may apply or be required.** *			

AMERICAN FORK CITY
ADOPTED FEE SCHEDULE - Effective July 1, 2025
Exhibit A

	Planning and Zoning Division Review Fees		Proposed	Justification
494				
495				
496				
497				
498				
499				
500				
501				
502				
503				
504				
505				
506				
507				
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514				
515				
516				
517				
518	s	$ 965.00		

AMERICAN FORK CITY
ADOPTED FEE SCHEDULE - Effective July 1, 2025
Exhibit A

519	Utilities			Proposed	Justification
520	Utility	$	30.00		
521	Tenant/La				
522					
523	**Properties outsi**				
524	CUP/Water Assessm				
525	Drain Fees				
526	Undeveloped Parcel				
527	Single Unit Residential Cus				
528	Multi Unit Residential				
529	Base Monthly Charge Per Unit				
530	Area Charge per 1000 Square Feet				
531	Commercial/Institutional				
532	Base Monthly Charge Per Unit				
533	Area Charge per 1000 Square Feet of Imperv				
534	Garbage Fees				
535	1st Container				Waive $0.45 increase (contract increase of 3.5% or $12.95)
536	Additional containers - each				Waive $0.30 increase (contract increase of 3.5% or $8.50)
537	Recycling				Waive $0.25 increase (contract increase of 3.5% or $7.60)
538	Recycling cancellation fee				
539	Sewer Fees				
540	Residential/Commercial/Industrial Customers AF City - base				
541	Residential/Commercial/Industrial Customers AF City - Usage rate per				
542	Residential/Commercial/Industrial Customers TSSD - base				
543	Residential/Commercial/Industrial Customers TSSD - Usage rate per 1,000 gal				
544	Residential Customers Unincorporated AF City - base				
545	Residential Customers Unincorporated AF City - Usage rate per 1,000 gallons				
546	Residential Customers Unincorporated TSSD - base				
547	Residential Customers Unincorporated TSSD - Usage rate per 1,000 gallons				
548	Schools AF City - per student				
549	Schools TSSD - per student				
550	Pressurized Irrigation				
551	Unmetered				
552	Base Rate (per month, 9,000 square foot lot)				
553	Overage (per month, per square foot over 9,000)	$			
554	Metered				
555	Base rate - 0 to 8,000 gallons per month usage	$			
556	Block 2 rate - 8,000 to 16,000 gallons per month usage	$			
557	Block 3 rate - over 16,000 gallons per month usage	$	5.1		
558	Pressurized Irrigation - Shareholder rates				
559	Unmetered				
560	Base Rate (per month, 9,000 square foot lot)	$	10.84		
561	Overage (per month, per square foot over 9,000)	$	0.001355		
562	Pressurized Irrigation - Additional discount for shares owned in excess of required minimum				
563	Possible Additional discount	$	43.36		

AMERICAN FORK CITY
ADOPTED FEE SCHEDULE - Effective July 1, 2025
Exhibit A

564	Utilities (continued)		Proposed	Justification
565	Large R			
566	Metered			
567	Base rate			
568	Block 2 rate -			
569	Block 3 rate - over			
570	Culinary Water Rates - **Rate a**			
571	Single Family Rates			
572	***Monthly Base Rate ($/meter/***			
573	3/4" and smaller			
574	1"			
575	1.5"			
576	2"			
577	***Volume Rates ($/thousand gallons)***			
578	*Base Allowance*			
579	0 to 3,000 gallons/month			
580	*Block 2 Rate*			
581	3,000 to 6,000 gallons/month			
582	*Block 3 Rate*			
583	6,000 to 9,000 gallons/month			
584	*Block 4 Rate*			
585	Above 9,000 gallons/month			
586	Culinary Water Rates - **Rate adjustments effective July 1, 2018**			
587	Multi-Family Rates			
588	***Monthly Base Rate ($/unit/month)***			
589	First Unit			
590	Each Additional Unit			
591	***Volume Rates ($/thousand gallons)***			
592	*Base Allowance*			
593	0 to 3,000 gallons/month/unit	$		
594	*Block 2 Rate*			
595	3,000 to 6,000 gallons/month/unit	$ 3.59		
596	*Block 3 Rate*			
597	6,000 to 9,000 gallons/month/unit	$ 4.32		
598	*Block 4 Rate*			
599	Above 9,000 gallons/month/unit	$ 5.06		

