WEST POINT CITY

STORM WATER MANAGEMENT PROGRAM

May 2021

Prepared by Gardner Engineering

West Point City
Storm Water Management Plan

Certification

To Whom It May Concern:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Signature: ____ Date: ______________

Title: ____

WEST POINT CITY
STORM WATER MANAGEMENT PLAN

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SECTION A
Executive Summary

The purpose of this Storm Water Management Plan (SWMP) is to fulfill the requirements of the general permit for discharges from Small Municipal Separate Storm Sewer Systems (MS4s) under the Utah Pollutant Discharge Elimination System.

This report will discuss the goals that West Point City will implement in the coming years to help reduce pollution and potential pollution from point and non-point sources. The format of this report closely follows the format requested by the State of Utah and focuses on the six minimum control measures that are required in the permit. West Point City is joint permitting with Davis County for coverage under a state permit with the Utah Division of Water Quality. Davis County Storm Water Coalition is responsible for Public Education and Outreach, and Public Participation/Involvement minimum control measures.

The current estimated population of West Point City is around 10,615. Currently West Point City is a rural and suburban area in the northwest corner of Davis County situated along the shoreline of the Great Salt Lake. The largest industry is agriculture, however, West Point is experiencing significant growth and future commercial activities are expected in the area.

The land is generally graded towards the Great Salt Lake. There is also somewhat of a ridgeline that divides the city into two distinct drainage basins, one to the north of 800 North Street and one to the south. There are several man-made open channels running through West Point City that collect irrigation water as well as storm water then discharge into the Great Salt Lake. The South Arm of the Howard Slough is the largest natural channel running through the northwest corner of the City. Davis County Flood Control owns and maintains a large man made channel that runs through the southern half of the City. In addition to the open channels West Point City owns and maintains a system of storm drain pipes which connect to the open channels or to the Lake.

West Point City is committed to a clean environment and to assisting citizens in caring for quality of water that is discharged from the City. By implementing the goals set forth in this plan and participating with Davis County Storm Water Coalition measures shall be taken to reduce pollution from entering open waters. The City will review and revise this plan in the future as needed. The Responsible parties for the City are the Public Works Director – City Manager - City Engineer - City Staff their contact info is (801)776-0970

SECTION B

Minimum Control Measures

The following subsections will address the six minimum control measures required in the general permit. Each section includes a description of how the minimum control measure will be addressed and measurable goals that will be implemented. The six minimum control measures are as follows:

1. Public Education and Outreach on Storm Water Impacts
2. Public Involvement/Participation
3. Illicit Discharge Detection and Elimination (IDDE)
4. Construction Site Storm Water Runoff Control
5. Long-Term Storm Water Management in New Development and Redevelopment (Post-Construction Storm Water Management)
6. Pollution Prevention and Good Housekeeping for Municipal Operations

Glossary

BMPs	Best Management Practices
IDDE	Illicit Discharge Detection and Elimination
SWMP	Storm Water Management Plan
SWPPP	Storm Water Pollution Prevention Plan
LID	Low Impact Development
DCSWC	Davis County Storm Water Coalition
SOP	Standard Operating Procedure
O&M	Operations & Maintenance
MS4	Municipal Separate Storm Sewer System

1.0 PUBLIC EDUCATION AND OUTREACH ON STORM WATER IMPACTS

The Public Education and Outreach section of this Storm Water Management Plan will be implemented to increase public awareness to reduce water quality impacts due to storm water runoff and illegal discharges.

To meet the requirements of section 4.2.1. West Point City will participate with the Davis County Storm Water Coalition on a multimedia level and will target all four of the audience's, with audience specific information.

Audience	Media
Residents	Newsletters, handouts, social media, TV/Movie ads, Websites
Businesses, institutions, industrial, and commercial facilities	Newsletters, handouts, social media, TV/Movie ads, Websites
Developers and Contractors	Contractor Trainings, pre-construction meetings, handouts.
MS4 industrial facilities	Handouts and employee trainings

West Point City will participate with the Davis County Storm Water Coalition in a jointed endeavor to inform the community. In the joint permit Davis County Storm Water Coalition is responsible to address the Public Education and Outreach minimum control measure. The City will evaluate the success by documenting the number of handouts provided by the city of the minimum control measures annually and revised the plan as needed. The program will be focused on the following Best Management practices (BMPs):

1.1 BMPs

a) Water Fair with Davis County School District and the Coalition
b) Coalition/City Contractor Training
c) Pre-Construction Meetings
d) Newsletter articles
e) Flyers and handouts
f) Social media with Davis County Storm Water Coalition
g) TV/Movie ads with Davis County Storm Water Coalition
h) West Point Employee Trainings

Davis County Storm Water Coalition Educational and Outreach Programs: West Point City plans to support Educational and Outreach programs through material distribution and training attendance. Davis County Storm Water Coalition is responsible for this minimum control measure as part of the joint permit.

Teaching at Public Schools: City and County personnel will coordinate with the Davis County School District to make presentations to the appropriate classes in all 51 elementary schools. County personnel will be trained, using the ongoing programs in Salt Lake County as a guide. After which, Davis County personnel will train all City personnel, who in turn will make the presentations in their respective community. Materials used in the school demonstrations will be jointly purchased and owned by the Cities and County. The materials and supplies will be stored in the County Public Works office and made available to each city on a reservation basis.

West Point Employee training: West Point is a small city with a small staff (20 or less). The City holds formal and informal training sessions on storm water issues for the City. Staff training is beneficial as the City reviews and approves subdivision and advises West Point citizens.

Printed Materials and Online Material: West Point City plans to attach all current Storm Water Education materials produced by the Coalition to its quarterly Newsletter. West Point City currently distributes a monthly newsletter and quarterly will add information on storm water to all residents and business owners in the City. While the newsletter does not specifically target storm water pollution prevention it is planned to use the distribution of the newsletter to simultaneously distribute storm water pollution prevention information. The City also post storm water information and material on the city website. Davis County Storm Water Coalition plans to produce a variety of printed materials that will be focused on pollution prevention. The materials will address a variety of topics and will target a variety of audiences. A range of topics will be covered such as the following:

Paint and Household Hazardous Waste
Household and Vehicle Maintenance
Swimming Pool Water Disposal
Landscaping, Gardening and Yard Maintenance
Pet Waste and Water Quality
Construction Material Disposal
LID Practices / Onsite Infiltration
Maintenance of Septic Systems
Pesticide and Fertilizer use
Water Conservation

West Point will document the amount and type of information distributed in their quarterly newsletter.

1.2 **Measurable Goals:** Table 1.1 summarizes the measurable goals for this section of the storm water management plan. The purpose of the goals is to measure success and program effectiveness.

Table 1.1					
Public Education and Outreach On Storm Water Impacts					
Item #	Activity/BMP	Measurable Goal	Description	Time Schedule	Permit Section
1.1	Davis County Storm Water Coalition Education	Have all elementary 4th and 5th grade classes attend fair.	Support the attendance of this fair. Provide bus transportation to fair.	Annually	4.2.1.2
1.2	Newsletter articles	Document the # and type of Material Distributed.	Include and distribute printed storm water materials in the Quarterly Newsletter. Mail to each resident, business owner, and contractor.	Quarterly	4.2.1.3
1.3	Flyers and handouts	Document the # of handouts given out.	Provide and have available flyers and handouts in the City Office.	On going	4.2.1.3
1.4	Davis County Storm Water Coalition Education	Teaching/Presentations in school class rooms	Support/coordinate the teaching/presentations given in all 51 schools.	On going	4.2.1.2
1.5	TV/Movie ads with Davis County Storm Water Coalition	Support the Coalition	TV and Movie theater ads – High school students get grant to make ads	On going	4.2.1.3
1.6	Coalition/City Contractor/Developer Training	Document those receiving training.	SWPPP and LID Training	Annually	4.2.1.4
1.7	Pre-Construction Meetings	Pre-Construction Meetings for all contractors and projects.	At pre-construction meeting provide information regarding storm water quality	On going	4.2.1.4

Item #	Activity/BMP	Measurable Goal	Description	Time Schedule	Permit Section
1.8	West Point Employee Trainings	Document those attending training.	Provide training for all related staff and new hires. Provide information regarding the use of Low impact Development (LID) to be distributed to MS4 engineers, development and plan review staff and land use planners	Annually	4.2.1.5 and 4.2.1.6

* Davis County Storm Water Coalition is responsible to address other aspects of this minimum control measure.

2.0 PUBLIC INVOLVEMENT AND PARTICIPATION

Working with the Davis County Storm Water Coalition will provide ongoing opportunities for public involvement and participation such as advisory panels, public hearings, watershed committees, stewardship programs, environmental activities, other volunteer opportunities, or similar activities. The program will comply with applicable State and Local public notice requirements.

- West Point City will adopt a program or policy directive to create opportunities for the public to provide input during the decision making processes involving the development, implementation and update of the SWMP document including development and adoption of all required ordinances or regulatory mechanisms.
- West Point City will make the revised SWMP document available to the public for review and input within 180 days form effective date of this Permit.
- A current version of the SWMP document will remain available for public review and input for the life of the Permit. The latest version of the SWMP document will be posted on West Point City's website, to allow the public to review and provide input.
- West Point City will at a minimum comply with State and Local public notice requirements when implementing a public involvement/participation program.

2.1 BMPs

a) Notify public of all SWMP related hearings
b) Public invited to Storm water Coalition meetings
c) County Public Hearings
d) SWMP available on West Point City's website.

Notify public of all SWMP related hearings: West Point City will notify the public of all SWMP related hearings in order to inform and involve the public. Notices will be posted on the website and in the newsletter.

Storm Water Coalition meetings: Invite public to storm water coalition meetings. Meetings will be publicized through newsletters and on City's web site. Listen to the publics input and revise SWMP as needed to meet citizen's needs and support of the programs in this report.

West Point City plans to support Davis County Storm Water Coalition in its efforts to increase public involvement and participation. Each of the municipalities within the county has been invited to participate. The group was originally formed for the purpose of distributing information regarding the General UPDES Permit regulations and to help the various municipalities to cooperate in completing their SWMPs. The group will be continued in the future and will become a public meeting where citizens are invited to participate. The group will specifically invite business owners, builders, landscapers, or other groups that have and interest in the SWMP. In the meetings the public will be given the opportunity to give input or voice concerns to the representatives who have the **responsibility** to carry out the plans. This will also be an opportunity to give training to the public in areas that concern storm water management.

2.2 Measurable Goals:

Table 2.1 summarizes the measurable goals for this section of the storm water management plan. The purpose of the goals is to measure success and program effectiveness.

Table 2.1

Public Involvement and Participation

Item #	Activity/BMP	Measurable Goal	Description	Time Schedule	Permit Section
2.1	Storm Water Coalition meetings	Participation in public Storm Water Coalition meetings	Regularly attend public Storm Water Coalition meetings and make staff available to public.	Monthly	4.2.2.1

2.2	revised SWMP document available to the public for review	Post updates to SWMP online and open it to public comment	West Point City will make the revised SWMP document available to the public for review and input within 180 days form effective date of this Permit online	11/9/2021	4.2.2.2
2.3	SWMP available on West Point City's website	Maintain updated SWMP online	Provide access to a current copy of the SWMP online for public comment	Ongoing	4.2.2.3

3.0 ILLICIT DISCHARGE DETECTION AND ELIMINATION

The Illicit Discharge Detection and Elimination section of this SWMP is intended to stop illicit discharges of potential pollutant sources into the West Point City storm drainage system. The BMPs outlined below will aid in detecting such discharges and eliminating the source of the discharge in conjunction with the efforts and plans of Davis County.

3.1 BMPs

a) Storm sewer system mapping
b) Storm Drain Ordinance
c) List of High Priority facilities
d) Dry Weather Screenings
e) Record of non-storm water discharge
f) IDDE Documentation
g) Educational Outreach
h) Proper disposal of hazardous waste
i) Hotline number
j) Tracking Spills
k) Employee Training

Ordinance to detect and eliminate illicit discharge: West Point City has adopted an ordinance to prohibit the discharge of pollutants into storm drains or any open water source. The ordinance is enforceable and West Point City will continue enforcing the ordinance as needed. The ordinance will be reviewed and updated to include the following.

- Track mud or sediment onto public streets by construction of delivery vehicles. Provisions shall be made at all construction sites to either clean the streets or clean the vehicles or both before vehicles leave the site.

- To wash out concrete trucks at all sites other than pre-approved designated areas. Dumping of excess concrete shall not be allowed.

- To stockpile construction or yard improvement materials or debris in the street or in the gutter unless being stored on a pallet or in a self-contained storage unit that has been pre-approved by the City Engineer. This includes, but is not limited to, ramps being constructed for temporary access across the existing curb and gutter; stockpiling of topsoil or other fill material; stockpiling of sand, gravel, landscape rock, bark, mulch, or any other material that may be considered a source of pollution in the storm water system.

It is unlawful for any person to allow an illicit discharge to the storm sewer system.

No person shall connect to the city's storm sewer system without first obtaining a storm sewer discharge permit.

Prohibiting the introduction of a deleterious substance into any part or portion of the storm drain system.

Restrict the opening of manholes or other inlet devices.

West Point City has the right to inspect premises at all reasonable times whenever the city has cause to believe that there exist, or potentially exist a storm water violation.

Restrict or control drainage onto other properties.

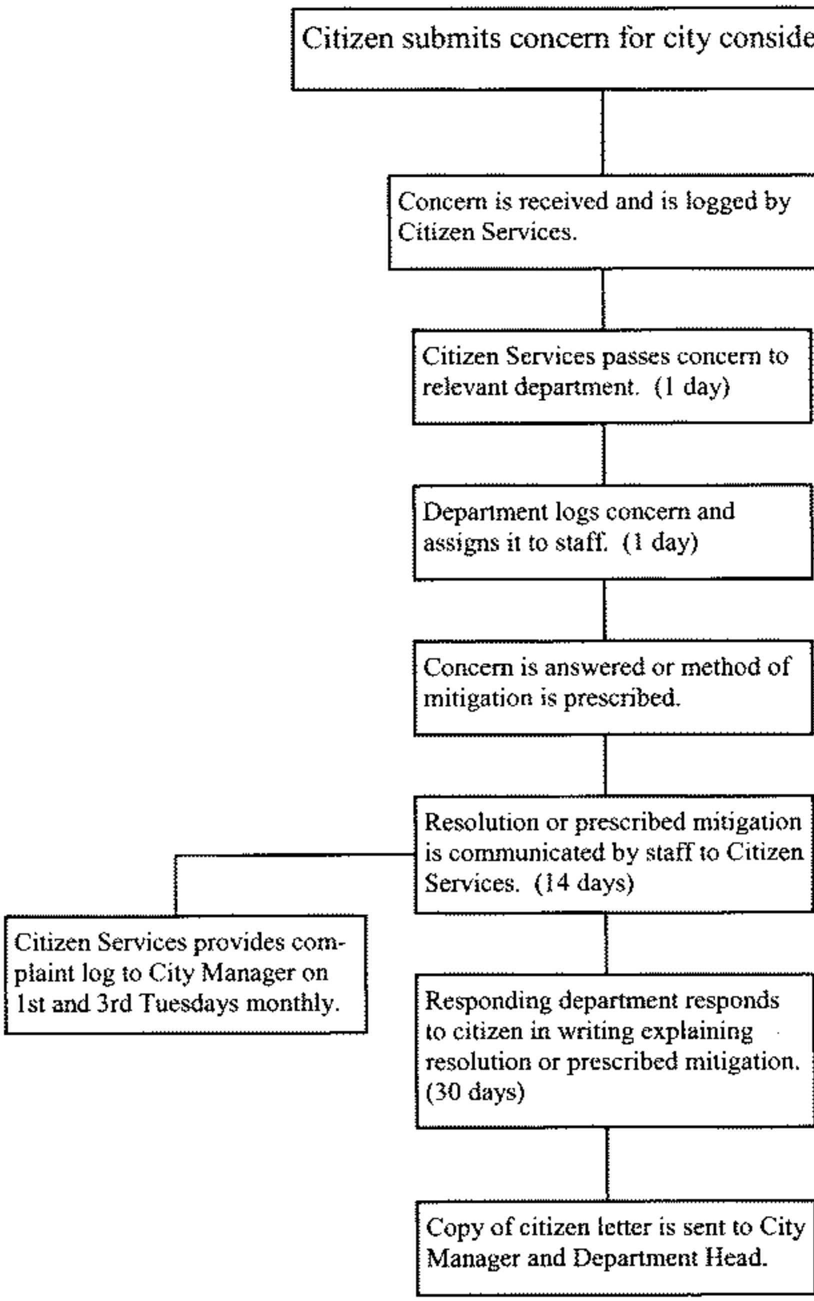
Require contractors to prepare Storm Water Pollution Prevention Plan and apply approved BMPs as necessary.

The Sewer District inspects all new sewer connections, septic tanks and drain fields. The ordinance will be reviewed and updated to include specific non-storm water discharges that may be allowed if certain conditions are met. These may include some or all of the following depending on whether the source is identified as a significant contributor of pollutants: water line flushing, landscape irrigation, diverted stream flows, rising ground waters, uncontaminated ground water infiltration, uncontaminated pumped ground water, discharges from potable water sources, foundation drains, air conditioning condensation, irrigation water, springs, water from crawl space pumps, footing drains, lawn watering, individual residential car washing, flows from riparian habitats and wetlands, dechlorinated swimming pool discharges, and street wash water.

Program to detect and eliminate illicit discharges: West Point City has developed and will implement, and enforce a program to detect and eliminate illicit discharges. The program to detect and eliminate illicit discharges is a key component to the success of the minimum control measure. The following are steps to the program:
Locate problem areas – possible methods to locate problem areas include: visual screening, public complaints, and storm water discharge sampling during dry weather.
Find the source – if problem areas are located measures will be taken to identify the source. Some methods that can be used to identify the source are: Dye-testing or smoke-testing buildings in problem areas, tracing the discharge upstream in the storm sewer, and video inspection.
Remove/Correct the illicit connection – once the source is identified, the discharger should be notified and directed to correct the problem. Efforts may be taken to work with the discharger before taking legal action.
Document actions taken – as a final step, all actions will be documented. The documentation will show that progress is being made to eliminate illicit connections and discharges.

Citizen Concern Resolution Process

IN WEST POINT CITY



Storm Sewer System Mapping: The City will include a storm drain map showing general location of all known storm drain, open ditches and discharge points (see Appendix 5). It also indicates the location of the outfall of each pipe or ditch into other major channels or other receiving waters. The storm drain map was created by collecting data for location and size using field observations, interviewing city staff, and updating older maps.

The storm water map will be very helpful when trying to locate the source of an illicit discharge, and will be updated and kept current. As new storm drain lines are constructed and put into service they will be added to the storm drain system map. This will be done on an annual basis. The map will be kept on file at the West Point City office and will also be shared with Davis County to be included in a County-wide map.

Educational Outreach: West Point City will implement training to all staff responsible for identification, investigation, termination, cleanup, and reporting of illicit discharges including spills or illicit connections. Office personnel who might receive reports of illicit discharges will also receive training. If some staff were unable to attend the training that was offered, it is the Permittee's responsibility to offer another form of training to meet requirements. This BMP also includes informing the general public and businesses hazards associated with illicit discharges and improper disposal of waste.

3.2 Measurable Goals: Table 3.1 summarizes the measurable goals for this section of the storm water management plan. The purpose of the goals is to measure success and program effectiveness.

Table 3.1

Illicit Discharge Detection and Elimination

Item #	Activity/BMP	Measurable Goal	Description	Time Schedule	Permit Section
3.1	Maintain current storm water system map	Up to date map	Keeping Storm Drain Outfall Map updated and current	Annually	4.2.3.1
3.2	IDDE Enforcement Strategy	Review Ordinance and SOP to make sure there are actions for illegal discharge	West Point City Storm Drain Ordinance and SOP's	On going	4.2.3.2
3.3	Develop SOP's for priority sites	SOP's for Priority sites	Keep developing and implementing SOP's for enforcement of priority sites.	On Going	4.2.3.2.1
3.4	Inspect priority areas	Document findings	Field inspections of priority areas as described in section 4.2.3.3.1	Annually	4.2.3.3.2

3.5	Dry Weather Screenings		Dry weather screenings, including more frequent screenings and visual inspection for high priority sites	On Going (all outfalls at least once during 5 yr. permit term)	4.2.3.3.3
3.6	Record of non-storm water discharge	Record on electronic database applications	Record all non-storm water discharges with appropriate information found in section 4.2.3.5.1	On Going	4.2.3.5.1
3.7	IDDE Documentation	Up to date documentation using electronic database applications	Provide adequate documentation as required by state	On going	4.2.3.6.1
3.8	Educate Public	Better Informed Public	Includes informing the general public and businesses hazards associated with illicit discharges and improper disposal of waste.	On Going	4.2.3.7
3.9	Collection of household hazardous waste	Proper disposal of household hazardous waste	Provide locations for proper disposal of household hazardous waste.	On Going	4.2.3.8
3.10	Hotline phone # for reporting illicit discharges		Provide a hotline for reporting of spills and other illicit discharges. And keep a written record of all calls received, and all follow-up actions taken.	On Going	4.2.3.9

3.11	Tracking spills	Updated Data base	Procedures for evaluation and assessment that includes: mapping, tracking of the number and type of spills or illicit discharges, and inspections conducted.	On Going	4.2.3.9.1
3.12	Employee training		Annual training for all related employees. Training must meet the requirement of section 4.2.3.11	Annually (new hires within 60 days)	4.2.3.11

West Point City

Standard Operating Procedures

Illicit Discharge Detection and Elimination

- **IDDE-Call-in Inspections**
- **IDDE – Opportunistic Illicit Discharge Observation**
- **IDDE-Outfall Inspections**
- **IDDE-Removing Illicit Discharges**
- **Spill Response Procedure (S.O.P)**
- **IDDE-Tracing Illicit Discharges**
- **Incident Tracking Sheet**

IDDE-Call-in Inspections

1. **Call Out Numbers**

   a. West Point's on call number (801) 628-6181

   b. Davis County Health Dept. (801) 525-5000

2. **Process**

   a. Use the Incident Tracking Sheet (see on page two of this SOP) to collect the appropriate information from the caller. Then, transfer the Incident Tracking sheet to the proper West Point authority i.e. (department head, storm water specialist, construction inspector, code enforcement officer, or other assigned personnel)

   b. Promptly investigate reported incidents.

   c. If an illicit discharge of unknown source is confirmed, follow the procedure of SOP IDDE – Tracing Illicit Discharges.

   d. If an illicit discharge known source is confirmed, follow the procedure of SOP IDDE-Removing Illicit Discharges.

3. **Clean up**

   a. Clean catch basin, clean storm drain, or initiate spill response, as applicable. Follow relevant SOP's.

4. **Documentation**

   a. File all completed forms (ie. Incident tracking, catch basins cleaning, storm drain cleaning.

   b. Document any further action taken.

   c. Review incidents reported by citizens on an annual basis to look for patterns of illicit discharges and to evaluate the call-in inspection program.

IDDE – Opportunistic Illicit Discharge Observation

1. **Preparation**

   a. Be alert for potential illicit discharges to the municipal storm water system while going about normal work activities.

2. **Process**

   a. Call the appropriate authority (ie. department head, storm water specialist, construction inspector, code enforcement officer or a supervisor) if you see evidence of an illicit discharge.

   b. Assess the general area of the illicit discharge to see if you can identify its source.

   c. Whenever possible, take photographs of the suspected illicit discharge.

   d. Responding department personnel or code enforcement officer will complete the following:

      1. Use the IDDE Incident Tracking Sheet to document observations.
      2. Obtain sample for visual observation and complete an Outfall Inspection Form, if applicable.
      3. Follow the procedure of SOP IDDE- Tracing Illicit Discharges.

3. **Clean Up**

   a. Clean catch basin, clean storm drain, or initiate spill response, as needed. Follow relevant SOP's.

4. **Documentation**

   a. File all completed forms (ie. Incident Tracking Form, Outfall Inspection Form, Catch Basin Cleaning Form, and Storm Drain Cleaning Log).

   b. Document any further action taken.

IDDE-Outfall Inspections

1. **Preparation:**
    a. Know the past present weather conditions. Conduct inspections during dry weather periods.
    b. Gather all necessary equipment including: tape measure, clear container, necessary forms, and flashlight.
    c. Obtain West Point City Outfall Map.

2. **Process**
    a. Perform an inspection of each outfall at least once per 5 year permit term. Whenever, possible use the same personnel for consistency in observations.
    b. Identify each outfall using outfall numbers on outfall map. Use maps and previous inspection reports to confirm the outfall identity and location.
    c. If dry weather flow is present at the outfall, then document and evaluate the discharge by completing the following steps:
        1. Collect field samples for visual observations in a clean, clear container and in a manner that avoids stirring up sediment that might distort the observation.
        2. Characterize and record observations on basic sensory and physical indicators (e.g., outfall condition, flow, odor, color, oil sheen) on the Outfall Inspection Form.
        3. Compare observation to previous inspections.
        4. If the flow does not appear to be an obvious illicit discharge (e.g., flow is clear, odorless, etc.), attempt to identify the source of the flow (groundwater, intermittent stream, etc.)
    d. If an illicit discharge (such as raw sewage, petroleum products, paint, etc.,) is encountered or suspected, follow the procedure of SOP IDDE-Tracing Illicit Discharges.

3. **Documentation**
    a. File completed outfall inspection forms.
    b. Update maps if new outfalls are observed and inspected.

IDDE-Removing Illicit Discharges

1. **Preparation**

   a. Obtain available property ownership information for the source of the illicit discharge.

2. **Process**

   a. Determine who is financially responsible, and follow associated procedures as given below.

   For Private Property Owner:
   Contact Owner,
   Issue Notice of Violation for violations of the municipal ordinance, and determine schedule for removal.

   For Municipal Facilities:
   Notify appropriate municipal authority or department head. Schedule removal, and remove illicit connection.

   b. Suspend access to storm drain if threats of serious physical harm to humans or the environment are possible.
   c. Direct responsible party to initiate repairs/ corrections/cleanup. Coordinate with enforcement official for escalating penalties in accordance with the municipal ordinance.
   d. Repair/correct cause of discharge if municipality is responsible. Schedule the work through the appropriate municipal authority or department head.
   e. Seek technical assistance from the Davis County Health Department or Utah Department of Water Quality, if needed.

3. **Clean- Up**

   a. Confirm illicit discharge is removed or eliminated by follow-up inspection.

4. **Document**

   a. Maintain records of notice of violation and penalties.
   b. Document repairs, corrections, and any other actions required.

Spill Response Procedure (S.O.P)

Even if a spill does not reach a storm drain, if is still an Illicit discharge it must be recorded.

Follow these steps if a spill occurs:

1. Stop source

2. Contain Spill

3. Call Supervisor

4. Identify substance

5. Quantify spill

6. Did spill leave the site?

7. Call County Health Department (801) 525-5000 if reportable amount.

8. Call State Environmental Emergency Response (801) 536-4123 if reportable amount.

9. Clean up & dispose

10. Document

IDDE-Tracing Illicit Discharges

1. **Preparation**

    a. Review/consider information collected when illicit discharge was initially identified and document using Incident Tracking form or Outfall Inspection Form.

    b. Obtain storm drain mapping for the area of the reported illicit discharge.

    c. Gather all necessary equipment including: tape measure, clear container, necessary forms, flashlight, and camera.

2. **Process**

    a. Survey the general area/surrounding properties to identify potential sources of the illicit discharge as a first step.

    b. Trace illicit discharges using visual inspections of upstream points as a second step. Use available mapping to identify tributary pipes, catch basins, etc.

    c. If the source of the illicit discharge cannot be determined by a survey of the area or observation of the storm drain system, then consider the following additional steps:

        1. Use weirs, sandbags, or dams to collect or pool intermittent discharges during dry weather.
        2. Smoke test or camera the storm drain system to trace high priority, difficult to detect illicit discharges.
        3. Dye test individual discharge points within suspected buildings.
        4. Consider collecting samples of flowing discharges to confirm/refute illicit discharge.

    d. If the source is located, follow (SOP IDDE-Removing Illicit Discharges).

    e. If the source cannot be found, add the location to a future inspection program.

3. **Clean up**

    a. Clean catch basin, clean storm drain, or initiate spill response, as applicable. Follow relevant SOP's.

4. **Documentation**

    a. Document tracing results for future reference.

Incident Tracking Sheet

Date illicit discharge was known: ______________________________
Date of illicit discharge: ______________________________
Date of initiated investigation: ______________________________
Date discharge was observed: ______________________________
Time of Discharge: ______________________________
Duration of discharge: ______________________________
Quantity of spill: ______________________________
Location of spill: ______________________________
Name of person or entity that had the spill: ______________________________
Name and phone number of person making the call: ______________________________

1. Is the spilled substance non-hazardous? Yes No N/A
2. Was the illicit discharge contained prior to entering the storm drain System? Yes No N/A
3. Was the illicit discharge contained prior to entering a water body? Yes No N/A
4. Is the spilled substance FREE from having any known or anticipated Acute or chronic health risks for exposed individuals associated with the emergency spill? Yes No N/A

Date of removal/repair: ______________________________
Clean up that has taken place: ______________________________
Clean up that is still needed: ______________________________
Who has been contacted to assist in the clean-up: ______________________________
Enforcement action: ______________________________
Date of enforcement action: ______________________________
Any additional notes that are needed: ______________________________
____
____
____
____

List health precautions taken: ______________________________
____

Was the spill reported-including if contact was made to the local fire department, health department, and state Division of Water Quality for any spill of reportable quantity?
Yes No N/A

4.0 CONSTRUCTION SITE STORM WATER RUNOFF CONTROL

This section of this SWMP addresses how polluted runoff from construction sites will be controlled. Construction site storm water runoff often contains high quantities of sediment from unprotected excavation as well as debris from the construction site. The sediments and harmful debris create problems downstream and thus must be controlled. This plan will require certain control measures to be implemented for any construction site greater than or equal to one acre in size, including projects less than one acre that are part of a larger common plan development or sale which collectively disturbs land greater than or equal to one acre.

4.1 <u>BMPs</u>

a) Review and update ordinance to require construction site SWPPPs
b) Maintain and review SOP's
c) Pre-Construction Meetings
d) Site Inspection
e) Staff Training

<u>Construction Site Runoff Control Ordinance:</u> West Point City plans to annually review and update the ordinance that will require that pollution from construction site storm water runoff be controlled. The ordinance will require at a minimum that a storm water pollution prevention plan (SWPPP) be submitted as part of the construction plans for any site greater than one acre in size 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 in size. As well as projects of all departments of West Point City. The plan must indicate how the runoff will be controlled and how sediment and harmful materials will be prevented from entering storm drainage systems during construction. The plan must list specific BMPs that will be used such as, but not limited to, construction entrance/exit stabilization, perimeter controls, sediment retention structures, sediment filters, vehicle maintenance and washing areas, and cement truck washout areas. West Point City Standards will be updated to include details of minimum requirements for typical sediment filters, stabilization and washing areas. The SWPPP requirements must be, at minimum, equivalent with the SWPPP requirements set forth in the most current UPDES Construction General Permit, or UPDES Common Plan Permit, which ever permit is applicable to the site. Information regarding appropriate BMPs and standard details will be made available to the responsible person for the construction site. Once the plan has been received and approved, the responsible person for the site must ensure that the BMPs are implemented. If BMPs are not implemented the City will have the right to stop work until the problems are corrected. The ordinance will include provisions to allow access by qualified personnel to inspect storm water BMPs on private properties.

<u>Maintain and Review SOP's:</u> West Point City will develop an enforcement strategy to enforce provisions of the ordinance. Procedures will be developed to minimize violations and obtain compliance from violators through escalating enforcement actions. An appeals process will be included in the enforcement procedures and actions and published in a publicly accessible location. The City will document and track all enforcement actions.

A site plan for any construction activity in West Point City is required by ordinance to be submitted for review prior to beginning work. The site plan is reviewed and approved by the City Engineer and other City Staff. The site plan review process will be revised to include a review of the SWPPP that will be required by ordinance for construction projects disturbing greater than or equal to one acre and to construction projects of 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. The City Engineer or qualified person will review the plan to ensure that the appropriate BMPs are included and that storm water pollution from the proposed construction site will be reduced to the maximum extent practicable. Work may not commence until the plan has been approved by the reviewer. The City will provide training to staff involved in permitting, planning, and review. The City will keep records of project site plan reviews, SWPPPs inspections and all enforcement actions on file for five years or until construction is completed, whichever is longer. Training records will be kept including dates, course description, and staff in attendance.

Site Inspections: West Point City currently requires several site inspections of construction activities by Engineering and City Staff. The inspections will ensure that the BMPs listed in the approved storm water pollution plan are being implemented. Inspections shall be conducted at least monthly. The inspector does have the right to stop work if the plan is not being followed or if he or she can see a problem that may cause pollution of storm water. Inspectors will receive necessary training in erosion prevention and sediment control and adhere to the guidelines in section 4.2.4.4.1. The City will identify priority construction sites considering the following:

- Soil erosion potential;
- Site slope;
- Project size and type;
- Sensitivity of receiving waterbodies (impaired or high quality waters);
- Proximity to receiving waters;
- Non-storm water discharges and past record of non-compliance by the operators of the construction site.

These priority sites will be inspected bi-weekly. Procedures will be implemented for keeping records of inspections and enforcement actions. Construction operator/owners shall notify the city of their completion of construction activities and a city inspector will verify before removal of all temporary control measures.

Staff Training: West Point City will ensure that all staff whose primary job duties are related to implementing the construction storm water program, including permitting and plan review, construction site inspections, and enforcement, are trained to conduct these activities annually. All new hires will be trained upon being hired (within 60 days) and will be annually trained thereafter.

4.2 **Measurable Goals:** Table 4.1 summarizes the measurable goals for this section of the storm water management plan. The purpose of the goals is to measure success and program effectiveness.

Table 4.1					
Construction Site Storm Water Runoff Control					
Item #	Activity/BMP	Measurable Goal	Description	Time Schedule	Permit Section
4.1	Review and update Ordinances		Review and Update Ordinance	Annually	4.2.4.1
4.2	Maintain SOP		Keep developing and implementing SOP's to address specific items and implementing escalating enforcement action items.	On Going	4.2.4.2.1
4.3	Pre-Construction Meetings	Hold Preconstruction Meeting for all projects	Keep developing and implementing SOP's to address specific items and implementing escalating enforcement action items.	On going	4.2.4.3 – 4.2.4.3.1
4.4	Site Inspection	Inspect all Construction Sites as required	Sites requiring a SWPPP, will be inspected at least monthly. Priority site must be inspected at least biweekly.	On going	4.2.4.4.5
4.5	Hotline Phone #	Active hotline phone number	Publicize hotline or other local telephone number for public reporting of storm water related issues.	On going	4.2.4.4.5
4.6	Staff Training	All Staff and new hires are trained	Ensure that all staff whose primary job duties are site inspections are trained to conduct these activities	Annually (new hires within 60 days)	4.2.4.5

West Point City

Standard Operating Procedures

Construction Site Storm Water Runoff Control

- **SWPPP Construction Plan Review**
- **SWPPP Construction Site Inspections**
- **SWPPP-Concrete Washouts**
- **SWPPP Verbal Warnings/Notice of Violation**
- **SWPPP Violations and Enforcement for Construction Sites**

SWPPP Construction Plan Review

Preparation

a. Make sure developer/contractor has all of the appropriate documents before Pre-Construction Meeting.
   - SWPPP
   - Site plan Showing all BMP's
   - Copy of UPDES (NOI) permit issued by the State
   - Copy of Inspection form to be used
   - Copy of West Point City's Applicant Certification form

Process

a. Make sure SWPPP is filled out properly.
b. Make sure (NOI) is taken out with the State of Utah.
c. Review site plan, checking for proper BMP's to be used during construction, concrete washouts, portable toilets, SWPPP sign and where SWPPP can be located etc. Concrete washouts must be lined, and cannot be more the 75% full at any time. Look for any area's that might need stabilization during construction, keeping in mind that 70% of area must be vegetated or stabilized. Except for flat areas with 5% or less grade, where no stabilization is needed.
d. When long term BMP's are needed, look to incorporate any low impact designs (LID) into the site design.
e. If any long term BMP's are needed on site a maintenance agreement must be arranged.

Follow Up

a. All of the above must be complete before construction can take place.

SWPPP CONSTRUCTION SITE INSPECTIONS

Preparation

a. Make sure the proper inspection is assigned to the site on compliance go or other electronic storm water management software, or have proper inspection form.

b. Contact operator of the site.

Process

a. Make physical inspection to insure all BMP's are in place and in good working order. UPDES number must be posted on site and SWPPP documents must be made available in a reasonable time frame.

b. Look for any areas where spills, leaks, or any other pollutants could occur.

c. Look for any areas where any new BMP's are needed or current BMP's are no longer needed.

d. Look for any points of discharge, where sediment or erosion may take place. Both on site and any receiving waters near the site.

e. Identify any corrective action items that need to be addressed, and time frame in which to be corrected.

f. Check that operator has been doing weekly/bi-weekly inspections, and that site map is current and up to date.

g. Fill out inspection form and notify operator of outcome of the inspection.

Follow Up

a. Physically make sure all corrective action items are taken care of, and documented in time frame given.

SWPPP-Concrete Washouts

Make sure concrete washouts are:

- **Marked**
- **Accessible**
- **Lined or in a container with no leaks**
- **Maintained**
- **Not more than 75% full**
- **Concrete can be dumped out on the ground, but must be hauled off. But washing out must be done in concrete washout.**

SWPPP Verbal Warnings/Notice of Violation

- All verbal warnings/notice of violation must be documented and recorded in Compliance go or other electronic storm water management software. If paper inspection sheet is used it must be filed and retained.

- All action items must be remedied in appropriate time frame given at time of inspection.

- All action items remedied must be documented and recorded in Compliance go or other electronic storm water management software. If paper inspection sheet is used it must be filed and retained.

- If action item is not remedied in appropriate time frame, a (Stop Work Order) will be issued.

- It will be thereby ordered in accordance with the given code that all persons cease and desist from and stop work at once pertaining to construction, until remedied.

SWPPP Violations and Enforcement for Construction Sites

Inspections

a. If a violation is found, it must be remedied within a reasonable time frame.

Evaluate

a. Evaluate the situation.
b. Based on evaluation give notice or warning to operator of the site. Including time frame in which to be remedied.
c. Follow up to make sure all action items are properly taken care of.

Enforcement

West Point City Ordinance 07-05-2005 Section 9-3a-17

a. (Verbal Warning) (Notice of Violation)- Inform site operator of violation. Document violation on inspection form, and given time to comply. Follow up to make sure problem is fixed, in the given time frame.

b. (Stop Work Order)- If site operator fails to comply within time frame, or refuses to comply at all. No activity will be allowed on site until any/all violations are remedied.

c. (Administrative Fines)- The city may skip the notice requirements set forth in Section 9-3a-17 of Ordinance 07-05-2005 and immediately proceed with criminal and/or civil action against the violator if (1) the violator has committed the same violation in the past, or (2) the violation, in the opinion of the city, creates a serious risk to persons, the environment or property, or (3) the city deems the violation to constitute an emergency.

d. If the violation appears to the West Point public works director as "egregious," or willful disregard for administrative actions issued by the West Point, then the city can issue a Class C Criminal citation under West Point City Ordinance 07-05-2005 Section 9-31-18. This ordinance does not preclude further administrative or criminal action by the State of Utah, or the United States Environmental Protection Agency.

5.0 Post-Construction Storm Water Management in New Development and Redevelopment

This section of the SWMP will address how polluted runoff from newly developed or redeveloped areas will be controlled. Pollution from new streets or other types of new construction can be a serious concern because of the quality of the runoff and the increased amount of runoff due to impervious surface created by new construction. The following sections will outline the methods and procedures that West Point City will implement to ensure that pollutants discharged into storm drainage facilities will be reduced to the maximum extent practicable.

West Point City will develop, implement and enforce a program to address post-construction storm water runoff to the MS4 from new development and redevelopment construction sites disturbing greater than or equal to one acre, 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. The objective of this control measure is for the hydrology associated with new development to mirror the pre-development hydrology of a redeveloped site and reduce the discharge of storm water. The water quality considerations of this control measure do not replace or substitute for water quantity or flood management requirements implemented on the local level for new developments. The water quality controls may be incorporated into the design of structures intended for flow control; or water quality control may be achieved with separate control measures. The program will apply to private and public development sites, including roads. West Point City will meet the following performance measures, required by section 4.2.5 of the MS4 General Permit.

West Point City's new development/redevelopment program will have requirements and standards to ensure that any storm water controls or management practices will prevent or minimize impacts to water quality.

West Point City's new program will include non-structural BMP's in areas susceptible to erosion and sediment loss; to minimize the disturbance of native soils and vegetation; to preserve areas that provide important water quality benefits; implement measures for flood control; and to protect the integrity of natural resources and sensitive areas.

5.1 <u>BMPs</u>

a) Develop and adopt ordinance.
b) Implement enforcement strategy.
c) Enforcement of BMP's
d) Documentation on how to protect water quality and reduce discharge of pollutants.
e) Standards for storm water control or management practices that will prevent or minimize impacts to water quality.
f) Non-structural BMP's
g) Low Impact Development (LID) Approach
h) Define specific hydrologic method for calculating runoff volumes

i) Site Plan reviews
j) Maintenance agreements
k) Development of SOP's
l) Inspections
m) Staff Training
n) Post-construction Inventory

Post-Construction Runoff Control Ordinance: West Point City has adopted Ordinance that requires long-term post-construction storm water controls at new development and redevelopment sites. The ordinance will apply, at a minimum to new development and redevelopment sites that discharge to the MS4 and disturb greater than or equal to one acre, 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. The ordinance also will meet the technical requirements set forth in the UPDES Storm Water General Permit for Construction Activities. The Ordinance will require BMP selection, design, installation, operation and maintenance standards necessary to protect water quality and reduce the discharge of pollutants to West Point City. The ordinance addresses standards for storm water runoff control methods, including structural and non-structural BMPs, which must be incorporated into the development plans. The ordinance addresses items such as required detention and allowable flow rates from new developments, and maintaining storm water quality by the use of structural BMPs such as oil water separators or debris separators these will be evaluated and adjusted as necessary to meet new requirements. The ordinance also discusses ongoing maintenance of storm drainage systems and will specify who will be responsible. West Point City will develop enforcement strategies and implement the enforcement provisions of the ordinance.

- West Point City will provide documentation on how the requirement of the ordinance will protect water quality and reduce the discharge of pollutants to West Point City.
- Documentation will include:

  How long-term storm water BMP's were selected.
  The pollutant removal expected from the selected BMP's.
  The technical basis which supports the performance claims for the selected BMP's.

Strategies to reduce pollutant discharges: West Point City will develop and implement strategies that will reduce the discharge of pollutants to the maximum extent practicable. The approved BMPs consist of structural and non-structural. The post construction runoff ordinance addresses site storm water runoff.

- West Point will review the enforcement of BMP's.
- Procedures that include specific processes and sanctions to minimize the occurrence of, and obtain compliance from, chronic and recalcitrant violators which shall include appropriate, escalating enforcement procedures and actions.

<u>Program to address post construction runoff:</u> West Point City will develop, implement, and enforce a program to address post construction runoff for new development and redevelopment sites that discharge to the MS4 and disturb greater than or equal to one acre, 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. The program will assure that controls are in place to protect water quality. The following will be implemented as part of the program:

Site Plan Review: As part of the site plan review process West Point City staff will ensure that the requirements of the ordinance will be met. Site plans and detailed construction drawings must clearly indicate how storm water will be handled and what structural and non-structural BMPs will be incorporated into the plans to ensure storm water quality is maintained to the maximum extent practicable. The development will not be approved until the city staff has reviewed and approved the SWPPP. The City will provide developers with preferred specifications to effectively treat storm water from industrial and commercial developments. The City will maintain information submitted for five years.

- Provide developers and contractors with preferred design specifications.
- Have site plan review which incorporate consideration of water quality. During SWPPP plan reviews.

Low Impact Development (LID): The City has adopted a LID standard. The Standard for Low Impact Development is included in Appendix 10. The primary goal of Low Impact Development methods is to mirror the predevelopment site hydrology by using site design techniques that store, infiltrate, evaporate, and retain 80th percentile storm water runoff. West Point City will require that new development retain the 80th percentile storm events. Redevelopment sites that increase 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 80th percentile rainfall event.
Encourage the use of Storm water harvesting on individual lots; this will reduce the size of detention/retention area needed. West Point City will look at implementing new innovative ideas for roadway sections that will the use of Bio-retention, Infiltration trenches, Roadside swales or other approved techniques for roadside retention.

- West Point City will develop and define specific hydrologic method or measure for calculating runoff volumes and flow rates to ensure consistent sizing of structural BMP's.

<u>Site Inspections:</u> West Point City inspection is responsible to see that new developments are constructed according to the approved plans. The inspections will ensure that structural BMPs are installed properly and that the drainage system is constructed as designed and approved. Structural BMPs will be inspected once during installation and at least once every year after completion. If the BMPs are maintained by the property owner/operator, The City will inspect the control measures at least once every 5 years. If deficiencies are identified, the City will repair the problem as soon as possible. The inspector will ensure that all requirements have been met. Records of inspection and enforcement actions will be maintained. The City will provide and keep record of training given to all staff involved in permitting, planning, review, inspection, and enforcement.

Long Term Operation and Maintenance Program: A maintenance program has been developed to provide an organized method for storm drainage system maintenance. The City Engineer along with the Maintenance Director and other City Staff will develop the plan. The program will include cleaning the structural BMP's such as oil water separators and debris separators on regularly scheduled intervals. The program will also address inspections and repairs of such systems. The following is the program outline:

Inventory – Of all post-construction structural storm water control measures installed on sites greater than or equal to one acre. Include a short description of storm water control measure, maintenance requirements and inspection information prior to closing out construction project. This inventory must include both public and private sector sites that meets section 4.2.5.4.
Inspect to locate problem areas – Annual inspections of structural BMPs and inspections to follow up on any complaints from the public.
Find the source – if problems are identified, the inspector will investigate to find the source of the problem so that the City can determine the appropriate solution.
Fix the problem – the City will make best effort to fix any identified problems and implement preventative maintenance methods.
Document actions taken – as a final step, all actions will be documented. The documentation will show that an effort is being made to implement the program. The following will be included:

- Inspection date;
- Name and signature of inspector;
- Project location;
- Current ownership information;
- A description of the condition of the storm water control measure.
- Specific maintenance issues or violations found that need to be corrected by the property owner or operator along with deadlines and re-inspection dates.

- The ordinance will include provisions for both construction-phase and post-construction access for inspections on private property. In lieu of city inspectors inspecting and maintaining storm water controls on private property, West Point can require owner/operator to conduct these activities. A Maintenance Agreement between private owner/operators will be made to ensure control measures are being maintained and operating as designed. Permittee will have the right to inspect and perform necessary maintenance or corrective actions neglected by the property owner/operator and recoup the costs from property owner/operator as needed.

- Permanent structural BMP's will be inspected at least once during installation by qualified personnel and a minimum of every other year or as necessary to maintain functionality.
- Inspections and any necessary maintenance will be conducted annually by either a city employee or through a maintenance agreement, with the owner/operator.
- On sites where the owner/operator is conducting maintenance, West Point City will inspect those sites at least every five years, or more if necessary.
- West Point City will provide adequate training for all staff involved in post-construction storm water management.
- West Point City will provide an inventory of all post-construction structural storm water controls implemented at new development and redeveloped sites, and keep inventory updated as needed.

5.2 **Measurable Goals:** Table 5.1 summarizes the measurable goals for this section of the storm water management plan. The purpose of the goals is to measure success and program effectiveness.

Table 5.1					
Post Construction Storm Water Management in New Development and Redevelopment					
Item #	Activity/BMP	Measurable Goal	Description	Time Schedule	Permit Section
5.1	Develop and adopt ordinance	Update Ordinance	West Point will develop and adopt an addition to Ordinance that requires long-term post-construction storm water controls at new development and redevelopment sites.	Annually	4.2.5.2
5.2	Implement enforcement strategy	The number of Violations reported drop	West Point City will develop enforcement strategies and implement the enforcement provisions of the ordinance	On going	4.2.5.2.1
5.3	Enforcement of BMP's	The number of Violations reported drop	Procedures that include specific processes and sanctions to minimize the occurrence of, and obtain compliance from, chronic and recalcitrant violators which shall include appropriate, escalating enforcement procedures and actions	On going	4.2.5.2.1

5.4	Documentation	Documentation of all BMP	Documentation: How long-term storm water BMP's were selected. The pollutant removal expected from the selected BMP's. The technical basis which supports the performance claims for the selected BMP's.	On going	4.2.5.2.2
5.5	Standards	Updated Standards	Requirements and standards to ensure that any storm water controls or management practices will prevent or minimize impacts to water quality.	On Going	4.2.5.1
5.6	non-structural BMP's		The use of non-structural BMP's in sensitive areas for flood control.	On Going	4.2.5.1.1
5.7	LID Approach	LID BMP's installed	Evaluate and encourage a Low Impact Development (LID). The selection and design of post-construction controls will take into consideration clogging or obstruction issues, freeze-thaw problems, effects on slope stability and groundwater, and the ability to effectively maintain the control.	On Going	4.2.5.1.3
5.8	Site Plan reviews	100% of Site Plans reviewed	Have site plan review which incorporate consideration of water quality. During SWPPP plan reviews.	On Going	4.2.5.3

5.9	Maintenance Agreements	Agreements Recorded / Received	When applicable maintenance agreements will be developed and recorded.	On Going	4.2.5.2.3
5.10	Development of SOP's	Updated SOP's	Keep developing and implementing SOP's for enforcement of post-construction storm water controls.	On Going	4.2.5.2.2
5.11	Inspections	All construction sites are inspected as required	The ordinance will include provisions for both construction-phase and post-construction access for inspections on private property	Bi-annually	4.2.5.2.5
5.12	Staff Training	100% of Staff Trained	West Point City will provide adequate training for all staff involved in post-construction storm water management.	Annually	4.2.5.5
5.13	Post-Construction Inventory	Up to date inventory	West Point City will provide an inventory of all post-construction structural storm water controls implemented at new development and redeveloped sites, and keep inventory updated as needed.	On Going	4.2.5.4 – 4.2.5.4.2

6.0 Pollution Prevention and Good Housekeeping for Municipal Operations

This section of the SWMP is intended to address plans for reducing pollutants discharged from municipal operations. West Point City owns facilities where materials are stored which may become pollutants if not handled properly and many of the operations of the public works crews can have an effect on the storm water quality. The plans set forth in this section are intended to reduce the pollutants discharged to the maximum extent practicable by providing training for City Staff and implementing procedures for proper handling of materials.

West Point City is currently developing and implementing an Operations and Maintenance (O&M) program for city owned or operated facilities, operations and structural storm water controls that includes (SOP's) and training components that have the goal of preventing or reducing pollutant runoff from all city owned or operated facilities and operations. All components will be included in this SWMP, and will identify the department responsible for performing each activity described in this section. West Point will meet the following performance measures:

Facilities covered under the General UPDES Permit for Strom Water Discharges Associated with Industrial Activities do not need an (O&M) program but must instead maintain the SWPPP plan required by the permit.

6.1 BMPs

a) Inventory of City Owned Facilities and Storm Water Controls
b) Review Inventory annually
c) Identify High Priority Facilities
d) Inspections as required
e) Develop SOP's and O&M
f) Street Sweeping
g) Catch Bain Cleaning
h) Plan to retrofit Existing City Owned Sites that are Adversely Impacting Water Quality.

Inventory of City Facilities: See Appendix 5 map of "High-Priority" Permittee-owned facility.

- Keep a written inventory and assessment of all city owned or operated facilities and storm water controls. See section 4.2.6.1 for list of facilities.
- Factors that must be considered in giving a facility a high priority ranking is the amount of urban pollutants stored at the site, the identification of improperly stored materials, activities that must be performed outside (e.g., changing automotive fluids), proximity to waterbodies, poor housekeeping practices, and discharge of pollutant(s) of concern to impaired water(s).
- Identify potential typical urban pollutants.
- A description of the assessment process and findings must be included in the SWMP document (4.2.6.2).

- The SWPPP shall identify potential sources of pollution that may reasonably be expected to affect the quality of storm water discharges associated with activity from the facility.
- The SWPPP shall include a site map showing the following information as listed under section 4.2.6.4
- Review inventory (annually) and updated as necessary.
- Any high priority facilities will have facility specific SOP's and BMP's, considering a Low Impact Design (LID) whenever possible.

High Priority Site Inspections: West Point City will conduct inspections at "high priority: Permittee-owned or operated facilities.

- Monthly visual inspection: West Point City will perform monthly visual inspections of 'high priority' facilities in accordance with developed SOP's. The monthly inspections will be tracked in a log for every facility and records will be kept.
- Semi-Annual comprehensive inspections: at least once semi-annually, a comprehensive inspection of 'high priority' facilities in accordance with the developed SOP's. The semi-annual inspections will be documented and recorded and kept.
- Annual visual observation of storm water discharges: at least once annually, West Point City will visually observe the quality of the storm water discharges from the 'high priority' facilities, unless climate conditions preclude doing so, in which case we will attempt to evaluate the discharge four times during the wet season.(Taking samples of sheet flows.) Following all related SOP's, the inspections will be recorded and documented and kept.

Street Sweeping: West Point currently cleans sediment filled gutters by means of removing sediment using street sweepers and shovel removal. West Point is setting a goal to increase the identification of streets in need of cleaning and to then keep accurate records of events and dates for use in future budgeting.

Plan to retrofit Existing City Owned Sites that are Adversely Impacting Water Quality: West Point City will develop a plan to retrofit existing developed City Owned sites that are adversely impacting water quality. The retrofit shall emphasize LID BMPs. The following will be included when developing criteria for the retrofit plan:

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

6.2 Measurable Goals: Table 6.1 summarizes the measurable goals for this section of the storm water management plan. The purpose of the goals is to measure success and program effectiveness.

Table 6.1					
Pollution Prevention and Good Housekeeping for Municipal Operations					
Item #	Activity/BMP	Measurable Goal	Description	Time Schedule	Permit Section
6.1	Inventory	current list of city owned facilities	Keep a written inventory and assessment of all city owned or operated facilities and storm water controls.	On going	4.2.6.1
6.2	Review Inventory		Review inventory (annually) and updated as necessary	Annually	4.2.6.2
6.3	Identify High Priority Facilities		Any high priority facilities will have facility specific SOP's and BMP's, considering a Low Impact Design (LID) whenever possible.	On going	4.2.6.3 4.2.6.4
6.4	Monthly Inspections	Monthly Inspections will be documented and recorded.	Monthly visual inspection: West Point City will perform Monthly visual inspections of 'high priority' facilities in accordance with developed SOP's.	Monthly	4.2.6.5.1
6.5	Semi-Annual Comprehensive Inspections	Semi-Annual inspections will be documented and recorded	Semi-Annual comprehensive inspections: at least once Semi-Annually, a comprehensive inspection of 'high priority' facilities in accordance with the developed SOP's.	Semi-Annual	4.2.6.5.2

6.6	Annual visual observation	Annual inspections will be documented	Annual visual observation of storm water discharges: at least once Annually, West Point City will visually observe the quality of the storm water discharges from the 'high priority' facilities.	Annual	4.2.6.5.3
6.7	Develop SOP's				4.2.6.6
6.8	Inventory of Floor Drains inside Permittee owned buildings	Up to date Inventory	Permittee must ensure that all floor drains discharge to appropriate location.	Annually	4.2.6.6.6
6.9	Street Sweeping		Clean sediment filled gutters by means of removing sediment using street sweepers and shovel removal.	On going	4.2.6.6.2
6.10	Catch Basin Cleaning	Keep priority catch basins cleaned	Create a priority schedule for cleaning catch basins	On going	4.2.6.6.2 - 4.2.6.6.3
6.11	Plan to retrofit sites that are adversely impacting water quality.	Retrofit as needed with adverse water quality impacts	The following will be included when developing criteria for the retrofit plan: -Proximity to waterbody -Status of waterbody to improve impaired waterbodies and protect unimpaired waterbodies -Hydrologic condition of the receiving waterbody Proximity or sensitive ecosystem or protected area -Any upcoming sites that could be further enhanced by retrofitting storm water controls	On Going	4.2.6.9

West Point City

Standard Operating Procedures

Pollution Prevention and Good Housekeeping for Municipal Operations

- **Parks – Chemical Application Pesticides, Herbicides, Fertilizers**
- **Parks – Cleaning Equipment**
- **Parks- Mowing and Trimming**
- **Parks- Planting Vegetation (Starters)**
- **Parks- Planting Vegetation (Seeds)**
- **Streets/Storm Drain - Catch Basin Cleaning**
- **Streets/Storm Drain - Curb Painting**
- **Streets/Storm Drain - Detention Pond Cleaning**
- **Streets/Storm Drain - Shouldering and Mowing**
- **Streets/Storm Drain - Concrete Work**
- **Streets/Storm Drain - Garbage Storage**
- **Streets/Storm Drain - Snow Removal and De-icing**
- **Streets/Storm Drain - Street Sweeping**

PARKS – Chemical Application Pesticides, Herbicides, Fertilizers

1. Preparation
   a. Make sure your state Chemical Handling Certification is complete and up-to-date before handling any chemicals.
   b. Calibrate fertilizer and pesticide application equipment to avoid excessive application.
   c. Use pesticides only if there is an actual pest problem and periodically test soils for determining proper fertilizer use
   d. Time and apply the application of fertilizers, herbicides or pesticides to coincide with the manufacturer's recommendation for best results ("Read the Label").
   e. Know the weather conditions. Do not use pesticides if rain is expected. Apply pesticides only when wind speeds are low(less than 5 mph).

2. Process
   a. Always follow the manufacturer's recommendations for mixing, application and disposal. ("Read the Label").
   b. Do not mix or prepare pesticides for application near storm drains, preferably mix inside a protected area with impervious secondary containment (preferably indoors) so that spills or leaks will not contact soils.
   c. Employ techniques to minimize off-target application (e.g. spray drift, over broadcasting.) of pesticides and fertilizers.

3. Clean-up
   a. Sweep pavements or sidewalks where fertilizers or other solid chemicals have fallen, back onto grassy areas before applying irrigation water.
   b. Triple rinse containers, and use rinse water as product. Dispose of unused pesticide as hazardous waste.
   c. Always follow all federal and state regulations governing use, storage and disposal of fertilizers, herbicides or pesticides and their containers. ("Read the Label")

4. Documentation
   a. Keep copies of MSD sheets for all pesticides, fertilizers and other hazardous products used.
   b. Record fertilizing and pesticide application activities, including date, individual who did the application, amount of product used and approximate area covered.

PARKS – Cleaning Equipment

1. Preparation
   a. Review process with all Parks employees

2. Process
   a. Wipe off dirt, dust and fluids with disposable towel
   b. Wash equipment in approved wash station

3. Clean-up
   a. Dispose of towels in proper trash receptacle
   b. Sweep floor and dispose of debris.

PARKS – Mowing and Trimming

1. Preparation
   a. Process overview with all employees
   b. Check the oil and fuel levels of the mowers and other equipment; fill if needed.

2. Process
   a. Put on eye and hearing protection
   b. Mow and trim the lawn
   c. Sweep or blow clippings to grass areas
   d. Remove inlet protection

3. Clean-up
   a. Mowers are to be scraped and brushed at shop – dry spoils are dry swept and disposed of properly.
   b. Wash equipment in approved wash station

PARKS – Planting Vegetation (Starters)

1. Preparation
   a. Call the Blue Stakes Center of Utah at least 2 working days before any digging will be done, to reveal the location of any underground utilities.
   b. Dial 811 or 1-800-662-4111
   c. Decide where any spoils will be taken.

2. Process
   a. Dig holes; place spoils near the hole where they may easily be placed back around roots. Avoid placing spoils in the gutter.
   b. Bring each plant near the edge of the hole dug for it.
   c. Check the depth of the hole, and adjust the depth if necessary. The depth of the hole for a tree should be as deep as the root ball, so that the top of the root ball is level with the top of the hole.
   d. Carefully remove pot or burlap.
   e. Place the plant in the hole.
   f. Backfill the hole with existing spoils, compost, and a litter fertilizer if desired. Do not use excessive amendments.
   g. Water the plant.
   h. Stake the plant, if necessary, to stabilize it.

3. Clean-up
   a. Move any extra spoils into truck or trailer. Place the spoils on a tarp if there is a likelihood that some of the dirt would be lost through openings in the bed.
   b. Sweep dirt from surrounding pavement(s) into the planter area
   c. Transport spoils to their designated fill or disposal area.

PARKS – Planting Vegetation (Seeds)

1. Preparation
   a. Call the Blue Stakes Center of Utah at least 2 working days before any digging will be done, to reveal the location of any underground utilities.
   b. Dial 811 or 1-800-662-4111
   c. Decide on the application rate, method, water source, and ensure adequate materials are on hand.
   d. Grade and prepare the soil to receive the seed. Place any extra soil in a convenient location to collect.

2. Process
   a. Place the seed and any cover using the pre-determined application method (and rate).
   b. Lightly moisten the seed.

3. Clean-up
   a. Move any extra spoils into truck or trailer. Place the spoils on a tarp if there is a likelihood that some of the dirt would be lost through openings in the bed.
   b. Sweep dirt, seed, and any cover material from surrounding pavement(s) into the planter area
   c. Transport spoils to their designated fill or disposal area.

STREETS/STORM DRAIN – Catch Basin Cleaning

1. Preparation:
   a. Clean sediment and trash off grate.
   b. Do visual inspection on outside of grate.
   c. Make sure nothing needs to be replaced.
   d. Do inside visual inspection to see what needs to be cleaned.

2. Process
   a. Clean using a high powered vacuum truck to start sucking out standing water and sediment.
   b. Use a high pressure washer to clean any remaining material out of catch basin, while capturing the slurry with the vacuum.
   c. After catch basin is clean, send the rodder of the vacuum truck downstream to clean pipe and pull back sediment that might have gotten down stream of pipe.
   d. Move truck downstream of pipe to next catch basin.

3. Clean-up
   a. When vacuum truck is full of sediment take it to the designated location to dump all the sediment out of truck into a drying bed.
   b. When it evaporates, clean it up with a backhoe, put it into a dump truck and take it to the landfill.

4. Documentation
   a. Keep logs of number of catch basins cleaned.
   b. Record the amount of waste collected.
   c. Keep any notes or comments of any problems.

STREETS/STORM DRAIN – Curb Painting

1. Preparation
   a. Calculate the amount of paint required for the job
   b. Use water based paints if possible.
   c. Determine whether the wastes will be hazardous or not and the required proper disposal of said wastes
   d. Determine locations of storm drain inlets and sewer inlets that may need to be protected
   e. Prepare surfaces to be painted without generating wastewater by sandblasting and/or scraping.
   f. Thoroughly sweep up all sand, blastings, and/or paint scrapings
   g. If paint stripping is needed, use a citrus-based paint remover whenever possible, which is less toxic than chemical strippers
   h. If wastewater will be generated, use curb, dyke, etc. around the activity to collect the filter and collect the debris.
2. Process
   a. Paint curb.
   b. Prevent over-spraying of paints and/or excessive sandblasting
   c. Use drip pans and drop clothes in areas of mixing paints and painting
   d. Store latex paint rollers and brushes in air tight bags to be reused later with the same color.
   e. Have available absorbent material and other BMP's ready for an accidental paint spill.
3. Clean-up
   a. Paint out brushes and rollers as much as possible. Squeeze excess paint from brushes and rollers back into the containers prior to cleaning them.
   b. Pour excess paint from trays and buckets back into the paint can containers and wipe with cloth or paper towels. Dispose of the towels according to the recommendations on the paint being used.
   c. Rinse water-based paint brushes in the sink after pre-cleaning. Never pour excess paint or wastewater from cleanup of paint in the storm drain.
   d. Cleanup oil based paints with paint thinner. Never clean oil based brushes in a sink or over a storm drain. Filter solvents for reuse if possible and/or store in approved drum for recycling.
   e. Dispose of waste collected by placing it in a garbage container. Left-over paint and solvents should be stored for later use (do not place these liquids in the garbage).
4. Documentation
   a. Write-up/report of any discharges into storm drain system

STREETS/STORM DRAIN – Detention Pond Cleaning

1. Preparation:
   a. Schedule the Pond cleaning work for a time when dry weather is expected.
   b. Remove any sediment and trash from grates, placing it in a truck for disposal.
   c. Do a visual inspection to make sure any grates, structures, manholes, boxes, and pipes are in good working order. Remove manhole covers and grates as necessary for inspecting.

2. Process
   a. Provide outlet protection where feasible to minimize the amount of debris that might leave basin during cleaning process.
   b. Start cleaning basin by using backhoe to remove debris and sediment off the bottom.
   c. Continue cleaning structures and pond bottom as necessary by sweeping and shoveling.
   d. Put all material removed from the pond into a dump truck.
   e. Some structures may require use of a vactor truck. If so use the same procedures described for cleaning catch basins.

3. Clean-up
   a. After cleaning basins, clean off the concrete pads using dry methods (sweeping and shoveling).
   b. Make sure they are swept up and clean.
   c. Take the material that was removed to the landfill for final disposal.

4. Documentation
   a. Keep a logs of each detention basins/pond cleaned including date, individuals involved in cleaning, and a description of the type of debris removed.
   b. Record the amount of waste collected.
   c. Keep any notes or comments of any problems.

STREETS/STORM DRAIN – Shouldering and Mowing

1. Preparation
   a. Set up temporary traffic control devices according to part VI of the MUTCD.

2. Process
   a. Place import material as needed and perform grading to achieve proper drainage.
   b. Sweep up and dispose of all clippings on the curb, gutter or roadway.

3. Clean-up
   a. Clean any loose material off asphalt or gutter.

4. Documentation
   a. Record location and date on the maintenance database and map

STREETS/STORM DRAIN – Garbage Storage

1. Preparation
   a. Locate dumpsters and trash cans with lids in convenient, easily observable areas.
   b. Provide properly-labeled recycling bins to reduce the amount of garbage disposed.
   c. Provide training to employees to prevent improper disposal of general trash.

2. Process
   a. Inspect garbage bins for leaks regularly, and have repairs made immediately by responsible party.
   b. Locate dumpsters on a flat, impervious surface that does not slope or drain directly into the storm drain system.
   c. Install berms, curbing or vegetation strips around storage areas to control water entering/leaving storage areas.
   d. Keep lids closed when not actively filling dumpster.

3. Clean-up
   a. Keep areas around dumpsters clean of all garbage.
   b. Have garbage bins empted as often as needed to keep from overfilling.
   c. Wash out bins or dumpsters as needed to keep odors from becoming a problem. Wash out in properly designated areas only.

STREETS/STORM DRAIN – Snow Removal and De-icing

1. Preparation
   a. Store de-icing material under a covered storage area or in an area where water coming off the de-icing materials is collected and delivered to the sanitary sewer or reused as salt brine.
   b. Slope loading area away from storm drain inlets
   c. Design drainage from loading area to collect runoff before entering storm water system
   d. Wash out vehicles (if necessary) in approved washout area before preparing them for snow removal.
   e. Calibrate spreaders to minimize amount of de-icing material used and still be effective
   f. Provide vehicles with spill cleanup kits in case of hydraulic line rupture or other spills
   g. Train employees in spill cleanup procedures and proper handling and storage of de-icing materials

2. Process
   a. Load material into trucks carefully to minimize spillage
   b. Periodically dry sweep loading area to reduce the amount of de-icing materials exposed to runoff
   c. Distribute the minimum amount of de-icing material to be effective on roads
   d. Do not allow spreaders to idle while distributing de-icing materials.
   e. Park trucks loaded with de-icing material inside when possible

3. Cleanup
   a. Sweep up all spilled de-icing material around loading area
   b. Clean out trucks after snow removal duty in approved washout area
   c. Provide maintenance for vehicles in covered area
   d. If sand is used in de-icing operations, sweep up residual sand from streets when weather permits

STREETS/STORM DRAIN – Street Sweeping

1. Preparation
   a. Prioritize cleaning routes to use at the highest frequency in areas with the highest pollutant loading.
   b. Increase sweeping frequency just before the rainy season, unless sweeping occurs continuously throughout the year.
   c. Perform preventative maintenance and services on sweepers to increase and maintain their efficiency
   d. Streets are to be swept as needed or specified by the city. Street maps are used to ensure all streets are swept at a specified interval

2. Process
   a. Drive street sweeper safely and pickup debris
   b. When full, take the sweeper to an approved street sweeper cleaning station.

3. Clean-up
   a. Street sweepers are to be cleaned out in an approved street sweeper cleaning station
   b. Street sweeping cleaning stations shall separate the solids from the liquids.
   c. Once solids have dried out, haul them to the local landfill
   d. Decant water is to be collected and routed to an approved wastewater collection system area only.
   e. Haul all dumped material to the landfill.

4. Documentation
   a. Keep accurate logs to track streets swept and streets still requiring sweeping.
   b. Log the amount of debris collected and hauled off.

APPENDIX 1

APPROVED BMPS

A Guide to Stormwater Best Management Practices

DAVIS COUNTY
STORM WATER
COALITION

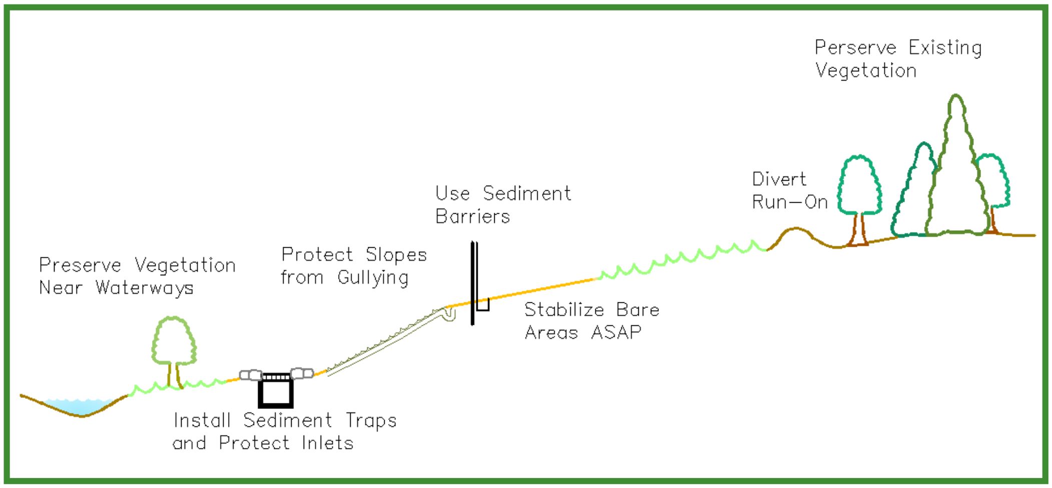
INTRODUCTION

Construction sites should be managed to minimize the pollution that can leave the site with storm water. Taking appropriate measures to reduce erosion, remove sediment, and manage construction materials and equipment will minimize storm water pollution.

Reducing soil erosion is a crucial aspect of storm water pollution prevention for construction sites. Reducing erosion is easier and less expensive than attempting to remove sediment from the storm water.

Contributions to an *increase* in erosion are:

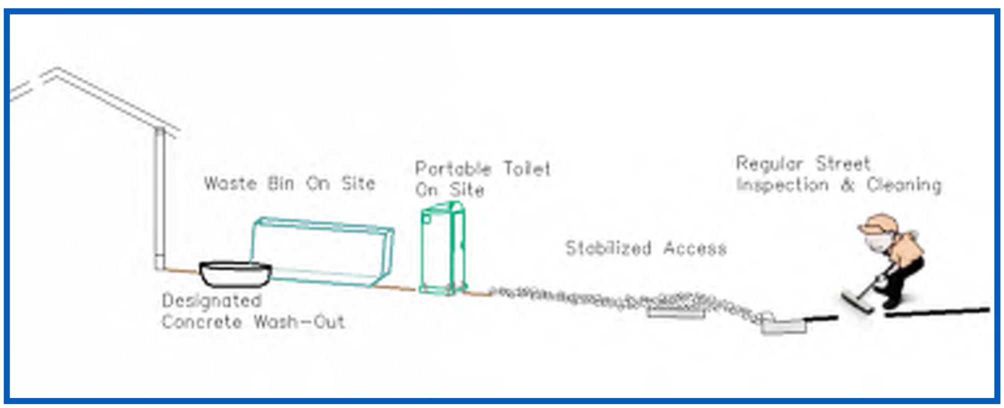
- Removing vegetation
- Exposing sub-soil to weathering
- Exposing sub-soil to vehicle traffic
- Re-shaping the land
- Allowing gullies to form and grow
- Longer/Steeper slopes



Steps must be taken to *minimize* these factors of erosion during and after construction.

Removing the sediment that does get into the storm water is also important to protect the storm drain system and waterways.

Managing construction material and equipment for pollution is important for any construction site, including building construction sites. There must be means for safe disposal of all types of waste. The tracking and washing of soil into the street must be prevented. Downstream storm water inlets should also be protected.



Regular inspection and proper maintenance of the site will help ensure the effectiveness of the BMPs in minimizing storm water pollution.

This manual includes Best Management Practices (BMPs) that are useful for reducing pollutants leaving construction sites, particularly those that may be discharged into the storm water systems. Implementing these measures is important because the water from the storm drain systems drains directly into the streams, usually untreated, then through the wetlands before entering the Great Salt Lake. Construction sites can be a significant source of pollution to the streams and wetlands, which can damage them and be detrimental to their role in our environment.

Not all possible BMPs are available from this menu. If you would like to use a BMP that is not included here, propose it to your local jurisdiction.

DAVIS COUNTY
STORM WATER
COALITION

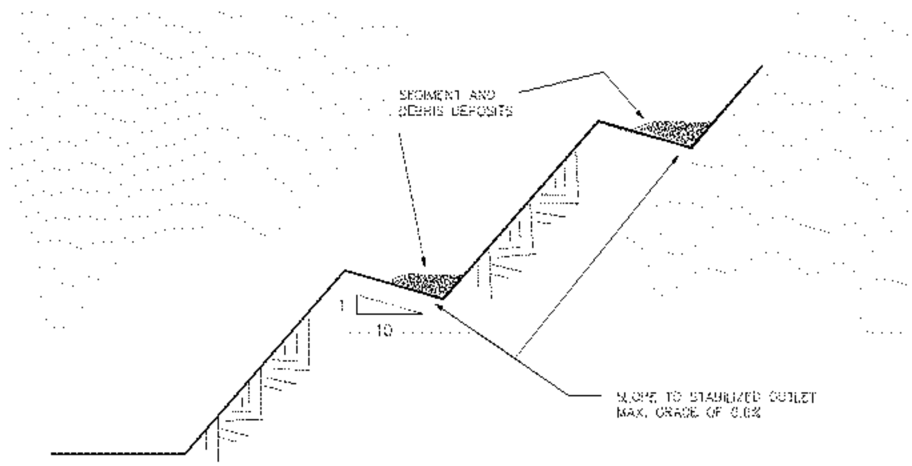
CONSTRUCTION

Best Management Practices

INDEX

		Waste and Material Management	Vehicle and Equipment Management	Stabilization	Runoff Diversion	Velocity Reduction	Sediment Removal
BE	Benching				✓		
BRF	Brush or Rock Filter						✓
BRRC	Building Repair, Remodeling, and Construction	✓					
CD	Check Dams				✓		
CESA	Contaminated or Erodible Surface Area			✓			
CM	Chemical Mulch			✓			
CP	Compaction			✓			
CR	Construction Road Stabilization			✓			
CST	Curb Sedimentation Trap						✓
CWM	Concrete Waste Management	✓					
DC	Dust Controls			✓			
DD	Diversion Dikes				✓		
DI	Drainage Isolation				✓		
EBB	Earth Berm Barrier	✓					
ECB	Erosion Control Blankets			✓			
EVWA	Equipment and Vehicle Washdown Area		✓				
FR	Fiber Rolls						✓
FS	Filter Strips			✓			
GM	Geotextiles and Mats			✓			
HM	Hydromulching			✓			
HWM	Hazardous Waste Management	✓					
IP-E	Inlet Protection - Excavated						✓
IP-GB	Inlet Protection - Gravel Bags						✓
IP-SB	Inlet Protection - Silt Bags						✓
IP-SF	Inlet Protection - Silt Fence or Straw Bale						✓
MS	Material Storage	✓					
MU	Mulching			✓			
OP	Outlet Protection					✓	
PEV	Preservation of Existing Vegetation			✓			
PT	Portable Toilet	✓					
SB	Sediment Basin						✓
SBB	Sand Bag Barrier						✓
SCE	Stabilized Construction Entrance			✓			
SCU	Spill Clean-Up	✓					
SD	Slope Drain				✓		
SF	Silt Fence						✓
SP	Seeding and Planting			✓			
SR	Surface Roughening					✓	
SS	Street Sweeping						✓
ST	Sediment Trap						✓
STB	Straw Bale Barrier						✓
TDS	Temporary Drains or Swales				✓		
TPS	Temporary and Permanent Seeding			✓			
TSC	Temporary Stream Crossing				✓		
VEC	Vehicle and Equipment Cleaning		✓				
VEF	Vehicle and Equipment Fueling		✓				
WD	Waste Disposal	✓					

BMP: Benching — BE



DESCRIPTION:

Slope construction with benches spaced at regular intervals perpendicular to the slope which intercept and collect sheet flow and direct it to a stable outfall point.

APPLICATION:

- Unstabilized cut and fill slopes
- Large stockpiles
- Existing unstable slopes

INSTALLATION / APPLICATION CRITERIA:

- Benches should be formed as slope is constructed and graded to the outlet point
- Stabilized outlet with sediment controls should be in place prior to slope construction

LIMITATIONS:

- Construction slope design must accommodate benching
- Not appropriate for sandy or rocky soil
- Only effective if suitable outlet provided

MAINTENANCE:

- Inspect after major storm events and at least biannually; repair damaged areas
- Remove debris blocking water flow
- Inspect outlet, repair/replace sediment controls and remove sediment build up

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☒ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☒	☐	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

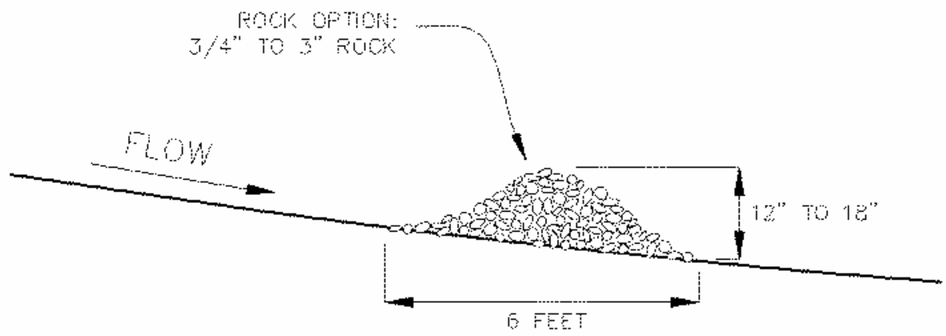
H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Brush or Rock Filter — BRF



DESCRIPTION:

A rock filter is made of rock 3/4" - 3" in diameter and placed along a level contour. A brush filter is composed of brush (usually obtained during the site clearing) wrapped in filter cloth and anchored to the toe of the slope. If properly anchored brush or rock filters may be used for sediment trapping and velocity reduction.

