**City of Leavenworth**
**Planning Commission Meeting**
**May 4, 2016 (Wednesday)**
**7:00 PM**
**City Hall – Council Chambers**

## AGENDA

1. Call Meeting to Order
2. Roll Call
3. PC Minutes: February 3, 2016, March 2, 2016, March 16, 2016 (special), and April 6, 2016.
4. **HOLD for Mayoral Ad Hoc Housing Affordability Committee** -- Preliminary draft amendment to LMC to create the option for the Council to forgive or forgo fees to support or subsidize City desired projects; and potential Comprehensive Plan amendments discussion. (no materials provided)
5. Future streets map within the Transportation Element to add streets for planned circulation patterns ("Grid" street), and general update - review to ensure the adoption by reference of the CDTC "2040 Regional Transportation Plan" that lays out a long-term blueprint for transportation investments throughout the region. (bring the maps from last meeting's homework)
6. Regional Stormwater / Wetland Master Plan feedback and comments to begin structuring the document.
7. LMC - Titles 21 and 18-Consolidation of Definitions (incorporated the update to resolve "Commercial and Family Amusement Centers/ Facilities," Floodplain, and other necessary updates)
8. PC members and public discussion regarding short-term / vacation / overnight rentals in residential neighborhoods.
    a. Preliminary direction – staff will subsequently return with research and options for PC to consider.
9. Upcoming Meetings (**tentative agenda items**)
    a. Continue LMC - Residential uses review and update. Short-term / vacation / overnight rentals in residential neighborhoods.
    b. LMC - Titles 21 and 18-Consolidation of Definitions
    c. Regional Stormwater / Wetland Master Plan.
    d. Future streets map within the Transportation
10. Adjourn Meeting.

# CITY OF LEAVENWORTH
# REGIONAL STORMWATER / WETLAND MANAGEMENT MASTER PLAN

FOR

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Leavenworth, WA 98826

BY

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Project No. 15080CA
March 16, 2016

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Section 9: BMP Ranking References.....

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# SECTION 1
## INTRODUCTION

**Regional Stormwater/Wetland Management Master Plan**
**Goals, Policies, and Strategies**
**OUTLINE**

## History...(add back to the origins???)

On July 1, 2014, the City was awarded a $150,000 Centennial Clean Water Program Grant. Special thank you to our funding partner DOE

Securing funding was the top priority and first step in addressing the wetland and stormwater issues in the City and Urban Growth Area. This funding has allowed the City to move forward with collecting information to identify the issues and also to develop solutions for addressing wetland and stormwater issues while allowing for future development. On March 24, 2015, the Council approved the Professional Service Agreements (contracts) with three qualified consultants to develop a Regional Stormwater Quality / Wetland Management Master (Plan) for stormwater control, protection, restoration, and enhancement through green infrastructure planning within the Urban Growth Area (UGA) of the City of Leavenworth (City).

## Introduction

Stormwater runoff is any form of precipitation (rain or melting snow and ice) that runs off the land. Under natural conditions, this runoff is but a small percentage of the total precipitation with the vast majority of water either infiltrating into subsurface soils and deep groundwater reserves or evapotranspirating into the air. This process is generally known as the hydrologic cycle. Experience has shown that human developments have a significant impact on the hydrologic cycle. These impacts are usually a result of increasing impervious area. As impervious cover increases, infiltration and evapotranspiration rates decrease which leads to a subsequent increase in stormwater runoff. A comprehensive stormwater management plan is the most effective approach for addressing stormwater runoff.

The Stormwater Master Plan establishes specific goals for stormwater management that are applicable over the next five, 10 and 20 years. These goals address water quality and water quantity as it relates to private and public development as well as infrastructure. This plan will also present a wide range of tools to provide the City with various methods to meet established goals

This plan also looks at opportunities to improve stormwater management in the areas of water quality and water quantity as well as funding opportunities to assist with stormwater and flooding improvements. Alternative approaches to stormwater management has been explored and presented including recommendations for policy changes, regional detention options and other opportunities. Exploration of methods to manage stormwater as a beneficial resource to the City is included.

One purpose of the City of Leavenworth (City) Storm Water Master Plan is to establish standard principles and practices for the analysis, design, and construction of drainage systems in the City for the benefit and safety of the community.

The goal of stormwater planning is to protect or maintain the health of streams, lakes and aquatic life as well as to provide opportunities for human uses of water by mitigating the effects of urban development.

The Plan addresses enhancements to the storm system infrastructure; and focus on the reduction of contaminants into the Wenatchee River Watershed and reduce the amount of stormwater that flows into the City's storm system.

**Acknowledgements:**
(DOE, Council (existing and former), Planning Commission, Chelan County, Citizens, Thom Kutrich (Pacific Engineering), Ryan Walker and Anne Hessburg (Grette Associates), and Nathan Pate (City staff) - Logos and nice image.

# SECTION 2
## GOALS AND POLICIES

## GOAL 1: UPDATE LOCAL CODE LANGUAGE

### Policy A: Clarify existing code language related to storm water

*Strategy:* Apply uniform verbiage to all terms related to storm water. Clarify and distinguish storm sewer from sanitary sewer.

- Title 3.78
- Title 8.56
- Titles 13.02, 13.68, 13.72, 13.76, 3.82, 13.83, 13.88, 13.90
- Titles 14.04, 14.14
- Title 17.14
- Title 18.50, 18.51

### Policy B: Update Titles 13.90, 14.04, and 14.14

*Strategy:*

- Bring into conformance with the Green Infrastructure Master Plan,
- Adopt additional existing appropriate guidelines, i.e. WSDOT Highway Runoff Manual, and Low Impact Development Guide for Eastern Washington.

## GOAL 2: PREPARE COMPLIANCE CRITERIA

### Policy A: Develop clear and concise project thresholds

*Strategy: Address the following subjects.*

- New development,
- Redevelopment (retrofit),
- Single Family Residential,
- See attached draft resolution.

### Policy B: Develop clear and concise performance standards

*Strategy: Address the following subjects.*

- Water Quality Treatment,
- Runoff Control,
- Exemptions.

### Policy C: Develop clear and concise local core requirements

*Strategy: Address the following Core Requirements.*

- Core Requirement no. 1: Stormwater Site Plan (SSP),
- Core Requirement no. 2: Construction Stormwater Prevention Pollution Plan (SWPPP),
- Core Requirement no. 3: Source Control of Pollution,
- Core Requirement no. 4: Preservation of Natural Drainage Systems,
- Core Requirement no. 5: Water Quality Treatment,
- Core Requirement no. 6: Runoff Control,
- Core Requirement no. 7: Operations and Maintenance.

### Policy D: Pollutants of Concern

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*Strategy: Address the following pollutant categories.*

- Total Suspended Solids (TSS)
- Oils
- Metals
- Total Maximum Daily Loads (TMDL)
- Use definition and procedures

## GOAL 3: STREAMLINE APPLICANT PROCESS AND EXPECTATIONS

### Policy A: Develop new permit compliance templates and checklists

*Strategy: Address the following*

- Application,
- Permitting,
- Construction Plans,
- Stormwater Report,
- Plans examiner review standards,
- Post construction.

### Policy B: Develop a project impact payment schedule to the stormwater utility for system capacity improvements in lieu of providing runoff control (detention)

*Strategy: Develop the following*

- See attached draft resolution and attachments,
- Locate regional detention facilities,
- Identify conveyance capacity improvements,
- Adopt a peak flow capacity threshold for each of the four city storm networks.

### Policy C: Develop a project impact payment schedule to the stormwater utility in lieu of providing water quality treatment

*Strategy: Develop the following*

- See attached draft resolution and attachments,
- Locate regional water quality treatment facilities,
- Adopt a pollutant capacity threshold for each of the four city storm networks.

## GOAL 4: STREAMLINE ENGINEERING REQUIREMENTS

### Policy A: Develop hydrologic and hydraulic analysis minimum standards

*Strategy:*

- Acceptable analysis methods and applicability,
- Standardize use of ground cover runoff curve numbers,
- Minimum conveyance roughness coefficient standards,
- Required precipitation depths,
- Eliminate rain on snow requirements.

### Policy B: Develop a water quality treatment BMP selection matrix

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*Strategy:*

- Rank acceptable BMPs based on local requirements and conditions

**Policy C: Develop a runoff control BMP selection matrix**

*Strategy:*

- Rank acceptable BMPs based on local requirements and conditions

## GOAL 5: ENCOURAGE AND PROMOTE LOCAL PARTNERSHIPS

**Policy A: Partner with the Icicle Irrigation District to eliminate the discharge of unused irrigation distribution water**

*Strategy:*

**Policy B: Encourage the establishment of a local Drainage District (Special Purpose District) via RCW 85 to reduce or eliminate impacts from nuisance surface / ground waters (non-stormwater)**

*Strategy:*

**Policy C: Partner with Chelan County Natural Resources to 1) increase in-stream flows in the Wenatchee River, and 2) improve stormwater quality prior to discharge to the Wenatchee River**

*Strategy:*

## GOAL 6: PURSUE AND LEVERAGE GRANT AND LOAN FINANCING FOR CAPITAL IMPROVEMENT PROGRAM

**Policy A: Prepare a 6 year and 20 year Capital Improvement Program**

*Strategy:*

**Policy B: Pursue stormwater system improvement funding from state programs and agencies, including but not limited to, Department of Commerce, Public Works Trust Fund, Ecology, and Transportation Improvement Board.**

*Strategy:*

**Policy C: Complete separation of sanitary sewer and storm drainage infrastructure**

*Strategy:*

## GOAL 8: ENHANCE EXISTING WETLANDS

**Policy A: Detention Improvements**

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*Strategy:*

**Policy B: Habitat Improvements**

*Strategy:*

**Policy C: Water Quality Improvements**

*Strategy: Provide water quality treatment to discharges tributary to identified wetlands.*

## GOAL 9: MAINTAIN A STORM DRAINAGE SYSTEM MODEL

**Policy A: Complete the field survey of the existing four networks**

*Strategy:*

**Policy B: Calibrate model based on actual storm events.**

*Strategy:*

**Policy C: Perform routine and timely updates of the network software models**

*Strategy:*

**Policy D: Require permit applicants to field survey and submit network infrastructure as-built data for model input**

*Strategy:*

**Policy E: Commit network models, reports, and maintenance records to GIS**

*Strategy:*

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*(???) Add "Rationale:" to each policy and/or goal*

**STATE GOAL (???) The long-range health and environmental goals for the state of Washington require the protection of the state's surface and underground waters for the health, safety, use, enjoyment, and economic benefit of its people.**

**WQ STATE AND FEDERAL GOAL (???) planning, design, acquisition, construction, and improvement of water pollution control facilities and related activities in the achievement of state and federal water pollution control requirements for the protection of the state's waters.**

**WQ STATE GOAL (???) Strive to implement elements of the Washington's Water Quality Management Plan to Control Nonpoint Sources of Pollution**

**WQ GOAL (???) Implement water quality infrastructure and nonpoint source pollution projects to improve and protect water quality.**

**WQ GOAL (???) increase, expand and maintain water pollution control facilities.**

**WQ GOAL: Reduce stormwater transported pollutant discharges into the Wenatchee River Watershed**

**GENERAL GOAL (???) Prevent adverse impacts from stormwater**

**GENERAL GOAL (???) Protect, preserve, and enhance our rivers and streams**

*(???) below is from a more precise plan, and may be to specific for our general goals.*

**RUNOFF CONTROL GOAL (???) formulate the long term solution for the flooding, drainage and stormwater management problems in the existing built-up areas in order to reduce the adverse effects of flooding on people and property and to protect the existing and proposed development by implementation of an integrated stormwater management by providing an appropriate level of affordable flood protection to community expectations.**

**RUNOFF CONTROL AND WQ GOAL (???) optimise the effectiveness of the existing stormwater infrastructure network within the study area in a way thet meets the needs of the community and where possible, by providing and maintaining stormwater management infrastucture at an acceptable quality of service, taking into account environmental effects and public expectations.**

**NPDES GOAL (???) control the excessive sediment in watercourses to acceptable levels by managing the catchment activities using at source control measures to prevent any acceleration of the rate of erosion from construction site, upland and in stream channel.**

**RUNOFF CONTROL AND WQ GOAL (???) Collect and convey stormwater from a catchment to its receiving waters with minimal impact by managing and improving the quality of stormwater runoff from urbanized catchment and its pollution loads in order to reduce the adverse effects of contamination on the receiving water environment and by**

**recommending ways to eliminate pollutions discharges to stromwater systems and receiving water.**

**WATER RESOURCES GOAL (???) maximise on the opportunity of water resources conservation by stormwater runoff utilization as an alternative for non-potable water supply as a resource to reduce demand on other water resources, where feasible.**

**HABITAT AND RECREATION GOAL (???) protect and enhance the natural water-dependent ecosystems and enhance community accessibility to enjoy and appreciate watercourses environments, and to protect and maintain the rivers environments through environmental and aeshetic stormwater facilities/systems.**

**ZONING AND COMPREHENSIVE PLANNING GOAL (???) minimise the impact of urbanisation on the stormwater environment and to strike a balance between social, economic and environmental concerns to achieve sustainable development**

# SECTION 3
## DRAFT RESOLUTION: STANDARD PROCEDURES FOR STORMWATER APPLICABILITY THRESHOLDS

**STANDARD PROCEDURES FOR STORMWATER APPLICABILITY THRESHOLDS**

**General**
The following standard procedures provide guidance for stormwater management related to development.

Via Ordinance No. 1355 the City Council adopted the Washington State Department of Ecology (Ecology) Stormwater Management Manual for Eastern Washington (SMMEW).

Ecology has developed technical manuals, guidelines, regulations, and model ordinances relating to stormwater management in order to: (1) guide design of stormwater facilities, (2) prevent construction stormwater pollution, (3) control pollution at its source, (4) preserve natural drainage systems, (5) provide water quality treatment best management practices, (6) provide runoff control best management practices, (7) ensure documentation of minimum operations and maintenance procedures, and (8) allow for adoption of local requirements.

**Policy**
Applicable thresholds for stormwater management impacts due to development shall be evaluated at the time of permitting and shall be implemented as follows:

1) SMMEW Core Elements (CE)
   a) All development shall comply with CE 1 – 4 and 8,
   b) When runoff treatment thresholds are met all development shall comply with CE 5 & 7,
   c) When runoff control thresholds are met all development shall comply with CE 6 & 7,
   d) Projects which expand the impervious area on an existing roadway are included in the definition of new development.
   e) Exemptions
      i) Road and parking preservation/maintenance, i.e. patching, crack sealing, resurfacing, overlays, shoulder grading, vegetation maintenance, and drainage reshaping/regrading.
   f) Partial exemptions
      i) Underground utility projects shall only comply with CE 2,
      ii) Road and parking preservation/maintenance, i.e. remove, replace or repair paving, surfacing, and subgrade without expanding the impervious area, shall only comply with CE 2.
2) All development shall be categorized as:
   a) New Development
   b) Redevelopment
   c) Single Family Residential (single building permit)
3) New Development
   a) Comply with section one above.
4) Redevelopment
   a) Definition: replacement of 5,000 sf or more of pollutant generating impervious surfaces (PGIS).
      i) All redevelopment PGIS shall comply with CE 1 – 4 and 7 - 8 provided any resultant non-PGIS and the redeveloped PGIS surface runoff are not co-mingled, otherwise

see section one.

ii) CE 5 shall also apply at:
   (1) Industrial sites with outdoor handling, processing, storage, or transfer of solid raw materials or finished products (40 CFR 122.26(b)(14)),
   (2) Commercial sites with outdoor storage or transfer of solid raw materials or treated wood products,
   (3) Site that discharge to surface water with an Ecology water quality assessment designation of Category 4a (has a TMDL), 4b (has a pollution control program) or 5 (requires a TMDL).
   (4) High use sites,

iii) CE 6 shall also apply at:
   (1) Any site exceeding the maximum allowable coverage per Title 18. Additional landscaping is required to avoid this threshold.

5) Single Family Residential (single building permit)
   a) Only CE 5 shall apply per the city standard plan(s) for single family residential storm water management.
   b) Only CE 6 shall apply per the city standard plan(s) for single family residential storm water management in areas documented and as recommended by a licensed engineering geologist, geologist, or equivalent licensed professional approved by the City.

6) Payment-in-lieu of complying with CE 5 or CE 6.
   a) Applicants may opt to providing a payment to the city in-lieu-of developing on site compliant facilities for CE 5 and/or CE 6. Eligibility for payment of such fee will based on all of the following:
      i) There is an adopted regional capital improvement within the drainage basin of the applicant, and
      ii) a pro-rata cost share has been adopted to design and construct the regional capital improvement.

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# SECTION 4
## DRAFT CAPITAL IMPROVEMENT PROGRAM

The following capital improvements were evaluated to review their respective impact regarding identified model network flood locations.

| | **6 Year Capital Improvements** | | | | |
|---|---|---|---|---|---|
| Priority | Basin / Location | Problem | Event | Capital Improvement | Result |
| 1 | Alpensee<br>- Cascade High School | Chumstick Road: Pipe crossing downstream 18" dia. pipe (84 LF) is at capacity. Upstream flooding results. | Regional 10, 25, and 100 yr storm. Short Duration 100 yr storm. | Replace 84 LF of 18" dia. pipe with 30" dia. smooth wall pipe. | Eliminates all flooding except for Regional 100 yr storm. |
| 2 | Ski Hill<br>- Basin BS-4D | Whitman Street: 32 acre basin enters storm network at Whitman/Clinton. Flooding along Whitman. | Regional and Short Duration 100 yr storm. | Slip line ±829 LF of 18" pipe. | Eliminates all flooding. |
| 3 | Downtown East<br>- Commercial Avenue | Commercial Ave: Division to 14th, 18" dia. pipe (1,355 LF) is at capacity. Upstream flooding occurs | Short Duration 100 yr storm. | Slip line ±1,159 LF of 18" pipe. | Eliminates all flooding. |
| | **20 Year Capital Improvements** | | | | |
| 4 | Ski Hill<br>- Basin BS-13 | Ski Hill Drive: 1,038 acre basin enters storm network at Pine/Ski Hill. Widespread flooding from Pine to Whitman including side streets. | Regional 100 yr storm. | Detention basin(s) to reduce peak flow rate and attenuate the peak flow. | Eliminates all flooding. |
| 5 | Alpensee<br>- Basin BA-7 | Titus Road: 376 acre basin enters storm network at roadway storm crossing. | Short Duration 100 yr storm. | Detention basin(s) to reduce peak flow rate and attenuate the peak flow. | Eliminates all flooding except Regional and Short Duration 100 yr storm. |
| 6 | Downtown West<br>- Basin BW-23 | Burke Avenue: Birch to Pine flooding. | Short Duration 100 yr storm. | Detention basin(s) to reduce peak flow rate and attenuate the peak flow. | Eliminates all flooding |