AMERICAN FORK CITY
ADOPTED FEE SCHEDULE - Effective July 1, 2025
Exhibit A

600	Utilities (continued)		Proposed	Justification
601	Culina 18			
602	Comm			
603	***Monthly***			
604	3/4" and s			
605	1"			
606	1.5"			
607	2"			
608	3"			
609	4"			
610	6"			
611	8"			
612	10"			
613	***Volume Rates ($/thousand gallons)***			
614	*Base Allowance*			
615	0 to 3,000 gallons/month			
616	*Block 2 Rate*			
617	Above 3,000 gallons/month			
618	Utility Hardship Discount Rate - for seniors who qualify under Utah County			for entire bill - all utilities (except TSSD Sewer and Garbage/Recycling) - with application (must be over 66 and proof of household income under threshold as noted per tax commission circuit breaker abatement requirements, currently $40,840 5/15/25)
619	Sewer TSSD or Garbage rates are excluded from discount rates			
620	~~Pressurized Irrigation~~			
621	~~Base Rate (per month up to 8,000 gallons)~~			
622	~~Each additional 1,000 gallons~~			
623	~~The city will pay entire cost to purchase and install meter for those seniors who quali~~			
624	~~Culinary Water~~			
625	~~10% of the base rate of the adopted culinary rates~~			
626	Hardship Exception Rates - for other cases, heard by City Council after filing a relief petition with City			
627	Reconnection Fee - *normal business hours*			
628	Reconnection - after hours			
629	Tampering Fee			
630	Fine for use without current utility account			
631	Mapping Fee	$		
632	Pressurized Irrigation Connection fee	$		
633	Account Suspension Fee			
634	NSF (Not Sufficient Funds) Fee	$2		
635	Full-Time Front Line Personnel Residing in American Fork Discount	As Adopte		
636	Military Discount Active Military (With Deployment Papers-While Deployed)			
637	Garbage Fees	As Adopted		
638	Recycling Fees	As Adopted		
639	Water Fees	Waived		
640	Sewer Fees	Waived		
641	Storm Drain Fees	Waived		

AMERICAN FORK CITY
ADOPTED FEE SCHEDULE - Effective July 1, 2025
Exhibit A

	Fitness Center Fees			Proposed	Justification
642					
643	12 Mon				
644	Residen				
645	Annual F				
646	per Mont				
647	Annual Couple				
648	per Month				
649	Annual Individual				
650	per Month				
651	Annual Senior Couple				
652	per Month				
653	Annual Senior/Student Individual				
654	per Month				
655	12 Month Contract				
656	Non-Resident Rate				
657	Annual Family				
658	per Month				
659	Annual Couple				
660	per Month				
661	Annual Individual				
662	per Month				
663	Annual Senior Couple				
664	per Month				
665	Annual Senior/Student Individual				
666	per Month				
667	6 Month Rate				
668	Resident Rate				
669	Semi-Annual Family				
670	Semi-Annual Couple				
671	Semi-Annual Individual	$			
672	Semi-Annual Senior Couple	$			
673	Semi-Annual Senior/Student Individual	$	1		
674	Non-Resident Rate				
675	Semi-Annual Family	$	410.00		
676	Semi-Annual Couple	$	340.00		
677	Semi-Annual Individual	$	250.00		
678	Semi-Annual Senior Couple	$	250.00		
679	Semi-Annual Senior/Student Individual	$	165.00		

AMERICAN FORK CITY
ADOPTED FEE SCHEDULE - Effective July 1, 2025
Exhibit A

680	**Fitness Center Fees (continued)**			**Proposed**	**Justification**
681	3 Mon				
682	Reside				
683	Quarter				
684	Quarterly C				
685	Quarterly Indiv				
686	Quarterly Senior C				
687	Quarterly Senior/Stude				
688	Non-Resident Rate				
689	Quarterly Family				
690	Quarterly Couple				
691	Quarterly Individual				
692	Quarterly Senior Couple				
693	Quarterly Senior/Student Individual				
694	Summer Family Pass (May 15 to Sept 15)				
695	Resident Rate				
696	Quarterly Family				
697	Quarterly Couple				
698	Quarterly Individual				
699	Quarterly Senior Couple				
700	Quarterly Senior/Student Individual				
701	Summer Family Pass (May 15 to Sept 15)				
702	Non-Resident Rate				
703	Quarterly Family				
704	Quarterly Couple				
705	Quarterly Individual				
706	Quarterly Senior Couple				
707	Quarterly Senior Individual				
708	Daily Admission Fees and Punch Card Rates				
709	Daily Adult (18 years and older)				
710	Daily Youth (4 years to 17 years)				
711	Daily Toddler (up to 3 years)				
712	Daily Senior "Track Only"	$			
713	Daily family	$			
714	Adult 20 Punch Card Resident	$	125.		
715	Adult 20 Punch Card Non-Resident	$	140.00		
716	Youth 20 Punch Card Resident	$	105.00		
717	Youth 20 Punch Card Non-Resident	$	120.00		
718	Senior Citizen 20 Punch Card Resident	$	85.00		
719	Senior Citizen 20 Punch Card Non-Resident	$	95.00		
720	Senior Citizen "Track Only" 20 Punch Card	$	20.00		

AMERICAN FORK CITY
ADOPTED FEE SCHEDULE - Effective July 1, 2025
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	Fitness Center Fees (continued)			Proposed	Justification
722	Day Car				
723	One chil				
724	Two children				
725	Three or more ch				
726	Day Care - Hourly Rates (				
727	Half Hour				
728	Hour				
729	20 Time Punch Card				
730	Business Rates				
731	Resident Rate 15% (1-20 employees)				
732	Annual Family				
733	Annual Couple				
734	Annual Individual				
735	Non-Resident Rate 15%				
736	Annual Family				
737	Annual Couple				
738	Annual Individual				
739	Resident Rate 20% (21-59 employees)				
740	Annual Family				
741	Annual Couple				
742	Annual Individual				
743	Non-Resident Rate 20%				
744	Annual Family				
745	Annual Couple				
746	Annual Individual				
747	Business Rates				
748	Resident Rate 25% (60+ employees)				
749	Annual Family	$			
750	Annual Couple	$	281.		
751	Annual Individual	$	195.00		
752	Non-Resident Rate 25%				
753	Annual Family	$	383.00		
754	Annual Couple	$	323.00		
755	Annual Individual	$	225.00		