APPLICATION:

- As check dams across mildly sloped construction roads
- Below the ote od slopes
- Along the site perimeter
- In areas where sheet flow occurs
- Around temporary spoil areas
- At sediment traps or culvert/pipe outlets

INSTALLATION / APPLICATION CRITERIA:

- For rock filter, use larger rock and place in a staked, woven wire sheathing if placed where concentrated flows occur
- Install along a level contour
- Leave area behind berm where runoff can pond and sediment can settle
- Drainage areas should not exceed 5 acres

LIMITATIONS:

- Rock berms may be difficult to remove
- Removal problems limit their usefulness in landscaped areas
- Runoff will pond upstream of the filter, possibly causing flooding if sufficient space does not exist

MAINTENANCE:

- Inspect after each rainfall and at a minimum of once every two weeks
- If berm is damaged, reshape and replace lost/dislodged rock
- Remove sediment when depth reaches 1/3 of berm height or 1 ft

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☒ Control Site Perimeter
- ☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☒	☐	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☐	☒	Maintenance
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☐	☐	☒	Administrative

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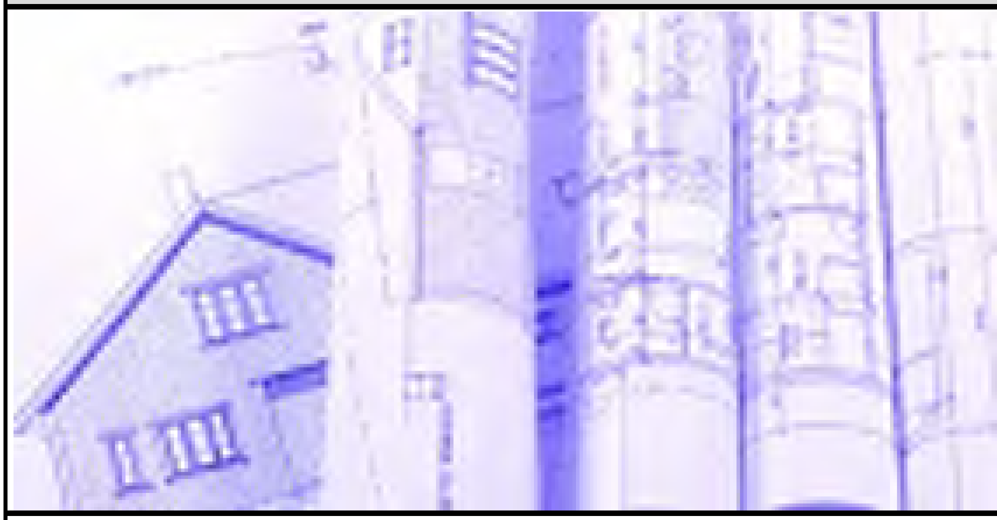
DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Building Repair, Remodeling, and Construction — BRRC



DESCRIPTION:

Prevent or reduce the discharge of pollutants to storm water from building repair, remodeling and construction by using soil erosion controls, enclosing or covering building material storage areas, using good housekeeping practices, using safer alternative products, and training employees.

APPLICATION:

- Use soil erosion control techniques if bare ground is temporarily exposed
- Use permanent soil erosion control techniques if the remodeling clears buildings from an area that are not to be replaced

INSTALLATION / APPLICATION CRITERIA:

- Enclose painting operations consistent with local air quality regulations and OSHA
- Properly store materials that are normally used in repair and remodeling such as paints and solvents
- Properly store and dispose waste materials generated from the activity
- Maintain good housekeeping practices while work is underway

LIMITATIONS:

- This BMP is for minor construction only
- Hazardous waste that cannot be re-used or recycled must be disposed of by a licensed hazardous waste hauler
- Safer alternative products may not be available, suitable, or effective in every case
- Be certain that actions to help storm water quality are consistent with OSHA and air quality regulations

MAINTENANCE:

None

OBJECTIVES

- ☒ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☐	☐	☒	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☒	☐	☐	Toxic Materials
☒	☐	☐	Oil & Grease
☒	☐	☐	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☐	☒	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☒	☐	Training
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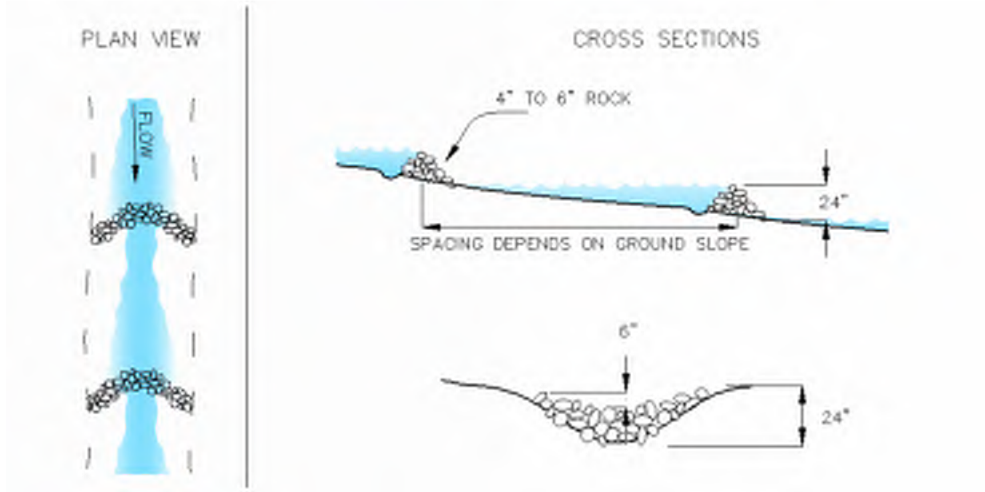
DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Check Dams — CD



DESCRIPTION:

Small, temporary dams constructed across a drainage ditch to reduce velocity of concentrated storm water flows thereby reducing the erosion of the ditch.

APPLICATION:

- Temporary drainage paths
- Permanent drainage ways not yet stabilized
- Existing drainage paths receiving increased flows due to construction

INSTALLATION / APPLICATION CRITERIA:

- Prepare location of dam by removing any debris and rough grading any irregularities in channel bottom
- Place rocks by hand or with appropriate machinery; do not dump
- Space dams to make the base of the upstream dam the same elevation as the top of the next lower dam
- Construct dam with center lower to create a weir effect
- Construct 50% side slopes on dams

LIMITATIONS:

- Maximum recommended drainage area is 10 acres
- Maximum recommended height is 24"
- Do not use in running stream

MAINTENANCE:

- Inspect dams daily during prolonged rainfall after each major rain event and at a minimum of once every two weeks
- Remove any large debris and repair any damage to dam, channel or sideslopes
- Remove accumulated sediment when it reaches one half the height of the dam

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☒ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

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☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
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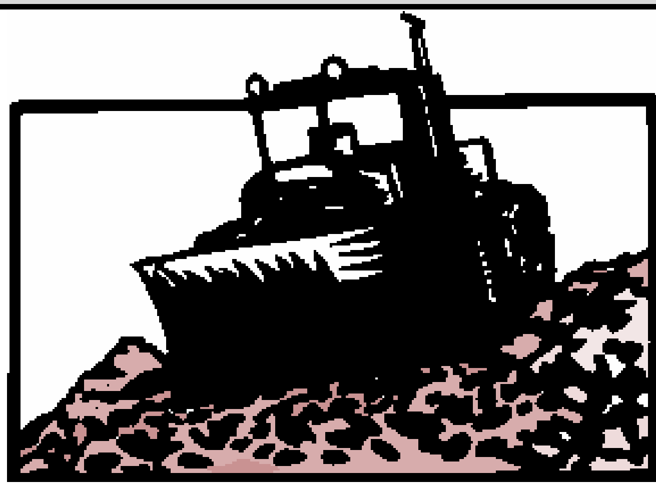
DAVIS COUNTY STORM WATER COALITION
1500 East 650 North
Fruit Heights, UT 84037

BMP: Contaminated or Erodible Surface Areas — CESA



DESCRIPTION:

Prevent or reduce the discharge of pollutants to storm water from contaminated or erodible surface areas by leaving as much vegetation on-site as possible, minimizing soil exposure time, stabilizing exposed soils, and preventing storm water runon and runoff.

APPLICATION:

This BMP addresses soils which are not so contaminated as to exceed criteria but the soil is eroding and carrrying pollutants off in the storm water.

INSTALLATION / APPLICATION CRITERIA:

Contaminated or erodible surface areas can be controlled by:
- Preservation of natural vegetation, revegitation, chemical stabilization, removal of contaminated soils or geosynthetics.

LIMITATIONS:

Disadvantages of preserving natural vegetation or re-vegetating include:
- Requires substantial planning to preserve and maintain the existing vegetation.
- May not be cost-effective with high land costs.
- Lack of rainfall and/or poor soils may limit the success of re-vegetated areas.

Disadvantages of chemical stabilization include:
- Creation of impervious surfaces.
- May cause harmful effects on water quality.
- Is usually more expensive than vegetative cover.

MAINTENANCE:

Maintenance should be minimal, except possibly if irrigation of vegetation is necessary.

OBJECTIVES

☒ Housekeeping Practices
☐ Contain Waste
☐ Minimize Disturbed Areas
☐ Stabilize Disturbed Areas
☐ Protect Slopes/Channels
☐ Control Site Perimeter
☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☒	☐	☐	Nutrients
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☒	☐	☐	Floatable Materials
☒	☐	☐	Bacteria & Viruses
☒	☐	☐	Other Waste

IMPLEMENTATION REQUIREMENTS

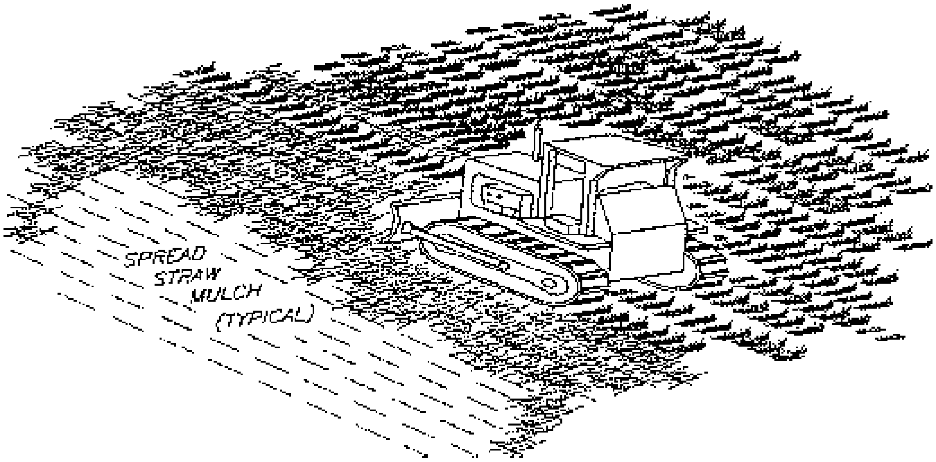
H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☐	☒	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Chemical Mulch　　　　CM



DESCRIPTION:

Applying materials such as vinyl, asphalt, plastics, or rubber on an unprotected slope to temporarily stabilize the slope.

APPLICATION:

- As a tacking agent to aid the stabilization of mulches (where matting is not used)
- As a short-term alternative in areas where temporary seeding practices cannot be used because of seasonal condition or climate
- On steep and rocky slopes where neither mechanical methods or mulches and protective netting can be effectively applied

INSTALLATION / APPLICATION CRITERIA:

- The application rates and procedures recommended by the manufacturer of a chemical stabilization product should be followed to prevent the products from forming ponds and from creating large areas where moisture cannot get through.
- For permanent application, chemical mulches (when used with seed and mulch) should be applied over wood fiber or straw mulch

LIMITATIONS:

- Chemical mulches can create impervious surfaces and impact water quality if not properly applied
- Some products may not be suitable for use near live streams

MAINTENANCE:

- Inspect at regular intervals and after each runoff-producing storm event or at a minimum of once every two weeks
- Replace chemical mulch as needed to ensure adequate level of coverage

OBJECTIVES

☐ Housekeeping Practices
☐ Contain Waste
☐ Minimize Disturbed Areas
☒ Stabilize Disturbed Areas
☒ Protect Slopes/Channels
☐ Control Site Perimeter
☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☒	☐	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

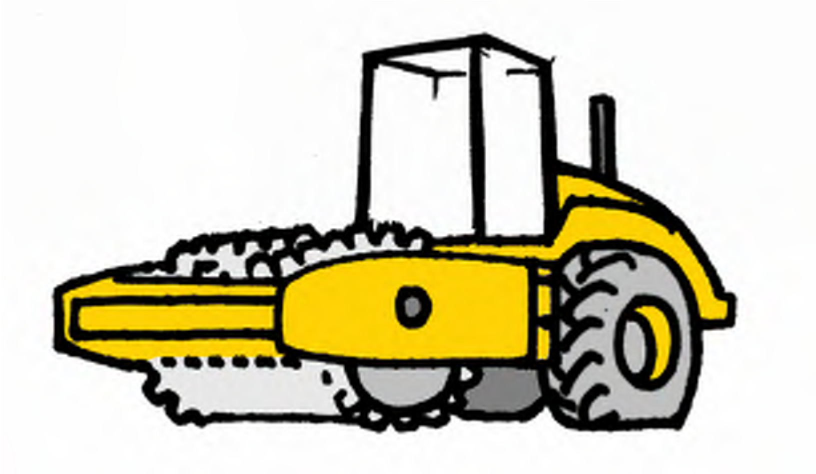
H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☐	☒	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M** = Medium **L** = Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Compaction CP



DESCRIPTION:

Use of rolling, tamping, or vibration to stabilize fill materials and control erosion by increasing the soil density. Increasing the density of soil improves soil strength, reduces long-term soil settlement, and provides resistance to erosion.

APPLICATIONS:

- Stabilize fill material placed around various structures.
- Improve soil in place as foundation support for roads, parking lots, and buildings.

INSTALLATION / APPLICATION CRITERIA:

- Make sure soil moisture content is at optimum levels.
- Use proper compaction equipment.
- Install sediment control and storm water management devices below compacted areas and runon interceptor devices above these areas. Drainage from compacted areas must be carefully planned to prodtect adjacent uncompacted soils.
- The surface of compacted areas should be scarified and seeded or mulched and seeded to increase the effectiveness of compaction.

LIMITATIONS:

- Compaction tends to increase runoff.
- Over-compaction will hamper revegitation efforts.

MAINTENANCE:

No maintenance required.

OBJECTIVES

☐ Housekeeping Practices
☐ Contain Waste
☒ Minimize Disturbed Areas
☒ Stabilize Disturbed Areas
☐ Protect Slopes/Channels
☐ Control Site Perimeter
☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☐	☒	Maintenance
☐	☒	☐	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

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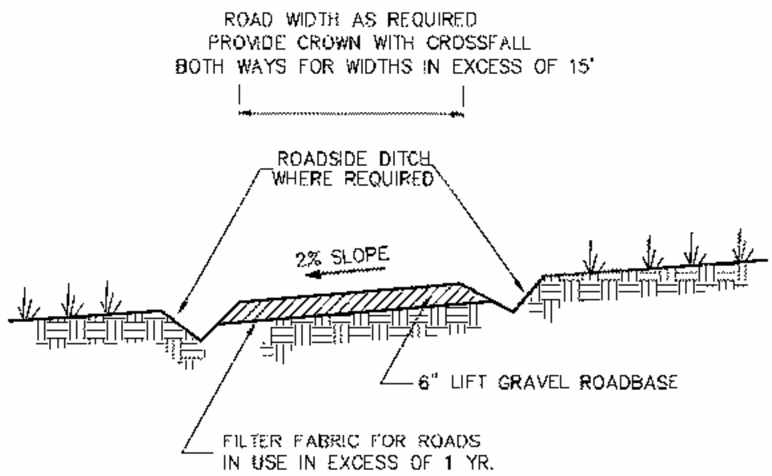
DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Construction Road Stabilization — CR



DESCRIPTION:

Temporary stabilization of on-site roadway by placement of gravel roadbase.

APPLICATION:

- On-site roadways used daily by constructioin traffic (may not apply to gravelly type soils)
- Parking or staging areas susceptible to erosion due to traffic use

INSTALLATION / APPLICATION CRITERIA:

- Grade temporary access road with 2% cross fall, for two-way width provide crown
- Provide roadside ditch and outlet controls where required
- Place 6 inches of 2-inch to 4-inch crushed rock on driving area

LIMITATIONS:

- May require removal of gravel roadbase at completion of activities if final cover is not impervious
- May require controls for surface storm water runoff

MAINTENANCE:

- Inspect after major rainfall events and at a minimum of once every two weeks
- Place additional gravel as needed and repair any damaged areas
- Maintain any roadside drainage controls

OBJECTIVES

☒ Housekeeping Practices
☐ Contain Waste
☒ Minimize Disturbed Areas
☒ Stabilize Disturbed Areas
☒ Protect Slopes/Channels
☐ Control Site Perimeter
☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

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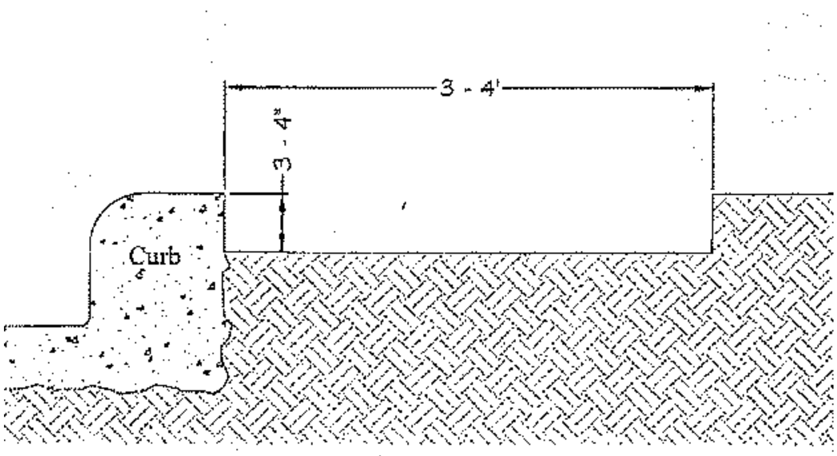
DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Curb Sedimentation Trap — CST



DESCRIPTION:

A temporary sediment trap formed by excavation behind the curb.

APPLICATION:

- Interception of runoff containing sediment from the lot during construction
- Retain sediment on the lot during construction

INSTALLATION / APPLICATION CRITERIA:

- Excavate soil behind the curb to a depth of 3-4 inches
- Extend excavation 3-4 feet behind the curb to form sediment trap

LIMITATIONS:

No limitations

MAINTENANCE:

- Inspect after each rainfall event and at a minimum of once every two weeks
- Remove accumulated sediment as it reaches 2/3 height of available storage
- May require additonal excavation if dirt from construction fills in the trap

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☒	☐	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☒	☐	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

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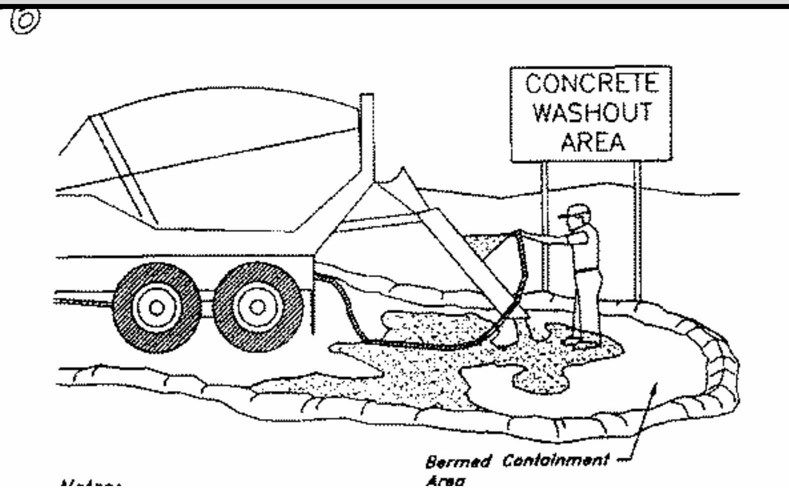
DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Concrete Waste Management CWM



DESCRIPTION:

Prevent or reduce the discharge of polllutants to storm water from concrete waste by conducting washout off-site, performing on-site washout ina designated area, and training employees and subcontractors.

APPLICATION:

This technique is applicable to all types of sites

INSTALLATION / APPLICATION CRITERIA:

- Store dry materials under cover, away from drainage areas
- Minimize excess mixing of fresh concrete, mortar or cement on site
- Do not wash out concrete trucks into storm drains, open ditches, streets, or streams
- Do not allow excess concrete to be dumped on-site, except in designated areas
- When washing concrete to remove fine particles and expose the aggregate, avoid creating runoff by draining the water within a bermed or level area (6" tall X 6' wide)
- Train employees and subcontractors in proper concrete waste management

LIMITATIONS:

- Off-site washout or concrete wastes may not always be possible

MAINTENANCE:

- Inspect subcontractors to ensure that concrete wastes are being properly managed
- If using a temporary pit, dispose of hardened concrete on a regular basis

OBJECTIVES

☐ Housekeeping Practices
☒ Contain Waste
☐ Minimize Disturbed Areas
☐ Stabilize Disturbed Areas
☐ Protect Slopes/Channels
☐ Control Site Perimeter
☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☐	☐	☒	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☒	☐	☐	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☐	☒	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☒	☐	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

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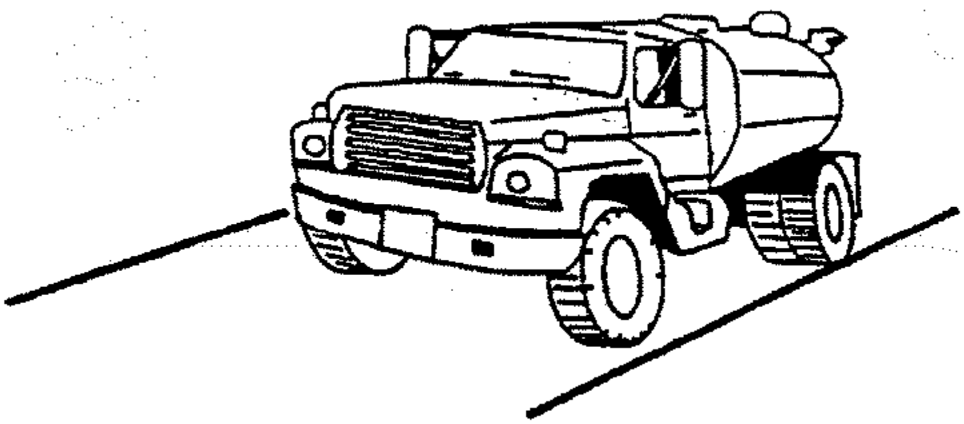
DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Dust Controls DC



DESCRIPTION:

Dust control measures are used to stabilize soil from wind erosion, and reduce dust by construction activities.

APPLICATION:

Dust control is useful in any process area, loading and unloading area, material handling agreas, and transfer areas where dust is generated. Street sweepin gis limited to areas that are paved.

INSTALLATION / APPLICATION CRITERIA:

- Mechanical dust collection systems are designed according to the size of dust particles and the amount of air to be processed. Manufacturers' recommendations should be followed for installation (as well as the design of the equipment.
- Two kinds of street sweepers are common: brush and vacuum. Vacuum sweepers are more efficient and work best when the area is dry.
- Mechanical equipment should be operated according to the manufacturers' recommendations and should be inspected regularly.

LIMITATIONS:

- More elaborate equipment may be impossible to maintain by plant personnel
- Is labor and equipment intensive and may not be effective for all pollutants (street sweepers)

MAINTENANCE:

If water sprayers are used, dust-contaminated waters should be collected and taken for treatment. Areas will probabley need to be resprayed to keep dust from spreading.

OBJECTIVES

☒ Housekeeping Practices
☐ Contain Waste
☐ Minimize Disturbed Areas
☒ Stabilize Disturbed Areas
☐ Protect Slopes/Channels
☐ Control Site Perimeter
☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

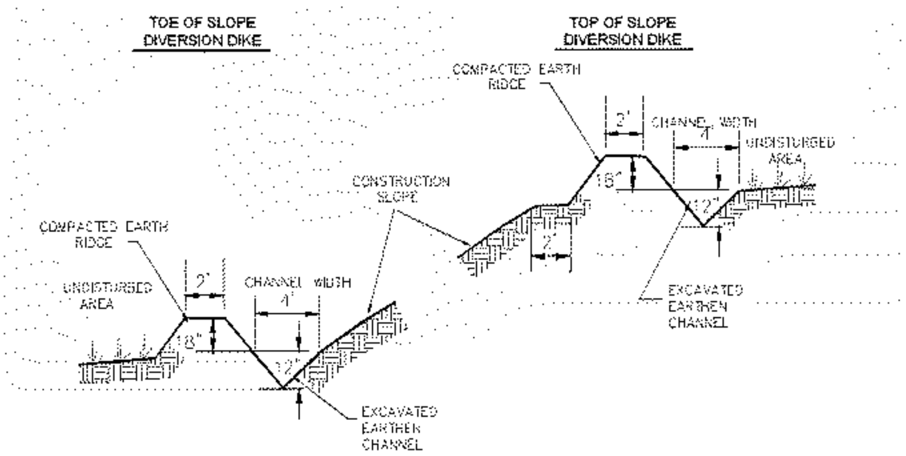
H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☒	☐	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Diversion Dike DD



DESCRIPTION:

A temporary sediment barrier and storm runoff conveyance consisting of an excavation channel and compacted earth ridge.

APPLICATION:

- Construct along top of construction slope to intercept upgradient runoff and convey around construction site
- Construct along toe of construction to divert sediment laden runoff
- Construct along midpoint of construction slope to intercept runoff and channel to controlled discharge point
- Construct around base of soil stockpiles to capture sediment
- Construct around perimeter of disturbed areas to capture sediment

INSTALLATION / APPLICATION CRITERIA:

- Clear and grub area for dike construction
- Excavate channel and place soil on downgradient side
- Shape and machine compact excavated soil to form ridge
- Place erosion protection (riprap, mulch) at outlet
- Stabilize channel and ridge ad required with mulch, gravel, or vegetative cover

LIMITATIONS:

- Recommended maximum drainage area of 5 acres
- Recommended maximum sideslopes of 2h:1v (50%)
- Recommended maximum slope of 1% on channel

MAINTENANCE:

- Inspect immediately after any rainfall and at least daily during prolonged rainfall
- Look for runoff breaching dike or eroding channel or sideslopes
- Check discharge point for erosion or bypassing of flows
- Repair and stabilize as necessary
- Inspect daily during vehicular activity on slope, check for and repair any traffic damage

OBJECTIVES

- ☐ Housekeeping Practices
- ☒ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☒ Control Site Perimeter
- ☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

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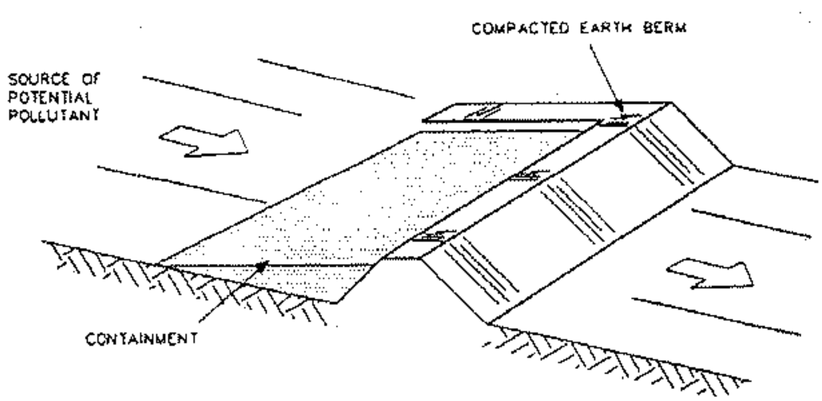
DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Earth Berm Barrier — EBB



DESCRIPTION:

A temporary containment control constructed of compacted soil.

APPLICATION:

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

INSTALLATION / APPLICATION CRITERIA:

- Construct an earthen berm down hill of the area to be controlled. The berm should surround fueling facilities and maintenance areas on three sides to provide containment
- Berm needs to sized for application and be compacted by compactor equipment

LIMITATIONS:

- Not effective on steep slopes
- Limits access to controlled area
- Personnel need to quickly respond to spills with remedial actions

MAINTENANCE:

- Observe daily for any non-stormwater discharge
- Look for runoff bypassing ends of berms or undercutting berms
- Repair or replace damaged areas of the berm and remove accumulated sediment
- Recompact soil around berm as necessary to prevent piping

OBJECTIVES

- ☐ Housekeeping Practices
- ☒ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☒ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☐	☐	☒	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☒	☐	☐	Toxic Materials
☐	☐	☒	Oil & Grease
☒	☐	☐	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

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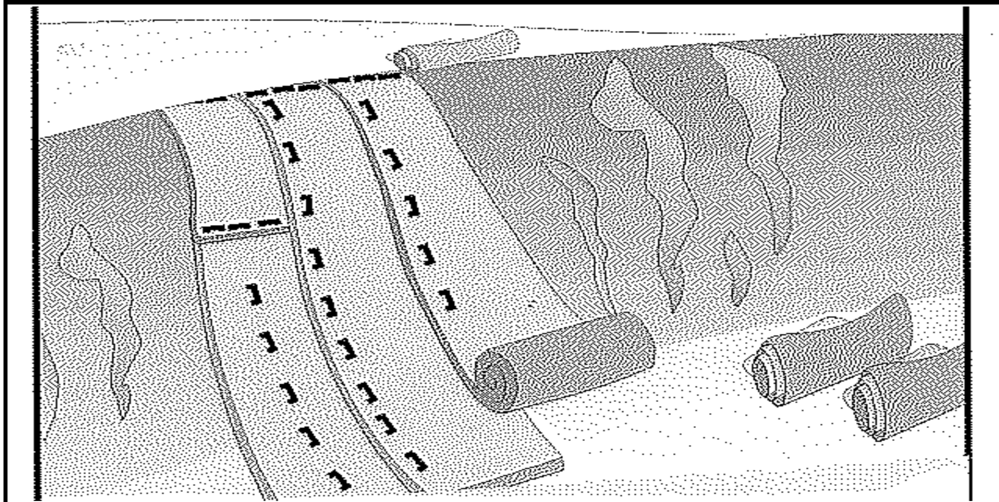
DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Erosion Control Blankets ECB



DESCRIPTION:

Erosion control blankets are used on areas of high velocity runoff and/or steep grade, to aid in controlling erosion on critical areas by protecting young vegetation.

APPLICATION:

- Where vegetation is likely to grow too slowly to provide adequate stabilization
- In areas subject to high winds where mulch would not be effective

INSTALLATION / APPLICATION CRITERIA:

- Install erosion control blankets parallel to the direction of the slope
- In ditches, apply in direction of the flow
- Place erosion control blankets loosely on soil-do not stretch
- Ends of blankets should be buried no less than six inches deep
- Staple the edges of the blanket at least every three feet - per manufacturers' specifications

LIMITATIONS:

- Not recommended in areas which are still under construction

MAINTENANCE:

- Check for erosion and undermining periodically, particulary after rainstorms
- Repair dislocations or failures immediately
- If washouts occur, reinstall after repairing slope damage
- Monitor until permanently stabilized

OBJECTIVES

☐ Housekeeping Practices
☐ Contain Waste
☐ Minimize Disturbed Areas
☒ Stabilize Disturbed Areas
☒ Protect Slopes/Channels
☐ Control Site Perimeter
☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☒	☐	Nutrients
☐	☐	☒	Heavy Metals
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☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☒	☐	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

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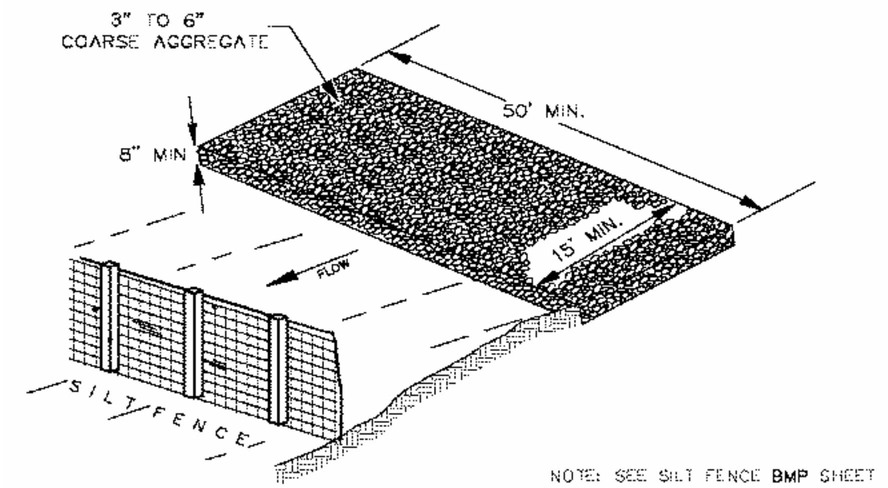
DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Equipment and Vehicle Wash Down Area — EVWA



DESCRIPTION:

A stabilized pad of crushed stone for general washing of equipment and construction vehicles.

APPLICATION:

At any site where regular washing of vehicles and equipment will occur. May also be used as a filling point for water trucks limiting erosion caused by overflow or spillage of water.

INSTALLATION / APPLICATION CRITERIA:

- Clear and grub area and grade to provide maximum slope of 1%
- Compact subgrade and place filter fabric if desired (recommended for wash areas to remain in use for more than 3 months)
- Place coarse aggregate, 1 to 2-1/2 inches in size, to a minimum depth of 8 inches
- Install silt fence downgradient (see silt fence BMP information sheet)

LIMITATIONS:

Cannot be utilized for washing equipment or vehicles that may cause contamination of runoff such as fertilizer equipment or concrete equipment. Solely used to control sediment in wash water.

MAINTENANCE:

- Inspect daily for loss of gravel or sediment buildup
- Inspect adjacent area for sediment deposit and install additional controls as necessary
- Repair area and replace gravel as required to maintain control in good working condition
- Expand stabilized area as required to accommodate activities
- Maintain silt fence as outlined in specific silt fence BMP information sheet

OBJECTIVES

☒ Housekeeping Practices
☒ Contain Waste
☐ Minimize Disturbed Areas
☐ Stabilize Disturbed Areas
☐ Protect Slopes/Channels
☐ Control Site Perimeter
☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☒	☐	☐	Toxic Materials
☒	☐	☐	Oil & Grease
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☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
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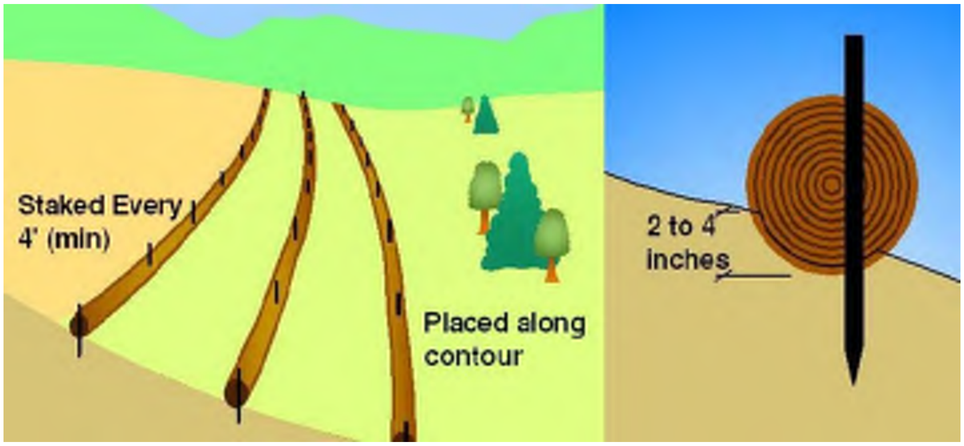
DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Fiber Rolls FR



Objectives

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☒ Control Site Perimeter
- ☐ Control Internal Erosion

Targeted Pollutants

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

Implementation Requirements

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☐	☒	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

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DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

Description:

Commercial products can be made from various types of fibers and shavings that are rolled up and used as sediment barriers.

Application:

- Good for sites with long slopes, generally flatter than 10:1

Installation / Application Criteria:

- Must be trenched into the ground 2 to 4 inches
- Must be staked every 4 feet (maximum)
- Manufacturer's instructions must be followed for installation of product

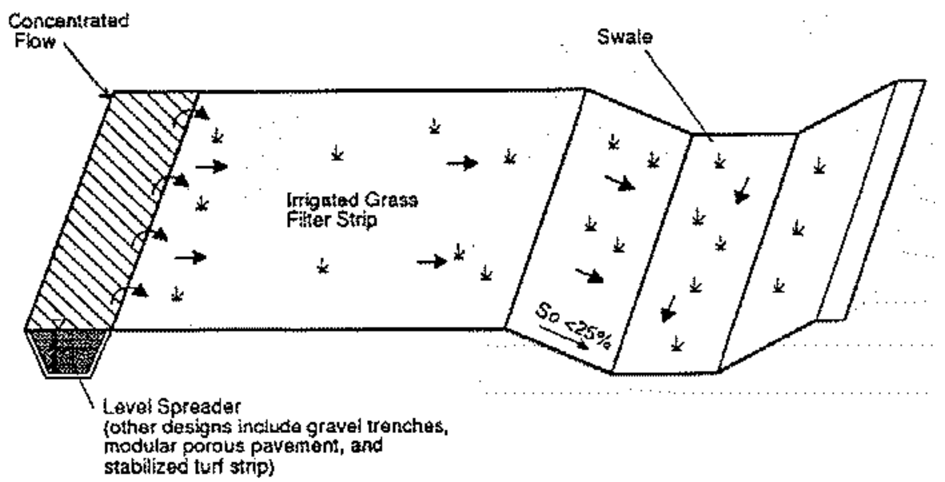
Limitations:

- Not applicable for high velocity flows
- Only use for a time period within the expected life-span of the product (check with manufacturer)

Maintenance:

- Must be checked to ensure that runoff does not run under or bypass the fiber rolls
- Sediment buildup must also be checked and excess sediment must be removed

BMP: Filter Strips FS



DESCRIPTION:

Filter strips are 20-foot-wide strips of natural or planted vegetation around a construction site. They are designed to cause deposition of sediments within the vegetation layer.

APPLICATION:

- Suited for areas where the soils are well drained or moderately well drained
- Areas where the bedrock and the water table are well below the surface

INSTALLATION / APPLICATION CRITERIA:

- Make sure the vegetative cover is dense enough to protect underlying soil while causing sediment to settle
- Filter strip must be approximately 20 feet wide to function well
- The length should be approximately 50 to 75 feet. Where slopes become steeper the length of the strip must be increased.

LIMITATIONS:

- Only applicable in areas where vegetation is previously established or where sod is added
- Vegetated filter strips will not function well on steep slopes, in hilly areas, or in highly paved areas
- Sites with slopes of 15 percent or more may not be suitable for filtering storm water flows

MAINTENANCE:

- Check for channels and repair
- Provide rock aprons to aid in slowing flow if necessary
- Maintain vegetation at optimal height and thickness

OBJECTIVES

☐ Housekeeping Practices
☐ Contain Waste
☐ Minimize Disturbed Areas
☒ Stabilize Disturbed Areas
☒ Protect Slopes/Channels
☒ Control Site Perimeter
☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☒	☐	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

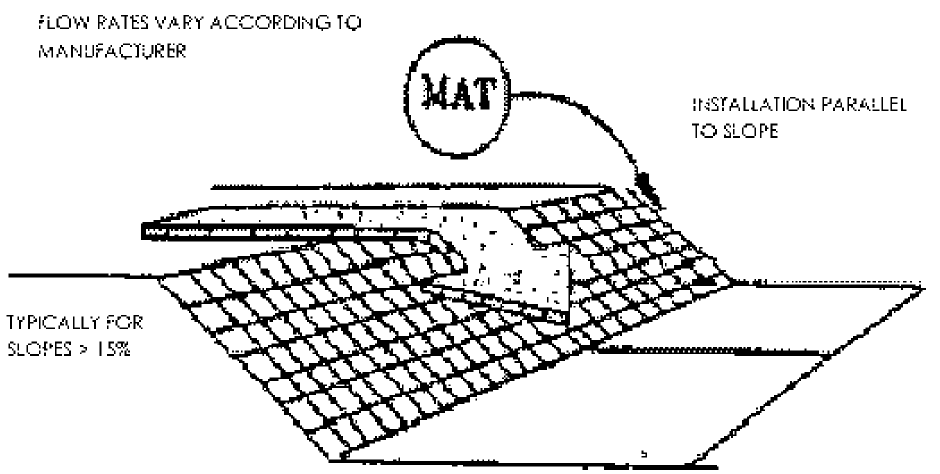
H	M	L	
☒	☐	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Geotextiles and Mats — GM



DESCRIPTION:

Mattings made of natural or synthetic material which are used to temporarily or permanently stabilize soil.

APPLICATION:

- Typically suited for post-construction site stabilization, but may be used for stabilization of highly erosive soils.
- Channels and Streams.
- Steep slopes.

INSTALLATION / APPLICATION CRITERIA:

- Mattings may be applied to disturbed soils and where existing vegetation has been removed.
- The following organic matting materials provide temporary protection until permanent vegetation is established, or when seasonal circumstances dictate the need for temporary stabilization until weather or construction delays are resolved: Jute mattings and straw mattings.
- The following synthetic mattings may be used for either temporary or post-construction stabilization, both with and without vegetation: excelsior matting, glass fiber matting, mulch matting
- Staples are needed to anchor the matting.

LIMITATIONS:

- Mattings are more costly than other BMP practices, limiting their use to areas where other BMPs are ineffective (e.g., channels, steep slopes).
- May delay seed germination, due to reduction in soil temperature.
- Installation requires experienced contractor to ensure soil stabilization and erosion protection.

MAINTENANCE:

- Inspect twice monthly and after significant rainfall.
- Re-anchor loosened matting and replace missing matting and staples as required.

OBJECTIVES

☐ Housekeeping Practices
☐ Contain Waste
☐ Minimize Disturbed Areas
☒ Stabilize Disturbed Areas
☒ Protect Slopes/Channels
☐ Control Site Perimeter
☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☒	☐	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☒	☐	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M** = Medium **L** = Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Hydromulching — HM

DESCRIPTION:

A combination of wood fiber mulch, processed grass, or hay or straw mulch and a tacking agent. It is made into a slurry, then applied to bare slopes or other bare areas to provide temporary stabilization.

APPLICATION:

- Small roadside slopes
- Large, relatively flat areas

INSTALLATION / APPLICATION CRITERIA:

- Legume seeds should be pellet inoculated with the appropriate bacteria.
- The seed should not remain in the hydromulcher tank for more than 30 minutes
- Wood fiber may be dyed to aid in uniform application
- Slurry should be uniformly applied until an adequate coverage is achieved
- The applicator should not be directed at on location for a long period of time; erosion will occur

LIMITATIONS:

- Will lose effectiveness after 1 year
- Can use only on physically stable slopes (at natural angle of repose, or less)

MAINTENANCE:

•Periodically inspect for damage caused by wind, water or human disturbance
•Promptly repair damaged areas

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☒ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☐	☒	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☒	☐	☐	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☒	☐	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M** = Medium **L** = Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Hazardous Waste Materials HWM

DESCRIPTION:

Prevent or reduce the discharge of pollutants to stormwater from hazardous waste throughproper material use,waste disposal,and training of employees and subcontractors.

APPLICATION:

Many of the chemicals used on-site can be hazardous materials which become hazardous waste upon disposal. These wastes may include:

- Paints and Solvents; petroleum products such as oils, fuels, and grease; herbicides and pesticides; Acids for cleaning masonry; and concrete curing compounds

In addition, sites with existing structures may contain wastes which must be disposed of in accordance with Federal, State, and local regulations, including:

- Sandblasting grit mixed with lead, cadmium, or chromium-based paints; Asbestos; and PCB's

INSTALLATION / APPLICATION CRITERIA:

The following steps will help reduce storm water pollution from hazardous wastes:

- Use all of the product before disposing of the container
- Do not remove the original product label, it contains important safety and disposal information
- Do not over-apply herbicides and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Apply surface dressings in several smaller applications, as opposed to one large application, to allow time for infiltration and to avoid excess material being carried off-site by runoff. Do not apply these chemicals just before it rains. People applying pesticides must be certified in accordance with Federal and State regulations.

LIMITATIONS:

Hazardous wastethat cannot be reused or recycled must be disposed of by a licensed hazardous waste hauler.

MAINTENANCE:

- Inspect hazardous waste receptacles and area regularly
- Arrange for regular hazardous waste collection

OBJECTIVES

☐ Housekeeping Practices
☒ Contain Waste
☐ Minimize Disturbed Areas
☐ Stabilize Disturbed Areas
☐ Protect Slopes/Channels
☐ Control Site Perimeter
☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☐	☐	☒	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☒	☐	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

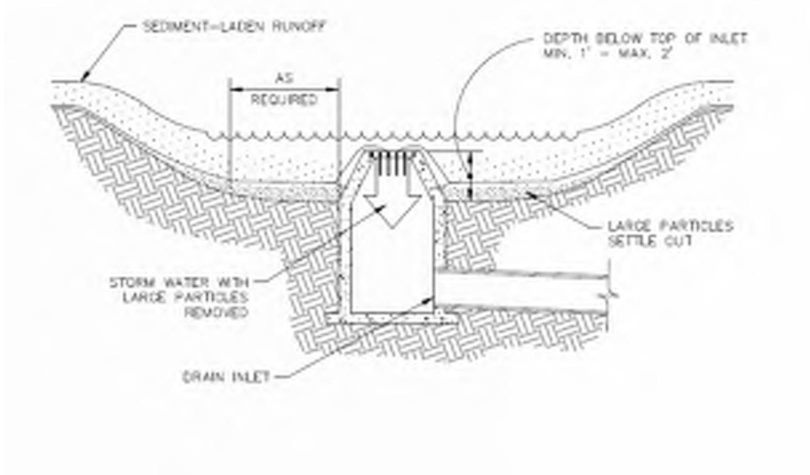
H	M	L	
☐	☐	☒	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☒	☐	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Inlet Protection - Excavated IP-E



DESCRIPTION:

An area excavated around a storm drain inlet to impound water below the inlet.

APPLICATION:

- Construct at storm drainage inlets located downgradient of areas to be disturbed by construction (for inlets in paved areas see other information sheets for inlet protection)

INSTALLATION / APPLICATION CRITERIA:

- Provide upgradient sediment controls, such as silt fence during construction of inlet
- When construciton of inlet is complete, excavate adjacent area 1 to 2 feet lower than the grate elevation. Size of excavated area should be based on soil type and contributing acreage

LIMITATIONS:

- Recommended maximum contributing drainage area of one acre
- Limited to inlets located in open unpaved areas
- Requires flat area adjacent to inlet

MAINTENANCE:

- Inspect inlet protection following storm event and at a minimum of once monthly
- Remove accumulated sediment when it reaches one half of the excavated sump below the grate
- Repair side slopes as required

OBJECTIVES

☐ Housekeeping Practices
☐ Contain Waste
☐ Minimize Disturbed Areas
☐ Stabilize Disturbed Areas
☐ Protect Slopes/Channels
☒ Control Site Perimeter
☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☒	☐	Toxic Materials
☐	☐	☒	Oil & Grease
☒	☐	☐	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

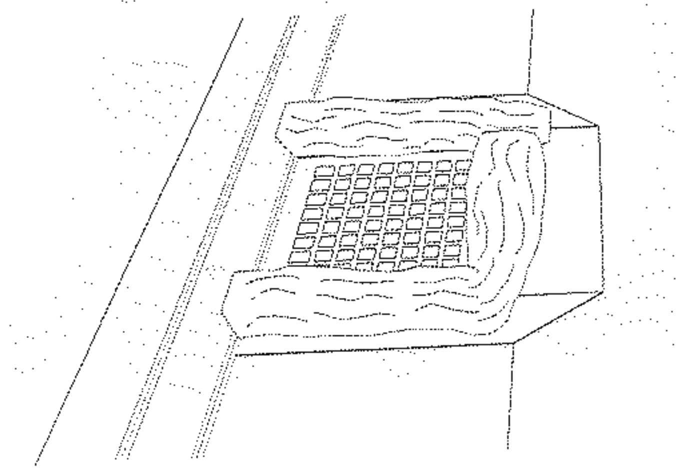
H	M	L	
☐	☐	☒	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Inlet Protection - Gravel Bags IP-GB



DESCRIPTION:

Sediment barrier erected around storm drain inlet.

APPLICATION:

Construct at storm drainage inlets located down-gradient of areas to be disturbed by construction

INSTALLATION / APPLICATION CRITERIA:

- Provide up-gradient sediment controls, such as silt fence during construction of inlet
- When construction of curb and gutter and roadway is complete, install gravel filled bags around perimeter of inlet
- Fill to recommended levels to reduce splitting of bags

LIMITATIONS:

- Recommended maximum contributing drainage area of one acre
- Requires shallow sloped adjacent to inlet.

MAINTENANCE:

- Inspect inlet protection following storm event and at a minimum of once every 14 days.
- Remove accumulated sediment when it reaches half the height of the bag.
- Look for bypassing or undercutting and repair or realign as needed.
- Replace and clean up spilled gravel when bags split.

OBJECTIVES

☒ Housekeeping Practices
☐ Contain Waste
☐ Minimize Disturbed Areas
☐ Stabilize Disturbed Areas
☐ Protect Slopes/Channels
☒ Control Site Perimeter
☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☒	☐	☐	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☒	☐	☐	Other Waste

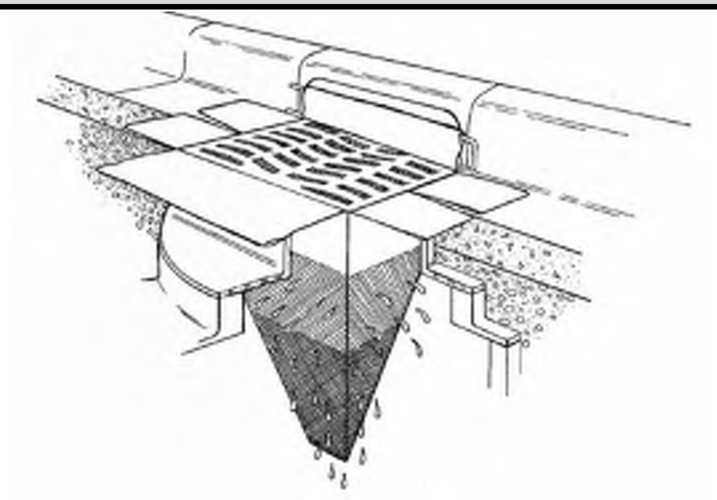
IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

1500 East 650 North
Fruit Heights, UT 84037

BMP: Inlet Protection- Silt Bags IP-SB



DESCRIPTION:

Collect and trap sediment and debris entering catch basins from either grated or curb inlets. Insert is made of fabric and is placed in the drain inlet around the perimeter of the grate. Runoff passes through the bag before discharging into the drain outlet pipe. Overflow holes are usually provided to pass larger flows without causing a backwater at the grate. Certain manufactured products include polymers intended to increase pollutant removal effectiveness.

APPLICATIONS:

- Storm drain inlet boxes

INSTALLATION / APPLICATION CRITERIA:

- Regular Maintenance is necessary
- Evaluation of the device chosen should be balanced with cost
- Hydraulic capacity controls effectiveness
- Most useful in small drainage areas (< 1 Acre)
- Ideal in combination with other BMP's

LIMITATIONS:

- Cost
- Maintenance required to prevent plugging and remain effective

MAINTENANCE:

Inspection after all storm events and as required between events

OBJECTIVES

☐ Housekeeping Practices
☒ Contain Waste
☐ Minimize Disturbed Areas
☐ Stabilize Disturbed Areas
☐ Protect Slopes/Channels
☐ Control Site Perimeter
☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☒	☐	☐	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

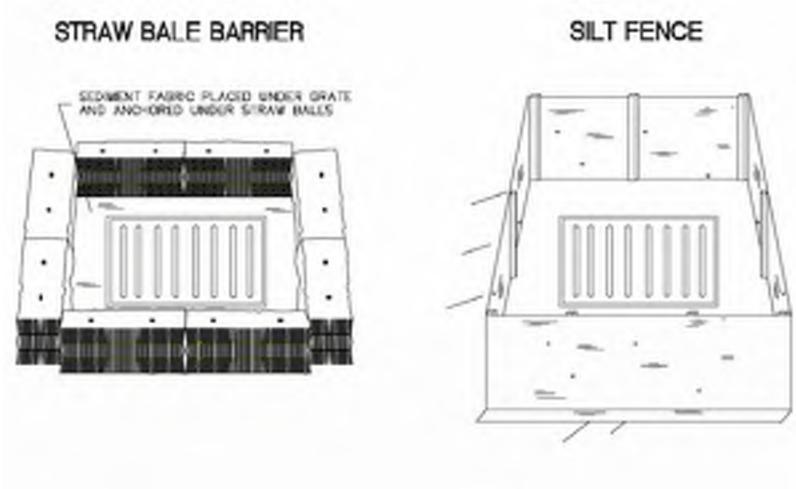
H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☒	☐	☐	Maintenance
☐	☒	☐	Training
☐	☐	☒	Staffing
☒	☒	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Inlet Protection - Silt Fence or Straw Bale — IP-SF



DESCRIPTION:

Sediment barrier erected around storm drain inlet.

APPLICATION:

- Construct at storm drainage inlets located downgradient of areas to be disturbed by construction (for inlets in paved areas see other information sheets for inlet protection)

INSTALLATION / APPLICATION CRITERIA:

- Provide upgradient sedimant controls, such as silt fence during construction of inlet
- When construction of linet is complete, erect straw bale barrier or silt fence surrounding perimeter of inlet. Follow instructions and guidelines on individual BMP information sheets for straw bale barrier and silt fence construction

LIMITATIONS:

- Recommended maximum contributing drainage area of one acre
- Limited to inlets located in open unpaved areas
- Requires shallow slopes adjacent to inlet

MAINTENANCE:

- Inspect inlet protection following storm event and at a minimum of once every two weeks
- Remove accumulated sediment when it reaches 4" in depth
- Repair or realign barrier/fence as needed
- Look for bypassing or undercutting and recompact soil around barrier/fence as required

OBJECTIVES

☐ Housekeeping Practices
☐ Contain Waste
☐ Minimize Disturbed Areas
☐ Stabilize Disturbed Areas
☐ Protect Slopes/Channels
☒ Control Site Perimeter
☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☒	☐	☐	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

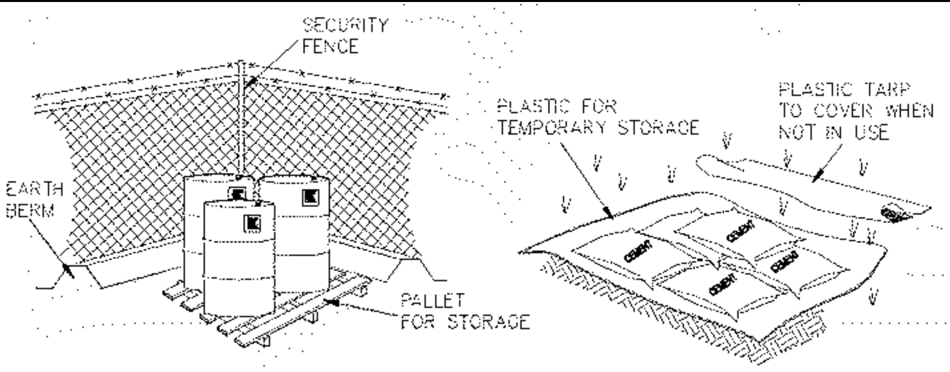
H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Materials Storage — MS



- CONTROLLED STORAGE LOCATION
- BARRIER AROUND PERIMETER
- ELEVATE CONTAINERS OFF GROUND
- COVER WHEN NOT IN USE

DESCRIPTION:

Controlled storage of on-site materials.

APPLICATION:

- Storage of hazardous, toxic, and all chemical substances
- Any construction site with outside storage of materials

INSTALLATION / APPLICATION CRITERIA:

- Designate a secured area with limited access as the storage location. Ensure no waterways or drainage paths are nearby
- Construct compacted earthen berm (See Earth Berm Barrier Information Sheet), or similar perimeter containment around storage location for impoundment in the case of spills
- Ensure all on-site personnel utilize designated storage area. Do not store excessive amounts of material that will not be utilized on site
- For active use of materials away from the storage area ensure materials are not set directly on the ground and are covered when not in use. Protect storm drainage during use

LIMITATIONS:

- Does not prevent contamination due to mishandling of products
- Spill Prevention and Response Plan still required
- Only effective if materials are actively stored in controlled location

MAINTENANCE:

- Inspect daily and repair any damage to perimeter impoundment or security fencing
- Check materials are being correctly stored (i.e. standing upright, in labeled containers, tightly capped) and that no materials are being stored away from the designated location

OBJECTIVES

- ☒ Housekeeping Practices
- ☒ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☐	☐	☒	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☒	☐	☐	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☒	☐	Other Waste

IMPLEMENTATION REQUIREMENTS

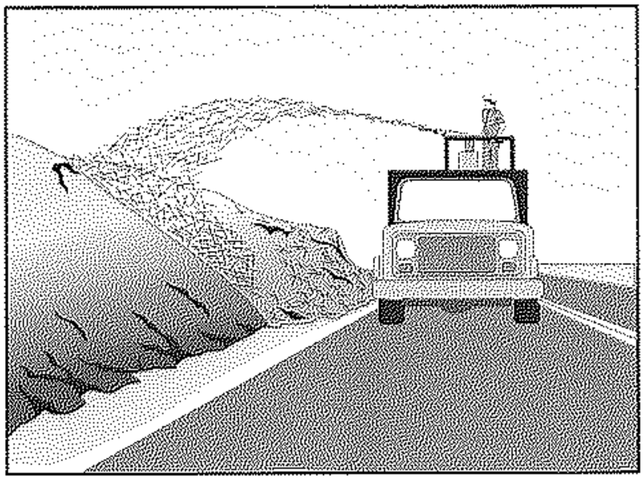
H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☒	☐	☐	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: MULCHING — MU



DESCRIPTION:

Placement of material such as straw, grass, woodchips, or wood fibers over open areas.

APPLICATION:

- Any exposed area to remain untouched longer than 14 days and that will be exposed less than 60 days (seed areas to be exposed in excess of 60 days)
- Areas that havebeen seeded
- Stockpiled soil materials

INSTALLATION / APPLICATION CRITERIA:

- Roughen area to receive mulch to create depressions that mulch material can settle into
- Apply mulch to required thickness and anchor as necessary
- Ensure material used is weed free and does not contain any constituents that will inhibit plant growth

LIMITATIONS:

- Anchoring may be required to prevent migration or mulch material
- Downgradient control may be required to prevent mulch material being transported to storm water system

MAINTENANCE:

- Inspect mulched areas after every rainfall event and at a minimum of monthly
- Replace mulch on any bare areas and reanchor as necessary
- Clean and replace downgradient controls as necessary

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☒ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☒	☐	Nutrients
☐	☐	☒	Heavy Metals
☒	☐	☐	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

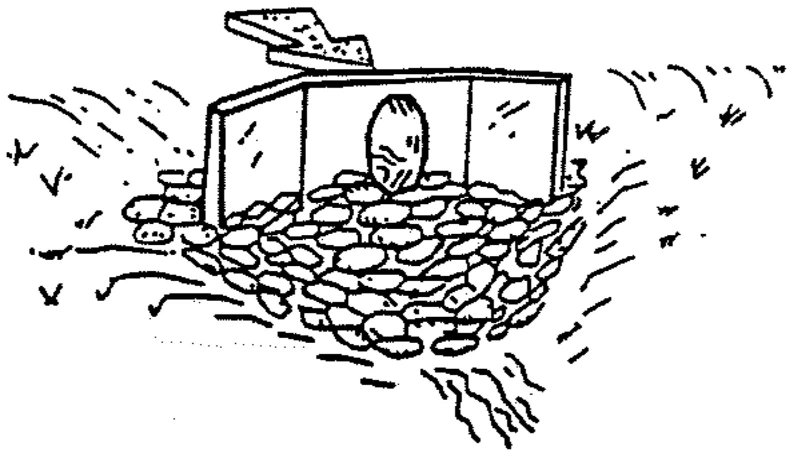
H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Outlet Protection OP



DESCRIPTION:

A rock outlet protection is a physical device composed of rock, or grouted riprap which is placed at the outlet of a pipe to prevent scour of the soil caused by high pipe flow velocities, and to absorb flow energy to produce nonerosive velocities.

APPLICATION:

- Wherever discharge velocities and energies at the outlets of culverts, conduits, or channels are sufficient to erode the next downstream reach
- Rock outlet protection is best suited for temporary use during construction because it is usually less expensive and easier to install than concrete aprons or energy dissipators
- A sediment trap below the pipe outlet is recommended if runoff is sediment laden
- Permanent rock riprap protection should be designed and sized by the engineer as part of the culvert, conduit or channel design
- Grouted riprap should be avoided in areas of freeze and thaw because the grout will break up

INSTALLATION / APPLICATION CRITERIA:

- Rock outlet protection is effective when the rock is sized and placed properly. When this is accomplished, rock outlets do much to limit erosion at pipe outlets. Rock size should be increased for high velocity flows. Best results are obtained when sound, durable, angular rock is used.

LIMITATIONS:

- Large storms often wash away the rock outlet protection and leave the area susceptible to erosion
- Sediment captured by the rock outlet protection may be difficult to remove without removing the rock
- Outlet protection may negatively impact the channel habitat

MAINTENANCE:

- Inspect after each significant rain for erosion and/or disruption of the rock, and repair immediately
- Grouted or wire-tied rock riprap can minimize maintenance requirements

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

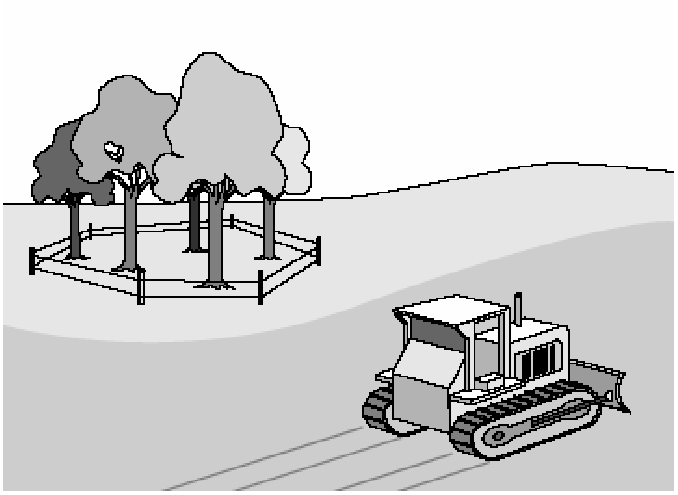
H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: **PEV**



DESCRIPTION:

Carefully planned preservation of existing vegetation minimizes the potential of removing or injuring existing trees, vines, shrubs and/or grasses that serve as erosion controls.

APPLICATION:

This technique is applicable to all types of sites. Areas where preserving vegetation can be particularly beneficial are floodplains, wetlands, stream banks, steep slopes, and other areas where erosion controls would be difficult to establish, install, or maintain.

INSTALLATION / APPLICATION CRITERIA:

- Clearly mark, flag or fence vegetation or areas where vegetation should be preserved.
- Prepare landscaping plans which include as much existing vegetation as possible and state proper care during and after construction.
- Define and protect with berms, fencing, signs, etc. a setback area from vegetation to be preserved.
- Propose landscaping plans which do not include plant species that compete with the existing vegetation.
- Do not locate construction traffic routes, spoil piles, etc. where significant adverse impact on existing vegetation may occur.

LIMITATIONS:

- Requires forward planning by the owner/developer, contractor and design staff.
- For sites with diverse topography, it is often difficult and expensive to save existing trees while grading the site satisfactorily for the planned development.
- May not be cost effective with high land costs.

MAINTENANCE:

- Inspection and maintenance requirements for protection of vegetation are low.
- Maintenance of native trees or vegetation should conform to landscape plan specifications.

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☒ Minimize Disturbed Areas
- ☒ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☒ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

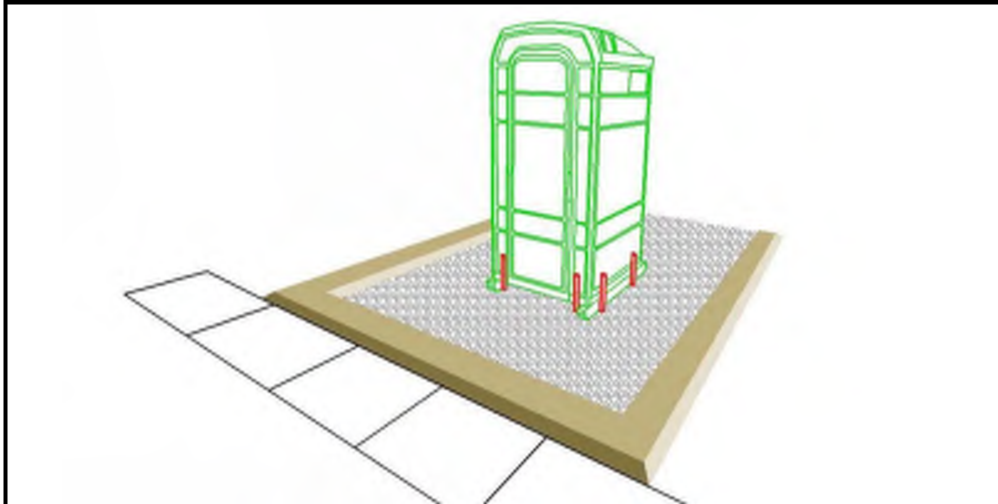
H	M	L	
☐	☐	☒	Capital Costs
☐	☐	☒	O&M Costs
☐	☐	☒	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M** = Medium **L** = Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Portable Toilet PT



Description:

Temporary on-site sanitary facilities for construction personnel.

Application:

All sites with no permanent sanitary facilities or where permanent facility is too far from activities.

Installation / Application Criteria:

- Locate portable toilets in a convenient locations throughout the site
- Prepare level, gravel surface and provide clear access to the toilets for servicing and for on-site personnel
- Construct earth berm perimiter (see Earth Berm Barrier Sheet), control for spill / leak protection.
- Anchor the portable toilet to prevent tipping

Limitations:

No limitations

Maintenance:

- Portable toilets should be maintained in good working order by licensed service with daily observation for leak detection
- Regular waste collection should be arranged with licensed service
- All waste should be deposited in sanitary sewer system for treatment with appropriate agency approval

Objectives

☒ Housekeeping Practices
☒ Contain Waste
☐ Minimize Disturbed Areas
☐ Stabilize Disturbed Areas
☐ Protect Slopes/Channels
☐ Control Site Perimeter
☐ Control Internal Erosion

Targeted Pollutants

H	M	L	
☐	☐	☒	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☒	☐	☐	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☒	☐	☐	Bacteria & Viruses
☒	☐	☐	Other Waste

Implementation Requirements

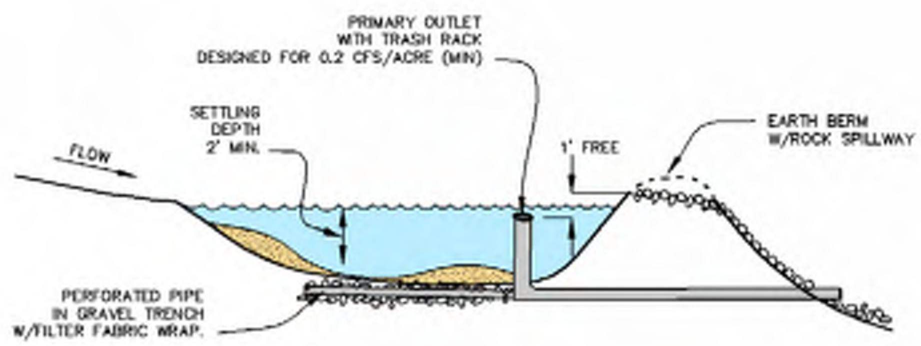
H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Sediment Basin — SB



DESCRIPTION:

A pond created by excavating or construction of an embankment, and designed to retain or detain runoff sufficiently to allow excessive sediment to settle.

APPLICATION:

- At the outlet of all disturbed watersheds 10 acres or larger
- At the outlet of smaller disturbed watersheds, as necessary
- Where post construction detention basins will be located

INSTALLATION / APPLICATION CRITERIA:

- Design basin for site specific location, maintian effective flow length 2 times width
- Excavate basin or construct compacted berm containment; ensure no downgradient hazard if failure should occur. (Provide minimum of 67 cy. per acre of drainage area.)
- Construct dewtering and outfall structure and emergency spillway with apron

LIMITATIONS:

- Should be sized based on anticipated runoff, sediment loading and drainage area size
- May require silt fence at outlet for entrapment of very fine silts and clays
- May require safety fencing to prevent public access
- Height restrictions for embankment regulated by Utah Division of Dam Safety

MAINTENANCE:

- Inspect after each rainfall event and at a minimum of once every two weeks
- Repair any damage to berm, spillway or sidewalls
- Remove accumulated sediment as it reaches 2/3 height of available storage
- Check outlet for sedimentation/erosion of downgradient area and remediate as necessary. Install silt fence if sedimentation apparent

OBJECTIVES

☐ Housekeeping Practices
☐ Contain Waste
☐ Minimize Disturbed Areas
☐ Stabilize Disturbed Areas
☐ Protect Slopes/Channels
☐ Control Site Perimeter
☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☒	☐	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☒	☐	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

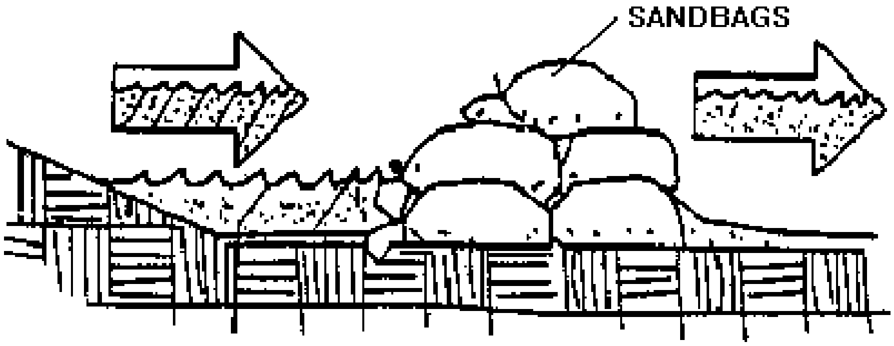
H	M	L	
☒	☐	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Sand Bag Barrier — SBB



OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☒ Control Site Perimeter
- ☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☒	☐	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☐	☒	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

DESCRIPTION:

Stacking sand bags along a level contour creates a barrier which detains sediment - laden water, ponding water upstream of the barrier and promoting sedimentation

APPLICATION:

- Along the perimeter of the site
- May be used in drainage areas up to 5 acres
- Along streams and channels
- Across swales with small catchments
- Around temporary spoil areas
- Below the toe of a cleared slope

INSTALLATION / APPLICATION CRITERIA:

- Install along a level contour
- Base of sand bag barrier should be at least 48" wide
- Height of sand bag barrier should be at least 18" high
- 4" PVC pipe may be installed between the top layer of sand bags to drain large flood flows
- Provide area behind barrier for runoff to pond and sediment to settle
- Place below the toe of a slope
- UV resistant bags should be used

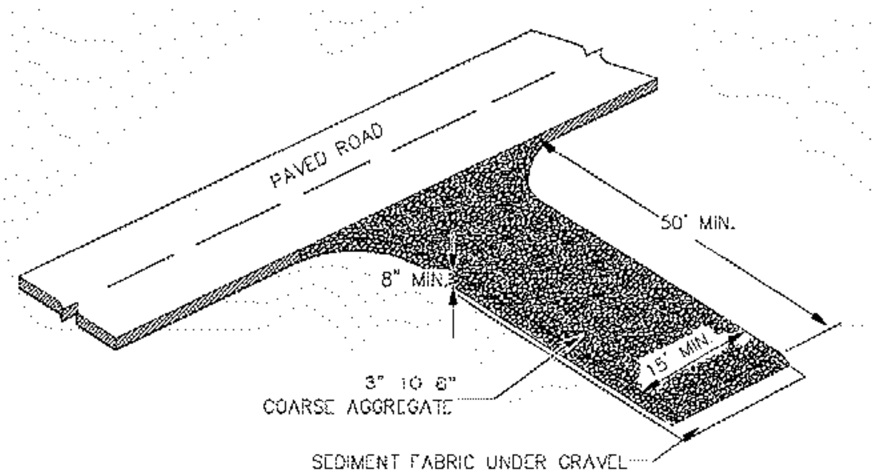
LIMITATIONS:

- Sand bags are more expensive than other barriers, but also more durable
- Burlap should not be used

MAINTENANCE:

- Inspect after each rain and a minimum of once every two weeks
- Reshape or replace damaged sand bags immediately
- Remove buildup of sediment

BMP: Stabilized Construction Entrance — SCE



DESCRIPTION:

A stabilized pad of crushed stone located where construction traffic enters or leaved the site from or to paved surface.

APPLICATION:

At any point of ingress and egress at a construction site where adjacent traveled way is paved. Generally applies to sites over 2 acres unless special conditions exist.

INSTALLATION / APPLICATION CRITERIA:

- Clear and grub area and grade to provide maximum slope of 2%
- Compact subgrade and place filter fabric if desired (recommended for entrances to remain for more than 3 months
- Place coarse aggregate, 3-6 inches in size, to a minimum depth of 8 inches

LIMITATIONS:

- Requires periodic top dressing with additional stones
- Should be used in conjuction with street sweeping on adjacent public right-of-way

MAINTENANCE:

- Inspect daily for loss of gravel or sediment buildup
- Inspect adjacent roadway for sediment deposit and clean by sweeping or shoveling
- Repair entrance and replace gravel as required to maintain control in good working condition
- Expand stabilized area as required to accommodate traffic and prevent erosion at driveways

OBJECTIVES

- ☒ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☒ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

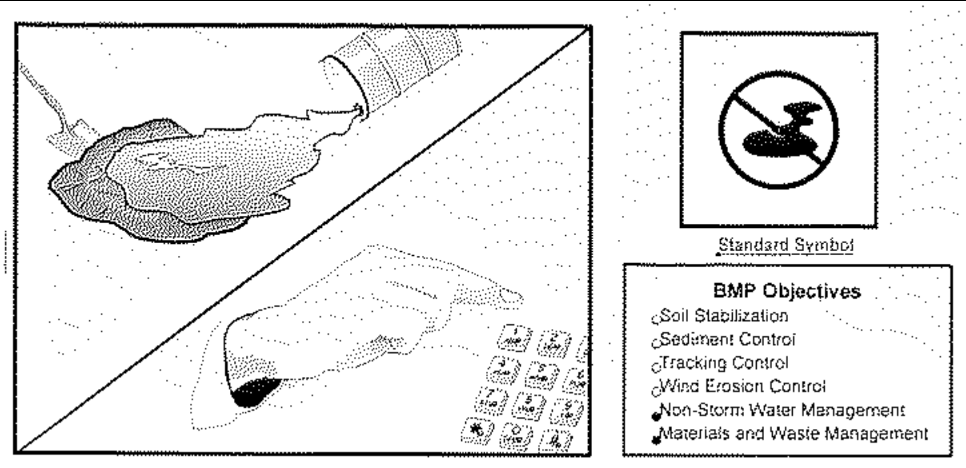
IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION
1500 East 650 North
Fruit Heights, UT 84037

BMP: Spill Clean-Up — SCU



DESCRIPTION:

Practices to clean-up leakage/spillage of on-site materials that may be harmful to receiving waters.

APPLICATION:

All sites

GENERAL:

- Store controlled materials within a storage area
- Educate personnel on prevention and clean-up
- Designate an Emergency Coordinator responsible practices and for providing spill response
- Maintain a supply of clean-up equipment on-site response agencies with phone numbers

METHODS:

- Clean-up spills/leaks immediately and remediate cause
- Use as little water as possible. NEVER HOSE DOWN OR BURY SPILL CONTAMINATED MATERIAL
- Use rags or absorbent material for clean-up. Excavate contaminated soils. Dispose of clean-up material and soil as hazardous waste
- Document all spills with date, location, substance, volume, actions taken and other pertinent data.
- Contact local Fire Department and State Division of Environmental Response and Remediation (Phone #536-4100) for any spill of reportable quantity

OBJECTIVES

- ☒ Housekeeping Practices
- ☒ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☐	☐	☒	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☒	☐	☐	Toxic Materials
☐	☒	☐	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

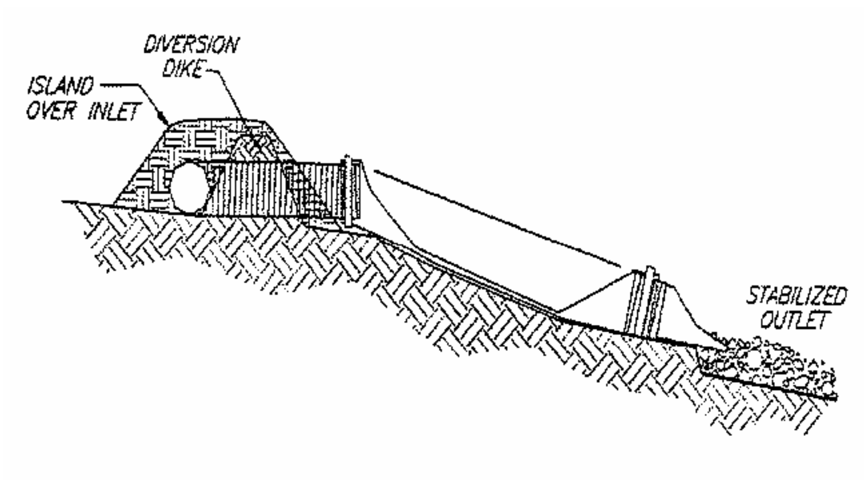
H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☐	☒	Maintenance
☒	☐	☐	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Slope Drain — SD



DESCRIPTION:

A tempoarary pipe or lined channel that drains the top of a slope to a stable discharge point at the bottom of a slope without causing erosion.

APPLICATION:

- Where concentrated flow of surface runoff must be conveyed down a slope in order ro prevent erosion
- Emergency spillway for a sediment basin

INSTALLATION / APPLICATION CRITERIA:

- Secure inlet and surround with dikes to prevent gully erosion, and anchor pipe to slope
- Size to convey at least the peak of a 10-year storm event
- Stabilize outlet (See Outlet Protection BMP.)

LIMITATIONS:

- Maximum drainage area per slope drain is 5 acres
- Clogged slope drains will force water around the pipe and cause slope erosion
- Dissipation of high flow velocities at the pipe outlet is required to avoid downstream erosion
- Failure can result in flooding and severe erosion

MAINTENANCE:

- Structure must be inspected weekly and after storms
- Inlet must be protected form undercutting and no water should circumvent the entry
- Outlet should not produce erosion; velocity dissipators must be maintained
- Pipe anchors must be checked to ensure that the pipe remains anchored to the slope

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

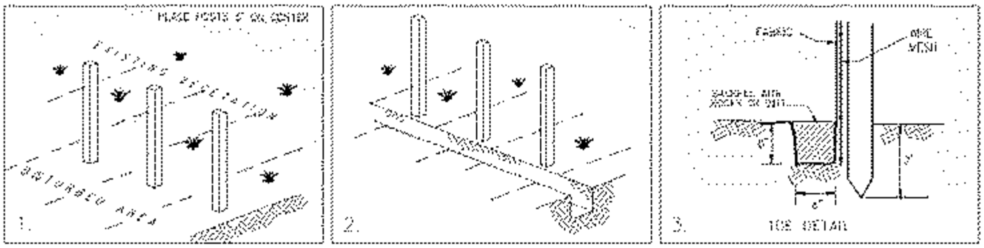
H	M	L	
☒	☐	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Silt Fence SF



DESCRIPTION:

A temporary sediment barrier consisting of entrenched filter fabric stretched across and secured to supporting posts.