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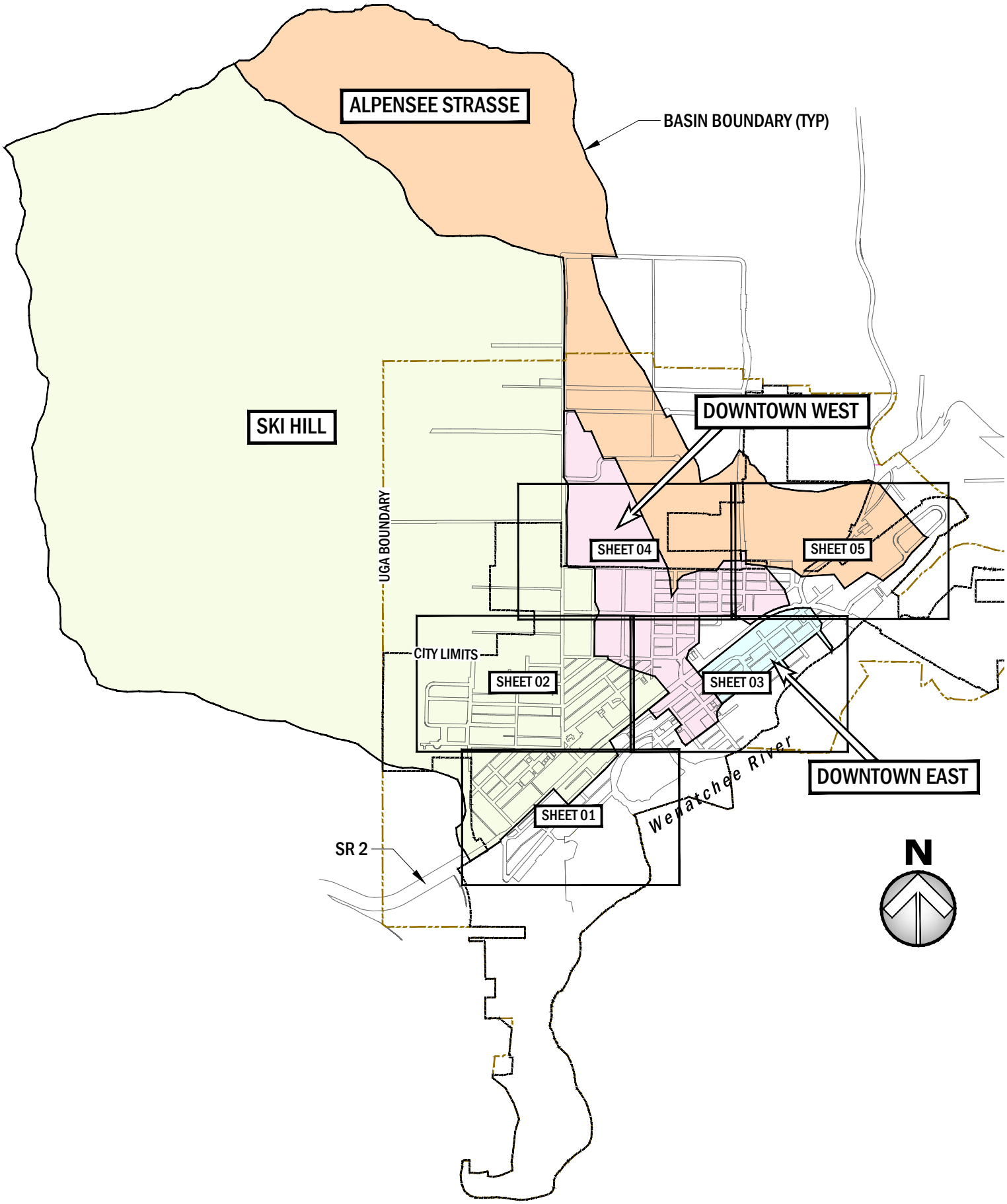
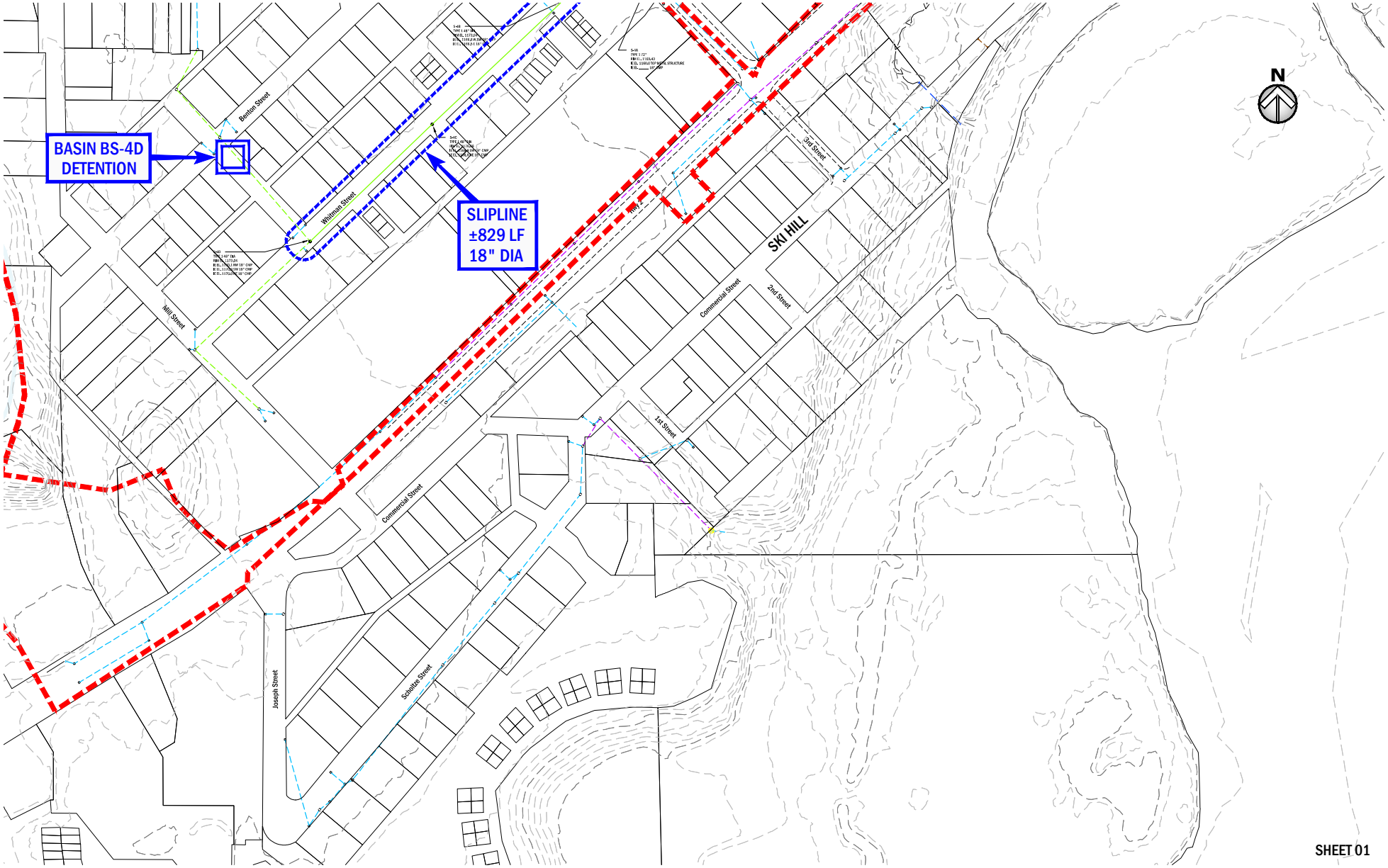
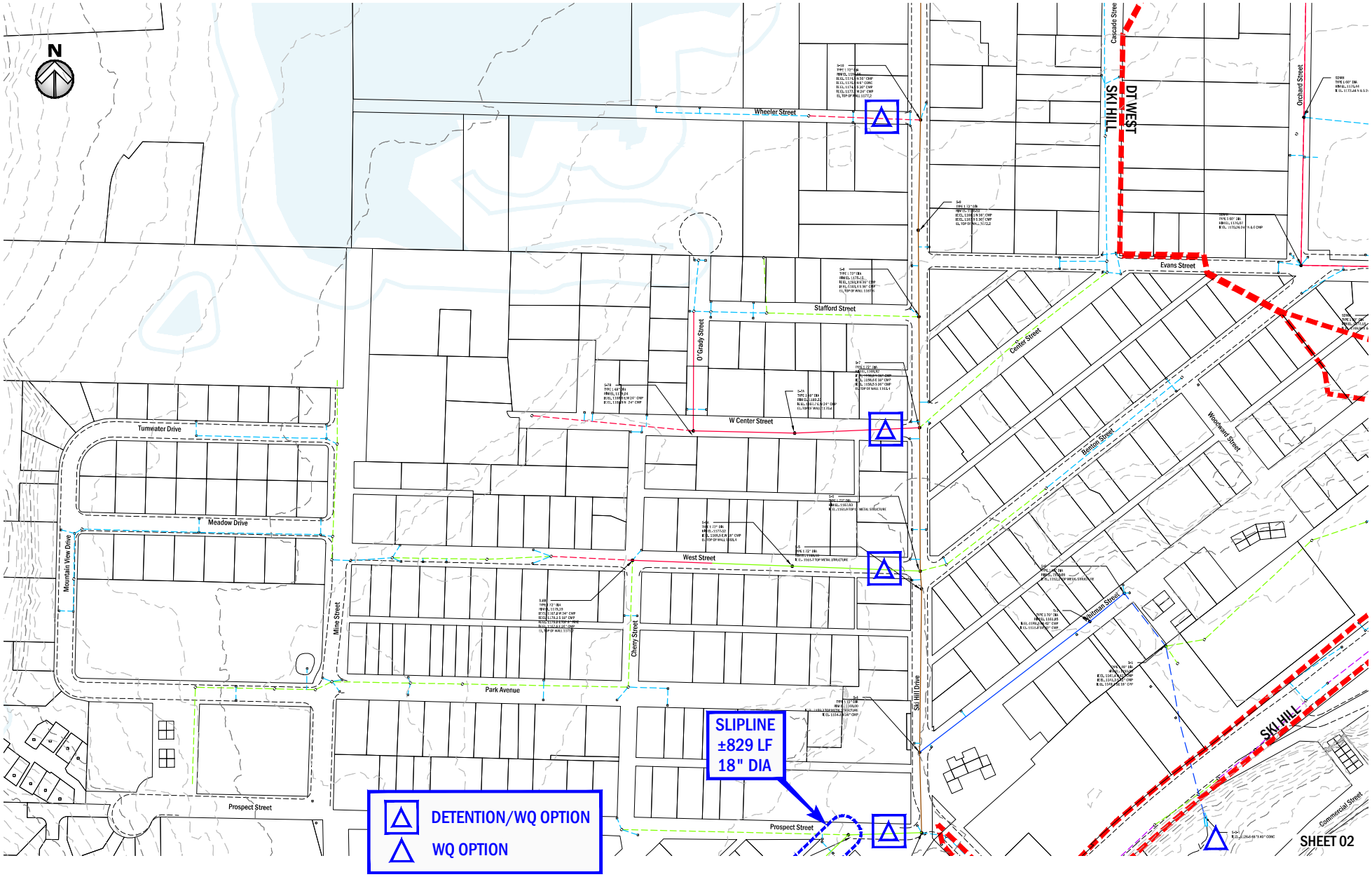
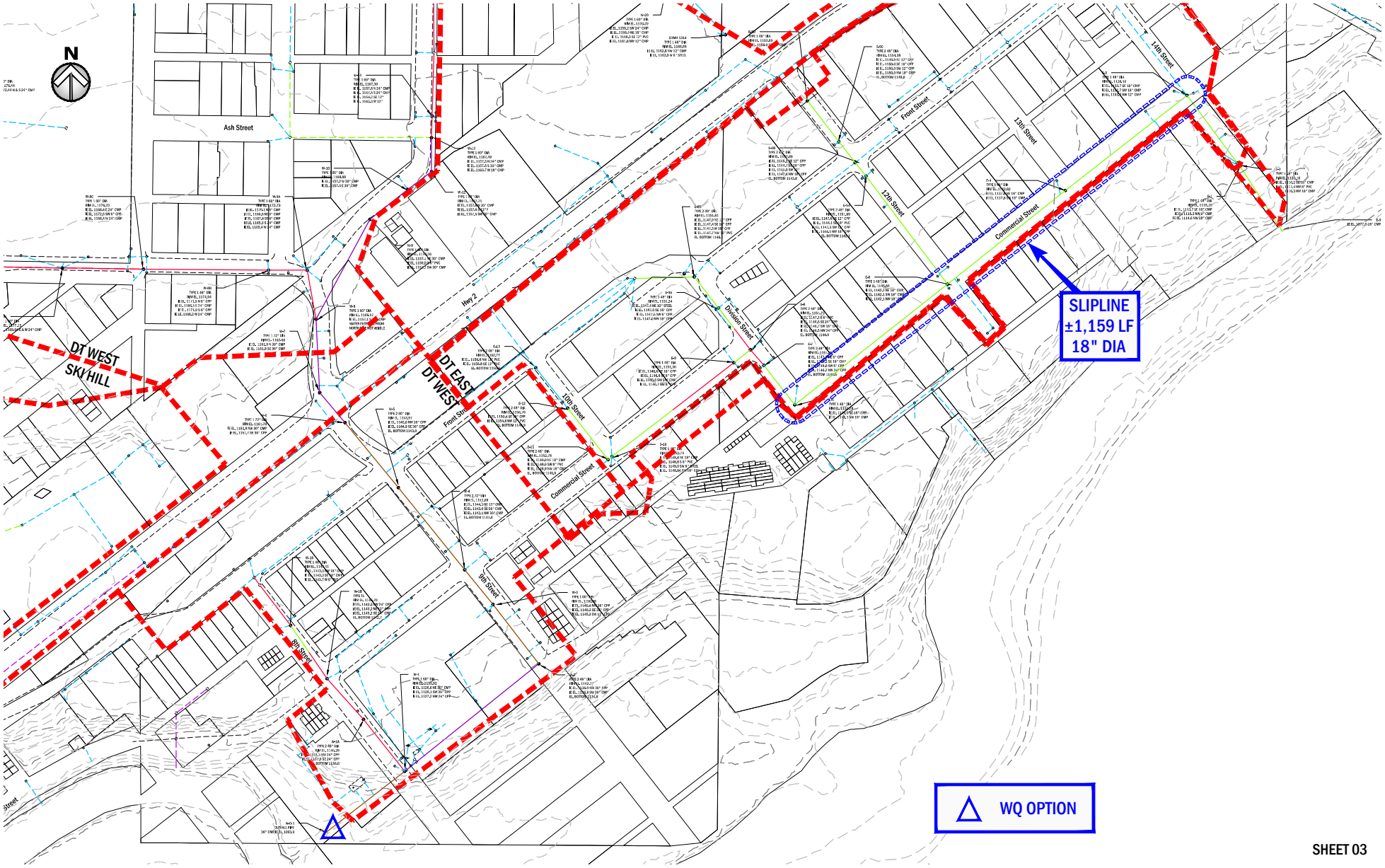



# DRAINAGE BASIN KEY MAP

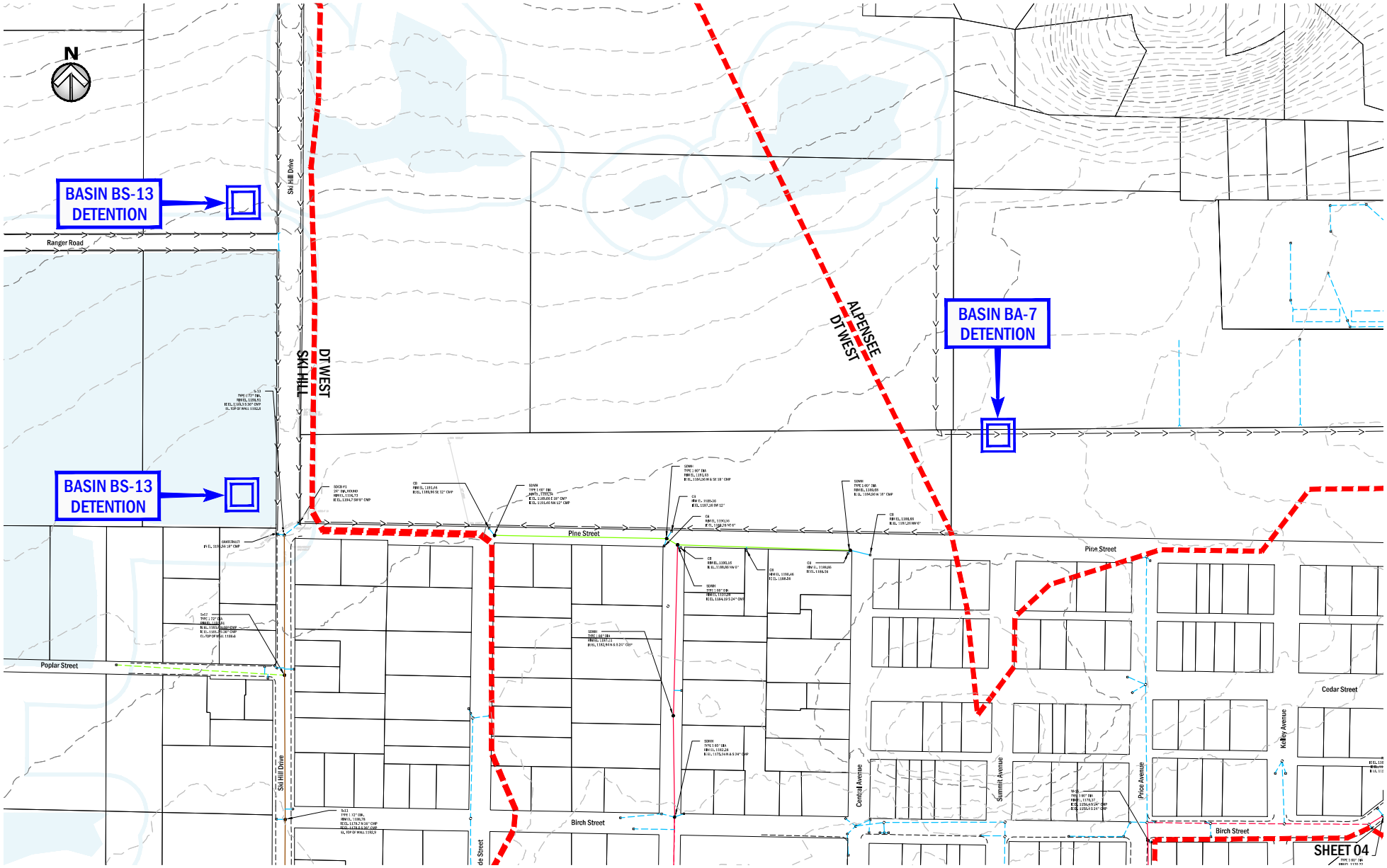

BASIN BS-4D
DETENTION
SLIPLINE
±829 LF
18" DIA
Benton Street
Whitman Street
Hill Street
Commercial Street
Joseph Street
Schultze Street
1st Street
2nd Street
3rd Street
SKI HILL
N

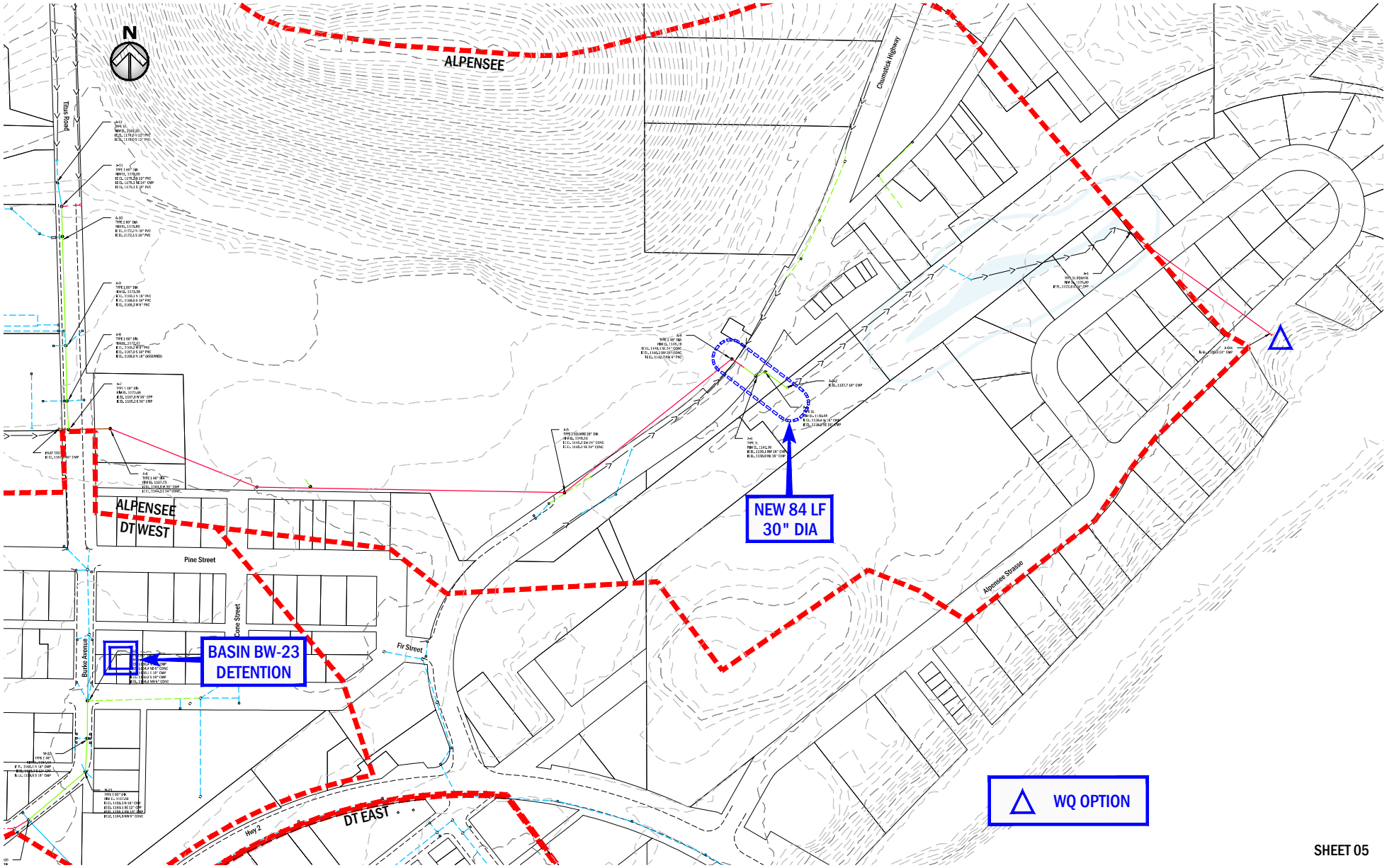
SHEET 01


N
Wheeler Street
Stafford Street
O'Grady Street
W Center Street
West Street
Park Avenue
Prospect Street
Tumwater Drive
Meadow Drive
Mountain View Drive
Mine Street
Cherry Street
Ski Hill Drive
Cascade Street
DT WEST
SKI HILL
Evans Street
Orchard Street
Center Street
Bangor Street
Woodward Street
Whitman Street
SKI HILL
Commercial Street
SLIPLINE
±829 LF
18" DIA
DETENTION/WQ OPTION
WQ OPTION
SHEET 02