AMERICAN FORK CITY
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			Proposed	Justification
756	**Fitness Center Fees (continued)**		**Proposed**	**Justification**
757	Gymn	Member/Non Member		
758	Paren			
759	Parent To			
760	Parent Tot (q			
761	Parent Tot (quar			
762	Gym Stars, Breeze, T			
763	Gym Stars, Breeze, Thu			
764	Gym Stars, Breeze, Thunde			
765	Gym Stars, Breeze, Thunder (q			
766	Kinder (quarterly) Resident, Mem			
767	Kinder (quarterly) Resident, Non-Me			
768	Kinder (quarterly) Non-Resident, Membe			
769	Kinder (quarterly) Non Resident, Non-Mem			
770	Blizzards (Quarterly) Resident, Member			
771	Blizzards (Quarterly) Resident, Non-Member			
772	Blizzards (Quarterly) Non-Resident, Member			
773	Blizzards (Quarterly) Non Resident, Non-Member			
774	Itty Bitty Sports (Quarterly) Resident, Member			
775	Itty Bitty Sports (Quarterly) Resident, Non-Member			
776	Itty Bitty Sports (Quarterly) Non-Resident, Member			
777	Itty Bitty Sports (Quarterly) Non Resident, Non-Member			
778	Dance Classes			
779	Ninja Warrior			
780	Preschool			
781	Swim Team/Lessons			
782	Swim Lessons Resident, Member			
783	Swim Lessons Resident, Non - Member			
784	Swim Lessons Non-Resident, Member			
785	Swim Lessons Non-Resident, Non - Member			
786	Lifeguard Training Courses			
787	HAST Swim Team			
788	Summer Swim Team			
789	Water Safety Courses	$		
790	Pool and Facility Rentals			
791	Competition pool rental-2 hour rental	$		
792	Leisure pool rental-2 hour rental	$ 50		
793	Combination Pool rental-2-hour	$ 975.0		
794	Spin Room rental-hourly rental	$ 150.00		
795	**Boat Harbor Fees**		**Proposed**	**Justification**
796	Day Use-All vehicles parking in ~~entering~~ the facility	$ 10.00	5.00	effective opening day May 28, 2025
797	Boat Launch		$	effective opening day May 28, 2025
798	Season Pass - Resident		$ 80.	effective opening day May 28, 2025
799	Season Pass - Nonresident		$ 100.00	effective opening day May 28, 2025
800	No charge for walk in or bike in			

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				Proposed	Justification
801	**Park and Field Rentals**				
802	Amphi				
803	Full D				
804	Full Day R				
805	Refundable				
806	Quail Cove Park-Spe				
807	Quail Cove Park-Specia				
808	Skate Park - 200 East 500 S				
809	Day Resident				
810	Day Non-Resident				
811	Pavilions - Rotary, Quail Cove, Everg				
812	Large Pavilion Resident				
813	Large Pavilion Non-Resident				
814	Small Pavilion Resident				
815	Small Pavilion Non-Resident				
816	Baseball Field Rentals - Rotary, Pony, Art Dye, Beehiv				
817	Hourly - Adult Teams Resident				
818	Hourly - Adult Teams Non-Resident				
819	Hourly - Youth Teams Resident				
820	Hourly - Youth Teams Non-Resident				
821	Full Day Resident				
822	Full Day Non-Resident				
823	Field Prep				
824	Field Lights - per hour				
825	Robinson Park Rental Resident				
826	Robinson Park Rental Non-Resident				
827	Playing Field Rentals - Evergreen, Hindley, Art Dye East or South Fields, Legacy, Bamberger				
828	Hourly - Adult Teams Resident				
829	Hourly - Adult Teams Non-Resident				
830	Hourly - Youth Teams Resident				
831	Hourly - Youth Teams Non-Resident				
832	Full Day Resident				
833	Full Day Non-Resident				
834	Field Prep				
835	Field Lights - per hour	$			
836	Art Dye - Full Rental - East Field, OR South Field, OR Baseball Field				
837	Half Day Resident	$			
838	Half Day Non-Resident	$	45		
839	Full Day Resident	$	500.0		
840	Full Day Non-Resident	$	700.00		
841	Entire Complex Resident	$	1,500.00		
842	Entire Complex Non-Resident	$	2,000.00		
843	Special Event Rental-events that are not sports activities Resident	$	2,000.00		
844	Special Event Rental-events that are not sports activities Non-Resident	$	2,500.00		
845	**Playground Equipment for all parks is on a first-come, first-served basis at no charge				

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Recreation Fees	Proposed	Justification
rograms require a $5 late fee for registering after the deadline		