APPLICATION:

- Perimeter control: place barrier at downgradient limits of disturbance
- Sediment barrier: place barrier at toe of slope or soil stockpile
- Protection of existing waterways: place barrier at top of stream bank
- Inlet protection: place fence surrounding catch basins

INSTALLATION / APPLICATION CRITERIA:

- Place posts 6' apart on center along contour (or use preassembled unit) and drive 2' minimum into ground. Excavate an anchor trench immediately up gradient of posts
- Cut fabric to require width, unroll along length of barrier and drape over barrier. Secure fabric to mesh with twine, staples, or similar, with trailing edge extending into anchor trench
- Backfill trench over fabric to anchor
- Fabric must have 85% minimum sediment removal efficiency

LIMITATIONS:

- Recommended maximum drainage area of 0.5 acre per 100 feet
- Recommended maximum upgradient slope length of 150'
- Recommended maximum uphill grade of 2:1 (50%)
- Recommended maximum flow rate of 0.5 cfs
- Ponding should not be allowed behind fence

MAINTENANCE:

- Inspect immedialty after any rainfall and at least daily during prolonged rainfall
- Look for runoff bypassing ends of barriers or undercutting barriers
- Repair or replace damaged areas of the barrier and remove accumulated sediment
- Reanchor fence as necessary to prevent shortcutting
- Remove accumulated sediment when it reaches 1/2 the height of the fence

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☒ Control Site Perimeter
- ☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

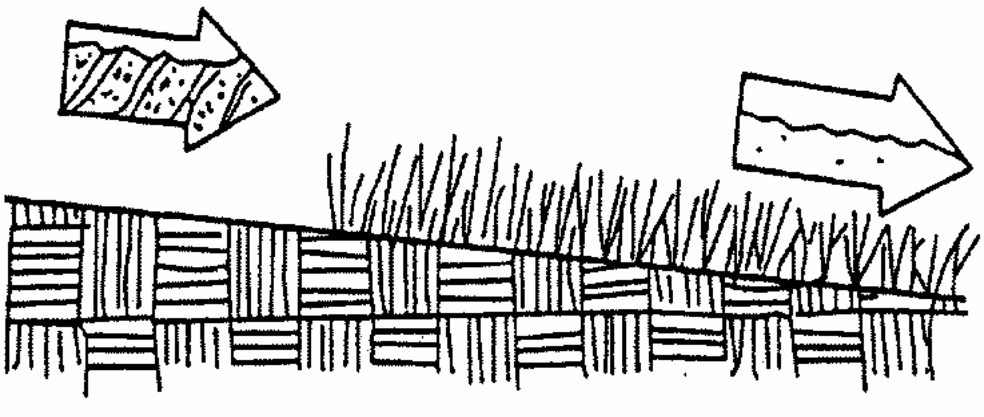
H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Seeding and Planting SP



OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☒ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☒	☐	Nutrients
☐	☐	☒	Heavy Metals
☐	☒	☐	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

DESCRIPTION:

Seeding of grass and plantings of trees, shrubs, vines and ground covers provide long-term stabilization of soil. In some areas, with suitable climates, grasses can be planted for temporary stabilization.

APPLICATION:

- Appropriate for site stabilization both during construction and post-construction
- Any graded/cleared areas where construction activities have ceased
- Open space cut and fill areas
- Steep slopes, spoil piles, vegetated swales, landscape corridors, stream banks. Use in conjunction with matting, mulch or blanketing where appropriate.

INSTALLATION / APPLICATION CRITERIA:

Type of vegetation, site and seedbed preparation, planting time, fertilization and water requirements should be considered for each application.

Grasses:

- Ground preparations: fertilize and mechanically stabilize the soil
- Tolerant of short-term temperature extremes and waterlogged soil composition
- Appropriate soil conditions: shallow soil base, good drainage, slope 2:1 or flatter
- Mowing, irrigating, and fertilizing are vital for promoting vigorous grass growth

Trees and Shrubs:

- Selection criteria: vigor, species, size, shape & wildlife food source
- Soil conditions: select species appropriate for soil, drainage & acidity
- Other factors: wind/exposure, temperature extremes, and irrigations needs

Vines and Ground Covers:

- Ground preparation: lime and fertilizer preparation
- Use proper seeding rates
- Appropriate soil conditions: drainage, acidity and slopes
- Generally avoid species requiring irrigation

BMP: Surface Roughening — SR

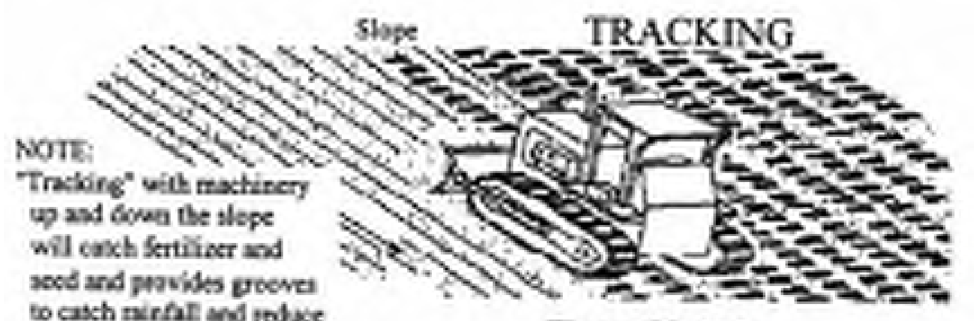


Figure ES-05-1
Surface Roughening – Equipment Tracking

DESCRIPTION:

Rough preparation of working areas leaving depressions and uneven surface. Depressions should be done parallel to contours.

APPLICATION:

- Surface roughening is appropriate for all construction that will not be receiving impervious cover within 14 days and that will be exposed less than 60 days (seed areas to be open in excess of 60 days)

INSTALLATION / APPLICATION CRITERIA:

- Surface should be left in rough condition during initial earthwork activity
- Surfaces that have become smoothed or compacted due to equipment traffic should be roughened by use of disks, spring harrows, teeth on front end loader, or similar, operating along the contours of the slope. Tracking (by crawler tractor driving up and down slope) may also be used to provide depressions parallel to contours
- Avoid compaction of soils during roughening as this inhibits plant growth and promotes storm water runoff. Limit tracked machinery to sandy soil
- Seed or mulch areas to be exposed in excess of 60 days
- Employ dust controls (see Dust Control Detail Sheet if appropriate)

LIMITATIONS:

- Will not withstand heavy rainfall
- Slopes steeper than 2:1 (50%) should be benched (see Benching Detail Sheet)

MAINTENANCE:

- Inspect following any storm event and at a minimum of weekly
- If erosion in the form of rills (small waterways formed by runoff) is evident, perform machine roughening of area
- For vegetated slopes reseed areas that are bare or have been reworked

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☒ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Street Sweeping SS

DESCRIPTION:

Prevent sediment from entering storm water by sweeping the streets near construction activities.

APPLICATION:

- Useful for any paved streets near construction sites where sediment is blown, tracked, or spilled onto the streets.

INSTALLATION / APPLICATION CRITERIA:

- The equipment used should be appropriate for the conditions. Vacuum sweepers work more effectively when the area is dry. Brush sweepers work better when the sediment is wet or stuck to the surface.
- Mechanical equipment should be operated and maintained according to the manufacturer's recommendations

LIMITATIONS:

- Is labor and equipment intensive
- May cause dust

MAINTENANCE:

- The street should be checked daily for any sediment deposits. Street sweeping should be implemented whenever sediment from construction activity is found on the streets

OBJECTIVES

☒ Housekeeping Practices
☐ Contain Waste
☐ Minimize Disturbed Areas
☐ Stabilize Disturbed Areas
☐ Protect Slopes/Channels
☒ Control Site Perimeter
☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☐	☒	Capital Costs
☐	☒	☐	O&M Costs
☒	☐	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

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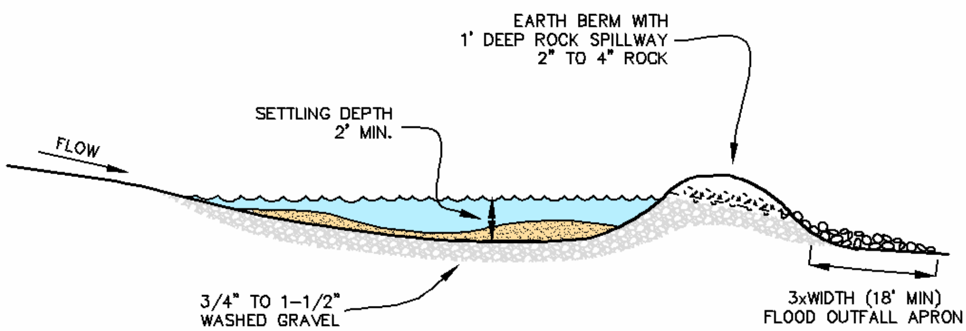
DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Sediment Trap — ST



OBJECTIVES

☐ Housekeeping Practices
☐ Contain Waste
☐ Minimize Disturbed Areas
☐ Stabilize Disturbed Areas
☐ Protect Slopes/Channels
☐ Control Site Perimeter
☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
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☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☐	☒	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DESCRIPTION:

A sediment trap is a small excavated or bermed area where runoff from small drainage areas is detained and sediment can settle.

APPLICATION:

- Temporary control for runoff from disturbed areas of less than 3 arcres
- Temporary control for discharge from diversion dike, surface benching, or other temporary drainage measures

INSTALLATION / APPLICATION CRITERIA:

- Design basin for site specific location
- Excavate basin or construct compacted berm containment
- Construct outfall spillway with apron
- Provide downstream silt fence if necessary

LIMITATIONS:

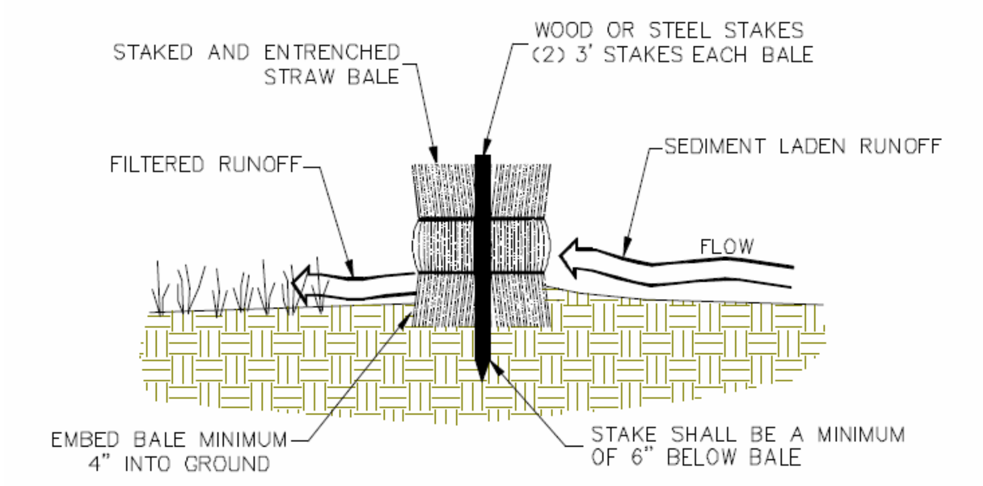
- Should be sized based on anticipated runoff, sediment loading and drainage area size
- May require silt fence at outlet for entrapment of very fine silts and calys

MAINTENANCE:

- Inspect after each rainfall event and at a minimum of once every two weeks
- Repair any damage to berm, spillway or sidewalls
- Remove accumulated sediment as it reaches 2/3 height of available storage
- Check outlet for sedimentation/erosion of downgradient area and remediate as necessary. Install silt fence if sedimentation apparent.

DAVIS COUNTY STORM WATER COALITION
1500 East 650 North
Fruit Heights, UT 84037

BMP: Straw Bale Barrier — SBB



DESCRIPTION:

Temporary sediment barrier consisting of a row of entrenched and anchored straw bales.

APPLICATION:

- Perimeter Control: place barrier at downgradient limits of disturbance
- Sediment barrier: place barrier at toe of slope or soil stockpile
- Protection of existing waterways: place barrier at top of stream bank
- Inlet Protection

INSTALLATION / APPLICATION CRITERIA:

- Excavate a 4" minimum deep trench along contour line, i.e., parallel to slope, removing all grass and other material that may allow underflow
- Place bales in trench with ends tightly abutting; fill any gaps by wedging loose straw into openings
- Anchor each bale and compact to prevent piping; backfill on uphill side to be built up 4" above ground at the barrier

LIMITATIONS:

- Recommended maximum area of 0.5 acre per 100' of barrier
- Recommended maximum upgradient slope length of 150 feet
- Recommended maximum uphill grade of 2:1 (50%)
- Maximum duristation of use is 6 months

MAINTENANCE:

- Inspect immediately after any rainfall and at least daily during prolonged rainfall
- Look for runoff bypassing ends of barriers or undercutting barriers
- Repair or replace damaged areas of the barrier and remove accumulated sediment
- Realign bales as necessary to provide continuous barrier and fill gaps
- Recompact soil around barrier as necessary to prevent piping

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☒ Control Site Perimeter
- ☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

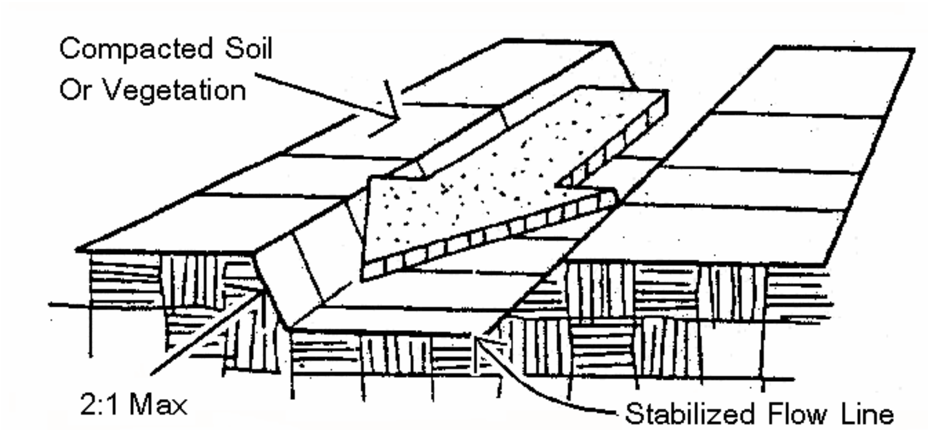
H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

BMP: Temporary Drains and Swales — TDS



DESCRIPTION:

Temporary drains and swales are used to divert off-site runoff around the construction site, divert runoff from stabilized areas around disturbed areas.

APPLICATION:

- Temporary drains and swales are appropriate for diverting and upslope runoff around unstabilized or disturbed areas of the construction site
- Prevent slope failures. Prevent damage to adjacent property. Prevents erosion and transport of sediments into water ways. Increases the potential for infiltration. Diverts sediment-laden runoff into sediment basins or traps.

INSTALLATION / APPLICATION CRITERIA:

- Temporary drainage swales will effectively convey runoff and avoid erosion if built properly
- Size temporary drainage swales using local drainage design criteria. A permanent drainage channel must be designed by a professional engineer (see the local drainage design criteria for proper design)
- At a minimum, the drain/swale should conform to predevelopment drainage patterns and capacities
- Construct the drain/swale with an uninterrupted positive grade to a stabilized outlet. Provide erosion protection or energy dissipation measures if the flow out of the drain or swale can reach an erosive velocity

LIMITATIONS:

- Temporary drains and swales or any other diversion of runoff should not adversely impact upstream or downstream properties
- Temporary drains and swales must conform to local floodplain management requirements

MAINTENANCE:

- Inspect weekly and after each rain
- Repair any erosion immediately
- Remove sediment which builds up in the swale and restrcts its flow capacity

OBJECTIVES

☐ Housekeeping Practices
☐ Contain Waste
☐ Minimize Disturbed Areas
☐ Stabilize Disturbed Areas
☒ Protect Slopes/Channels
☒ Control Site Perimeter
☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☒	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☐	☒	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION
1500 East 650 North
Fruit Heights, UT 84037

BMP: Temporary and Permanent Seeding — TPS

DESCRIPTION:

Temporary seeding-establishment of short term cover by application of rapidly germinating seed mix (alternatively hydroseeding may be utilized).
Permanent seeding-establishment of final term cover by application of perennial seed mix (alternatively sod may be utilized).

APPLICATION:

Disturbed areas that are at final grade and which will not be disturbed by continuing activities on site. Also areas that are not at final grade but which will be left untouched in excess of one year.

RECOMMENDED SEED MIX:

The recommended seed mix will be dependent on site specific information such as elevation, exposure, soils, water available and topography. Check with the County Extension Service for recommended mixes for site specific conditions:

Utah State University Extension Service
28 E. State Street (Room 20D)
Farmington, Utah 84025
Phone: (801) 451-3412

LIMITATIONS:

- Limited to areas that will not be subject to traffic or high usage
- May require irrigation and fertilizer which creates potential for impacting runoff quality
- May only be applied during appropriate planting season, temporary cover required until that time

INSTALLATION:

- Roughen soil to a depth of 2 inches. Add fertilizer, manure, topsoil as necessary
- Evenly distribute seed using a commonly accepted method such as; breast seeding, drilling, hydro-seeding
- Use a seed mix appropriate for soil and location that will provide rapid germination and growth. Check with County for recommended mix and application rate.
- Cover area with mulch if required due to steep slopes or unsuitable weather conditions

MAINTENANCE:

- Provide irrigation as required to establish growth and to maintain plant cover through duration of project
- Reseed as necessary to provide 75% coverage
- Remediate any areas damaged by erosion or traffic
- When 75% coverage is achieved inspect monthly for damage and remediate as necessary

OBJECTIVES

☐ Housekeeping Practices
☐ Contain Waste
☐ Minimize Disturbed Areas
☒ Stabilize Disturbed Areas
☒ Protect Slopes/Channels
☐ Control Site Perimeter
☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☒	☐	☐	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

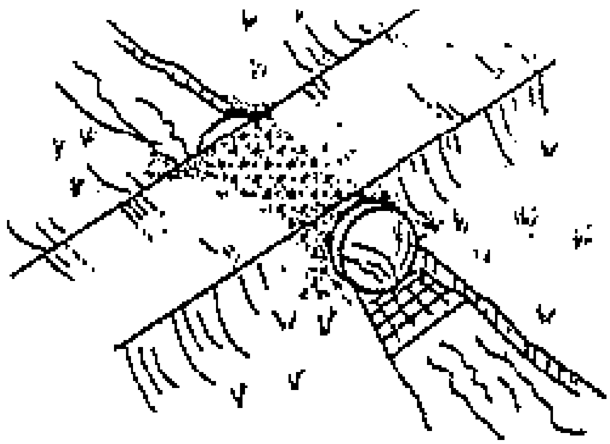
IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION
1500 East 650 North
Fruit Heights, UT 84037

BMP: Temporary Stream Crossing TSC



OBJECTIVES

- ☒ Housekeeping Practices
- ☐ Contain Waste
- ☒ Minimize Disturbed Areas
- ☒ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☒	☐	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

DESCRIPTION:

A temporary access stream crossing is a temporary culvert, ford or bridge placed across a waterway to provide access for construction purposes for a period of less than one year. Temporary access crossings are not intended to be used to maintain traffic for the general public.

APPLICATION:

- Temporary stream crossings should be installed at all designated crossings of perennial and intermittent streams on the construction site, as well as for dry channels which may be significantly eroded by construction traffic.

INSTALLATION / APPLICATION CRITERIA:

- Requires knowledge of stream flows and soil strength and should be designed under the direction of a Utah registered engineer with knowledge of both hydraulics and construction loading requirements for structures.

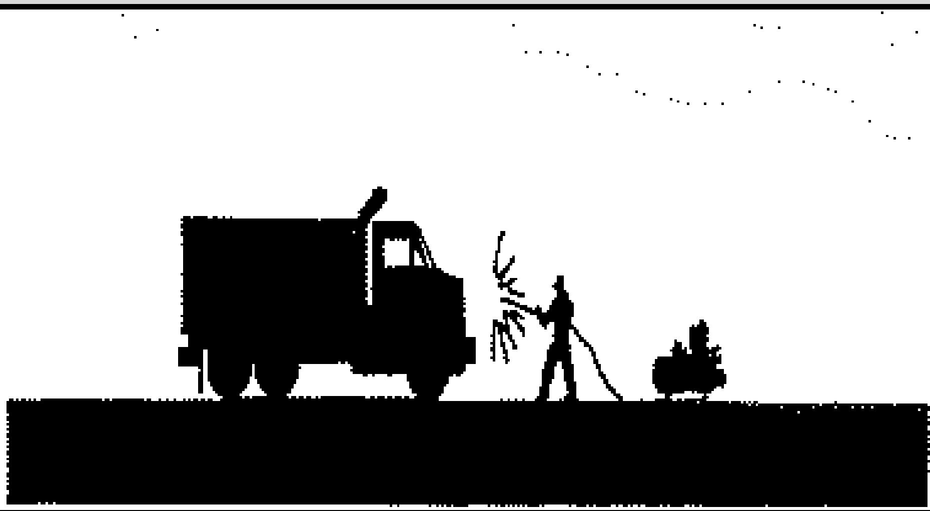
LIMITATIONS:

- May be expensive for a temporary improvement
- Requires other BMP's to minimize soil disturbance during installation and removal
- Fords should only be used in dry weather
- A Stream Alteration Permit may be required, contact the Utah Division of Water Rights before implemention

MAINTENANCE:

- Inspect weekly and after each significant rainfall, including assessment of foundations
- Periodically remove silt from crossings
- Replace lost aggregate from inlets and outlets of culverts

BMP: Vehicle And Equipment Cleaning — VEC



DESCRIPTION:

Prevent or reduce the discharge of pollutants to storm water from vehicle and equipment cleaning by using off-site facilities, washing in designated, contained areas only, eliminating discharges to the storm drain by infiltrating or recycling the wash water, and/or training employees and subcontractors.

INSTALLATION / APPLICATION CRITERIA:

- Use off-site commercial washing businesses as much as possible. Washing vehicles and equipment outdoors or in areas where wash water flows onto paved surfaces or into drainage pathways can pollute storm water. If you wash large number of vehicles or pieces of equipment, consider conducting this work at an off-site commercial business. These businesses are better equipped to handle and dispose of the wash waters properly. Performing this work off-site can also be economical by eliminating the need for a separate washing operation at your site.
- If washing must occur on-site, use designated, bermed wash areas to prevent wash water contact with storm water, creeks, rivers, and other water bodies. The wash area can be sloped for wash water collection and subsequent infiltration into the ground.
- Use as little water as possible to avoid having to install erosion and sediment controls for the wash area. Use phosphate-free biodegradable soaps. Educate employees and subcontractors on pollution prevention measures. Do not permit steam cleaning on-site. Steam cleaning can generate significant pollutant concentrations.

LIMITATIONS:

- Even phosphate-free, biodegradable soaps have been shown to be toxic to fish before the soap degrades
- Sending vehicles/equipment off-site should be done in conjunction with Stabilized Construction Entrance

MAINTENANCE:

- Minimal, some berm repair may be necessary

OBJECTIVES

- ☒ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☒ Control Site Perimeter
- ☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☐	☐	☒	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☒	☐	Toxic Materials
☐	☒	☐	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

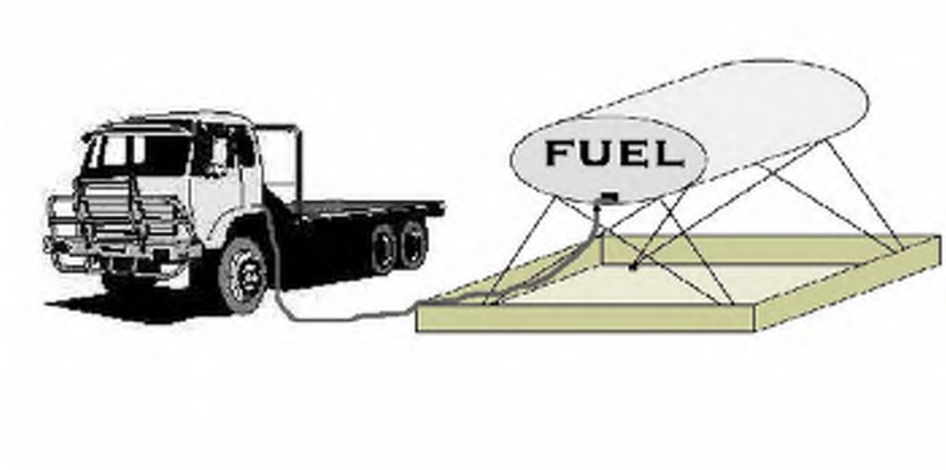
IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M** = Medium **L** = Low

DAVIS COUNTY STORM WATER COALITION
1500 East 650 North
Fruit Heights, UT 84037

BMP: Vehicle And Equipment Fueling — VEF



DESCRIPTION:

Prevent fuel spills and leaks, and reduce their impacts to storm water by using offsite facilities, fueling in designated areas only, enclosing or covering stored fuel, implementing spill controls, and training employees and subcontractors.

INSTALLATION / APPLICATION CRITERIA:

- Use off-site fueling stations as much as possible. Fueling vehicles and equipment outdoors or in areas where fuel may spill/leak onto paved surfaces or into drainage pathways can pollute storm water. If you fuel a large number of vehicles or pieces of equipment, consider using an off-site fueling station. These businesses are better equipped to handle fuel and spills properly. Performing this work off-site can also be economical by eliminating the need for a separate fueling area at your site.
- If fueling must occur on-site, use designated areas, located away from drainage courses, to prevent the run on of storm water and the runoff of spills. Discourage "topping-off" of fuel tanks.
- Always use secondary containment, such as a drain pan or drop cloth, when fueling to catch spills/leaks. Place a stockpile of spill cleanup materials where it will be readily accessible. Use adsorbent materials on small spills rather than hosing down or burying the spill. Remove the adsorbent materials promptly and dispose of properly.
- 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. With the exception of tracked equipment such as bulldozers and perhaps forklifts, most vehicles should be able to travel to a designated area with little lost time. Train employees and subcontractors in proper fueling and cleanup procedures.

LIMITATIONS:

Sending vehicles/equipment off-site should be done in conjunction with Stabilized Construction Entrance

MAINTENANCE:

- Keep ample supplies of spill cleanup materials on-site
- Inspect fueling areas and storage tanks on a regular schedule

OBJECTIVES

- ☒ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☐	☐	☒	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☒	☐	Toxic Materials
☐	☒	☐	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

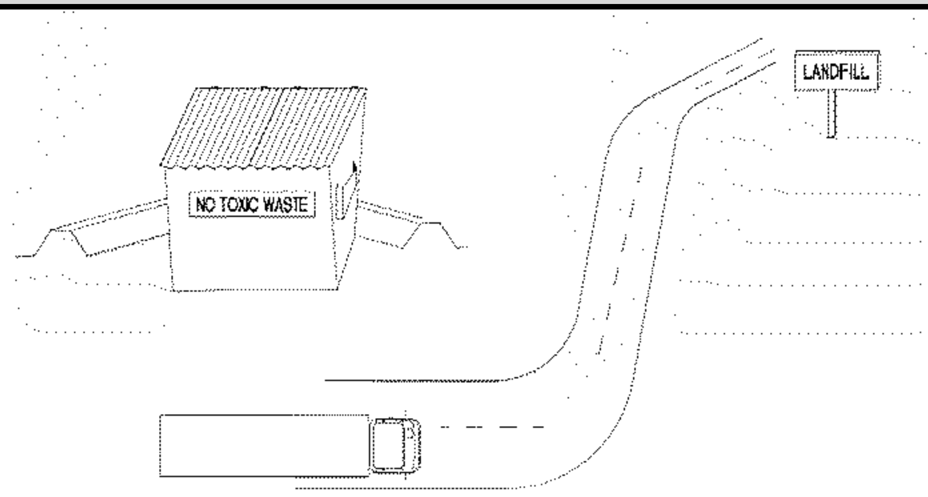
IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☒	☐	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

1500 East 650 North
Fruit Heights, UT 84037

BMP: Waste Disposal WD



DESCRIPTION:

Controlled storage and disposal of solid waste generated by construction activities.

APPLICATION:

All construction sites

INSTALLATION / APPLICATION CRITERIA:

- Designate one or several waste collection areas with easy access for construction vehicles and personnel. Ensure no waterways or storm drainage inlets are located near the waste collection areas.
- Construct compacted earthen berm (See Earth Berm Barrier Information Sheet), or similar perimeter containment around collection area for impoundment in the case of spills.
- Ensure all on site personnel are aware of and utilize designated waste collection area properly and for intended use only (e.g. all toxic, hazardous, or recyclable materials shall be properly disposed of separately from general construction waste).
- Arrange for periodic pickup, transfer and disposal of collected waste at an authorized disposal location. Include regular Porto-potty service in waste management activities.

LIMITATIONS:

- On-site personnel are responsible for correct disposal of waste

MAINTENANCE:

- Discuss waste management procedures at progress meetings
- Collect site trash daily and deposit in containers at designated collection areas
- Randomly check disposed materials for any unauthorized waste (e.g. toxic materials).

OBJECTIVES

☒ Housekeeping Practices
☒ Contain Waste
☐ Minimize Disturbed Areas
☐ Stabilize Disturbed Areas
☐ Protect Slopes/Channels
☐ Control Site Perimeter
☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☐	☐	☐	Sediment
☐	☐	☐	Nutrients
☐	☐	☐	Heavy Metals
☒	☐	☐	Toxic Materials
☐	☒	☐	Oil & Grease
☒	☐	☐	Floatable Materials
☐	☐	☐	Bacteria & Viruses
☒	☐	☐	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☒	☐	☐	Capital Costs
☒	☐	☐	O&M Costs
☐	☒	☐	Maintenance
☒	☐	☐	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DAVIS COUNTY STORM WATER COALITION

1500 East 650 North
Fruit Heights, UT 84037

STORMWATER RESOURCES

Environmental Protection Agency (EPA) Region VIII .... (800) 227-8917

Army Corps of Engineers .... (801) 295-8380

Utah Department of Environmental Quality

Division of Water Quality...538-6146

Division of Environmental Response and Remediation 536-4100

Division of Air Quality 536-4000

Solid and Hazardous Waste - Used Oil Hotline.. (800) 458-0145

Utah Division of Natural Resources

General Information...539-4001

Davis County Health Department

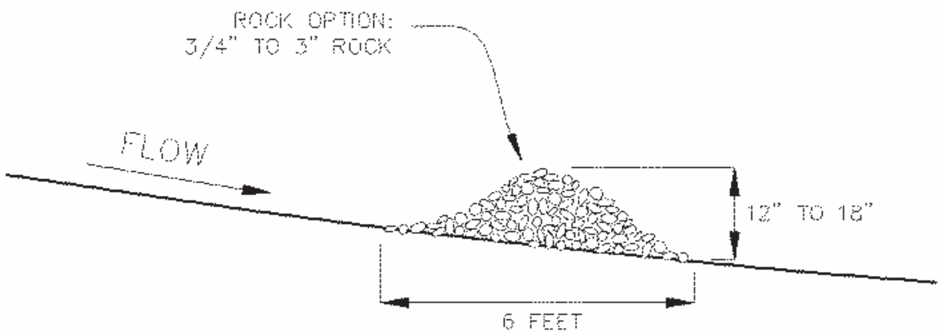
Water Quality and Hazardous Waste

Environmental Health

Davis County Public Works Engineering

Bountiful City
Centerville City
Clinton City
Farmington City
Fruit Heights City
Kaysville City
Layton City
North Salt Lake City
South Weber City
Sunset City
West Bountiful City
West Point City
Woods Cross City

BMP: Brush or Rock Filter — BRF



DESCRIPTION:

A rock filter is made of rock 3/4" - 3" in diameter and placed along a level contour. A brush filter is composed of brush (usually obtained during the site clearing) wrapped in filter cloth and anchored to the toe of the slope. If properly anchored brush or rock filters may be used for sediment trapping and velocity reduction.

APPLICATION:

- As check dams across mildly sloped construction roads
- Below the ote od slopes
- Along the site perimeter
- In areas where sheet flow occurs
- Around temporary spoil areas
- At sediment traps or culvert/pipe outlets

INSTALLATION / APPLICATION CRITERIA:

- For rock filter, use larger rock and place in a staked, woven wire sheathing if placed where concentrated flows occur
- Install along a level contour
- Leave area behind berm where runoff can pond and sediment can settle
- Drainage areas should not exceed 5 acres

LIMITATIONS:

- Rock berms may be difficult to remove
- Removal problems limit their usefulness in landscaped areas
- Runoff will pond upstream of the filter, possibly causing flooding if sufficient space does not exist

MAINTENANCE:

- Inspect after each rainfall and at a minimum of once every two weeks
- If berm is damaged, reshape and replace lost/dislodged rock
- Remove sediment when depth reaches 1/3 of berm height or 1 ft

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☒ Control Site Perimeter
- ☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☒	☐	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☐	☒	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M** = Medium **L** = Low

West Point Utah

BMP: Building Repair, Remodeling, and Construction — BRRC

DESCRIPTION:

Prevent or reduce the discharge of pollutants to storm water from building repair, remodeling and construction by using soil erosion controls, enclosing or covering building material storage areas, using good housekeeping practices, using safer alternative products, and training employees.

APPLICATION:

- Use soil erosion control techniques if bare ground is temporarily exposed
- Use permanent soil erosion control techniques if the remodeling clears buildings from an area that are not to be replaced

INSTALLATION / APPLICATION CRITERIA:

- Enclose painting operations consistent with local air quality regulations and OSHA
- Properly store materials that are normally used in repair and remodeling such as paints and solvents
- Properly store and dispose waste materials generated from the activity
- Maintain good housekeeping practices while work is underway

LIMITATIONS:

- This BMP is for minor construction only
- Hazardous waste that cannot be re-used or recycled must be disposed of by a licensed hazardous waste hauler
- Safer alternative products may not be available, suitable, or effective in every case
- Be certain that actions to help storm water quality are consistent with OSHA and air quality regulations

MAINTENANCE:

None

OBJECTIVES

☒ Housekeeping Practices
☐ Contain Waste
☐ Minimize Disturbed Areas
☐ Stabilize Disturbed Areas
☐ Protect Slopes/Channels
☐ Control Site Perimeter
☐ Control Internal Erosion

TARGETED POLLUTANTS

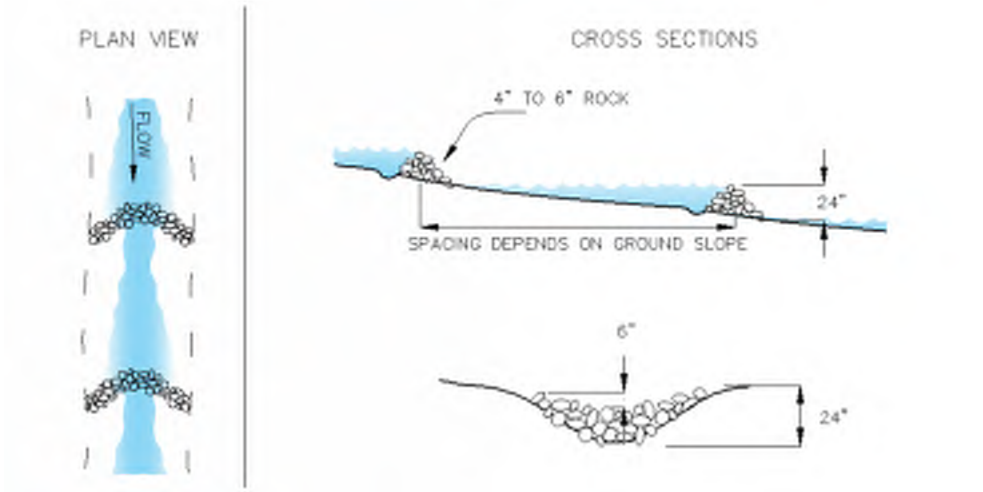
H	M	L	
☐	☐	☒	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☒	☐	☐	Toxic Materials
☒	☐	☐	Oil & Grease
☒	☐	☐	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☐	☒	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☒	☐	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M** = Medium **L** = Low

BMP: Check Dams	CD



DESCRIPTION:

Small, temporary dams constructed across a drainage ditch to reduce velocity of concentrated storm water flows thereby reducing the erosion of the ditch.

APPLICATION:

- Temporary drainage paths
- Permanent drainage ways not yet stabilized
- Existing drainage paths receiving increased flows due to construction

INSTALLATION / APPLICATION CRITERIA:

- Prepare location of dam by removing any debris and rough grading any irregularities in channel bottom
- Place rocks by hand or with appropriate machinery; do not dump
- Space dams to make the base of the upstream dam the same elevation as the top of the next lower dam
- Construct dam with center lower to create a weir effect
- Construct 50% side slopes on dams

LIMITATIONS:

- Maximum recommended drainage area is 10 acres
- Maximum recommended height is 24"
- Do not use in running stream

MAINTENANCE:

- Inspect dams daily during prolonged rainfall after each major rain event and at a minimum of once every two weeks
- Remove any large debris and repair any damage to dam, channel or sideslopes
- Remove accumulated sediment when it reaches one half the height of the dam

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☒ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
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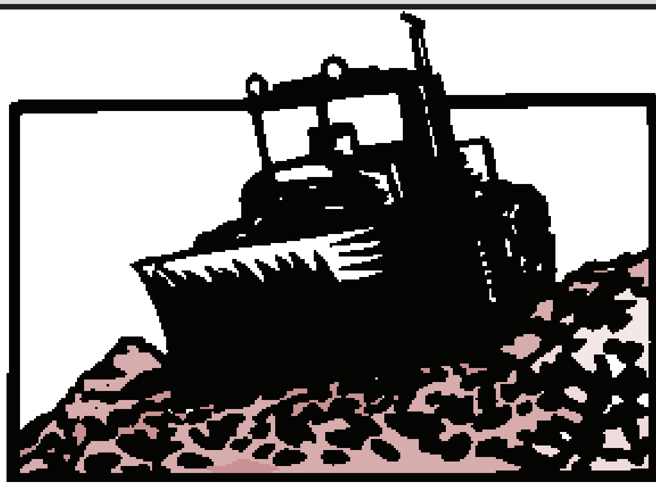
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M** = Medium **L** = Low

BMP: Contaminated or Erodible Surface Areas — CESA



DESCRIPTION:

Prevent or reduce the discharge of pollutants to storm water from contaminated or erodible surface areas by leaving as much vegetation on-site as possible, minimizing soil exposure time, stabilizing exposed soils, and preventing storm water runon and runoff.

APPLICATION:

This BMP addresses soils which are not so contaminated as to exceed criteria but the soil is eroding and carrrying pollutants off in the storm water.

INSTALLATION / APPLICATION CRITERIA:

Contaminated or erodible surface areas can be controlled by:

- Preservation of natural vegetation, revegitation, chemical stabilization, removal of contaminated soils or geosynthetics.

LIMITATIONS:

Disadvantages of preserving natural vegetation or re-vegetating include:

- Requires substantial planning to preserve and maintain the existing vegetation.
- May not be cost-effective with high land costs.
- Lack of rainfall and/or poor soils may limit the success of re-vegetated areas.

Disadvantages of chemical stabilization include:

- Creation of impervious surfaces.
- May cause harmful effects on water quality.
- Is usually more expensive than vegetative cover.

MAINTENANCE:

Maintenance should be minimal, except possibly if irrigation of vegetation is necessary.

OBJECTIVES

- ☒ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☒	☐	☐	Nutrients
☒	☐	☐	Heavy Metals
☒	☐	☐	Toxic Materials
☒	☐	☐	Oil & Grease
☒	☐	☐	Floatable Materials
☒	☐	☐	Bacteria & Viruses
☒	☐	☐	Other Waste

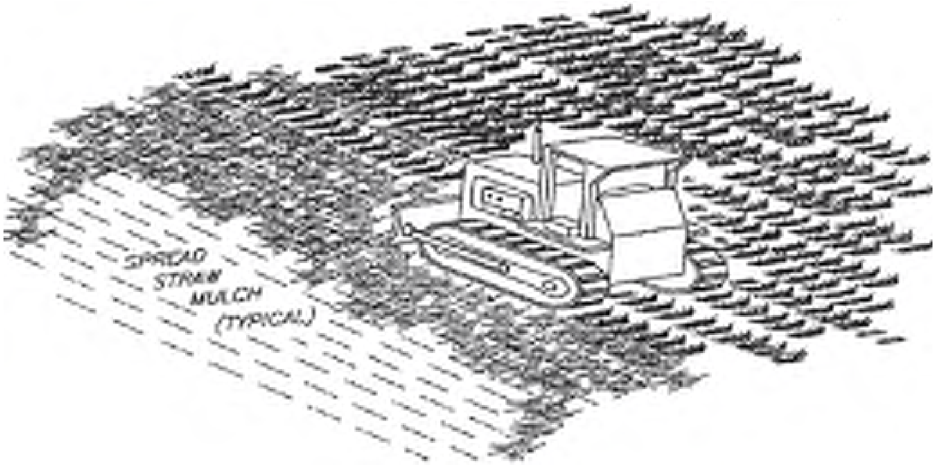
IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☐	☒	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M** = Medium **L** = Low

WEST POINT UTAH

BMP: Chemical Mulch CM



OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☒ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☒	☐	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☐	☒	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M** = Medium **L** = Low

DESCRIPTION:

Applying materials such as vinyl, asphalt, plastics, or rubber on an unprotected slope to temporarily stabilize the slope.

APPLICATION:

- As a tacking agent to aid the stabilization of mulches (where matting is not used)
- As a short-term alternative in areas where temporary seeding practices cannot be used because of seasonal condition or climate
- On steep and rocky slopes where neither mechanical methods or mulches and protective netting can be effectively applied

INSTALLATION / APPLICATION CRITERIA:

- The application rates and procedures recommended by the manufacturer of a chemical stabilization product should be followed to prevent the products from forming ponds and from creating large areas where moisture cannot get through.
- For permanent application, chemical mulches (when used with seed and mulch) should be applied over wood fiber or straw mulch

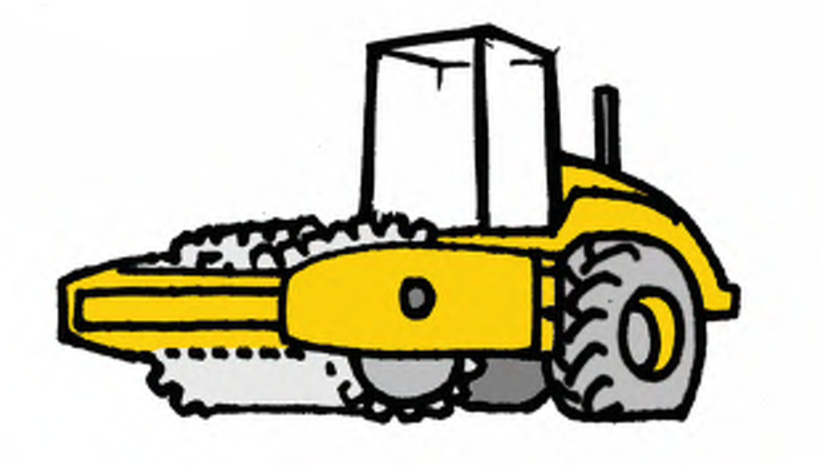
LIMITATIONS:

- Chemical mulches can create impervious surfaces and impact water quality if not properly applied
- Some products may not be suitable for use near live streams

MAINTENANCE:

- Inspect at regular intervals and after each runoff-producing storm event or at a minimum of once every two weeks
- Replace chemical mulch as needed to ensure adequate level of coverage

BMP: Compaction CP



OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☒ Minimize Disturbed Areas
- ☒ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☐	☒	Maintenance
☐	☒	☐	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DESCRIPTION:

Use of rolling, tamping, or vibration to stabilize fill materials and control erosion by increasing the soil density. Increasing the density of soil improves soil strength, reduces long-term soil settlement, and provides resistance to erosion.

APPLICATIONS:

- Stabilize fill material placed around various structures.
- Improve soil in place as foundation support for roads, parking lots, and buildings.

INSTALLATION / APPLICATION CRITERIA:

- Make sure soil moisture content is at optimum levels.
- Use proper compaction equipment.
- Install sediment control and storm water management devices below compacted areas and runon interceptor devices above these areas. Drainage from compacted areas must be carefully planned to prodtect adjacent uncompacted soils.
- The surface of compacted areas should be scarified and seeded or mulched and seeded to increase the effectiveness of compaction.

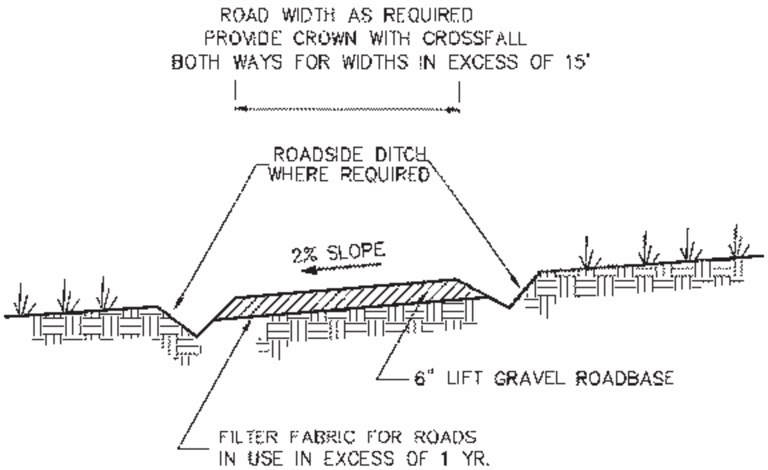
LIMITATIONS:

- Compaction tends to increase runoff.
- Over-compaction will hamper revegitation efforts.

MAINTENANCE:

No maintenance required.

BMP: Construction Road Stabilization CR



DESCRIPTION:

Temporary stabilization of on-site roadway by placement of gravel roadbase.

APPLICATION:

- On-site roadways used daily by constructioin traffic (may not apply to gravelly type soils)
- Parking or staging areas susceptible to erosion due to traffic use

INSTALLATION / APPLICATION CRITERIA:

- Grade temporary access road with 2% cross fall, for two-way width provide crown
- Provide roadside ditch and outlet controls where required
- Place 6 inches of 2-inch to 4-inch crushed rock on driving area

LIMITATIONS:

- May require removal of gravel roadbase at completion of activities if final cover is not impervious
- May require controls for surface storm water runoff

MAINTENANCE:

- Inspect after major rainfall events and at a minimum of once every two weeks
- Place additional gravel as needed and repair any damaged areas
- Maintain any roadside drainage controls

OBJECTIVES

- [x] Housekeeping Practices
- [ ] Contain Waste
- [x] Minimize Disturbed Areas
- [x] Stabilize Disturbed Areas
- [x] Protect Slopes/Channels
- [ ] Control Site Perimeter
- [ ] Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

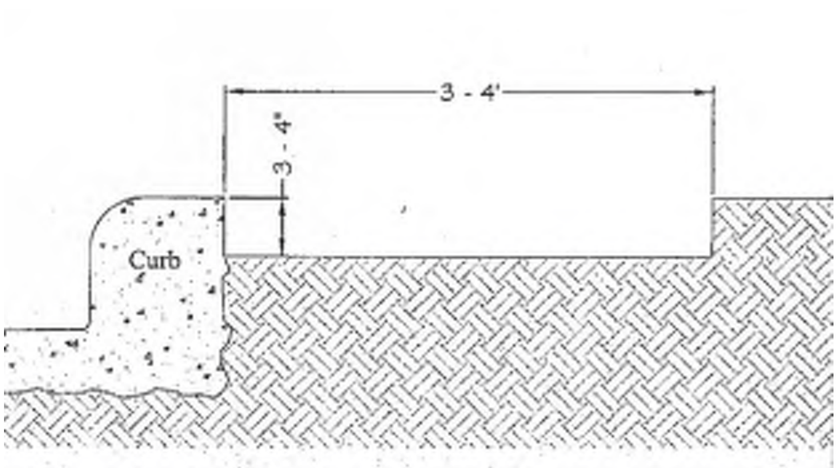
IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

WEST POINT UTAH

BMP: Curb Sedimentation Trap — CST



DESCRIPTION:

A temporary sediment trap formed by excavation behind the curb.

APPLICATION:

- Interception of runoff containing sediment from the lot during construction
- Retain sediment on the lot during construction

INSTALLATION / APPLICATION CRITERIA:

- Excavate soil behind the curb to a depth of 3-4 inches
- Extend excavation 3-4 feet behind the curb to form sediment trap

LIMITATIONS:

No limitations

MAINTENANCE:

- Inspect after each rainfall event and at a minimum of once every two weeks
- Remove accumulated sediment as it reaches 2/3 height of available storage
- May require additonal excavation if dirt from construction fills in the trap

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☒	☐	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☒	☐	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

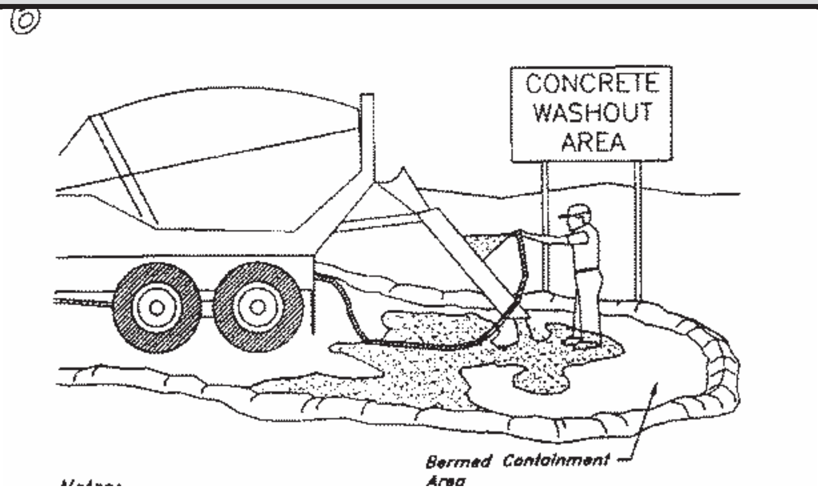
IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M** = Medium **L** = Low

WEST POINT UTAH

BMP: Concrete Waste Management CWM



DESCRIPTION:

Prevent or reduce the discharge of polllutants to storm water from concrete waste by conducting washout off-site, performing on-site washout ina designated area, and training employees and subcontractors.

APPLICATION:

This technique is applicable to all types of sites

INSTALLATION / APPLICATION CRITERIA:

- Store dry materials under cover, away from drainage areas
- Minimize excess mixing of fresh concrete, mortar or cement on site
- Do not wash out concrete trucks into storm drains, open ditches, streets, or streams
- Do not allow excess concrete to be dumped on-site, except in designated areas
- When washing concrete to remove fine particles and expose the aggregate, avoid creating runoff by draining the water within a bermed or level area (6" tall X 6' wide)
- Train employees and subcontractors in proper concrete waste management

LIMITATIONS:

- Off-site washout or concrete wastes may not always be possible

MAINTENANCE:

- Inspect subcontractors to ensure that concrete wastes are being properly managed
- If using a temporary pit, dispose of hardened concrete on a regular basis

OBJECTIVES

☐ Housekeeping Practices
☒ Contain Waste
☐ Minimize Disturbed Areas
☐ Stabilize Disturbed Areas
☐ Protect Slopes/Channels
☐ Control Site Perimeter
☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☐	☐	☒	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☒	☐	☐	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☐	☒	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☒	☐	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

WEST POINT UTAH

BMP: Dust Controls DC

DESCRIPTION:

Dust control measures are used to stabilize soil from wind erosion, and reduce dust by construction activities.

APPLICATION:

Dust control is useful in any process area, loading and unloading area, material handling agreas, and transfer areas where dust is generated. Street sweepin gis limited to areas that are paved.

INSTALLATION / APPLICATION CRITERIA:

- Mechanical dust collection systems are designed according to the size of dust particles and the amount of air to be processed. Manufacturers' recommendations should be followed for installation (as well as the design of the equipment.
- Two kinds of street sweepers are common: brush and vacuum. Vacuum sweepers are more efficient and work best when the area is dry.
- Mechanical equipment should be operated according to the manufacturers' recommendations and should be inspected regularly.

LIMITATIONS:

- More elaborate equipment may be impossible to maintain by plant personnel
- Is labor and equipment intensive and may not be effective for all pollutants (street sweepers)

MAINTENANCE:

If water sprayers are used, dust-contaminated waters should be collected and taken for treatment. Areas will probabley need to be resprayed to keep dust from spreading.

OBJECTIVES

- [x] Housekeeping Practices
- [ ] Contain Waste
- [ ] Minimize Disturbed Areas
- [x] Stabilize Disturbed Areas
- [ ] Protect Slopes/Channels
- [ ] Control Site Perimeter
- [ ] Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

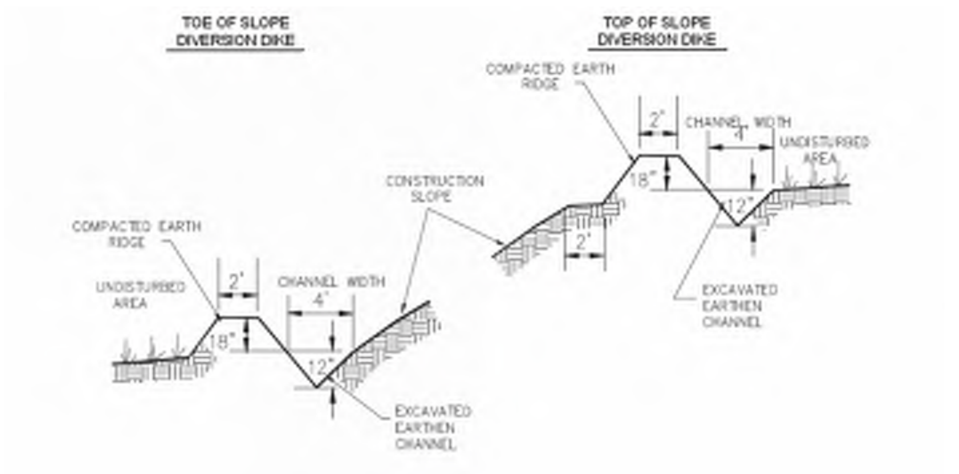
IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☒	☐	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M** = Medium **L** = Low

WEST POINT UTAH

BMP: Diversion Dike	**DD**



DESCRIPTION:

A temporary sediment barrier and storm runoff conveyance consisting of an excavation channel and compacted earth ridge.

APPLICATION:

- Construct along top of construction slope to intercept upgradient runoff and convey around construction site
- Construct along toe of construction to divert sediment laden runoff
- Construct along midpoint of construction slope to intercept runoff and channel to controlled discharge point
- Construct around base of soil stockpiles to capture sediment
- Construct around perimeter of disturbed areas to capture sediment

INSTALLATION / APPLICATION CRITERIA:

- Clear and grub area for dike construction
- Excavate channel and place soil on downgradient side
- Shape and machine compact excavated soil to form ridge
- Place erosion protection (riprap, mulch) at outlet
- Stabilize channel and ridge ad required with mulch, gravel, or vegetative cover

LIMITATIONS:

- Recommended maximum drainage area of 5 acres
- Recommended maximum sideslopes of 2h:1v (50%)
- Recommended maximum slope of 1% on channel

MAINTENANCE:

- Inspect immediately after any rainfall and at least daily during prolonged rainfall
- Look for runoff breaching dike or eroding channel or sideslopes
- Check discharge point for erosion or bypassing of flows
- Repair and stabilize as necessary
- Inspect daily during vehicular activity on slope, check for and repair any traffic damage

OBJECTIVES

- ☐ Housekeeping Practices
- ☒ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☒ Control Site Perimeter
- ☒ Control Internal Erosion

TARGETED POLLUTANTS

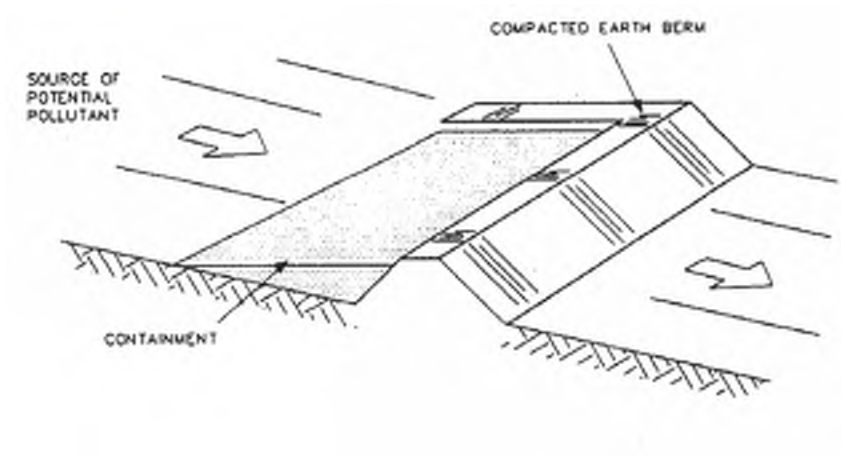
H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

BMP: Earth Berm Barrier — EBB



DESCRIPTION:

A temporary containment control constructed of compacted soil.

APPLICATION:

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

INSTALLATION / APPLICATION CRITERIA:

- Construct an earthen berm down hill of the area to be controlled. The berm should surround fueling facilities and maintenance areas on three sides to provide containment
- Berm needs to sized for application and be compacted by compactor equipment

LIMITATIONS:

- Not effective on steep slopes
- Limits access to controlled area
- Personnel need to quickly respond to spills with remedial actions

MAINTENANCE:

- Observe daily for any non-stormwater discharge
- Look for runoff bypassing ends of berms or undercutting berms
- Repair or replace damaged areas of the berm and remove accumulated sediment
- Recompact soil around berm as necessary to prevent piping

OBJECTIVES

- [ ] Housekeeping Practices
- [x] Contain Waste
- [ ] Minimize Disturbed Areas
- [ ] Stabilize Disturbed Areas
- [ ] Protect Slopes/Channels
- [x] Control Site Perimeter
- [ ] Control Internal Erosion

TARGETED POLLUTANTS

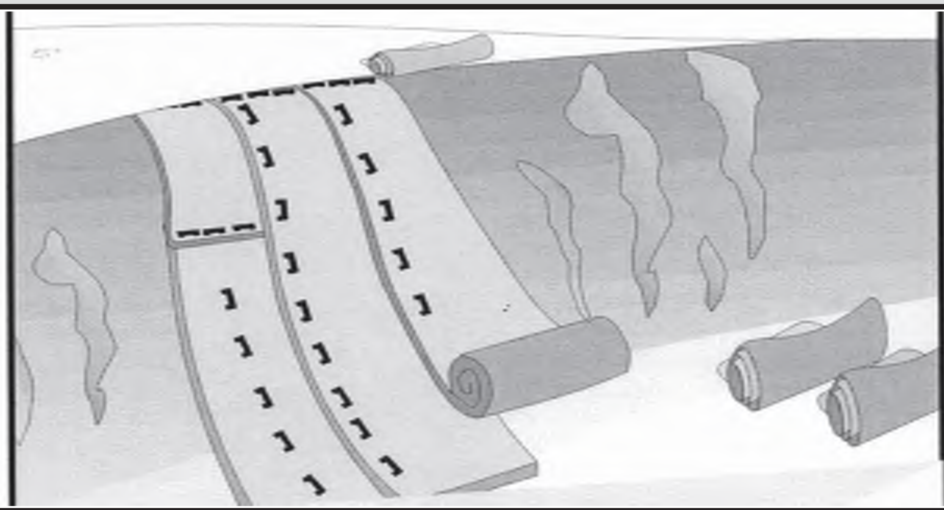
H	M	L	
		X	Sediment
		X	Nutrients
		X	Heavy Metals
X			Toxic Materials
		X	Oil & Grease
X			Floatable Materials
		X	Bacteria & Viruses
		X	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
	X		Capital Costs
		X	O&M Costs
	X		Maintenance
		X	Training
		X	Staffing
		X	Administrative

H = High **M =** Medium **L =** Low

BMP: Erosion Control Blankets — ECB



DESCRIPTION:

Erosion control blankets are used on areas of high velocity runoff and/or steep grade, to aid in controlling erosion on critical areas by protecting young vegetation.

APPLICATION:

- Where vegetation is likely to grow too slowly to provide adequate stabilization
- In areas subject to high winds where mulch would not be effective

INSTALLATION / APPLICATION CRITERIA:

- Install erosion control blankets parallel to the direction of the slope
- In ditches, apply in direction of the flow
- Place erosion control blankets loosely on soil-do not stretch
- Ends of blankets should be buried no less than six inches deep
- Staple the edges of the blanket at least every three feet - per manufacturers' specifications

LIMITATIONS:

- Not recommended in areas which are still under construction

MAINTENANCE:

- Check for erosion and undermining periodically, particulary after rainstorms
- Repair dislocations or failures immediately
- If washouts occur, reinstall after repairing slope damage
- Monitor until permanently stabilized

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☒ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☒	☐	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

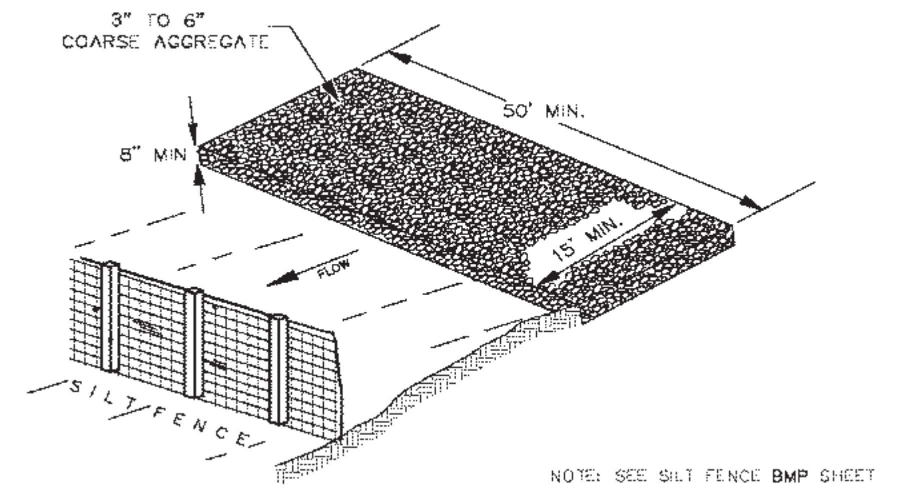
IMPLEMENTATION REQUIREMENTS

H	M	L	
☒	☐	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

WEST POINT UTAH

BMP: Equipment and Vehicle Wash Down Area EVWA



DESCRIPTION:

A stabilized pad of crushed stone for general washing of equipment and construction vehicles.

APPLICATION:

At any site where regular washing of vehicles and equipment will occur. May also be used as a filling point for water trucks limiting erosion caused by overflow or spillage of water.

INSTALLATION / APPLICATION CRITERIA:

- Clear and grub area and grade to provide maximum slope of 1%
- Compact subgrade and place filter fabric if desired (recommended for wash areas to remain in use for more than 3 months)
- Place coarse aggregate, 1 to 2-1/2 inches in size, to a minimum depth of 8 inches
- Install silt fence downgradient (see silt fence BMP information sheet)

LIMITATIONS:

Cannot be utilized for washing equipment or vehicles that may cause contamination of runoff such as fertilizer equipment or concrete equipment. Solely used to control sediment in wash water.

MAINTENANCE:

- Inspect daily for loss of gravel or sediment buildup
- Inspect adjacent area for sediment deposit and install additional controls as necessary
- Repair area and replace gravel as required to maintain control in good working condition
- Expand stabilized area as required to accommodate activities
- Maintain silt fence as outlined in specific silt fence BMP information sheet

OBJECTIVES

☒ Housekeeping Practices
☒ Contain Waste
☐ Minimize Disturbed Areas
☐ Stabilize Disturbed Areas
☐ Protect Slopes/Channels
☐ Control Site Perimeter
☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☒	☐	☐	Toxic Materials
☒	☐	☐	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

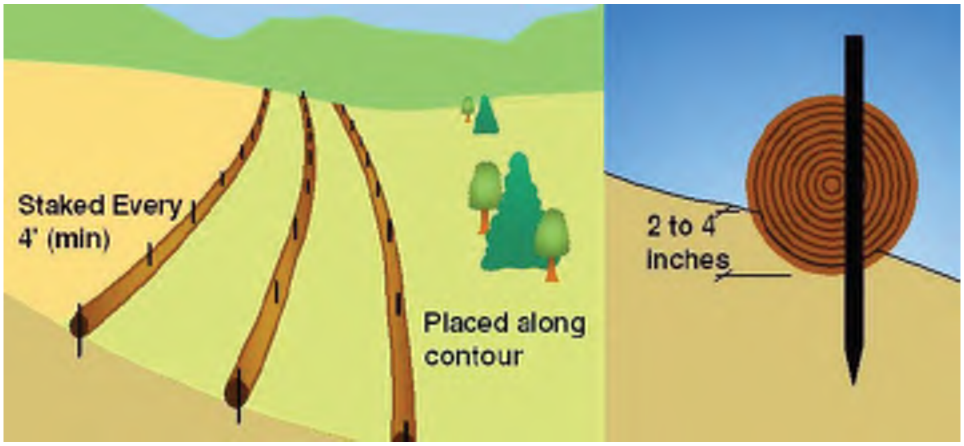
IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

WEST POINT
UTAH

BMP: Fiber Rolls FR



DESCRIPTION:

Commercial products can be made from various types of fibers and shavings that are rolled up and used as sediment barriers.

APPLICATION:

- Good for sites with long slopes, generally flatter than 10:1

INSTALLATION / APPLICATION CRITERIA:

- Must be trenched into the ground 2 to 4 inches
- Must be staked every 4 feet (maximum)
- Manufacturer's instructions must be followed for installation of product

LIMITATIONS:

- Not applicable for high velocity flows
- Only use for a time period within the expected life-span of the product (check with manufacturer)

MAINTENANCE:

- Must be checked to ensure that runoff does not run under or bypass the fiber rolls
- Sediment buildup must also be checked and excess sediment must be removed

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☒ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

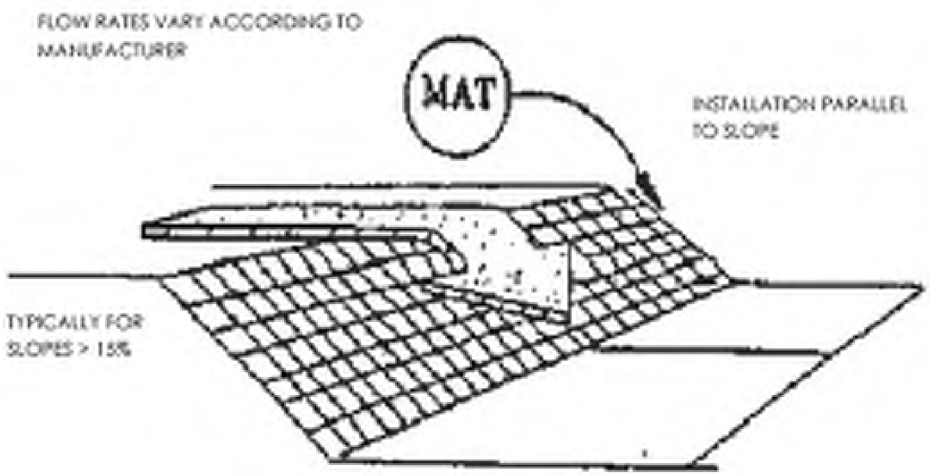
H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☐	☒	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M** = Medium **L** = Low

BMP: Geotextiles and Mats GM



Description:

Mattings made of natural or synthetic material which are used to temporarily or permanently stabilize soil.

Application:

- Typically suited for post-construction site stabilization, but may be used for stabilization of highly erosive soils.
- Channels and Streams.
- Steep slopes.

Installation / Application Criteria:

- Mattings may be applied to disturbed soils and where existing vegetation has been removed.
- The following organic matting materials provide temporary protection until permanent vegetation is established, or when seasonal circumstances dictate the need for temporary stabilization until weather or construction delays are resolved: Jute mattings and straw mattings.
- The following synthetic mattings may be used for either temporary or post-construction stabilization, both with and without vegetation: excelsior matting, glass fiber matting, mulch matting
- Staples are needed to anchor the matting.

Limitations:

- Mattings are more costly than other BMP practices, limiting their use to areas where other BMPs are ineffective (e.g., channels, steep slopes).
- May delay seed germination, due to reduction in soil temperature.
- Installation requires experienced contractor to ensure soil stabilization and erosion protection.

Maintenance:

- Inspect twice monthly and after significant rainfall.
- Re-anchor loosened matting and replace missing matting and staples as required.

Objectives

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☒ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☒ Control Internal Erosion

Targeted Pollutants

H	M	L	
☒	☐	☐	Sediment
☐	☒	☐	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

Implementation Requirements

H	M	L	
☒	☐	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M** = Medium **L** = Low

WEST POINT UTAH

BMP: Hydromulching HM

DESCRIPTION:

A combination of wood fiber mulch, processed grass, or hay or straw mulch and a tacking agent. It is made into a slurry, then applied to bare slopes or other bare areas to provide temporary stabilization.

APPLICATION:

- Small roadside slopes
- Large, relatively flat areas

INSTALLATION / APPLICATION CRITERIA:

- Legume seeds should be pellet inoculated with the appropriate bacteria.
- The seed should not remain in the hydromulcher tank for more than 30 minutes
- Wood fiber may be dyed to aid in uniform application
- Slurry should be uniformly applied until an adequate coverage is achieved
- The applicator should not be directed at on location for a long period of time; erosion will occur

LIMITATIONS:

- Will lose effectiveness after 1 year
- Can use only on physically stable slopes (at natural angle of repose, or less)

MAINTENANCE:

•Periodically inspect for damage caused by wind, water or human disturbance
•Promptly repair damaged areas

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☒ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☐	☒	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☒	☐	☐	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☒	☐	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M** = Medium **L** = Low

BMP: Hazardous Waste Materials HWM

DESCRIPTION:

Prevent or reduce the discharge of pollutants to stormwater from hazardous waste throughproper material use,waste disposal,and training of employees and subcontractors.

APPLICATION:

Many of the chemicals used on-site can be hazardous materials which become hazardous waste upon disposal. These wastes may include:

- Paints and Solvents; petroleum products such as oils, fuels, and grease; herbicides and pesticides; Acids for cleaning masonry; and concrete curing compounds

In addition, sites with existing structures may contain wastes which must be disposed of in accordance with Federal, State, and local regulations, including:

- Sandblasting grit mixed with lead, cadmium, or chromium-based paints; Asbestos; and PCB's

INSTALLATION / APPLICATION CRITERIA:

The following steps will help reduce storm water pollution from hazardous wastes:

- Use all of the product before disposing of the container
- Do not remove the original product label, it contains important safety and disposal information
- Do not over-apply herbicides and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Apply surface dressings in several smaller applications, as opposed to one large application, to allow time for infiltration and to avoid excess material being carried off-site by runoff. Do not apply these chemicals just before it rains. People applying pesticides must be certified in accordance with Federal and State regulations.

LIMITATIONS:

Hazardous wastethat cannot be reused or recycled must be disposed of by a licensed hazardous waste hauler.

MAINTENANCE:

- Inspect hazardous waste receptacles and area regularly
- Arrange for regular hazardous waste collection

OBJECTIVES

- ☐ Housekeeping Practices
- ☒ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

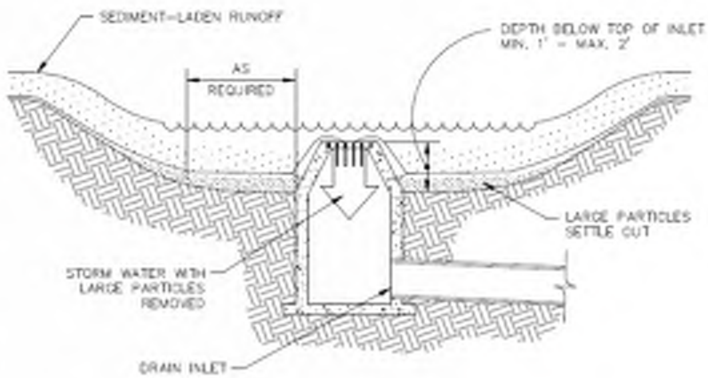
H	M	L	
☐	☐	☒	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☒	☐	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☐	☒	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☒	☐	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

BMP: Inlet Protection - Excavated — IP-E



DESCRIPTION:

An area excavated around a storm drain inlet to impound water below the inlet.

APPLICATION:

- Construct at storm drainage inlets located downgradient of areas to be disturbed by construction (for inlets in paved areas see other information sheets for inlet protection)

INSTALLATION / APPLICATION CRITERIA:

- Provide upgradient sediment controls, such as silt fence during construction of inlet
- When construciton of inlet is complete, excavate adjacent area 1 to 2 feet lower than the grate elevation. Size of excavated area should be based on soil type and contributing acreage

LIMITATIONS:

- Recommended maximum contributing drainage area of one acre
- Limited to inlets located in open unpaved areas
- Requires flat area adjacent to inlet

MAINTENANCE:

- Inspect inlet protection following storm event and at a minimum of once monthly
- Remove accumulated sediment when it reaches one half of the excavated sump below the grate
- Repair side slopes as required

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☒ Control Site Perimeter
- ☒ Control Internal Erosion

TARGETED POLLUTANTS

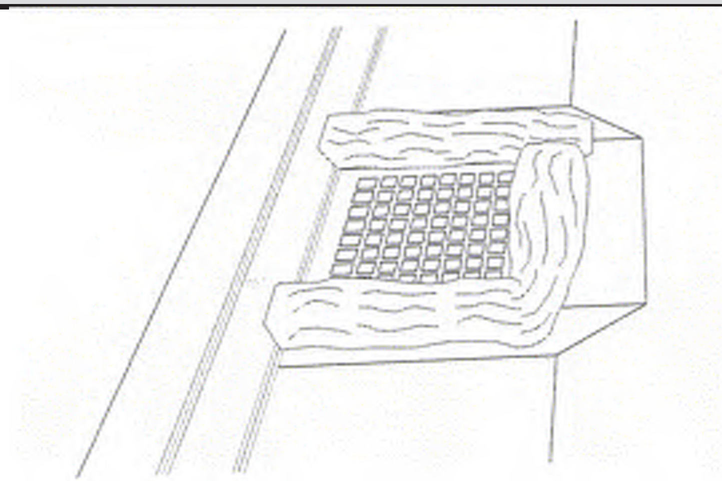
H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☒	☐	Toxic Materials
☐	☐	☒	Oil & Grease
☒	☐	☐	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☐	☒	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

BMP: Inlet Protection - Gravel Bags IP-GB



DESCRIPTION:

Sediment barrier erected around storm drain inlet.

APPLICATION:

Construct at storm drainage inlets located down-gradient of areas to be disturbed by construction

INSTALLATION / APPLICATION CRITERIA:

- Provide up-gradient sediment controls, such as silt fence during construction of inlet
- When construction of curb and gutter and roadway is complete, install gravel filled bags around perimeter of inlet
- Fill to recommended levels to reduce splitting of bags

LIMITATIONS:

- Recommended maximum contributing drainage area of one acre
- Requires shallow sloped adjacent to inlet.

MAINTENANCE:

- Inspect inlet protection following storm event and at a minimum of once every 14 days.
- Remove accumulated sediment when it reaches half the height of the bag.
- Look for bypassing or undercutting and repair or realign as needed.
- Replace and clean up spilled gravel when bags split.

OBJECTIVES

☒ Housekeeping Practices
☐ Contain Waste
☐ Minimize Disturbed Areas
☐ Stabilize Disturbed Areas
☐ Protect Slopes/Channels
☒ Control Site Perimeter
☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☒	☐	☐	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☒	☐	☐	Other Waste

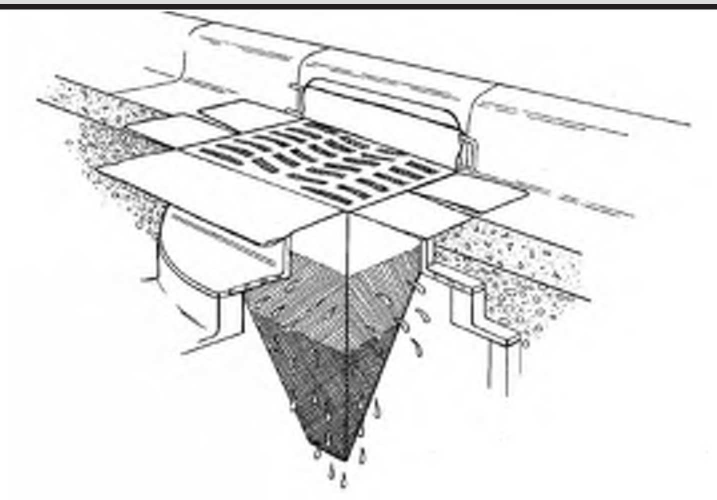
IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

WEST POINT UTAH

BMP: Inlet Protection- Silt Bags IP-SB



OBJECTIVES

- ☐ Housekeeping Practices
- ☒ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☒	☐	☐	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☒	☐	☐	Maintenance
☐	☒	☐	Training
☐	☐	☒	Staffing
☒	☒	☒	Administrative

H = High **M =** Medium **L =** Low

DESCRIPTION:

Collect and trap sediment and debris entering catch basins from either grated or curb inlets. Insert is made of fabric and is placed in the drain inlet around the perimeter of the grate. Runoff passes through the bag before discharging into the drain outlet pipe. Overflow holes are usually provided to pass larger flows without causing a backwater at the grate. Certain manufactured products include polymers intended to increase pollutant removal effectiveness.

APPLICATIONS:

- Storm drain inlet boxes

INSTALLATION / APPLICATION CRITERIA:

- Regular Maintenance is necessary
- Evaluation of the device chosen should be balanced with cost
- Hydraulic capacity controls effectiveness
- Most useful in small drainage areas (< 1 Acre)
- Ideal in combination with other BMP's

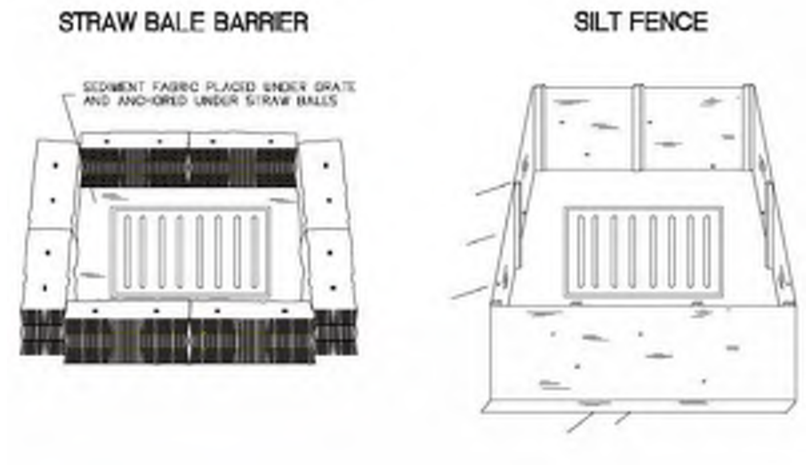
LIMITATIONS:

- Cost
- Maintenance required to prevent plugging and remain effective

MAINTENANCE:

Inspection after all storm events and as required between events

BMP: Inlet Protection - Silt Fence or Straw Bale IP-SF



DESCRIPTION:

Sediment barrier erected around storm drain inlet.