N
Ash Street
DT WEST
SKI HILL
DT EAST
DT WEST
Front Street
Hwy 2
Division Street
10th Street
Commercial Street
9th Street
8th Street
Front Street
12th Street
13th Street
14th Street
Commercial Street
SLIPLINE
±1,159 LF
18" DIA
WQ OPTION

SHEET 03


N
BASIN BS-13
DETENTION
BASIN BS-13
DETENTION
BASIN BA-7
DETENTION
Ski Hill Drive
Ranger Road
SKI HILL
DT WEST
ALPENSEE
DT WEST
Pine Street
Pine Street
Poplar Street
Ski Hill Drive
Birch Street
Birch Street
Central Avenue
Summit Avenue
Price Avenue
Kelley Avenue
Cedar Street
SHEET 04


N
ALPENSEE
Chumstick Highway
Titus Road
ALPENSEE
DT WEST
Pine Street
Cone Street
Fir Street
Burke Avenue
BASIN BW-23
DETENTION
NEW 84 LF
30" DIA
Alpentage Strasse
DT EAST
Hwy 2
WQ OPTION

SHEET 05

# SECTION 5
## DRAFT PROCEDURES FOR FEE-IN-LIEU OF BMPS

| Drainage Basin | Area (ac) | Wetlands (ac) | Woods (ac) | Total Developable (ac) |
|---|---|---|---|---|
| Ski Hill | 1,578.00 | 42.75 | 1012.37 | 522.88 |
| | | | | |
| Downtown West | 128.60 | 2.15 | | 126.45 |
| | | | | |
| Downtown East | 22.66 | 0 | 0 | 22.66 |
| | | | | |
| Alpensee | 457.60 | 2.29 | 150.5 | 304.81 |

**Example: Central Commercial Zone within Downtown East Basin (base assessment)**

| | | | |
|---|---|---|---|
| Capital Project | WQ Treatment at Outfall | | |
| Estimated Cost | $ 250,000 | | |
| Total Area | 22.66 | ac | |
| Public PGIS (Parking / Road) | 7.00 | ac (est.) | 100% max. impervious coverage |
| Private PGIS (Parking / Road) | 7.00 | ac (est.) | |
| Roofs (NPGIS) | 8.66 | ac (est.) | |

Equation: Estimated Cost ÷ Total Area = $ / ac or sf

| Cost | Acres | Cost per Acre |
|---|---|---|
| $ 250,000 | 22.66 | $ 11,033 |

**Example: General Commercial Zone within Downtown East Basin (adjusted assessment)**

| | | | |
|---|---|---|---|
| Capital Project | WQ Treatment at Outfall | | |
| Estimated Cost | $ 250,000 | | |
| Total Area | 22.66 | ac | |
| Public PGIS (Parking / Road) | 6.00 | ac (est.) | 75% max. impervious coverage |
| Private PGIS (Parking / Road) | 5.00 | ac (est.) | |
| Roofs (NPGIS) | 6.00 | ac (est.) | |
| Landscaping | 5.66 | ac | 25% of area |

Equation: Estimated Cost ÷ Landscaping = $ / ac or sf

| Cost | Landscape Credit | Cost per Impervious Acre |
|---|---|---|
| $ 11,033 | 25% | $ 8,274 |

# SECTION 6
## RESIDENTIAL DRIVEWAY WATER QUALITY TREATMENT

**RESIDENTIAL DRIVEWAY WATER QUALITY TREATMENT REQUIREMENTS**

All residential driveways are required to discharge their stormwater surface runoff to a level spreader. The level spreader is then required to discharge the collected runoff to a vegetated filter strip prior to discharge downstream.

**BMP C206: Level Spreader**
A linear open (top) facility which converts concentrated runoff to sheet flow and releases it to an engineered filter strip.
**Design Guidelines**
- See Figures 7.3.12 and 7.3.13 (examples only).
- Longitudinal grade shall be 0 percent – follow finished site contours.
- Depth minimum shall be 6 inches.
- Width minimum shall be 12 inches.
- Length minimum length of any spreader shall be 6 feet.
- Spreader length shall be determined by the peak flow from the 10-year design storm. The length of the spreader shall be a minimum of 15 feet for 0.1 cfs and shall be 10 feet for each 0.1 cfs thereafter to a maximum of 0.5 cfs per spreader.
- Spreaders shall be setback from the property line per zoning code.

**Maintenance Standards**
- The spreader shall be inspected after every runoff event.

**BMP T5.50 Vegetated Filter Strip**
A vegetated filter strip (filter strip) is a biological surface area designed to provide stormwater quality treatment of conventional pollutants. Discharge from a level spreader passes through the filter strip prior to discharge downstream.
**Design Guidelines**
- See Figures 5.5.1 and 5.5.2.
- Place a minimum of 5’ from driveway.
- Step 1: Determine the length of the driveway flowpath from the upstream to the downstream edge.
- Step 2: Determine average longitudinal or cross slope of the filter strip. Use a 2% minimum for sizing purposes. The maximum longitudinal or cross slope allowed is 6:1 or 17%.
- Step 3: The minimum required filter strip length is: 4’ for a 10’ flowpath; 4.5’ for a 25’ flowpath; and 5.5’ for a 30’ flowpath.

**Construction and Maintenance Criteria**
- Construct filter strips immediately after paving.
- Groomed filter strips planted in grasses should be mowed during the summer to promote growth.
- Inspect filter strips periodically, especially after periods of heavy runoff.
- Remove sediments and reseed as necessary.

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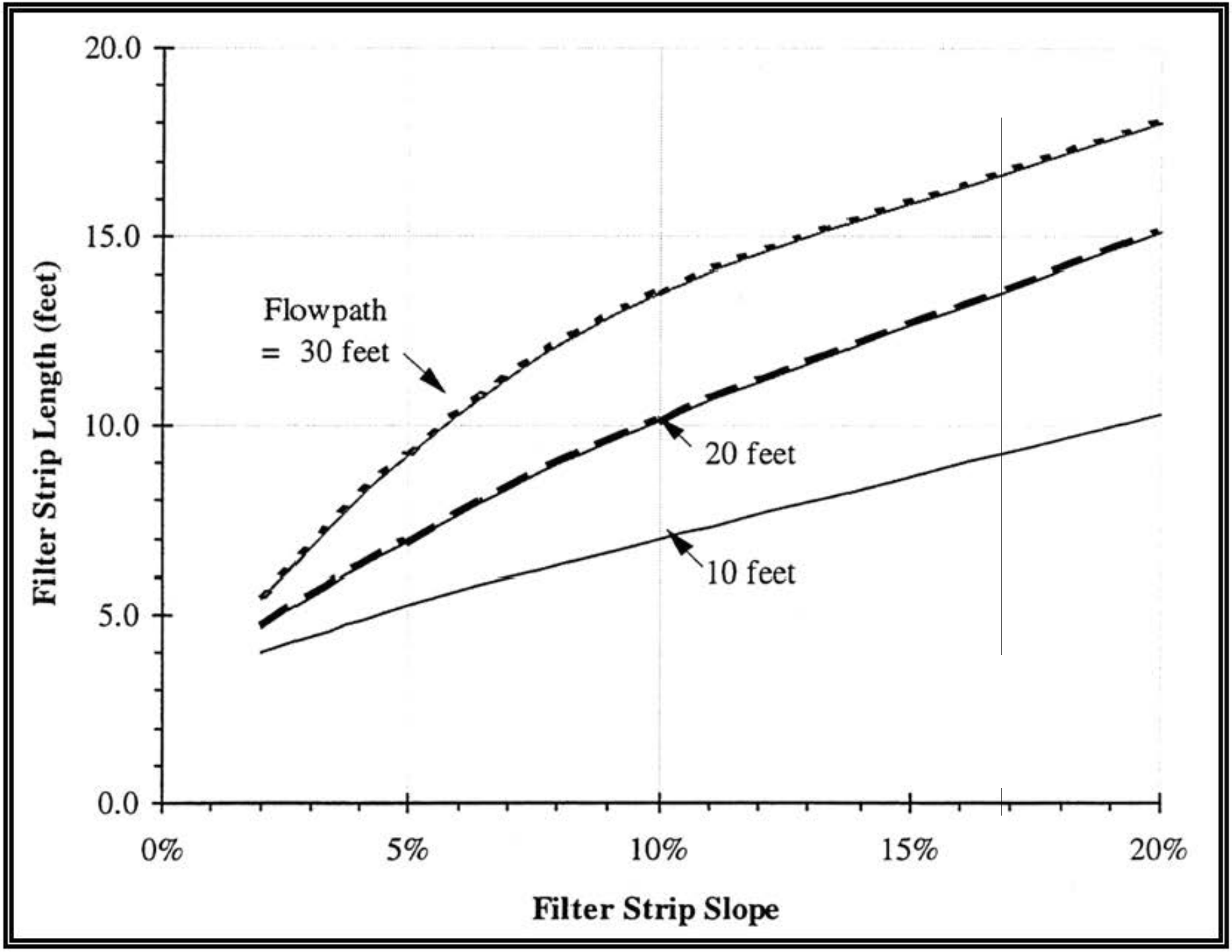
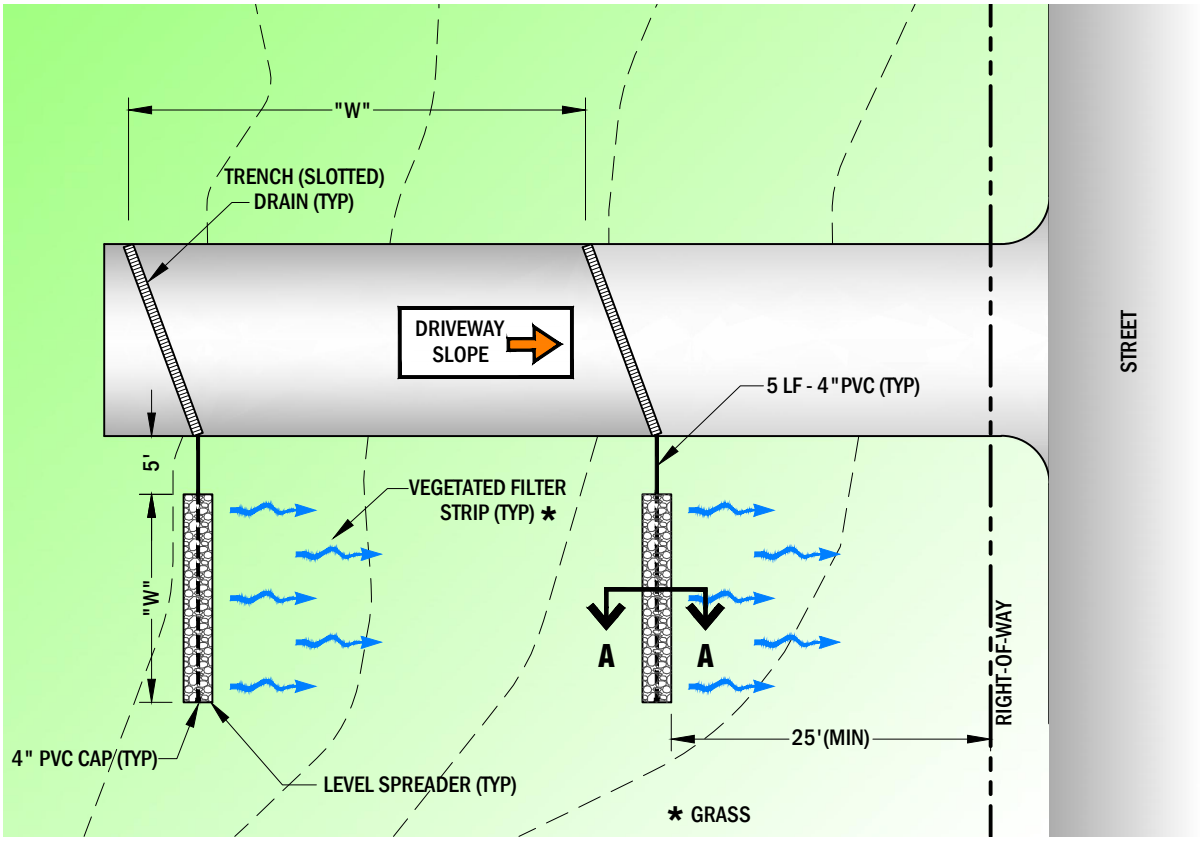
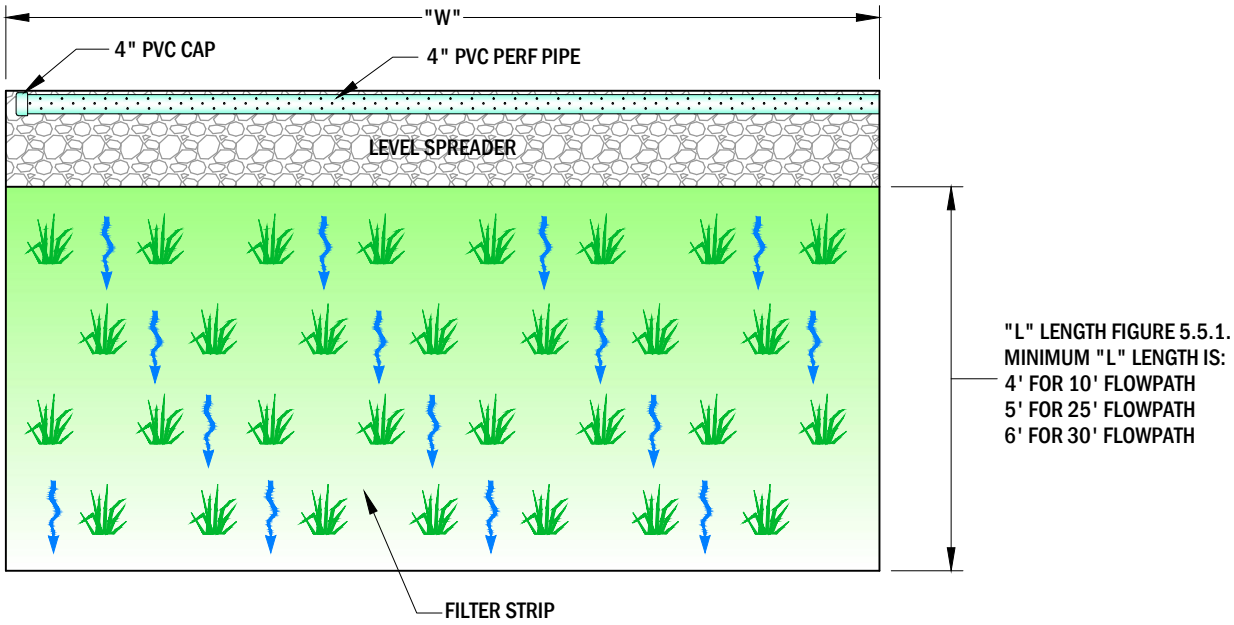
## Figure 5.5.1 Vegetated Filter Strip (design graph)






## PLAN




## DETAIL

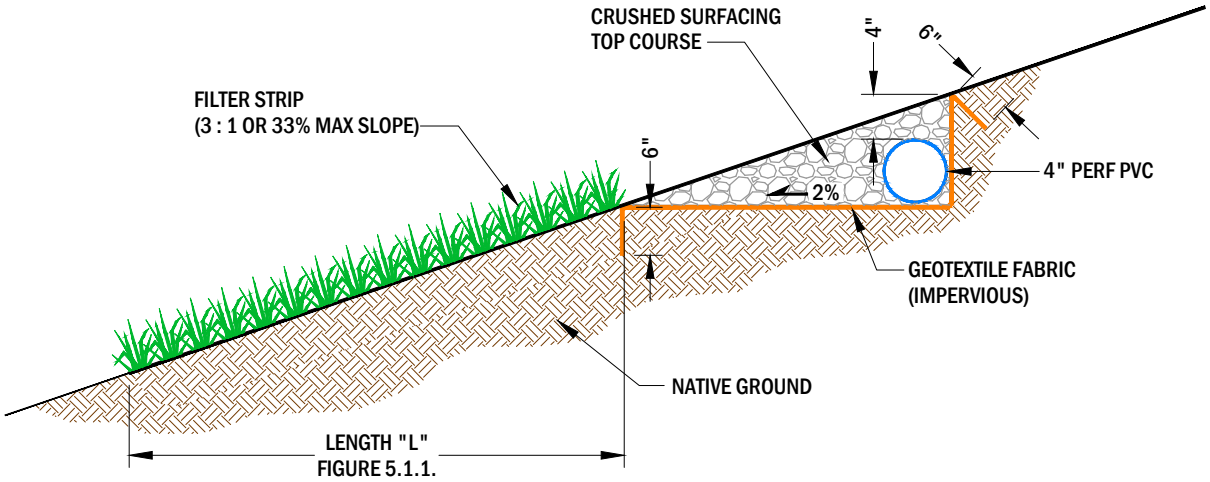
PACIFIC ENGINEERING

CITY OF LEAVENWORTH

**RESIDENTIAL DRIVEWAY**

**VEGETATED FILTER STRIP**

SHEET 1 OF 2




## SECTION A-A

PACIFIC ENGINEERING

CITY OF LEAVENWORTH

**RESIDENTIAL DRIVEWAY**

**VEGETATED FILTER STRIP**

SHEET 2 OF 2

# SECTION 7
## BMP DESCRIPTIONS

Brief summaries of each Best Management Practice (BMP) are presented here.

## BIOFILTRATION

### Introduction
Vegetated treatment systems (typically grasses) which remove pollutants by means of sedimentation, filtration, soil sorption, and/or plant uptake. These facilities are designed to remove low concentrations and quantities of total suspended solids (TSS), heavy metals, petroleum hydrocarbons, and/or nutrients.

### Biofiltration Swale
A sloped, vegetated open channel, of varying geometry, that can also convey high flows. No runoff control.

### Vegetated Filter Strip
A sloped vegetated linear strip located adjacent and parallel to paved areas such as parking lots, driveways, and roads. Thin sheet flow from the paved area passes through the filter strip prior to conveyance downstream. No runoff control.

### Media Filter Drain
A linear strip flow-through filter sited parallel to roadway side slopes. No runoff control.

### Bioretention
A sloped, vegetated open channel, with amended soils, of varying geometry that can also convey high flows. In Washington the term is used to describe an engineered facility designed and sized for specific water quality treatment and flow control objectives. Minor runoff control.

### Vegetated roof
Thin layers of engineered soil and vegetation constructed on top of conventional flat or sloped roofs. Minor runoff control.

### Amended Site Soils
Installation of amended soils over broad areas to regain functions lost when development strips away native soil and vegetation and replaces it with minimal soil, sod or other plantings. Requires adequate depth, permeability, and organic matter to sustain itself. Minor runoff control.

## WETPOOL / WETPOND

### Basic Wetpond / Large Wetpond
A constructed surface pond which retains a permanent pool of water. The wetpool volume is directly correlated to its effectiveness in settling particulate pollutants. A shallow marsh component can also provide nutrient treatment. Provides runoff control.

### Wetvault
An underground structure which retains a permanent pool of water. Lacks biological pollutant removal mechanisms, such as algae uptake. Runoff control can be provided.

## STORMWATER TREATMENT WETLAND

DRAFT

A shallow man-made pond of varying geometry which treats stormwater through biological processes associated with emergent aquatic plants. Ideal for capturing pollutants in a managed environment so that they will not reach natural wetlands and other ecologically important habitats. Optional runoff control

**SAND FILTRATION**

Begins with a pretreatment component, followed by a flow spreader which delivers runoff to a sand filter bed, and collection by an underdrain pipe which conveys treated flow downstream. Ideal for locations with space constraints. Typically utilized in small drainage basins. No runoff control.

**Basic Sand Filter / Large Sand Filter**
A surface filter located at the low point of a pond or swale. Will not provide treatment when the ground is frozen.

**Linear Sand Filter**
A linear, shallow, two-celled, underground rectangular vault(s). Cell no. one settles out coarse particles. Cell no. 2 contains a sand bed.

**Sand Filter Vault**
An underground vault with a sand filter layer.

**DETENTION**

This facility provides for the temporary storage and metered release of surface water runoff pursuant to the runoff control performance standards set forth by the regulatory agency.

**Detention Pond**
A surface pond of varying geometry and depth associated with a runoff control device.

**Detention Tank**
Underground storage facility commonly constructed with large diameter corrugated metal pipe associated with a runoff control device.

**Detention Vault**
Underground box-shaped storage facility typically constructed with reinforced concrete associated with a runoff control device.

**Rain Water Harvesting**
Traditional use is in environments where rainfall or other conditions limit water supply. Some well-documented benefits include: Reduces domestic water demand; Emergency water for fire suppression; Source for irrigation and non-potable uses; and Runoff control.

**INFILTRATION**

Water Quality Treatment: An impoundment, typically a pond, trench, or swale whose underlying soil filters pollutants from stormwater.

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Runoff Control: Typically an open basin (pond), trench, or buried perforated pipe used for distributing stormwater runoff into the underlying soil.

Pretreatment for removal of TSS, oil, and/or soluble pollutants may be necessary. Companion practices, such as street sweeping and catch basin inserts can provide additional benefits, and reduce cleaning and maintenance needs. Can serve a dual purpose of aquifer recharging.