APPLICATION:

- Construct at storm drainage inlets located downgradient of areas to be disturbed by construction (for inlets in paved areas see other information sheets for inlet protection)

INSTALLATION / APPLICATION CRITERIA:

- Provide upgradient sedimant controls, such as silt fence during construction of inlet
- When construction of linet is complete, erect straw bale barrier or silt fence surrounding perimeter of inlet. Follow instructions and guidelines on individual BMP information sheets for straw bale barrier and silt fence construction

LIMITATIONS:

- Recommended maximum contributing drainage area of one acre
- Limited to inlets located in open unpaved areas
- Requires shallow slopes adjacent to inlet

MAINTENANCE:

- Inspect inlet protection following storm event and at a minimum of once every two weeks
- Remove accumulated sediment when it reaches 4" in depth
- Repair or realign barrier/fence as needed
- Look for bypassing or undercutting and recompact soil around barrier/fence as required

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☒ Control Site Perimeter
- ☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☒	☐	☐	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

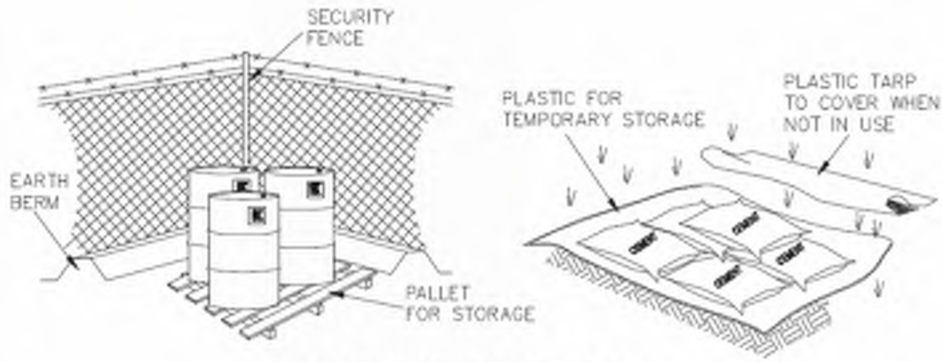
IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

WEST POINT UTAH

BMP: Materials Storage MS



- CONTROLLED STORAGE LOCATION
- BARRIER AROUND PERIMETER
- ELEVATE CONTAINERS OFF GROUND
- COVER WHEN NOT IN USE

DESCRIPTION:

Controlled storage of on-site materials.

APPLICATION:

- Storage of hazardous, toxic, and all chemical substances
- Any construction site with outside storage of materials

INSTALLATION / APPLICATION CRITERIA:

- Designate a secured area with limited access as the storage location. Ensure no waterways or drainage paths are nearby
- Construct compacted earthen berm (See Earth Berm Barrier Information Sheet), or similar perimeter containment around storage location for impoundment in the case of spills
- Ensure all on-site personnel utilize designated storage area. Do not store excessive amounts of material that will not be utilized on site
- For active use of materials away from the storage area ensure materials are not set directly on the ground and are covered when not in use. Protect storm drainage during use

LIMITATIONS:

- Does not prevent contamination due to mishandling of products
- Spill Prevention and Response Plan still required
- Only effective if materials are actively stored in controlled location

MAINTENANCE:

- Inspect daily and repair any damage to perimeter impoundment or security fencing
- Check materials are being correctly stored (i.e. standing upright, in labeled containers, tightly capped) and that no materials are being stored away from the designated location

OBJECTIVES

- ☒ Housekeeping Practices
- ☒ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

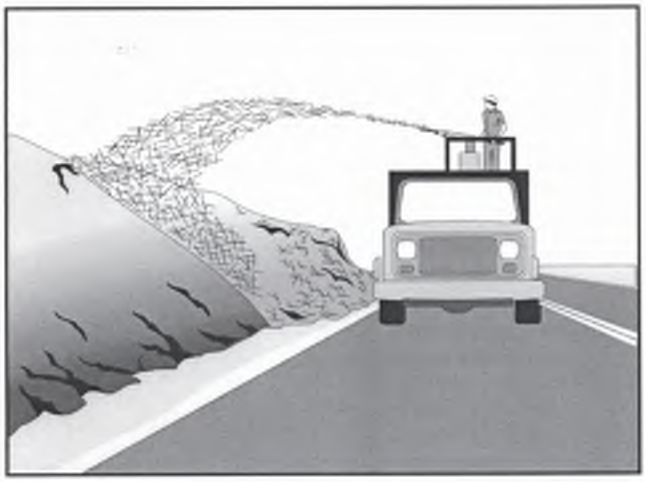
H	M	L	
☐	☐	☒	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☒	☐	☐	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☒	☐	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☒	☐	☐	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

BMP: MULCHING — MU



DESCRIPTION:

Placement of material such as straw, grass, woodchips, or wood fibers over open areas.

APPLICATION:

- Any exposed area to remain untouched longer than 14 days and that will be exposed less than 60 days (seed areas to be exposed in excess of 60 days)
- Areas that havebeen seeded
- Stockpiled soil materials

INSTALLATION / APPLICATION CRITERIA:

- Roughen area to receive mulch to create depressions that mulch material can settle into
- Apply mulch to required thickness and anchor as necessary
- Ensure material used is weed free and does not contain any constituents that will inhibit plant growth

LIMITATIONS:

- Anchoring may be required to prevent migration or mulch material
- Downgradient control may be required to prevent mulch material being transported to storm water system

MAINTENANCE:

- Inspect mulched areas after every rainfall event and at a minimum of monthly
- Replace mulch on any bare areas and reanchor as necessary
- Clean and replace downgradient controls as necessary

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☒ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☒	☐	Nutrients
☐	☐	☒	Heavy Metals
☒	☐	☐	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

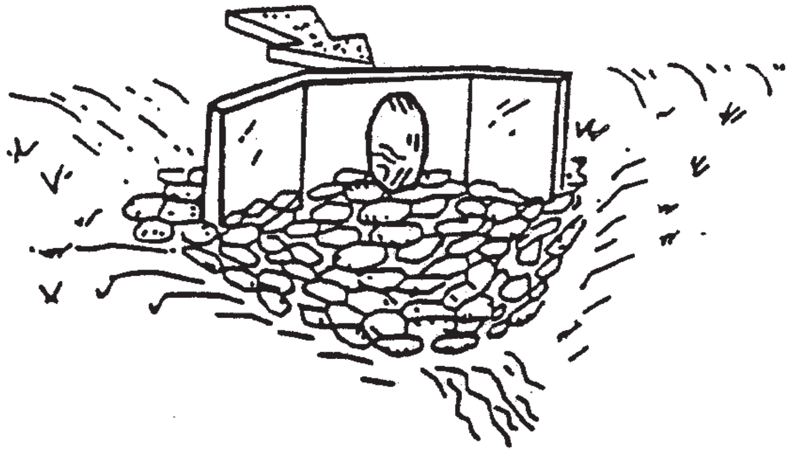
IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M** = Medium **L** = Low

WEST POINT UTAH

BMP: Outlet Protection OP



OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DESCRIPTION:

A rock outlet protection is a physical device composed of rock, or grouted riprap which is placed at the outlet of a pipe to prevent scour of the soil caused by high pipe flow velocities, and to absorb flow energy to produce nonerosive velocities.

APPLICATION:

- Wherever discharge velocities and energies at the outlets of culverts, conduits, or channels are sufficient to erode the next downstream reach
- Rock outlet protection is best suited for temporary use during construction because it is usually less expensive and easier to install than concrete aprons or energy dissipators
- A sediment trap below the pipe outlet is recommended if runoff is sediment laden
- Permanent rock riprap protection should be designed and sized by the engineer as part of the culvert, conduit or channel design
- Grouted riprap should be avoided in areas of freeze and thaw because the grout will break up

INSTALLATION / APPLICATION CRITERIA:

- Rock outlet protection is effective when the rock is sized and placed properly. When this is accomplished, rock outlets do much to limit erosion at pipe outlets. Rock size should be increased for high velocity flows. Best results are obtained when sound, durable, angular rock is used.

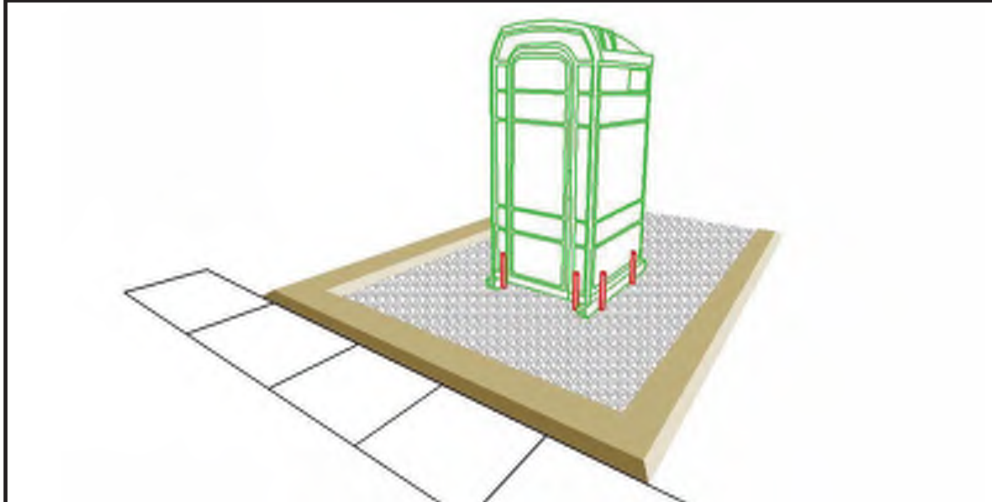
LIMITATIONS:

- Large storms often wash away the rock outlet protection and leave the area susceptible to erosion
- Sediment captured by the rock outlet protection may be difficult to remove without removing the rock
- Outlet protection may negatively impact the channel habitat

MAINTENANCE:

- Inspect after each significant rain for erosion and/or disruption of the rock, and repair immediately
- Grouted or wire-tied rock riprap can minimize maintenance requirements

BMP: Portable Toilet — PT



DESCRIPTION:

Temporary on-site sanitary facilities for construction personnel.

APPLICATION:

All sites with no permanent sanitary facilities or where permanent facility is too far from activities.

INSTALLATION / APPLICATION CRITERIA:

- Locate portable toilets in a convenient locations throughout the site
- Prepare level, gravel surface and provide clear access to the toilets for servicing and for on-site personnel
- Construct earth berm perimiter (see Earth Berm Barrier Sheet), control for spill / leak protection.
- Anchor the portable toilet to prevent tipping

LIMITATIONS:

No limitations

MAINTENANCE:

- Portable toilets should be maintained in good working order by licensed service with daily observation for leak detection
- Regular waste collection should be arranged with licensed service
- All waste should be deposited in sanitary sewer system for treatment with appropriate agency approval

OBJECTIVES

- [x] Housekeeping Practices
- [x] Contain Waste
- [ ] Minimize Disturbed Areas
- [ ] Stabilize Disturbed Areas
- [ ] Protect Slopes/Channels
- [ ] Control Site Perimeter
- [ ] Control Internal Erosion

TARGETED POLLUTANTS

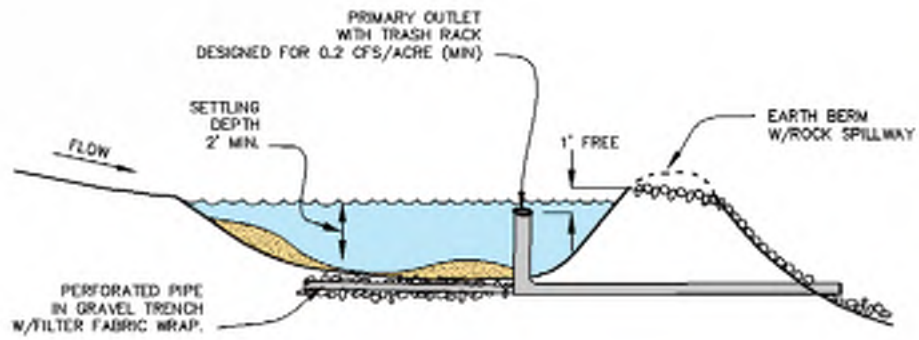
H	M	L	
☐	☐	☒	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☒	☐	☐	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☒	☐	☐	Bacteria & Viruses
☒	☐	☐	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M** = Medium **L** = Low

BMP: Sediment Basin — SB



OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☒	☐	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☒	☐	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☒	☐	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DESCRIPTION:

A pond created by excavating or construction of an embankment, and designed to retain or detain runoff sufficiently to allow excessive sediment to settle.

APPLICATION:

- At the outlet of all disturbed watersheds 10 acres or larger
- At the outlet of smaller disturbed watersheds, as necessary
- Where post construction detention basins will be located

INSTALLATION / APPLICATION CRITERIA:

- Design basin for site specific location, maintian effective flow length 2 times width
- Excavate basin or construct compacted berm containment; ensure no downgradient hazard if failure should occur. (Provide minimum of 67 cy. per acre of drainage area.)
- Construct dewtering and outfall structure and emergency spillway with apron

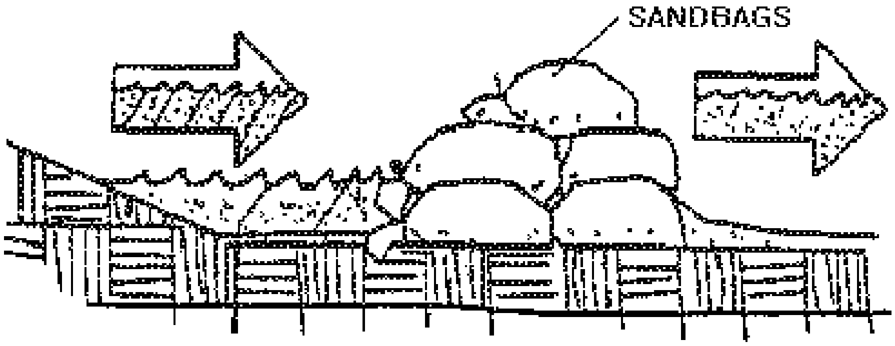
LIMITATIONS:

- Should be sized based on anticipated runoff, sediment loading and drainage area size
- May require silt fence at outlet for entrapment of very fine silts and clays
- May require safety fencing to prevent public access
- Height restrictions for embankment regulated by Utah Division of Dam Safety

MAINTENANCE:

- Inspect after each rainfall event and at a minimum of once every two weeks
- Repair any damage to berm, spillway or sidewalls
- Remove accumulated sediment as it reaches 2/3 height of available storage
- Check outlet for sedimentation/erosion of downgradient area and remediate as necessary. Install silt fence if sedimentation apparent

BMP: Sand Bag Barrier — SBB



OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☒ Control Site Perimeter
- ☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☒	☐	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☐	☒	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

DESCRIPTION:

Stacking sand bags along a level contour creates a barrier which detains sediment - laden water, ponding water upstream of the barrier and promoting sedimentation

APPLICATION:

- Along the perimeter of the site
- May be used in drainage areas up to 5 acres
- Along streams and channels
- Across swales with small catchments
- Around temporary spoil areas
- Below the toe of a cleared slope

INSTALLATION / APPLICATION CRITERIA:

- Install along a level contour
- Base of sand bag barrier should be at least 48" wide
- Height of sand bag barrier should be at least 18" high
- 4" PVC pipe may be installed between the top layer of sand bags to drain large flood flows
- Provide area behind barrier for runoff to pond and sediment to settle
- Place below the toe of a slope
- UV resistant bags should be used

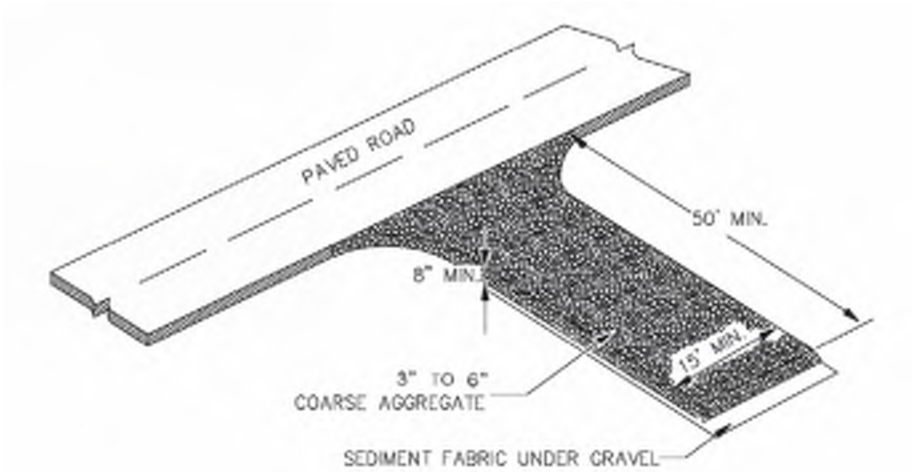
LIMITATIONS:

- Sand bags are more expensive than other barriers, but also more durable
- Burlap should not be used

MAINTENANCE:

- Inspect after each rain and a minimum of once every two weeks
- Reshape or replace damaged sand bags immediately
- Remove buildup of sediment

BMP: Stabilized Construction Entrance SCE



DESCRIPTION:

A stabilized pad of crushed stone located where construction traffic enters or leaved the site from or to paved surface.

APPLICATION:

At any point of ingress and egress at a construction site where adjacent traveled way is paved. Generally applies to sites over 2 acres unless special conditions exist.

INSTALLATION / APPLICATION CRITERIA:

- Clear and grub area and grade to provide maximum slope of 2%
- Compact subgrade and place filter fabric if desired (recommended for entrances to remain for more than 3 months
- Place coarse aggregate, 3-6 inches in size, to a minimum depth of 8 inches

LIMITATIONS:

- Requires periodic top dressing with additional stones
- Should be used in conjuction with street sweeping on adjacent public right-of-way

MAINTENANCE:

- Inspect daily for loss of gravel or sediment buildup
- Inspect adjacent roadway for sediment deposit and clean by sweeping or shoveling
- Repair entrance and replace gravel as required to maintain control in good working condition
- Expand stabilized area as required to accommodate traffic and prevent erosion at driveways

OBJECTIVES

- ☒ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☒ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

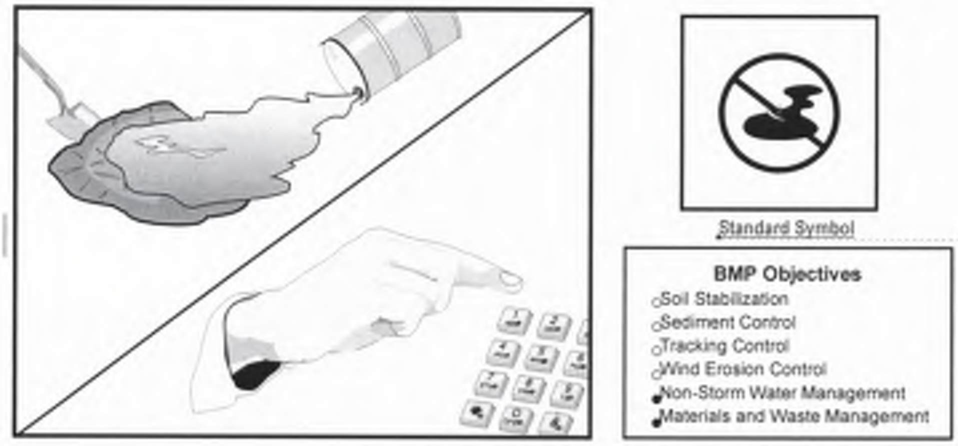
H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

BMP: Spill Clean-Up — SCU



DESCRIPTION:

Practices to clean-up leakage/spillage of on-site materials that may be harmful to receiving waters.

APPLICATION:

All sites

GENERAL:

- Store controlled materials within a storage area
- Educate personnel on prevention and clean-up
- Designate an Emergency Coordinator responsible practices and for providing spill response
- Maintain a supply of clean-up equipment on-site response agencies with phone numbers

METHODS:

- Clean-up spills/leaks immediately and remediate cause
- Use as little water as possible. NEVER HOSE DOWN OR BURY SPILL CONTAMINATED MATERIAL
- Use rags or absorbent material for clean-up. Excavate contaminated soils. Dispose of clean-up material and soil as hazardous waste
- Document all spills with date, location, substance, volume, actions taken and other pertinent data.
- Contact local Fire Department and State Division of Environmental Response and Remediation (Phone #536-4100) for any spill of reportable quantity

OBJECTIVES

- ☒ Housekeeping Practices
- ☒ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

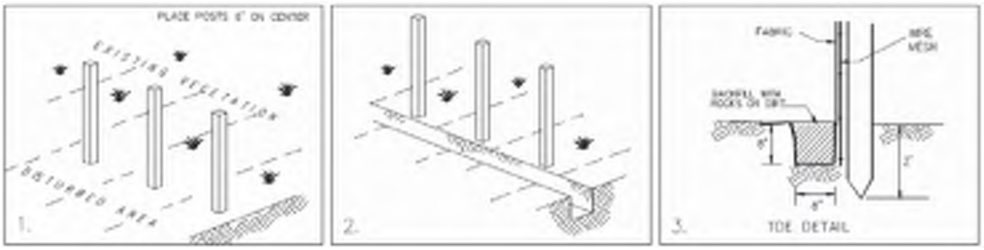
H	M	L	
☐	☐	☒	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☒	☐	☐	Toxic Materials
☐	☒	☐	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☐	☒	Maintenance
☒	☐	☐	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M** = Medium **L** = Low

BMP: Silt Fence SF



DESCRIPTION:

A temporary sediment barrier consisting of entrenched filter fabric stretched across and secured to supporting posts.

APPLICATION:

- Perimeter control: place barrier at downgradient limits of disturbance
- Sediment barrier: place barrier at toe of slope or soil stockpile
- Protection of existing waterways: place barrier at top of stream bank
- Inlet protection: place fence surrounding catch basins

INSTALLATION / APPLICATION CRITERIA:

- Place posts 6' apart on center along contour (or use preassembled unit) and drive 2' minimum into ground. Excavate an anchor trench immediately up gradient of posts
- Cut fabric to require width, unroll along length of barrier and drape over barrier. Secure fabric to mesh with twine, staples, or similar, with trailing edge extending into anchor trench
- Backfill trench over fabric to anchor
- Fabric must have 85% minimum sediment removal efficiency

LIMITATIONS:

- Recommended maximum drainage area of 0.5 acre per 100 feet
- Recommended maximum upgradient slope length of 150'
- Recommended maximum uphill grade of 2:1 (50%)
- Recommended maximum flow rate of 0.5 cfs
- Ponding should not be allowed behind fence

MAINTENANCE:

- Inspect immedialty after any rainfall and at least daily during prolonged rainfall
- Look for runoff bypassing ends of barriers or undercutting barriers
- Repair or replace damaged areas of the barrier and remove accumulated sediment
- Reanchor fence as necessary to prevent shortcutting
- Remove accumulated sediment when it reaches 1/2 the height of the fence

OBJECTIVES

- [ ] Housekeeping Practices
- [ ] Contain Waste
- [ ] Minimize Disturbed Areas
- [ ] Stabilize Disturbed Areas
- [x] Protect Slopes/Channels
- [x] Control Site Perimeter
- [x] Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

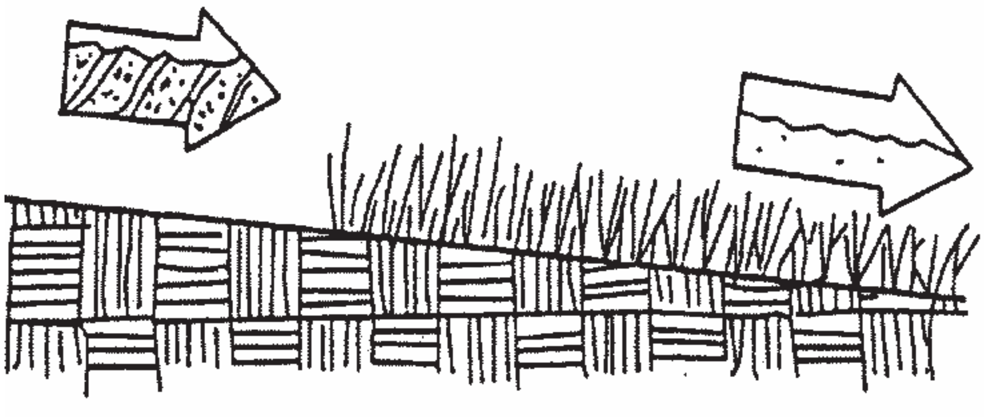
IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

WEST POINT UTAH

BMP: Seeding and Planting SP



DESCRIPTION:

Seeding of grass and plantings of trees, shrubs, vines and ground covers provide long-term stabilization of soil. In some areas, with suitable climates, grasses can be planted for temporary stabilization.

APPLICATION:

- Appropriate for site stabilization both during construction and post-construction
- Any graded/cleared areas where construction activities have ceased
- Open space cut and fill areas
- Steep slopes, spoil piles, vegetated swales, landscape corridors, stream banks. Use in conjunction with matting, mulch or blanketing where appropriate.

INSTALLATION / APPLICATION CRITERIA:

Type of vegetation, site and seedbed preparation, planting time, fertilization and water requirements should be considered for each application.

Grasses:

- Ground preparations: fertilize and mechanically stabilize the soil
- Tolerant of short-term temperature extremes and waterlogged soil composition
- Appropriate soil conditions: shallow soil base, good drainage, slope 2:1 or flatter
- Mowing, irrigating, and fertilizing are vital for promoting vigorous grass growth

Trees and Shrubs:

- Selection criteria: vigor, species, size, shape & wildlife food source
- Soil conditions: select species appropriate for soil, drainage & acidity
- Other factors: wind/exposure, temperature extremes, and irrigations needs

Vines and Ground Covers:

- Ground preparation: lime and fertilizer preparation
- Use proper seeding rates
- Appropriate soil conditions: drainage, acidity and slopes
- Generally avoid species requiring irrigation

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☒ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☒	☐	Nutrients
☐	☐	☒	Heavy Metals
☐	☒	☐	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

BMP: Surface Roughening SR

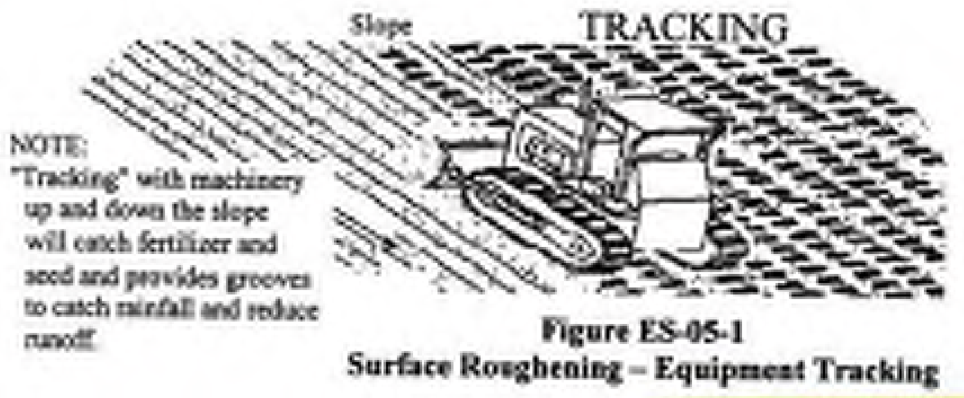


Figure ES-05-1
Surface Roughening – Equipment Tracking

DESCRIPTION:

Rough preparation of working areas leaving depressions and uneven surface. Depressions should be done parallel to contours.

APPLICATION:

- Surface roughening is appropriate for all construction that will not be receiving impervious cover within 14 days and that will be exposed less than 60 days (seed areas to be open in excess of 60 days)

INSTALLATION / APPLICATION CRITERIA:

- Surface should be left in rough condition during initial earthwork activity
- Surfaces that have become smoothed or compacted due to equipment traffic should be roughened by use of disks, spring harrows, teeth on front end loader, or similar, operating along the contours of the slope. Tracking (by crawler tractor driving up and down slope) may also be used to provide depressions parallel to contours
- Avoid compaction of soils during roughening as this inhibits plant growth and promotes storm water runoff. Limit tracked machinery to sandy soil
- Seed or mulch areas to be exposed in excess of 60 days
- Employ dust controls (see Dust Control Detail Sheet if appropriate)

LIMITATIONS:

- Will not withstand heavy rainfall
- Slopes steeper than 2:1 (50%) should be benched (see Benching Detail Sheet)

MAINTENANCE:

- Inspect following any storm event and at a minimum of weekly
- If erosion in the form of rills (small waterways formed by runoff) is evident, perform machine roughening of area
- For vegetated slopes reseed areas that are bare or have been reworked

OBJECTIVES

- [ ] Housekeeping Practices
- [ ] Contain Waste
- [ ] Minimize Disturbed Areas
- [x] Stabilize Disturbed Areas
- [x] Protect Slopes/Channels
- [ ] Control Site Perimeter
- [x] Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

WEST POINT
UTAH

BMP: Street Sweeping — SS

DESCRIPTION:

Prevent sediment from entering storm water by sweeping the streets near construction activities.

APPLICATION:

- Useful for any paved streets near construction sites where sediment is blown, tracked, or spilled onto the streets.

INSTALLATION / APPLICATION CRITERIA:

- The equipment used should be appropriate for the conditions. Vacuum sweepers work more effectively when the area is dry. Brush sweepers work better when the sediment is wet or stuck to the surface.
- Mechanical equipment should be operated and maintained according to the manufacturer's recommendations

LIMITATIONS:

- Is labor and equipment intensive
- May cause dust

MAINTENANCE:

- The street should be checked daily for any sediment deposits. Street sweeping should be implemented whenever sediment from construction activity is found on the streets

OBJECTIVES

- ☒ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☒ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

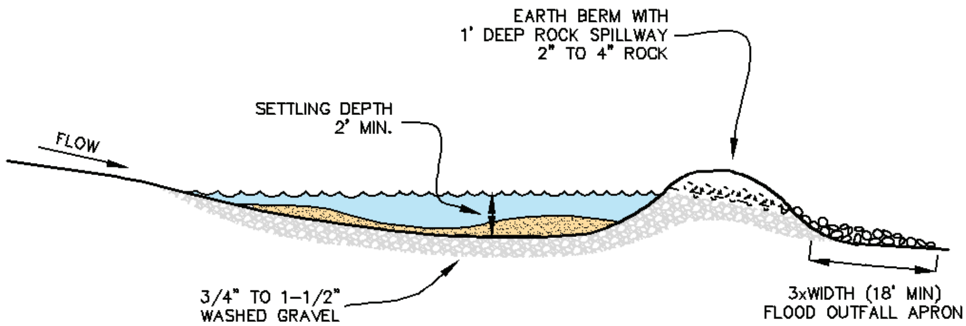
IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☐	☒	Capital Costs
☐	☒	☐	O&M Costs
☒	☐	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M** = Medium **L** = Low

WEST POINT
UTAH

BMP: Sediment Trap — ST



DESCRIPTION:

A sediment trap is a small excavated or bermed area where runoff from small drainage areas is detained and sediment can settle.

APPLICATION:

- Temporary control for runoff from disturbed areas of less than 3 arcres
- Temporary control for discharge from diversion dike, surface benching, or other temporary drainage measures

INSTALLATION / APPLICATION CRITERIA:

- Design basin for site specific location
- Excavate basin or construct compacted berm containment
- Construct outfall spillway with apron
- Provide downstream silt fence if necessary

LIMITATIONS:

- Should be sized based on anticipated runoff, sediment loading and drainage area size
- May require silt fence at outlet for entrapment of very fine silts and calys

MAINTENANCE:

- Inspect after each rainfall event and at a minimum of once every two weeks
- Repair any damage to berm, spillway or sidewalls
- Remove accumulated sediment as it reaches 2/3 height of available storage
- Check outlet for sedimentation/erosion of downgradient area and remediate as necessary. Install silt fence if sedimentation apparent.

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☒	☐	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

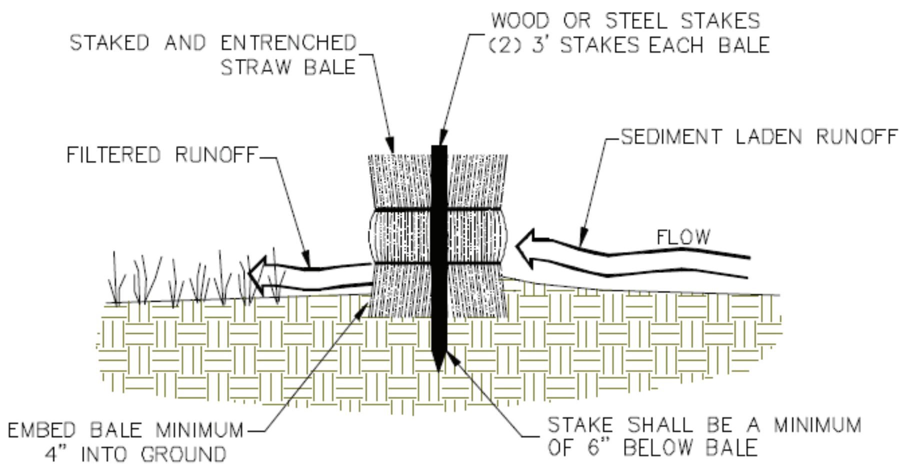
IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☒	☐	O&M Costs
☐	☐	☒	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

WEST POINT
UTAH

BMP: Straw Bale Barrier — SBB



DESCRIPTION:

Temporary sediment barrier consisting of a row of entrenched and anchored straw bales.

APPLICATION:

- Perimeter Control: place barrier at downgradient limits of disturbance
- Sediment barrier: place barrier at toe of slope or soil stockpile
- Protection of existing waterways: place barrier at top of stream bank
- Inlet Protection

INSTALLATION / APPLICATION CRITERIA:

- Excavate a 4" minimum deep trench along contour line, i.e., parallel to slope, removing all grass and other material that may allow underflow
- Place bales in trench with ends tightly abutting; fill any gaps by wedging loose straw into openings
- Anchor each bale and compact to prevent piping; backfill on uphill side to be built up 4" above ground at the barrier

LIMITATIONS:

- Recommended maximum area of 0.5 acre per 100' of barrier
- Recommended maximum upgradient slope length of 150 feet
- Recommended maximum uphill grade of 2:1 (50%)
- Maximum duristation of use is 6 months

MAINTENANCE:

- Inspect immediately after any rainfall and at least daily during prolonged rainfall
- Look for runoff bypassing ends of barriers or undercutting barriers
- Repair or replace damaged areas of the barrier and remove accumulated sediment
- Realign bales as necessary to provide continuous barrier and fill gaps
- Recompact soil around barrier as necessary to prevent piping

OBJECTIVES

- ☐ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☒ Protect Slopes/Channels
- ☒ Control Site Perimeter
- ☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☐	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

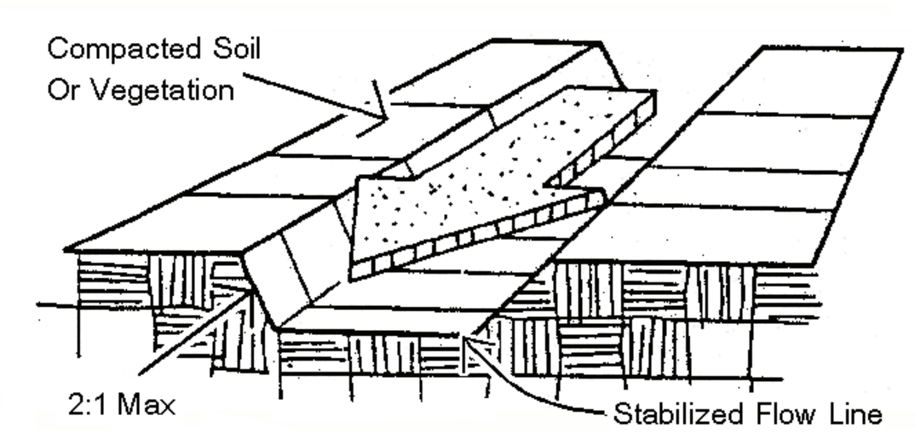
IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

WEST POINT UTAH

BMP: Temporary Drains and Swales — TDS



DESCRIPTION:

Temporary drains and swales are used to divert off-site runoff around the construction site, divert runoff from stabilized areas around disturbed areas.

APPLICATION:

- Temporary drains and swales are appropriate for diverting and upslope runoff around unstabilized or disturbed areas of the construction site
- Prevent slope failures. Prevent damage to adjacent property. Prevents erosion and transport of sediments into water ways. Increases the potential for infiltration. Diverts sediment-laden runoff into sediment basins or traps.

INSTALLATION / APPLICATION CRITERIA:

- Temporary drainage swales will effectively convey runoff and avoid erosion if built properly
- Size temporary drainage swales using local drainage design criteria. A permanent drainage channel must be designed by a professional engineer (see the local drainage design criteria for proper design)
- At a minimum, the drain/swale should conform to predevelopment drainage patterns and capacities
- Construct the drain/swale with an uninterrupted positive grade to a stabilized outlet. Provide erosion protection or energy dissipation measures if the flow out of the drain or swale can reach an erosive velocity

LIMITATIONS:

- Temporary drains and swales or any other diversion of runoff should not adversely impact upstream or downstream properties
- Temporary drains and swales must conform to local floodplain management requirements

MAINTENANCE:

- Inspect weekly and after each rain
- Repair any erosion immediately
- Remove sediment which builds up in the swale and restrcts its flow capacity

OBJECTIVES

☐ Housekeeping Practices
☐ Contain Waste
☐ Minimize Disturbed Areas
☐ Stabilize Disturbed Areas
☒ Protect Slopes/Channels
☒ Control Site Perimeter
☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☒	☐	☒	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☐	☒	Toxic Materials
☐	☐	☒	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☐	☒	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

WEST POINT UTAH

BMP: Temporary and Permanent Seeding — TPS

Description:

Temporary seeding-establishment of short term cover by application of rapidly germinating seed mix (alternatively hydroseeding may be utilized).
Permanent seeding-establishment of final term cover by application of perennial seed mix (alternatively sod may be utilized).

Application:

Disturbed areas that are at final grade and which will not be disturbed by continuing activities on site. Also areas that are not at final grade but which will be left untouched in excess of one year.

Recommended Seed Mix:

The recommended seed mix will be dependent on site specific information such as elevation, exposure, soils, water available and topography. Check with the County Extension Service for recommended mixes for site specific conditions:

Utah State University Extension Service
28 E. State Street (Room 20D)
Farmington, Utah 84025
Phone: (801) 451-3412

Limitations:

- Limited to areas that will not be subject to traffic or high usage
- May require irrigation and fertilizer which creates potential for impacting runoff quality
- May only be applied during appropriate planting season, temporary cover required until that time

Installation:

- Roughen soil to a depth of 2 inches. Add fertilizer, manure, topsoil as necessary
- Evenly distribute seed using a commonly accepted method such as; breast seeding, drilling, hydro-seeding
- Use a seed mix appropriate for soil and location that will provide rapid germination and growth. Check with County for recommended mix and application rate.
- Cover area with mulch if required due to steep slopes or unsuitable weather conditions

Maintenance:

- Provide irrigation as required to establish growth and to maintain plant cover through duration of project
- Reseed as necessary to provide 75% coverage
- Remediate any areas damaged by erosion or traffic
- When 75% coverage is achieved inspect monthly for damage and remediate as necessary

Objectives

- [ ] Housekeeping Practices
- [ ] Contain Waste
- [ ] Minimize Disturbed Areas
- [x] Stabilize Disturbed Areas
- [x] Protect Slopes/Channels
- [ ] Control Site Perimeter
- [ ] Control Internal Erosion

Targeted Pollutants

H	M	L	
X			Sediment
X			Nutrients
		X	Heavy Metals
		X	Toxic Materials
		X	Oil & Grease
		X	Floatable Materials
		X	Bacteria & Viruses
		X	Other Waste

Implementation Requirements

H	M	L	
	X		Capital Costs
		X	O&M Costs
	X		Maintenance
		X	Training
		X	Staffing
		X	Administrative

H = High **M** = Medium **L** = Low

BMP: Vehicle And Equipment Cleaning — VEC

DESCRIPTION:

Prevent or reduce the discharge of pollutants to storm water from vehicle and equipment cleaning by using off-site facilities, washing in designated, contained areas only, eliminating discharges to the storm drain by infiltrating or recycling the wash water, and/or training employees and subcontractors.

INSTALLATION / APPLICATION CRITERIA:

- Use off-site commercial washing businesses as much as possible. Washing vehicles and equipment outdoors or in areas where wash water flows onto paved surfaces or into drainage pathways can pollute storm water. If you wash large number of vehicles or pieces of equipment, consider conducting this work at an off-site commercial business. These businesses are better equipped to handle and dispose of the wash waters properly. Performing this work off-site can also be economical by eliminating the need for a separate washing operation at your site.
- If washing must occur on-site, use designated, bermed wash areas to prevent wash water contact with storm water, creeks, rivers, and other water bodies. The wash area can be sloped for wash water collection and subsequent infiltration into the ground.
- Use as little water as possible to avoid having to install erosion and sediment controls for the wash area. Use phosphate-free biodegradable soaps. Educate employees and subcontractors on pollution prevention measures. Do not permit steam cleaning on-site. Steam cleaning can generate significant pollutant concentrations.

LIMITATIONS:

- Even phosphate-free, biodegradable soaps have been shown to be toxic to fish before the soap degrades
- Sending vehicles/equipment off-site should be done in conjunction with Stabilized Construction Entrance

MAINTENANCE:

- Minimal, some berm repair may be necessary

OBJECTIVES

☒ Housekeeping Practices
☐ Contain Waste
☐ Minimize Disturbed Areas
☐ Stabilize Disturbed Areas
☐ Protect Slopes/Channels
☒ Control Site Perimeter
☒ Control Internal Erosion

TARGETED POLLUTANTS

H	M	L	
☐	☐	☒	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☒	☐	Toxic Materials
☐	☒	☐	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

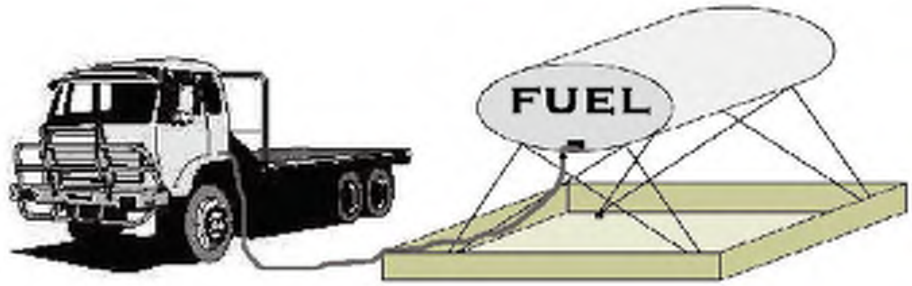
IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☐	☒	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

WEST POINT UTAH

BMP: Vehicle And Equipment Fueling — VEF



DESCRIPTION:

Prevent fuel spills and leaks, and reduce their impacts to storm water by using offsite facilities, fueling in designated areas only, enclosing or covering stored fuel, implementing spill controls, and training employees and subcontractors.

INSTALLATION / APPLICATION CRITERIA:

- Use off-site fueling stations as much as possible. Fueling vehicles and equipment outdoors or in areas where fuel may spill/leak onto paved surfaces or into drainage pathways can pollute storm water. If you fuel a large number of vehicles or pieces of equipment, consider using an off-site fueling station. These businesses are better equipped to handle fuel and spills properly. Performing this work off-site can also be economical by eliminating the need for a separate fueling area at your site.
- If fueling must occur on-site, use designated areas, located away from drainage courses, to prevent the run on of storm water and the runoff of spills. Discourage ”topping-off” of fuel tanks.
- Always use secondary containment, such as a drain pan or drop cloth, when fueling to catch spills/leaks. Place a stockpile of spill cleanup materials where it will be readily accessible. Use adsorbent materials on small spills rather than hosing down or burying the spill. Remove the adsorbent materials promptly and dispose of properly.
- 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. With the exception of tracked equipment such as bulldozers and perhaps forklifts, most vehicles should be able to travel to a designated area with little lost time. Train employees and subcontractors in proper fueling and cleanup procedures.

LIMITATIONS:

Sending vehicles/equipment off-site should be done in conjunction with Stabilized Construction Entrance

MAINTENANCE:

- Keep ample supplies of spill cleanup materials on-site
- Inspect fueling areas and storage tanks on a regular schedule

OBJECTIVES

- ☒ Housekeeping Practices
- ☐ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

TARGETED POLLUTANTS

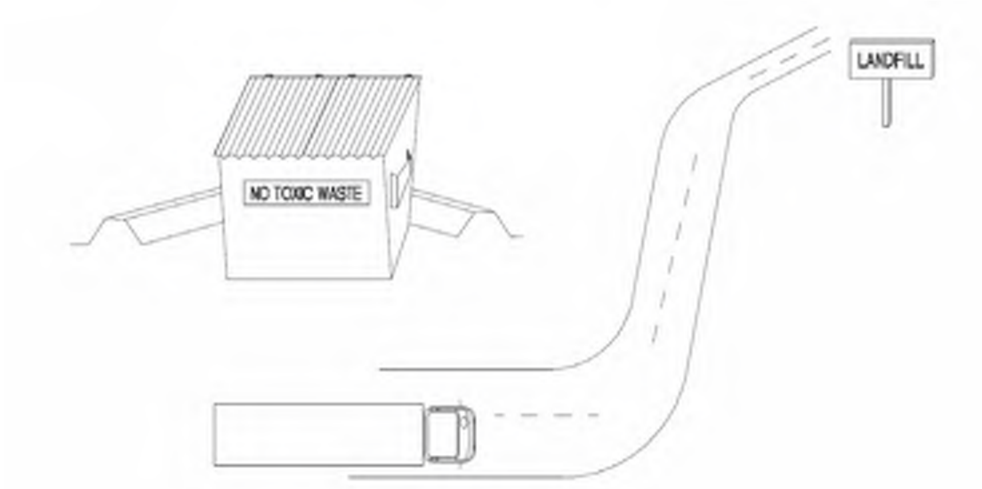
H	M	L	
☐	☐	☒	Sediment
☐	☐	☒	Nutrients
☐	☐	☒	Heavy Metals
☐	☒	☐	Toxic Materials
☐	☒	☐	Oil & Grease
☐	☐	☒	Floatable Materials
☐	☐	☒	Bacteria & Viruses
☐	☐	☒	Other Waste

IMPLEMENTATION REQUIREMENTS

H	M	L	
☐	☒	☐	Capital Costs
☐	☐	☒	O&M Costs
☐	☒	☐	Maintenance
☐	☒	☐	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

BMP: Waste Disposal WD



Description:

Controlled storage and disposal of solid waste generated by construction activities.

Application:

All construction sites

Installation / Application Criteria:

- Designate one or several waste collection areas with easy access for construction vehicles and personnel. Ensure no waterways or storm drainage inlets are located near the waste collection areas.
- Construct compacted earthen berm (See Earth Berm Barrier Information Sheet), or similar perimeter containment around collection area for impoundment in the case of spills.
- Ensure all on site personnel are aware of and utilize designated waste collection area properly and for intended use only (e.g. all toxic, hazardous, or recyclable materials shall be properly disposed of separately from general construction waste).
- Arrange for periodic pickup, transfer and disposal of collected waste at an authorized disposal location. Include regular Porto-potty service in waste management activities.

Limitations:

- On-site personnel are responsible for correct disposal of waste

Maintenance:

- Discuss waste management procedures at progress meetings
- Collect site trash daily and deposit in containers at designated collection areas
- Randomly check disposed materials for any unauthorized waste (e.g. toxic materials).

Objectives

- ☒ Housekeeping Practices
- ☒ Contain Waste
- ☐ Minimize Disturbed Areas
- ☐ Stabilize Disturbed Areas
- ☐ Protect Slopes/Channels
- ☐ Control Site Perimeter
- ☐ Control Internal Erosion

Targeted Pollutants

H	M	L	
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☐	☒	☐	Oil & Grease
☒	☐	☐	Floatable Materials
☐	☐	☐	Bacteria & Viruses
☒	☐	☐	Other Waste

Implementation Requirements

H	M	L	
☒	☐	☐	Capital Costs
☒	☐	☐	O&M Costs
☐	☒	☐	Maintenance
☒	☐	☐	Training
☐	☐	☒	Staffing
☐	☐	☒	Administrative

H = High **M =** Medium **L =** Low

APPENDIX 2

DAVIS COUNTY STORM WATER COALITION

Copy

**2016 INTERLOCAL COOPERATION AGREEMENT
BETWEEN DAVIS COUNTY CITIES AND
DAVIS COUNTY
FOR
UPDES GENERAL PERMIT**

THIS AGREEMENT (Agreement) is entered into this ____ day of _____, 2016, by and between the following parties: DAVIS COUNTY, a body corporate and politic of the State of Utah, and the following cities, each of which is a municipal corporation of the State of Utah: BOUNTIFUL, CENTERVILLE, CLEARFIELD, CLINTON, FARMINGTON, FRUIT HEIGHTS, KAYSVILLE, LAYTON, NORTH SALT LAKE, SOUTH WEBER, SUNSET, SYRACUSE, WEST BOUNTIFUL, WEST POINT and WOODS CROSS(Parties).

WITNESSETH:

WHEREAS, the parties are "public agencies" and are authorized by the *Utah Interlocal Cooperation Act*, §11-13-101, *et seq*., *Utah Code Annotated*, to enter into agreements with each other for joint or cooperative action; and

WHEREAS, the Environmental Protection Agency (EPA) has published its "Final Rule" setting forth the National Pollutant Discharge Elimination System (NPDES) permit application rules and regulations for stormwater discharges to municipal separate storm sewer systems; and

WHEREAS, the State of Utah, through its Department of Environmental Quality, Division of Water Quality (DWQ), has statutory rulemaking authority and authority to issue pollutant discharge elimination system permits within the State of Utah pursuant to the rules and regulations of the Utah Pollutant Discharge Elimination System (UPDES); and

WHEREAS, the State of Utah has issued a General Permit for Discharges from Small Municipal Separate Storm Sewer Systems, Permit No. UTR 090000 (Permit), to each party of this Agreement, which Permit is incorporated herein by this reference; and

WHEREAS, the rules and regulations provide that more than one entity may jointly implement activities to comply with UPDES permit requirements under Section 4.3 of the General Permit for Discharges from Small Municipal Separate Storm Sewer Systems; and

WHEREAS, the parties are willing to jointly implement activities to fulfill a portion of the UPDES permit requirements; and

WHEREAS the parties desire to enter into this Agreement setting forth their present understanding as to their respective responsibilities with regard to their participation as permittees under their Permit.

NOW, THEREFORE, in consideration of the mutual promises set forth herein, the parties agree as follows:

1. Compliance with Permit. As permittees, the parties agree to jointly implement and enforce within their own jurisdictions, their respective responsibilities for complying with the Permit requirements including but not limited to, those responsibilities and requirements set forth in Parts 4.0, 5.0, and 6.0 of the Permit.

2. Administration of Agreement. The administration of this Agreement shall be done by the public works directors of each party, or their official designee, constituting the Davis County Storm Water Coalition (Coalition). Each party will have one voting right. No separate legal entity is created by the terms of this Agreement.

3. Costs. The parties agree that each party shall be responsible to pay for those costs relating to their own stormwater systems, and that the parties shall reimburse each other for expenses incurred in providing services for each other as may be agreed by the parties concerning the various tasks and responsibilities required under the Permit

4. Joint Cooperation. As reasonably necessary, the parties agree to assist each other in providing and sharing information, drawings, plans, data, etc., which are required to comply

with the requirements set forth in the Permit. The specific activities that the parties agree to assist each other in are set forth as follows:

a. Jointly purchase educational and training materials, as determined by the Coalition, for distribution to:
    i. Residents
    ii. Institutions, industrial and commercial facilities
    iii. Developers and contractors (construction)
    iv. Municipal Separate Storm Sewer System (MS4) owned or operated facilities
b. Use the Coalition as a county-wide committee to:
    i. Train personnel
    ii. Create partnerships
    iii. Obtain input and feedback from special interest groups
c. Annually contribute updated storm drain system information for county-wide mapping purposes
d. Jointly prepare and promote model ordinances, updates and standards that addresses:
    i. Illicit discharges
    ii. Construction site storm water runoff
    iii. Long-term storm water management
e. Jointly arrange for and provide education about hydrologic methods and criteria for selecting and sizing post-construction BMPs
f. Jointly participate to develop draft Standard Operating Procedures
g. Jointly evaluate, identify, target and provide educational materials and

outreach to address the reduction of water quality impacts associated with nitrogen and phosphorus in discharges

5. Term of Agreement. The parties agree that the duration of this Agreement shall commence upon entry and shall continue in effect for the term of the Permit (which expires at midnight, February 28, 2021) and for an additional 120 days from the effective date of the renewal of the Permit by the Division.

6. Property. In the event that any property is acquired by the parties jointly for the undertaking, and paid for by them, then it shall be divided as the parties' representatives shall agree, or if no agreement is reached, then it shall be divided according to their respective payments for property, or if it cannot be practically divided, then the property shall be sold and the proceeds divided according to the parties' proportionate share of the purchase of the item of property. If property is purchased at one party's sole expense in connection with this Agreement, then the property so purchased shall be and remain the property of the party which purchased it.

7. Entire Agreement. This Agreement embodies the entire agreement between the parties and it cannot be altered except in a written amendment which is signed by the parties.

8. Governmental Immunity. The parties recognize and acknowledge that each party is covered by the Utah Governmental Immunity Act, as set forth in *Utah Code Ann.* §§ 63G-7-101, *et seq.*, as amended, and nothing herein is intended to waive or modify any and all rights, defenses or provisions provided therein. Officers and employees performing services pursuant to this Agreement shall be deemed officers and employees of the party employing their services, even if performing functions outside of the territorial limits of such party and shall be deemed officers and employees of such party under the provisions of the Utah Governmental Immunity Act. Each party shall be responsible and shall defend the action of its own employees, negligent

or otherwise, performed pursuant to the provisions of this Agreement.

9. No Third Party Benefits. This Agreement is not intended to benefit any person or entity not named as a party hereto.

10. Severability. If any provision of this Agreement is determined by a court to be invalid or unenforceable, such determination shall not affect any other provision hereof, each of which shall be construed and enforced as if the invalid or unenforceable portion were not contained herein. Such invalidity or unenforceability shall not affect any valid and enforceable application thereof, and each such provision shall be deemed to be effective, operative and entered into in the manner and to the full extent permitted by applicable law.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement to be effective as of the day and year first above written.

[Signature Pages to Follow]

Approval of
Interlocal Cooperation Agreement
between Davis County and Davis County Cities
for UPDES General Permit

Date 5/17/16

CITY OF WEST POINT

By: ______________________

Mayor

ATTEST:

____

City Recorder

Approved as to Form:

Felshaw King

City Attorney

APPENDIX 3

PUBLIC EDUCATION AND OUTREACH

PUBLIC EDUCATION AND OUTREACH

Documentation and Records

Date	Description	Comments

PUBLIC EDUCATION AND OUTREACH

Effectiveness Evaluation

Year	Description	Comments
	(goals achieved/not achieved, targeted audience, information distributed)	

APPENDIX 4

PUBLIC INVOLVEMENT / PARTICIPATION

PUBLIC INVOLVEMENT / PARTICIPATION

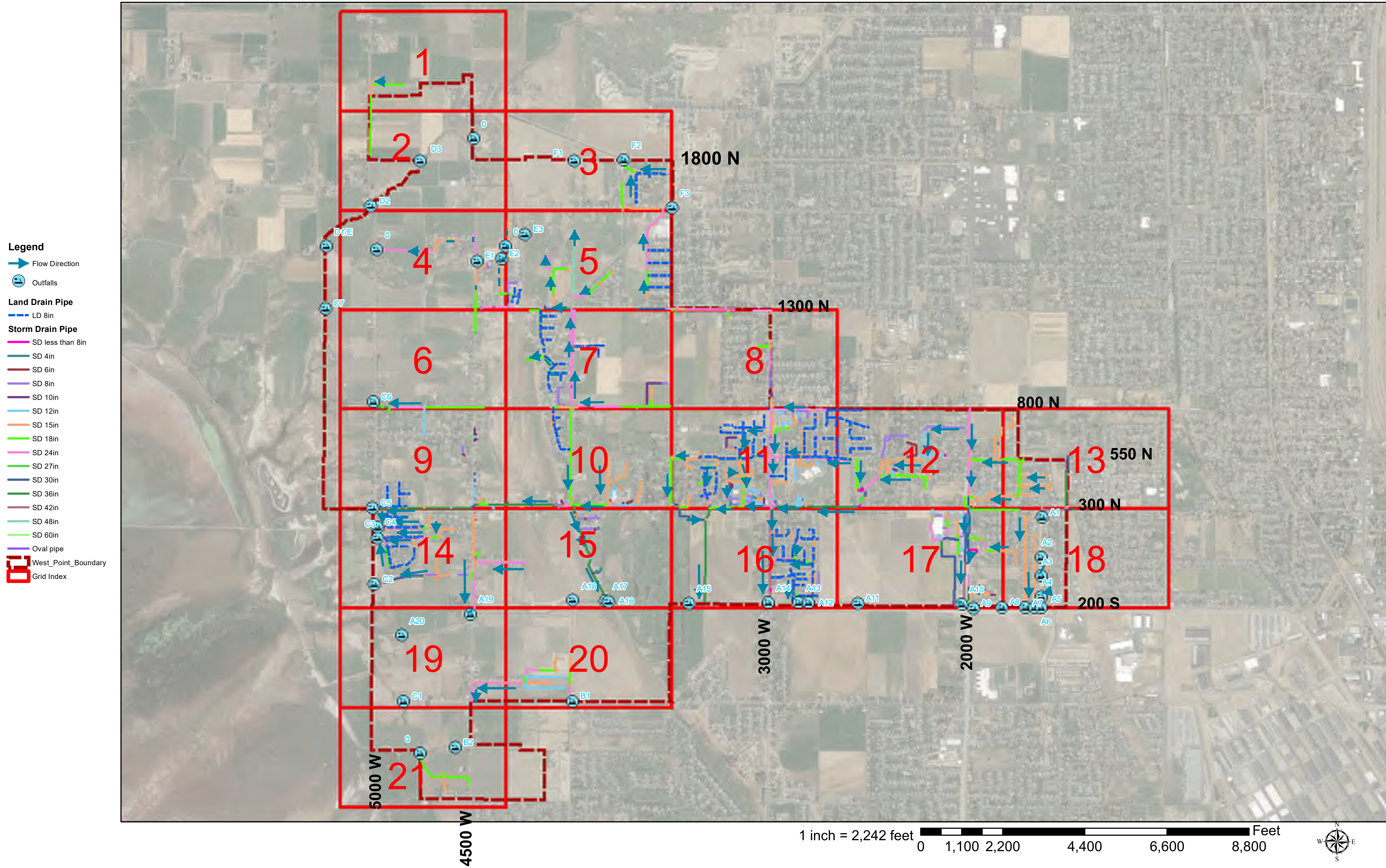
List of Projects for Volunteers

Projects	Description	Comments

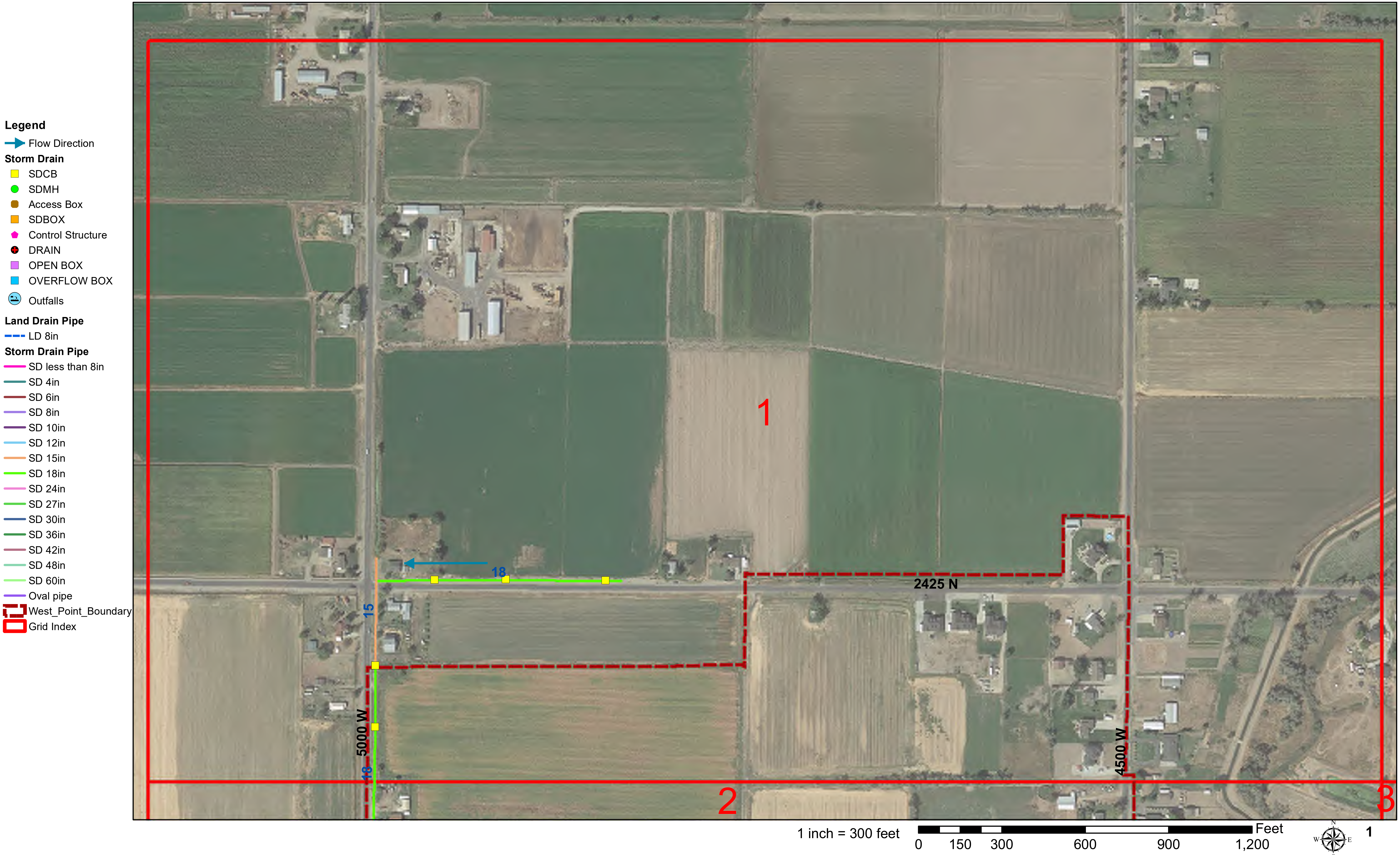
APPENDIX 5

ILLICIT DISCHARGES DETECTION AND ELIMINATION (IDDE)

West Point Storm Drain Overview



West Point Storm Drain 2021



Legend

- Flow Direction

Storm Drain

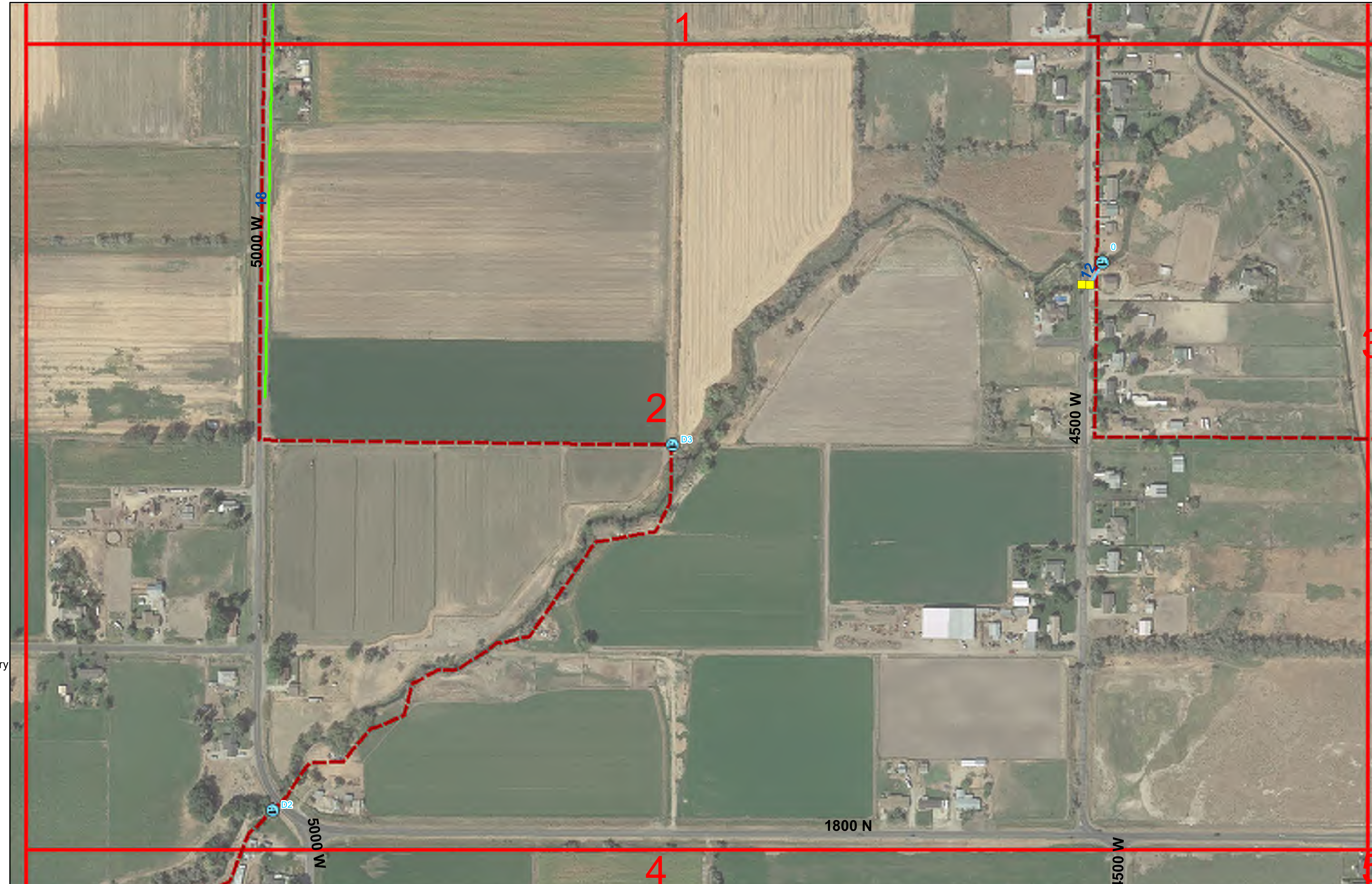
- SDCB
- SDMH
- Access Box
- SDBOX
- Control Structure
- DRAIN
- OPEN BOX
- OVERFLOW BOX
- Outfalls

Land Drain Pipe

- LD 8in

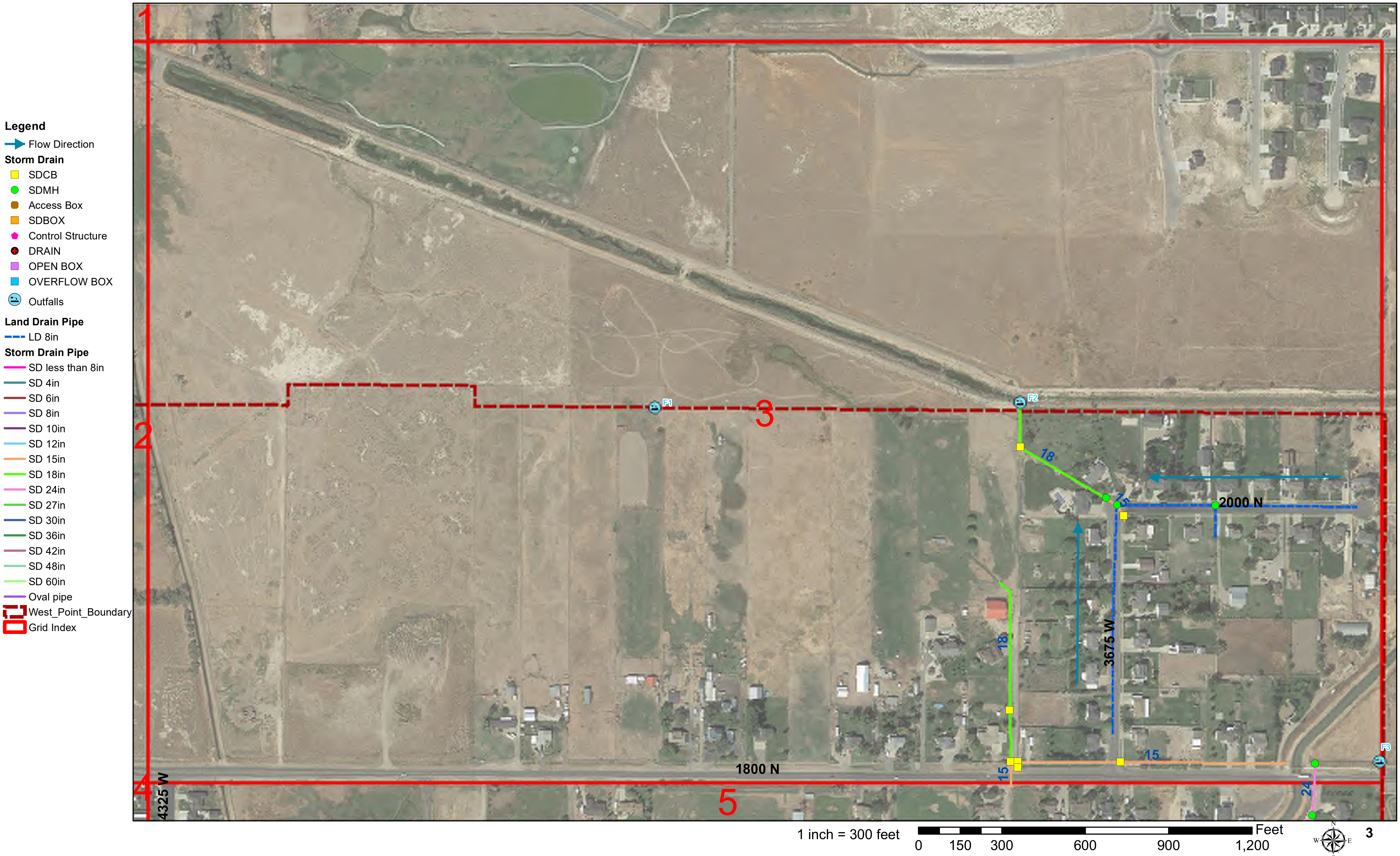
Storm Drain Pipe

- SD less than 8in
- SD 4in
- SD 6in
- SD 8in
- SD 10in
- SD 12in
- SD 15in
- SD 18in
- SD 24in
- SD 27in
- SD 30in
- SD 36in
- SD 42in
- SD 48in
- SD 60in
- Oval pipe
- West_Point_Boundary
- Grid Index



1 inch = 300 feet

0 150 300 600 900 1,200 Feet


Legend
Flow Direction
Storm Drain
SDCB
SDMH
Access Box
SDBOX
Control Structure
DRAIN
OPEN BOX
OVERFLOW BOX
Outfalls
Land Drain Pipe
LD 8in
Storm Drain Pipe
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SD 27in
SD 30in
SD 36in
SD 42in
SD 48in
SD 60in
Oval pipe
West_Point_Boundary
Grid Index
1
2
3
4
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F1
F2
F3
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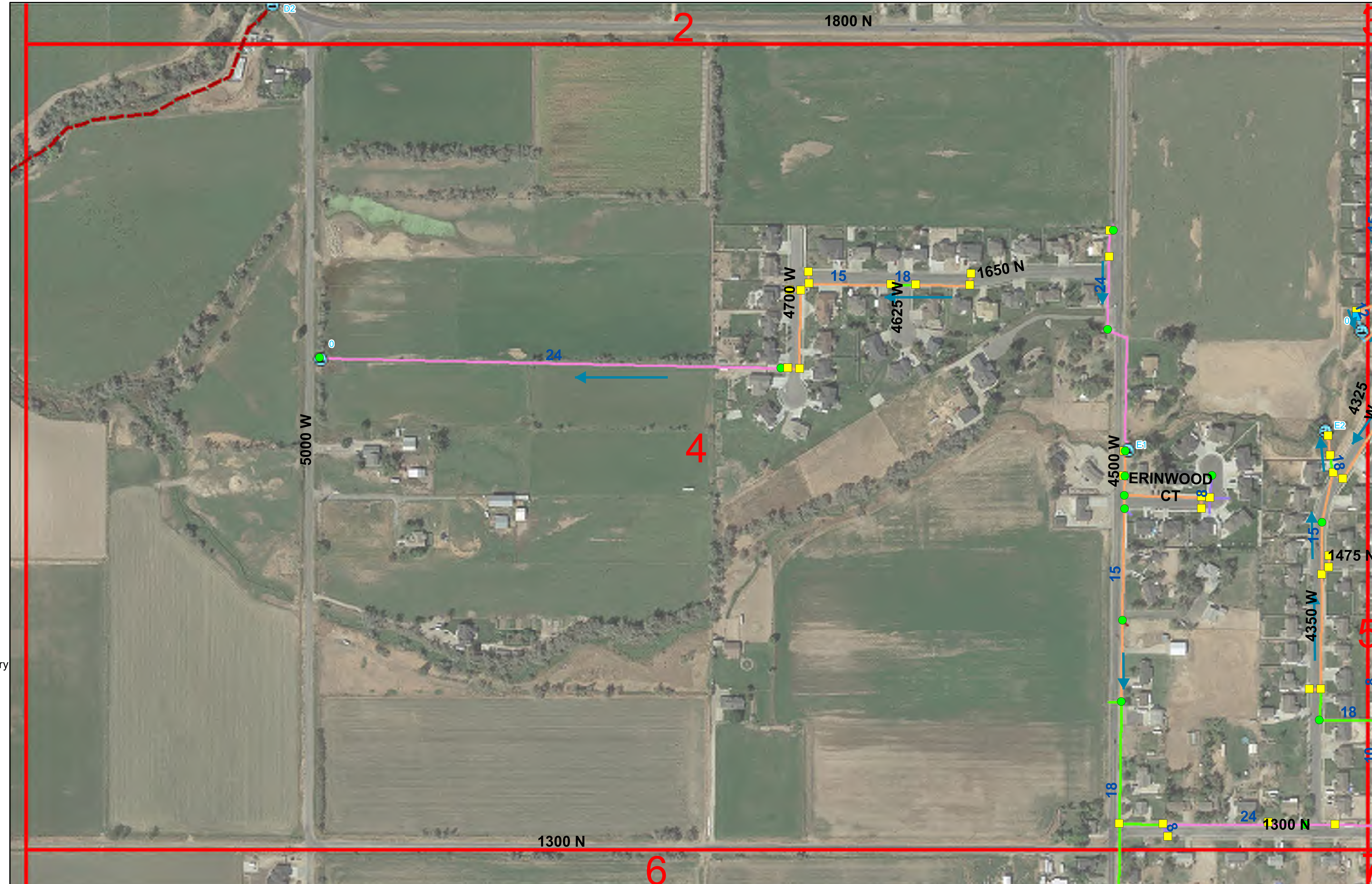
1800 N
4325 W
24
1 inch = 300 feet
0 150 300 600 900 1,200 Feet

West Point Storm Drain 2021



Legend

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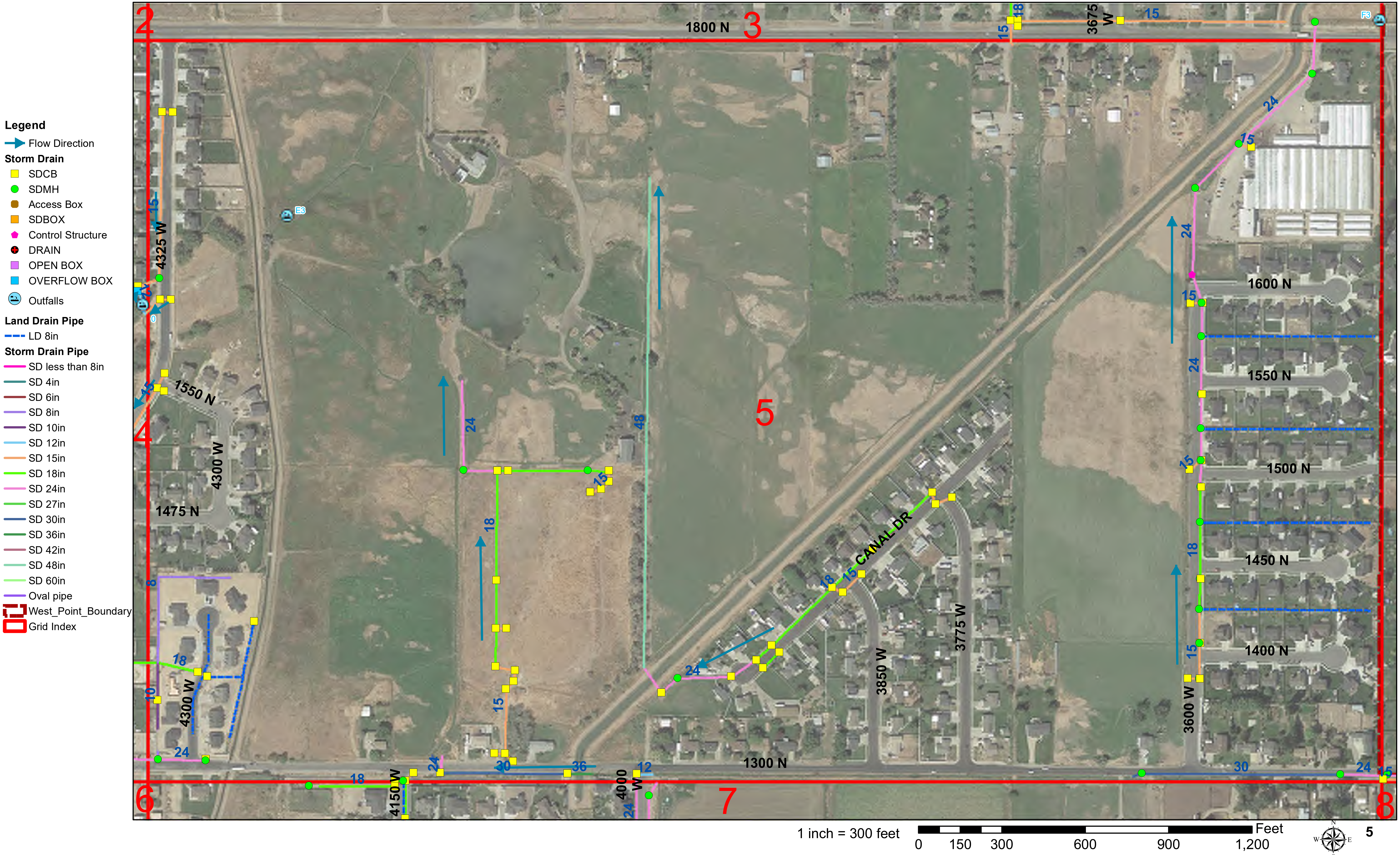
- Grid Index

1 inch = 300 feet

0 150 300 600 900 1,200 Feet

West Point Storm Drain 2021



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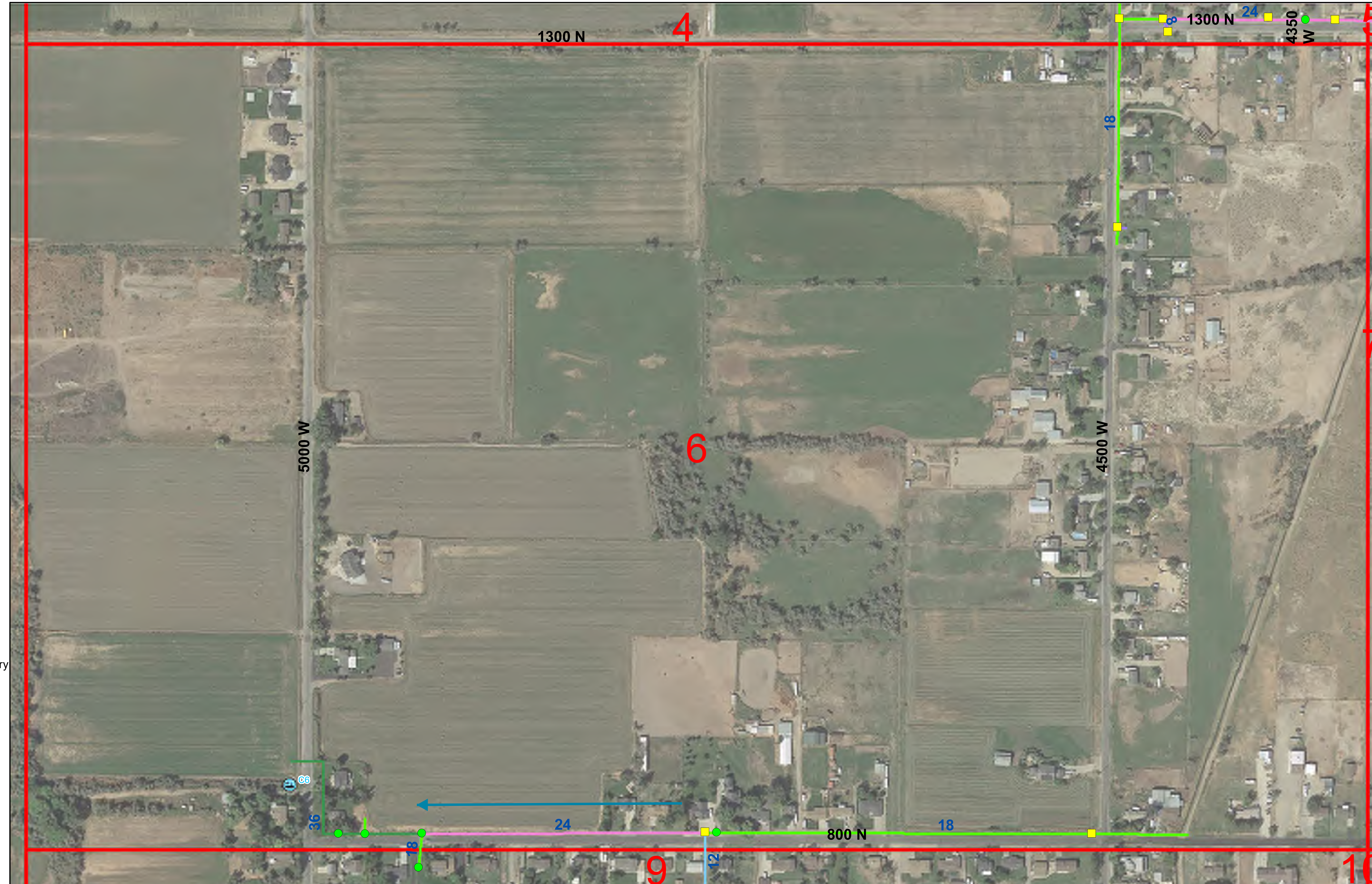

Legend

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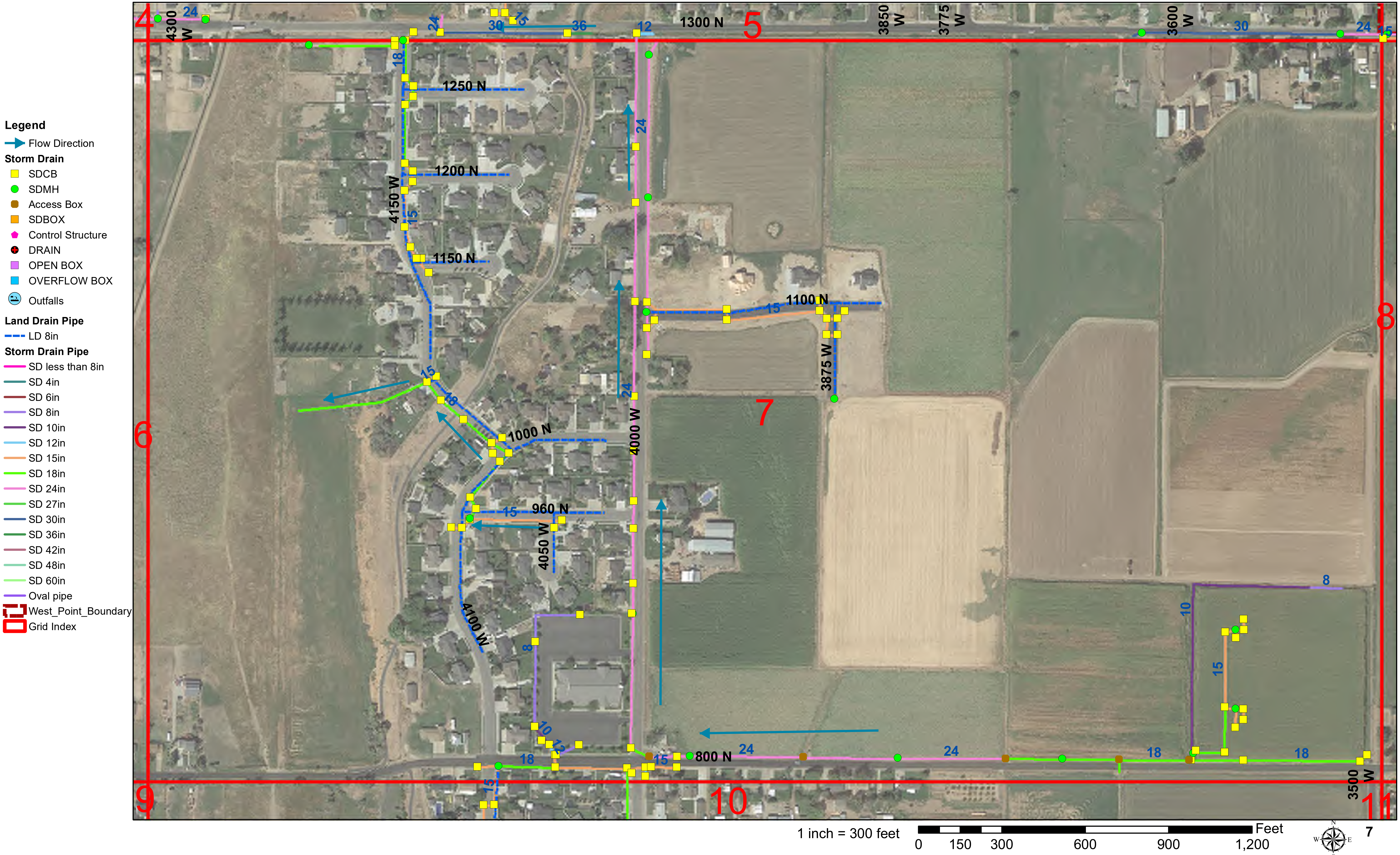
1 inch = 300 feet

Feet 0 150 300 600 900 1,200



4300 W
1250 N
1200 N
4150 W
1150 N
1100 N
3875 W
1000 N
4000 W
960 N
4050 W
4100 W
800 N
1300 N
3850 W
3775 W
3600 W
3500 W
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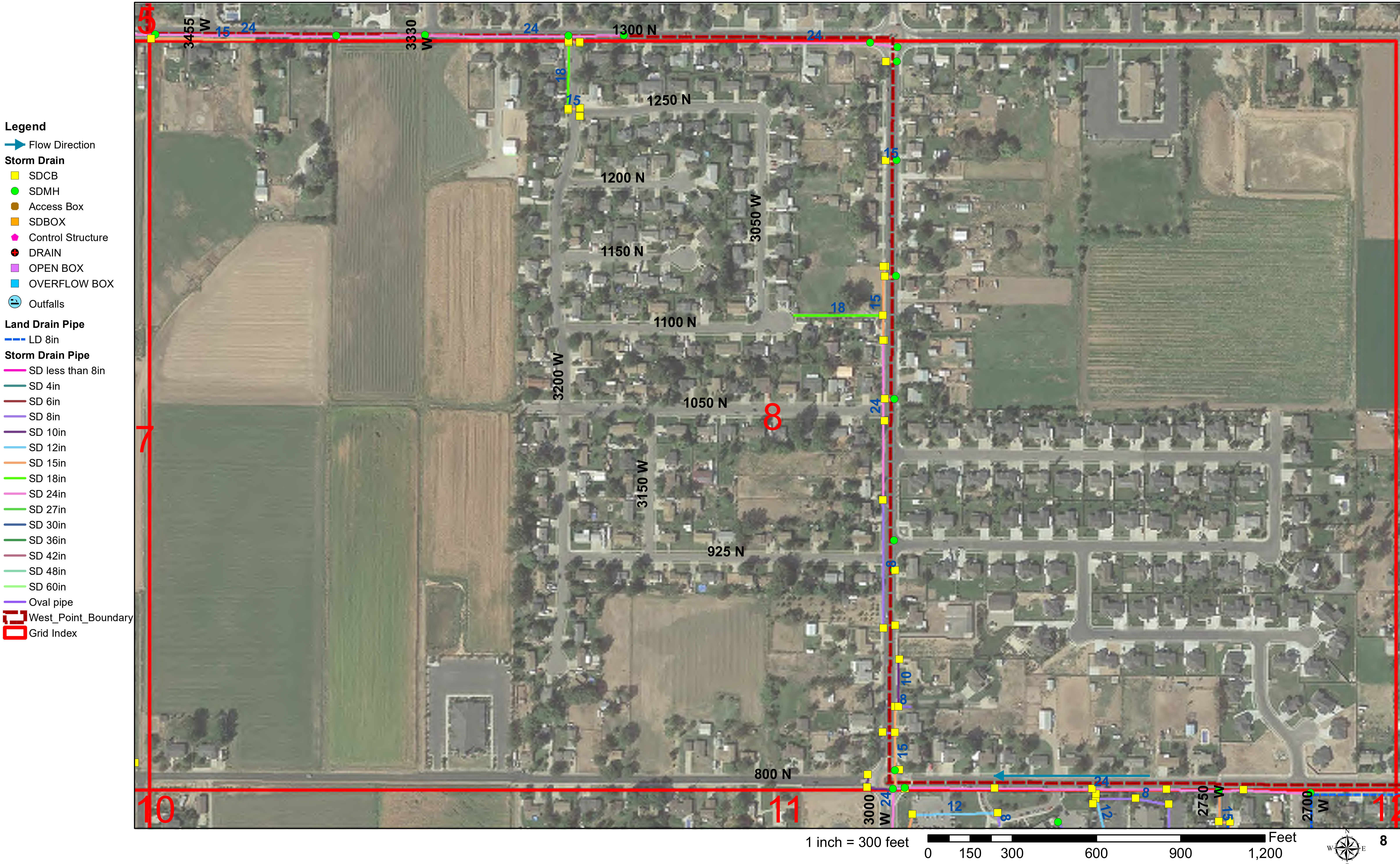
Grid Index
1 inch = 300 feet
0 150 300 600 900 1,200 Feet

West Point Storm Drain 2021



West Point Storm Drain 2021

Legend

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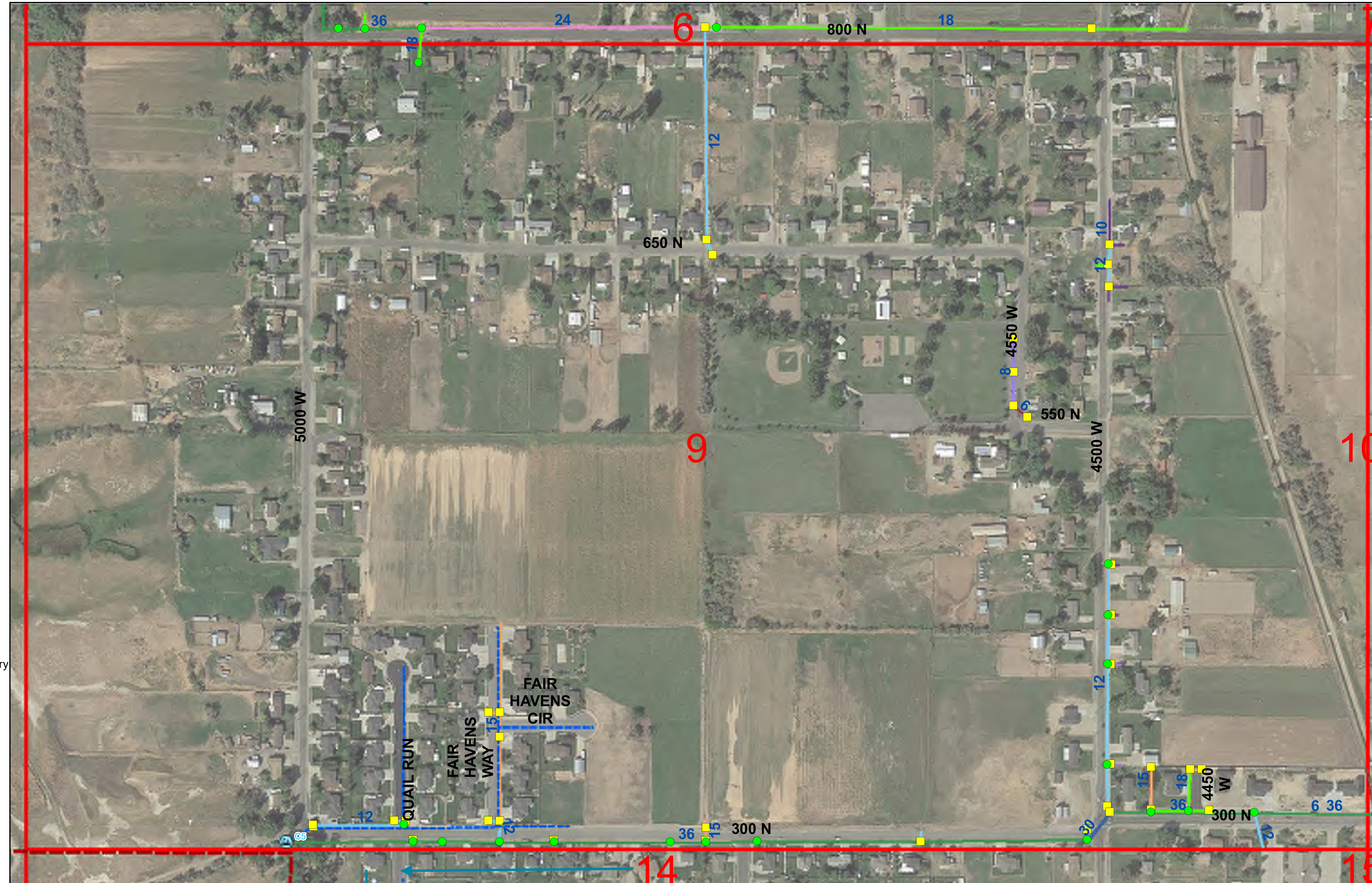

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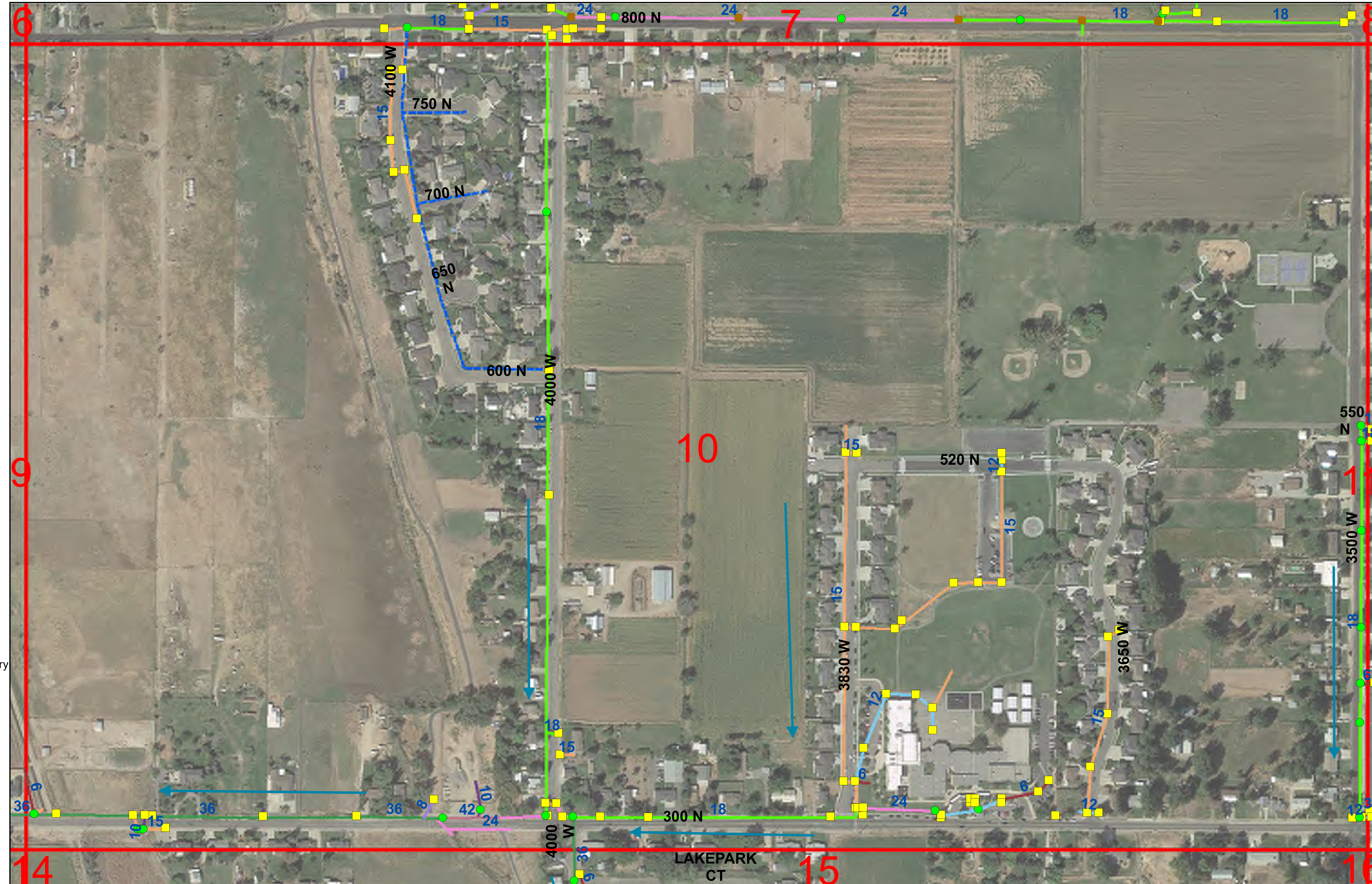
0 150 300 600 900 1,200 Feet



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1 inch = 300 feet

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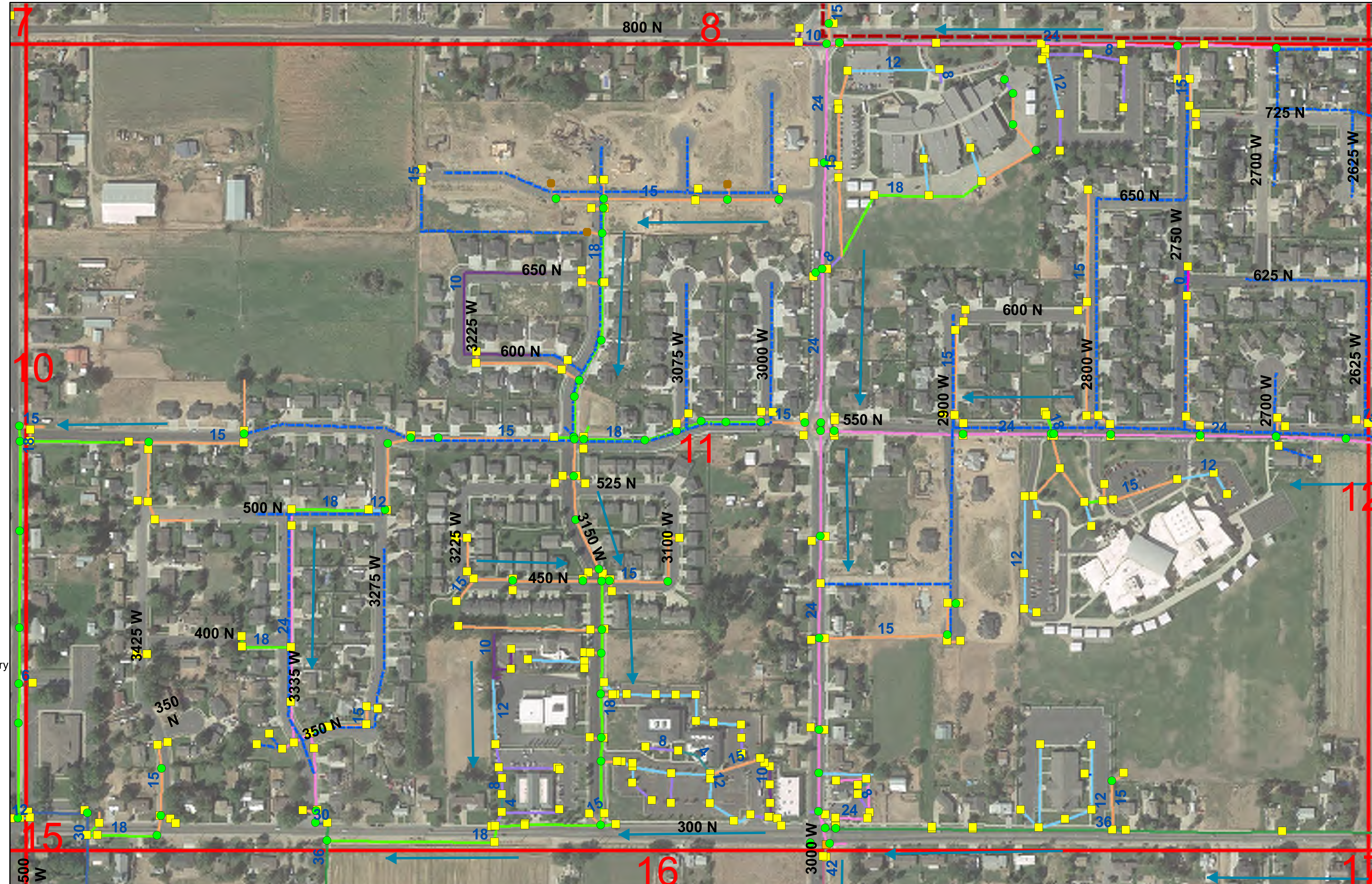

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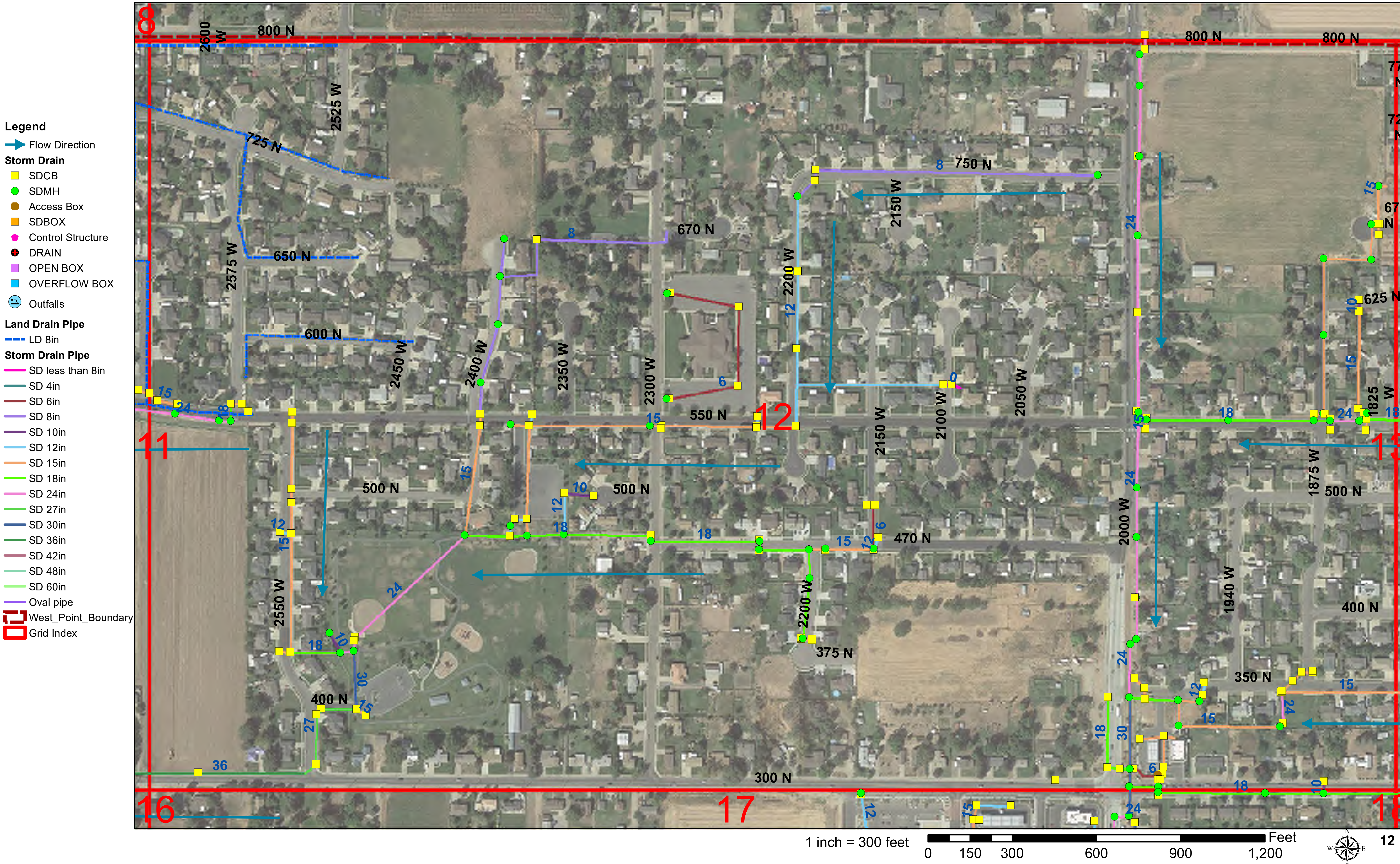
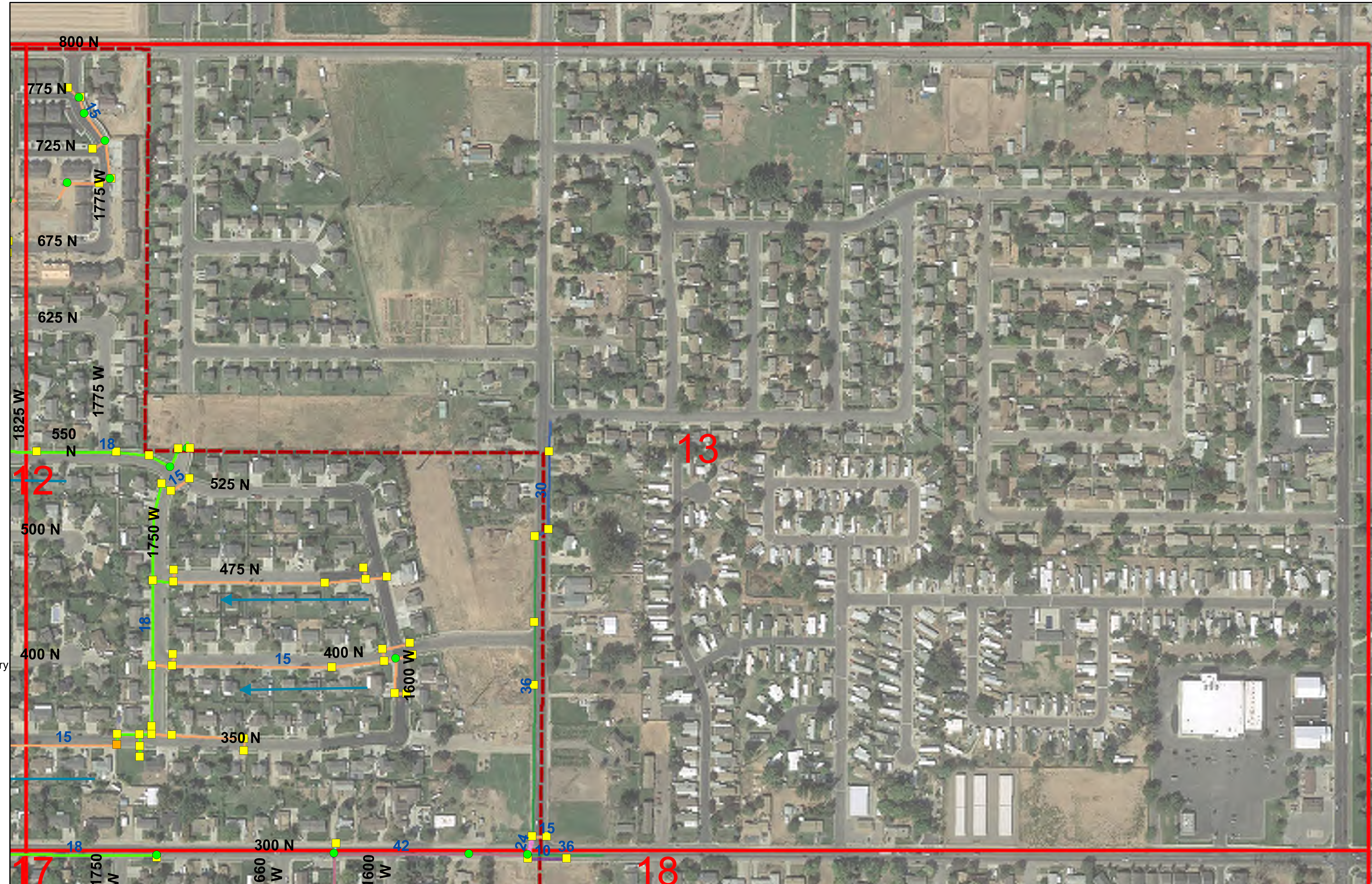
0 150 300 600 900 1,200 Feet

West Point Storm Drain 2021





Legend

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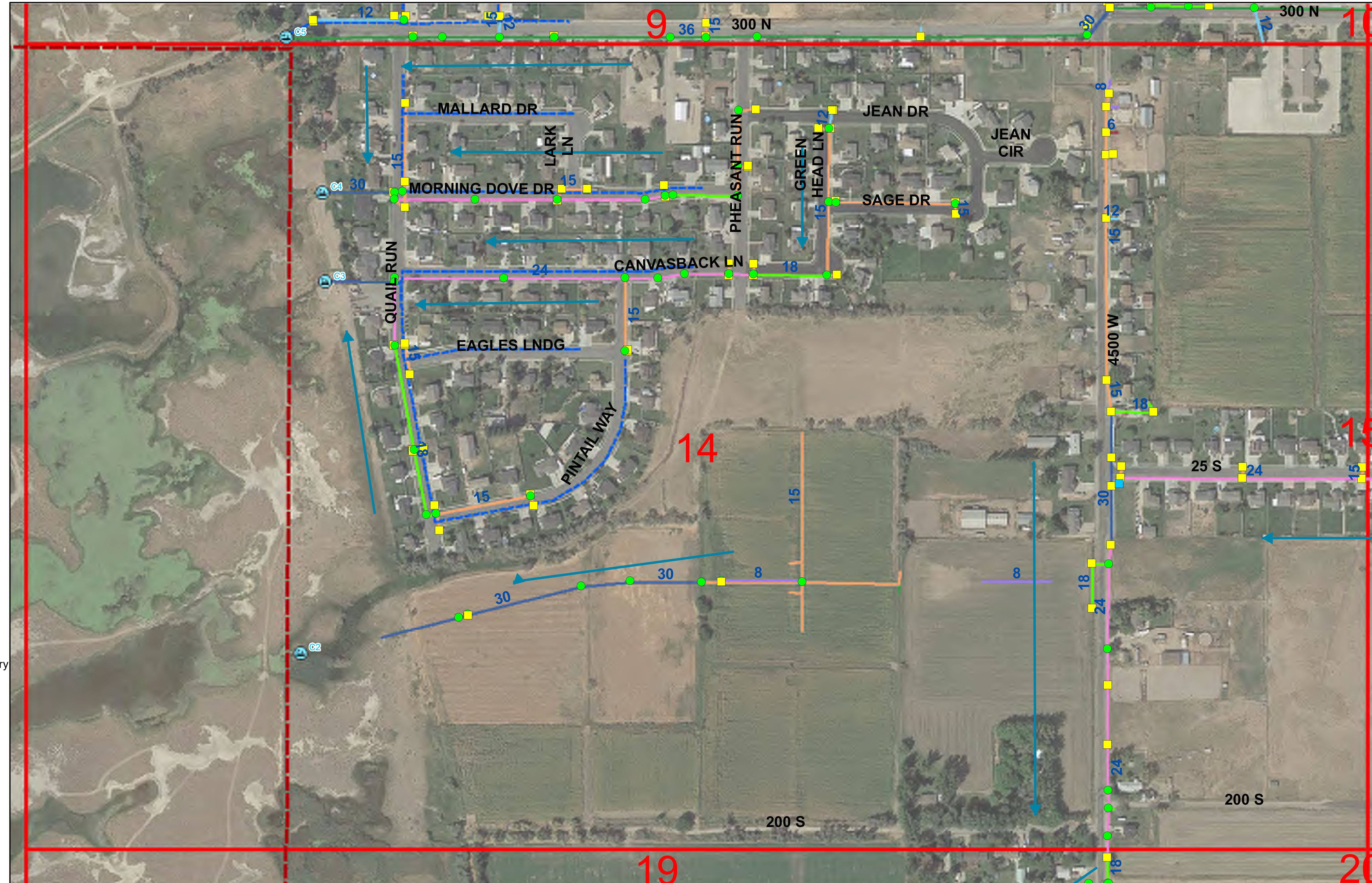
1 inch = 300 feet

Feet: 0, 150, 300, 600, 900, 1,200



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- SD 27in
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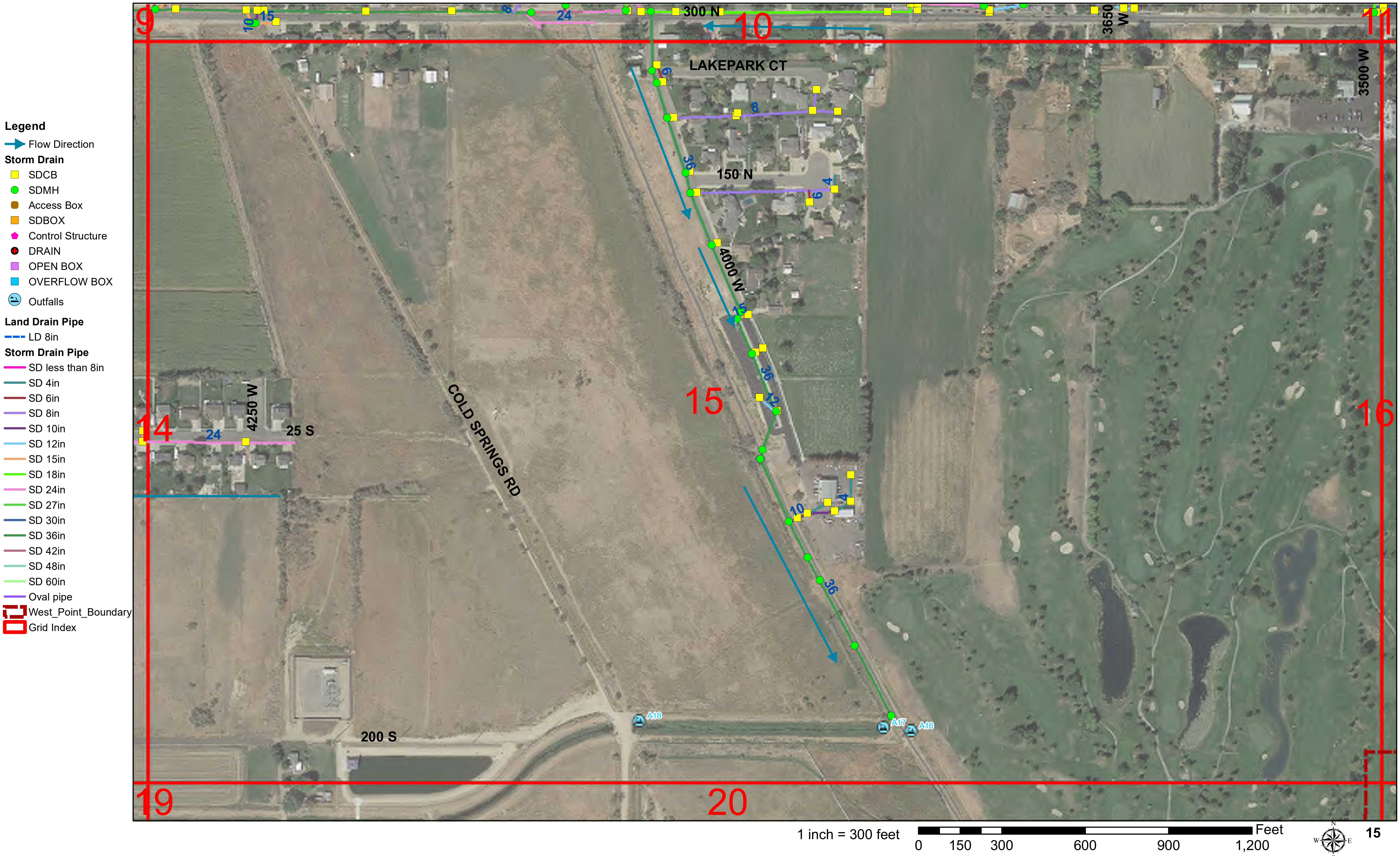
- SD 42in
- SD 48in
- SD 60in
- Oval pipe
- West_Point_Boundary
- Grid Index

1 inch = 300 feet

0 150 300 600 900 1,200 Feet


Legend
Flow Direction
Storm Drain
SDCB
SDMH
Access Box
SDBOX
Control Structure
DRAIN
OPEN BOX
OVERFLOW BOX
Outfalls
Land Drain Pipe
LD 8in
Storm Drain Pipe
SD less than 8in
SD 4in
SD 6in
SD 8in
SD 10in
SD 12in
SD 15in
SD 18in
SD 24in
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SD 30in
SD 36in
SD 42in
SD 48in
SD 60in
Oval pipe
West_Point_Boundary
Grid Index
300 N
LAKEPARK CT
150 N
4000 W
3650 W
3500 W
4250 W
25 S
COLD SPRINGS RD
200 S
9
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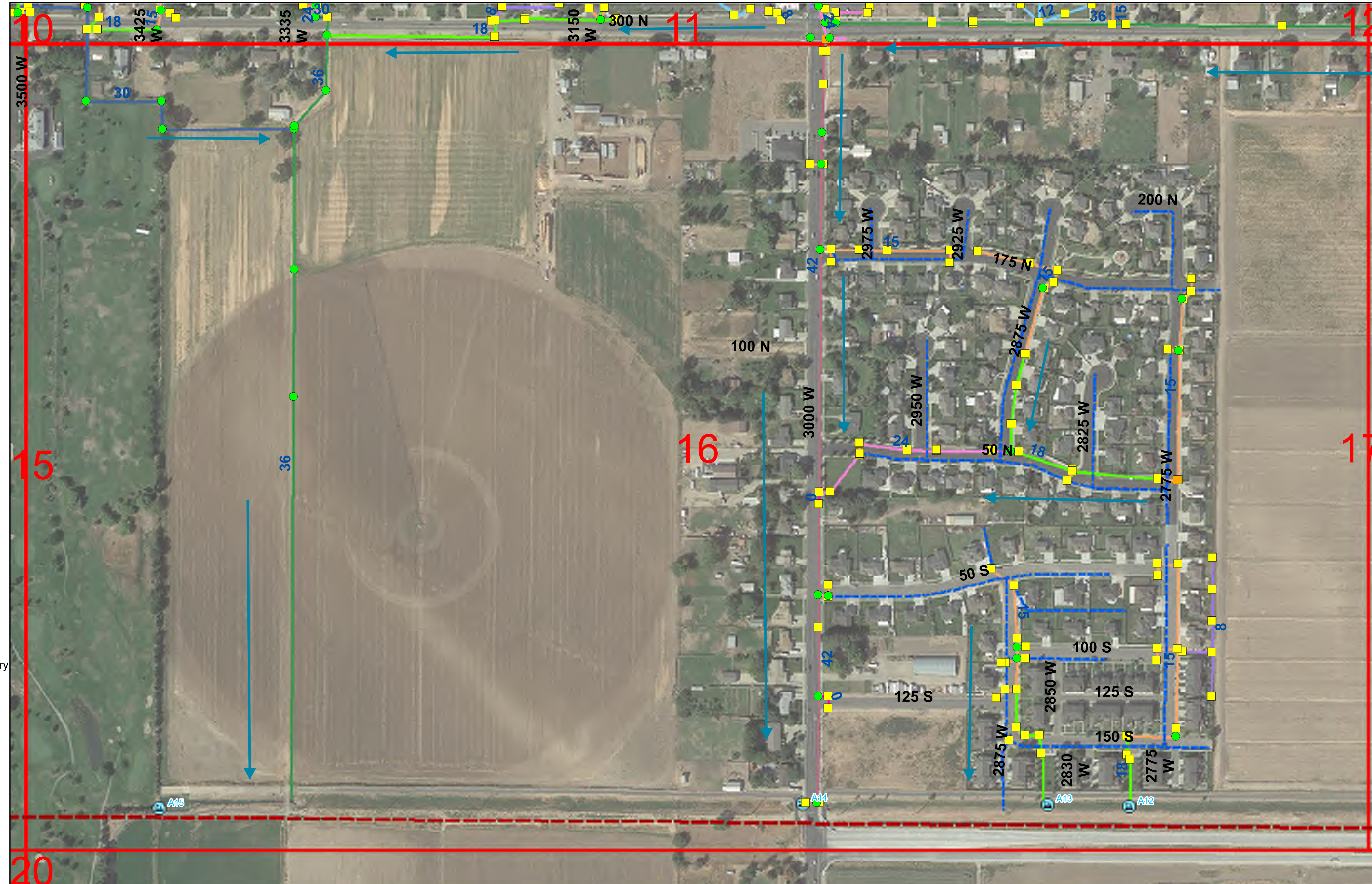
1 inch = 300 feet
0 150 300 600 900 1,200
Feet

West Point Storm Drain 2021



Legend

- Flow Direction

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West Point Storm Drain 2021

Legend

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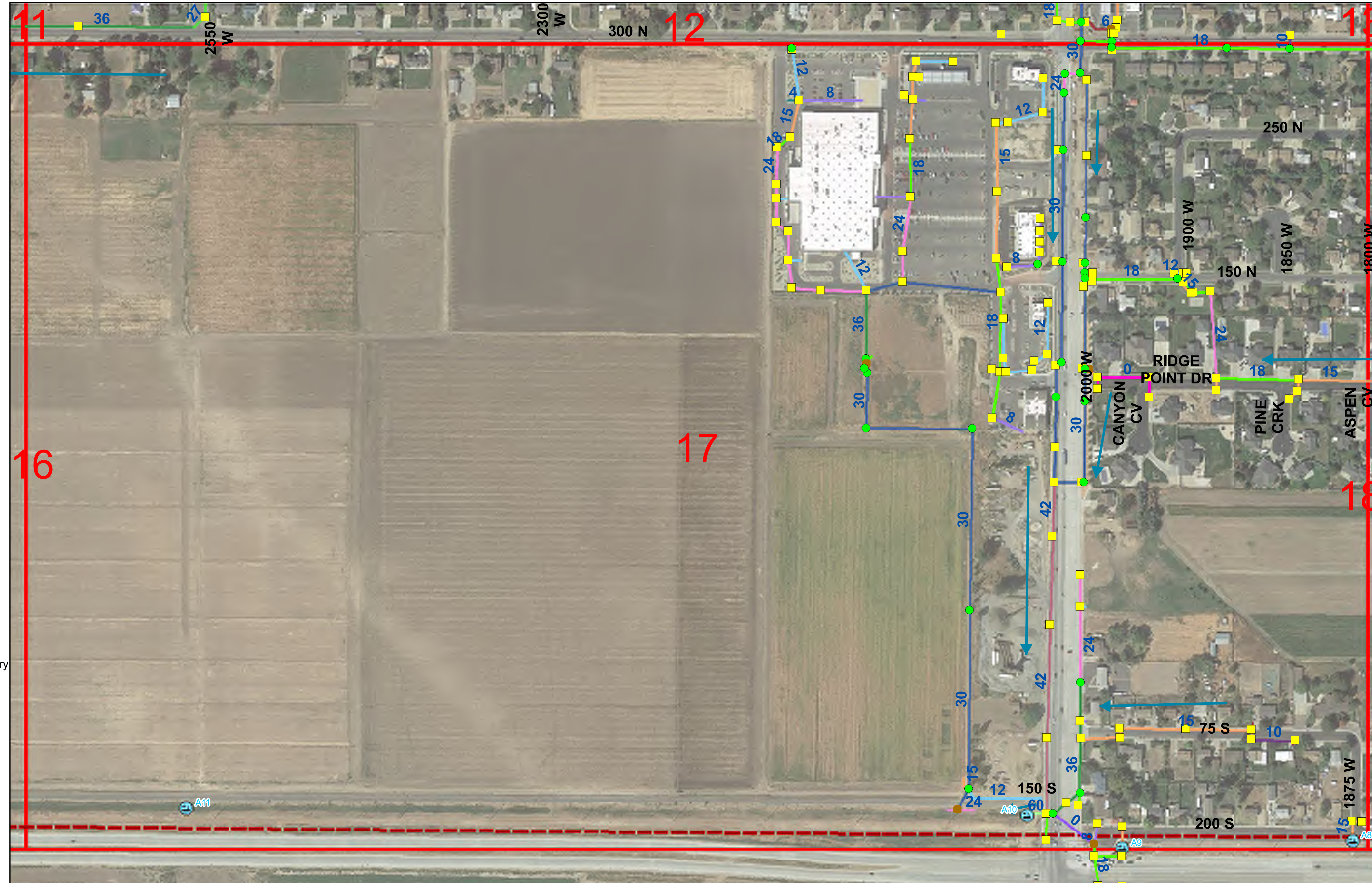

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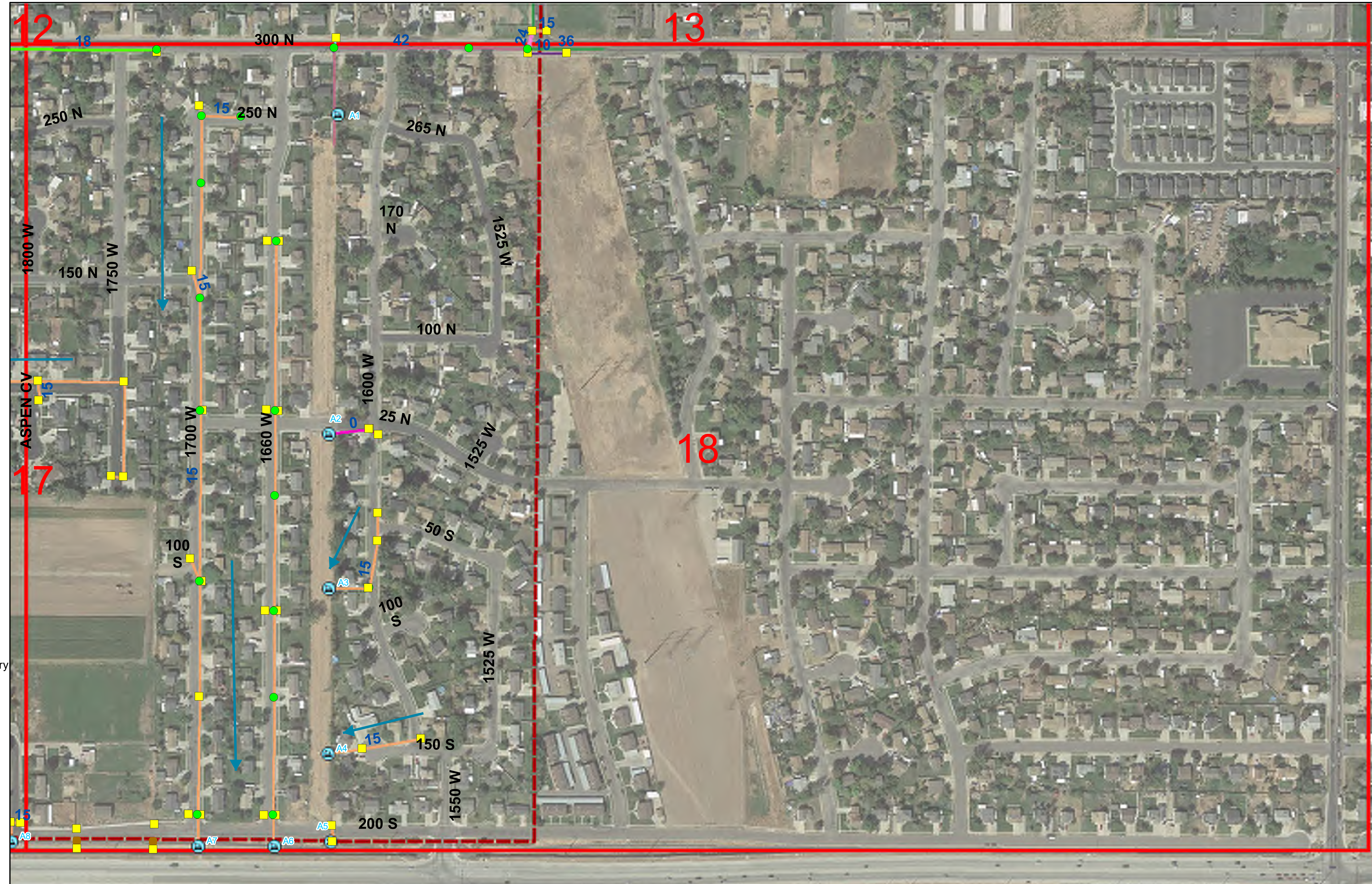

1 inch = 300 feet
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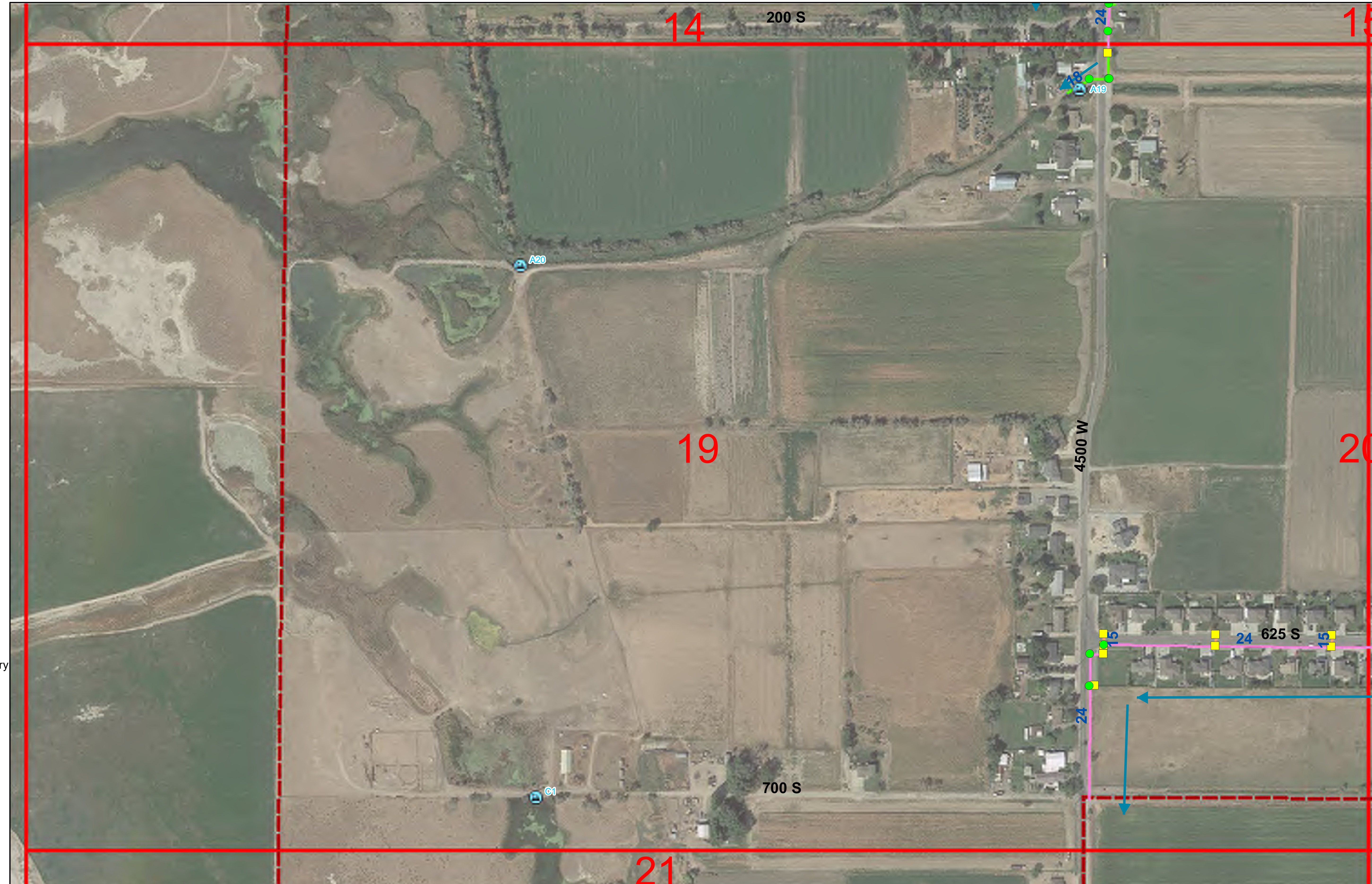
West Point Storm Drain 2021



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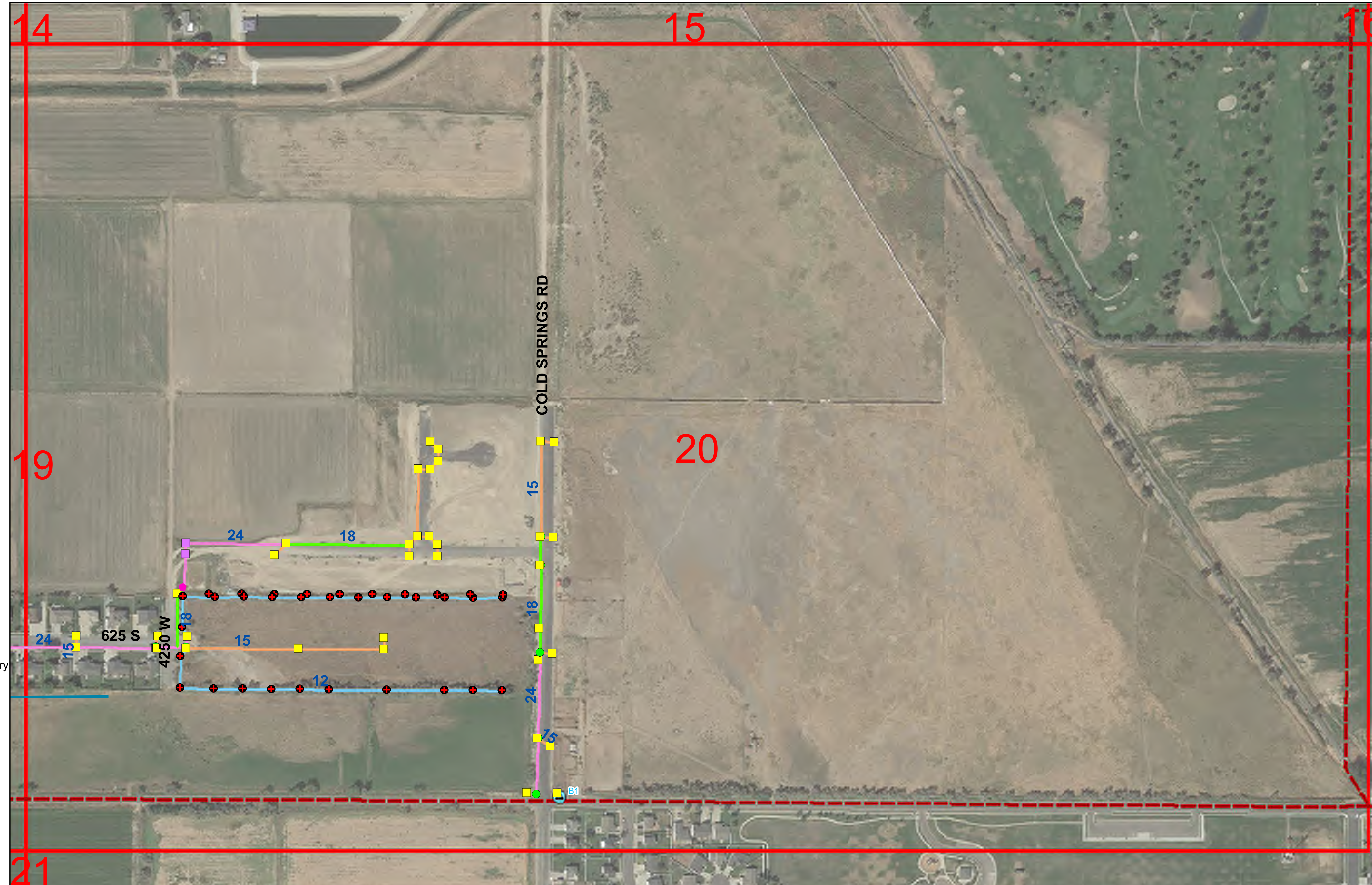

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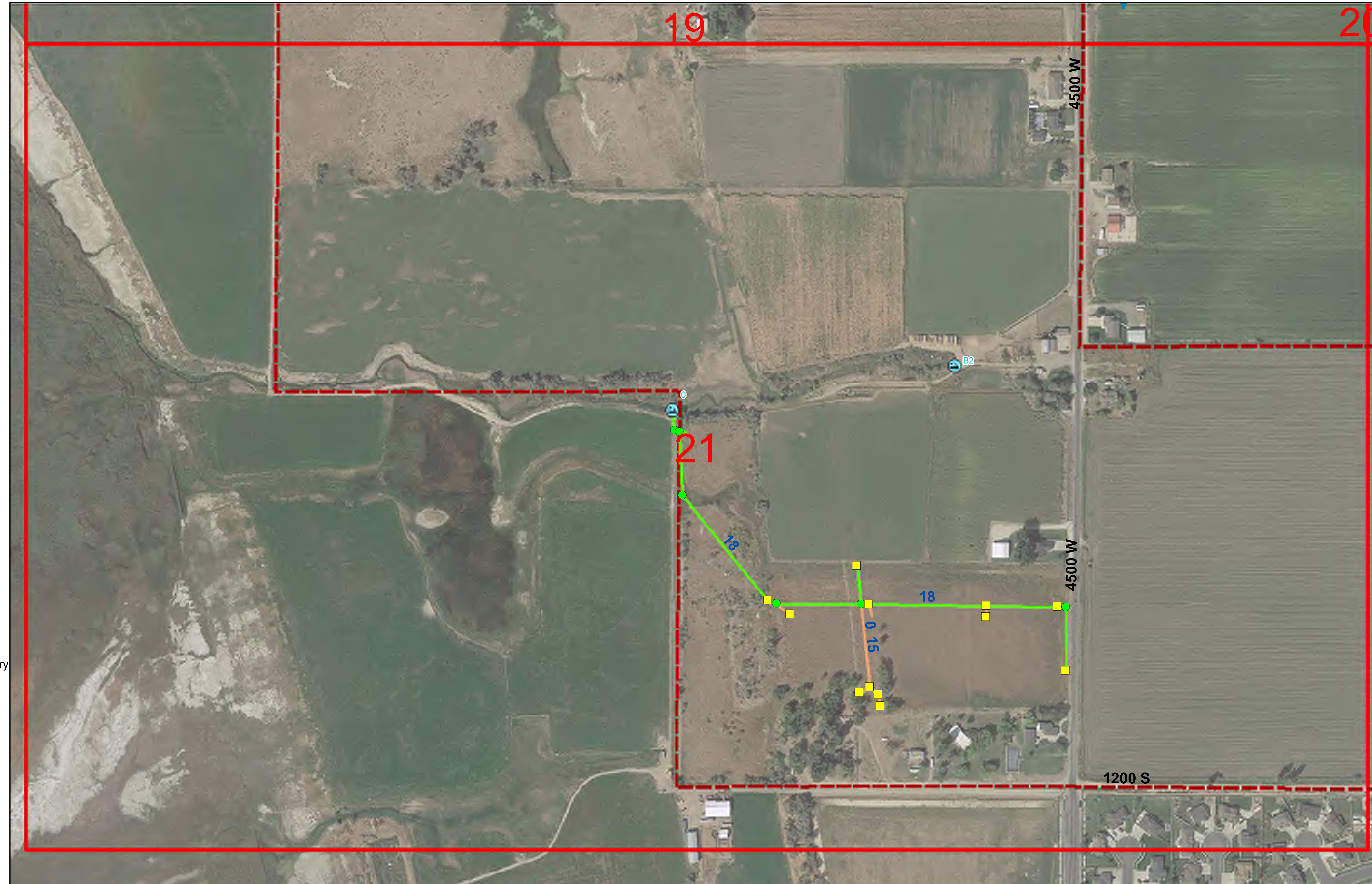

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Feet 0 150 300 600 900 1,200

West Point Soil Rating Hydrologic Soil Group Map

Legend **Soil Rating**

- A — Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.
- B — Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.
- C — Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.
- C/D — If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.
- D — Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.
- Water

ILLICIT DISCHARGE DETECTION AND ELIMINATION

Examples of Priority Areas

(Example Areas likely to have illicit discharges)

Area Descriptions	Comments
Areas with older infrastructure	
Industrial, commercial, or mixed use areas	
Areas with a history of past illicit discharges or illegal dumping or cross connections	
Areas with onsite sewage disposal system	
Areas Upstream of sensitive water bodies	
Receiving Waters	

ILLICIT DISCHARGE DETECTION AND ELIMINATION

Field Assessment Inspection Form

Inspector: ______________________________________ **Date / Time:** ___________________

Owner / Name: ____

Address: ____

Weather Conditions: Sunny ❒ Cloudy ❒ Raining ❒ Snowing ❒ Other__________

Site Description:

____
____
____
____
____
____
____
____
____
____
____
____
____

Description of Storm Water Discharge:

COLOR (Circle the ones that apply):

1. Identification of Color.

Clear Brown Green Rust Other________________

CLARITY (Circle the right one):

Totally Opague Slightly Translucent Translucent Nearly Transparent Transparent

ODOR (Circle the ones that apply):

None *Diesel* *Gasoline* *Petroleum* *Solvent* *Musty* *Sewage*

Rotten Egg *Sulfur* *No Odor* *Noxious* *Chlorine* *Other*

SOLIDS:

Floating Solids: *Yes / No*

Settled Solids: *Yes / No*

Suspended Solids: *Yes / No*

FOAM:

Foam: *Yes / No*

Inspector Observations / Comments

____

____

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____

Signature: ____

ILLICIT DISCHARGE DETECTION AND ELIMINATION

Field Assessment

(Inspect 20% of the Priority Areas within the 1st year, and 20% each year after)
(Use Field Assessment Inspection Form)

Owner	Area Description and Location	Date Assessed

ILLICIT DISCHARGE DETECTION AND ELIMINATION

IDDE Tracking Records

Date Identified	Location	Action Taken	Date Corrected	Follow-up Date

ILLICIT DISCHARGE DETECTION AND ELIMINATION

Incident Tracking and Illicit Discharge Inspection Report

Inspector: ____

Date permittee became aware of discharge:

____

____

Date investigation initiated:

____

____

Date discharge observed:

____

____

Location and description of the discharge:

____

____

____

____

____

____

____

Method of discovery:

____

____

____

____

____

____

____

Date and method of removal:

Enforcement Action:

Date and method of removal verification:

Inspector comments:

Signature: ____

ORDINANCE NO. 07-05-2005

AN ORDINANCE AMENDING THE REVISED ORDINANCES OF WEST POINT CITY 2000 BY ADDING TO TITLE 9 A NEW CHAPTER 3a ENTITLED "ILLICIT DISCHARGE AND EROSION CONTROL" AMENDING SECTIONS 19-1-5 AND 19-1-7 PROVIDING FOR AN EFFECTIVE DATE.

WHEREAS, new Federal and State regulations make it necessary and desirable to enact new provisions to govern illicit discharge and to control erosion.

NOW, THEREFORE, BE IT ORDAINED BY THE CITY COUNCIL OF WEST POINT CITY, STATE OF UTAH AS FOLLOWS:

The Revised Ordinances of West Point City 2000 are hereby amended by adding to Title 9 a new Chapter 3a to read as follows:

Section One: **Adoption of New Chapter 3a to Title 9**

"Chapter 3a
ILLICIT DISCHARGE AND EROSION CONTROL

9-3a-1 Purpose
9-3a-2 Applicability
9-3a-3 Responsibility of Administration
9-3a-4 Ultimate Responsibility
9-3a-5 Prohibitions
9-3a-6 Illicit Discharges
9-3a-7 Construction Sites
9-3a-8 Waiver
9-3a-9 Fee in Lieu of Storm Water management Practices
9-3a-10 Dedication of Land
9-3a-11 Review and Approval
9-3a-12 Storm Water Management Concept Plan
9-3a-13 Inspection
9-3a-14 As Built Plans
9-3a-15 Post Construction
9-3a-16 Basic Storm Water Management Design Criteria
9-3a-17 Enforcement
9-31-18 Violation and Penalties

9-3a-1 Purpose.

The purpose of this Chapter is to protect the health, safety, and welfare of citizens by improving the City's storm system, managing and controlling storm water runoff, protecting property, preventing polluted water from entering the City's storm water system and other receiving waters to the extent practicable as required by Federal and State law. The objectives of this Chapter are:

A. To regulate the contribution of pollutants to the municipal separate storm sewer system (the "System") by storm water discharges by any user.

B. To prohibit illicit connections and discharges to the System.

C. To guide, regulate, and control the design, construction, use, and maintenance of any development or other activity that results in the movement of earth on land within West Point City.

D. To minimize increases in non-point source pollution caused by storm water runoff from development which would otherwise degrade local water quality.

E. To reduce storm water runoff rates and volumes, soil erosion and non-point source pollution, wherever feasible, through storm water management controls and ensure that these management controls are properly maintained and reduce threats to public safety.

F. To establish legal authority to carry out all inspections, surveillance, and monitoring procedures to ensure compliance with this Chapter.

9-3a-2 **Applicability**.

This Chapter shall apply to all water entering the storm system generated on any developed and undeveloped lands, unless explicitly exempted by this Chapter.

9-3a-3 **Responsibility of Administration**.

The City Engineer shall administer, implement, and enforce the provisions of this Chapter. Any powers granted or duties imposed upon the authorized enforcement agency may be delegated in writing by the City Engineer.

<u>9-3a-4</u> **<u>Ultimate Responsibility</u>**.

The standards set forth herein and promulgated pursuant to this Chapter are minimum standards. This Chapter does not imply that compliance by any person will ensure that there will be no contamination, pollution, and/or unauthorized discharge of pollutants.

<u>9-3a-5</u> **<u>Prohibitions</u>**.

It is unlawful for any person to:

A. Track mud or sediment onto public streets by construction of delivery vehicles. Provisions shall be made at all construction sites to either clean the streets or clean the vehicles or both before vehicles leave the site.

B. To wash out concrete trucks at all sites other than pre-approved designated areas. Dumping of excess concrete shall not be allowed.

C. To stockpile construction or yard improvement materials or debris in the street or in the gutter unless being stored on a pallet or in a self-contained storage unit that has been pre-approved by the City Engineer. This includes, but is not limited to, ramps being constructed for temporary access across the existing curb and gutter; stockpiling of topsoil or other fill material; stockpiling of sand, gravel, landscape rock, bark, mulch, or any other material that may be considered a source of pollution in the storm water system.

<u>9-3a-6</u> **<u>Illicit Discharges</u>**.

No person shall discharge or cause to be discharged into the City's storm system or watercourses any materials, including but not limited to pollutants or waters containing any pollutants that cause or contribute to a violation of applicable water quality standards.

A. The commencement, conduct, or continuance of any illegal discharge to the storm system is prohibited except as described as follows:

1. Water line flushing or other potable water sources

2. Landscape and agricultural irrigation or lawn watering

3. Diverted stream flows

4. Rising ground water

5. Ground water infiltration to storm drains

6. Uncontaminated pumped ground water

7. Foundation or footing drains (not including active ground water] de-watering systems)

8. Crawl space pumps

9. Air conditioning condensation

10. Springs

11. Non-commercial washing of vehicles

12. Natural riparian habitat or wet-land flows

13. Swimming pools (if de-chlorinated, typically less than one part per million chlorine)

14. Fire fighting activities, and any other water source not containing pollutants

15. Discharges specified in writing by the City as being necessary to protect the public's health, safety, and welfare.

B. Dye testing is an allowable discharge, but requires a verbal notification to the City prior to the time of the test.

C. The prohibition shall not apply to any non-storm water discharge permitted under an UPDES permit, waiver, or water discharge order issued to the discharger and administered under the authority of the Federal Environmental Protection Agency, provided that the discharger is in full compliance with all requirements of the permit, waiver, or order and other applicable laws and regulations, and provided that written approval has been granted for any discharge to the storm drain system.

D. This prohibition expressly includes, without limitation, illicit connections made in the past, regardless of whether the connection was permissible under law or practices applicable or prevailing at the time of the connection. This prohibition also expressly includes, without limitation, connections of sanitary sewer lines to the System.

9-3a-7 **Construction Sites**.

Permits for Construction Sites one Acre or Larger

A. No person shall be granted a site development permit for land-disturbing activity that would require the uncovering of one acre or more without the approval by the City Engineer of an Erosion and Sediment Control Plan.

B. Individuals not exempted from this requirement, as provided in Subsection C below, shall include as part of the project's cost estimate and escrow, bond, or otherwise secure funds necessary to cover all costs associated with compliance, as determined and approved by the City Engineer.

C. The following activities are exempted from this requirement:

1. Any emergency activity that is immediately necessary for the protection of life, property, or natural resources.

2. Existing nursery and agricultural operations conducted as a permitted main or accessory use.

9-3a-8 **Waiver**.

Every permit applicant whose project falls within the parameters of this Chapter shall provide for storm water management as required by this Chapter unless a written request is filed to waive this requirement. Requests to waive the storm water management plan requirements shall be submitted to the City Engineer.

A. The minimum requirements for storm water 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 Chapter's objectives.

2. Alternative minimum requirements for on-site management of storm water discharges have been established in a storm water management plan that has been approved by the City Engineer.

3. Provisions are made to manage storm water by an off-site facility. The off-site facility is required to be in place, to be designed, and adequately sized to provide a level of storm water control that is equal to or greater than that which would be afforded by on-site practices and there is a legally obligated entity responsible for long-term operation and maintenance of the storm water practice.

4. The City Engineer finds that meeting the minimum on-site management requirements is impractical and/or infeasible due to the natural or existing physical characteristics of a site.

5. Non-structural practices will be used on the site that reduce:

a. The generation of storm water from the site,

b. The size and cost of storm water storage, and

c. The pollutants generated at the site.

B. In instances where one of the conditions put forth in Subsection A above applies, the City Engineer may grant a waiver from strict compliance with these storm water management provisions, as long as acceptable mitigation measures are provided. Notwithstanding this provision, the applicant must demonstrate to the satisfaction of the City Engineer that the variance will not result in any of the following impacts to downstream waterways:

1. Deterioration of existing culverts, bridges, dams, and other structures;

2. Degradation of biological functions or habitat;

3. Accelerated stream bank or streambed erosion or siltation;

4. Increased threat of flood damage to public health, life, and/or property.

C. Where compliance with minimum requirements for storm water management is waived, the applicant will satisfy the minimum requirements by meeting one of the mitigation measures selected by the City Engineer. Mitigation measures may include, but are not limited to the following:

1. The purchase and donation of privately owned lands, or the grant of an easement to be dedicated for preservation and/or revegetation. These lands should be located adjacent to the stream corridor in order to provide permanent buffer areas and protect water quality and aquatic habitat;

2. The creation of a storm water management facility or other drainage improvements on previously developed properties, public or private, that currently lack storm water management facilities designed and constructed in accordance with the purposes and standards of this Chapter.

3. Monetary contributions (Fee-in-Lieu) to fund storm water management activities.

9-3a-9 Fee in Lieu of Storm Water Management Practices

Where the City Engineer waives all or part of the minimum storm water management requirements, or where the waiver is based on the provision of adequate storm water facilities provided downstream of the proposed development, the applicant may be required to pay a fee in an amount as determined by the City Engineer. This fee shall be established as part of the City Fee Schedule and shall be based on the cubic feet of storage required for storm water management relative to the development in question. All fees shall be paid by the developer to the City prior to the issuance of any building permit.

9-3a-10 Dedication of Land.

In lieu of a monetary contribution, an applicant may obtain a waiver by entering into an agreement with the City for the granting of an easement or the dedication of land by the applicant. This land shall be used for the construction of off-site storm water management facilities. The agreement shall be entered into by the applicant and the City prior to the recording of plats or issuance of building permits.

9-3a-11 Review and Approval.

A. The City Engineer will review each application to determine its conformance with the provisions of this Chapter. Within 30 days after receiving an application, the City Engineer shall in writing:

1. Approve the permit application;

2. Approve the permit application subject to such reasonable conditions as may be necessary to secure substantially the objectives of this regulation and issue the permit subject to these conditions; or

3. Disapprove the permit application, indicating the reason(s) and procedure for submitting a revised application and/or submission.

9-3a-12 Storm Water Management Concept Plan.

A. A storm water management concept plan shall be required with all permit applications and will include sufficient information 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. This plan shall be prepared in accordance with a checklist provided by the City Engineer.

B. For development or redevelopment occurring on a previously developed site, an applicant shall be required to include within the plan measures for controlling existing storm water run-off discharges from the site.

9-3a-13 Inspection.

Field inspection shall be conducted by the City Engineer or other designated agent of the City.

9-3a-14 As Built Plans.

All applicants are required to submit actual "as built" plans for any storm water management practices located on-site after final construction is complete. The plan must show the final design specifications for all storm water management facilities and must be certified by a professional engineer. A final inspection by the City Engineer or other City agent is required before the release of any performance securities.

9-3a-15 **Post Construction**.

Unless exempted or granted a waiver, the following performance criteria shall be addressed at all sites:

A. All site designs shall establish storm water management practices to control the peak flow rates of storm water discharge associated with specified design storms and reduce the generation of storm water. 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 degree feasible.

B. All storm water runoff generated from new development shall not discharge untreated storm water directly into a jurisdictional wetland or local water body without adequate treatment. Where such discharges are proposed, the impact of the proposal on wetland functional values shall be assessed using a method acceptable to the City Engineer. In no case shall the impact on functional values be any less than allowed by the Army Corp of Engineers (ACE) or the Department of Environmental Quality (DEQ) responsible for natural resources.

C. Storm water discharges to critical areas with sensitive resources may be subject to additional performance criteria or may need to utilize or restrict certain storm water management practices.

D. Storm water discharges from land uses or activities with higher potential pollutant loadings, known as "hotspots", may require the use of specific structural BMPs and pollution prevention practices.

E. Prior to design, applicants are required to consult with the City Engineer to determine if they are subject to additional storm water design requirements.

9-3a-16 **Basic Storm Water Management Design Criteria**.

Site Design Feasibility

Storm water management practices for a site shall be chosen based on the physical conditions of the site. Among the factors that should be considered are the following:

1. Topography
2. Maximum Drainage Area
3. Depth to Water Table
4. Soils
5. Slopes
6. Terrain
7. Head
8. Location in relation to environmentally sensitive features or ultra-urban areas.

Conveyance Issues

All storm water management practices shall be designed to convey storm water to allow for the maximum removal of pollutants and reduction flow velocities. This shall include, but not be limited to the following:

1. Maximizing of flow paths from inflow points to outflow points
2. Protection of inlet and outfall structures
3. Elimination of erosive flow velocities
4. Providing of under-drain systems, where applicable

Landscaping Plans Required

All storm water management practices must have a landscaping plan detailing both the vegetation to be in the practice and how and who will manage and maintain this vegetation.

Maintenance Agreements

All storm water treatment practices on privately owned and operated facilities shall have an enforceable operation and maintenance agreement to ensure the system functions as designed.

A. This agreement shall include any and all maintenance easements required to access and inspect the storm water treatment practices and to perform routine maintenance as necessary to ensure proper functioning of the storm water treatment practice. The agreement shall include provisions allowing for access and inspections on a reasonable basis. In addition, a legally binding covenant specifying the parties responsible for the proper maintenance of all storm water treatment practices shall be secured prior to issuance of any permits for land disturbance activities.

B. If a responsible party fails or refuses to meet the requirements of the maintenance covenant, the City Engineer, after reasonable notice, may correct a violation of the design standards or maintenance needs by performing all necessary work to place the facility in proper working condition. In the event that the storm water management facility becomes a danger to public health and safety, the City Engineer shall notify the party responsible for maintenance of the storm water management facility in writing. Upon receipt of that notice, the responsible person shall have 30 days to effect maintenance and repair of the facility in an approved manner. After proper notice, the City Engineer may assess the owner(s) of the facility for the cost of repair work and any penalties; and the cost of the work shall be a lien on the property, or prorated against the beneficial users of the property, and may be placed on the tax bill and collected as ordinary taxes by the County.

9-3a-17 **Enforcement**.

Stop-Work Order – Revocation of Permit

In the event that any person holding a site development permit pursuant to this Chapter violates the terms of the permit or implants site development in such a manner as to materially and adversely affect the health, safety, and welfare of person residing or working in the neighborhood or development site, so as to be materially detrimental to the public welfare or injurious to property or improvements in the neighborhood, the City Engineer may suspend or revoke the site development permit.

9-3a-18 **Violation and Penalties**.

Whenever the City Engineer finds that a person has violated a prohibition or failed to meet a requirement of this Chapter, the authorized enforcement agency may order compliance by written notice or violation to the responsible person. Such notice may require, without limitation:

1. The performance of monitoring, analyses, and reporting;
2. The elimination of illicit connections or discharges;
3. The cessation of violating discharges, practices, or operations;
4. The abatement or remediation of storm water pollution or contamination hazards and the restoration of any affected property;
5. Payment of a fine to cover administrative and/or remediative costs;
6. The implementation of source control or treatment BMPs.

Any person violating any of the provisions of this Chapter shall be deemed guilty of a misdemeanor and each day during which any violation of any of the provisions of this ordinance is committed, continued, or permitted, shall constitute a separate offense".

Section Two: **Amendment of Section 19-1-5**

Section 19-1-5 of the Revised Ordinances of West Point City 2000 is amended by adding Subsection (20) to read as follows:

> "(20) A storm water pollution prevention plan that complies with the requirements of Title 9, Chapter 3a of the Revised Ordinances of West Point City 2000."

Section Three: **Amendment of Section 19-1-7**

Section 19-1-7 of the Revised Ordinances of West Point City 2000 is amended by adding Subsection (10) to read as follows:

> "(10) A storm water pollution protection plan that complies with the requirements of Title 9, Chapter 3a of the Revised Ordinances of West Point City 2000."

Section Four: **Severability**

The provisions of this Chapter are hereby declared to be severable. If any provision, clause, sentence, or paragraph of this Chapter or the application thereof to any person, establishment, or circumstances shall be held invalid, such invalidity shall not affect the other provisions or application of this Chapter.

Section Five: **Effective Date**

This Ordinance shall become effective upon the date of publication of a Summary thereof, one time only, in the Standard Examiner.

PASSED AND ADOPTED this ____ day of July, 2005.

WEST POINT CITY, a Municipal Corporation

By: ___________________________________

JOHN PETROFF, JR.