**Drywell**
A precast concrete perforated manhole installed underground and backfilled with a coarse stone aggregate. Suitable for small areas.

**Infiltration Trench**
A subsurface trench with a perforated pipe(s) and backfilled with a coarse stone aggregate. Common when dry wells are insufficient.

**Infiltration Swale / Pond**
An impoundment of varying geometry excavated out of native soil.

**Bio-infiltration Swale / Pond**
An impoundment of varying geometry excavated out of native soil with added biological treatment via vegetation. Common in Spokane County.

**Permeable Pavement**
Hot mix asphalt, concrete, and pavers which capture surface runoff and allow it to percolate into native soils. Most common in parking lots.

**NATURAL DISPERSION**

Attempts to minimize the hydrologic changes created by new impervious surfaces by restoring the natural drainage patterns of sheet flow to existing preserved natural areas. Provides runoff control.

**Full / Natural Dispersion**
Runoff from roofs, driveways, roads and other impervious surfaces are traditionally collected then uniformly dispersed via level spreaders to areas of existing preserved vegetation.

**Sheet Flow Dispersion**
An engineered graded surface which maintains sheet flow (eliminates the concentration of surface runoff). Flows need only traverse a narrow strip of adjacent vegetation for effective attenuation and treatment.

**Concentrated Flow Dispersion**
An engineered vegetated pervious area which disperses concentrated flows from impervious surfaces. Effectively attenuates runoff prior to entry into the conveyance system.

**OIL WATER SEPARATOR**

**API Separator / Coalescing Plate (CP) Separator**

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Most common separators are the 1) American Petroleum Institute (API) “baffle” or the 2) Coalescing Plate (CP).

Separators typically consist of three compartments; forebay, separator section, and the afterbay.

A CP separator need considerably less space.

Sediments can overwhelm separators.

For low concentrations of oil, other treatments may be more applicable, including sand filters and emerging technologies.

Without intense maintenance, oil/water separators may not be sufficiently effective in achieving oil and TPH removal down to required levels.

Pretreatment should be considered if the level of TSS in the inlet flow would cause clogging or otherwise impair the long-term efficiency of the separator.

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| BMP | Runoff Control | WQ Treatment | Hydrocarbons | Phosphorus | Total Suspended Solids (TSS) | Metals | Pesticides / Fungacides | Capital Costs | O & M Costs | Effective Life (yr) | Region Suitability | Cold Region Suitability | Pretreatment Required | Slope Limitations | High groundwater limitations | Footprint | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Amended Soils<br>LID4.2 | √ | √ | | | | | | | | | | | | ≤ 3:1 | √ | Varies | 4 year soil maturation. |
| Bio-filtration: Media Filter Drain (cfs) | | √ | | √ | | √ | | Low | Low to Moderate | 5-20 | *Limited* | Fair | | ≤ 4:1 | √ | Linear | Ideal for roads / parking - mulitple alternatives.<br>Snow storage. |
| Bio-filtration: Swale (cfs)<br>*RT.04, T5.40 | | √ | ~ | ~ | √<br>~** | ~<br>√* | ~ | Low to Moderate | Low to Moderate | 5-20 | Limited - 1<br>No - 2 | Fair | | 1.5-5% | √ | Linear | *CA only - not allowed in areas with phosphorus TMDL<br>**EPA Region 1<br>Vegetation maturation period |
| Bio-filtration: Swale Continuous Inflow (cfs)<br>RT.06 | | √ | | | √ | ~ | | Low to Moderate | Low to Moderate | 5-20 | Limited - 1<br>No - 2 | *Poor to Fair* | | 1.5-5% | | Linear | *CA only - not allowed in areas with a phosphorus TMDL<br>Vegetation maturation period |
| Bio-filtration: Swale Wet (cfs)<br>RT.05 | | √ | | | √ | | | Low to Moderate | Low to Moderate | 5-20 | Limited - 1<br>No - 2 | *Poor to Fair* | | ≤ 1.5% | | Linear | Good in high groundwater and saturated soils<br>Vegetation maturation period |
| Bio-filtration: Vegetated Filter Strip (cfs)<br>*RT.02, T5.50 | | √ | ~<br>√* | ~ | √ | ~<br>√* | ~ | Low | Low | 20-50 | *Limited - 1* | Fair | | ≤ 3:1 | √ | Linear | Ideal for roads / parking. Snow storage.<br>*CA only - not allowed in areas with phophorus TMDL.<br>Vegetation maturation period |
| Bio-infiltration Pond / Swale (cf)<br>IN.01, T5.30 | √ | √ | √ | ~<br>√* | √ | √ | √ | Low to Moderate | Low | 5-20 | Preferred-1<br>Limitations-2 | Fair | √ | ≤ 1% | √ | Small to Large | Snow storage. Vegetation maturation period.<br>*EPA Region 1 |
| Bio-retention (cfs)<br>RT.08, LID4.4 | √ | √ | √ | ~ | √ | √ | √ | Moderate | Moderate | 5-20 | *Preferred-1<br>Limitations-2* | *Fair* | | √ | √ | Varies | |
| Buildings: Rain Water Harvesting<br>LID4.9 | √ | | | | | | | | | | | | | | | Small | Supplements other water sources.<br>Roof material limitations. |
| Buildings: Vegetated Roof<br>LID4.7 | √ | √ | ~ | ~ | √ | ~ | ~ | | | | | Fair | | | | Varies | Highest benefit from large buildings.<br>Small benefit from individual residences.<br>High roof loads (lb/sf). Energy savings |
| Detention: Extended Dry (cf) | √ | √ | √***<br>* | ~*<br>√** | ~*<br>√** | ~*<br>√** | | Low | Low | 5-20 | Acceptable-1<br>Preferred-2 | *Fair to Good* | √ | √ | √ | Large | Snow Storage.<br>*IDEQ. **ISBD ***Spokane |
| Detention: Pond (cfs)<br>FC.03, F6.10 | √ | | | | | | | Moderate | Low | 20-50 | *Limited* | *Fair to Good* | √ | √ | √ | Small to Large | Snow storage. Fencing. |
| Detention: Tank / Vault (cfs)<br>F6.11, F6.12 | √ | | | | | | | Moderate to High | High | 50-100 | *Limitations* | *Good* | | √ | √ | Small | |
| Dispersion: Natural / Engineered<br>FC.01, FC.02, F6.40, F6.41, F6.42, LID4.3 | √ | √ | √ | √ | √ | √ | | Low | Low | 50-100 | *Limited* | *Fair* | | ≤ 3:1 | √ | Linear | Ideal for roads / parking.<br>Utilizes only native existing vegetation.<br>Groundwater vertical separation (>3') |
| Filter: Compost Vault (cfs)<br>Emerging Technology | | √ | √ | | √ | ~<br>√* | √ | *Moderate to High* | *High* | *20 | *Limited* | *Fair | | | √ | Small | *IDEQ |

| BMP | Runoff Control | WQ Treatment | Hydrocarbons | Phosphorus | Total Suspended Solids (TSS) | Metals | Pesticides / Fungacides | Capital Costs | O & M Costs | Effective Life (yr) | Region Suitability | Cold Region Suitability | Pretreatment Required | Slope Limitations | High groundwater limitations | Footprint | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Filter: Sand / Amended (cf/cfs)* | | √ | ~ | ~<br>√* | √ | √ | | *Low to Moderate* | *Moderate* | *25 | *Preferred* | *Poor* | √ | | √ | *Medium to Large* | *Not effective in winter*<br>**IDEQ* |
| Filter: Sand Basic/Large (cf/cfs)<br>T5.80, T5.81 | | √ | ~ | ~<br>√* | √ | ~<br>√* | | *Low to Moderate* | *Moderate* | **25 | Preferred | Poor | √ | | √ | Medium to Large | Not effective in winter<br>*ISBD **IDEQ |
| Filter: Sand Vault/Linear (cf/cfs)<br>T5.82, T5.83 | | √ | ~ | ~ | √ | ~ | | Moderate to High | *High* | *25 | Preferred | Fair to Poor | √ | | √ | Small to Medium | Effective in winter.<br>*IDEQ |
| Infiltration: Drywell (cfs)<br>IN.05, F6.20 | √ | √ | ~ | √ | √ | ~ | ~ | Low to Moderate | Low to Moderate | 5-20 | Limitations | Fair to Good | √ | | √ | Small | Ecology registration required |
| Infiltration: Permeable Pavement (cfs)<br>IN.06, LID4.6 | √ | √ | * | * | √ | * | * | *High* | High | 5-20 | Limitations | *Fair* | | √ | √ | Varies | Restricted to light-medium vehicular loads.<br>Succeptible to clogging (winter sanding, sedimentation).<br>*Dependent on supporting native soils |
| Infiltration: Pond (cfs)<br>IN.02, T5.10, F6.21 | √ | √ | ~ | √ | √ | ~ | ~ | Moderate | Moderate | 5-10 | Limitations | Fair | √ | ≤ 3% | √ | Medium to Large | Snow storage. |
| Infiltration: Swale (cfs)<br>T5.21 | √ | √ | ~ | √ | √ | ~ | ~ | *Moderate* | *Moderate* | *5-10* | Limitations | *Fair* | √ | √ | √ | Medium | |
| Infiltration: Trench (cfs)<br>IN.03, T5.20, F6.22 | √ | √ | ~<br>√* | √ | √ | ~<br>√* | ~ | Low | Low | 20-50 | Limitations | Fair | √ | √ | √ | Linear | *IDEQ |
| Infiltration: Vault (cfs)<br>IN.04 | √ | √ | ~ | √ | √ | ~ | ~ | Moderate to High | Moderate to High | 5-10 | Limitations | Fair | √ | ≤ 4% | √ | Varies | |
| Oil Water Separator: Baffle / Coalescing (cfs)<br>T5.100, T5.110 | | √ | √ | | | *~ | | High | | *20 | *Limited* | *Fair | √ | | √ | Small | Intense maintenance. *IDEQ<br>Last choice for oil control. |
| *Trees*<br>*LID4.5* | √ | | | | | | | Low | Low | 20-50 | Preferred | Good | | | | Small | *Large trees provide highest benefit.*<br>*Utility conflicts.*<br>*Encourages infiltration.* |
| Wet Pool / Pond (cf)<br>*RT.12, T5.70, T5.71 | √ | √ | ~ | ~<br>√* | √<br>~*** | ~<br>√** | | Moderate to High | Low to Moderate | 20-50 | Limited - 1<br>No - 2 | Fair to Good | | √ | | Large | Snow storage. Needs water source.<br>*Large only **IDEQ ***EPA Region 1 |
| Wet Vault (cf)<br>T5.72 | √** | √ | ~* | | √ | ~* | | Moderate to High | High | 50-100 | Limitations | Good<br>*Fair | | | √ | Small | *IDEQ<br>**limited |
| Wetland: Constructed Treatment (cf)<br>RT.13, T5.73 | | √ | √ | ~ | √ | √ | √ | Moderate to High | Moderate | 20-50 | Limited - 1<br>No - 2 | Good | | √ | | Large | Year round adequate water supply.<br>Aquatic plant establishment required.<br>Not intended as an aquatic habitat |
| Wetland: Constructed WQ / Runoff (cf/cfs)<br>CO.02 | √ | √ | √ | ~ | √ | √ | √ | Low to Moderate | Moderate | 20-50 | Limited - 1<br>No - 2 | Good | | √ | | Large | Year round adequate water supply.<br>Evaporation can be a concern.<br>Aquatic plant establishment required. |
| Wetlands: Natural | √ | | | | | | | NA | NA | NA | NA | NA | √ | | | Varies | Hydroperiod analysis required. |

**Factor**

# SECTION 8
## BMP RANKINGS BY POLLUTANT TREATMENT EFFICIENCY

**Score Sheet**

| Scoring Parameter | Points (max) | | | | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| **Type** | | | | | | | | | |
| Runoff Control | 3 | | 6 | 11% | | | High vol. | Mid vol. | Small vol. |
| WQ Treatment | 3 | | | | | | Yes | | |
| | | | | | | | | | |
| **Treatment Effectiveness** | | | | | | | | | |
| Hydrocarbons | 3 | | | | | | √ | | ~ |
| Phosphorus | 5 | | | | √ | | ~ | | |
| TSS | 3 | | 15 | 27% | | | √ | | ~ |
| Metals | 3 | | | | | | √ | | ~ |
| Pesticide/Fungicide | 1 | | | | | | √ | | ~ |
| | | | | | | | | | |
| **Cost** | | | | | | | | | |
| Capital Costs | 5 | | | | Low | Low to Moderate | Moderate | Moderate to High | High |
| O&M Costs | 5 | | 15 | 27% | Low | Low to Moderate | Moderate | Moderate to High | High |
| Effective Life | 5 | | | | 50-100 | 20-50 | 5-20 | 5-10 | |
| | | | | | | | | | |
| **Climate** | | | | | | | | | |
| Regional Suitability | 5 | | 10 | 18% | Preferred | Acceptable | Limitations | Limited Use | |
| Cold Suitability | 5 | | | | Good | Good to Fair | Fair | Fair to poor | Poor |
| | | | | | | | | | |
| **Site Constraints** | | | | | | | | | |
| Slope Limitations | 1 | | | | | | | | No |
| High Groundwater Limitations | 5 | | 9 | 16% | No | | | | |
| Footprint | 3 | | | | | | Large | Medium | Small |
| | | | | | | | | | |
| No Pretreatment | 5 | | | 9% | No | | | | |
| | | | | | | | | | |
| **Total** | | | **55** | | | | | | |

BMP SCORING MATRIX

| BMP | Rank | Runoff Control | | WQ Treatment | | Phosphorus | |
|---|---|---|---|---|---|---|---|
| Column1 | Column | Column | Column | Column | Column | lumn | lumn |
| Dispersion: Natural / Engineered<br>FC.01, FC.02, F6.40, F6.41, F6.42, LID4.3 | **47** | √ | 3 | √ | 3 | √ | 5 |
| Bio-infiltration Pond / Swale (cf)<br>IN.01, T5.30 | **44** | √ | 3 | √ | 3 | ~<br>√* | 4 |
| Wet Pool / Pond (cf)<br>*RT.12, T5.70, T5.71 | **42** | √ | 3 | √ | 3 | ~<br>√* | 4 |
| Infiltration: Trench (cfs)<br>IN.03, T5.20, F6.22 | **40** | √ | 2 | √ | 3 | √ | 5 |
| Detention: Extended Dry (cf) | **39** | √ | 3 | √ | 3 | ~*<br>√** | 4 |
| Infiltration: Drywell (cfs)<br>IN.05, F6.20 | **37** | √ | 1 | √ | 3 | √ | 5 |
| Bio-filtration: Media Filter Drain (cfs) | **35** | | | √ | 3 | √ | 5 |
| *Filter: Sand / Amended (cf/cfs)* | ***34*** | | | *√* | 3 | ~<br>*√** | *4* |
| Infiltration: Swale (cfs)<br>T5.21 | **33** | √ | 3 | √ | 3 | √ | 5 |
| Filter: Sand Basic/Large (cf/cfs)<br>T5.80, T5.81 | **33** | | | √ | 3 | ~<br>√* | 4 |
| Infiltration: Pond (cfs)<br>IN.02, T5.10, F6.21 | **33** | √ | 3 | √ | 3 | √ | 5 |
| Infiltration: Vault (cfs)<br>IN.04 | **30** | √ | 1 | √ | 3 | √ | 5 |

PHOSPHORUS - SCORING

| BMP | Rank | Runoff Control | | WQ Treatment | | High groundwater limitations | |
|---|---|---|---|---|---|---|---|
| **Column1** | Column | Column | Column | Column | Column | Column | Column |
| Wetland: Constructed WQ / Runoff (cf/cfs)<br>CO.02 | **50** | √ | 3 | √ | 3 | | 5 |
| Wetland: Constructed Treatment (cf)<br>RT.13, T5.73 | **45** | | | √ | 3 | | 5 |
| Wet Pool / Pond (cf)<br>*RT.12, T5.70, T5.71 | **42** | √ | 3 | √ | 3 | | 5 |
| *Trees*<br>*LID4.5* | ***39*** | *√* | *1* | | | | 5 |
| Wetlands: Natural | **36** | √ | 3 | | | | 5 |
| Bio-filtration: Swale Continuous Inflow (cfs)<br>RT.06 | **34** | | | √ | 3 | | 5 |
| Bio-filtration: Swale Wet (cfs)<br>RT.05 | **33** | | | √ | 3 | | 5 |
| Buildings: Vegetated Roof<br>LID4.7 | **28** | √ | 1 | √ | 3 | | 5 |
| Buildings: Rain Water Harvesting<br>LID4.9 | **14** | √ | 1 | | | | 5 |

HIGH GROUNDWATER - SCORING

| BMP | Rank | Runoff Control | | WQ Treatment | | Cold Region Suitability | |
|---|---|---|---|---|---|---|---|
| **Column1** | Column | Column | Column | Column | Column | Column26 | Column |
| Wetland: Constructed WQ / Runoff (cf/cfs)<br>CO.02 | **50** | √ | 3 | √ | 3 | Good | 5 |
| Dispersion: Natural / Engineered<br>FC.01, FC.02, F6.40, F6.41, F6.42, LID4.3 | **47** | √ | 3 | √ | 3 | *Fair* | *3* |
| Wetland: Constructed Treatment (cf)<br>RT.13, T5.73 | **45** | | | √ | 3 | Good | 5 |
| Bio-infiltration Pond / Swale (cf)<br>IN.01, T5.30 | **44** | √ | 3 | √ | 3 | Fair | 3 |
| Bio-retention (cfs)<br>RT.08, LID4.4 | **44** | √ | 2 | √ | 3 | *Fair* | *3* |
| Wet Pool / Pond (cf)<br>*RT.12, T5.70, T5.71 | **42** | √ | 3 | √ | 3 | Fair to Good | 4 |
| Bio-filtration: Vegetated Filter Strip (cfs)<br>*RT.02, T5.50 | **40** | | | √ | 3 | Fair | 3 |
| Infiltration: Trench (cfs)<br>IN.03, T5.20, F6.22 | **40** | √ | 2 | √ | 3 | Fair | 3 |
| *Trees*<br>*LID4.5* | ***39*** | *√* | *1* | | | Good | 5 |
| Detention: Extended Dry (cf) | **39** | √ | 3 | √ | 3 | *Fair to Good* | *4* |
| Infiltration: Drywell (cfs)<br>IN.05, F6.20 | **37** | √ | 1 | √ | 3 | Fair to Good | 4 |
| Bio-filtration: Media Filter Drain (cfs) | **35** | | | √ | 3 | Fair | 3 |
| Bio-filtration: Swale (cfs)<br>*RT.04, T5.40 | **35** | | | √ | 3 | Fair | 3 |
| Filter: Compost Vault (cfs)<br>Emerging Technology | **34** | | | √ | 3 | *Fair | 3 |
| Wet Vault (cf)<br>T5.72 | **33** | √** | 1 | √ | 3 | Good<br>*Fair | 4 |
| Infiltration: Swale (cfs)<br>T5.21 | **33** | √ | 3 | √ | 3 | *Fair* | *3* |

COLD REGIONS - SCORING

| BMP | Rank | Runoff Control | | WQ Treatment | | Hydrocarbons | |
|---|---|---|---|---|---|---|---|
| Column1 | Column | Column | Column | Column | Column | Column | Column |
| Wetland: Constructed WQ / Runoff (cf/cfs)<br>CO.02 | **50** | √ | 3 | √ | 3 | √ | 3 |
| Dispersion: Natural / Engineered<br>FC.01, FC.02, F6.40, F6.41, F6.42, LID4.3 | **47** | √ | 3 | √ | 3 | √ | 3 |
| Wetland: Constructed Treatment (cf)<br>RT.13, T5.73 | **45** | | | √ | 3 | √ | 3 |
| Bio-infiltration Pond / Swale (cf)<br>IN.01, T5.30 | **44** | √ | 3 | √ | 3 | √ | 3 |
| Bio-retention (cfs)<br>RT.08, LID4.4 | **44** | √ | 2 | √ | 3 | √ | 3 |
| Bio-filtration: Vegetated Filter Strip (cfs)<br>*RT.02, T5.50 | **40** | | | √ | 3 | ~<br>√* | 2 |
| Infiltration: Trench (cfs)<br>IN.03, T5.20, F6.22 | **40** | √ | 2 | √ | 3 | ~<br>√* | 2 |
| Detention: Extended Dry (cf) | **39** | √ | 3 | √ | 3 | √***<br>* | 2 |
| Filter: Compost Vault (cfs)<br>Emerging Technology | **34** | | | √ | 3 | √ | 3 |
| Oil Water Separator: Baffle / Coalescing (cfs)<br>T5.100, T5.110 | **20** | | | √ | 3 | √ | 3 |

HYDROCARBONS - SCORING

| BMP | Rank | Runoff Control | | WQ Treatment | | Metals | |
|---|---|---|---|---|---|---|---|
| Column1 | Column | Column | Column | Column | Column | lumn | lumn |
| Wetland: Constructed WQ / Runoff (cf/cfs)<br>CO.02 | **50** | √ | 3 | √ | 3 | √ | 3 |
| Dispersion: Natural / Engineered<br>FC.01, FC.02, F6.40, F6.41, F6.42, LID4.3 | **47** | √ | 3 | √ | 3 | √ | 3 |
| Wetland: Constructed Treatment (cf)<br>RT.13, T5.73 | **45** | | | √ | 3 | √ | 3 |
| Bio-infiltration Pond / Swale (cf)<br>IN.01, T5.30 | **44** | √ | 3 | √ | 3 | √ | 3 |
| Bio-retention (cfs)<br>RT.08, LID4.4 | **44** | √ | 2 | √ | 3 | √ | 3 |
| Wet Pool / Pond (cf)<br>*RT.12, T5.70, T5.71 | **42** | √ | 3 | √ | 3 | ~<br>√** | 2 |
| Bio-filtration: Vegetated Filter Strip (cfs)<br>*RT.02, T5.50 | **40** | | | √ | 3 | ~<br>√* | 2 |
| Infiltration: Trench (cfs)<br>IN.03, T5.20, F6.22 | **40** | √ | 2 | √ | 3 | ~<br>√* | 2 |
| Detention: Extended Dry (cf) | **39** | √ | 3 | √ | 3 | ~*<br>√** | 2 |
| Bio-filtration: Media Filter Drain (cfs) | **35** | | | √ | 3 | √ | 3 |
| Bio-filtration: Swale (cfs)<br>*RT.04, T5.40 | **35** | | | √ | 3 | ~<br>√* | 2 |
| Filter: Compost Vault (cfs)<br>Emerging Technology | **34** | | | √ | 3 | ~<br>√* | 2 |
| *Filter: Sand / Amended (cf/cfs)* | ***34*** | | | *√* | 3 | *√* | *3* |
| Filter: Sand Basic/Large (cf/cfs)<br>T5.80, T5.81 | **33** | | | √ | 3 | ~<br>√* | 2 |

METALS - SCORING

| Manufacturer | Product | Ranking | Pretreatment | Oil | Metals | Basic | Phosphorus |
|---|---|---|---|---|---|---|---|
| Contech | Filterra Boxless 100 in/hr | 18 | | General | General | General | General |
| Contech | Filterra System 100 in/hr | 18 | | General | General | General | General |
| Bio Clean | Modular Wetland 0.46 cfs or 20,145 cf | 13 | | | General | General | General |
| WSDOT | Media Filter Drain | 13 | | | General | General | General |
| WSDOT | CA Biofiltration Swale | 11 | | Conditional | General | General | |
| BaySaver Technologies | BayFilter | 9 | | | Conditional | General | Conditional |
| Kristar / Oldcastle | FloGard Perk Filter 2.1 cfs | 8 | | | | General | General |
| StormwateRx | Aquip | 8 | | | Conditional | Conditional | Conditional |
| AquaShield | Aqua-Swirl System | 6 | General | | | General | |
| Contech | CDS Stormwater Treatment | 6 | General | Pilot | | Conditional | |
| Contech | Media Filtration Perlite | 5 | | | | Conditional | Conditional |
| Contech | StormFilter MetalRx Media | 5 | | | Conditional | Conditional | |
| Contech | StormFilter PhosphoSorb | 5 | | | | Conditional | Conditional |
| Lean Environment | Enpurion Metals Treatment | 5 | | | Conditional | Conditional | |
| AquaShield | Aqua-Filter System | 4 | | Pilot | Pilot | Pilot | Pilot |
| Contech | Jellyfish Filter | 4 | | Pilot | | Conditional | Pilot |
| Contech | UrbanGreen BioFilter | 4 | | Pilot | Pilot | Conditional | |
| Contech | StormFilter Perlite | 3 | | | | Conditional | Pilot |
| Contech | StormFilter ZPG Media | 3 | | | | General | |
| Contech | Vortechs System | 3 | General | | | | |
| Hydro International | Downstream Defender | 3 | General | | | | |
| Imbrium Systems | Stormceptor | 3 | General | | | | |
| Royal Environmental | ecoStorm plus | 3 | | | | General | |
| BaySaver Technologies | BaySeparator | 2 | Conditional | | | | |
| Hydro International | Up-Flo Filter | 2 | | | | Conditional | |
| Torrent Resources | Maxwell Plus | 2 | | Pilot | | Pilot | |
| Environment 21 | StormPro | 1 | Pilot | | | | |

| | | | |
|---|---|---|---|
| **General** | Ok for use | 3 | **Points** |
| **Conditional** | Under Testing | 2 | |
| **Pilot** | Ecology Notification Required | 1 | |

EMERGING TECHNOLOGY - SCORING

# SECTION 9
## BMP RANKING REFERENCES

Presented here., they are listed in order of decreasing localized focus, i.e. Leavenworth code, State guidelines, etc.

**Stormwater Management Manual for Eastern Washington, Ecology, 2004**

- Table 5.2.2 Ability of Treatment Facilities To Remove Key Pollutants
- Table 5.2.3 Screening Treatment Facilities Based on Soil Type
- Table 5.2.4 Suggested Stormwater Treatment Options Based on Annual Average Rainfall
- Table 5.2.6 Summary of BMP Applicability in Cold Regions
- 5.11 Phosphorus Treatment and Metals Treatment, p. 5-112 to 5-116
- Table 5.11.1 Treatment Trains for Phosphorus Removal
- Table 5.11.2 Treatment Trains for Dissolved Metals Removal

**Highway Runoff Manual, WSDOT, 2014**

- Figure 5-3 Runoff treatment BMP selection flow chart
- Figure 5-4 Site development LID BMP selection flow chart
- Table 5-1 Relative rankings of cost elements and effective life of BMP options
-

**Regional Stormwater Manual, Spokane, 2008**

- 6.5 Treatment Goals, p. 6-9 to 6-10

**Storm Water Best Management Practices Catalogue, Idaho Department of Environmental Quality (IDEQ), 2005**

- Table 4-1b Selection Matrix for Post Construction BMPs

**CALTRANS, 2010**

- Table data below is highly weighted towards infiltration
- Table 4.1 Concentration-based BMP Ranking for Target Design Constituents
- Table 4.2 Load-based BMP Ranking for Target Design Constituents

**BMP Performance Analysis, EPA, Region 1 (Northeast), 2008**

- 4.1.4 BMPDDS Test Results, p. 42-44

**International Stormwater BMP Database (ISBD)**

- Advanced Analysis: Influence of Design Parameters on Performance, ISBD, 2013, p. 69-71
- Pollutant Category Statistical Summary Report, ISBD, 2014

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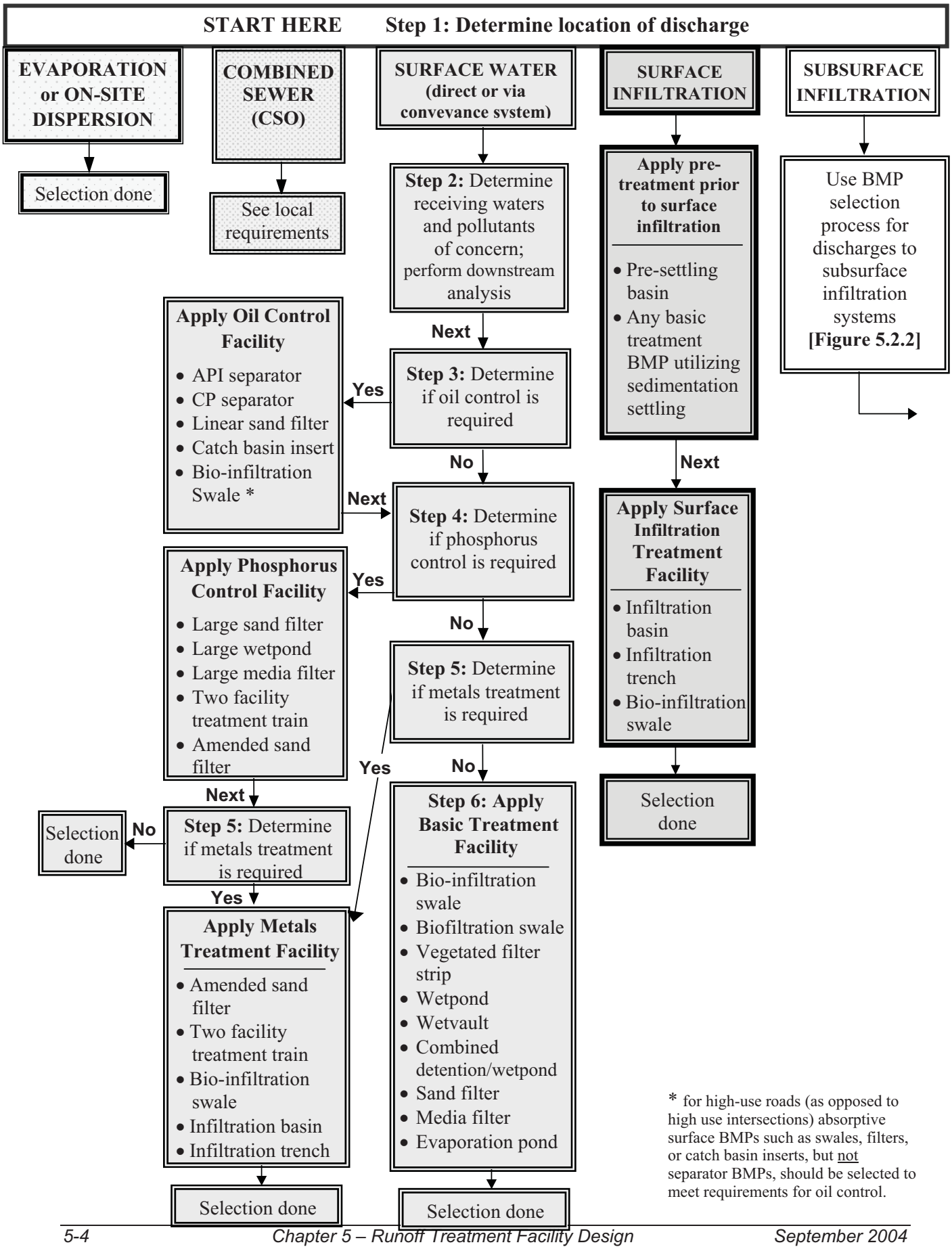
# ECOLOGY: STORMWATER MANAGEMENT FOR EASTERN WASHINGTON

**Figure 5.2.1 BMP Selection Process**




* for high-use roads (as opposed to high use intersections) absorptive surface BMPs such as swales, filters, or catch basin inserts, but not separator BMPs, should be selected to meet requirements for oil control.

**Figure 5.2.2 BMP Selection Process for Discharges to Subsurface Infiltration Systems**

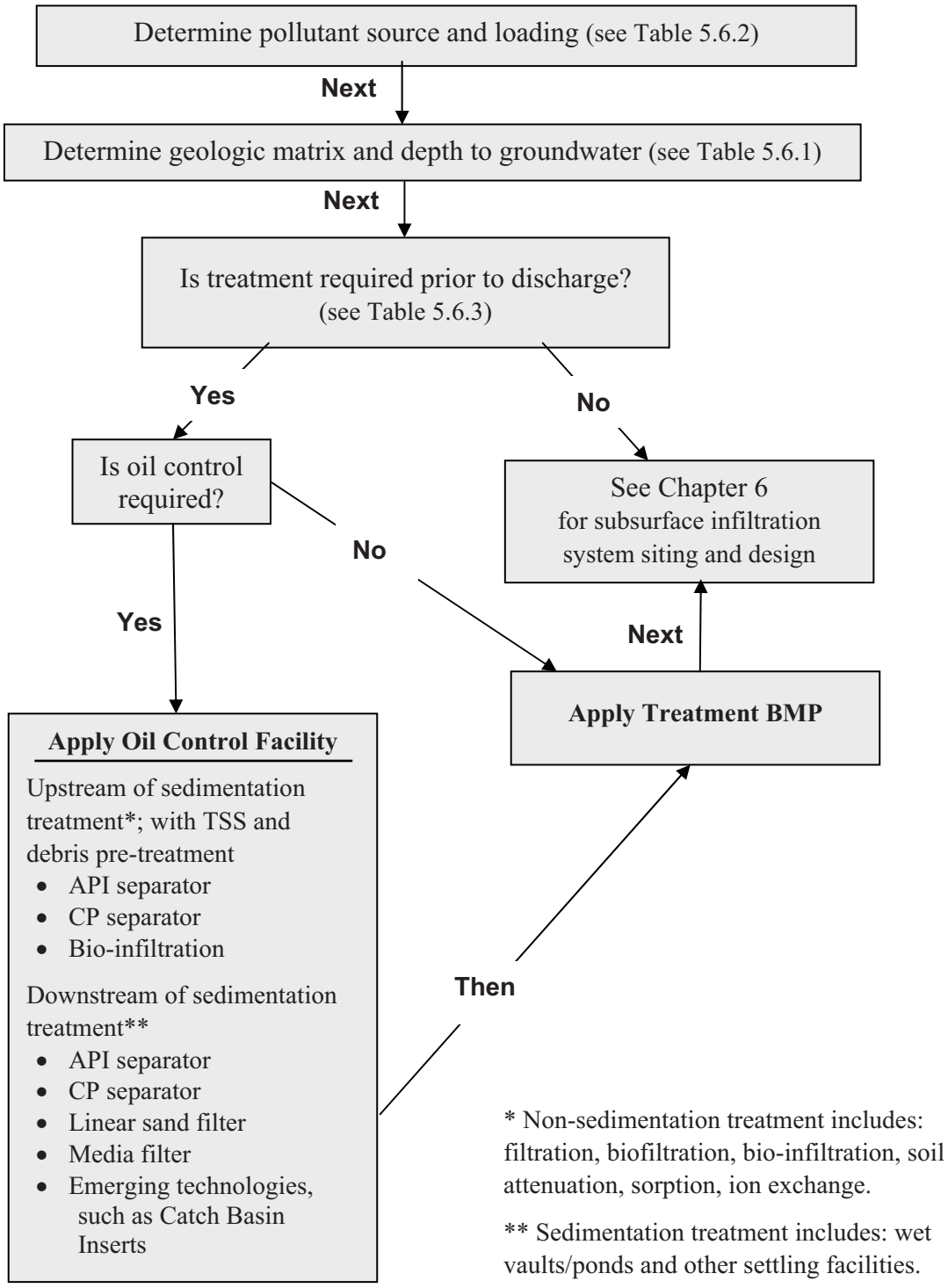


**Table 5.2.2[4] Ability of Treatment Facilities to Remove Key Pollutants[1] [3]**

| Treatment Facility | TSS | Dissolved Metals incl. Cu, Zn | Total Phosphorus | Pesticides/ Fungicides | Hydro-carbons incl. O&G, PAH |
|---|---|---|---|---|---|
| Wet Pond | ■ | + | + | | + |
| Wet Vault | ■ | | | | |
| Biofiltration | ■ | + | + | + | + |
| Sand Filter | ■ | + | + | | + |
| Constructed Wetland | ■ | ■ | + | ■ | ■ |
| Leaf Compost Filters | ■ | + | | ■ | ■ |
| Infiltration[2] | ■ | + | | + | + |
| Oil/Water Separator | | | | | ■ |
| Bio-infiltration | ■ | ■ | + | ■ | ■ |

*Footnotes:*
■ *Significant Process*
*+ Lesser Process*
*(1) Adapted from Kulzer, King Co. Additional BMPs not included in the table, but that have metals treatment benefit, are amended sand filter, and two facility treatment trains; for phosphorus treatment are large sand filter, two facility treatment trains, and amended sand filter.*
*(2) Assumes loamy sand, sandy loam, or loam soils*
*(3) If a cell is blank, then the treatment facility is not particularly effective at treating the identified pollutant*

**Table 5.2.3 Screening Treatment Facilities Based on Soil Type**

| Soil Type | Infiltration | Wet Pond* | Bio-Infiltration | Biofiltration* (Swale or Filter Strip) |
|---|---|---|---|---|
| Coarse Sand or Cobbles | - | - | - | - |
| Sand | ■ | - | - | - |
| Loamy Sand | ■ | - | ■ | ■ |
| Sandy Loam | ■ | - | ■ | ■ |
| Loam | - | - | ■ | ■ |
| Silt Loam | - | - | ■ | ■ |
| Sandy Clay Loam | - | ■ | - | ■ |
| Silty Clay Loam | - | ■ | - | - |
| Sandy Clay | - | ■ | - | - |
| Silty Clay | - | ■ | - | - |
| Clay | - | ■ | - | - |

*Notes:*
■ *Indicates that use of the technology is generally appropriate for this soil type.*
\- *Indicates that use of the technology is generally not appropriate for this soil type*
* *Coarser soils may be used for these facilities if a liner is installed to prevent infiltration, or if the soils are amended to reduce the infiltration rate.*
***Note:*** *Sand filtration is not listed because its feasibility is not dependent on soil type.*

**Table 5.2.4 Suggested Stormwater Treatment Options Based on Average Annual Rainfall**

| Stormwater Practice | Arid Watersheds<br>< 16 in. rainfall | Semi-Arid Watersheds<br>16 in. to 35 in. rainfall |
|---|---|---|
| Sand filters | Preferred:<br>▪ Requires greater pretreatment<br>▪ Sensitive to sediment loadings | Preferred |
| Bio-infiltration Swales | Acceptable with Limitations:<br>▪ Use dryland grass | Preferred:<br>▪ Use dryland or irrigated grass |
| Extended detention dry ponds | Preferred:<br>▪ Multiple storm extended detention<br>▪ Stable pilot channels<br>▪ "Dry" forebay | Acceptable:<br>▪ Dry or wet forebay needed |
| Infiltration | Acceptable with Limitations:<br>▪ See Table 5.6.3<br>▪ Minimize erodable soils that reduce infiltration<br>▪ Pretreatment<br>▪ Soil limitations | Acceptable with Limitations:<br>▪ See Table 5.6.3<br>▪ Minimize erodable soils that reduce infiltration<br>▪ Pretreatment |
| Wet ponds | Not Recommended:<br>▪ Evaporation rates are too high to maintain a normal pond without extensive use of scarce water | Limited Use:<br>▪ Liners to prevent water loss require water balance analysis design for a variable rather than permanent normal pool<br>▪ Use water sources such as AC condensate for pool<br>▪ Aeration unit to prevent stagnation |
| Stormwater wetlands | Not Recommended:<br>▪ Evaporation rates too great to maintain wetlands plants | Limited Use:<br>▪ Require supplemental water<br>▪ Submerged gravel wetlands can help reduce water loss |
| Biofiltration Swales | Not Recommended:<br>▪ Not recommended for pollutant removal, but rock berms and grade control needed for open channels to prevent channel erosion | Limited Use:<br>▪ Limited use unless irrigated or use dryland grasses<br>▪ Rock berms and grade control essential to prevent erosion in open channels |

Adapted from: *Stormwater Strategies for Arid and Semi-Arid Watersheds*, Watershed Protection Techniques, Vol. 3, No. 3, March 2000

### Other Physical Factors

- Slope: Steep site slopes restrict the use of several BMPs. A geotechnical/hydrologic evaluation should be done for sites on steeper slopes. See specific guidance for each BMP.
- High Water Table: Unless there is sufficient horizontal hydraulic receptor capacity, the water table acts as an effective barrier to exfiltration and can sharply reduce the efficiency of an infiltration system. If the high water table extends to within five (5) feet of the bottom of an infiltration BMP, the site is seldom suitable.
- Depth to Limiting Layer: The downward exfiltration of stormwater is also impeded if a bedrock or till layer lies too close to the surface. If

**Table 5.2.6 Summary of BMP Applicability in Cold Regions**

| ***Section*** ---- BMP # | BMP Category or Type | Applica-bility | Notes |
|---|---|---|---|
| ***5.4*** | ***Infiltration and Bio-infiltration*** | | |
| T5.10 | Infiltration Pond | fair | Can be effective but may be restricted by groundwater quality concerns related to infiltration of chlorides. Frozen ground may inhibit the infiltration capacity of ground. |
| T5.20 | Infiltration Trench | fair | Same concerns as for Infiltration Pond |
| T5.21 | Infiltration Swale | fair | Same concerns as for Infiltration Pond |
| T5.30 | Bio-infiltration Swale | fair | Same concerns as for Infiltration Pond |
| ***5.5*** | ***Biofiltration*** | | |
| T5.40 | Biofiltration Swale | fair | Reduced effectiveness in the winter because of dormant vegetation. Very valuable for snow storage and meltwater infiltration. |
| T5.50 | Vegetated Filter Strip | fair | Reduced effectiveness in the winter because of dormant vegetation. Very valuable for snow storage and meltwater infiltration. |
| ***5.6*** | ***Subsurface Infiltration*** | fair to good | Infiltration surface below frost line. |
| | Drywell | fair to good | Infiltration surface below frost line. |
| ***5.7*** | ***Wetpools and Dry Ponds*** | | |
| T5.70 | Basic Wetpond | fair | Can be effective but needs modifications to prevent freezing of outlet pipes. Limited by reduced treatment volume and biological activity during ice cover. |
| T5.71 | Large Extended Detention (ED) Wetpond | good | Some modifications needed to conveyance structures. Extended detention storage provides treatment during winter season. |

**Table 5.2.6 Summary of BMP Applicability in Cold Regions**

| ***Section*** ---- BMP # | BMP Category or Type | Applica-bility | Notes |
|---|---|---|---|
| See section 5.7.3 | Large Extended Detention (ED) Dry Ponds | fair | Few modifications needed to adapt to cold climates. Not highly recommended because of relatively poor warm season performance. |
| T5.72 | Wet Vault | good | Design pool elevation below frost line or per manufacturer specs. Some modifications needed to conveyance structures. |
| T5.73 | Extended Detention (ED) Wetland | good | Extended detention storage provides treatment during winter season. Modifications needed to wetland plant species. Some modifications needed to conveyance structures. |
| ***5.8*** | ***Sand Filtration*** | | |
| T5.80 | Basic Sand Filter | poor | Frozen ground considerations, combined with frost heave, make this ineffective in cold climates. |
| T5.81 | Large Sand Filter | poor | Same concerns as for Basic Sand Filter. |
| T5.82 | Sand Filter Vault | good | Design filter elevation below frost line or per manufacturer specs |
| T5.83 | Linear Sand Filter | poor to fair | Design filter elevation below frost line or per manufacturer specs. Cold conditions may plug surface inlet and impact performance. |
| ***5.9*** | ***Evaporation Ponds*** | fair to good | Evaporation not expected to result in significant water losses during cold weather; hence must size to provide adequate storage. |
| ***5.10*** | ***Oil and Water Separator*** | | |
| T5.100 | API Separator Bay | poor to fair | Check with the manufacturer for cold weather applicability. |
| T5.110 | Coalescing Plate Bay | poor to fair | Check with the manufacturer for cold weather applicability. |

- ~~Inspect oil/water separators monthly during the wet season of October 1-June 30 (WEF & ASCE, 1998; Woodward-Clyde Consultants) to ensure proper operation, and, during and immediately after a large storm event of greater than or equal to 1 inch per 24 hours. In region 2, it is most important to check these facilities in the spring before the summer thunderstorm season begins; one annual check done at this time of year should be sufficient for oil/water separators in region 2.~~
- ~~Clean oil/water separators regularly to keep accumulated oil from escaping during storms. They must be cleaned by October 15 to remove material that has accumulated during the dry season (Woodward-Clyde Consultants), after all spills and after a significant storm. Coalescing plates may be cleaned in-situ or after removal from the separator. An eductor truck may be used for oil, sludge, and wash water removal. (King County Surface Water Management, 1998) Replace wash water in the separator with clean water before returning it to service.~~
- ~~Remove the accumulated oil when the thickness reaches 1 inch. Also remove sludge deposits when the thickness reaches 6 inches (King County Surface Water Management, 1998).~~
- ~~Replace oil absorbent pads before their sorbed oil content reaches capacity.~~
- ~~Train designated employees on appropriate separator operation, inspection, record keeping, and maintenance procedures.~~

~~See Appendix 5A for more detailed information.~~

# 5.11 Phosphorus Treatment and Metals Treatment

## 5.11.1 Phosphorus Treatment

**Where Applied**

Phosphorus treatment applies to projects within watersheds that have been determined by local governments, the Department of Ecology, or the USEPA to be sensitive to phosphorus and that are being managed to control phosphorus inputs from stormwater.