Mayor

ATTEST:

JULIE GENTRY,

City Recorder

ILLICIT DISCHARGE DETECTION AND ELIMINATION

Priority Area Locations

(list of priority locations within the City – identify highest to lowest priority)

Owner	Area Description and Location	Comments

ILLICIT DISCHARGE DETECTION AND ELIMINATION

Public Reporting Records

Date / Time of report:

Incident Location:

Incident Description:

Follow-up actions taken:

APPENDIX 6

CONSTRUCTION SITE STORM WATER RUNOFF CONTROL

CONSTRUCTION SITE STORM WATER RUNOFF CONTROL

Priority Construction Sites

Date	Location	SWPPP Approved	Date Completed

Staff Training Records

(Keep log of names and positions of attendees)

Date	Course Description

APPENDIX 7

LONG-TERM STORM WATER MANAGEMENT IN NEW DEVELOPMENT AND REDEVELOPMENT

LONG-TERM STORM WATER MANAGEMENT IN NEW DEVELOPMENT AND REDEVELOPMENT

Post Construction Control Inspection Form

Inspector: ______________________________________ **Date / Time:** _____________

Owner / Name: ____
Address: ____

Description of Condition:

(vegetation and soils, inlet / outlet structures, sediment / debris accumulation etc)

____
____
____
____
____

Maintenance Issues or Violations:

____
____
____
____
____

Correction Deadlines and Scheduled Reinspection Dates:

____
____
____
____
____

Signature: ____

LONG-TERM STORM WATER MANAGEMENT IN NEW DEVELOPMENT AND REDEVELOPMENT

Post Construction Control Inventory

Name	Owner / Contact Info	Location	Start Up Date	Stop Date

Description of Control	Maintenance Requirement

Name	Owner / Contact Info	Location	Start Up Date	Stop Date

Description of Control	Maintenance Requirement

LONG-TERM STORM WATER MANAGEMENT IN NEW DEVELOPMENT AND REDEVELOPMENT

Post Construction Control Standards

LONG-TERM STORM WATER MANAGEMENT IN NEW DEVELOPMENT AND REDEVELOPMENT

Staff Training Records

(Keep log of names and positions of attendees)

Date	Course Description

Reset Form

APPENDIX 8

POLLUTION PREVENTION AND GOOD HOUSEKEEPING FOR MUNICIPAL OPERATIONS

COY BLAKE PARK FLOOR DRAINS

NEW BATHROOM BY PLAYGROUND - MENS BATHROOM | DRAIN
WOMANS BATHROOM | DRAIN
PLUMBING ROOM | DRAIN

BATHROOM BY LARGE PAVILLION - MENS BATHROOM | DRAIN
WOMANS BATHROON | DRAIN
PLUMBING ROOM | DRAIN
STORAGE ROOM | DRAIN

EAST PARK FLOOR DRAINS

MENS BATHROOM | 1 DRAIN
WOMANS BATHROOM | 1 DRAIN

BINGHAM PARK FLOOR DRAINS

MENS BATHROOM - 1 DRAIN
WOMANS BATHROOM - 1 DRAIN

PUBLIC WORKS SHOP

BAY 1, 2, & 3 ALL HAVE FLOOR DRAIN INSIDE SHOP.

BATHROOM 1 FLOOR DRAIN & 1 SHOWER FLOOR DRAIN.

RESERVOIR - | DRAIN

WELL (1750 W. 300 N.) | DRAIN

WELL (2250 W. 300 N.) | DRAIN

CITY HALL FLOOR DRAIN LIST

- MAINTENANCE ROOM - 1 FLOOR DRAIN BY WATER HEATER
  & 1 DRAIN FOR FILLING UP MOP BUCKET.
- MENS BATHROOM - 1 FLOOR DRAIN IN CENTER OF BATHROOM
- WOMANS BATHROOM - 1 FLOOR DRAIN IN CENTER OF BATHROOM
- SHERIFFS BATHROOM - 1 FLOOR DRAIN IN CENTER OF BATHROOM
  & 1 FLOOR DRAIN FOR THE SHOWER.

POLLUTION PREVENTION AND GOOD HOUSEKEEPING FOR MUNICIPAL OPERATIONS

City Facilities Inventory and Assessment

Name	Owner / Contact Info	Location
High Priority Facility *(Urban pollutants stored at the site, improperly stored materials, and proximity to water bodies)*		YES / NO
Comments		

Name	Owner / Contact Info	Location
High Priority Facility *(Urban pollutants stored at the site, improperly stored materials, and proximity to water bodies)*		YES / NO
Comments		

Name	Owner / Contact Info	Location
High Priority Facility *(Urban pollutants stored at the site, improperly stored materials, and proximity to water bodies)*		YES / NO

Comments	

POLLUTION PREVENTION AND GOOD HOUSEKEEPING FOR MUNICIPAL OPERATIONS

Floor Drain Inventory

(Inventory map shall be created and maintained along with this inventory)

Name	Location	Non Storm Water Discharge (Y / N)

DRAINAGE AND SITE MAP

DRAINAGE AREA - 1.74 ACRES

DRAINAGE OUTFALL - SEE MAP. OUTFALL IS TO THE WEST.

STRUCTURAL AND NON-STRUCTURAL CONTROLS - CATCH BASIN CLEANING; CURBING; DRIP PANS; MATERIAL STORAGE; SPILL CLEANUP; VEHICLE AND EQUIPMENT CLEANING, FUELING, MAINTENANCE AND REPAIR; EMPLOYEE TRAINING; HOUSE KEEPING PRACTICE.

SIGNIFICANT MATERIALS EXPOSED TO PRECIPITATION - EXPOSED MATERIALS AT THE SITE CONSIST OF VEHICLE AND EQUIPMENT STORED IN THE OPEN STORAGE AREA. DRIP PANS ARE USED AND CATCH BASIN / SEDIMENT TRAP CLEANING IS PERFORMED TO MINIMIZE CONTAMINATION.

0' 30' 60' 120'

Scale in Feet
1" = 60'

Date: 6-28-16
Scale: 1" = 60'
Designed: KAN
Drafted: KAN
Checked: RC

Revisions	
Date	Description

CITY SHOP - SWPPP
MAINTENANCE YARD
HIGH PRIORITY SITE
WEST POINT, DAVIS, UTAH

GARDNER ENGINEERING
CIVIL - LAND PLANNING
MUNICIPAL - LAND SURVEYING
5150 SOUTH 375 EAST OGDEN, UT
OFFICE: 801-476-0202 FAX: 801-476-0066

SW
1

POLLUTION PREVENTION AND GOOD HOUSEKEEPING FOR MUNICIPAL OPERATIONS

High Priority Weekly Visual Inspection Form

Inspector: ____ **Date / Time:** ______________

Facility Name: ____

Address: ____

Description of Conditions:

____

____

____

Evidence of Spills:

____

____

____

Clean-up Actions Required:

____

____

____

Follow-up Date and Comments (if required):

____

____

____

Signature: ____

POLLUTION PREVENTION AND GOOD HOUSEKEEPING FOR MUNICIPAL OPERATIONS

Quarterly Comprehensive Inspection Form

(All high priority facilities and storm water controls)

Inspector: ______________________________________ **Date / Time:** _____________

Facility Name: ____

Address: ____

Areas to be Inspected:

1. Vehicle and Equipment Storage Area
2. Vehicle and Equipment Maintenance Area
3. Vehicle and Equipment Cleaning Area
4. Fueling Area
5. Material Storage Area
6. Other (describe)

Area:_______________________________________

List Deficiencies Observed: ____

____

____

____

____

Method Used to Correct Deficiencies: ____

____

____

____

____

Date of Return Inspection: _____________________

Area:_______________________________________

List Deficiencies Observed: ____

____

____

____

____

Method Used to Correct Deficiencies: ____

____

Date of Return Inspection: ____________________

Area:____

List Deficiencies Observed:

Method Used to Correct Deficiencies:

Date of Return Inspection: ____________________

Area:____

List Deficiencies Observed:

Method Used to Correct Deficiencies:

Date of Return Inspection: ____________________

Area:____

List Deficiencies Observed:

Method Used to Correct Deficiencies:

Date of Return Inspection: ____________________

Area:____

List Deficiencies Observed:

Method Used to Correct Deficiencies:

Date of Return Inspection: ____________________

Area:____

List Deficiencies Observed:

Method Used to Correct Deficiencies:

Date of Return Inspection: ____________________

POLLUTION PREVENTION AND GOOD HOUSEKEEPING FOR MUNICIPAL OPERATIONS

Quarterly Visual Observation of Storm Water Discharges Inspection Form

(All high priority facilities)

Inspector: ______________________________________ **Date / Time:** ___________________

Owner / Name: ____

Address: ____

Weather Conditions: Sunny ❒ Cloudy ❒ Raining ❒ Snowing ❒ Other__________

Site Description:

____

____

____

____

____

Description of Storm Water Discharge:

COLOR (Circle the ones that apply):

1. *Identification of Color.*

Clear Brown Green Rust Other_________________

CLARITY (Circle the right one):

Totally Opague Slightly Translucent Translucent Nearly Transparent Transparent

ODOR (Circle the ones that apply):

None *Diesel* *Gasoline* *Petroleum* *Solvent* *Musty* *Sewage*

Rotten Egg *Sulfur* *No Odor* *Noxious* *Chlorine* *Other*

SOLIDS:

Floating Solids: *Yes / No*

Settled Solids: *Yes / No*

Suspended Solids: *Yes / No*

FOAM:

Foam: *Yes / No*

Inspector Observations / Comments

(deficiencies identified and corrected actions taken)

Signature: ____

POLLUTION PREVENTION AND GOOD HOUSEKEEPING FOR MUNICIPAL OPERATIONS

Staff Training Records

(Keep log of names and positions of attendees)

Date	Course Description

APPENDIX 9

SMALL MS4 GENERAL UPDES PERMIT

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STATE OF UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF WATER QUALITY

Authorization to Discharge Under the
Utah Pollutant Discharge Elimination System (UPDES)

General Permit for Discharges from Small Municipal Separate
Storm Sewer Systems (MS4s)

UPDES PERMIT NUMBER UTR090000

This Permit is issued in compliance with the provisions of the Utah Water Quality Act, Utah Code Title 19, Chapter 5, (the "Act") and the Federal Water Pollution Control Act (33 U.S.C. §§ 1251 et. seq., as amended to date), and the rules and Regulations made pursuant to those statutes.

This Permit authorizes storm water discharges to waters of the state of Utah resulting from a Small Municipal Separate Storm Sewer System (Small MS4) as provided in Part 1.0 of this Permit. This authorization is conditioned upon an operator of a Small MS4 meeting the eligibility requirements in Part 1.2 of this Permit prior to filing a Notice of Intent ("NOI") to discharge under this General Permit. An operator of a Small MS4 is not covered by this General Permit if the operator submits an NOI but has not met these conditions.

This authorization is subject to the authority of the *Director* of the Division of Water Quality to reopen this Permit (see Part 6.22 of Permit), or to require a discharger to obtain an individual Permit (see Part 6.15 of this Permit). The issuance of a discharge Permit authorization under this General Permit does not relieve Permittees of other duties and responsibilities under the Act or rules made under that Act. Significant terms used in this Permit are defined in Part 7.0 of this Permit.

This Permit shall become effective May 12th, 2021.

This Permit and the authorization to discharge shall expire at midnight, May 11th, 2026, except as described in Part 6.3 of this Permit.

Signed this 11th of May, 2021.

John K. Mackey
John Mackey (May 12, 2021 06:59 MDT)

John K. Mackey, P.E.
Acting Director

DWQ-2021-008110

UPDES GENERAL PERMIT FOR DISCHARGES FROM
SMALL MUNICIPAL SEPARATE STORM SEWER SYSTEMS (MS4s)

TABLE OF CONTENTS

1.0 Coverage Under this Permit

1.1. Authority to Discharge

This General Permit authorizes the discharge, to waters of the state of Utah, of storm water from a Small MS4 as defined in R317-8-1.6(15) and Part 7.0. of this Permit. This authorization is subject to all of the terms and conditions of this Permit. This General Permit does not authorize discharges prohibited under Part 1.4. of this Permit.

1.2. Permit Area and Eligibility

1.2.1. This Permit covers all areas of the State of Utah.

1.2.1.1. No operator of a Small MS4 as described in 40 CFR 122.32 may discharge from that system without authorization from the *Director*. (See Utah Administrative Code Section R317-8-11.3(1)(h), which sets forth the Permitting requirement, and R317-8-1.10(12), which incorporates 40 CFR 122.32 by reference.) Authorization to discharge under the terms and conditions of this Permit is granted if:

1.2.1.1.1 It applies to an operator of a Small MS4 within the State of Utah.

1.2.1.1.2 The operator is not a "large" or "medium" MS4 as defined in 40 CFR 122.26(b)(4) or (7);

1.2.1.1.3 The operator submits a Notice of Intent (NOI) in accordance with Part 2.0 of this Permit;

1.2.1.1.4 The MS4 is located fully or partially within an urbanized area as determined by the latest Decennial Census by the Bureau of Census;

1.2.1.1.5 The operator is ordered by the *Director* to obtain coverage under this Permit, as provided in the UPDES rules, R317-8.

1.2.2. The following are types of authorized discharges:

1.2.2.1. *Storm water discharges.* This Permit authorizes storm water discharges to waters of the state from the Small MS4s identified in 1.2.1., except as excluded in Part 1.4.

1.2.2.2. *Non-storm water discharges.* The following non-storm water discharges do not need to be addressed unless the Permittee or the *Director* identifies these discharges as significant sources of pollutants to waters of the state or as causing or contributing to a violation of water quality standards:

- Water line flushing;
- Landscape irrigation;
- Diverted stream flows;
- Rising ground waters;
- Uncontaminated ground water infiltration;
- Uncontaminated pumped ground water;

- Discharges from potable water sources;
- Foundation drains;
- Air conditioning condensate;
- Irrigation water;
- Springs;
- Water from crawl space pumps;
- Footing drains;
- Lawn watering runoff;
- Individual residential car washing;
- Flows from riparian habitats and wetlands;
- Dechlorinated swimming pool discharges;
- Residual street wash water;
- Dechlorinated water reservoir discharges; and
- Discharges or flows from emergency firefighting activity

1.3. Local Agency Authority

This Permit does not pre-empt or supersede the authority of local agencies to prohibit, restrict, or control discharges to storm drain systems or other water courses within their jurisdiction.

1.4. Limitations on Coverage

This Permit does not authorize:

1.4.1. Discharges that are mixed with sources of non-storm water unless such non-storm water discharges are in compliance with a separate UPDES Permit or are determined not to be a substantial contributor of pollutants to waters of the state.

1.4.2. Storm water discharges associated with industrial activity as defined in *Utah Administrative Code (UAC) R317-8-11.3(6)(c).*

1.4.3. Storm water discharges associated with construction activity as defined in *UAC R317-8-11.3(6)(e).*

1.4.4. Storm water discharges currently covered under another Permit.

1.4.5. Discharges that would cause or contribute to in-stream exceedances of water quality standards as contained in *UAC R317-2*.

1.4.6. Discharges of any pollutant into any waters of the state for which a <u>Total Maximum Daily Load (TMDL)</u> has been approved by EPA, unless the discharge is consistent with the TMDL. The discharge must be consistent with the TMDL at the time a Notice of Intent is submitted. If conditions change after coverage is issued, the coverage may remain active provided the conditions and requirements of Part 3.1. of this Permit are complied with.

2.0 Notice of Intent and Storm Water Management Program Requirements

2.1. The requirements of this Part apply only to Permittees **not** covered under the previous General Permit for Storm Water Discharges from Small Municipal Separate Storm Sewer Systems**. ("New Applicant")**. Permittees that were covered under the previous MS4 General Permit ("Renewal Permittees") and have submitted a notice of intent (NOI) at least **180 days** prior to the expiration date of the previous Permit, are covered by this Permit and must follow the requirements of Part 2.3.

2.1.2. **New Applicants** must meet the following application requirements. The Notice of Intent (NOI) must include submittal of the Storm Water Management Program (SWMP) document. Detailed information on SWMP requirements can be found in Part 4.0 of this Permit.

2.1.3. Within **180 days** of notification from the *Director*, the operator of the MS4 shall submit a NOI form as provided by the Division at https://documents.deq.utah.gov/water-quality/permits/updes/DWQ-2018-001322.pdf. (The *Director* retains the right to grant permission for a later submission date when a good cause has been demonstrated). One original completed NOI shall be submitted, by mail or hand delivery to:

Attention: MS4 Coordinator
General Permitting Section
Department of Environmental Quality
Division of Water Quality
195 North 1950 West
PO Box 144870
Salt Lake City, UT 84114-4870

2.1.4. Late submittal of an NOI is prohibited (unless permission has been granted by the *Director*). If a late NOI is submitted, authorization is only for discharges that occur after Permit coverage is granted. The *Director* reserves the right to take appropriate enforcement actions for any unpermitted discharges.

2.1.5. Where application is made by a New Applicant that has assumed operational control of an MS4 for which coverage under this Permit was previously held by a separate entity, the *Director* may determine that the new applicant shall comply with the Permit requirements in this Permit, as directed for Renewal Permittees. Notification shall be made by the *Director* of this requirement in writing to the New Applicant prior to issuance of Permit coverage

2.1.6. Implementation of the Permittee's SWMP must include the six minimum control measures, including development of Measurable Goals, as described in Part 4.2. Measurable Goals for each of the minimum control measures must include, at a minimum, the year by which the Permittee will undertake required actions, including: interim milestones and the frequency of the action (if applicable.)

2.1.7. Implementation of the Permittee's SWMP as described in the Permittee's application is required to begin within **30 days** after the completed application is submitted. The

Permittee must fully develop and implement the SWMP as discussed in Part 4.0 of the Permit by the end of the Permit term unless a more restrictive timeframe is indicated.

2.1.8. If an Operator is designated by the *Director* as requiring Permit coverage later than one year after the effective date of this General Permit, the *Director* may approve alternative deadlines that would allow the Permittee to have its program areas implemented.

2.2. Contents of the Notice of Intent

The Notice of Intent requires, at a minimum, the following information:

2.2.1. Name, address, and telephone number of the principal executive officer, ranking elected official or other duly authorized employee in charge of municipal resources used for implementation of the SWMP;

2.2.2. Name(s)/ identification of waters of the state as defined by UAC R317-1-1that receive discharges from the Permittee's MS4;

2.2.3. Name of the person responsible for overseeing implementation and coordination of the SWMP;

2.2.4. Summary description of the overall water quality concerns, priorities, and measurable goals specific to the Permittee that were considered in the development of the SWMP;

2.2.5. The SWMP document shall consist of, at a minimum, a description of the program elements that will be implemented (or already exist) for each of the SWMP minimum control measures. The plan must be detailed enough for the *Director* to determine the Permittee's general strategy for complying with the required items in each of the six minimum control measures in the SWMP document (see Part 4.2 of this Permit);

2.2.6. Information on the chosen Best Management Practices (BMPs) and the measurable goals for each of the storm water minimum control measures in Part 4.2 of this Permit and, as appropriate, the timeframe by which the Permittee will achieve required actions, including interim milestones;

2.2.7. Permittees which are applying as Co-Permittees shall each submit an NOI and individual SWMP document which will clearly identify the areas of the MS4 for which each of the Co-Permittees are responsible. Permittees which are relying on another entity (ies) to satisfy one or more of their Permit obligations shall include with the NOI, a summary of the Permit obligations that will be carried out by the other entity (ies). During the term of the Permit, Permittees may terminate or amend shared responsibility arrangements by notifying the *Director*, provided this does not alter implementation deadlines.

2.2.8. Certification and signature requirements in accordance with Part 6.8.

2.3. Storm Water Management Program Plan Description for Renewal Permittees

2.3.1. The requirements of this part apply only to **Renewal Permittees** that were previously covered under the last MS4 General Permit. New Applicants are not required to meet the requirements of this Part and must follow the requirements of Part 2.0.

2.3.2. Renewal Permittees must submit a **revised SWMP document** to the *Directo*r within **180 days** of the effective date of this Permit, which includes at a minimum, the following information:

2.3.2.1. Permit number;

2.3.2.2. MS4 location description and map;

2.3.2.3. Information regarding the overall water quality concerns, priorities, measurable goals, and interim milestones specific to the Permittee that were considered in the development and/or revisions to the SWMP document;

2.3.2.4. A description of the program elements that will be implemented (or are already being implemented) in each of the six minimum control measures (see Part 4.0);

2.3.2.5. A description of any modifications to ordinances or long-term/ongoing processes implemented in accordance with the previous MS4 General Permit for each of the six minimum control measures;

2.3.2.6. A description of how the Permittee intends to meet the requirements of the Permit as described in Part 4.0 by either referencing existing program areas that already meet the Permit requirements or a description and relevant measurable goals that include, as appropriate, the year by which the Permittee will achieve required actions, including interim milestones.

2.3.2.7. Indicate the joint submittal(s) of Co-Permittees (if applicable) and the associated responsibility (ies) in meeting requirements of the SWMP.

2.3.2.8. Certification and signature requirements in accordance with Part 6.8.

2.3.2.9. The revised SWMP document must contain specific details for complying with the required items in each of the six minimum control measures contained within the SWMP document (See Part 4.2.).

3.0 Special Conditions

3.1. Discharges to Water Quality Impaired Waters

3.1.1. Applicability:

3.1.1.1. Permittees must determine whether storm water discharge from any part of the MS4 contributes to a 303(d) listed (i.e., impaired) waterbody. A 303(d) list of impaired waterbodies is available at: https://enviro.deq.utah.gov/. Water quality impaired waters means any segment of surface waters that has been identified by the *Director* as failing to support one or more of its designated uses. If the Permittee has any discharges to an impaired waterbody, the Permittee must comply with Part 3.1.2. and if no discharges to impaired waterbodies exist, the remainder of this Part 3.1 does not apply.

3.1.1.2. If the Permittee has "303(d)" discharges described above, the Permittee must determine whether a Total Maximum Daily Load (TMDL) has been developed by the *Directo*r and approved by EPA for the listed waterbody. If there is an approved TMDL, the Permittee must comply with all requirements associated with the TMDL in addition to the requirements of Part 3.1.2. If no TMDL has been approved, the Permittee must comply with Part 3.1.2. and will be required to meet any TMDL requirements once it is developed and approved.

3.1.2. If the Permittee discharges to an impaired waterbody, the Permittee must include in its SWMP document a description of how the Permittee will control the discharge of all pollutants of concern. This description must identify the measures and BMPs that will collectively control the discharge of the pollutants of concern. The measures should be presented in the order of priority with respect to controlling the pollutants of concern.

3.1.3. Where a discharge is already authorized under this Permit and is later determined to cause or have the reasonable potential to cause or contribute to the violation of an applicable water quality standard, the *Director* will notify the Permittee of such violation(s). The Permittee must take all necessary actions to ensure future discharges do not cause or contribute to the violation of a water quality standard and document these actions as required by the *Director*. If violations remain or re-occur, coverage under this Permit may be terminated by the *Director* and an alternative General Permit or Individual Permit may be issued. Compliance with this requirement does not preclude the State from taking an enforcement action as provided by the Utah Water Quality Act for the underlying violation.

3.2. Nitrogen and Phosphorus Reduction

3.2.1. As part of the Permittee's Storm Water Management Program (SWMP), all Permittees must specifically address the reduction of water quality impacts associated with nitrogen and phosphorus in discharges from the MS4.

3.2.1.1. The Permittee can meet the requirements of this section through contribution to a collaborative program (e.g. storm water coalitions) that evaluates, identifies, and targets sources, as well as provides outreach that addresses potential sources within the Permittee's watershed.

3.2.1.2. The Permittee must identify and target sources (e.g., residential, industrial, agricultural, or commercial) that are contributing, or have the potential to contribute, nitrogen and phosphorus to waters of the state, where the Permittee is authorized under this Permit to discharge.

3.2.1.3. The Permittee must prioritize targeted sources that are likely to result in a reduction of nitrogen and phosphorus in discharges through education and outreach. The Permittee must distribute educational materials or equivalent outreach to the prioritized targeted sources. Educational materials or equivalent outreach must describe storm water quality impacts associated with nitrogen and phosphorus in storm water runoff and illicit discharges, the behaviors of concern, and actions that the target source can take to reduce nitrogen and phosphorus. The Permittee may incorporate the education and outreach to meet this requirement into the education and outreach strategies provided in accordance with Permit Part 4.2.1.

3.3. Co-Permittees

3.3.1. Two or more operators of interrelated or neighboring Small MS4s may apply as Co-Permittees.

3.3.2. In order to be permitted as Co-Permittees, the MS4(s) must each submit an NOI which meets the requirements outlined in Permit Part 2.0. Each description of the MS4(s) Storm Water Management Program Plan(s) must clearly describe which Permittees are responsible for implementing each of the minimum control measures.

3.3.3. Each Co-Permittee is individually liable for:

3.3.3.1. Permit compliance for discharges from portions of the MS4 where it is the operator and for areas within its legal jurisdiction;

3.3.3.2. Ensuring that the six minimum control measures described in Part 4.2 are implemented for portions of the MS4 where it is the operator and in areas within its legal jurisdiction; and

3.3.3.3. If any Permit conditions are established for specific portions of the MS4, Co-Permittees need only comply with the Permit conditions relating to those portions of the MS4 for which they are the operator.

3.3.4. Each Co-Permittee is jointly liable for compliance with annual reporting requirements identified in Part 5.5, with the exception that a Co-Permittee is individually liable for any parts of the annual report that relate exclusively to portions of the MS4 where it is the operator.

3.3.5. Specific Co-Permittees are jointly liable for Permit compliance on portions of the MS4 as follows:

3.3.5.1. Where operational or SWMP implementation authority over portions of the MS4 has been transferred from one Co-Permittee to another in accordance with legally binding interagency agreements, both the owner and the operator may be jointly liable for Permit compliance on those portions of the MS4; and;

3.3.5.2. Where one or more Co-Permittees jointly owns or operates a portion of the MS4, each owner/operator is jointly liable for compliance with Permit conditions on the shared portion of the MS4.

4.0 Storm Water Management Program

Permittees covered under the previous General Permit for Storm Water Discharges from Small Municipal Separate Storm Sewer Systems, ("**Renewal Permittees")**, are expected to have fully implemented all of the following six minimum control measures as required in the previous Permit term. Permittees that were newly designated during the previous Permit term have 5 years from the date of their submitted NOI to develop, fully implement, and enforce their Storm Water Management Program (SWMP). A Renewal Permittee must continue to implement its SWMP designed to reduce the discharge of pollutants from the MS4 as described in the application and submittals provided in accordance with the previous MS4 General Permit, while updating its SWMP document pursuant to this Permit. This Permit does not extend the compliance deadlines set forth in the previous MS4 General Permit unless specifically noted. All requirements contained in this renewal Permit are effective immediately unless an alternative timeframe is indicated.

4.1. Requirements

4.1.1. All Permittees must develop, implement, and enforce a SWMP designed to reduce the discharge of pollutants to the Maximum Extent Practicable from the MS4, protect water quality, and satisfy the appropriate water quality requirements of the *Utah Water Quality Act.* The SWMP must include the six minimum control measures described in Part 4.2 of this Permit.

4.1.1.1. The SWMP shall be developed and implemented in accordance with the schedules contained in Part 4.0. of this Permit.

4.1.2. Each Permittee shall have an ongoing documentation process for gathering, maintaining, and using information to conduct planning, set priorities, track the development and implementation of the SWMP, evaluate Permit compliance/non-compliance, and evaluate the effectiveness of the SWMP implementation.

4.1.2.1. Each Permittee shall track the number of inspections performed, official enforcement actions taken, and types of public education activities implemented as required for each SWMP component. This information shall be provided to the *Director* upon request and used by the *Director* to determine compliance with this Permit.

4.1.2.2. Each Permittee must secure the resources necessary to meet all requirements of this permit. Each Permittee must conduct an annual analysis of the capital and operation and maintenance expenditures needed, allocated, and spent, as well as, the necessary staff resources needed and allocated to meet the requirements of this permit, including any development, implementation, and enforcement activities required. Each permittee must submit a summary of its fiscal analysis with each annual report.

4.1.3. The SWMP document shall include BMPs that the Permittee or another entity will implement for each of the storm water minimum control measures.

4.1.3.1. The Measurable Goals for each of the BMPs shall include, at a minimum, the months and years in which the Permittee will undertake required actions including: interim milestones and the frequency of the actions (if applicable).

4.1.3.2. The SWMP document shall indicate the person(s) responsible for implementing or coordinating the BMPs contained within the SWMP document.

4.1.3.3. Within **180 days** of the effective date of the Permit, the Permittee shall revise the SWMP document to clearly identify the roles and responsibilities of all offices, departments, Directors, or sub-sections, and if necessary other responsible entities. It shall also include any necessary agreements, contracts, or memorandum of understanding (MOUs) between said entities that affect the implementation and operation of the SWMP. Necessary agreements, contracts, and MOUs shall deal with coordination or clarification of the responsibilities associated with the detection and elimination of improper connections or illicit discharges to the MS4, BMP coordination or other coordinated programs or sensitive issues of unclear or overlapping responsibility. Such agreements, contracts, and MOUs shall be retained by the Permittee as required by the SWMP document.

4.2. <u>Minimum Control Measures</u>

Permittees covered under the previous Small MS4 General UPDES Permit No. UTR090000 (“**Renewal Permittees”)**, are expected to have fully implemented Storm Water Management Programs (SWMPs) that reflect the permit requirements of the previous permit cycle. A Renewal Permittee shall continue to implement its SWMP as described in the application and submittals provided in accordance with the previous Small MS4 General Permit, while updating its SWMP document pursuant to this renewal Permit to achieve pollutant reductions to the Maximum Extent Practicable from the MS4, as specified in Part 4.1. This Permit does not extend the compliance deadlines set forth in the previous MS4 Permit or any corrective action plans and associated schedules unless specifically noted.

To achieve pollutant reductions to the Maximum Extent Practicable, Permittees shall include the following six minimum control measures in the SWMP:

4.2.1. Public Education and Outreach on Storm Water Impacts

The Permittee must implement a public education and outreach program to promote behavior change by the public to reduce water quality impacts associated with pollutants in storm water runoff and illicit discharges. Outreach and educational efforts shall include a multimedia approach and shall be targeted and presented to specific audiences for increased effectiveness. The educational program must include documented education and outreach efforts for the following four audiences: (1) residents, (2) institutions, industrial, and commercial facilities, (3) developers and contractors (construction), and (4) MS4-owned or operated facilities.

The minimum performance measures which should be based on the land uses and target audiences found within the community include:

4.2.1.1. Target specific pollutants and pollutant sources determined by the Permittee to be impacting, or have the potential to impact, the beneficial uses of a receiving water. This includes providing information which describe the potential impacts from storm water discharges; methods for avoiding, minimizing, reducing and /or eliminating the adverse impacts of storm water discharges; and the actions individuals can take to improve water quality, including encouraging participation in local environmental stewardship activities.

4.2.1.2. Provide and document education outreach given to the general public on the Permittee's prohibitions against illicit discharges and improper disposal of waste and the impacts to water quality associated with these types of discharges. The Permittee must at a minimum consider the following topics: maintenance of septic systems; effects of outdoor activities such as lawn care (use of pesticides, herbicides, and fertilizers); benefits of onsite infiltration of storm water; effects of automotive work and car washing on water quality; proper disposal of swimming pool water; and proper management of pet waste. These topics are not inclusive and the Permittee must focus on those topics most relevant to the community.

4.2.1.3. Provide and document education and outreach given to institutions, industrial, and commercial facilities on an annual basis of the Permittee's prohibitions against illicit discharges and improper disposal of waste and the impacts to water quality associated with these types of discharges. The Permittee must at a minimum consider the following topics: proper lawn maintenance (use of pesticides, herbicides and fertilizer); benefits of appropriate onsite infiltration of storm water; building and equipment maintenance (proper management of waste water); use of salt or other deicing materials (cover/prevent runoff to storm system and contamination to ground water); proper storage of materials (emphasize pollution prevention); proper management of waste materials and dumpsters (cover and pollution prevention); and proper management of parking lot surfaces (sweeping). These topics are not inclusive and the Permittee must focus on those topics most relevant to the community This education can also be a part of the Illicit Discharge Detection and Elimination measure detailed in Part 4.2.3.

4.2.1.4. Provide and document education and outreach given to engineers, construction contractors, developers, development review staff, and land use planners concerning the development of storm water pollution prevention plans (SWPPPs) and BMP use, to reduce adverse impacts from storm water runoff from development sites. This education can also be a part of the Construction Site Storm Water Runoff minimum control measure detailed in Part 4.2.4.

4.2.1.5. Provide and document education and training given to employees of Permittee-owned or operated facilities concerning the Permittee's prohibition against illicit discharges and improper disposal of waste and the impacts to water quality associated with these types of discharges. The Permittee must at a minimum consider the following topics: equipment inspection to ensure timely maintenance; proper storage of industrial materials (emphasize pollution prevention); proper management and disposal of wastes; proper management of dumpsters; minimization of use of salt and other de-icing materials (cover/prevent runoff to MS4 and ground water contamination); benefits of appropriate onsite infiltration (areas with low exposure to industrial materials such as roofs or employee parking); and proper maintenance of parking lot surfaces (sweeping).

4.2.1.6. Provide and document education and training to MS4 engineers, development and plan review staff, land use planners, and other pertinent parties about Low Impact Development (LID) practices, green infrastructure practices, and the specific requirements for post-construction control and the associated Best Management Practices (BMPs) chosen within the SWMP.

4.2.1.7. An effective program must show evidence of focused messages and audiences, as well as, demonstrate that the defined goal of the program has been achieved. The Permittee must identify specific messages for each targeted audience. The Permittee must also identify methods that will be used to evaluate the effectiveness of the educational messages and overall education program. Any methods used to evaluate the effectiveness of the program must be tied to the defined goals of the program and the overall objective of changes in behavior and knowledge.

4.2.1.8. The Permittee must include written documentation or rationale as to why particular BMPs were chosen for its public education and outreach program.

4.2.2. Public Involvement/Participation

The Permittee must implement a program that complies with applicable State and Local public notice requirements. The SWMP shall include ongoing opportunities for public involvement and participation, but at a minimum two (2) times annually. Permittees can meet this requirement through advisory panels, public hearings, watershed committees, stewardship programs, environmental activities, volunteer opportunities, or other similar activities. The Permittee should involve potentially affected stakeholder groups, including but is not limited to, commercial and industrial businesses, trade associations, environmental groups, homeowners' associations, and education organizations.

The minimum performance measures are:

4.2.2.1. Permittees shall adopt a program or policy directive to create opportunities for the public to provide input during the decision-making processes involving the development, implementation and update of the SWMP document, including development and adoption of all required ordinances or regulatory mechanisms.

4.2.2.2. **Renewal Permittees** shall make the revised SWMP document available to the public for review and input within **180** days from the effective date of this Permit. **New Applicants** shall make the SWMP document available to the public for review and input within **180** days of receiving notification from the *Director* of the requirement for Permit coverage.

4.2.2.3. A current version of the SWMP document shall remain available for public review and input for the life of the Permit. If the Permittee maintains a website, the latest version of the SWMP document shall be posted on the website within **180 days** from the effective date of this Permit and shall clearly identify a specific contact person and provide the phone number and/or email address to allow the public to review and provide input for the life of the Permit.

4.2.3. Illicit Discharge Detection and Elimination (IDDE)

All Permittees shall revise (as necessary), implement and enforce an Illicit Discharge and Elimination (IDDE) program to systematically find and eliminate sources of non-storm water discharges from the MS4 and to implement defined procedures to prevent illicit connections and discharges according to the minimum performance measures listed below. The IDDE program must be described in writing, incorporated as part of the Permittee's SWMP document, and contain the elements detailed in this part of the Permit.

The minimum performance measures are:

4.2.3.1. Maintain a current storm sewer system map of the MS4, showing the location of all municipal storm sewer outfalls with the names and location of all State waters that receive discharges from those outfalls, storm drain pipes, and other storm water conveyance structures within the MS4.

4.2.3.2. Effectively prohibit, through ordinance or other regulatory mechanism, non-storm water discharges to the MS4, including spills, illicit connections, illegal dumping and sanitary sewer overflows ("SSOs") into the storm sewer system. The IDDE program shall require removal of such discharges consistent with Part 4.2.3.6. of this Permit and implement appropriate enforcement procedures and actions. The Permittee must have a variety of enforcement options in order to apply and escalate enforcement procedures as necessary based on the severity of violation and/or the failure of the violator to address the violation(s). Discharges pursuant to a separate UPDES Permit (other than the UPDES Permit for discharges from the MS4) and non-storm water discharges listed in Part 1.2.2.2. are exempt.

4.2.3.2.1 The Permittee's IDDE program must have adequate legal authority to detect, investigate, eliminate, and enforce against non-storm water discharges, including illegal dumping, into the MS4. Adequate legal authority consists of an effective ordinance, by-law, or other regulatory mechanism. The documented IDDE program that is included in the Permittee's SWMP must include a reference or citation of the authority the Permittee will use to implement all aspects of the IDDE program.

4.2.3.3. Implement a written plan to detect and address non-storm water discharges to the MS4, including spills, illicit connections, sanitary sewer overflows and illegal dumping. The plan shall include:

4.2.3.3.1 Written systematic procedures for locating and listing the following priority areas likely to have illicit discharges (if applicable to the jurisdiction):

- Areas with older infrastructure with increased potential for illicit connections;
- Industrial, commercial, or mixed-use areas;
- Areas with a history of past illicit discharges;
- Areas with a history of illegal dumping;
- Areas with onsite sewage disposal systems;
- Areas with older sewer lines or a history of sewer overflows or cross-connections;
- Areas upstream of sensitive waterbodies; and,
- Other areas the Permittee determines to have increased potential for illicit discharges.

The Permittee must document the basis for its selection of each priority area and create a list of all priority areas identified in the system. This priority area list must be updated annually to reflect changing priorities.

4.2.3.3.2 Field inspections of areas which are considered a priority area as identified in Permit Part 4.2.3.3.1. Compliance with this provision shall be achieved by inspecting each priority area annually at a minimum. All field assessment activities shall utilize an inspection form to document findings.

4.2.3.3.3 Dry weather screening (See Definitions in 7.0) activities for the purpose of verifying outfall locations and detecting illicit discharges within the Permittee's jurisdiction that discharge to a receiving water. All outfalls shall be inspected at least once during the 5-year Permit term. Dry weather screening activities shall utilize an inspection form to document findings.

4.2.3.3.4 If the Permittee discovers or suspects that a discharger may need a separate UPDES Permit (e.g., Industrial Storm Water Permit, Dewatering Permit), the Permittee shall notify the *Directo*r within **30 days**.

4.2.3.4. Implement standard operating procedures (SOPs) or similar types of documents for tracing the source of an illicit discharge. The document should include procedures such as: visual inspections, opening manholes when necessary, using mobile cameras, using field tests of selected chemical parameters as indicators of discharge sources, collecting and analyzing water samples for the purpose of determining sanctions or penalties, and/or other detailed inspection procedures.

4.2.3.5. Implement SOPs or similar types of documents for characterizing the nature of illicit discharges and the potential public or environmental threat posed by them when found by or reported to the Permittee by the hotline or other telephone number described in 4.2.3.9. These procedures shall include detailed instructions for evaluating how the discharge will be immediately contained and the steps to be taken to contain the discharge. Compliance with this provision will be achieved by initiating an investigation immediately upon being alerted of a potential illicit discharge.

4.2.3.5.1 When the source of an illicit non-storm water discharge is identified and confirmed, the Permittee must record the following information in an inspection report: the date the Permittee became aware of the non-storm water discharge, the date the Permittee initiated an investigation of the discharge, the date the discharge was observed, the location of the discharge, a description of the discharge, the method of discovery, date of removal, repair, or enforcement action; date and method of removal verification. Analytical monitoring may be necessary to aid in the identification of potential sources of an illicit discharge and to characterize the nature of the illicit discharge. The decision process for utilizing analytical monitoring must be fully documented in the inspection report.

4.2.3.6. Implement SOPs or similar types of documents for ceasing the illicit discharge, including notification of appropriate authorities; notification of the property owner; technical assistance for removing the source of the discharge or otherwise eliminating the discharge; follow-up inspections; and escalating enforcement and legal actions if the discharge is not eliminated. Illicit discharges to the MS4 are prohibited and any such discharges violate this Permit and remain in violation until they are eliminated.

4.2.3.6.1 Upon detection, the Permittee shall require immediate cessation of improper disposal practices upon confirmation of responsible parties in accordance with its enforceable legal authorities established pursuant to Part 4.2.3.2.1. of this Permit.

4.2.3.6.2 Although the Permittee is required to prohibit illicit discharges within their boundaries and to take appropriate action to detect and address any violations, this Permit does not impose strict liability on the Permittee.

4.2.3.6.3 All IDDE investigations must be thoroughly documented and may be requested at any time by the *Director*. If a Permittee is unable to meet the minimum performance measures outlined in Parts 4.2.3.5. or 4.2.3.6., the Permittee must immediately submit to the *Director* written documentation or rationale describing the circumstances why compliance with the minimum performance measures was not possible. All IDDE documentation shall be retained by the Permittee as required by the SWMP document.

4.2.3.7. Permittees shall inform public employees, businesses, and the general public of hazards associated with illicit discharges and improper disposal of waste.

4.2.3.8. Permittees shall promote or provide services for the collection of household hazardous waste.

4.2.3.9. Permittees shall publicly list and promote a hotline or other local telephone number for public reporting of spills and other illicit discharges. A written record shall be kept of all calls received, all follow-up actions taken, and any feedback received from public education efforts.

4.2.3.9.1 The Permittee must develop a written spill and improper disposal response SOP or similar type of document and a flow chart for internal use, that shows the procedures for responding to public referrals of illicit discharges, the various responsible agencies and their contacts, and who would be involved in illicit discharge incident response, even if it is a different entity, other than the Permittee. The procedure and list must be incorporated as part of the IDDE program and incorporated into the Permittee's SWMP document. The list must be maintained and updated as changes occur.

4.2.3.10. Permittees shall implement procedures for program evaluation and assessment which includes maintaining a database for mapping, tracking of the number and type of spills or illicit discharges identified; and inspections conducted.

4.2.3.11. Permittees shall at a minimum, require that all staff, contracted staff, or other responsible entities, that as part of their normal job responsibilities might come into contact with or otherwise observe an illicit discharge or illicit connection to the MS4 receives annual training in the IDDE program including identification, investigation, termination, cleanup, and reporting of illicit discharges including spills, improper disposal, and illicit connections. Office personnel who might receive initial reports of illicit discharges, should also receive the annual training, All Permittees shall require that all new hires are trained within **60 days** of hire date and annually thereafter, at a minimum. Follow-up training shall be provided as needed to address changes in procedures, methods, or staffing. Training shall include how to identify a spill, an improper disposal, or an illicit connection to the MS4 and proper procedures for reporting the illicit discharge. Training records must be kept and shall include dates, activities or course descriptions, and names and positions of staff in attendance. The Permittee shall include a summary of such training in the annual report.

4.2.3.12. The *Director* reserves the right to request documentation or further investigation of a particular non-storm water discharge of concern, to determine a reasonable basis for allowing the non-storm water discharge and excluding the discharge from the Permittee's program or to require inclusion of the discharge in the Permittee's program, if water quality concerns cannot otherwise be reasonably satisfied.

4.2.4. Construction Site Storm Water Runoff Control

All Permittees shall revise (as necessary), implement and enforce a program to reduce pollutants in any storm water runoff to the MS4 from construction sites with a land disturbance of greater than or equal to one acre. This includes 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 according to the minimum performance measures listed below. Public and private projects, including projects proposed by the Permittee's own departments and agencies, shall comply with these requirements.

The minimum performance measures are:

4.2.4.1. Revise (as necessary) and enforce an ordinance or other regulatory mechanism that requires the use of erosion and sediment control practices at construction sites. The ordinance or other regulatory mechanism shall, at a minimum, be equivalent with the requirements set forth in the most current UPDES Storm Water General Permits for Construction activities which can be found at http://www.deq.utah.gov/Permits/water/updes/stormwatercon.htm. The ordinance or other regulatory mechanism shall include sanctions to ensure compliance. The ordinance or other regulatory mechanism shall apply, at a minimum, to construction projects disturbing greater than or equal to one acre, as well as, construction projects of 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. Existing local requirements to apply storm water controls at sites less than 1 acre or not part of a Common Plan of Development may be retained.

4.2.4.1.1 The ordinance or other regulatory mechanism shall, at a minimum, require construction operators to prepare a Storm Water Pollution Prevention Plan (SWPPP) and apply sediment and erosion control BMPs as necessary to protect water quality, reduce the discharge of pollutants, and control waste. This includes, but not limited to, discarded building materials, concrete truck washout, chemicals, litter and sanitary waste at the construction site that may cause adverse impacts to water quality. The SWPPP requirements must be, at a minimum, equivalent with the SWPPP requirement set forth in the most current UPDES Storm Water General Permits for Construction Activities, which can be found at: http://www.deq.utah.gov/Permits/water/updes/stormwatercon.htm.

4.2.4.1.2 Permittees shall require construction operators to obtain coverage under the current UPDES Storm Water General Permits for Construction Activities for the duration of the project. Coverage can be renewed; or obtained online by completing a NOI or renewal request at
https://deq.utah.gov/water-quality/updes-ereporting#construction

4.2.4.1.3 The ordinance shall include a provision for access by qualified personnel to inspect construction storm water BMPs on private properties that discharge to the MS4.

4.2.4.2. Develop a written enforcement strategy and implement the enforcement provisions of the ordinance or other regulatory mechanism. The enforcement strategy shall include:

4.2.4.2.1 Standard operating procedures (SOPs) or similar types of documents that include specific processes and sanctions to minimize the occurrence of violations and obtain compliance from violators. The SOP or similar type of document shall include appropriate, escalating enforcement procedures and actions, including an appeals process that is published in a publicly accessible location.

4.2.4.2.2 Documentation and tracking of all enforcement actions.

4.2.4.3. Development and implementation of a checklist for pre-construction SWPPP review that is consistent with the requirements of the current UPDES Storm Water General Permits for Construction Activities. MS4s are required to keep records for, at a minimum, all construction sites that disturb greater than or equal to one acre, 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, to ensure plans are complete and in compliance with State regulations. Permittees shall keep records of these projects for five years or until construction is completed, whichever is longer.

Prior to construction, the Permittee shall:

4.2.4.3.1 Conduct a pre-construction SWPPP meeting which includes a review of the site design, planned operations at the construction site, planned BMPs during the construction phase, and planned BMPs to be used to manage runoff created after development.

4.2.4.3.2. The Permittee must develop procedures for receiving and considering information and comments submitted by the public on proposed projects.

4.2.4.3.2 Identify priority construction sites considering the following factors at a minimum:

- Soil erosion potential;
- Site slope;
- Project size and type;
- Sensitivity of receiving waterbodies (impaired or high-quality waters);
- Proximity to receiving waterbodies; and,
- Non-storm water discharges and past record of non-compliance by the operators of the construction site.

4.2.4.4. All Permittees shall develop and implement SOPs or similar types of documents for construction site inspection and enforcement of construction storm water pollution control measures. The procedures must clearly identify who is responsible for site inspections, as well as, who has authority to implement enforcement procedures. An individual or entity who prepares a SWPPP for a construction project may not perform the construction site inspections required of Part 4.2.4.4.1 and 4.2.4.4.3 on behalf of the Permittee. The Permittee must have the authority to the extent authorized by law to impose sanctions to ensure compliance with the local program. These procedures and regulatory authorities must be written and documented in the SWMP.

The construction site storm water runoff control inspection program must provide:

4.2.4.4.1 At a minimum, monthly inspections of all new construction sites with a land disturbance of greater than or equal to one acre, 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 are required. These inspections must be conducted by qualified personnel using the Construction Storm Water Inspection Form (Checklist) found on the Division's website at https://deq.utah.gov/water-quality/municipal-separate-storm-sewer-system-ms4s-permits-updes-permits.

A "qualified person" is a person knowledgeable in the principles and practice of erosion and sediment controls and pollutant prevention, who possesses the skills to assess conditions at effectiveness of any storm water controls selected and installed to meet the requirements of this permit, such as but not limited to the following:

- Utah Registered Storm Water Inspector (RSI)
- Certified Professional in Erosion and Sediment Control (CPESC)
- Certified Professional in Storm Water Quality (CPSWQ)
- Certified Erosion, Sediment, and Storm Water Inspector (CESSWI)
- Certified Inspector of Sediment and Erosion Control (CISEC)
- National Institute for Certification in Engineering Technologies, Erosion and Sediment Control, Level 3 (NICET)
- Utah Department of Transportation Erosion Control Supervisor (ECS) (applicable to road/street projects only)

4.2.4.4.2 The Permittee must inspect all phases of construction, including prior to land disturbance, during active construction, and following active construction. The Permittee must document the procedure for being notified by construction operators/owners of their completion of active construction in its SWMP. Notification is required so that verification of final stabilization and removal of all temporary control measures may be conducted. This procedure must be provided to the construction operator/owner before active construction begins.

4.2.4.4.3 Inspections by the MS4 of priority construction sites, as defined in Part 7.0., must be conducted at least biweekly (every two weeks) using the Construction Storm Water Inspection Form (Checklist) found on the *Division's* website at https://deq.utah.gov/water-quality/municipal-separate-storm-sewer-system-ms4s-permits-updes-permits.

4.2.4.4.4 Permittees may utilize an electronic site inspection tool in place of up to one-half of on-site MS4 inspections at a construction site provided that the Permittee demonstrates to the Director that the tool meets the requirements of Part 4.2.4.

4.2.4.4.5 Based on site inspection findings, the Permittee must take all necessary follow-up actions (i.e., re-inspection, enforcement) to ensure compliance in accordance with the Permittee's enforcement strategy. These follow-up and enforcement actions must be tracked and documented.

4.2.4.5 The Permittee must ensure that all staff whose primary job duties are related to implementing the construction storm water program, including permitting, plan review, construction site inspections, and enforcement, are annually trained to conduct these activities. The training can be conducted by the MS4 or outside training can be attended. Such training must be extended to third-party inspectors and plan reviewers as well. The Permittee shall ensure that all new hires are trained within **60 days** of hire date and annually thereafter, at a minimum. Follow-up training shall be provided as needed to address changes in procedures, methods, or staffing. Training records must be kept and contain, at a minimum, dates, activities or course descriptions, and names and positions of staff in attendance.

4.2.4.6. All Permittees shall maintain records of all projects disturbing greater than or equal to one acre, 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. Permittees shall keep records which include but not limited to, site plan reviews, SWPPPs, inspections, and enforcement actions including verbal warnings, stop work orders, warning letters, notices of violation, and any other enforcement conducted. Permittees shall keep records of these projects for five years or until construction is completed, whichever is longer.

4.2.5. Long-Term Storm Water Management in New Development and Redevelopment (Post-Construction Storm Water Management)

The Permittee shall revise (as necessary), implement, and enforce a program to address post-construction storm water runoff to the MS4 from private and public new development and redevelopment construction sites meeting the thresholds below. The water quality considerations of this minimum control measure do not replace or substitute for water quantity or flood management requirements implemented on the local level for new development or redevelopment sites. The water quality controls may be incorporated into the design of structures intended for flow control; or water quality control may be achieved with separate control measures. The program must apply to private and public development sites.

The minimum performance measures are:

4.2.5.1. Post-construction Controls. The Permittee's new development/redevelopment program must have requirements or standards to ensure that any storm water controls or management practices for new development and redevelopment will prevent or minimize impacts to water quality. BMPs must be selected that address pollutants known to be discharged or have potential to be discharged from the site.

4.2.5.1.1. The Permittee's new development/redevelopment program should include non-structural BMPs. The Permittee should consider non-structural BMPs, including. requirements and standards to minimize development in areas susceptible to erosion and sediment loss; minimize the disturbance of native soils and vegetation; preserve areas that provide important water quality benefits; implement measures for flood control; and protect the integrity of natural resources and sensitive areas.

4.2.5.1.2. Retention Requirement. The Permittee must develop and define a specific hydrologic method or methods for calculating runoff volumes and flow rates to ensure consistent sizing of structural BMPs in their jurisdiction and to facilitate plan review.

New development projects that disturb land greater than or equal to one acre, including projects that are part of a larger common plan of development or sale which collectively disturbs land greater than or equal to one acre must manage rainfall on-site and prevent the off-site discharge of the precipitation from all rainfall events less than or equal to the 80th percentile rainfall event or a predevelopment hydrologic condition, whichever is less. This objective must be accomplished by the use of practices that are designed, constructed, and maintained to infiltrate, have evapotranspiration, and/or harvest and reuse rainwater. The 80th percentile rainfall event is the event whose precipitation total is greater than or equal to 80 percent of all storm events over a given period of record.

Redevelopment projects that disturb greater than or equal to one acre, including projects less than an acre that are part of a larger common plan of development or sale which collectively disturbs land greater than or equal to one acre must provide a site-specific and project-specific plan aimed at net gain to onsite retention or a reduction to impervious surface to provide similar water quality benefits. 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 80th percentile rainfall event. This objective must be accomplished by the use of practices that are designed, constructed, and maintained to infiltrate, have evapotranspiration, and/or harvest and reuse rainwater.

4.2.5.1.3. Low Impact Development Approach. The program shall include a process which ***requires*** the evaluation of a Low Impact Development (LID) approach for all projects subject to the requirements in 4.2.5.1.2. A LID approach promotes the implementation of BMPs that allow storm water to infiltrate, have evapotranspiration or harvest[1] and use storm water on site to reduce runoff from the site and protect water quality.

Guidance for implementing LID can be found in DWQ's LID controls which are appropriate for use in the State of Utah can be found in *A Guide to Low Impact Development within Utah* (the Guide), available on DWQ's website.

Permittees must allow for use of a minimum of five LID practices from the list in Appendix C of the Guide. If a Permittee has not adopted specific LID practices from Appendix C, any LID approach that meets 4.2.5.1.2 and is feasible may be used to meet this requirement.

4.2.5.1.4. Feasibility. If meeting the retention standards described in Part 4.2.5.1.2 is infeasible, a rationale shall be provided for the use of alternative design criteria. The new or redevelopment project must document and quantify that infiltration, evapotranspiration, and rainwater harvesting have been used to the maximum extent feasible and that full employment of these controls are infeasible due to constraints. LID infeasibility may be due to one or more of the following conditions: high groundwater, drinking water source protection areas, soil conditions, slopes, accessibility, excessive costs, or any other justifiable constraint.

Guidance for assessing and documenting site conditions can be found in DWQ's "A Guide to Low Impact Development within Utah" Appendix B "Storm Water Quality Report Template" located on the DWQ website at: https://documents.deq.utah.gov/water-quality/stormwater/updes/DWQ-2019-000161.pdf.

A MS Word version can be found on DWQ's website at: https://documents.deq.utah.gov/water-quality/stormwater/DWQ-2018-013750.docx.

4.2.5.2. Regulatory Mechanism. Develop and adopt an ordinance or other regulatory mechanism that requires long-term post-construction storm water controls at new development and redevelopment sites. The ordinance or other regulatory mechanism shall apply, at a minimum, to new development and redevelopment sites that discharge to the MS4 that disturb greater than or equal to one acre, 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. The ordinance or other regulatory mechanism shall require BMP selection, design, installation, operation, and maintenance standards necessary to protect water quality and reduce the discharge of

[1]Since 2010, rainwater harvesting is legal in the State of Utah. Depending on the volume of rainwater collected and stored for beneficial use, the Permittee must meet the requirements of the Utah Division of Water Rights to harvest rainwater found on their website: http://waterrights.utah.gov/forms/rainwater.asp.

The Permittee's ordinance or other regulatory mechanism must include an appeals process.

4.2.5.2.1 The Permittee must include enforcement provisions in the ordinance or other regulatory mechanism that must contain procedures for specific processes and sanctions to minimize the occurrences of violations and obtain compliance from chronic and recalcitrant violators. These processes and sanctions shall include appropriate, escalating enforcement procedures and actions.

4.2.5.2.2 The Permittee must maintain documentation on how the requirements of the ordinance or other regulatory mechanism will protect water quality and reduce the discharge of pollutants to the MS4.

Documentation shall include:

- How long-term storm water BMPs were selected;
- The pollutant removal performance expected from the selected BMPs; and
- The technical basis which supports the performance claims for the selected BMPs.

All Permittees shall adopt and implement SOPs or similar types of documents for site inspection and enforcement of post-construction storm water control measures. These procedures must ensure adequate ongoing long-term operation and maintenance of approved storm water control measures.

4.2.5.2.3 The ordinance or other regulatory mechanism shall include provisions for post-construction access for Permittees to inspect storm water control measures on private properties that discharge to the MS4 to ensure that adequate maintenance is being performed. The ordinance or other regulatory mechanism may require private property owner/operators or qualified third parties to conduct maintenance and provide annual certification that adequate maintenance has been performed and the structural controls are operating as designed to protect water quality, in lieu of the Permittee. If the Permittee requires a maintenance agreement addressing maintenance requirements for any control measures installed on site, the agreement must allow the Permittee to conduct oversight inspections of the storm water control measures and also account for transfer of responsibility in leases and/or deeds. The agreement must also allow the Permittee to perform necessary maintenance or corrective actions neglected by the property owner/operator and bill or recoup costs from the property owner/operator as needed.

4.2.5.2.4 Permanent structural BMPs shall be inspected at least once during installation by qualified personnel. Upon completion, the Permittee must verify that long-term BMPs were constructed as designed.

4.2.5.2.5 Inspections and any necessary maintenance must be conducted at least every other year or as necessary to maintain functionality of the control by either the Permittee, or, if applicable, the property owner/operator. On sites where the property owner/operator is conducting maintenance, the Permittee shall inspect those storm water control measures at least once every five years, or more frequently as determined by the Permittee, to verify and ensure that adequate maintenance is being performed. Following an inspection, if there is an observed failure of a facility to perform as designed, the Permittee must document its findings in an inspection report.
The inspection report must include the following:

- Inspection date;
- Name and signature of inspector;
- Project location;
- Current ownership information;
- A description of the condition of the storm water control measure including the quality of: vegetation and soils; inlet and outlet channels and structures; catch basins; spillways; weirs, and other control structures; and sediment and debris accumulation in storage as well as in and around inlet and outlet structures; and,
- Specific maintenance issues or violations found that need to be corrected by the property owner or operator along with deadlines and re-inspection dates.

4.2.5.3. Plan Review. The Permittee shall:

4.2.5.3.1 Adopt and implement procedures for site plan review which evaluates potential water quality impacts. The procedures shall apply through the life of the project from conceptual design to project closeout.

[1]Since 2010, rainwater harvesting is legal in the State of Utah. Depending on the volume of rainwater collected and stored for beneficial use, the Permittee must meet the requirements of the Utah Division of Water Rights to harvest rainwater found on their website: http://waterrights.utah.gov/forms/rainwater.asp.

4.2.5.3.2 Review post-construction plans for, at a minimum, all new development and redevelopment sites that disturb greater than or equal to one acre, 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, to ensure that the plans include long-term storm water management measures meet the requirements of this minimum control measure.

4.2.5.4. Inventory. The Permittee must maintain an inventory of all post-construction structural storm water control measures installed and implemented at new development and redeveloped sites that disturb greater than or equal to one acre, 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. This inventory must include both public and private sector sites located within the Permittee's service area that were developed since the Permittee obtained coverage by this permit or the date that post-construction requirements came into effect, whichever is later.

4.2.5.4.1 Each entry to the inventory must include basic information on each project, such as project's name, owner's name and contact information, location, start/end date, etc.

In addition, inventory entries must include the following for each project:

- Short description of each storm water control measure (type, number, design or performance specifications);
- Short description of maintenance requirements (frequency of required maintenance and inspections); and
- Inspection information (date, findings, follow up activities, prioritization of follow-up activities, compliance status).

4.2.5.4.2 Based on inspections conducted pursuant to Part 4.2.5.2.5, the Permittee must update the inventory when changes occur in property ownership or the specific control measures implemented at the site.

4.2.5.5. Training. Permittees shall ensure that all staff involved in post-construction storm water management, including those that conduct plan review, annual maintenance inspections, and enforcement, receive appropriate training. Training shall be provided or made available for staff in the fundamentals of long-term storm water management through the use of structural and non-structural control methods. Training records must be kept and include, at a minimum, dates, activities or course descriptions, and names and positions of staff in attendance. The Permittee shall ensure that all new hires are trained within **60 days** of hire and annually thereafter, at a minimum. Follow-up training shall be provided as needed to address changes in procedures, methods, or staffing.

4.2.6. Pollution Prevention and Good Housekeeping for Municipal Operations

All Permittees must implement a program for Permittee-owned or operated facilities, operations and structural storm water controls that includes SOPs, pollution prevention BMPs, storm water pollution prevention plans or similar type of documents, and a training component that have the ultimate goal of preventing or reducing the runoff of pollutants to the MS4 and waters of the state. All components of the program shall be included in the SWMP document and must identify the department responsible for performing each activity described in this section. The Permittee shall develop an inventory of all such Permittee-owned or operated facilities. The Permittee must review this inventory annually and update as necessary.

4.2.6.1. The Permittee shall develop and keep current a written inventory of all the below potential "high priority" facilities that are owned or operated by the Permittee and all the associated storm water controls, at a minimum. The *Director* maintains the authority to add additional facilities to the list, as needed.
The inventory should include, but not limited to, the following facilities:

- Composting facilities;
- Equipment storage and maintenance facilities;
- Fuel farms;
- Hazardous waste disposal facilities;
- Hazardous waste handling and transfer facilities;
- Incinerators;
- Landfills;
- Landscape maintenance facilities on municipal property;
- Materials storage yards;
- Pesticide storage facilities;
- Public buildings, including libraries, police stations, fire stations, municipal buildings, restrooms, and similar Permittee-owned or operated buildings;
- Public parking lots;
- Public golf course maintenance facilities;
- Public swimming pool maintenance facilities;
- Public works yards;
- Public Marinas and Boat Launches;
- Recycling facilities;
- Salt storage facilities and de-icing storage facilities;
- Solid waste handling and transfer facilities;
- Street repair and maintenance facilities and or shed sites;
- Vehicle storage and maintenance yards;
- Airports;
- Animal control facilities;
- Vehicle salvage yards;
- Chemical storage facilities; and
- Transportation hubs, including bus stations

4.2.6.2. All Permittees shall assess the written inventory of Permittee-owned or operated facilities, operations, and storm water controls identified in Part 4.2.6.1 and make a list of common pollutants that may originate from these facilities and how to prevent them from entering the storm water system. A description of the assessment process and findings must be included in the SWMP document.

4.2.6.3. Based on the assessment required in Part 4.2.6.2., the Permittee must identify as "high-priority" those facilities or operations that have:

- Pollutants stored at the site;

- Improperly stored materials;
- Potential pollutant-generating activities performed outside (e.g. changing automotive fluids)
- Close proximity to fresh water and water bodies, including but not limited, to streams, canals, rivers, ponds and lakes;
- Potential to discharge pollutant(s) of concern to impaired water(s).

The Permittee shall provide water quality control measures and BMPs at all high-priority sites designed to target the specific pollutants generated onsite, and/or the pollutants associated with the impaired waters. The Permittee shall monitor the control measures and BMPs regularly to verify that the BMPs are functioning. Control measures, BMPs, and monitoring schedules shall be specified in the Permittee's SWMP.

4.2.6.4 The Permittee shall update the SWMP to include a list of "high priority" facilities according to 4.2.6.3 and prepare a Storm Water Pollution Prevention Plan (SWPPP) for each facility within **180 days** from the effective date of this permit. Each "high priority" facility shall implement a SWPPP outlining measures to prevent pollutants from entering the storm drain system from each of these facilities and contain an inspection schedule of the facility.

The SWPPP shall include a site map showing the following information:

- Facility address;
- Staff/contact information for the facility;
- Property boundaries;
- Buildings and impervious surfaces;
- Directions of storm water flow (use arrows);
- Locations of structural control measures;
- Facility BMPs (non-structural);
- Location and name of the nearest defined drainage(s) which could receive runoff from the facility, whether it contains water or not;
- Locations of all storm water conveyances including ditches, pipes, basins, inlets, and swales;
- Locations where on-site activities may be exposed to storm water, including, but limited to the following:
  -Fixed fueling operations;
  -Vehicle and equipment maintenance and/or cleaning areas;
  -Brine making areas;
  -Loading/unloading areas;
  -Waste storage or disposal areas;
  -Liquid storage tanks;
  -Process and equipment operating areas;
  -Materials storage or disposal areas;
- Locations where significant spills or leaks have occurred;
- Locations of all visual storm water monitoring points;
- Locations of storm water inlets and outfalls, with a unique identification code for each outfall and an approximate outline of the areas draining to each outfall;

- Locations of all non-storm water discharges; and
- Locations of sources of run-on to your site from adjacent properties.

4.2.6.5. The following inspections shall be conducted at "high priority" Permittee-owned or operated facilities:

4.2.6.5.1 Monthly visual inspections: The Permittee must perform monthly visual inspections of "high priority" facilities and related storm water outfalls in accordance with the developed SOPs to verify the performance of the BMPs and all other systems designed and placed to eliminate pollutant discharges. The monthly inspections must be tracked in a log for every facility and records must be kept with the SWMP document. The inspection log should also include any identified deficiencies and the corrective actions taken to fix the deficiencies.

4.2.6.5.2 Semi-Annual comprehensive inspections: At least twice per year, a comprehensive inspection of "high priority" facilities, including all storm water controls, must be performed, with specific attention paid to waste storage areas, dumpsters, vehicle and equipment maintenance/fueling areas, material handling areas, and similar pollutant-generating areas. The semi-annual inspection results must be documented and records kept with the SWMP document. This inspection must be done in accordance with the developed SOPs. An inspection report must also include any identified deficiencies and the corrective actions taken to remedy the deficiencies.

4.2.6.5.3 Annual visual observation of storm water discharges: At least once per year, the Permittee must visually observe the quality of the storm water discharges from the "high priority" facilities. Any observed problems (e.g., color, foam, sheen, turbidity) that can be associated with pollutant sources or controls must be remedied as soon as practicable, but at a minimum, before the next storm event. Remediation is required to prevent discharge to the storm drain system. Visual observations must be documented and records kept with the SWMP document. This inspection must be done in accordance with the developed SOPs. The inspection report must also include any identified deficiencies and the corrective actions taken to remedy the deficiencies.

4.2.6.6. Permittees shall develop and implement SOPs to protect water quality at each of the facilities owned or operated by the Permittee and/or activities conducted by the Permittee including, but not limited to, those listed below:

- Buildings and facilities;
- Material storage areas;
- Heavy equipment storage areas and maintenance areas;
- Parks and open space;
- Vehicle and Equipment;
- Roads, highways, and parking lots; and
- Storm water collection and conveyance system.

4.2.6.6.1 SOPs shall address the following practices to ensure they are protective of water quality:

- Use, storage and disposal of chemicals;
- Storage of salt, sand, gravel, landscaping materials, asphalt and other materials;

- Waste and trash management;
- Cleaning, washing, painting and maintenance activities including: cleaning of maintenance equipment, building exteriors, and trash containers;
- Sweeping roads and parking lots;
- Proper application, storage, and disposal of fertilizer, pesticides, and herbicides and minimizing their use;
- Lawn maintenance and landscaping activities including: proper disposal of lawn clipping and vegetation;
- Green waste deposited in the street;
- Proper disposal of pet wastes;
- Vehicle maintenance and repair activities including: use of drip pans and absorbents under or around leaky vehicles and equipment;
- Vehicle/equipment storage including storing indoors where feasible;
- Vehicle fueling including placing fueling areas under cover in order to minimize exposure where feasible;
- Road and parking lot maintenance, including: pothole repair, pavement marking, sealing, and repaving;
- Cold weather operations, including: plowing, sanding, application of deicing compounds, and maintenance of snow disposal areas;
- Right-of-way maintenance, including: mowing, herbicide and pesticide application;
- Municipally-sponsored events such as large outdoor festivals, parades, or street fairs and the clean-up following these events;
- Regular inspection, cleaning, and repair of storm water conveyance and structural storm water controls;
- Graffiti removal; and
- Any activities or operations not listed above that would reasonably be expected to discharge contaminated runoff;

4.2.6.6.2 SOPs must include a schedule for Permittee owned road and parking lot sweeping and storm drain system maintenance. The SOPs must include regular inspection, cleaning, and repair of catch basins, storm water conveyance pipes, ditches and irrigation canals, culverts, structural storm water controls, and structural runoff treatment and/or flow control facilities. Permittees must prioritize sweeping and storm sewer system maintenance, with the highest priority areas being maintained at the greatest frequency. Priorities should be driven by water quality concerns, most recent assessment the receiving water, the amount and type of material that typically accumulates in an area, or other location-specific factors.

4.2.6.6.3 Permittees must ensure and document proper disposal methods of all waste and wastewater removed during cleaning and maintenance of the storm water conveyance system. These disposal methods apply to, but are not limited to, street sweeping and catch basin cleaning. Materials removed from the MS4 should be dewatered in a contained area and discharged to the local sanitary sewer (with approval of local authorities) where feasible. The solid material will need to be stored and disposed of properly to avoid discharge during a storm event. Any other treatment and disposal measures shall be reviewed and approved by the *Director*. Some materials removed from storm drains and open channels may require special handling and disposal, and may not be authorized to be disposed of in a landfill. The solid material shall be stored and disposed of in accordance to federal, state and local laws.

4.2.6.6.4 Permittees must ensure that vehicle, equipment, and other wash waters are not discharged to the MS4 or waters of the state as these types of discharges are strictly prohibited under this Permit. Additionally, the Permittee must minimize discharges to waters of the state that are associated with snow disposal and melt.

4.2.6.6.5 The Permittee shall develop a spill prevention plan in coordination with the local fire department.

4.2.6.6.6 All Permittees must maintain an inventory of all floor drains inside all Permittee-owned or operated buildings and ensure that all floor drains discharge to appropriate locations. The inventory shall be updated as necessary to ensure accuracy.

4.2.6.7. The Permittee shall be responsible for ensuring, through contractually-required documentation and/or periodic site visits that contractors performing Operation and Maintenance (O&M) activities for the Permittee are using appropriate storm water controls and following the SOPs, storm water control measures, and good housekeeping practices of the Permittee.

4.2.6.8. The Permittee must develop and implement a process to assess the water quality impacts and the design of all new flood management structural controls that are associated with the Permittee or that discharge to the MS4. This process shall include consideration of controls that can be used to minimize the impacts to site water quality and hydrology while still meeting project objectives. A description of this process shall be included in the SWMP document.

4.2.6.8.1 Existing flood management structural controls shall be assessed to determine whether changes or additions should be made to improve water quality. A description of this process and any changes or additions made should be included in the SWMP document.

4.2.6.9. The Permittee must develop a plan to retrofit existing developed sites that the Permittee owns or operates that are adversely impacting water quality. The retrofit plan must be developed to emphasize controls that infiltrate, have evapotranspiration, or harvest and use storm water discharges.

The plan must include a ranking of retrofit sites based on the following criteria:

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

4.2.6.10. The Permittee shall require that all employees, contracted staff, and other responsible entities that have primary operation, or maintenance job functions that are likely to impact storm water quality receive annual training. The annual training shall address the importance of protecting water quality, the requirements of this Permit, O&M requirements, inspection procedures, ways prevent or minimize impacts to water quality by how they perform their job activities SOPs and SWPPPs for the various Permittee-owned or operated facilities, as well as, procedures for reporting water quality concerns, including potential illicit discharges. Training records must be kept and contain, at a minimum, dates, activities or course descriptions, and names and positions of staff in attendance. The Permittee shall document and maintain records of the training provided and the staff in attendance. The Permittees must ensure that all new hires are trained within **60 days** of hire and annually thereafter, at a minimum. Follow-up training shall be provided as needed to address changes in procedures, methods, or staffing.

4.3. Sharing Responsibility

4.3.1. Implementation of one or more of the six minimum measures may be shared with another entity, or the entity may fully take over the measure. A Permittee may rely on another entity only if:

4.3.2. The other entity, in fact, implements the control measure;

4.3.3. The particular control measure, or component of that measure, is at least as stringent as the corresponding Permit requirement; and

4.3.4. The other entity agrees to implement the control measure through a written agreement. This obligation must be maintained as part of the description given in the Permittee's SWMP document. If the other entity agrees to report on the minimum control measure, the Permittee must supply the other entity with the reporting requirements contained in Part 5.5. of this Permit. If the other entity fails to implement the control measure, then the Permittee remains liable for any discharges due to any failure to implement the control measure.

4.3.5. The Permittee conducts training of the responsible entity on the Permit requirements and applicable standard operating procedures.

4.4. Reviewing and Updating Storm Water Management Programs

4.4.1. *Storm Water Management Program Review:* All Permittees must conduct, at a minimum, an annual review of the SWMP document in conjunction with preparation of the annual report required in Part 5.5.

4.4.2. *Storm Water Management Program Update:* A Permittee may change the SWMP document during the life of the Permit in accordance with the following procedures:

4.4.2.1. Changes adding components, controls, or requirements to the SWMP document may be made at any time upon written notification to the *Director*. Changes that reduce or replace any component, control, or requirement of the SWMP document is not authorized, unless it meets requirements outlined in Part 4.4.2.2.

4.4.2.2. Changes replacing an ineffective or unfeasible BMP specifically identified in the SWMP document with an alternate BMP may be adopted at any time, provided the analysis is clearly outlined and subsequently approved by the *Director*.

An analysis shall include:

4.4.2.2.1 An explanation of why the BMP is ineffective or infeasible;

4.4.2.2.2 Expectations or report on the effectiveness of the replacement BMP; and

4.4.2.2.3 An analysis of why the replacement BMP is expected to achieve the goals of the BMP to be replaced, or has achieved those goals.

4.4.3. Change requests or notifications must be made in writing and signed in accordance with Part 6.8.

4.4.4. Change requests or notifications will receive confirmation and approval or denial in writing from the *Director*.

4.4.5. Storm Water Management Program Updates required by the *Director:* The *Director* may require changes to the SWMP as needed to:

4.4.5.1. Address impacts on receiving water quality caused, or contributed to, by discharges from the MS4;

4.4.5.2. Include more stringent requirements necessary to comply with new Federal regulatory requirements; or

4.4.5.3. Include such other conditions deemed necessary by the *Director* to comply with the goals and requirements of the Clean Water Act.

5.0 Narrative Standard, Monitoring, Recordkeeping and Reporting

5.1. Narrative Standard

It shall be unlawful and a violation of this Permit, for the Permittee to discharge or place any waste or other substance in such a way as will be or may become offensive such as unnatural deposits, floating debris, oil, scum or other nuisances such as color, odor or taste, or conditions which produce undesirable aquatic life or which produces objectionable tastes in edible aquatic organisms; or concentrations or combinations of substances which produce undesirable physiological responses in desirable resident fish, or other desirable aquatic life, or undesirable human health effects, as determined by bioassay or other tests performed in accordance with standard procedures.

5.2. Analytical Monitoring

Permittees are not required to conduct analytical monitoring (see definition in Part 7.0) during the effective term of this Permit, with the following exceptions:

5.2.1. Water quality sampling may be required for compliance with TMDLs, pursuant to Part 3.1. of this Permit.

5.2.2. Sampling or testing may be required for characterizing illicit discharges pursuant to Parts 4.2.3.4., 4.2.3.5., and 4.2.3.5.1 of this Permit.

5.2.3. In the event that the Permittee elects to conduct analytical monitoring as part of its Storm Water Management Program, the Permittee is required to comply with Part 6.18. of this Permit.

5.3. Non-analytical Monitoring

5.3.1. Non-analytical monitoring (see definitions in Part 7.0) such as visual dry weather screening is required to comply with Part 4.2.3.3.2 of this Permit.

5.4. Record keeping

5.4.1. Permittees must keep all supplementary documents associated with this Permit (e.g., Storm Water Management Program (SWMP) document, SWMP Implementation Schedule) current and up to date to ensure the purpose and objectives of the required document are achieved.

5.4.2. All modifications to supplementary documents must be submitted to the *Director* in accordance with Parts 4.4 and 6.8.

5.4.3. The *Director* may at any time make a written determination that parts or all of the supplementary documents are not in compliance with this Permit. If such a determination is made the Permittee must make modifications to these parts within a time frame specified by the *Director*.

5.4.4. The Permittee shall retain all required plans, records of all programs, records of all monitoring information, copies of all reports required by this Permit, and records of all other data required by or used to demonstrate compliance with this Permit, for at least five years. This period may be explicitly modified by alternative provisions of this Permit or extended by request of the *Director* at any time.

5.4.5. The Permittee must make records, including the Notice of Intent (NOI) and the SWMP document, available to the public if requested.

5.5. Reporting

5.5.1. The Permittee must submit an annual report to the *Director* by October 1 for the reporting period of July 1 to June 30 of each year of the Permit term.

5.5.2. The report must be submitted using the report form provided on the *Division's* website at https://deq.utah.gov/legacy/permits/water-quality/utah-pollutant-discharge-elimination-system/docs/2009/07Jul/MS4_UT_09_annual_report_form.pdf

5.5.3. The Permittee shall sign and certify the annual report in accordance with Part 6.8.

5.5.4. Signed copies of the Annual Report and all other reports required herein, must be submitted directly to the DWQ electronic document system at: https://deq.utah.gov/water-quality/water-quality-electronic-submissions

6.0 Standard Permit Conditions

6.1. Duty to Comply

The Permittee must comply with all conditions of this Permit. Any Permit noncompliance constitutes a violation of the Act and is grounds for enforcement action; for Permit termination; revocation and reissuance; modification; or for denial of Permit coverage. The Permittee shall give advance notice to the *Director* of any planned changes in the Permitted facility or activity, which may result in noncompliance with Permit requirements.

6.2. Penalties for Violations of Permit Conditions

The *Act* provides that any person who violates a Permit condition implementing provisions of the *Act* is subject to a civil penalty not to exceed $10,000 per day of such violation. Any person who willfully or negligently violates Permit conditions or the Act is subject to a fine not exceeding $25,000 per day of violation. Any person convicted under *UCA 19-5-115(2)* a second time shall be punished by a fine not exceeding $50,000 per day.

6.3. Duty to Reapply

If the Permittee wishes to continue an activity regulated by this Permit after the expiration date of this Permit, the Permittee shall apply for and obtain a new Permit. The application shall be submitted at least **180 days** before the expiration date of this Permit. Continuation of expiring Permits shall be governed by regulations promulgated at *UAC R317-8-5* and any subsequent amendments.

6.4. Need to Halt or Reduce Activity not a Defense

It shall not be a defense for a Permittee in an enforcement action that it would have been necessary to halt or reduce otherwise permitted activities in order to maintain compliance with the conditions of this Permit.

6.5. Duty to Mitigate

The Permittee must take all reasonable steps to minimize or prevent any discharge in violation of this Permit, which has a reasonable likelihood of adversely affecting human health or the environment.

6.6. Duty to Provide Information

The Permittee shall furnish to the *Director,* within a time specified by the *Director*, any information which the *Director* may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this Permit, or to determine compliance with this Permit. The Permittee shall also furnish to the *Director*, upon request, copies of records required to be kept by this Permit.

6.7. Other Information

When the Permittee becomes aware that it failed to submit any relevant facts in a Permit application, or submitted incorrect information in a Permit application or any report to the *Director*, it shall promptly submit such facts or information.

6.8. Signatory Requirements

All notices of intent, storm water management programs, storm water pollution prevention plans, reports, certifications or information either submitted to the *Director* or that this Permit requires to be maintained by the Permittee, shall be signed, dated and certified as follows:

6.8.1. All Permit applications shall be signed by either a principal executive officer or ranking elected official.

6.8.2. All reports required by the Permit and other information requested by the *Director* shall be signed by a person described above or by a duly authorized representative of that person. A person is a duly authorized representative only if:

6.8.2.1. The authorization is made in writing by a person described above and submitted to the *Director*, and,

6.8.2.2. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility, such as the position of plant manager, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters. A duly authorized representative may thus be either a named individual or any individual occupying a named position.