**Performance Goal**

The Phosphorus Treatment facility choices are intended to achieve a goal of 50% total phosphorus removal for a range of influent concentrations of 0.1 – 0.5 mg/l total phosphorus. In addition, the choices are intended to achieve the Basic Treatment performance goal. The performance goal applies to the water quality design storm volume or flow rate, whichever is applicable, and on an annual average basis. The incremental portion of runoff in excess of the water quality design flow rate or volume can be routed around the facility (off-line treatment facilities), or can be passed

through the facility (on-line treatment facilities) provided a net pollutant reduction is maintained. Ecology encourages the design and operation of treatment facilities that engage a bypass at flow rates higher than the water quality design flow rate. However, this is acceptable provided that the overall reduction in phosphorus loading (treated plus bypassed) is at least equal to that achieved with initiating bypass at the water quality design flow rate.

**Phosphorus Treatment Options**

Any one of the following options may be chosen to satisfy the phosphorus treatment requirement.

Infiltration with Appropriate Pretreatment – See Section 5.4.

Infiltration treatment – If infiltration is through soils meeting the minimum site suitability criteria for infiltration treatment (see Section 5.4), a presettling basin or a basic treatment facility can serve for pretreatment.

Infiltration preceded by Basic Treatment – If infiltration is through soils that do not meet the site suitability criteria for infiltration treatment, treatment must be provided by a basic treatment facility unless the soil and site fit the description in the next option below.

Infiltration preceded by Phosphorus Treatment – Requirements to be determined by TMDL.

Amended Sand Filter – See Section 5.12.

***Note:*** *Processed steel fiber and crushed calcitic limestone are the only sand filter amendments for which Ecology has data that document increased dissolved metals removal. Though Ecology is interested in obtaining additional data on the effectiveness of these amendments, local governments may exercise their judgment on the extent to which to allow their use.*

Large Wetpond – See Section 5.7.

Media Filter Targeted for Phosphorus Removal – See Section 5.12.

***Note:*** *The use of a Stormfilter™ with iron-infused media is approved for use in limited circumstances, provided a monitoring program consistent with adopted protocols is implemented.*

Two-Facility Treatment Trains – See Table 5.11.1. Note that if a filter is preceded by a wetpond, a horizontal rock filter may reduce transfer of algae from the pond to the filter.

**Table 5.11.1 - Treatment trains for phosphorus removal**

| First Basic Treatment Facility | Second Treatment Facility |
|---|---|
| Biofiltration Swale | Basic Sand Filter or Sand Filter Vault |
| Vegetated Filter Strip | Linear Sand Filter (no presettling needed) |
| Linear Sand Filter | Filter Strip |
| Basic Wetpond | Basic Sand Filter or Sand Filter Vault |
| Wetvault | Basic Sand Filter or Sand Filter Vault |
| Basic Combined Detention and Wetpool | Basic Sand Filter or Sand Filter Vault |
| NOTE: See Section 5.2.3 (or Table 5.2.6) for Cold Weather Considerations and Table 5.2.4 for Arid and Semi-Arid Climate Considerations. | |

## 5.11.2 Metals Treatment

### Where Applied

Metals treatment is required for sites and uses determined in Core Element 5 to be subject to metals treatment requirements. Metals treatment is required for moderate- and high-use sites as defined in section 2.2.5 and sites that meet any of the following definitions and discharge to a non-exempt surface water:

- Industrial sites as defined by EPA (40 CFR 122.26(b)(14)) with benchmark monitoring requirements for metals; or industrial sites subject to handling, storage, production, or disposal of metallic products or other materials, particularly those containing arsenic, cadmium, chromium, copper, lead, mercury, nickel or zinc; or
- An urban road with expected ADT greater than 7,500; or a rural road or freeway with expected ADT greater than 15,000; or
- A commercial or industrial site with an expected trip end count equal to or greater than 40 vehicles per 1,000 square feet of gross building area; or a customer or visitor parking lot with equal to or greater than 100 trip ends; or on-street parking areas of municipal streets in commercial and industrial areas; or highway rest areas; or
- Runoff from metal roofs not coated with an inert, non-leachable material.

Discharges to nonfish-bearing streams are exempt from additional metals treatment requirements. Direct discharges to the main channels of the following rivers and direct discharges to the following lakes are exempt from metals treatment requirements: Banks Lake, Lake Chelan, Columbia River, Grande Ronde River, Kettle River, Klickitat River, Methow River, Moses Lake, Potholes Reservoir, Naches River, Okanogan River, Pend Oreille River, Similkameen River, Snake River, Spokane River, Wenatchee River, and Yakima River. Subsurface discharges via rule-

authorized Underground Injection Control (UIC) facilities (see section 5.6) are also exempt from metals treatment requirements. Restricted residential and employee-only parking areas are exempt from metals treatment requirements unless subject to through traffic.

Areas of arterials and highways, multifamily, industrial and commercial project sites that do not discharge to fish-bearing streams or lakes or are identified in a storm drainage comprehensive plan or basin plan as subject to Basic Treatment requirements are not subject to Metals Treatment requirements. For developments with a mix of land use types, the Metals Treatment requirement shall apply when the runoff from the areas subject to the Metals Treatment requirement comprise 50% or more of the total runoff to a discharge location.

**Performance Goal**

The Metals Treatment facility choices are intended to provide a higher rate of removal of dissolved metals than Basic Treatment facilities. Due to the sparse data available concerning dissolved metals removal in stormwater treatment facilities, a specific numeric removal efficiency goal could not be established at the time of publication. Instead, Ecology relied on available nationwide and local data and knowledge of the pollutant removal mechanisms of treatment facilities to develop the list of options below. In addition, the choices are intended to achieve the Basic Treatment performance goal. The performance goal assumes that the facility is treating stormwater with dissolved copper typically ranging from 0.003 to 0.02 mg/l, and dissolved zinc ranging from 0.02 to 0.3 mg/l.

The performance goal applies to the water quality design storm volume or flow rate, whichever is applicable, and on an annual average basis. The incremental portion of runoff in excess of the water quality design flow rate or volume can be routed around the facility (off-line treatment facilities) or can be passed through the facility (on-line treatment facilities) provided a net pollutant reduction is maintained. Ecology encourages the design and operation of treatment facilities that engage a bypass at flow rates higher than the water quality design flow rate as long as the reduction in dissolved metals loading exceeds that achieved with initiating bypass at the water quality design flow rate.

**Metals Treatment Options**

Any one of the following options may be chosen to satisfy the Metals Treatment requirement:

<u>Infiltration with Appropriate Pretreatment</u> – See Section 5.4.

<u>Infiltration Treatment</u> – If infiltration is through soils meeting the minimum site suitability criteria for infiltration treatment (see Section 5.4), a presettling basin or a basic treatment facility can serve for pretreatment.

Infiltration preceded by Basic Treatment – If infiltration is through soils that do not meet the soil suitability criteria for infiltration treatment, treatment must be provided by a basic treatment facility unless the soil and site fit the description in the next option below.

Infiltration preceded by Metals Treatment – If the soils do not meet the soil suitability criteria and the infiltration site is within ¼ mile of a fish-bearing stream, a tributary to a fish-bearing stream, or a lake, treatment must be provided by one of the other treatment facility options listed below.

Large Sand Filter – See Section 5.8.

Amended Sand Filter – See Section 5.12.

***Note:*** *Processed steel fiber and crushed calcitic limestone are the only sand filter amendments for which Ecology has data that document increased dissolved metals removal. Though Ecology is interested in obtaining additional data on the effectiveness of these amendments, local governments may exercise their judgment on the extent to which to allow their use.*

Two Facility Treatment Trains – See Table 5.11.2.

**Table 5.11.2 -Treatment Trains for Dissolved Metals Removal**

| First Basic Treatment Facility | Second Treatment Facility |
|---|---|
| Biofiltration Swale | Basic Sand Filter or Sand Filter Vault or Media Filter(1) |
| Filter Strip | Linear Sand Filter with no pre-settling cell needed |
| Linear Sand Filter | Filter Strip |
| Basic Wetpond | Basic Sand Filter or Sand Filter Vault or Media Filter(1) |
| Wetvault | Basic Sand Filter or Sand Filter Vault or Media Filter(1) |
| Basic Combined Detention/Wetpool | Basic Sand Filter or Sand Filter Vault or Media Filter(1) |
| Basic Sand Filter or Sand Filter Vault with a presettling cell if the filter isn't preceded by a detention facility | Media Filter(1) |
| (1) The media must be of a nature that has the capability to remove dissolved metals effectively based on at least limited data. Ecology includes Stormfilter's ™ leaf compost and zeolite media in this category. | |

- **Groundwater management plans** (wellhead protection plans and sole-source aquifers): To protect groundwater quality and quantity, these plans may identify actions required of stormwater discharges.
- **Lake management plans:** These plans are developed to protect lakes from eutrophication due to phosphorus-laden runoff from the drainage basin. Control of phosphorus from new development is a likely requirement in any such plans.

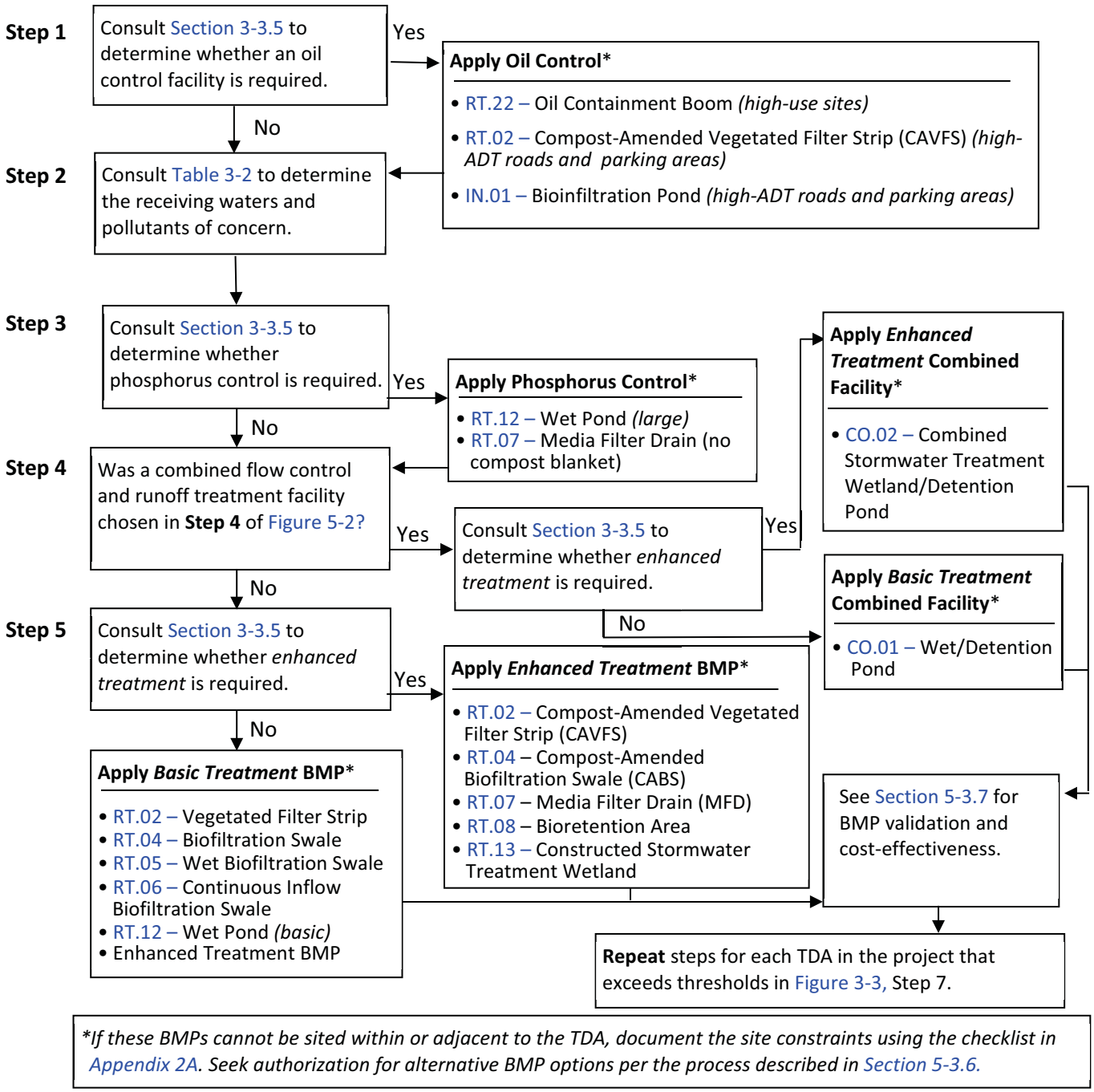
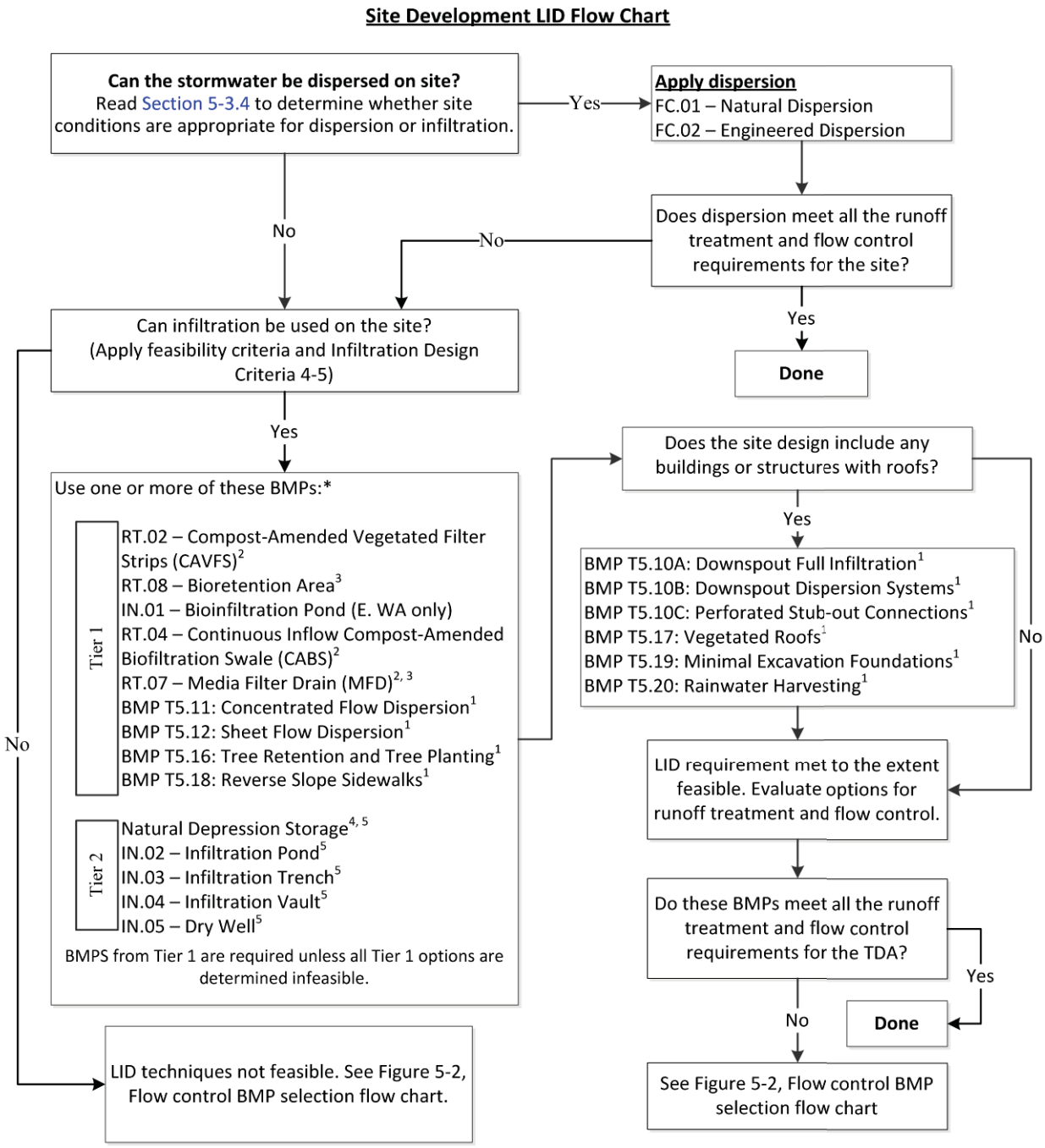



**Figure 5-3 Runoff treatment BMP selection flow chart.**




*** See Section 5-3.6 for BMP validation and cost-effectiveness. Repeat steps for each TDA in the project that exceeds thresholds in Figure 3-3, Step 7.**

1. Ecology SWMMWW Volume V.
2. Model for flow control benefit through infiltration using site-specific infiltration data.
3. The use of underdrains is not allowed if used to meet the LID requirement.
4. Use Section 4-7, Closed Depression Analysis, for modeling methods, and use performance requirements for infiltration pond.
5. Apply Pretreatment RT.24 – Presettling Basin or any basic treatment BMP listed on the next page if the underlying soils meet or exceed Soil Suitability Criteria 7. Otherwise, apply pretreatment in the form of any basic or enhanced treatment BMP.

**Figure 5-4 Site development LID BMP selection flow chart.**

Depending on the nature of the alternative approach proposal, you may need a dilution analysis to demonstrate that the project will not adversely affect water quality. If applicable to the proposal, base the dilution analysis on (1) critical flow rates of the discharge and the receiving water, and (2) estimated concentrations of pollutants of concern in the discharge and the upgradient receiving water. A standard procedure for determining the value of those four variables has yet to be developed by Ecology. Until it is developed, Ecology will have to make case-by-case decisions concerning valid approaches to the analysis.

## 5-3.7 BMP Validation and Cost-Effectiveness

Once you select a stormwater BMP, be aware that there are costs and obligations involved in the long-term operation and maintenance of the BMP. For this reason, you should contact the local maintenance office and discuss the proposed stormwater BMPs and overall stormwater design to determine any area-specific BMP restrictions or requirements. Table 5-1 helps you evaluate the cost-effectiveness of different stormwater BMPs by assessing typical construction costs, annual operation and maintenance (O&M) expenses, and effective life (how soon the BMP may need to be replaced).