6.8.2.3. <u>Changes to authorization.</u> If an authorization under *Part 6.8.2.* is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of *Part 6.8.2.* must be submitted to the *Director* prior to or together with any reports, information, or applications to be signed by an authorized representative.

6.8.3. *Certification*. Any person signing documents under this Part shall make the following certification:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

6.9 Availability of Reports

Except for data determined to be confidential under the Government Records Access and Management Act (*see* particularly Utah Admin. Code § 63-2-309) and Utah Admin Code § 19-1-3-6, all reports prepared in accordance with the terms of this Permit shall be available for public inspection at the office of the *Director*. As required by the *Act*, Permit applications, Permits and effluent data shall not be considered confidential.

6.10. Penalties for Falsification of Reports

The *Act* provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this Permit, including monitoring reports or reports of compliance or noncompliance shall, upon conviction be punished by a fine of not more than $10,000.00 per violation, or by imprisonment for not more than six months per violation, or by both. Utah Admin Code § 19-5-115(4)

6.11. Penalties for Tampering

The *Act* provides that any person who falsifies, tampers with, or knowingly renders inaccurate, any monitoring device or method required to be maintained under this Permit shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than six months per violation, or by both.

6.12. Property Rights

The issuance of this Permit does not convey any property rights of any sort, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of federal, state or local laws or regulations.

6.13. Severability

The provisions of this Permit are severable, and if any provision of this Permit, or the application of any provision of this Permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this Permit shall not be affected thereby.

6.14. Requiring a Different Permit

The *Director* may require the Permittee authorized by this Permit to obtain an individual *UPDES* Permit. Any interested person may petition the *Director* to take action under this paragraph. The *Director* may require the Permittee authorized to discharge under this Permit to apply for an individual *UPDES* Permit only if the Permittee has been notified in writing that a Permit application is required. This notice shall include a brief statement of the reasons for this decision, an application form (as necessary), a statement setting a deadline for the Permittee to file the application, and a statement that on the effective date of the municipal *UPDES* Permit, coverage under this Permit shall automatically terminate. Permit applications shall be submitted to the address of the *Division* shown in *Part 5.5.* of this Permit. The *Director* may grant additional time to submit the application upon request of the applicant. If the municipality fails to submit in a timely manner a municipal *UPDES* Permit application as required by the *Director*, then the applicability of this Permit to the Permittee is automatically terminated at the end of the day specified for application submittal.

6.15. State/Federal Laws

Nothing in this Permit shall be construed to preclude the institution of any legal action or relieve the Permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable State law or regulation under authority preserved by *UCA 19-5-117* and *Section 510* of the *Clean Water Act* or any applicable Federal or State transportation regulations.

6.16. Proper Operation and Maintenance

The Permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the Permittee to achieve compliance with the conditions of this Permit and with the requirements of the SWMP. Proper operation and maintenance also include adequate laboratory controls and appropriate quality assurance procedures. Proper operation and maintenance requires the operation of backup or auxiliary facilities or similar systems, installed by the Permittee only when necessary to achieve compliance with the conditions of the Permit.

6.17. Monitoring and Records

6.17.1. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.

6.17.2. The Permittee shall retain records of all monitoring information including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of the reports required by this Permit, and records of all data used to complete the application for this Permit, for a period of at least five years from the date of the sample, measurement, report or application. This period may be extended by request of the *Director* at any time.

6.17.3. Records of monitoring information shall include:

6.17.3.1 The date, exact place, and time of sampling or measurements;

6.17.3.2 The name(s) of the individual(s) who performed the sampling or measurements;

6.17.3.3 The date(s) and time(s) analyses were performed;

6.173.4 The name(s) of the individual(s) who performed the analyses;

6.17.3.5 The analytical techniques or methods used; and

6.17.3.6 The results of such analyses.

6.18. Monitoring Procedures

Monitoring must be conducted according to test procedures approved under *Utah Admin. Code ("UAC") R317-2-10*, unless other test procedures have been specified in this Permit.

6.19. Inspection and Entry

The Permittee shall allow the *Director* or an authorized representative, upon the presentation of credentials and other documents as may be required by law, to:

6.19.1. Enter upon the Permittee's premises where a regulated facility or activity is located or conducted or where records must be kept under the conditions of this Permit;

6.19.2. Have access to and copy at reasonable times, any records that must be kept under the conditions of this Permit;

6.19.3. Inspect at reasonable times any facilities or equipment (including monitoring and control equipment); and

6.19.4. Sample or monitor at reasonable times, for the purposes of assuring Permit compliance or as otherwise authorized by law, any substances or parameters at any location.

6.20. Permit Actions

This Permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the Permittee for a Permit modification, revocation and re-issuance, termination, or a notification of planned changes or anticipated noncompliance does not suspend any Permit condition.

6.21. Storm Water-Reopener Provision

At any time during the duration (life) of this Permit, this Permit may be reopened and modified (following proper administrative procedures) as per *UAC R317.8*, to include, any applicable storm water provisions and requirements, a storm water pollution prevention plan, a compliance schedule, a compliance date, monitoring and/or reporting requirements, or any other conditions related to the control of storm water discharges to "waters of state".

7.0 **Definitions**

Definitions related to this Permit and small municipal separate storm sewers (MS4s).

"40 CFR" refers to Title 40 of the Code of Federal Regulations, which is the codification of the general and permanent rules published in the Federal Register by the executive departments and agencies of the Federal government.

"Act" means the *Utah Water Quality Act*.

"Analytical monitoring" refers to monitoring of waterbodies (streams, ponds, lakes, etc.) or of storm water, according to UAC R317-2-10 and 40 CFR 136 "Guidelines Establishing Test Procedures for the Analysis of Pollutants," or to State or Federally established protocols for biomonitoring or stream bio-assessments.

"Beneficial Uses" means uses of the waters of the state, which include but are not limited to: domestic, agricultural, industrial, recreational, and other legitimate beneficial uses.

"Best Management Practices" (BMPs) means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the state. BMPs also include treatment requirements, operating procedures, and practices to control facility site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

"CWA" means *The Clean Water Act of 1987*, formerly referred to as the Federal Water Pollution Control Act.

"Co-Permittee" means any operator of a regulated Small MS4 that is applying jointly with another applicant for coverage under this Permit. A Co-Permittee owns or operates a regulated Small MS4 located within or adjacent to another regulated MS4. A Co- Permittee is only responsible for complying with the conditions of this Permit relating to discharges from the MS4 the Co-Permittee owns or operates. See also 40 CFR 122.26(b)(1).

"Control Measure" refers to any Best Management Practice or other method used to prevent or reduce the discharge of pollutants to waters of the state.

"Common plan of development or sale" means one plan for development or sale, separate parts of which are related by any announcement, piece of documentation (including a sign, public notice or hearing, sales pitch, advertisement, drawing, plat, blueprint, contract, Permit application, zoning request, computer design, etc.), physical demarcation (including contracts) that identify the scope of the project. A plan may still be a common plan of development or sale even if it is taking place in separate stages or phases, is planned in combination with other construction activities, or is implemented by different owners or operators.

"Developed site" means a parcel or property that was previously in commercial, industrial, institutional, governmental, or residential use. A parcel that was previously in an agricultural use would not be considered to be a developed site.

“Director” means the director of the Utah Division of Water Quality, otherwise known as the Executive Secretary of the Utah Water Quality Board.

“Division” means the Utah Division of Water Quality.

"Discharge" for the purpose of this Permit, unless indicated otherwise, refers to discharges from the Municipal Separate Storm Sewer System (MS4).

"Dry weather screening" is monitoring done in the absence of storm events to discharges representing, as much as possible, the entire storm drainage system for the purpose of obtaining information about illicit connections and improper dumping.

“Escalating enforcement procedures” refers to a variety of enforcement actions in order to apply as necessary for the severity of the violation and/or the recalcitrance of the violator.

“Entity” means a governmental body or a public or private organization.

"EPA" means the United States Environmental Protection Agency.

“General Permit” means a Permit which covers multiple dischargers of a point source category within a designated geographical area, in lieu of individual Permits being issued to each discharger.

“Ground water” means water in a saturated zone or stratum beneath the surface of the land or below a surface water body.

“High quality waters” means any water, where, for a particular pollutant or pollutant parameter, the water quality exceeds that quality necessary to support the existing or designated uses, or which supports an exceptional use.

"Illicit connection" means any man-made conveyance connecting an illicit discharge directly to a municipal separate storm sewer.

"Illicit discharge" means any discharge to a municipal separate storm sewer that is not composed entirely of storm water except discharges pursuant to a UPDES Permit (other than the UPDES Permit for discharges from the municipal separate storm sewer) to waters of the state.

“Impaired waters” means any segment of surface waters that has been identified by the *Directo*r as failing to support one or more of its designated uses. The *Director* periodically compiles a list of such waters known as the 303(d) List.

“Large MS4” *Large municipal separate storm sewer system* means all municipal separate storm sewers that are located in an incorporated place with a population of 250,000 or more as determined by the current Decennial Census by the Bureau of the Census.

“Low Impact Development” (LID) is an approach to land development (or re-development) that works with nature to more closely mimic pre-development hydrologic functions. LID employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treat storm water as a resource rather than a waste product. There are many practices that have been used to adhere to these principles such as bio-retention facilities, rain gardens, vegetated rooftops, rain barrels, and permeable pavements.

"MS4" is an acronym for "municipal separate storm sewer system".

"Maximum Extent Practicable" (MEP) is the technology-based discharge standard for Municipal Separate Storm Sewer Systems established by paragraph 402(p)(3)(B)(iii) of the Federal Clean Water Act (CWA), which reads as follows: "Permits for discharges from municipal storm sewers shall require controls to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques, and system, design, and engineering methods, and other such provisions as the Administrator or the State determines appropriate for the control of such pollutants."

"Medium MS4" *Medium municipal separate storm sewer system* means all municipal separate storm sewers that are located in an incorporated place with a population of 100,000 or more but less than 250,000, as determined by the1990 Decennial Census by the Bureau of the Census

"Monitoring" refers to tracking or measuring activities, progress, results, etc.;

"Municipal separate storm sewer system" means a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains) pursuant to paragraphs R317-8-1.6(4), (8), & (15), or designated under UAC R317-8-11.3(6)(a) and UAC R317-8-11.3(6)(b):

- that is owned or operated by a state, city, town, county, district, association, or other public body (created by or pursuant to State Law) having jurisdiction over disposal of wastes, storm water, or other wastes, including special districts under State Law such as a sewer district, flood control district or drainage district, or similar entity, or a designated and approved management agency under section 208 of the CWA that discharges to waters of the state;

- that is designed or used for collecting or conveying storm water;

- which is not a combined sewer; and

- which is not part of a Publicly Owned Treatment Works (POTW) as defined in 40 CFR 122.2.

"NOI" is an acronym for "Notice of Intent" to be covered by this Permit and is the mechanism used to "register" for coverage under a General Permit.

"Non-analytical monitoring" refers to monitoring for pollutants by means other than UAC R317-2-10 and 40 CFR 136, such as visually or by qualitative tools that provide comparative or rough estimates.

"Operator" is the person or entity responsible for the operation and maintenance of the MS4.

"Outfall" means a point source as defined by UAC R317-8-1.5(34) at the point where a municipal separate storm sewer discharges to waters of the state and does not include open conveyances connecting two municipal separate storm sewers, or pipes, tunnels or other conveyances which connect segments of the same stream or other waters of the state and are used to convey waters of the state.

“Phase II areas” means areas regulated under UPDES storm water regulations encompassed by Small MS4's (see definition 7.39.).

“Priority construction site” means a construction site that has potential to threaten water quality when considering the following factors: soil erosion potential; site slope; project size and type; sensitivity of receiving waterbodies; proximity to receiving waterbodies; non-storm water discharges and past record of non-compliance by the operators of the construction site.

“Redevelopment” is the replacement or improvement of impervious surfaces on a developed site.

“Runoff” is water that travels across the land surface, or laterally through the ground near the land surface, and discharges to water bodies either directly or through a collection and conveyance system. Runoff includes storm water and water from other sources that travels across the land surface.

“SWMP” is an acronym for storm water management program. The SWMP document is the written plan that is used to describe the various control measures and activities the Permittee will undertake to implement the storm water management plan.

“SWPPP" is an acronym for storm water pollution prevention plan.

“Small municipal separate storm sewer system” is any MS4 not already covered by the Phase I program as a medium or large MS4. The Phase II Rule automatically covers on a nationwide basis all Small MS4s located in “urbanized areas” (UAs) as defined by the Bureau of the Census (unless waived by the UPDES Permitting authority), and on a case-by-case basis those Small MS4s located outside of UAs that the UPDES Permitting authority designates.

- This term includes systems similar to separate storm sewer systems in municipalities, such as systems at military bases, large hospital or prison complexes, and highways and other thoroughfares. The term does not include separate storm sewers in very discrete areas, such as individual buildings.

“SOP” is an acronym for standard operating procedure which is a set of written instructions that document a routine or repetitive activity. For the purpose of this Permit, SOPs should emphasize pollution control measures to protect water quality.

"Storm water" means storm water runoff, snowmelt runoff, and surface runoff and drainage.

“Storm water management program” means a set of measurable goals, actions, and activities designed to reduce the discharge of pollutants from the Small MS4 to the maximum extent practicable and to protect water quality.

“TMDL” is an acronym for “Total Maximum Daily Load” and in this Permit refers to a study that: 1) quantifies the amount of a pollutant in a stream; 2) identifies the sources of the pollutant; and 3) recommends regulatory or other actions that may need to be taken in order for the impaired waterbody to meet water quality standards.

“Urbanized area” is a land area comprising one or more places and the adjacent densely settled surrounding area that together have a residential population of at least 50,000 and an overall population density of at least 1,000 people per square mile.

“waters of the state” means all streams, lakes, ponds, marshes, water-courses, waterways, wells, springs, irrigation systems, drainage systems, and all other bodies or accumulations of water, surface and underground, natural or artificial, public or private which are contained within, flow through, or border upon this state or any portion thereof, except bodies of water confined to and retained within the limits of private property, and which do not develop into or constitute a nuisance, or a public health hazard, or a menace to fish and wildlife which shall not be considered to be “waters of the state” under this definition (“UAC” R317-1-1).

APPENDIX 10

STANDARD FOR LOW IMPACT DEVELOPMENT (LID)

WEST POINT CITY

STANDARD FOR LOW IMPACT DEVELOPMENT (LID)

May 2021

WEST POINT CITY
STANDARD FOR LOW IMPACT DEVELOPMENT (LID)

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SECTION A - Executive Summary

The purpose of this Low Impact Development (LID) Standard is to fulfill the requirements of the "Section 4.2.5 Long-Term Storm Water Management in New Development and Redevelopment (Post-Construction Strom water Management) of the General Permit" (Section 4.2.5 of the General Permit) under the Utah Pollutant Discharge Elimination System.

This standard covers the Small MS4 General Permit and West Point City requirements for new developments and redevelopment projects in preventing the off-site discharge of the precipitation from all rainfall events less than or equal to the 80^{th} percentile rain event. Meeting the 80^{th} percentile requirements will be accomplished by implementing approved LID practices that are discussed later in this report.

West Point City's 80^{th} percentile storm depth is 0.50 inches. Developments are required to obtain and submit a soils report. This soils report will help to determine effective methods to retain the 80^{th} percentile storm event. The storm water depths and soil characteristics will be used to calculate the water quality volume (WQV).

Each LID practice discussed in this report must be approved by West Point City prior to use. The selected LID practices must be shown to be feasible, effective, and maintainable. This standard will go into further detail on best management practices (BMPs), technical information, background, and how to decide which LID practice is best suited for each Permittees development. If an LID approach cannot be utilized, the Permittee must provide documentation and explanation of why the development will not meet LID standards. Documentation and explanation must be submitted for an alternative to retention of the 80^{th} percentile storm.

All LID practices will be submitted by the Permittee as part of the plan review process and be reviewed by West Point City Storm Water Manager or Engineering staff. Long term maintenance agreements between the Permittee and West Point City will be required after plan approval and prior to construction. The City will review and revise this plan in the future as needed.

West Point City is committed to a clean environment and caring for the quality of water that is discharged from the City. By implementing the new requirements set forth in this plan measures will be taken to reduce off-site discharge and minimize negative impacts on water quality.

SECTION 1 – Summary & Permit Requirements

1.1 Background

The purpose of traditional storm water management in the past was to convey runoff flow offsite as directly as possible. Strom drains have been used as flood control infrastructure to convey runoff and discharge it to some receiving water. This runoff discharged to receiving waters often carries pollutants and degrades the quality of the receiving water. These negative impacts can be reduced with the incorporation of Low Impact Development practices.

Low Impact Development (LID) is referred to as engineered systems 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. These engineered systems can be made by structural or natural means.

West Point City has developed this standard to incorporate LID practices into new and redevelopment projects. As of May 12, 2021 all new development and redevelopment projects will be required to prevent off site discharge of all rainfall events less than or equal to the 80th percentile rainfall event, and incorporate LID practices into development.

1.2 Summary of LID Report

This Standard for Low Impact Development Report will be the guideline for all new developments and redevelopment project in West Point. All developments will be required to submit LID practices to West Point City for plan review prior to construction. The requirements and expectations from both the Small MS4 General Permit and West Point City will be addressed in this document.

The new requirements state that all new developments and redevelopments must implement section 4.2.5.1.2 of the General Permit, located in Appendix E, requiring Permittee to manage rainfall, on site, less than or equal to the 80th percentile rainfall event. West Point City's 80th percentile storm depth is 0.50 inch for a rainfall event. Calculations for water quality volume (WQV), using 80th percentile storm depth, will need to be submitted. A Soils Report will be required to determine effective methods to retain the 80th percentile rainfall event.

A list of the LID practices can be found in "A Guide to Low Impact Development within Utah" located in this documents Appendix F. Prior to use, LID practices discussed in this standard must be approved by West Point City. The selected LID practices must be shown to be feasible, effective, and maintainable. If an LID approach cannot be utilized, documentation and explanation must be submitted for an alternative to retention of the 80th percentile storm by the Permittee.

1.3 Requirements

The requirements covered in this standard have been specified in "Section 4.2.5 of the General Permit," shown in Appendix E. Additional requirements are also included in the section.

General Permit and West Point City Requirement are as follows:

- Permit Part 4.2.5.1.2 – "New development projects that disturb land greater than or equal to one acre, including projects that are part of a larger common plan of development or sale which collectively disturbs land greater than or equal to one acre must manage rainfall on-site, and prevent the off-site discharge of the precipitation from all rainfall events less than or equal to the 80th percentile rainfall event or a predevelopment hydrologic condition, whichever is less. This objective must be accomplished by the use of practices that are designed, constructed, and maintained to infiltrate, evapotranspire and/or harvest and reuse rainwater. The 80th percentile rainfall event is the event whose precipitation total is greater than or equal to 80 percent of all storm events over a given period of record."

- Permit Part 4.2.5.1.2 – "Redevelopment projects that disturb greater than or equal to one acre, including projects less than an acre that are part of a larger common plan of development or sale which collectively disturbs land greater than or equal to one acre must provide a site-specific and project-specific plan aimed at net gain to onsite retention or a reduction to impervious surface to provide similar water quality benefits. 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 80th percentile rainfall event. This objective must be accomplished by the use of practices that are designed, constructed, and maintained to infiltrate, evapotranspire and/or harvest and reuse rainwater."

- Permit Part 4.2.5.1.3 – "The program shall include a process which ***requires*** the evaluation of a Low Impact Development (LID) approach for all projects subject to the requirements in 4.2.5.1.2. A LID approach promotes the implementation of BMPs that allow storm water to infiltrate, evapotranspire or harvest and use storm water on site to reduce runoff from the site and protect water quality."

- Permit Part 4.2.5.1.3 – "Permittees must allow for use of a minimum of five LID practices from the list in Appendix C of the Guide. If a Permittee has not adopted specific LID practices from Appendix C, any LID approach that meets 4.2.5.1.2 and is feasible may be used to meet this requirement."

- Permit Part 4.2.5.1.4 – "Feasibility. If meeting the retention standards described in Part 4.2.5.1.2 is infeasible, a rationale shall be provided for the use of alternative design criteria. The new or redevelopment project must document and quantify that infiltration, evapotranspiration, and rainwater harvesting have been used to the maximum extent feasible and that full employment of these controls are infeasible due to constraints. LID infeasibility may be due to one or more of the following conditions: high groundwater, drinking water source protection areas, soil conditions, slopes, accessibility, excessive costs, or other justifiable constraint."

- Permit Part 4.2.5.2.3 – "The ordinance or other regulatory mechanism shall include provisions for post-construction access for Permittees to inspect storm water control measures on private properties that discharge to the MS4 to ensure that adequate maintenance is being performed."

- Permit Part 4.2.5.2.4 – "Permanent structural BMPs shall be inspected at least once during installation by qualified personnel. Upon completion, the Permittee must verify that long-term BMPs were constructed as designed."

- Permit Part 4.2.5.2.5 – "Inspections and any necessary maintenance must be conducted at least every other year or as necessary to maintain functionality of the control by either the Permittee, or, if applicable, the property owner/operator…… Following an inspection, if there is an observed failure of a facility to perform as designed, the Permittee must document its findings in an inspection report." (See General Permit for inspection report guidelines)

- Permit Part 4.2.5.3.1 – "Adopt and implement procedures for site plan review which evaluates water quality impacts. The procedures shall apply though the life of the project from conceptual design to project closeout."

- All LID practices must be submitted to West Point City to show that each LID practice is feasible, maintainable, and effect. City must approve LID practices prior to instillation.

- Submit Soils Report identifying soil properties to be used in design and selection of LID practices and calculations. See section 3 for more details.

- Provide a "Storm Water Quality Report" shown in Appendix C as part of the submittal to West Point City.

- A long term maintenance agreement between West Point City and Permittee will be required prior to construction.

1.4 Checklist

- ☐ Soils Report
- ☐ Calculations (Depth & WQV)
- ☐ LID practices to meet 80th percentile requirement
- ☐ Storm water quality report
- ☐ Infeasibility documentation and explanation (if applicable)
- ☐ Plan Approval prior to construction
- ☐ Long term maintenance agreement identifying management plan and inspection schedule

SECTION 2 - Water Quality Volume

2.1 Summary of Calculations

The 80th percentile rainfall depth represents the depth of rainfall which is not exceeded in 80 percent of all runoff producing rainfall events within the time period analyzed. Meaning that 80 percent of all storm events that happen in West Point that produce runoff will be less than or equal to the depth calculated. Calculating the rainfall depth and WQV with be required prior to selecting LID techniques to infiltrate, harvest or evapotranspire the runoff generated by the rainfall.

2.2 Method for Calculating 80th Percentile Depth

The depth is calculated by obtaining the long term daily rainfall data reported in inches. Precipitation data is sorted from low to high and events less than or equal to 0.1 inch are eliminated. Events less than 0.1 inch do not result in a measurable runoff due to evaporation, infiltration, etc.

The percentile function in excel (k=0.2….0.8, 0.85, 0.9, 0.95) is used to calculate the 80th percentile value of data, see Table 1 below. A frequency curve, is shown in Figure 1 below, which depicts the percentile of rainfall events greater than or equal to a given rainfall depth. The Utah Department of Environmental Quality has calculated a 0.50 inch rainfall depth for the 80th percentile event for West Point City, shown in Appendix A. This depth will be used to calculate the volume of water required to be retained onsite or the WQV more detail can be found in Appendix F – "A Guide to Low Impact Development within Utah."

Table 1 – West Point 80th Percentile Value of Data

Depth (in)	Percentile
0.15	10%
0.17	20%
0.20	30%
0.24	40%
0.28	50%
0.33	60%
0.40	70%
0.50	**80%**
0.59	85%
0.67	90%

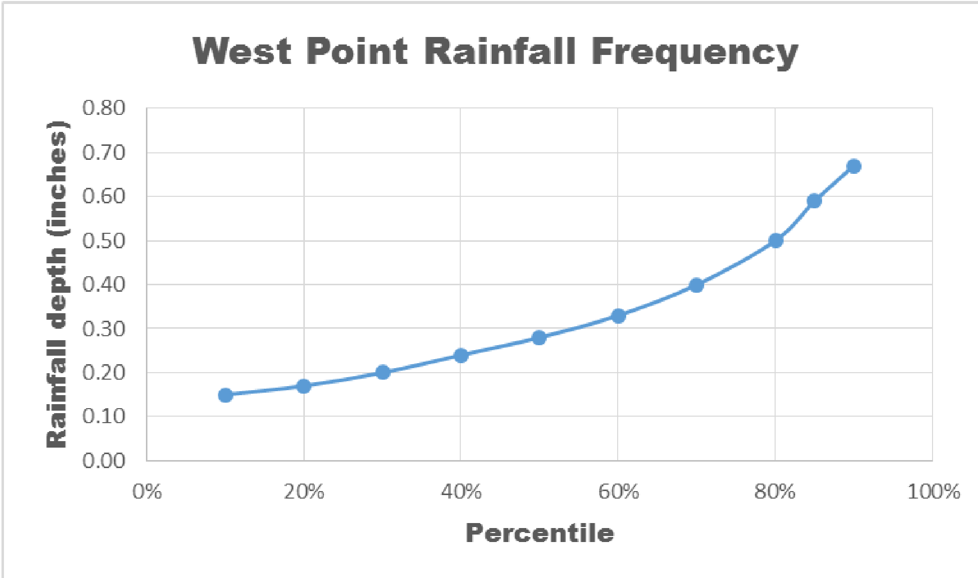

Figure 1 - West Point Frequency Curve

2.3 Method for Calculating Water Quality Volume

The volume of runoff generated within the projects limits of disturbance over a 24-hour period during the 80th percentile storm event is called the WQV. To calculate the WQV the following equation can be used:

$$V=Rv*d*A$$

V= Water Quality Volume, cf
Rv = Volumetric runoff coefficient, unitless
d = 80th Percentile precipitation depth, ft
A = Project area, sf

The volumetric runoff coefficient, Rv, is a calculation of the percentage of rainfall that results in surface runoff. Methods for calculating runoff coefficient can be found in Appendix F, Guide to Low Impact Development within Utah. See "A Guide to Low Impact Development within Utah" for examples of the process to obtain the WQV.

SECTION 3 – LID Practices

3.1 Summary of Practices

West Point City is requiring each Permittee to use LID practices that are approved by West Point City prior to use. The selected LID practices must be shown to be feasible, effective, and maintainable. Documentation of each LID practice should be put into the "Storm Water Quality Report," located in Appendix C, when submitting the plan to West Point City for review. Refer to the “A Guide to Low Impact Development within Utah” for in depth detail about each LID practices.

3.2 List of LID Practices

There are many different LID practices available to use. Each will depend on the development characteristics to best decide which LID practices to use. “A Guide to Low Impact Development within Utah” in appendix F provides detail for possible LID practices that should be considered. The permittee must decide which LID practice best fits within their project. The following is a list of LID practices from the “A Guide to Low Impact Development within Utah”:

- Rain Garden
- Bioretention Cell
- Bioswale
- Vegetated Strip
- Tree Box Filter
- Green Roofs
- Pervious Surfaces
- Infiltration Basin
- Infiltration Trench
- Dry Well
- Underground Infiltration Galleries
- Harvest and Reuse

Design criteria, calculation methods, example calculations, effectiveness, designer checklist, vegetation, installation, installation costs, maintenance, and a figures for LID practices can be found in “A Guide to Low Impact Development within Utah”.

3.3 Soils Report

When designing and planning LID practices, soil characteristics and depth of ground water must be considered. Soil properties should also be considered in plant selection. A Hydrologic Soil Group Map for West Point that shows an estimate of what soils are in each area of the city is included for reference in Appendix B.

A Soils report is required to for each new development and redevelopment and must be submitted during the plan review with all other documentation for Permittees LID practices. A Soils Report will provide soil properties, ground water depth, infiltration rates, and other information needed in selecting LID’s.

SECTION 4 – Infeasibility

4.1 Infeasibility Guidelines

Permittee is required to implement LID practices. “A Guide to Low Impact Development within Utah, Appendix C”, shown in Appendix F, should be used for reference in LID selection to retain the 80^{th} percentile storm.

There may be cases where it is infeasible to meet the requirements of retaining the 80^{th} percentile storm onsite. If an LID approach cannot be utilized and is infeasible, the Permittee must submit to West Point City documentation and explanation of why an LID approach is infeasible. This documentation must also include an alternative to retention of the 80^{th} percentile storm and LID implementation, explaining what degree of compliance the project will reach.

This alternative criteria must be approved by West Point City.

APPENDIX A

80TH PERCENTILE CALCULATIONS

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
Brigham City Corporation	0.54	Orem	0.50
Farr West City Corp	0.43	Payson City	0.46

Facility Operator Name (MS4)	80th Percentile Storm Depth (in)	Facility Operator Name (MS4)	80th Percentile Storm Depth (in)
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

APPENDIX B

WEST POINT HYDROLOGIC SOILS GROUP MAP

West Point Soil Rating Hydrologic Soil Group Map

Legend **Soil Rating**

- A — Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.
- B — Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.
- C — Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.
- C/D — If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.
- D — Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.
- Water

APPENDIX C

STORM WATER QUALITY REPORT FORM

Storm Water Quality Report – Template

Date: ________________________________

Project Name: _________________________

Project ID: ____________________________

Design Engineer: _______________________

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

If yes:

Name of receiving water(s): ____

Listed Impairment(s): ____

Does the watershed that has an approved TMDL? _________________

If yes:

Approved TMDL(s): ____

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

____

[name], Project Manager

____

[name], Designate Storm Water Coordinator

____

[name], Head of Maintenance

[stamp required at final design phase]

____

[name], Landscape Architect or Equivalent

Project Information

80^{th} Percentile Storm Depth (in): ______

New Development

Area of Land Disturbance (ac): ______

Project Impervious Area (ac): ______

Project Imperviousness (%): ______

Project Volumetric Runoff Coefficient, R_V: ______

80^{th} Percentile Volume (cf): ______

Predevelopment Hydrologic Condition (cf): ______

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

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: ______

80^{th} Percentile Volume, V_1 (cf): ______

Proposed Project Conditions

Imperviousness (%): ______

Volumetric Runoff Coefficient, R_V: ______

80^{th} Percentile Volume, V_2 (cf): ______

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

Subsurface Information

Groundwater

Depth to Groundwater (ft): _______

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

Source: ________________________________

Groundwater Contamination at Site: __________

Soil Information

Infiltration Rate (in/hr): _________

Hydrologic Soil Group: __________

Source: ______________________

Soil Contamination at Site: ___________

Drinking Water

Within Drinking Water Source Area Protection: __________

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					
CDA 2					
CDA 3					
CDA 4					
				Total WQV (cf)	

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				
CDA 2				
CDA 3				
CDA 4				
		Total Volume Retained (cf)		

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

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 D

Long Term Maintenance Agreement

When recorded, mail to:

West Point City
3200 W 300 N
West Point, UT
84015

Affects Parcel No(s): ___________________________________

LONG-TERM STORMWATER MANAGEMENT AGREEMENT

This Long-Term Stormwater Management Agreement ("Agreement") is made and entered into this _______ day of _______________________, 20_______, by and between WEST POINT CITY, a Utah municipal corporation ("City"), and ____, a ____ ("Owner").

RECITALS

WHEREAS, the City is authorized and required to regulate and control the storm and surface waters within the MS4, as set forth in the City Stormwater Ordinance, ("Ordinance"), adopted pursuant to the Utah Water Quality Act, as set forth in *Utah Code Ann*. §§ 19-5-101, *et seq*., as amended ("Act"); and

WHEREAS, the Owner hereby represents and acknowledges that it is the owner in fee simple of certain real property more particularly described in Exhibit "A", attached hereto and incorporated herein by this reference ("Property"); and

WHEREAS, the Owner desires to build or develop the Property and/or to conduct certain regulated construction activities on the Property which will alter existing storm and surface water conditions on the Property and/or adjacent lands; and

WHEREAS, in order to accommodate and regulate these anticipated changes in existing storm and surface water flow conditions, the Owner is required to build and maintain at Owner's expense a storm and surface water management facility or improvements ("Stormwater Facilities"); and

WHEREAS, the Stormwater Facilities are more particularly described and shown in the final site plan or subdivision approved for the Property and related engineering drawings, and any amendments thereto, which plans and drawings are on file with the City and are hereby incorporated herein by this reference ("Development Plan"); and

WHEREAS, summary description of all Stormwater Facilities, details and all appurtenance draining to and affecting the Stormwater Facilities and establishing the standard operation and routine maintenance procedures for the Stormwater Facilities, and control measures installed on the Property, ("Long Term Stormwater Management Plan") more particularly shown in Exhibit "B" on file with the City Recorder and,

WHEREAS, a condition of Development Plan approval, and as required as part of the City's Small MS4 UPDES General Permit from the State of Utah, Owner is required to enter into this Agreement establishing a means of documenting the execution of the Long Term Stormwater Management Plan and,

NOW, THEREFORE, in consideration of the benefits received and to be received by the Owner, its successors and assigns, as a result of the City's approval of the Long Term Stormwater Management Plan, and the mutual covenants contained herein, the parties agree as follows:

Section 1

Construction of Stormwater Facilities. The Owner shall, at its sole cost and expense, construct the Stormwater Facilities in accordance with the Development Plans and specifications, and any amendments thereto which have been approved by the City.

Section 2

Maintenance of Stormwater Facilities. The Owner shall, at its sole cost and expense, adequately maintain the Stormwater Facilities. Owner's maintenance obligations shall include all system and appurtenance built to convey stormwater, as well as all structures, improvements, and vegetation provided to control the quantity and quality of the stormwater. Adequate maintenance, for purposes of this Agreement, is defined as good working condition so that the Stormwater Facilities are performing their design functions. The Owner shall, at its sole cost and expense, perform all work necessary to keep the Stormwater Facilities in good working condition.

Section 3

Annual Maintenance Report of Stormwater Facilities. The Owner shall, at its sole cost and expense, inspect the Stormwater Facilities and submit an inspection report and certification to the MS4 annually. The purpose of the inspection and certification is to assure safe and proper functioning of the Stormwater Facilities. The annual inspection shall cover all aspects of the Stormwater Facilities, including, but not limited to, the parking lots, structural improvements, berms, channels, outlet structure, pond areas, access roads, vegetation, landscaping, etc. Deficiencies shall be noted in the inspection report. The report shall also contain a certification as to whether adequate maintenance has been performed and whether the structural controls are operating as designed to protect water quality. The annual inspection report and certification shall be due by June 30th of each year and shall be on forms acceptable to the City.

Section 4

City Oversight Inspection Authority. The Owner hereby grants permission to the City, its authorized agents and employees, to enter upon the Property and to inspect the Stormwater Facilities upon reasonable notice not less than three business days to the Owner. Such inspections shall be conducted in a reasonable manner and at reasonable times, as determined appropriate by the City. The purpose of the inspection shall be to determine and ensure that the Stormwater Facilities are being adequately maintained, are continuing to perform in an adequate manner, and are in compliance with the Act, the Ordinance, and the Stormwater Facilities Maintenance Plan.

Section 5

Notice of Deficiencies. If the City finds that the Stormwater Facilities contain any defects or are not being maintained adequately, the City shall send Owner written notice of the defects or deficiencies and provide Owner with a reasonable time, but not less than sixty (60) days, to cure such defects or deficiencies. Such notice shall be confirmed delivery to the Owner or sent certified mail to the Owner at the address listed on the County Tax Assessor.

Section 6

Owner to Make Repairs. The Owner shall, at its sole cost and expense, make such repairs, changes or modifications to the Stormwater Facilities as may be determined as reasonably necessary by the City within the required cure period to ensure that the Stormwater Facilities are adequately maintained and continue to operate as designed and approved.

Section 7

City's Corrective Action Authority. In the event the Owner fails to adequately maintain the Stormwater Facilities in good working condition acceptable to the City, after due notice of deficiencies as provided in Section 5 and failure to cure, then, upon Owner's failure to cure or correct within thirty days following a second notice delivered to Owner, the City may issue a Citation punishable as a Misdemeanor in addition to any State or EPA fine. The City may also give written notice that the facility storm drain connection will be disconnected. Any damage resulting from the disconnection is subject to the foregoing cure periods. It is expressly understood and agreed that the City is under no obligation to maintain or repair the Stormwater Facilities, and in no event shall this Agreement be construed to impose any such obligation on the City. The actions described in this Section are in addition to and not in lieu of any and all equitable remedies available to the City as provided by law for Owner's failure to remedy deficiencies or any other failure to perform under the terms and conditions of this Agreement.

Section 8

Reimbursement of Costs. In the event the City, pursuant to this Agreement, incurs any costs, or expends any funds resulting from enforcement or cost for labor, use of equipment, supplies, materials, and the like related to storm drain disconnection from the City system, the Owner shall reimburse the City upon demand, within thirty (30) days of receipt thereof for all actual costs incurred by the City. After said thirty (30) days, such amount shall be deemed delinquent and shall be subject to interest at the rate of ten percent (10%) per annum. Owner shall also be liable for any collection costs, including attorneys' fees and court costs, incurred by the City in collection of delinquent payments.

Section 9

Successor and Assigns. This Agreement shall be recorded in the County Recorder's Office and the covenants and agreements contained herein shall run with the land and whenever the Property shall be held, sold, conveyed or otherwise transferred, it shall be subject to the covenants, stipulations, agreements and provisions of this Agreement which shall apply to, bind and be obligatory upon the Owner hereto, its successors and assigns, and shall bind all present and subsequent owners of the Property described herein.

Section 10

Severability Clause. The provisions of this Agreement shall be severable and if any phrase, clause, sentence or provision is declared unconstitutional, or the applicability thereof to the Owner, its successors and assigns, is held invalid, the remainder of this Covenant shall not be affected thereby.

Section 11

Utah Law and Venue. This Agreement shall be interpreted under the laws of the State of Utah. Any and all suits for any claims or for any and every breach or dispute arising out of this Agreement shall be maintained in the appropriate court of competent jurisdiction in Weber County, Utah.

Section 12

Indemnification. This Agreement imposes no liability of any kind whatsoever on the City, and the Owner agrees to hold the City harmless from any liability in the event the Stormwater Facilities fail to operate properly. The Owner shall indemnify and hold the City harmless for any and all damages, accidents, casualties, occurrences, or claims which might arise or be asserted against the City from failure of Owner to comply with its obligations under this agreement relating to the Stormwater Facilities.

Section 13

Amendments. This Agreement shall not be modified except by written instrument executed by the City and the Owner of the Property at the time of modification, and no modification shall be effective until recorded in the Weber County Recorder's Office.

Section 14

Subordination Requirement. If there is a lien, trust deed or other property interest recorded against the Property, the trustee, lien holder, etc., shall be required to execute a subordination agreement or other acceptable recorded document agreeing to subordinate their interest to the Agreement.

Section 15

Exhibit B. The Long-Term Stormwater Management Plan (LTSWMP) must adapt to change in good judgment when site conditions and operations change and when existing programs are ineffective. Exhibit B will not be filed with the agreement at County Recorder but is included by reference and kept on file with the City Recorder. Revision applications must be filed with the City _________________ and amended into the LTSWMP on file with the ______________ City recorder.

LONG-TERM STORMWATER MANAGEMENT PLAN AGREEMENT

SO AGREED this ____________day of ___________________20_______.

PROPERTY OWNER

By:_________________________________ Title: _______________________

By:_________________________________ Title: _______________________

STATE OF UTAH)
:ss.
COUNTY OF)

The above instrument was acknowledged before me by __________________, this _______ day of _____________________, 20______.

____
Notary Public
Residing in: _________________________
My commission expires: _______________

_______________________ CITY

By: __________________________________ Date: _____________________
Mayor _______________

Attest: ________________________________
City Recorder

STATE OF UTAH)
:ss.
COUNTY OF)

The above instrument was acknowledged before me by __________________, this _______ day of _____________________, 20______.

____
Notary Public
Residing in: _________________________
My commission expires: _______________ LTSWMP_____

Attachments:

Exhibit A: Legal Description
Exhibit B: Long-Term Stormwater Management Plan; Filed with WEST POINT City Recorder

APPENDIX E

GENERAL PERMIT SECTION 4.2.5 – LONG-TERM STORM WATER MANAGEMENT IN NEW DEVELOPMENT AND REDEVELOPMENT (POST-CONSTRUCTION STORM WATER MANAGEMENT)

4.2.4.5 The Permittee must ensure that all staff whose primary job duties are related to implementing the construction storm water program, including permitting, plan review, construction site inspections, and enforcement, are annually trained to conduct these activities. The training can be conducted by the MS4 or outside training can be attended. Such training must be extended to third-party inspectors and plan reviewers as well. The Permittee shall ensure that all new hires are trained within **60 days** of hire date and annually thereafter, at a minimum. Follow-up training shall be provided as needed to address changes in procedures, methods, or staffing. Training records must be kept and contain, at a minimum, dates, activities or course descriptions, and names and positions of staff in attendance.

4.2.4.6. All Permittees shall maintain records of all projects disturbing greater than or equal to one acre, 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. Permittees shall keep records which include but not limited to, site plan reviews, SWPPPs, inspections, and enforcement actions including verbal warnings, stop work orders, warning letters, notices of violation, and any other enforcement conducted. Permittees shall keep records of these projects for five years or until construction is completed, whichever is longer.

4.2.5. Long-Term Storm Water Management in New Development and Redevelopment (Post-Construction Storm Water Management)

The Permittee shall revise (as necessary), implement, and enforce a program to address post-construction storm water runoff to the MS4 from private and public new development and redevelopment construction sites meeting the thresholds below. The water quality considerations of this minimum control measure do not replace or substitute for water quantity or flood management requirements implemented on the local level for new development or redevelopment sites. The water quality controls may be incorporated into the design of structures intended for flow control; or water quality control may be achieved with separate control measures. The program must apply to private and public development sites.

The minimum performance measures are:

4.2.5.1. <u>Post-construction Controls.</u> The Permittee's new development/redevelopment program must have requirements or standards to ensure that any storm water controls or management practices for new development and redevelopment will prevent or minimize impacts to water quality. BMPs must be selected that address pollutants known to be discharged or have potential to be discharged from the site.

4.2.5.1.1. The Permittee's new development/redevelopment program should include non-structural BMPs. The Permittee should consider non-structural BMPs, including. requirements and standards to minimize development in areas susceptible to erosion and sediment loss; minimize the disturbance of native soils and vegetation; preserve areas that provide important water quality benefits; implement measures for flood control; and protect the integrity of natural resources and sensitive areas.

4.2.5.1.2. Retention Requirement. The Permittee must develop and define a specific hydrologic method or methods for calculating runoff volumes and flow rates to ensure consistent sizing of structural BMPs in their jurisdiction and to facilitate plan review.

New development projects that disturb land greater than or equal to one acre, including projects that are part of a larger common plan of development or sale which collectively disturbs land greater than or equal to one acre must manage rainfall on-site and prevent the off-site discharge of the precipitation from all rainfall events less than or equal to the 80th percentile rainfall event or a predevelopment hydrologic condition, whichever is less. This objective must be accomplished by the use of practices that are designed, constructed, and maintained to infiltrate, have evapotranspiration, and/or harvest and reuse rainwater. The 80th percentile rainfall event is the event whose precipitation total is greater than or equal to 80 percent of all storm events over a given period of record.

Redevelopment projects that disturb greater than or equal to one acre, including projects less than an acre that are part of a larger common plan of development or sale which collectively disturbs land greater than or equal to one acre must provide a site-specific and project-specific plan aimed at net gain to onsite retention or a reduction to impervious surface to provide similar water quality benefits. 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 80th percentile rainfall event. This objective must be accomplished by the use of practices that are designed, constructed, and maintained to infiltrate, have evapotranspiration, and/or harvest and reuse rainwater.

4.2.5.1.3. Low Impact Development Approach. The program shall include a process which ***requires*** the evaluation of a Low Impact Development (LID) approach for all projects subject to the requirements in 4.2.5.1.2. A LID approach promotes the implementation of BMPs that allow storm water to infiltrate, have evapotranspiration or harvest[1] and use storm water on site to reduce runoff from the site and protect water quality.

Guidance for implementing LID can be found in DWQ's LID controls which are appropriate for use in the State of Utah can be found in *A Guide to Low Impact Development within Utah* (the Guide), available on DWQ's website.

Permittees must allow for use of a minimum of five LID practices from the list in Appendix C of the Guide. If a Permittee has not adopted specific LID practices from Appendix C, any LID approach that meets 4.2.5.1.2 and is feasible may be used to meet this requirement.

4.2.5.1.4. Feasibility. If meeting the retention standards described in Part 4.2.5.1.2 is infeasible, a rationale shall be provided for the use of alternative design criteria. The new or redevelopment project must document and quantify that infiltration, evapotranspiration, and rainwater harvesting have been used to the maximum extent feasible and that full employment of these controls are infeasible due to constraints. LID infeasibility may be due to one or more of the following conditions: high groundwater, drinking water source protection areas, soil conditions, slopes, accessibility, excessive costs, or any other justifiable constraint.

Guidance for assessing and documenting site conditions can be found in DWQ's "A Guide to Low Impact Development within Utah" Appendix B "Storm Water Quality Report Template" located on the DWQ website at: https://documents.deq.utah.gov/water-quality/stormwater/updes/DWQ-2019-000161.pdf.

A MS Word version can be found on DWQ's website at: https://documents.deq.utah.gov/water-quality/stormwater/DWQ-2018-013750.docx.

4.2.5.2. Regulatory Mechanism. Develop and adopt an ordinance or other regulatory mechanism that requires long-term post-construction storm water controls at new development and redevelopment sites. The ordinance or other regulatory mechanism shall apply, at a minimum, to new development and redevelopment sites that discharge to the MS4 that disturb greater than or equal to one acre, 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. The ordinance or other regulatory mechanism shall require BMP selection, design, installation, operation, and maintenance standards necessary to protect water quality and reduce the discharge of

[1]Since 2010, rainwater harvesting is legal in the State of Utah. Depending on the volume of rainwater collected and stored for beneficial use, the Permittee must meet the requirements of the Utah Division of Water Rights to harvest rainwater found on their website: http://waterrights.utah.gov/forms/rainwater.asp.

The Permittee's ordinance or other regulatory mechanism must include an appeals process.

4.2.5.2.1 The Permittee must include enforcement provisions in the ordinance or other regulatory mechanism that must contain procedures for specific processes and sanctions to minimize the occurrences of violations and obtain compliance from chronic and recalcitrant violators. These processes and sanctions shall include appropriate, escalating enforcement procedures and actions.

4.2.5.2.2 The Permittee must maintain documentation on how the requirements of the ordinance or other regulatory mechanism will protect water quality and reduce the discharge of pollutants to the MS4.

Documentation shall include:

- How long-term storm water BMPs were selected;
- The pollutant removal performance expected from the selected BMPs; and
- The technical basis which supports the performance claims for the selected BMPs.

All Permittees shall adopt and implement SOPs or similar types of documents for site inspection and enforcement of post-construction storm water control measures. These procedures must ensure adequate ongoing long-term operation and maintenance of approved storm water control measures.

4.2.5.2.3 The ordinance or other regulatory mechanism shall include provisions for post-construction access for Permittees to inspect storm water control measures on private properties that discharge to the MS4 to ensure that adequate maintenance is being performed. The ordinance or other regulatory mechanism may require private property owner/operators or qualified third parties to conduct maintenance and provide annual certification that adequate maintenance has been performed and the structural controls are operating as designed to protect water quality, in lieu of the Permittee. If the Permittee requires a maintenance agreement addressing maintenance requirements for any control measures installed on site, the agreement must allow the Permittee to conduct oversight inspections of the storm water control measures and also account for transfer of responsibility in leases and/or deeds. The agreement must also allow the Permittee to perform necessary maintenance or corrective actions neglected by the property owner/operator and bill or recoup costs from the property owner/operator as needed.

4.2.5.2.4 Permanent structural BMPs shall be inspected at least once during installation by qualified personnel. Upon completion, the Permittee must verify that long-term BMPs were constructed as designed.

4.2.5.2.5 Inspections and any necessary maintenance must be conducted at least every other year or as necessary to maintain functionality of the control by either the Permittee, or, if applicable, the property owner/operator. On sites where the property owner/operator is conducting maintenance, the Permittee shall inspect those storm water control measures at least once every five years, or more frequently as determined by the Permittee, to verify and ensure that adequate maintenance is being performed. Following an inspection, if there is an observed failure of a facility to perform as designed, the Permittee must document its findings in an inspection report. The inspection report must include the following:

- Inspection date;
- Name and signature of inspector;
- Project location;
- Current ownership information;
- A description of the condition of the storm water control measure including the quality of: vegetation and soils; inlet and outlet channels and structures; catch basins; spillways; weirs, and other control structures; and sediment and debris accumulation in storage as well as in and around inlet and outlet structures; and,
- Specific maintenance issues or violations found that need to be corrected by the property owner or operator along with deadlines and re-inspection dates.

4.2.5.3. Plan Review. The Permittee shall:

4.2.5.3.1 Adopt and implement procedures for site plan review which evaluates potential water quality impacts. The procedures shall apply through the life of the project from conceptual design to project closeout.

[1]Since 2010, rainwater harvesting is legal in the State of Utah. Depending on the volume of rainwater collected and stored for beneficial use, the Permittee must meet the requirements of the Utah Division of Water Rights to harvest rainwater found on their website: http://waterrights.utah.gov/forms/rainwater.asp.

4.2.5.3.2 Review post-construction plans for, at a minimum, all new development and redevelopment sites that disturb greater than or equal to one acre, 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, to ensure that the plans include long-term storm water management measures meet the requirements of this minimum control measure.

4.2.5.4. Inventory. The Permittee must maintain an inventory of all post-construction structural storm water control measures installed and implemented at new development and redeveloped sites that disturb greater than or equal to one acre, 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. This inventory must include both public and private sector sites located within the Permittee's service area that were developed since the Permittee obtained coverage by this permit or the date that post-construction requirements came into effect, whichever is later.

4.2.5.4.1 Each entry to the inventory must include basic information on each project, such as project's name, owner's name and contact information, location, start/end date, etc.

In addition, inventory entries must include the following for each project:

- Short description of each storm water control measure (type, number, design or performance specifications);
- Short description of maintenance requirements (frequency of required maintenance and inspections); and
- Inspection information (date, findings, follow up activities, prioritization of follow-up activities, compliance status).

4.2.5.4.2 Based on inspections conducted pursuant to Part 4.2.5.2.5, the Permittee must update the inventory when changes occur in property ownership or the specific control measures implemented at the site.

4.2.5.5. Training. Permittees shall ensure that all staff involved in post-construction storm water management, including those that conduct plan review, annual maintenance inspections, and enforcement, receive appropriate training. Training shall be provided or made available for staff in the fundamentals of long-term storm water management through the use of structural and non-structural control methods. Training records must be kept and include, at a minimum, dates, activities or course descriptions, and names and positions of staff in attendance. The Permittee shall ensure that all new hires are trained within **60 days** of hire and annually thereafter, at a minimum. Follow-up training shall be provided as needed to address changes in procedures, methods, or staffing.

4.2.6. Pollution Prevention and Good Housekeeping for Municipal Operations

All Permittees must implement a program for Permittee-owned or operated facilities, operations and structural storm water controls that includes SOPs, pollution prevention BMPs, storm water pollution prevention plans or similar type of documents, and a training component that have the ultimate goal of preventing or reducing the runoff of pollutants to the MS4 and waters of the state. All components of the program shall be

APPENDIX F

GUIDE TO LOW IMPACT DEVELOPMENT WITHIN UTAH

A Guide to Low Impact Development within Utah

Prepared for:
Utah Department of Environmental Quality
Division of Water Quality

195 North 1950 West
Salt Lake City, UT 84116

December 2018

Revised: August 2020

Prepared by:
Michael Baker International
7090 South Union Park Ave, Suite 500
Salt Lake City, UT 84047

Environmental Planning Group, LLC
208 E 800 S
Salt Lake City, UT 84111

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 80th 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 80th 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, 80^{th} 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 80th percentile volume (*Figure 4*). Determine the 80th percentile volume of the contributing drainage area and provide an outlet near the bottom of the structure that releases the 80th 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.

<u>Additional site design practices</u>

- 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.

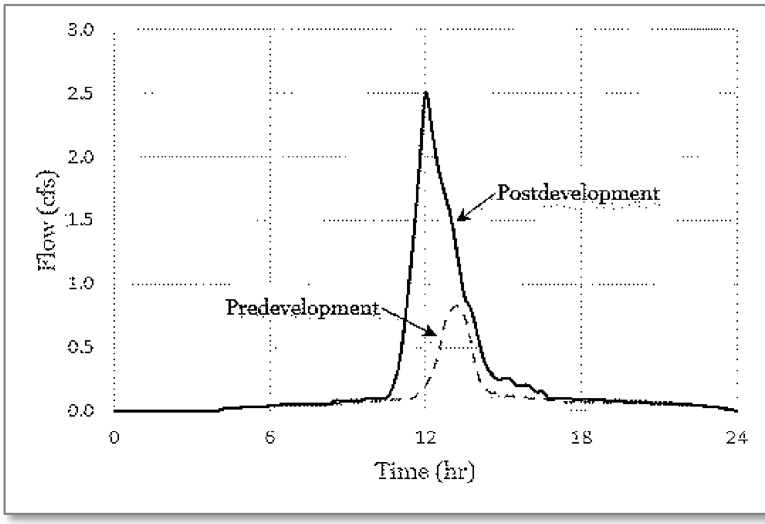


Figure 9: Typical hydrologic impact of development on-site hydrology.

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.

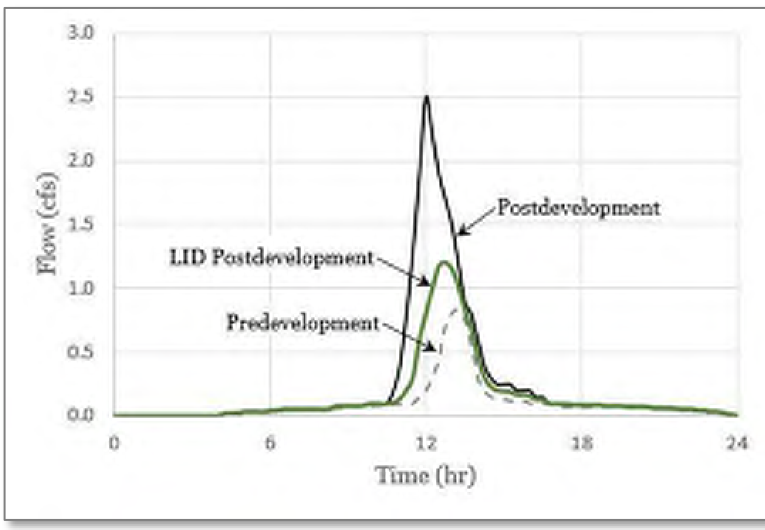


Figure 10: General post development hydrograph with LID.

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).

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.

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)

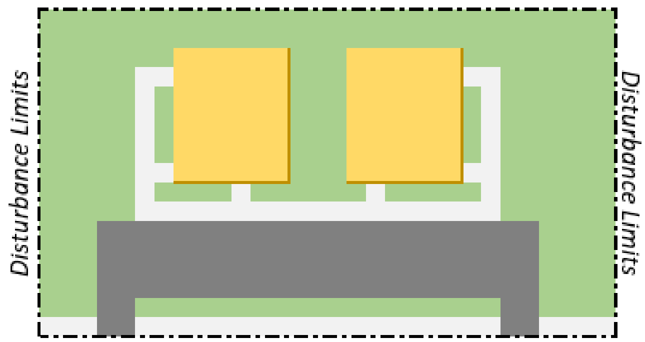
A = Project area or BMP drainage area, sf

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.



$V_{goal} = R_V dA$

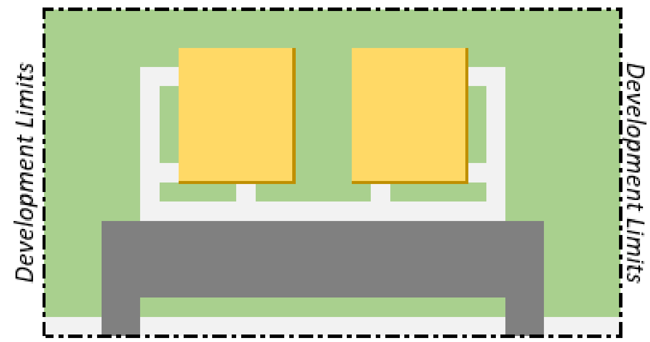
R_V = Volumetric runoff coefficient (based on the project's total area)

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%)

$V_{goal} = V2 - V1$

$V_2 = R_V dA$

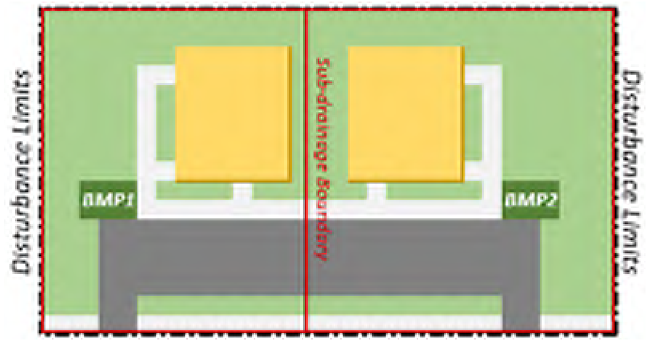
- Volume generated by the 80th percentile storm depth for the proposed project condition.

$V_1 = R_V dA$

- 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*

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

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

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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.

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.

Figure 13: Proprietary tree box filter

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.

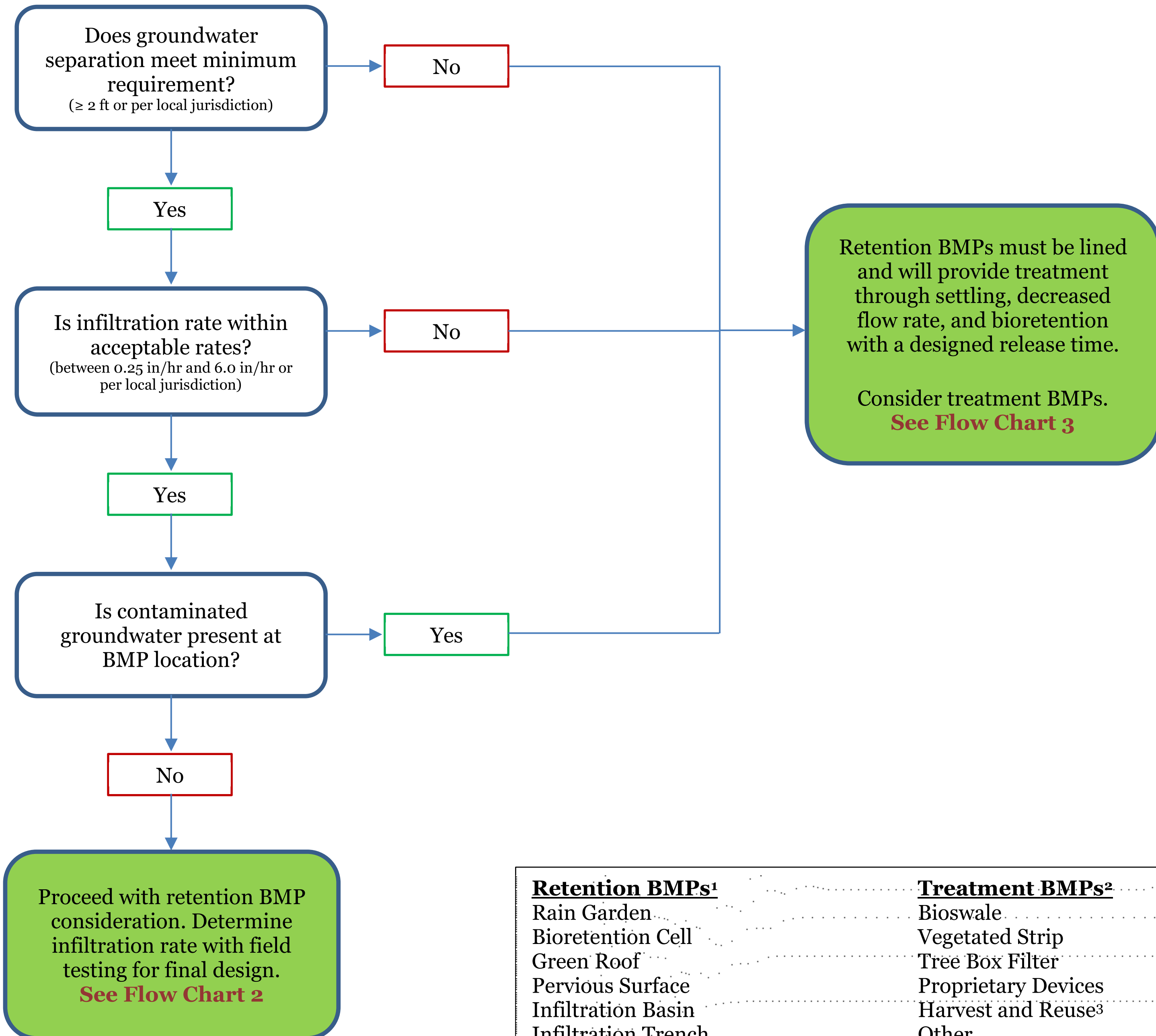
Three flow charts have been developed to assist in the selection of appropriate BMPs. The flow charts guide the user through the general BMP evaluation and selection process. Ultimately, BMP selection will be site-specific; BMP recommendations contained within the flow chart do not necessarily rule out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

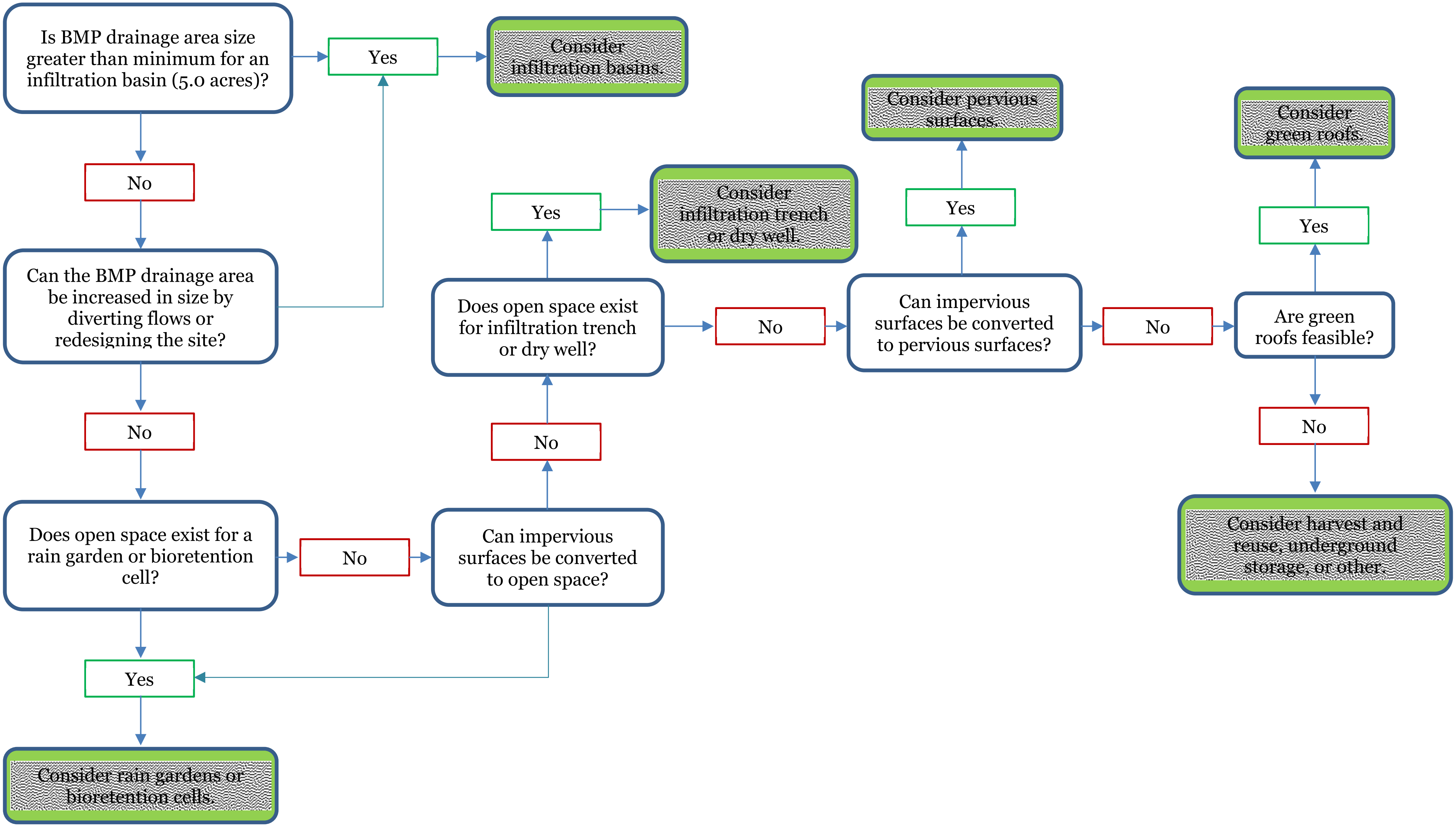


Retention BMPs[1]	**Treatment BMPs**[2]
Rain Garden	Bioswale
Bioretention Cell	Vegetated Strip
Green Roof	Tree Box Filter
Pervious Surface	Proprietary Devices
Infiltration Basin	Harvest and Reuse[3]
Infiltration Trench	Other
Underground Infiltration Galleries	
Dry Well	
Proprietary Devices	
Harvest and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

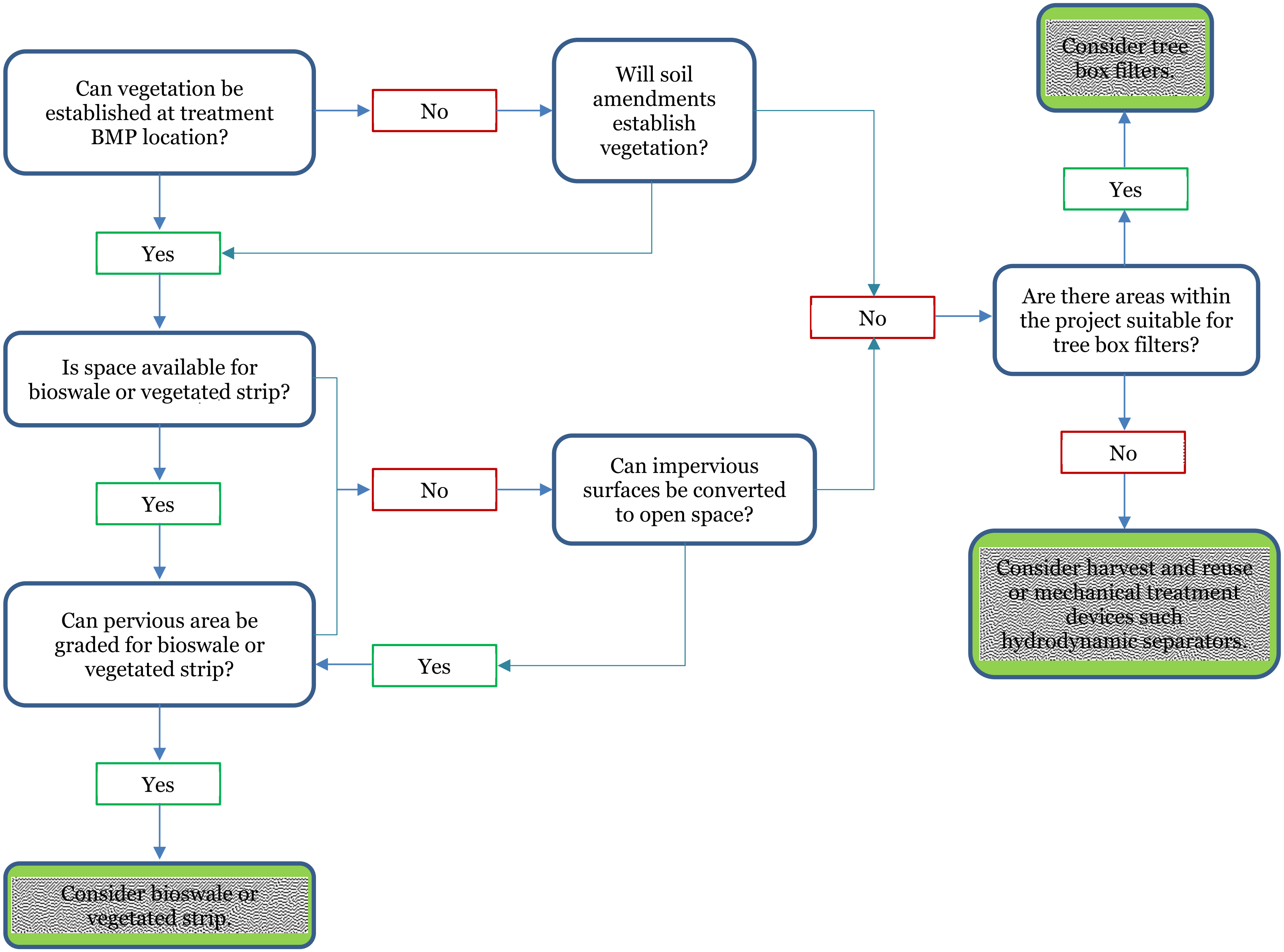
Flow Chart 2: Retention BMP Selection

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

80th percentile storm depth: 0.50 in

Hydrologic soil group: B

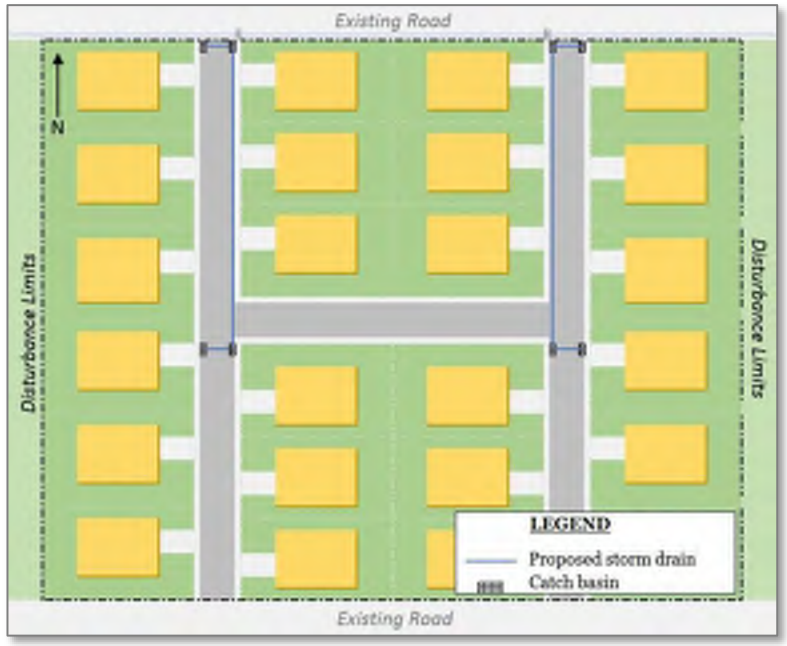


Figure 14: Proposed residential development.

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 80th 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

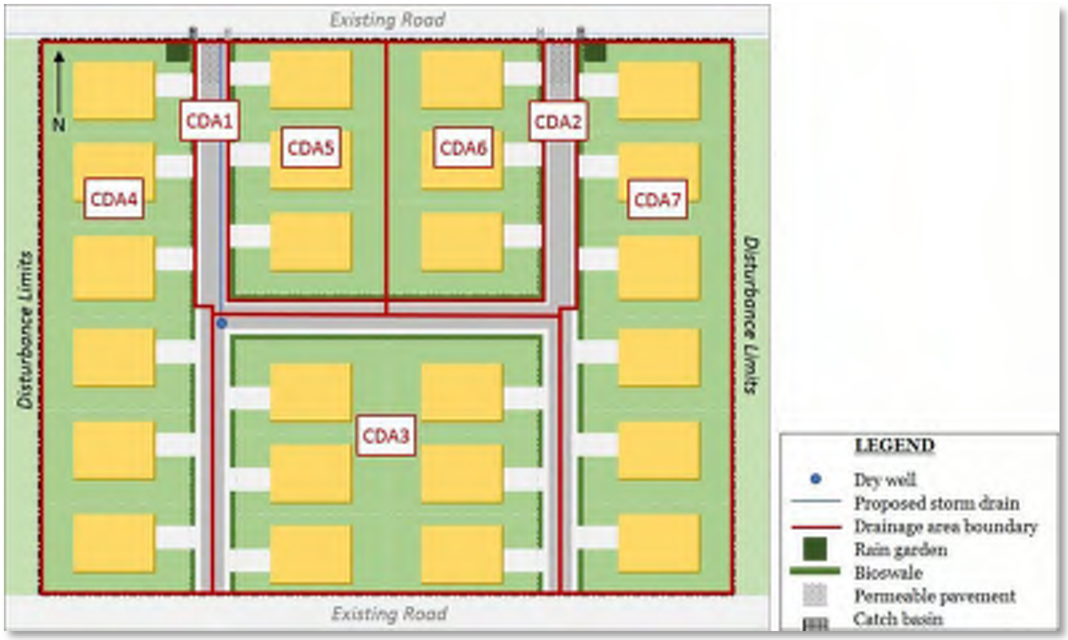


Figure 15: LID approach to residential development.

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).

Development size: 1.84 ac

Existing Impervious Area: 1.56 ac

Volumetric runoff coefficient: 0.75

80th percentile storm depth: 0.50 in

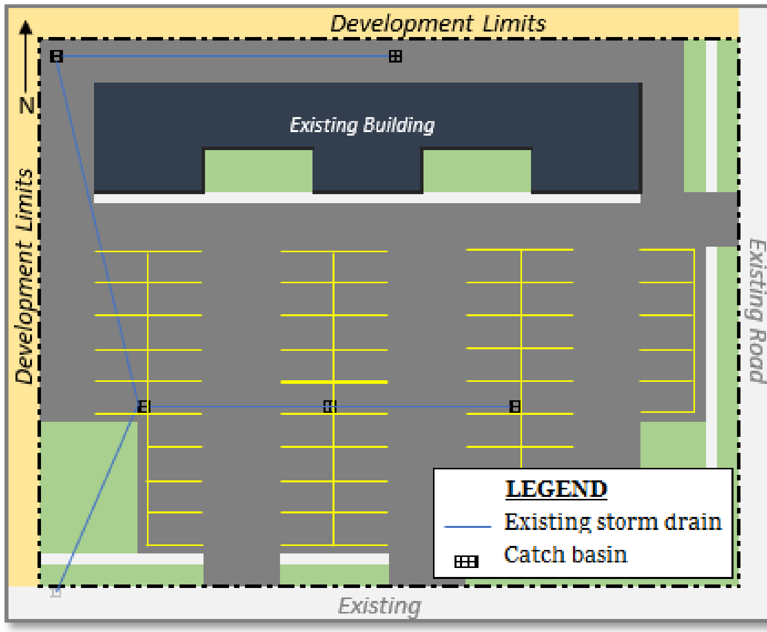


Figure 16: Existing commercial development.

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 ac) (43,560 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 ac) (43,560 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_VdA = (0.86) (0.50"/12) (0.37 ac) (43,560 sf/ac) = 584 cf

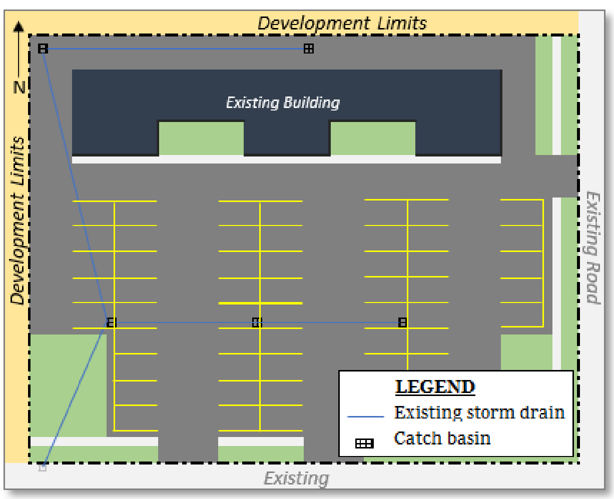
The water quality volume of this drainage area is greater than V_{goal}. The bioretention cell only needs to be sized for V_{goal}. In *Figure 16*, the bioretention area is 5' x 135'. The calculations below show that the storage depth of the bioretention cell needs to be at least 7" (0.58 ft) to retain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

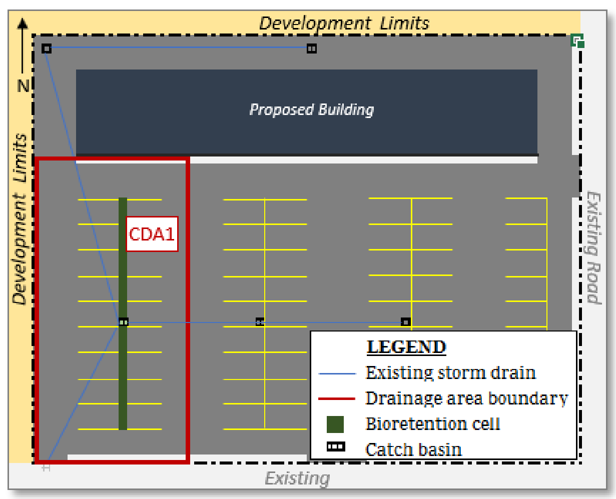


Figure 17: Bioretention cell within the redevelopment's project limits.

Development Size: 2.64 ac

Imperviousness: 94%

Volumetric runoff coefficient: 0.83

80th percentile storm depth: 0.50 in

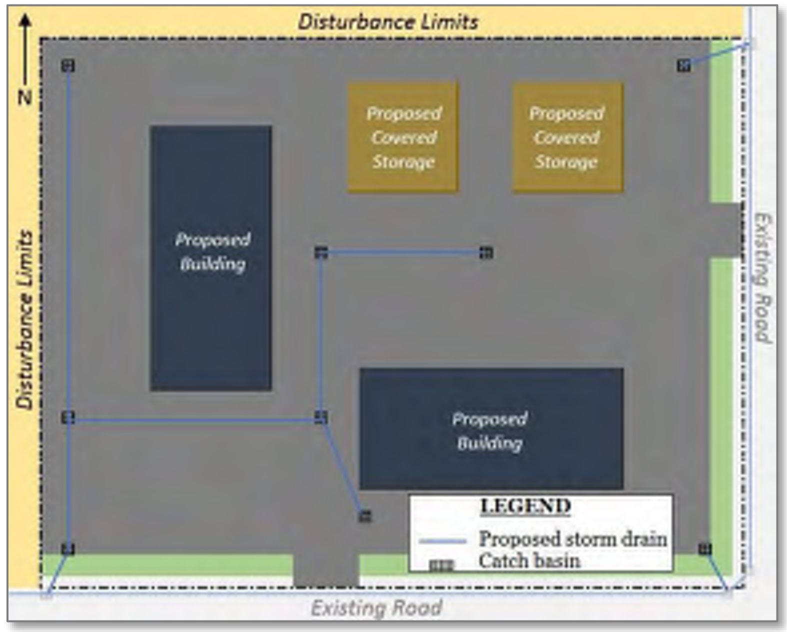


Figure 18: Proposed industrial development.