**Table 5-1 Relative rankings of cost elements and effective life of BMP options.**

| BMP | Capital Costs | O&M Costs | Effective Life[1] |
|---|---|---|---|
| Vegetated Filter Strip | Low | Low | 20–50 years |
| Wet Biofiltration Swale | Low to Moderate | Low to Moderate | 5–20 years |
| Continuous Inflow Biofiltration Swale | Low to Moderate | Low | 5–20 years |
| Media Filter Drain | Low | Low to Moderate | 5–20 years[2] |
| Compost-Amended Vegetated Filter Strip | Low | Low | 5–20 years[2] |
| Wet Pond | Moderate to High | Low to Moderate | 20–50 years |
| Combined Wet/Detention Pond | Moderate | Low to Moderate | 20–50 years |
| Constructed Stormwater Treatment Wetland | Moderate to High | Moderate | 20–50 years |
| Combined Stormwater Wetland/Detention Pond | Low to Moderate | Moderate | 20–50 years |
| Wet Vault (Category 1 BMP) | Moderate to High | High | 50–100 years |
| Combined Wet/Detention Vault (Category 1 BMP) | Moderate to High | High | 50–100 years |
| Bioinfiltration Pond | Low to Moderate | Low | 5–20 years |
| Infiltration Pond | Moderate | Moderate | 5–10 years before deep tilling required |
| Infiltration Trench | Moderate to High | Moderate | 10–15 years |
| Infiltration Vault | Moderate | Moderate to High | 5–10 years |
| Drywell | Low to Moderate | Low to Moderate | 5–20 years |
| Engineered and Natural Dispersion | Low | Low | 50–100 years |
| Detention Pond | Moderate | Low | 20–50 years |
| Detention Vault (Category 1 BMP) | Moderate to High | High | 50–100 years |
| Detention Tank (Category 1 BMP) | Moderate to High | High | 50–100 years |
| Presettling Basin | Low to Moderate | Moderate | |
| Proprietary Presettling Devices | Moderate | Moderate | 50–100 years |
| Bioretention | Moderate | Moderate | 5–20 years |

Sources: Adapted from Young et al. (1996); Claytor and Schueler (1996); U.S. EPA (1993); and others.

[1] Assumes regular maintenance, occasional removal of accumulated materials, and removal of any clogged media.
[2] Estimated based on best professional judgment.

SPOKANE

# 6.5 TREATMENT GOALS

The goal for water quality treatment facilities is to treat approximately 90% of the annual runoff volume generated at a project site. Facilities that are designed according to the criteria set forth in this chapter should also capture and treat nearly all of the runoff from first flush events (heavy rainfall after a dry period). In urban areas, bio-infiltration swales are the expected BMP for providing basic treatment. The following subsections describe the key pollutants of concern.

## 6.5.1 TOTAL SUSPENDED SOLIDS (TSS)

Basic treatment facilities presented in this chapter are intended to achieve 80% removal of suspended solids, including solid components of metals, for flows with TSS concentrations ranging from 100 mg/L to 200 mg/L. The following BMPs have been found to provide a significant removal process for TSS:

- Bio-infiltration swales;
- Biofiltration channels;
- Vegetated buffer strips;
- Evaporation ponds.

## 6.5.2 TOTAL PETROLEUM HYDROCARBONS (TPH)

The oil control facilities presented in this chapter are intended to achieve the goal of removing any visible sheen and reducing the TPH concentration to a maximum of 10 mg/L for a 24-hour average and a maximum of 15 mg/L for a discrete sample. The following BMPs provide removal of TPH:

- Significant removal for high-use and high-ADT sites:
  - Bio-infiltration swales;
  - Oil/water separators (coalescing plate and baffle type);
  - Vegetated buffer strips (for High-ADT sites only); and,
  - Evaporation ponds designed using the Alternative Method (refer to Section 5.7.2)
- Significant removal for all sites except high-ADT sites:
  - Oil/water separators (spill control type).
- Lesser removal (this BMP shall not be used for high-use or high-ADT sites unless preceded by an oil/water separator):
  - Biofiltration channels.

### 6.5.3 METALS TREATMENT

Metals treatment facilities presented in this chapter are intended to achieve approximately 50% removal of dissolved metals. The following BMPs have been found to provide removal for metals:

- Significant removal:
  - Bio-infiltration swales; and,
  - Evaporation ponds designed using the Alternative Method (refer to Section 5.7.2)
- Lesser removal (this BMP shall not be used for high-use or high-ADT sites without being preceded by another treatment BMP)
  - Biofiltration channels.

### 6.5.4 PHOSPHOROUS TREATMENT

The phosphorus treatment facilities are intended to achieve a goal of 50% total phosphorus removal for a range of influent concentrations from 0.1 to 0.5 mg/L of total phosphorus. Bio-infiltration swales are the only BMP presented here that have been found to meet this removal goal for phosphorus. The following BMPs have been found to provide a lesser removal of phosphorus and shall only be used for phosphorus removal in combination with some other basic treatment BMP:

- Biofiltration channels;
- Vegetated buffer strips; and,
- Evaporation ponds designed using the Alternative Method (refer to Section 5.7.2)

## 6.6 APPLICABILITY

The exemptions listed in the sections below are superseded by requirements set forth in any applicable Total Maximum Daily Load (TMDL) or other water cleanup plan. At the time of the writing of this Manual, no TMDLs exist for water bodies in Spokane County. Contact the local jurisdiction for current information on whether any TMDLs have been issued.

**IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY**

| Table 4-1. Selection Matrix for Best Management Practices | Targeted Pollutants | | | | | Physical Constraints | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sediment | Phosphorus | Trace Metals | Bacteria | Petroleum Hydrocarbons | Drainage area (acres) | Maximum slope (%) | Minimum depth to bedrock, ft | Depth to high water table, ft | SCS soil type[1] | Use with freeze/thaw cycle | Drainage/flood control | Expected life[2] |
| **Stormwater Filters** | | | | | | | | | | | | | |
| Vegetated swale | 65% | 15% | ◖ | ○ | ◖ | 15 | 4 | 3 | 2 | BCD | Fair | Yes | Permanent |
| Bioretention swale | 75% | 30% | ● | ◖ | ● | 5 | 4 | 3 | 3 | AB | Fair | Yes | Permanent |
| Vegetative filter strip | 50% | 40% | ◖ | ◖ | ◖ | 5 | 6 | 5 | 3 | BCD | Fair | | Permanent |
| Sand filter | 85% | 55% | ◖ | ◖ | ◖ | 5(inlets) 50 (basin) | 6 | 3 | 3 | NA | Fair | Yes | 25 yrs |
| Compost filter | 95% | 40% | ● | ◖ | ● | 1 | 6 | NA | NA | NA | Fair | | 20+ yrs |
| Catchbasin insert | 35% | 5% | ◖ | ○ | ◖ | 0.1 | NA | NA | NA | NA | Fair | | |
| Media filter | ● | 50% | ● | ◖ | ● | According to manufacturer's specifications | | | | NA | Fair | | 20+ yrs |
| **Infiltration Facilities** | | | | | | | | | | | | | |
| Infiltration trench | 75% | 65% | ● | ● | ● | 10 | 15 | 3 | 3 | AB | Fair | | 10 yrs |
| Bioretention basin | 90% | 75% | ● | ● | ● | 5 | 2 | 3 | 3 | AB | Fair | Yes | 25 yrs |
| Porous pavement | 85% | 64% | ● | ● | ◖ | 0.25-10 | 2 | 2-5 | 2-5 | AB | Fair | No | |
| **Detention Facilities** | | | | | | | | | | | | | |
| Wet pond (conventional pollutants) | 80% | 45% | ● | ◖ | ◖ | 15-20 | 10 | 3 | 2 | CD | Good | Yes | Permanent |
| Wet pond (nutrient control) | 80% | 65% | ● | ◖ | ◖ | 5-20 | 5 | 3 | 2 | CD | Fair | Yes | Permanent |
| Wet extended detention pond | 80% | 65% | ● | ◖ | ◖ | 10-50 | 10 | 3 | 2 | CD | Good | Yes | Permanent |
| Dry extended detention pond | 45% | 25% | ◖ | ○ | ◖ | 10-50 | 10 | 6 | 4 | ABC | Good | Yes | Permanent |

| Table 4 -1. Selection Matrix for Best Management Practices (cont.) | Targeted Pollutants | | | | | Physical Constraints | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sediment | Phosphorus | Trace Metals | Bacteria | Petroleum Hydrocarbons | Drainage area (acres) | Maximum slope (%) | Minimum depth to bedrock, ft | Depth to high water table, ft | SCS soil type[1] | Use with freeze/thaw cycle | Drainage/flood control | Expected life[2] |
| Biodetention basin | 75% | 45% | ● | ◖ | ● | 25-50 | 5 | 3 | 2 | CD | Fair | Yes | Permanent |
| Presettling/sedimentation basin | 60% | 30% | ◖ | ○ | ○ | 10+ | 10 | 3 | 2 | CD | Good | | Permanent |
| Wet vault/tank | 60% | 30% | ◖ | ○ | ○ | 5 | 15 | 12 | 12 | ABC | Fair | Yes | Permanent |
| **Other Structural Controls** | | | | | | | | | | | | | |
| Oil/water separator | 15% | 5% | ◖ | ○ | ● | 1 | 15 | 8 | 8 | ABC | Fair | | 20+ yrs |
| Swirl concentrator | 35% | 15-20% | ◖ | ○ | ◖ | According to manufacturer's specifications | | | | NA | Fair | | |
| Level spreader | NA | NA | ○ | ○ | ○ | 5 | 1 | NA | NA | ABCD | Fair | Yes | |

● = very effective, removes > 70% of pollutant ◖ = moderately effective, removes 25-70% of pollutant ○ = least effective, removes < 25% of pollutant

N/A = Not applicable

[1] NRCS soil types (A,B,C,D) range from A = high infiltration to D = little or no infiltration

[2] Longevity data collected from various sources, including Panhandle Health District 1996, Boise City 1997, and EPA 1993. The numbers shown represent industry guidelines; the actual life expectancy is dependent on proper design, placement, and maintenance of BMPs.

The pollutant removal efficiencies given above are for planning purposes only. Actual removal rates are dependent on specific site characteristics, maintenance, and other factors. The following sources were used to determine the most likely average removal rate for conditions prevalent in

CALTRANS

**Table 4.1 Concentration-based BMP Ranking for Target Design Constituents**

| | Concentration-Based Ranking[a] | |
|---|---|---|
| | **Concentration-Based Regulation[b]** | **Load-based Regulation where Infiltration <20%[c]** |
| | | |
| ***TSS*** | | |
| **Tier 0** | Infiltration basins[d]<br>Infiltration trenches[d,e] | |
| **Tier 1** | Wet basin<br>MCTT<br>Delaware filter<br>Austin filter<br>Strip – HRT>5 | Wet basin<br>MCTT<br>Delaware filter<br>Austin filter<br>Strip – HRT>5 |
| **Tier 2** | Strip – HRT<5<br>EDB<br>Swale | Strip – HRT<5<br>EDB<br>Swale |
| **Tier 3** | EDB – lined | EDB – lined |
| | | |
| ***Phosphorus (total)*** [f] | | |
| **Tier 0** | Infiltration basins[d]<br>Infiltration trenches[d,e] | |
| **Tier 1** | Delaware filter<br>Austin filter<br>EDB<br>Strip – HRT<5 | Delaware filter<br>Austin filter<br>EDB<br>Strip – HRT<5 |
| **Tier 2** | --- | --- |
| **Tier 3** | EDB – lined<br>MCTT<br>Wet basin<br>Strip – HRT>5<br>Swale | EDB – lined<br>MCTT<br>Wet basin<br>Strip – HRT>5<br>Swale |
| | | |
| ***Nitrogen (total)*** [g] | | |
| **Tier 0** | N.A. | |
| **Tier 1** | N.A. | --- |
| **Tier 2** | N.A. | (Austin filter – both)<br>EDB<br>EDB – lined<br>Wet basin |
| **Tier 3** | N.A. | Delaware<br>MCTT<br>Strip – all<br>(Swale) |

(Table 4.1 continued)

| | Concentration-Based Ranking[a] | |
|---|---|---|
| | **Concentration-Based Regulation[b]** | **Load-based Regulation where Infiltration <20%[c]** |
| | | |
| ***Copper (total)*** | | |
| **Tier 0** | Infiltration basins[d]<br>Infiltration trenches[d,e] | |
| **Tier 1** | Strip – HRT<5<br>Wet basin<br>(MCTT)<br>Delaware filter | Strip – HRT<5<br>Wet basin<br>(MCTT)<br>Delaware filter |
| **Tier 2** | Austin filter<br>Strip – HRT>5<br>Swale<br>EDB | Austin filter<br>Strip – HRT>5<br>Swale<br>EDB |
| **Tier 3** | --- | --- |
| | | |
| ***Copper (dissolved)*** | | |
| **Tier 0** | Infiltration basins[d]<br>Infiltration trenches[d,e] | |
| **Tier 1** | Strip – HRT<5<br>(Delaware filter)<br>(MCTT)<br>Strip – HRT>5 | Strip – HRT<5<br>(Delaware filter)<br>(MCTT)<br>Strip – HRT>5 |
| **Tier 2** | Wet basin<br>Swale | Wet basin<br>Swale |
| **Tier 3** | EDB – lined<br>Austin filter<br>EDB | EDB – lined<br>Austin filter<br>EDB |
| | | |
| ***Lead (total)*** | | |
| **Tier 0** | Infiltration basins[d]<br>Infiltration trenches[d,e] | |
| **Tier 1** | Wet basin<br>Austin filter<br>MCTT<br>Delaware filter<br>Strip – HRT<5<br>Strip – HRT>5 | Wet basin<br>Austin filter<br>MCTT<br>Delaware filter<br>Strip – HRT<5<br>Strip – HRT>5 |
| **Tier 2** | Swale<br>EDB | Swale<br>EDB |
| **Tier 3** | EDB – lined | EDB – lined |

(Table 4.1 continued)

| | Concentration-Based Ranking[a] | |
|---|---|---|
| | **Concentration-Based Regulation[b]** | **Load-based Regulation where Infiltration <20%[c]** |
| | | |
| ***Lead (dissolved)*** | | |
| **Tier 0** | Infiltration basins[d]<br>Infiltration trenches[d,e] | |
| **Tier 1** | Delaware filter<br>(MCTT)<br>Strip – HRT<5<br>Austin filter<br>Wet basin<br>EDB<br>Strip – HRT>5 | Delaware filter<br>(MCTT)<br>Strip – HRT<5<br>Austin filter<br>Wet basin<br>EDB<br>Strip – HRT>5 |
| **Tier 2** | Swale | Swale |
| **Tier 3** | EDB – lined | EDB – lined |
| | | |
| ***Zinc (total)*** | | |
| **Tier 0** | Infiltration basins[d]<br>Infiltration trenches[d,e] | |
| **Tier 1** | Delaware filter<br>MCTT<br>Wet basin<br>Strip – HRT<5 | Delaware filter<br>MCTT<br>Wet basin<br>Strip – HRT<5 |
| **Tier 2** | Swale<br>Austin filter<br>Strip – HRT>5<br>EDB | Swale<br>Austin filter<br>Strip – HRT>5<br>EDB |
| **Tier 3** | EDB – lined | EDB – lined |
| | | |
| ***Zinc (dissolved)*** | | |
| **Tier 0** | Infiltration basins[d]<br>Infiltration trenches[d,e] | |
| **Tier 1** | MCTT<br>Wet basin<br>Austin filter | MCTT<br>Wet basin<br>Austin filter |
| **Tier 2** | Strip – HRT>5<br>Swale<br>Strip – HRT<5<br>Delaware filter | Strip – HRT>5<br>Swale<br>Strip – HRT<5<br>Delaware filter |
| **Tier 3** | EDB – lined<br>EDB | EDB – lined<br>EDB |

(Table 4.1 continued)

| | Concentration-Based Ranking[a] | |
|---|---|---|
| | **Concentration-Based Regulation[b]** | **Load-based Regulation where Infiltration <20%[c]** |
| | | |
| ***Cadmium (total)[h]*** | | |
| **Tier 0** | Infiltration basins[d]<br>Infiltration trenches[d,e] | |
| **Tier 1** | Strip – HRT<5<br>Wet basin<br>Austin filter<br>Delaware filter<br>Strip – HRT>5<br>Swale | Strip – HRT<5<br>Wet basin<br>Austin filter<br>Delaware filter<br>Strip – HRT>5<br>Swale |
| **Tier 2** | EDB | EDB |
| **Tier 3** | EDB – lined<br>MCTT | EDB – lined<br>MCTT |
| | | |
| ***Chromium (total)[h]*** | | |
| **Tier 0** | Infiltration basins[d]<br>Infiltration trenches[d,e] | |
| **Tier 1** | Wet basin<br>(MCTT)<br>Delaware filter<br>Austin filter<br>EDB<br>Swale | Wet basin<br>(MCTT)<br>Delaware filter<br>Austin filter<br>EDB<br>Swale |
| **Tier 2** | Strip – HRT>5 | Strip – HRT>5 |
| **Tier 3** | EDB – lined<br>Strip – HRT<5 | EDB – lined<br>Strip – HRT<5 |

(Table 4.1 continued)

| | Concentration-Based Ranking[a] | |
|---|---|---|
| | **Concentration-Based Regulation[b]** | **Load-based Regulation where Infiltration <20%[c]** |
| | | |
| | | |
| ***Nickel (total)[d]*** | | |
| **Tier 0** | Infiltration basins[d]<br>Infiltration trenches[d,e] | |
| **Tier 1** | Strip – HRT<5<br>(Delaware filter)<br>EDB<br>Wet basin<br>Swale<br>Strip – HRT>5 | Strip – HRT<5<br>(Delaware filter)<br>EDB<br>Wet basin<br>Swale<br>Strip – HRT>5 |
| **Tier 2** | (Austin filter) | (Austin filter) |
| **Tier 3** | EDB – lined<br>MCTT | EDB – lined<br>MCTT |

a. Within tiers 1, 2, and 3, BMPs are sorted from lowest to highest average effluent concentration as estimated from the mixed-model statistical analysis.

b. This ranking is intended for concentration-based regulations that require maximum reduction of average discharge (effluent) concentration. If there is a not-to-exceed concentration standard, this analysis is not appropriate and a frequency analysis on exceedances may be more appropriate.

c. When there are no concentration-based standards, these rankings should only be consulted when there are no earthen BMPs that will achieve greater than 20% infiltration.

d. If minimizing average effluent concentrations is a regulatory requirement, infiltration BMPs should be considered first because complete elimination of a discharge will comply with concentration-based requirements.

e. Infiltration trenches often require pre-treatment to reduce the risk of clogging failures, unless site conditions show low sediment loads and large separation from normal high groundwater.

f. Strip classifications for phosphorus assume that salt grass is not planted. Pilot strips and swales planted with salt grass did not effectively reduce phosphorus.

g. For total nitrogen, there is no concentration-based ranking. The ranking shown for Infiltration < 20% is based on the sum of loads method.

h. Proposed New TDCs.

General Notes

- Strips are classified in two ways. For concentration-based rankings, the hydraulic residence time (HRT) was used because of its relationship to surface treatment processes, especially sedimentation. HRT<5 and HRT>5 mean hydraulic residence times less than and greater than 5 minutes.
- BMPs shown in parentheses involved either exceptions to these rules or other judgments that are explained in Table 3.1.