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

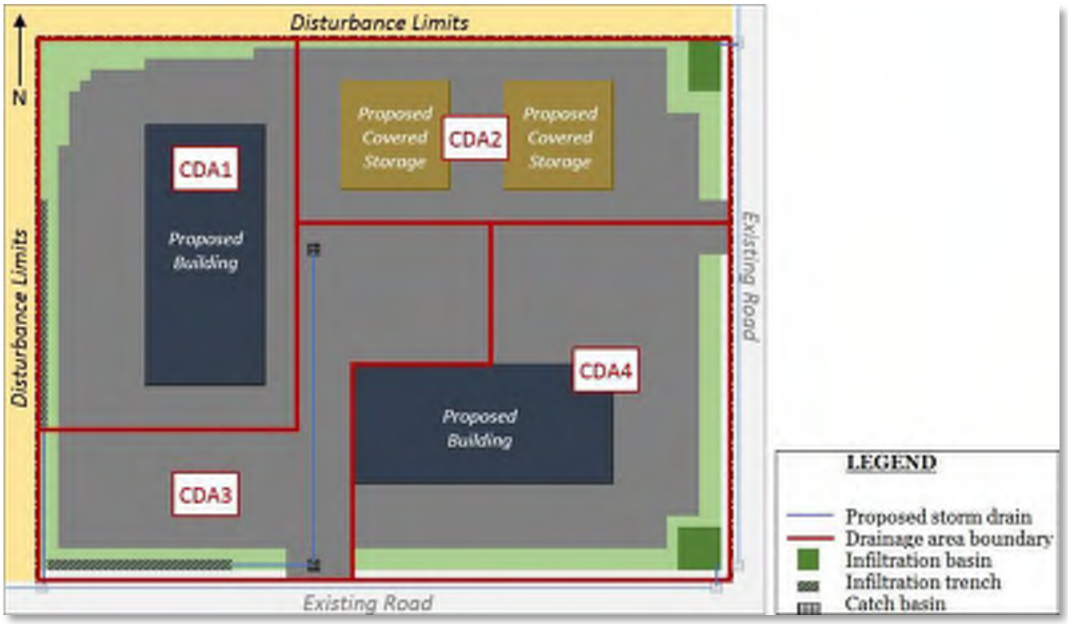


Figure 19: LID approach to industrial development.

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.

Bioswales/Rain Gardens/Pervious Surfaces

Sandy City Public Works – Sandy City

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

80^{th} 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

80^{th} 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: ______

80^{th} Percentile Volume, V_1 (cf): ______

Proposed Project Conditions

Imperviousness (%): ______

Volumetric Runoff Coefficient, R_V: ______

80^{th} 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

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

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

80^{th} 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)

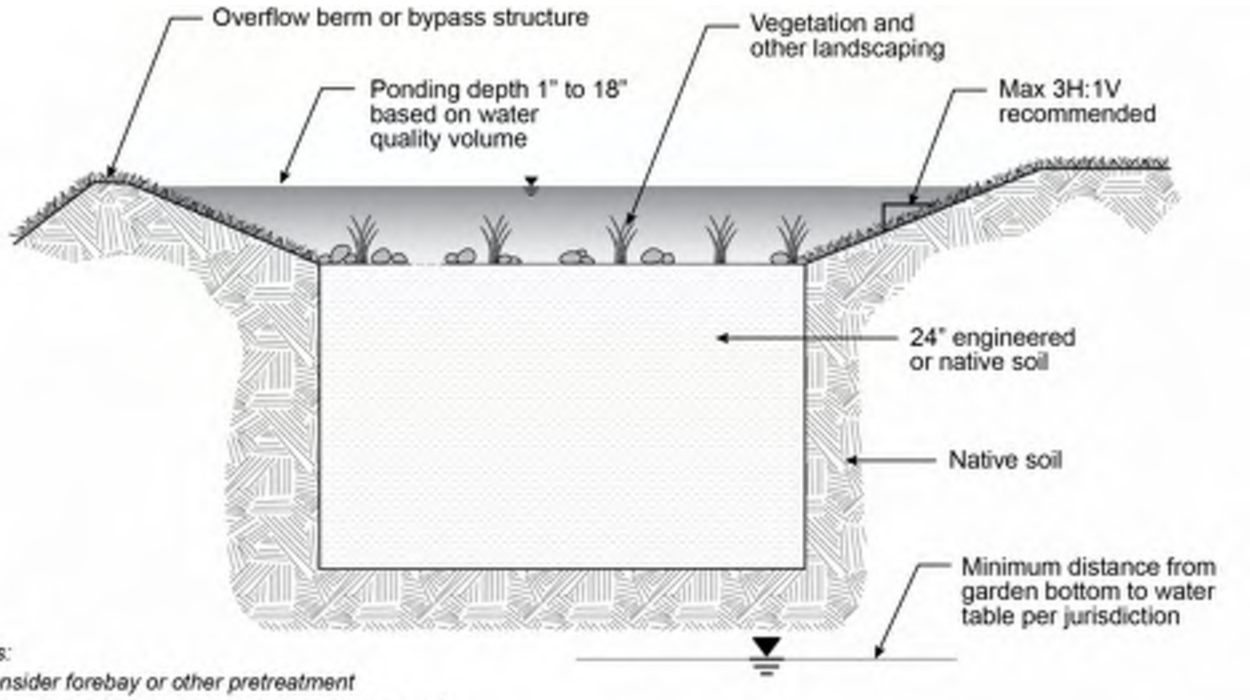
Maintenance

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

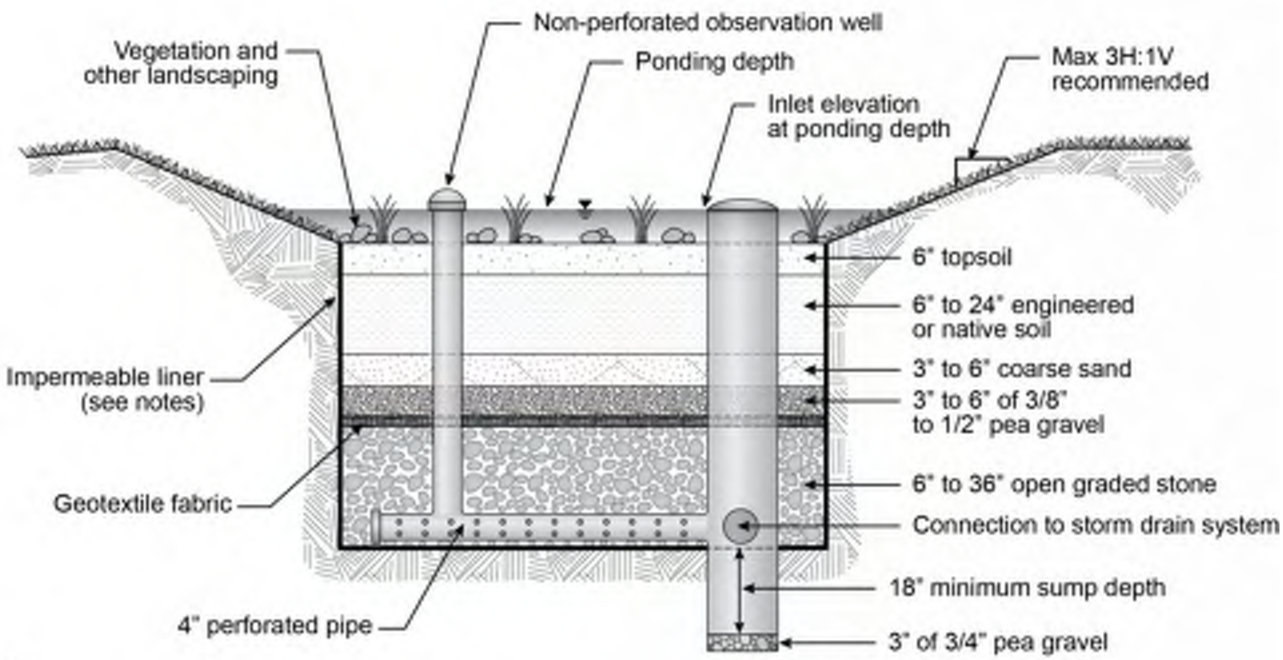
Inspection	Inspection/Maintenance Frequency	Maintenance Activity	Effort
		basin or if buildup results in standing water. Notify the engineer in the case of standing water as it may indicate clogging within the basin's soil layers.	
Inspect for standing water within rain garden or within observation well.	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

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*)

$R_{V-A} = 0.84i^{1.302}$ (R_V based on hydrologic soil group)

$R_{V-A} = 0.84(0.90)^{1.302}$

$R_V = 0.73$

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?	☐	☐
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 less than 5 acres? (If no, consider an infiltration basin or subdividing to create smaller drainage areas.)	☐	☐
Do utility conflicts make installation of the bioretention cell technically infeasible?	☐	☐
Do geotechnical conditions exist that compromise the stability of the bioretention cell or surrounding structures?	☐	☐
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.)	☐	☐
Does an overflow outlet structure or bypass mechanism exist?	☐	☐

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.

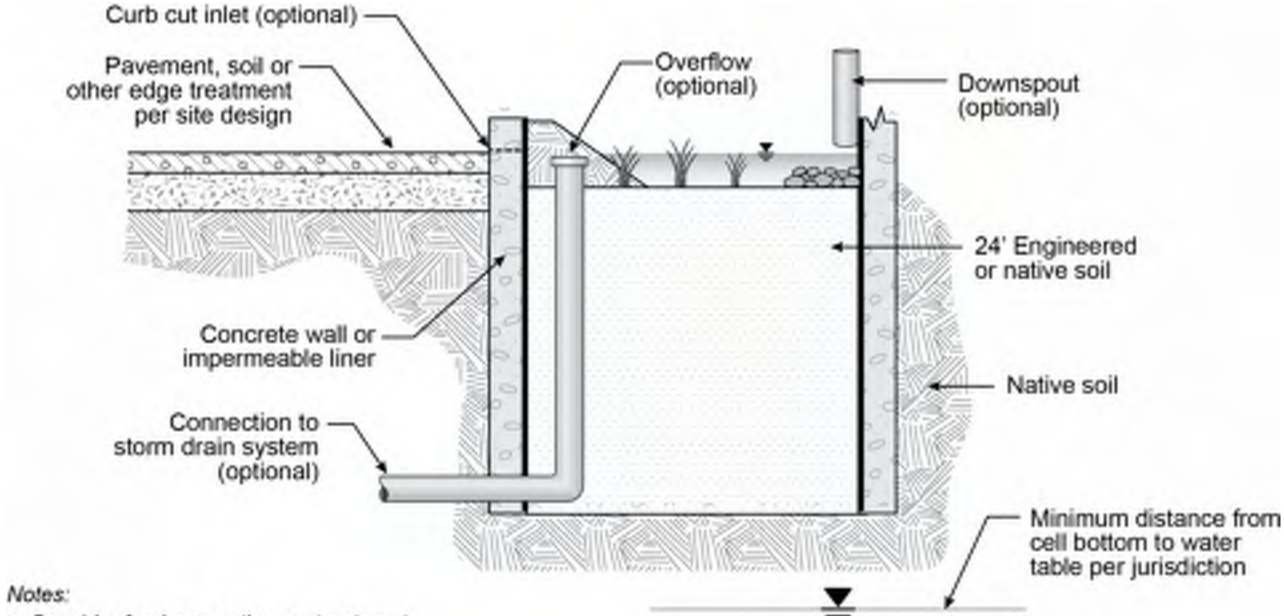
- Excavation
- Landscaping and vegetation
- Top layer
- Engineered soil
- Coarse sand
- Crushed gravel
- Open graded stone
- Geotextile fabric
- Outlet structure or upstream bypass structure (for larger storm events)
- Observation wells
- Curb and gutter
- Impermeable liner (if needed)
- Underdrain system (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

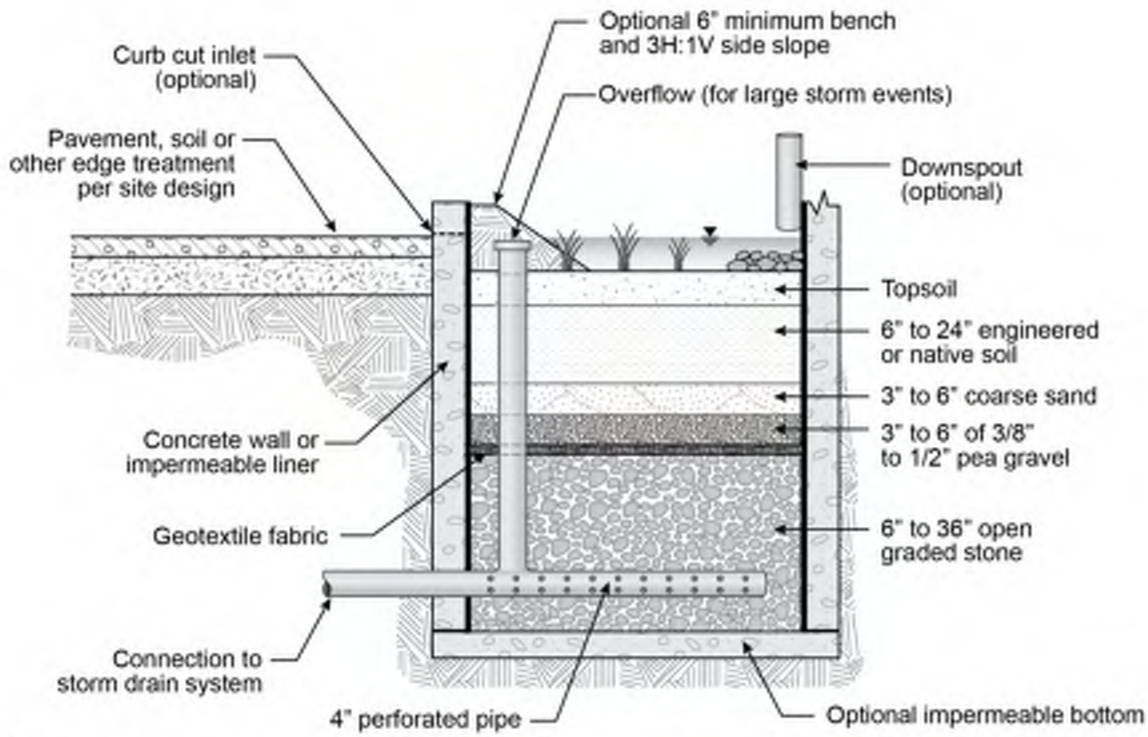


Notes:

- *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

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.

Given

Contributing drainage area: 1.0 ac

Imperviousness: 0.85

80th 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.

$V_{\text{check dam}}$ = (2 ft)(25 ft)(0.5 ft) / 2

$V_{\text{check dam}}$ = 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.

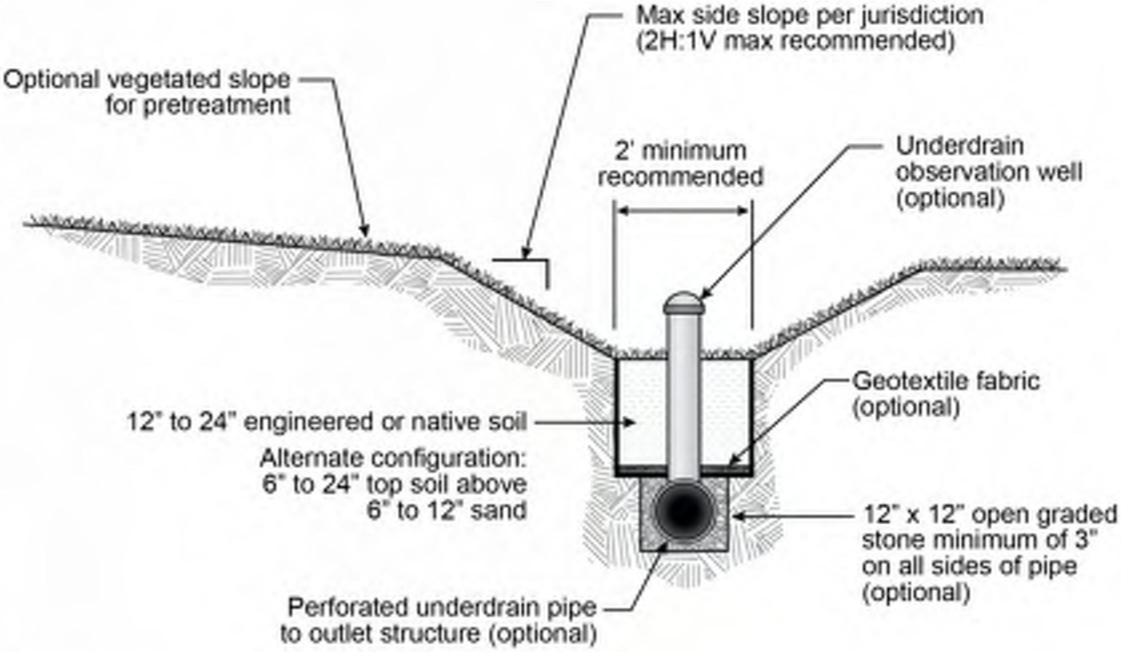
- Excavation
- Grading
- Fine grading
- Granular borrow fill
- Landscaping and vegetation
- Top layer
- Engineered soil
- Open graded stone
- Geotextile fabric
- Impermeable liner
- Outlet structure or upstream bypass structure (for larger storm events)
- Observation wells
- Underdrain system (if needed)
- 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

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.

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.

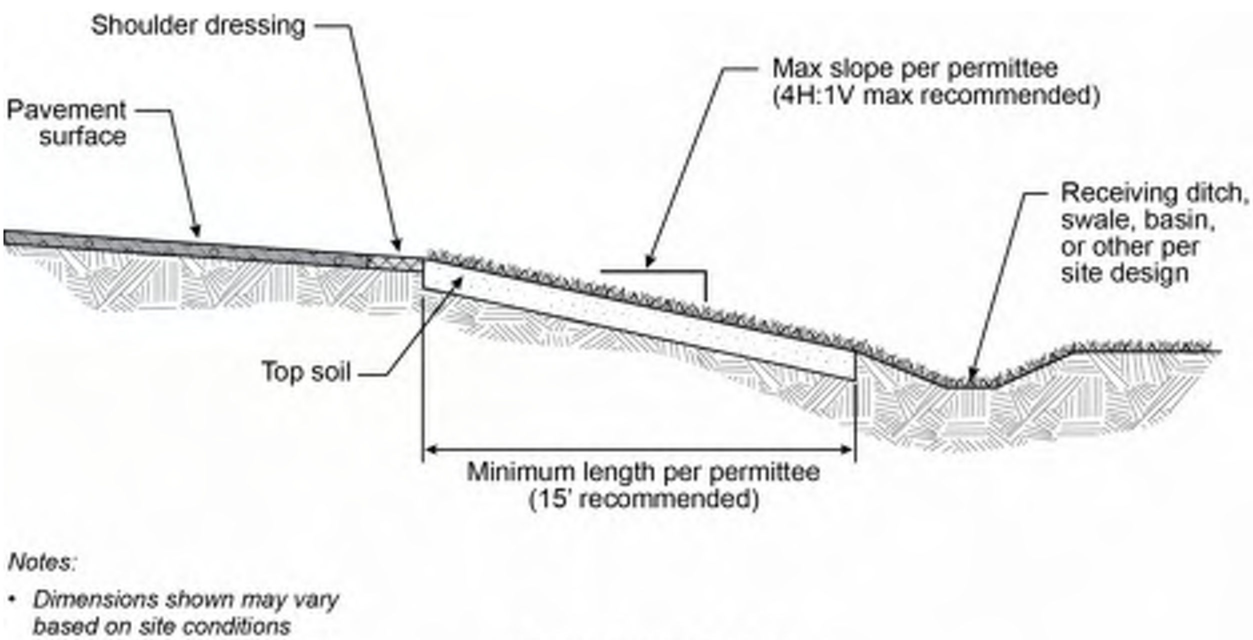
- Grading
- Landscaping and vegetation
- Topsoil
- Engineered soil
- Shoulder dressing upstream of vegetated strip

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



Vegetated Strips

Not to scale

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*.

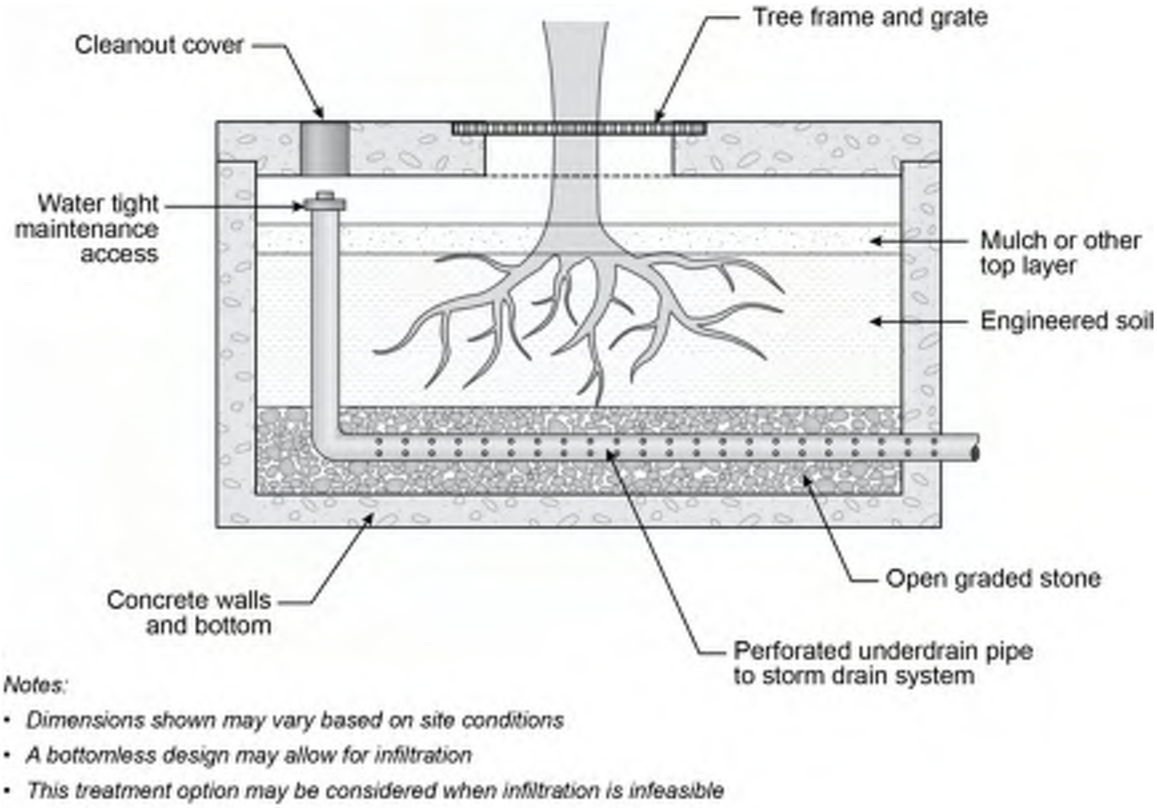
Maintenance

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



Tree Box Filters

Not to scale

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.

Primary Functions	
Bioretention	Yes
Volume Retention	Yes
Biofiltration	Yes

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.

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

80th 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.

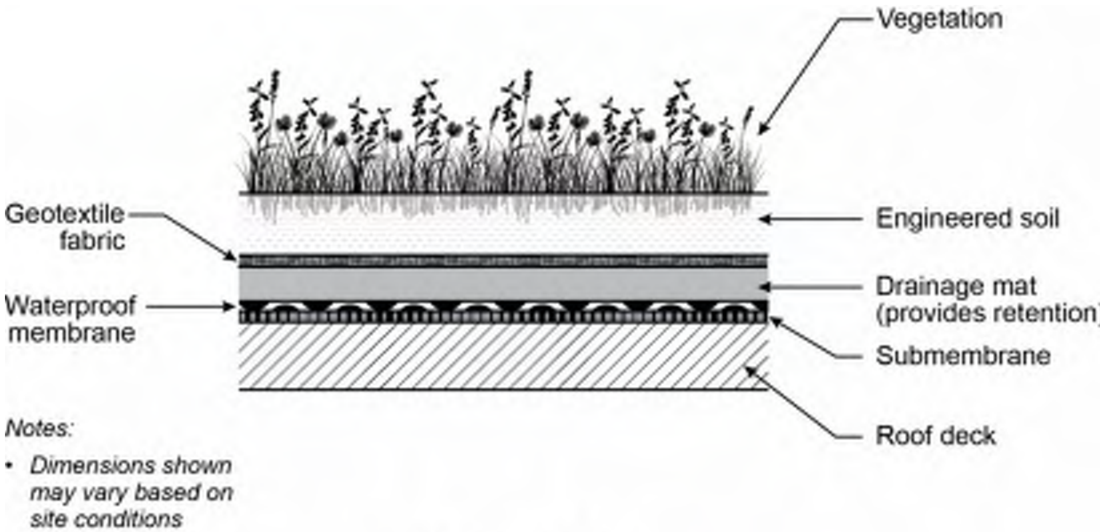
- Vegetation and landscaping expertise
- Horticulturist expertise
- Structural expertise

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



Green Roof

Not to scale

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.

Given

Contributing drainage area: 0.90 ac

Imperviousness: 0.95

80^{th} percentile storm event: 0.48 in

Design infiltration rate: 0.5 in/hr

Design Goals

Determine an acceptable area size and depth of the permeable asphalt section.

Calculations

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.

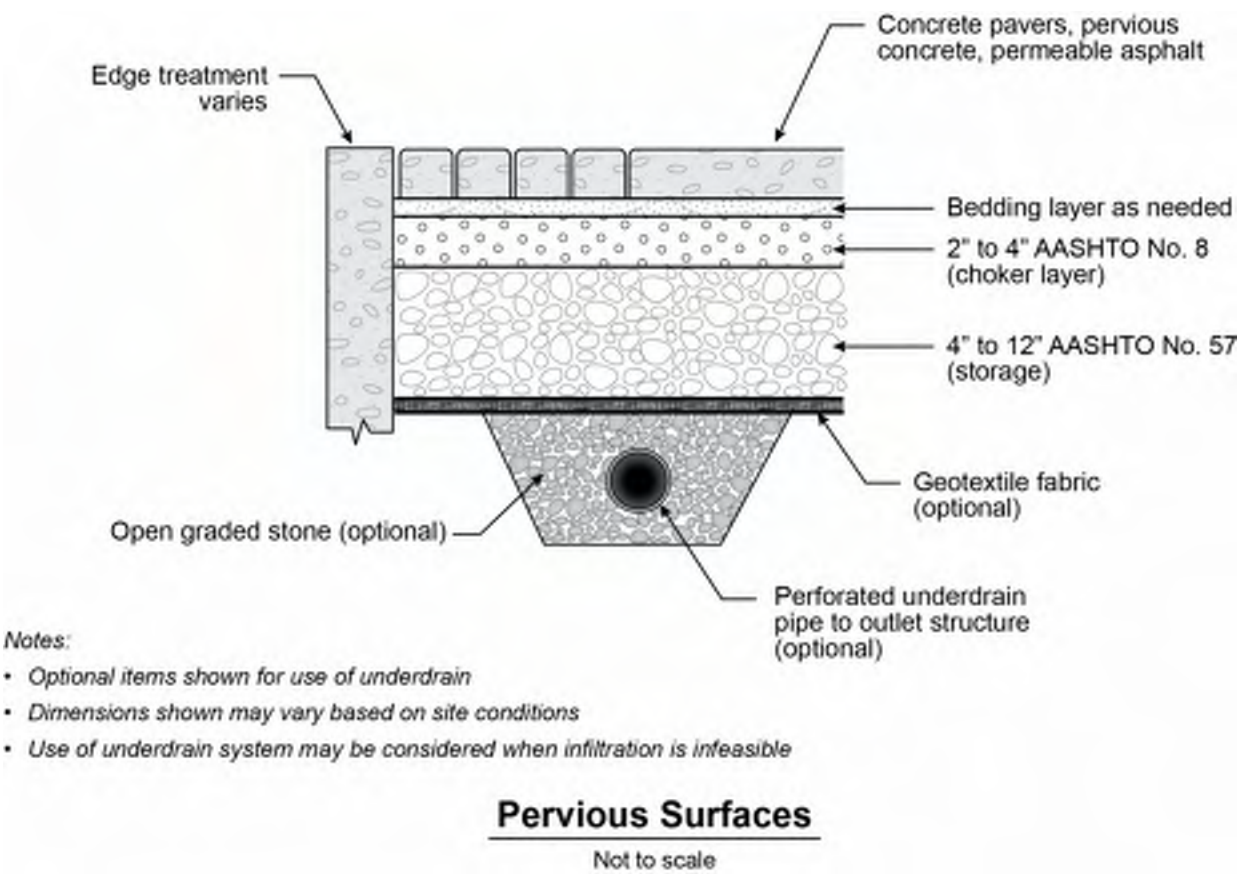
- Excavation
- Grading
- Fine grading
- Pervious surface
- Top layer
- Engineered soil
- Choker layer
- Open graded stone
- Geotextile fabric
- Impermeable liner
- Observation wells (if needed)
- Underdrain system (if needed)

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



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?	☐	☐ (red)
Is there available right-of-way, property, or easement for the infiltration basin?	☐	☐ (red)
Is contaminated groundwater present at the infiltration basin location?	☐ (red)	☐
Is the water quality volume above the 4,356 cf threshold?	☐	☐ (red)

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.

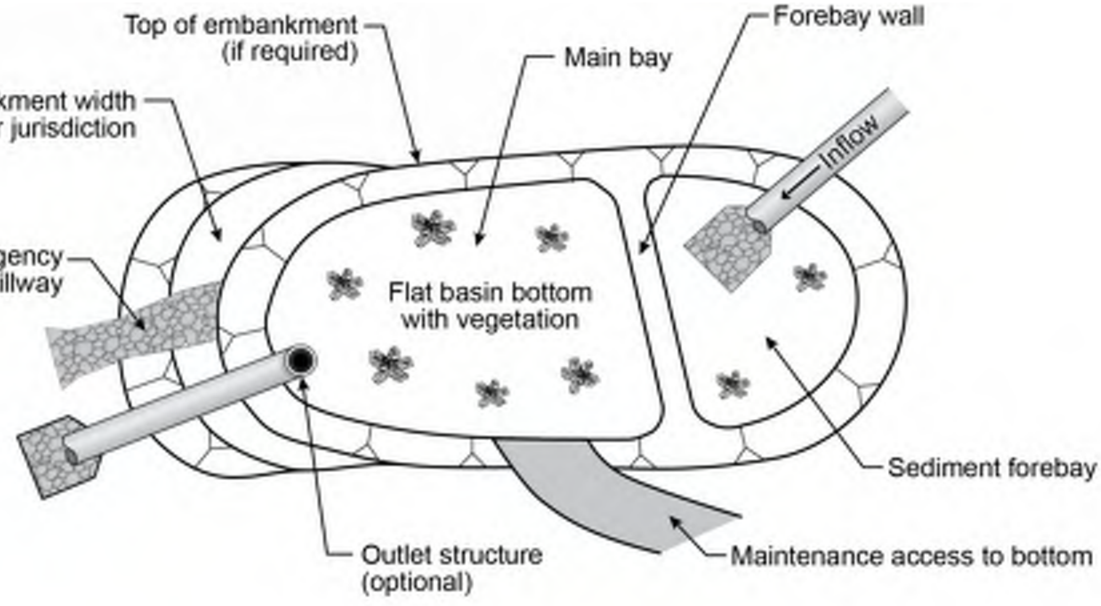
- Excavation
- Grading
- Outlet structure or upstream bypass structure (for larger storm events)
- Forebay and associated items: outlet protection, forebay wall, and connection between forebay and main bay.

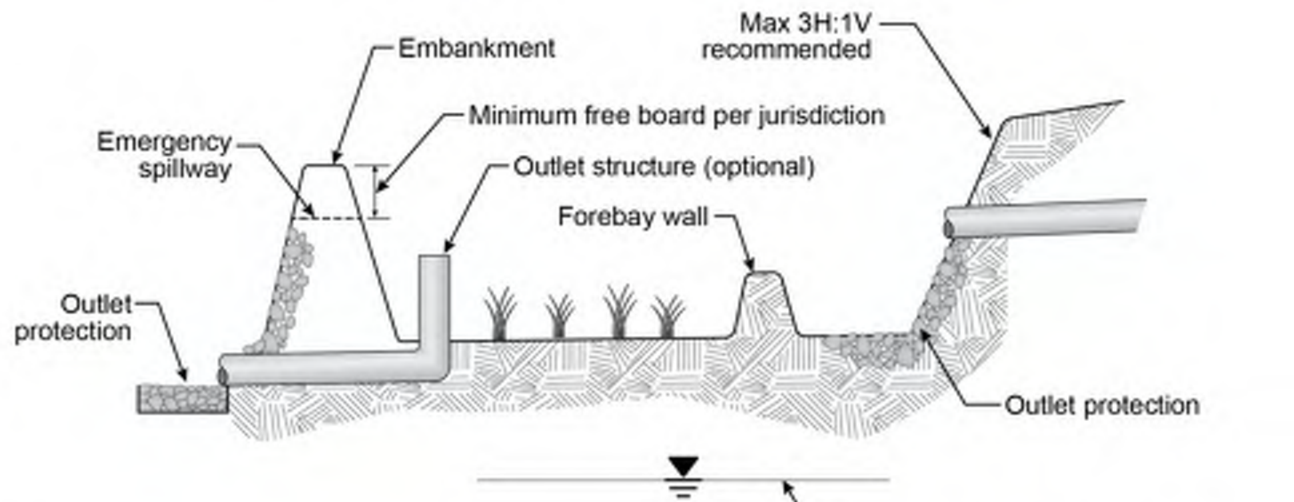
Maintenance

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.

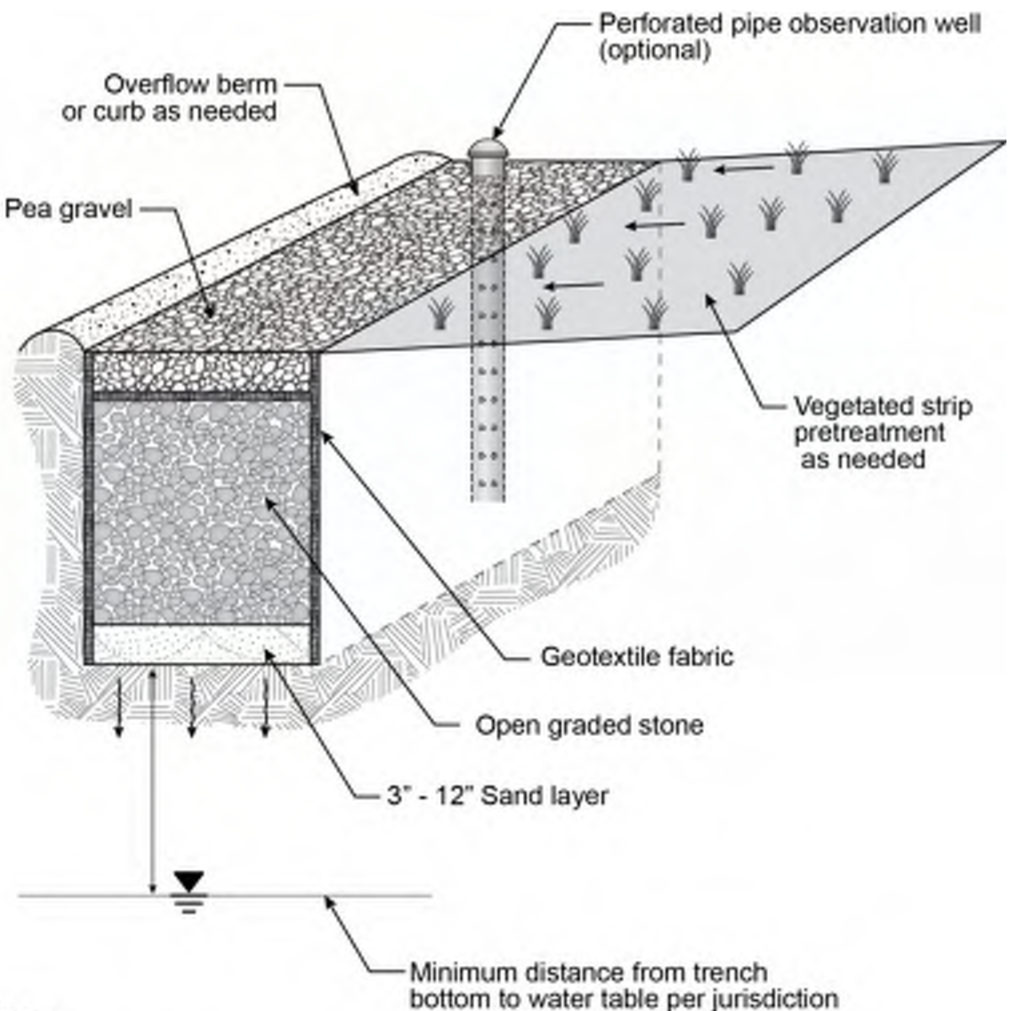
- Excavation
- Landscaping and vegetation
- Pea gravel
- Open graded stone
- Sand layer
- Geotextile separator

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

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

80^{th} 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.

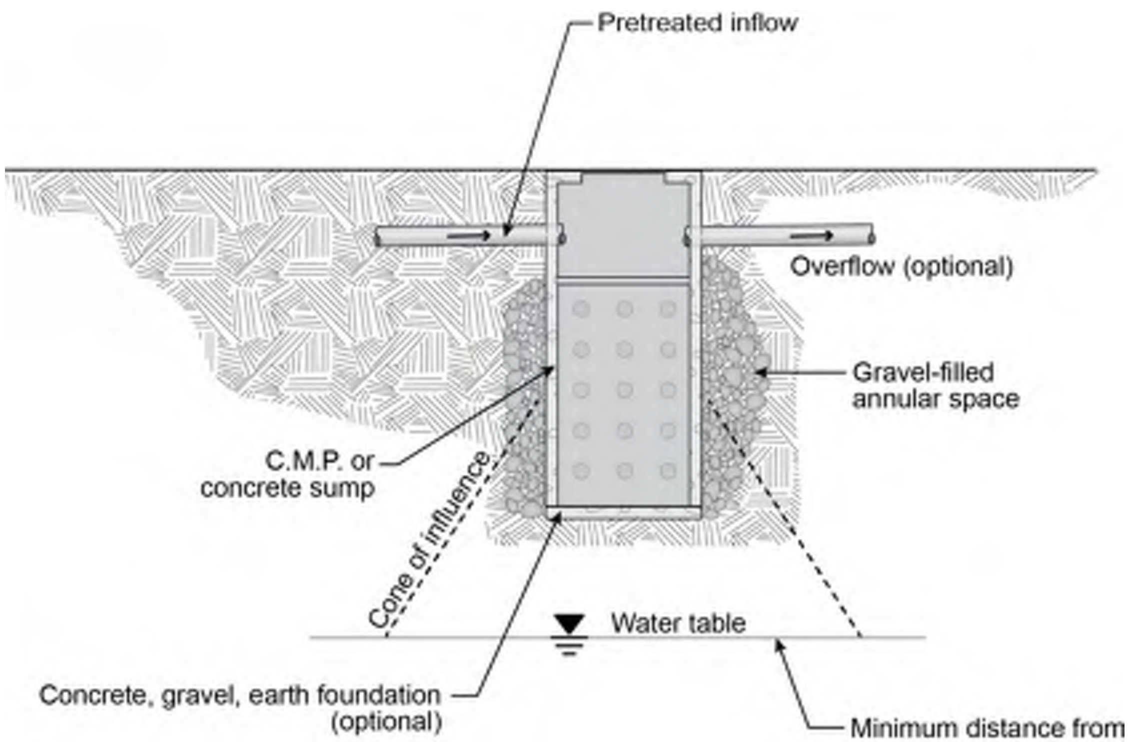
- Excavation
- Dry well
- Permit application fees for Class V Injection Wells
- Gravel-filled annular space surrounding dry well
- Pretreatment upstream of dry well
- Overflow connection to downstream system
- Gravel foundation (optional)

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
WATER QUALITY

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?	☐	☐
Is the infiltration rate of the existing soils within acceptable rates?	☐	☐
Is contaminated groundwater present?	☐	☐
Do utility conflicts exist that make installation of the device technically infeasible?	☐	☐
Do geotechnical conditions exist that compromise the stability of the device or surrounding structures?	☐	☐
Is pretreatment provided upstream of or within the underground storage device?	☐	☐
Is the soil bearing capacity of the underlying soil sufficient for the system?	☐	☐
Will the underground system support the expected loads above it?	☐	☐

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.

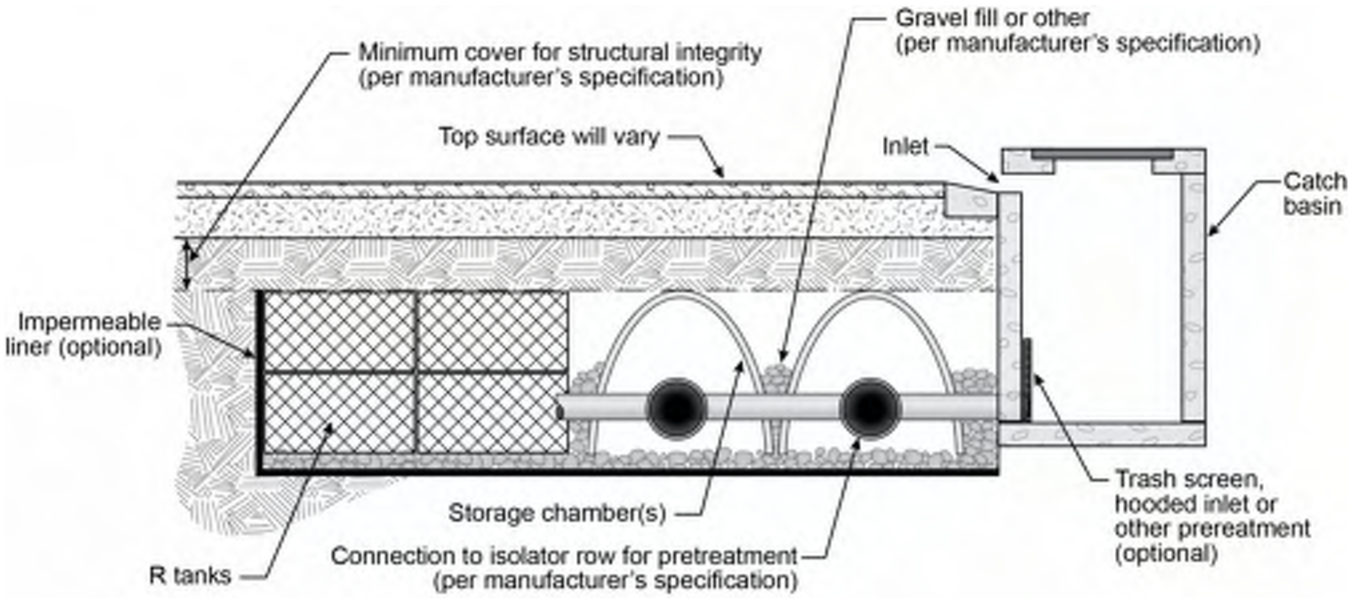
Maintenance Activities

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

UTAH DEPARTMENT of ENVIRONMENTAL QUALITY
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

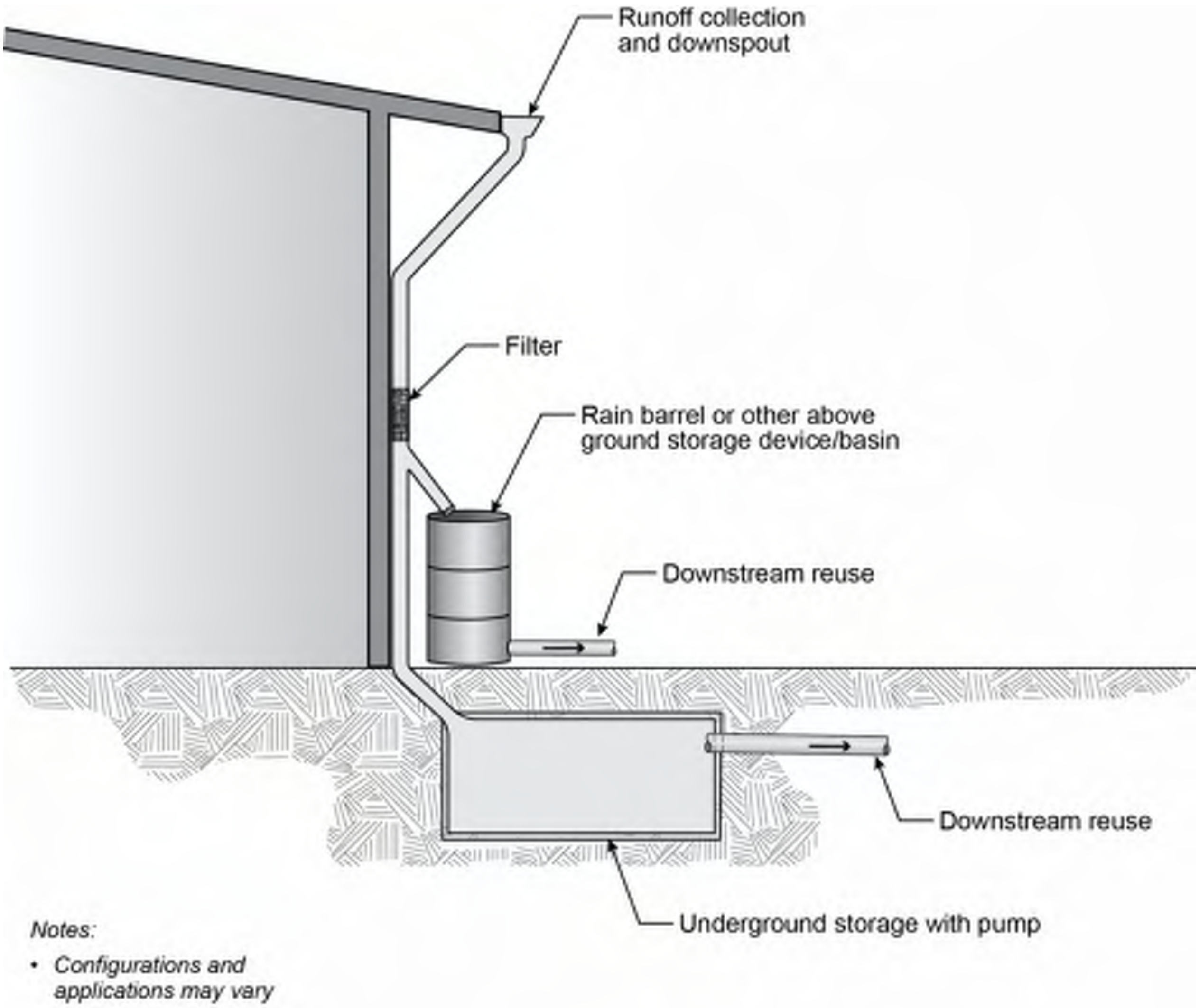
-Other items will be dependent on site-specific use

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



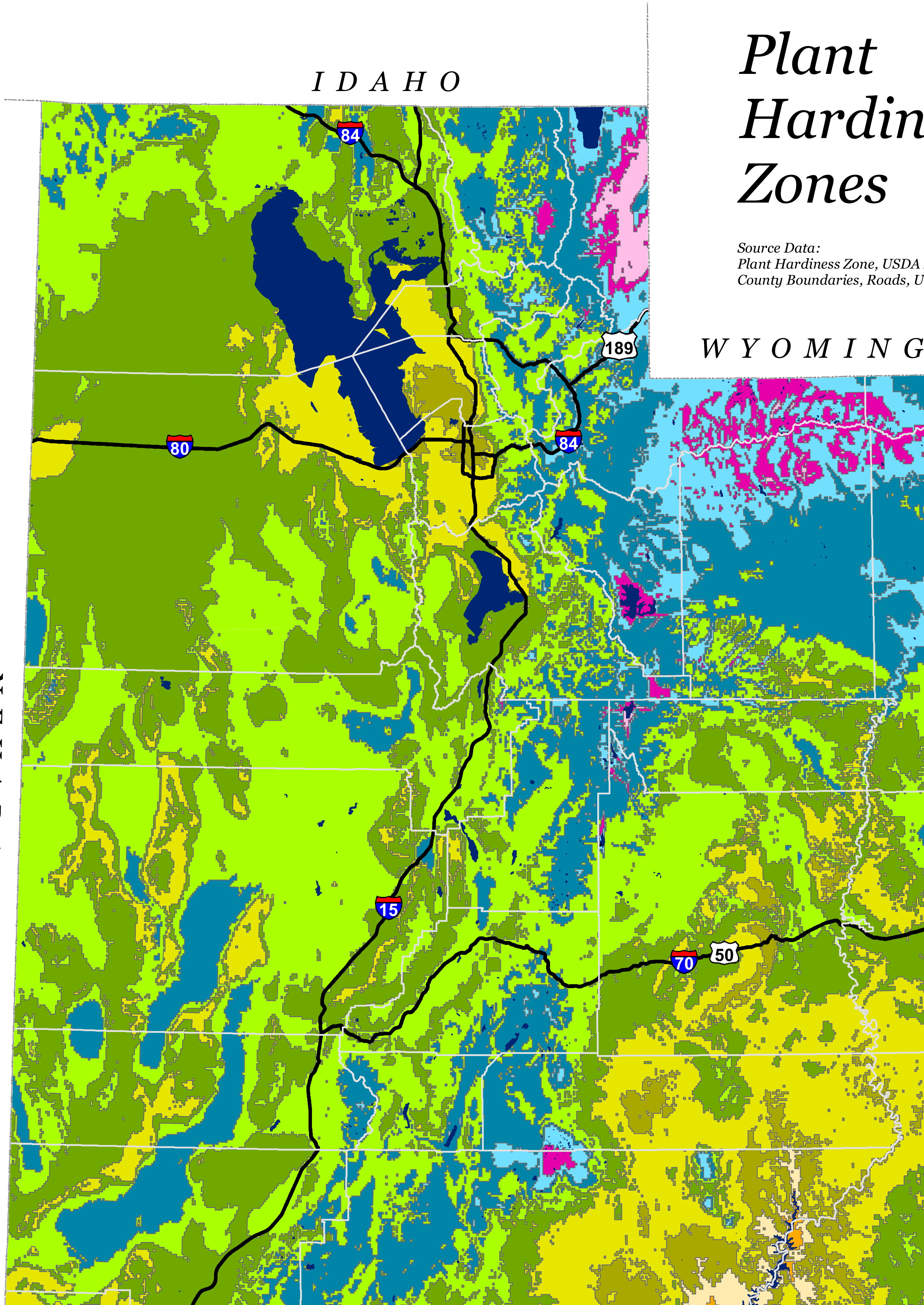
Harvest and Reuse

Not to scale

Appendix D Utah Plant Hardiness Zones

Plant Hardin
Zones

Source Data:
Plant Hardiness Zone, USDA
County Boundaries, Roads, U



Appendix E Utah Plant Selection Matrix by Climate Zone and BMP

Plants							Zones										Be
Trees		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Ba Upl
Acer campestre	Hedge Maple		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					
Acer ginnala	Amur Maple	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			
Acer grandidentatum	Bigtooth Maple	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					
Acer griseum	Paperbark Maple		x	x	x	x	x	x	x	x	x	x					
Acer microphyllum	Big Leaf Maple						x	x	x	x					x	x	
Acer negundo 'Sensation'	Sensation Boxelder		x	x	x	x	x	x									
Acer palmatum sp.	Japanese Maples				x	x	x	x	x	x	x	x					
Acer palmatum "Garnet"	Garnet Japanese Maple				x	x	x	x	x	x	x	x	x	x			
Acer palmatum 'Bloodgood'	Bloodgood Japanese Maples				x	x	x	x	x	x	x	x					
Acer palmatum 'Trompenburg'	Trompenburg Japanese Maple				x	x	x	x	x	x	x	x					
Acer platanoides	Norway Maple		x	x	x	x	x	x	x	x							
Acer platanoides 'Columnare'	Columnar Norway Maple		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							
Acer pseudoplatanus 'Esk Sunset' ESKIMO SUNSET	Eskimo Sunset Sycamore Maple'				x	x	x	x	x	x	x	x					
Acer pseudoplatanus 'Spaethii'	Purple Sycamore Maple				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			
Acer rubrum	Red Maple	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	
Acer tataricum	Tatarian Maple	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					
Acer tataricum 'GarAnn' PP 15,023	HOT WINGS® Tatarian maple		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					
Aesculus hippocastanum	Horsechestnut	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							
Alnus incana sp. Tenufolia	Thinleaf Alder	x	x	x	x	x											
Alnus rubra	Red Alder		x	x	x	x											
Alnus sinuata	Sitka Alder		x	x	x	x											
Amelanchier arborea	Serviceberry		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									
Betula alleghaniensis	Yellow Birch	x	x	x	x	x	x	x									
Betula nigra	River Birch		x	x	x	x	x	x	x	x	x	x	x	x		x	
Betula occidentalis	Water Birch	x	x	x	x	x									x	x	
Betula papyrifera	Paper Birch	x	x	x	x	x	x	x							x	x	
Betula pendula	Silver Birch	x	x	x	x	x	x	x							x	x	
Betula pubescens	White Birch	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					
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			
Carya glabra	Pignut Hickory		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	
Carya ovata	Shabgark Hickory		x	x	x	x	x	x	x	x	x	x					
Carya lacinosa	Shellbark Hickory				x	x	x	x	x	x	x	x					
Catalpa speciosa	Catalpa				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			
Celtis occidentalis 'Prairie Pride'	Prairie Pride Hackberry	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			

Plants		Zones															Be
Trees		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Ba Upl
Crataegus crusgalli var. inermis	Thornless Cockspur Hawthorn		x	x	x	x	x	x	x	x	x	x					
Crataegus douglasii	Black/ Douglas Hawthorn		x	x	x	x	x	x									
Crataegus laevigata	English Hawthorn		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			
Ginkgo biloba	Maidenhair Tree	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	
Ginkgo biloba 'PNI 2720'	Princeton Sentry Ginkgo	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					
Gleditsia triacanthos 'Imperial'	Imperial Honey Locust		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	
Gleditsia triacanthos 'Skyline'	Skyline Honelocust	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					
Gymnocladus dioica	Kentucky Coffeetree				x	x	x	x	x	x	x	x	x	x			
Juglans nigra	Black Walnut				x	x	x	x	x	x	x	x	x	x			
Koelreuteria paniculate	Golden Raintree				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			
Liquidambar styraciflua	Sweet Gum				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			
Maackia amurensis	Amur Maackia	x	x	x	x	x	x	x	x	x							
Magnolia grandiflora	Souhthern Magnolia								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	
Malus pumila 'Obelisk' STARK CRIMSON SPIRE	Stark Crimson Spire Apple		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			
Malus sargentii 'Tina'	Tina Sargent Crabapple		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			
Malus 'Prairifire'	Prairifire Crabapple				x	x	x	x	x	x	x	x					
Malus 'JFSKW213MZ'	Raspberry Spear Upright Crabapple		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			
Malus 'Royalty'	Royalty Crabapple				x	x	x	x	x	x	x	x					
Malus 'Spring Snow'	Spring Snow Crabapple				x	x	x	x	x	x	x	x					
Malus 'Weepcanzam'	Candied Apple Crabapple		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	
Morus alba 'Chaparral'	Chaparral Weeping Mulberry		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			
Nyssa sylvatica	Black Gum	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			
Olea europaea 'Tolley's Upright'	Tolley's Upright Olive										x	x	x	x			
Ostrya virginiana	Hop-Hornbeam	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	
Platanus racemosa	Western Sycamore						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	
Platanus x hispanica	London Plane Tree		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					
Populus fremontii	Fremont Cottonwood		x	x	x	x	x	x							x	x	
Populus tremuloides	Quaking Aspen	x	x	x	x	x	x	x									
Populus trichocarpa	Black Cottonwood		x	x	x	x	x	x									
Prunus americana	American Plum	x	x	x	x	x	x	x	x	x	x	x				x	

Plants		Zones															Be
Trees		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Ba Upl
Prunus virginiana	Chokecherry	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	
Prunus x blireana	Blireana Plum			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	
Pyrus calleryana 'Chanticleer'	Chanticleer Flowering Pear				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			
Quercus bicolor	Swamp White Oak	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	
Quercus imbricaria	Shingle Oak																
Quercus macrocarpa	Bur Oak	x	x	x	x	x	x	x	x	x	x	x			x	x	
Quercus muehlenbergii	Chinkapin Oak				x	x	x	x	x	x							
Quercus palustris	Pin Oak		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					
Quercus robur	English Oak				x	x	x	x	x	x	x	x					
Quercus robur f. fastigiata	Columnar English Oak				x	x	x	x	x	x	x	x					
Quercus rubra	Northern Red Oak				x	x	x	x	x	x	x	x					
Quercus undulata	Wavyleaf Oak				x	x	x	x	x	x	x	x					
Quercus 'Clemson' HERITAGE	Heritage Oak		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					
Salix alba	White Willow		x	x	x	x											
Salix amygdaloides	Peachleaf Willow		x	x	x	x											
Salix lasiandra	Pacific Willow	x	x	x												x	
Salix nigra	Black Willow	x	x	x	x	x											
Salix sitchensis	Sitka Willow		x	x	x												
Salix prolixa	Mackenzie Willow		x	x	x	x											
Sambucus coerulea	Blue Elderberry		x	x	x	x	x	x									
Sambucus racemosa 'SMNSRD4' LEMONY LACE	Lemony Lace Elderberry	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					
Shepherdia argentea	Silver Buffaloberry	x	x	x	x	x	x	x									
Sophora japonica 'Halka'	Millstone Japanese Pagoda Tree				x	x	x	x	x	x	x	x					
Sophora japonica 'Regent'	Regent Japanese Pagodatree				x	x	x	x	x	x	x						
Sorbus aucuparia	European Mountain Ash	x	x	x	x	x	x	x									
Syringa reticulata 'Ivory Silk'	Ivory Silk Tree Lilac	x	x	x	x	x	x	x	x	x							
Syringa vulgaris 'Sensation'	Sensation Lilac	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			
Taxodium distichum 'Shawnee Brave'	Shawnee Brave Bald Cypress		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					
Tilia cordata 'Greesnspire'	Greenspire Linden		x	x	x	x	x	x	x	x	x	x					
Tilia tomentosa	Silver Linden		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						
Ulmaus parvifolia 'Emer II' ALLEE	Allee Lacebark Elm		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			
Ulmus x 'Morton' ACCOLADE	Accolade Elm			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			
Ulmus 'Homestead'	Homestead Elm	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					
Zelkova serrata 'Green Vase'	Green Vase Zelkova				x	x	x	x	x	x	x	x	x				
Zelkova serrata 'Kiwi Sunset'	Kiwi Sunset Zelkova				x	x	x	x	x	x	x	x					
Zelkova serrata 'Village Green'	Village Green Zelkova				x	x	x	x	x	x	x	x					

Plants		Zones															Be
Trees		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Ba Upl
Picea pungens 'Mesa Verde'	Mesa Verde Spruce	x	x	x	x	x	x	x	x	x	x	x					
Picea pungens 'The Blues'	The Blues Blue Spruce																
Picea pungens var. glauca 'MonWal'	Sparkler Colorado Blue Spruce	x	x	x	x	x	x	x	x	x	x	x					
Pinus mugo	Mugo Pine	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							
Pinus mugo 'Carsten's Wintergold'	Carsten's Wintergold Mugo Pine	x	x	x	x	x	x	x	x	x							
Pinus mugo 'Jakobsen'	Pinus mugo 'Jakobsen'	x	x	x	x	x	x	x	x	x							
Pinus nigra	Austrian Pine				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					
Pinus ponderosa	Ponderosa Pine	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					
Pinus sylvestris	Scots Pine	x	x	x	x	x	x	x	x	x	x	x					
Pseudotsuga menziesii	Douglas Fir		x	x	x	x	x	x									
Thuja occidentalis	American Arbovitae	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	

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 Ma			
Shrubs		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Basin Upland	Swa
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
Amelanchier alnifolia 'Obelisk'	Standing Ovation Serviceberry	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				
Aronia melanocarpa var. elata	Black Chokeberry		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						
Artemisia nova	Black Sagebrush	x	x	x	x	x	x	x										
Atriplex canescens	Four-Wing Saltbrush						x	x	x	x	x	x	x	x			x	x
Baccharis pilularis	Coyote Brush										x	x	x	x		x	x	
Berberis aquifolium	Barberry				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
Berberis thunbergii f. atropurpurea	Japanese Barberry		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
Berberis thunbergii f. atropurpurea 'Golden Ring'	Golden Ring Japanese Barberry		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
Berberis thunbergii f. atropurpurea 'Rose Glow'	Rose Glow Japanese Barberry		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
Berberis thunbergii 'Maria'	Sunjoy Gold Pillar Japanese Barberry		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
Berberis thunbergii 'Pygruzam'	Pygmy Ruby Japanese Barberry		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				
Buxus microphylla 'Green Gem'	Boxwood 'Green Gem'		x	x	x	x	x	x	x	x	x	x	x	x				
Callistemon 'Little John'	Little John Dwarf Bottlebrush										x	x	x	x			x	
Caragana arborescens	Siberian Peashrub	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
Caragana frutex 'Globosa'	Globe Peashrub	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				
Caryopteris x clandonensis 'Heavenly Blue'	Heavenly Blue Bluebeard				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				
Caryopteris x clandonensis 'Janice'	Lil Miss Sunshine Bluebeard				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				
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				
Cephalanthus occidentalis	Buttonbush				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				
Cornus alba 'Cream Cracker'	Cornus alba 'Cream Cracker'	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
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
Cornus sericea	Red Twig Dogwood	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
Cornus sericea 'Budd's Yellow'	Budd's Yellow Dogwood	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
Cornus sericea 'Farrow'	Artic Fire Dogwood	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
Cornus sericea 'Isanti'	Isanti Red Twig Dogwood	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
Cornus stolonifera 'Neil Z' PUCKER UP	Pucker Up Red Twig Dogwood	x	x	x	x	x	x	x	x	x	x	x				x		x

Plants		Zones													Best Ma			
Shrubs		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Basin Upland	Swa
Helianthemum 'Ben More'	Ben More Sun Rose				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				
Helianthemum 'Dazzler'	Dazzler Sun Rose		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				
Helianthemum 'Raspberry Ripple'	Raspberry Ripple Sun Rose		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				
Helianthemum 'St. Mary's'	St Mary's Sun Rose		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				
Holodiscus discolor	Oceanspray				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				
Juniperus chinensis 'Kaizuka'	Kaizuka Juniper				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				
Juniperus communis	Common Juniper	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				
Juniperus horizontalis 'Bar Harbor'	Bar Harbor Juniper	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				
Juniperus horizontalis 'Hughes'	Hughes Juniper	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				
Juniperus horizontalis 'Wiltonii'	Blue Rug Juniper	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								
Juniperus sabina 'Buffalo'	Buffalo Juniper	x	x	x	x	x	x	x	x	x	x	x						
Juniperus sabina 'Skandia'	Skandia Juniper		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				
Juniperus scopulorum 'Gray Gleam'	Gray Gleam Juniper		x	x	x	x	x	x	x	x								
Juniperus scopulorum 'Skyrocket'	Skyrocket Juniper	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								
Juniperus x pfitzeriana 'Monsan'	Sea of Gold Juniper	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				
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				
Lonicera periclymenum 'Winchester'	Winchester Honeysuckle				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				
Mahonia aquifolium 'Compacta'	Dwarf Oregon Grape		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
Maireana sedifolia	Pearl Bluebush										x	x	x	x				
Nandina domestica 'Nana'	Nandina						x	x	x	x	x	x	x	x			x	
Pentaphylloides floribunda	Shrubby Cinquefoil				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
Philadelphus lewisii 'Blizzard'	Blizzard Mock Orange	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
Philadelphus lewisii 'PWY01S'	CHEYENNE® mock orange	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	
Physocarpus opulifolius 'Dart's Gold'	Dart's Gold Ninebark	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	
Physocarpus opulifolius 'Nanus'	Dwarf Ninebark	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	
Physocarpus opulifolius 'Seward'	Summer Wine Ninebark	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	

Plants		Zones													Best Ma			
Shrubs		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Basin Upland	Swa
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
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				
Ribes aureum	Golden Currant	x	x	x	x	x	x	x									x	x
Ribes cereum	Wax Currant		x	x	x	x												
Rhamnus frangula 'Columnaris'	Tallhedge Buckthorn	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							
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
Rhus glabra	Smooth Sumac	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x
Rhus glabra 'Laciniata'	Cutleaf Smooth Sumac	x															x	x
Rhus trilobata	Three-Leaf Sumac		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
Rhus typhina 'Bailtiger'	Tiger Eyes Sumac		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
Ribes cereum	Wax Currant		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
Rosmarinus officinalis 'Arp'	Arp Rosemary						x	x	x	x	x	x	x	x				
Rosmarinus officinalis 'Huntington Carpet'	Huntington Carpet Rosemary										x	x	x	x				
Salix bebbiana	Bebb's Willow		x	x	x	x											x	x
Salix boothii	Bebb's Willow		x	x	x	x											x	x
Salix drummondiana	Drummond Willow	x	x	x													x	x
Salix exigua	Coyote Willow	x	x	x													x	x
Salix geyeriana	Geyer Willow	x	x	x													x	x
Salix lemmonii	Lemmon Willow	x	x	x													x	x
Salix lutea	Yellow Willow	x	x	x													x	x
Salix planifolia	Planeleaf Willow	x	x	x													x	x
Salix scouleriana	Scouler Willow		x	x	x	x	x	x									x	x
Salvia clevelandii	Cleveland Sage								x	x						x	x	
Salvia leucophylla	Purple Sage						x	x	x	x	x	x	x	x		x	x	
Salvia spathacea	Hummingbird Sage										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	
Sambucus nigra 'EIFFEL 1'	Black Tower Elderberry		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
Sambucus nigra 'Gerda' x	Black Beauty Elderberry		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		
Shepherdia argentea	Silver Buffaloberry	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
Symphoricarpos x chenaultii 'Hancock'	Hancock Coralberry		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
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								
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		

Plants		Zones													
Grasses		**3b**	**4a**	**4b**	**5a**	**5b**	**6a**	**6b**	**7a**	**7b**	**8a**	**8b**	**9a**	**9b**	**Basin Bottom**
Acorus calamus	Sweet Flag		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
Agropyron spp.	BioNative Wheatgrass Mix		x	x	x	x	x	x	x	x					
Agrostis sp.	Redtop Bentgrass	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	
Andropogon gerardii 'PWIN01S'	WINDWALKER® big bluestem				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	
Bouteloua gracilis 'Blonde Ambition'PP 22,048	Blonde Ambition grama grass		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	
Buchloë dactyloides 'Cody'	Cody Buffalo Grass	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	
Calamagrostis x acutiflora 'Avalanche'	Avalanche Feather Reed Grass		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	
Calamagrostis x acutiflora 'Karl Foerster'	Karl Foerster Feather Reed Grass		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	
Calamagrostis brachytricha	Korean feather reed grass		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	
Carex albula	Frosty Curlse Sedge								x	x	x	x	x	x	
Carex buchananii	Fox Red Curly Sedge			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	
Carex elata 'Aurea'	Bowles Golden Sedge		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	
Carex lacustris	Common Lake Sedge				x	x	x	x	x	x					
Carex lurida	Bottlebrush Sedge	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	
Carex morrowii 'Ice Dance'	Ice Dance Japanese Sedge				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	
Carex phyllocephala 'Sparkler'	Sparkler Sedge								x	x	x	x	x	x	
Carex siderosticha 'Banana Boat'	Banana Boat Creeping Sedge				x	x	x	x	x	x	x	x	x	x	
Carex stricata	Common Tussock Sedge	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	
Carex vulpinoidea	Brown Fox Sedge	x	x	x	x	x	x	x	x	x					
Cephalanthus occidentalis	Buttonbush				x	x	x	x	x	x	x	x	x	x	
Cynodon dactylon	Bermuda Grass								x	x	x	x	x	x	x
Decodon verticillatus	Swamp Loosestrife	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
Deschampsia cespitosa var. vivipara	Tufted Hair Grass		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
Elodea canadensis	Common Waterweed		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			
Eriogonum caespitosum	Mat Buckwheat		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
Festuca arundinacea	Dwarf Tall Fescue				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
Festuca arundinacea 'Bonsai'	Bonsai Dwarf Tall Fescue				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	
Festuca glauca 'Boulder Blue'	Border Blue Fescue		x	x	x	x	x	x	x	x	x	x	x	x	

Plants		Zones													
Grasses		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom
Miscanthus sinensis 'Cabaret'	Cabaret Japanese Silver Grass				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
Miscanthus sinensis 'Gracillimus'	Gracillimus Maiden Grass				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
Miscanthus sinensis 'Silberfeder' SILVER FEATHER	Silver Feather Maiden Grass		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
Miscanthus sinensis 'varigatus'	Variegated Maiden Grass				x	x	x	x	x	x	x	x	x	x	x
Miscanthus sinensis 'Pünktchen' LITTLE DOT	Little Dot Maiden Grass				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
Miscanthus sinensis 'Yaku Jima'	Yaku Jima Maiden Grass				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
Muhlenbergia rigens	Deer Grass						x	x	x	x	x	x	x	x	
Nasella tenuissima	Mexican Feather Grass						x	x	x	x	x	x	x	x	
Panicum virgatum	Switch Grass				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	
Panicum virgatum 'Cloud Nine'	Cloud Nine Switch Grass				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	
Panicum virgatum 'Prairie Sky'	Prairie Sky Switch Grass		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	
Panicum virgatum 'Shenandoah'	Shenandoah Switch Grass				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	
Pennisetum alopecuroides 'Little Bunny'	Little Bunny Dwarf Fountain Grass						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	
Pennisetum orientale 'Karley Rose'	Karley Rose Oriental Fountain Grass				x	x	x	x	x	x	x	x			
Poa pratensis	BioBlue Kentucky Bluegrass Mix				x	x	x	x	x	x	x	x			x
Schizachyrium scoparium	Little Bluestem				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	
Schizachyrium scoparium 'MinnblueA'	Blue Heaven Little Bluestem	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	
Schizachyrium scoparium 'Standing Ovation' PP25,202	Standing Ovation little bluestem	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	
Spartina pectinata	Prairie Cordgrass		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	
Sporobolus wrightii	Giant sacaton				x	x	x	x	x	x	x	x			
Sporobolus wrightii 'Windbreaker'	Windbreaker Giant Sacaton				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													
Perennials		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Botton
Achillea millefolium 'Lilac Beauty'	Lilac Beauty Yarrow	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	
Achillea millefolium 'Paprika'	Paprika Yarrow	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	
Agalinus tenuifolia	Slender False Foxglove	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	
Agastache 'Desert Sunrise'	Desert Sunrise Hummingbird Mint				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	
Agastache 'Pink Pop'	Pink Pop Hummingbird Mint				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	
Agastache 'Summer Glow'	Giant Hyssop				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	
Agastache aurantiaca 'Apricot Sprite'	Apricot Sprite Hyssop				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	
Agastache aurantiaca 'P012S'	CORONADO® hyssop				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	
Agastache foeniculum 'Golden Jubilee'	Golden Jubilee Hyssop		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	
Agastache x 'Blue Boa'	Blue Boa Hummingbird Mint				x	x	x	x	x	x	x	x	x	x	
Angelica atropurpurea	Great Angelica		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
Aquilegia formosa	Western Columbine	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
Allium schoenoprasum	Chives		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
Armeria maritima 'Cotton Tail'	Cotton Tail Thrift	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
Armeria maritima 'Rubifolia'	Red Leaf Thrift	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
Asarum caudatum	Wild Ginger								x	x	x	x	x	x	x
Asclepias incarnata	Swamp Milkweed	x	x	x	x	x	x	x							
Ceratostigma plumbaginoides	Blue Plumbago				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			
Delosperma cooperi 'Eye Candy' Patent Applied For	Eye Candy Ice Plant								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	
Delosperma cooperi 'Jewel of the Desert Garnet'	Jewel of the Desert Garnet Icepant				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	
Delosperma cooperi 'Perfect Orange' Plant Patent Applied For	Perfect Orange Ice Plant								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	
Delosperma cooperi 'WOWDRW5' Plant Patent #25,572	Wheels of Wonder Violet Wonder Ice Plant				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			
Eupatorium perfoliatum	Common Boneset	x	x	x	x	x	x	x	x	x	x	x			
Euphorbia rigida	Spurge								x	x	x	x	x	x	
Gentiana andrewsii	Bottle Gentian	x	x	x	x	x	x	x	x	x					
Guara lindheimeri	Bee Blossom				x	x	x	x	x	x	x	x	x	x	
Helenium autumnale	Sneezeweed	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	

Plants		Zones													
Perennials		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom
Lavandula x ginginsii 'Goodwin Creek Gray'	Goodwin Creek Gray Lavender								x	x	x	x	x	x	
Lavandula x intermedia 'Provence'	Provence French Lavender				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	
Ludwigia alternifolia	Seedbox		x	x	x	x	x	x	x	x	x	x			
Mimulus cardinalis	Scarlet Monkey Flower								x	x	x	x	x	x	
Mimulus ringens	Mondey Flower	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	
Nepeta racemosa 'Blue Wonder'	Blue Wonder Catmint														
Nepeta x faassenii 'Junior Walker'	Junior Walker Catmint					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	
Nepeta x faassenii 'Walker's Low'	Walker's Low Catmint		x	x	x	x	x	x	x	x	x	x	x	x	
Ocimum basilicum 'Boxwood'	Boxwood Basil												x	x	
Ocimum basilicum 'Fino Verde'	Fino Verde Basil												x	x	
Origanum distamnus	Dittany of Crete								x	x	x	x	x	x	
Origanum vulgare	Oregano		x	x	x	x	x	x	x	x	x	x			
Peltandra virginica	Arrow Arrum				x	x	x	x	x	x	x	x	x	x	
Penstemon 'Dark Towers'	Dark Towers Penstemon				x	x	x	x	x	x	x	x			
Penstemon 'Midnight Blue'	Midnight Blue Penstemon			x	x	x	x	x	x	x	x	x			
Penstemon x 'Coral Baby'	Coral Baby penstemon				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			
Penstemon barbatus 'Navigator'	Navigator Penstemon		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			
Penstemon fruticosus 'Purple Haze'	Purple Haze Penstemon				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	
Penstemon grandiflorus 'Prairie Jewel'	Prairie Jewel Penstemon	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	
Penstemon linarioides ssp. coloradoensis 'P014S'	SILVERTON® bluemat penstemon		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	
Penstemon pseudospectabilis	Desert beardtongue				x	x	x	x	x	x	x	x	x	x	
Penstemon rostriflorus	Bridges' penstemon			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			
Penstemon x mexicali 'Pike's Peak Purple'	Pike's Peak Purple Beardtongue														
Penstemon x mexicali 'Psmyers'	SHADOW MOUNTAIN® penstemon			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			
Penstemon x mexicali 'P007S'	PIKES PEAK PURPLE® penstemon			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			
Physotegia virginiana	Obedient Plant	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	
Pycnanthemum muticum	Mountain Mint		x	x	x	x	x	x	x	x					
Pycanthemum virginianum	Common Mountain Mint	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	
Rosa rugosa	Pink Rugosa Rose	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	
Sagittaria latifolia	Common Arrowhead				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	
Salvia microphylla x greggii 'EGGBEN003' Plant Patent #24,155	Heatwave Glimmer Sage						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	

Plants		Zones													
Perennials		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Botton
Sedum spurium 'Bronze Carpet'	Bronze Carpet Stonecrop	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	
Sedum rupestre 'Variegated'	Variegated Stonecrop	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	
Sidalcea 'Party Girl'	Party Girl Prairie Mallow				x	x	x	x	x	x					
Silphium perfoliatum	Cup Plant	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	
Sisyrinchium angustifolium 'Lucerne'	Lucerne Blue-Eyed Grass				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	
Stachys byzantina 'Helen von Stein'	Helen von Stein Lamb's Ear		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			
Symphyotrichum novae-angliae	New England Aster		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	
Thymus argenteus 'Hi Ho Silver'	Hi Ho Silver Thyme				x	x	x	x	x	x	x	x	x	x	
Thymus pseudolanuginosus	Woolly Thyme				x	x	x	x	x	x	x	x			
Thymus serpyllum	Creeping Thyme					X	X	X	X	X	X	X	X	X	
Thymus serpyllum 'Elfin'	Elfin Thyme					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	
Thymus vulgaris	English Thyme				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
Verbena hastata	Blue Verain	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	
Zizia aurea	Golden Alexander	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;

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Plants		Zones													
Groundcovers		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom
Ajuga x 'Toffe Chip' Plant Patent # 18,805	**Toffe Chip Carpet Bugle**		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	
Diachondra repens	Diochondra								x	x	x	x	x	x	x
Delosperma 'Strong Red'	Strong Red Ice Plant								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	
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	
Juniperus horizontalis 'Bar Harbor'	Bar Harbor Juniper	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	
Juniperus horizontalis 'Plumosa Compacta'	Compact Plumosa Juniper	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	
Juniperus horizontalis 'Youngstown'	Youngstown Andorra Juniper	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			
Juniperus sabina 'Skandia'	Skandia Juniper		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	
Nepeta sibirica 'Souvenir d' André Chaudron'	Souvenir d Andre Chaudron Catmint	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	
Nepeta 'Psfike'	Little Trudy Catmint		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	
Veronica armeria	Thyme-leaf Speedwell		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	
Veronica 'Reavis'	CRYSTAL RIVER® veronica	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	

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Plants		Zones													Best M		
Vines		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Basin Upland
Aristolochia californica	Pipe Vine										x	x	x	x		x	
Campsis radicans f. flava	Yellow Trumpetvine				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
Vitis labrusca 'Concord'	Concord Grape				x	x	x	x	x	x	x	x					x
Vistis labrusca 'Niagara'	Niagara Grape				x	x	x	x	x	x	x	x					x
Vitis labrusca 'Niagara'	Niagara Grape				x	x	x	x	x	x	x	x					x
Vitis 'Himrod'	Himrod Grape				x	x	x	x	x	x	x	x					x
Vistis 'St. Theresa'	St. Theresa Grape				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

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Plants		Zones													Best Management Pra				
Cacti & Succulents		3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	Basin Bottom	Basin Edge	Basin Upland	Swales	St
Aloe 'Carmine'	Retro Succulents Carmine Aloe												x	x					
Aloe 'Donnie'	Retro Succulents Donnie Aloe												x	x					
Aloe 'Guido'	Retro Succulents Guido Aloe												x	x					
Aloe 'Pink Blush'	Pink Blush Aloe												x	x					
Aloe 'Sal'	Retro Succulents Sal Aloe												x	x					
Asclepias speciosa Torr.	Showy Milkweed				x	x	x	x	x	x	x	x	x	x	x	x		x	
Echeveria agavoides 'Lipstick'	Lipstick Echeveria												x	x					
Echeveria elegans	Mexican Snowball												x	x					
Echeveria imbricata	Blue Rose Echeveria												x	x					
Echeveria setosa	Firecracker Echeveria												x	x					
Echeveria shaviana	Mexican Hens Echeveria												x	x					
Echeveria 'Black Prince'	Black Prince Echeveria												x	x					
Echeveria 'Perle von Nurnberg'	Perle von Nurnberge Echeveria												x	x					
Echeveria 'Ruffles'	Ruffles Echeveria												x	x					
Hesperaloe parviflora	Red yucca				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					
Hesperaloe parviflora 'Yellow'	Yellow Yucca				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					
Sempervivum tectorum ssp. greenii	Greenii Hens and Chicks		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					
Sempervivum 'Royal Ruby'	Royal Ruby Hens and Chicks		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					
Yucca filamentosa	Adam's Needle				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					

Plant Select, 2018; Conservation Garden Park, 2018; Charter Township of Canton, 2006; USDA-Natural Resources Conservation Service, 2000; Missouri Botanical Garden, 2018;

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Appendix F References

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