**Table 4.2 Load-based BMP Ranking for Target Design Constituents**

| | Load-Based Ranking[a] | |
|---|---|---|
| | **Infiltration 20 to 50%** | **Infiltration >50%** |
| | | |
| ***TSS*** | | |
| **Tier 0** | | Infiltration basins<br>Infiltration trenches[b] |
| **Tier 1** | Austin filter – both[c]<br>Delaware filter[c]<br>EDB<br>MCTT[c]<br>Strip – all<br>Swale<br>Wet basin[c] | Austin filter – both[c]<br>Delaware filter[c]<br>EDB<br>MCTT[c]<br>Strip – $A_S/A_D > 0.2$<br>Strip $0.1 < A_S/A_D < 0.2$<br>(Strip – $A_S/A_D < 0.1$)<br>Swale<br>Wet basin[c] |
| **Tier 2** | --- | --- |
| **Tier 3** | EDB – lined[c] | EDB – lined[c] |
| | | |
| ***Phosphorus (total)[d]*** | | |
| **Tier 0** | | Infiltration basins<br>Infiltration trenches[b] |
| **Tier 1** | Austin filter – earthen<br>EDB | Austin filter – earthen<br>EDB<br>(Strip – $A_S/A_D>0.2$) |
| **Tier 2** | Austin filter – concrete[c]<br>Delaware filter[c]<br>Strip – $A_S/A_D>0.2$<br>Strip – $0.1<A_S/A_D<0.2$<br>(Strip – $A_S/A_D <0.1$)<br>(Swale)<br>Wet basin[c] | Austin filter – concrete[c]<br>Delaware filter[c]<br>Strip – $A_S/A_D<0.1$<br>(Strip – $0.1<A_S/A_D<0.2$)<br>(Swale)<br>Wet basin[c] |
| **Tier 3** | EDB – lined[c]<br>(MCTT)[c] | EDB – lined[c]<br>(MCTT)[c] |
| | | |
| ***Nitrogen (total)*** | | |
| **Tier 0** | | Infiltration basins<br>Infiltration trenches[b] |
| **Tier 1** | --- | EDB<br>Strip – all<br>Swale |
| **Tier 2** | (Austin filter – concrete)[c]<br>Austin filter – earthen<br>EDB<br>EDB – lined[c]<br>Swale<br>Wet basin[c] | (Austin filter – concrete)[c]<br>Austin filter – earthen<br>EDB – lined[c]<br>Wet basin[c] |
| **Tier 3** | Delaware filter[c]<br>MCTT[c]<br>(Strip – all) | Delaware filter[c]<br>MCTT[c] |

(Table 4.2 continued)

| | Load-Based Ranking[a] | |
|---|---|---|
| | **Infiltration 20 to 50%** | **Infiltration >50%** |
| | | |
| ***Copper (total)*** | | |
| **Tier 0** | | Infiltration basins<br>Infiltration trenches[b] |
| **Tier 1** | (Austin filter – earthen)<br>EDB<br>Strip – $A_S/A_D$ >0.2<br>Swale<br>Wet basin[c] | Austin filter – earthen<br>EDB<br>(Strip – $A_S/A_D$ > 0.2)<br>Strip – $A_S/A_D$ < 0.1<br>Strip – 0.1<$A_S/A_D$<0.2<br>Swale<br>Wet basin[c] |
| **Tier 2** | Austin filter – concrete[c]<br>Delaware filter[c]<br>EDB – lined[c]<br>MCTT[c]<br>Strip – $A_S/A_D$ <0.1<br>Strip – 0.1<$A_S/A_D$<0.2 | Austin filter – concrete[c]<br>EDB – lined[c]<br>Delaware filter[c]<br>MCTT[c] |
| **Tier 3** | --- | --- |
| | | |
| ***Copper (dissolved)*** | | |
| **Tier 0** | | Infiltration basins<br>Infiltration trenches[b] |
| **Tier 1** | (Strip – $A_S/A_D$ > 0.2) | Austin filter – earthen<br>EDB<br>Strip – all<br>Swale |
| **Tier 2** | (Austin filter – earthen)<br>Delaware filter[c]<br>EDB<br>(MCTT)[c]<br>Strip – 0.1 < $A_S/A_D$ < 0.2<br>(Strip – $A_S/A_D$ < 0.1)<br>Swale<br>Wet basin[c] | Delaware filter[c]<br>(MCTT)[c]<br>Wet basin[c] |
| **Tier 3** | Austin filter – concrete[c]<br>EDB – lined[c] | Austin filter – concrete[c]<br>EDB – lined[c] |

(Table 4.2 continued)

| | Load-Based Ranking[a] | |
|---|---|---|
| | **Infiltration 20 to 50%** | **Infiltration >50%** |
| | | |
| ***Lead (total)*** | | |
| **Tier 0** | | Infiltration basins<br>Infiltration trenches[b] |
| **Tier 1** | Austin filter – concrete[c]<br>(Austin filter – earthen)<br>Delaware filter[c]<br>EDB<br>MCTT[c]<br>Strip – $A_S/A_D > 0.2$<br>(Strip – $0.1 < A_S/A_D < 0.2$)<br>Strip –$A_S/A_D < 0.1$<br>Swale<br>Wet basin[c] | Austin filter – both[c]<br>Delaware filter[c]<br>EDB<br>MCTT[c]<br>Strip – all<br>Swale<br>Wet basin[c] |
| **Tier 2** | EDB – lined[c] | EDB – lined[c] |
| **Tier 3** | --- | --- |
| | | |
| ***Lead (dissolved)*** | | |
| **Tier 0** | | Infiltration basins<br>Infiltration trenches[b] |
| **Tier 1** | Swale<br>Wet basin[c] | EDB<br>(Strip – $A_S/A_D > 0.2$)<br>Strip – $0.1 < A_S/A_D < 0.2$<br>Strip –$A_S/A_D < 0.1$<br>Swale |
| **Tier 2** | (Austin filter – concrete) [c]<br>Austin filter – earthen<br>Delaware filter[c]<br>EDB<br>(MCTT) [c]<br>(Strip – $A_S/A_D > 0.2$)<br>Strip – $0.1 < A_S/A_D < 0.2$<br>Strip –$A_S/A_D < 0.1$ | (Austin filter – concrete) [c]<br>Austin filter – earthen<br>Delaware filter[c]<br>(MCTT) [c]<br>Wet basin[c] |
| **Tier 3** | EDB – lined[c] | EDB – lined[c] |

(Table 4.2 continued)

| | Load-Based Ranking[a] | |
|---|---|---|
| | **Infiltration 20 to 50%** | **Infiltration >50%** |
| | | |
| ***Zinc (total)*** | | |
| **Tier 0** | | Infiltration basins<br>Infiltration trenches[b] |
| **Tier 1** | Austin filter – both[c]<br>Delaware filter[c]<br>EDB<br>MCTT[c]<br>Strip – $A_S/A_D > 0.2$<br>(Strip – $0.1 < A_S/A_D < 0.2$)<br>Strip –$A_S/A_D < 0.1$<br>Swale<br>Wet basin[c] | Austin filter – both[c]<br>Delaware filter[c]<br>EDB<br>MCTT[c]<br>Strip – all<br><br><br>Swale<br>Wet basin[c] |
| **Tier 2** | EDB – lined[c] | EDB – lined[c] |
| **Tier 3** | --- | --- |
| | | |
| ***Zinc (dissolved)*** | | |
| **Tier 0** | | Infiltration basins<br>Infiltration trenches[b] |
| **Tier 1** | Austin filter – earthen<br>Delaware filter[c]<br>MCTT[c] | Austin filter – earthen<br>Delaware filter[c]<br>EDB<br>MCTT[c]<br>Strip – all<br>Swale |
| **Tier 2** | Austin filter – concrete[c]<br>EDB<br>EDB – lined[c]<br>(Strip – all)<br>Swale | Austin filter – concrete[c]<br>EDB – lined[c] |
| **Tier 3** | Wet basin[c] | Wet basin[c] |

(Table 4.2 continued)

| | Load-Based Ranking[a] | |
|---|---|---|
| | **Infiltration 20 to 50%** | **Infiltration >50%** |
| | | |
| ***Cadmium (total)[e]*** | | |
| **Tier 0** | | Infiltration basins<br>Infiltration trenches[b] |
| **Tier 1** | Delaware filter[c]<br>EDB<br>Swale<br>Wet basin[c] | Austin filter – earthen<br>Delaware filter[c]<br>EDB<br>Strip – all<br>Swale<br>Wet basin[c] |
| **Tier 2** | (Austin filter – concrete) [c]<br>Austin filter – earthen<br>Strips – all | (Austin filter – concrete) [c] |
| **Tier 3** | EDB – lined[c] | EDB – lined[c] |
| | | |
| ***Chromium (total)[e]*** | | |
| **Tier 0** | | Infiltration basins<br>Infiltration trenches[b] |
| **Tier 1** | Austin filter – earthen<br>EDB<br>(Strip – $A_S/A_D > 0.2$)<br>Strip – $0.1 < A_S/A_D < 0.2$<br>Wet basin | Austin filter – earthen<br>EDB<br>Strip – all<br>Swale<br>Wet basin |
| **Tier 2** | (Austin filter – concrete) [c]<br>Delaware filter[c]<br>EDB – lined[c]<br>MCTT[c]<br>Strip – $A_S/A_D < 0.1$<br>Swale | (Austin filter – concrete) [c]<br>Delaware filter[c]<br>EDB – lined[c]<br>MCTT[c] |
| **Tier 3** | --- | --- |

(Table 4.2 continued)

| | Load-Based Ranking[a] | |
|---|---|---|
| | **Infiltration 20 to 50%** | **Infiltration >50%** |
| | | |
| ***Nickel (total)[e]*** | | |
| **Tier 0** | | Infiltration basins<br>Infiltration trenches[b] |
| **Tier 1** | (Austin filter – earthen)<br>EDB<br>(Strip – all)<br>Swale | Austin filter – earthen<br>EDB<br>Strip – all<br>Swale |
| **Tier 2** | (Austin filter – concrete) [c]<br>Delaware filter[c]<br>Wet basin[c] | (Austin filter – concrete) [c]<br>Delaware filter[c]<br>Wet basin[c] |
| **Tier 3** | EDB – lined[c]<br>MCTT[c] | EDB – lined[c]<br>MCTT[c] |

a. For load removal, Tier 1 = greater than 60% treatment efficiency; Tier 2 = 20-60% treatment efficiency; Tier 3 = less than 20% treatment efficiency (same as concentration alone). BMPs shown in parentheses involved either exceptions to these rules or other judgments that are explained in Table 3.1. Within tiers, BMPs are sorted alphabetically.

b. Infiltration trenches often requires pre-treatment to reduce the risk of clogging failures, unless site conditions show low sediment loads and large separation from normal high groundwater.

c. Lined BMPs are shown in the columns where substantial infiltration occurs for earthen BMPs. Though these BMPs never infiltrate, regardless of site conditions, they are shown in these columns solely to allow the user to more easily compare the load removal of lined BMPs to those that infiltrate.

d. Strip classifications for phosphorus assume that salt grass is not planted. Pilot strips and swales planted with salt grass did not effectively reduce phosphorus.

e. Proposed New TDCs

General Notes

- For load removal, the ratio of the strip area to the drainage area ($A_S/A_D$) was used to classify strips because of the relationship of the ratio to infiltration and because it is easy to calculate.

## *4.2 Qualifiers*

### *4.2.1 BMP Selection Factor*

The BMP rankings proposed in this document are based solely on constituent reduction performance. General factors that are not addressed in this analysis include safety, cost, and ease of maintenance.

### *4.2.2 Limitations in Statewide Interpretation of Water Quality Data*

This report draws from the most comprehensive stormwater dataset directly collected by a single agency. Despite an unmatched BMP monitoring program, there is still difficulty in developing standard recommendations that are applicable for all project-specific

circumstances in a state as large and diverse as California. The ranking methodologies presented here are based on comparing data collected from different places at different times. The validity of these comparisons is affected by the limited number of representative BMP test locations. For instance, several BMPs were not tested at highway locations as shown in Table 4.3.

Facility type can have a strong influence on whether the test location is relatively cleaner or dirtier than other locations. And even among highway locations, prior work by Caltrans has found that average annual daily traffic (AADT) and ecoregion play a significant role in highway runoff concentrations (Caltrans, 2009a). Besides influent concentrations, there are many other BMP test conditions that could affect performance, such as soil type, vegetation, and antecedent storm conditions.

It is unreasonable to expect that every BMP would be tested under all Caltrans conditions, because of limitations including time, budget, space constraints, safe access, construction conflicts, and space for monitoring equipment. Nevertheless, not testing BMPs for all conditions dictates the use of numeric methods and professional judgment to extrapolate certain observations to typical highway applications. From a statistical perspective, because the important site conditions were not sufficiently controlled among the BMP test locations, statistical tests could not always support these professional judgments. An improved mixed-model could be developed to handle the subjective adjustments needed in the sum of loads method.

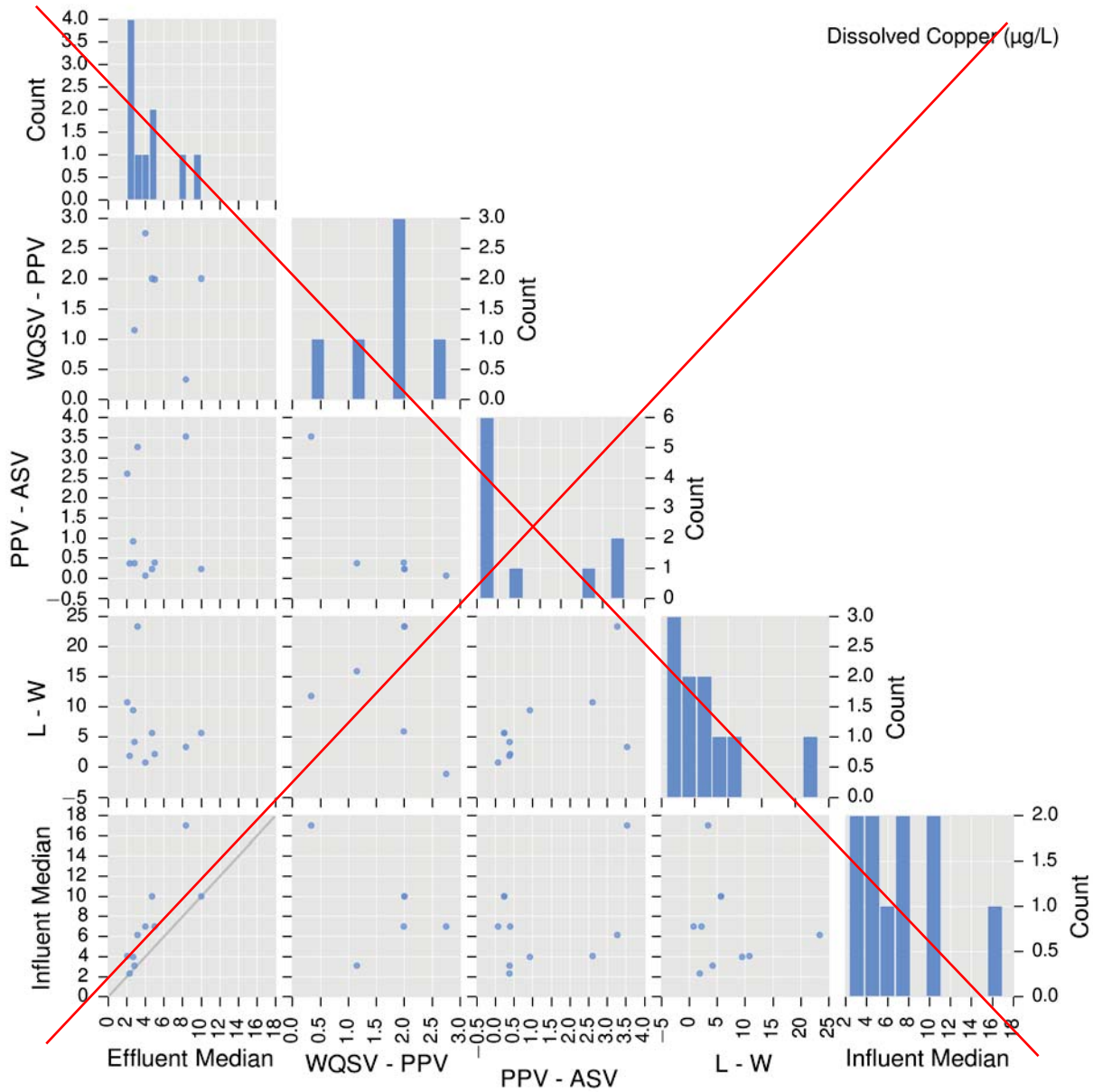
**Table 4.3 Select Site Characteristics for BMP Studies**

| | Facility Type[a] | | | Average Annual Rainfall | | |
|---|---|---|---|---|---|---|
| **BMP Type** | **Hwy** | **P&R** | **MS** | **<15”** | **15 - 30”** | **>30”** |
| Austin Sand Filters, lined, full-sedimentation | ✓ | | | ✓ | ✓ | |
| Austin Sand Filters, unlined, partial-sedimentation | ✓ | | | | | ✓ |
| Austin Sand Filters, unlined, full-sedimentation | | | ✓ | | | ✓ |
| Delaware Sand Filters | | | ✓ | ✓ | | |
| Detention Basins, lined | ✓ | | | ✓ | | |
| Detention Basins, unlined | ✓ | | | ✓ | | |
| Multi-Chambered Treatment Train (MCTT) | | ✓ | | ✓ | ✓ | |
| Strips | ✓ | | ✓ | ✓ | ✓ | ✓ |
| Swales | ✓ | | | ✓ | | |
| Wet basins | ✓ | | | ✓ | | |

[a] Facility Types: MS = maintenance station; P&R = park and ride; Hwy = highway

A factor limiting the precision of these rankings is the natural variability of the data from storm to storm. Because of these variations, the regressions that provided the basis of the performance comparisons are often not very tight, as evidenced by low $r^2$ values. This isn’t failure to exercise care in collecting the data. It is, however, reflective of the fact that the data sets are inherently “noisy,” and that relationships between influent and effluent values are not always linear.

# INTERNATIONAL STORMWATER BMP DATABASE




~~**Figure 49. Scatter matrix of median dissolved copper concentration in the influent and effluent with selected design parameters for retention ponds.**~~

# 3 SUMMARY AND CONCLUSIONS

The BMPDB is a long-term project that has steadily grown to over 530 BMPs and has resulted in improved understanding of performance of various BMP types. For the most part, analyses to date have focused on summarizing influent and effluent concentration statistics, along with some limited analysis of volume reduction. However, a long-term objective of the project has always been to provide a source of information to practitioners on the relationship between performance

and various BMP design parameters. Given significant growth of the BMPDB, the Project Team reviewed the available design information stored in the BMPDB for various BMP types and evaluated potential relationships between selected design parameters and performance for a subset of water quality parameters. As a result of this evaluation, a few design-related findings emerged; however, for the most part, the design-related content of the BMP Database is still relatively limited for many BMP categories. Additionally, this analysis showed that most of the BMP design parameters that were significantly correlated with effluent concentration often displayed a similar correlation with influent concentration. This finding confounds conclusions that can be drawn regarding causal relationships between BMP design parameters and removal of constituents, without applying more advanced statistical methods, such as analysis of covariance and multi-parameter regression. Also, the analysis of nutrient removal is difficult since monitoring may not capture all influent sources, including leaves and grass clippings, which may result in apparent nutrient export due to an incomplete mass balance analysis. Primary observations and conclusions reached for each BMP category analyzed include:

1. Retention Ponds: The retention pond (wet pond) category is one of the larger data sets in the BMP database, both in terms of number of studies, water quality data and design parameters. Based on statistical analysis in this report, retention ponds provide statistically significant removal of all constituents evaluated (i.e., total suspended solids, total and dissolved copper, total phosphorus, NOx) except for dissolved phosphorus. Analysis of the relationships between selected design parameters and median effluent concentrations showed that higher permanent pool volume (PPV) to average storm volume (ASV) ratios are associated with lower concentrations of total suspended solids and possibly total phosphorus and nitrate, but the relationships for these two constituents are not quite statistically significant ($p=0.11$ and 0.14, respectively). Additionally, a higher water quality surcharge volume (WQSV) to permanent pool volume (PPV) ratio may result in lower effluent total phosphorus and dissolved phosphorus; however, hypothesis test results were not quite statistically significant for dissolved phosphorus ($p=0.15$) and the influent concentration may be confounding the results for total phosphorus. Lower total phosphorus concentrations were also identified for higher length to width ratios, but, again, the influent concentrations showed a similar relationship. No other statistically significant relationships between design parameters and effluent concentrations were identified based on the available data set.

2. Detention Basins: The detention pond (extended detention dry pond) category is also relatively large in terms of number of studies and water quality data; however, reporting of design parameters is less consistent. Based on statistical analyses in this report, detention ponds provide statistically significant removal of total suspended solids, total copper, and nearly significant removal of total phosphorus, but not dissolved phosphorus or NOx. Analysis conducted showed no explainable, significant relationships between design storm depth (DSD) to average storm depth (ASD) ratio, brimful emptying time (BFET), or length to width ratios based on the available data set.

3. Media Filters: Several different types of media filters are included in the BMP Database. This analysis focused on sand filters. Sand filters showed statistically significant reductions of total suspended solids, total copper, and total phosphorus; however, they did not significantly reduce dissolved phosphorus or dissolved copper. Statistically

significant increases in NOx were present. Analysis of the relationships between selected design parameters and median effluent concentrations did not result in identification of statistically significant causal relationships between design variables and effluent concentrations.

4. Bioretention: The bioretention category is growing data set in the BMPDB, which tends to include more consistent reporting of design parameters in newer studies, but the data set overall remains smaller in terms of numbers of BMPs and constituents available. Additionally, this analysis focused on designs with underdrains, which further narrows the number of studies evaluated. Based on statistical analysis in this report, bioretention facilities with underdrains provide statistically significant removal of total suspended solids, but not total phosphorus or NOx. (Inadequate studies with design data were available to evaluate dissolved phosphorus and copper in this report.) The scatterplot matrices indicate that the combination of a large footprint to drainage area ratio and deep media bed may provide a higher water quality benefit than a smaller area ratio and shallower media bed, but additional data and research is needed to evaluate this relationship statistically. The composition of the media mix also is expected to play a significant role in pollutant removal, but with the variety of mixes reported in the BMPDB there currently are too few studies to meaningfully analyze this design parameter. Analysis of the relationships between selected design parameters and median effluent concentrations did not result in identification of statistically significant causal relationships between design variables and effluent concentrations. An important caveat for the bioretention findings is that volume reduction is typically a primary design objective and process for reducing pollutant loads. The analyses in this particular report do not consider volume reduction; however, bioretention has been shown to provide significant volume reduction in studies by other researchers, as well as in previous BMPDB analyses (see Geosyntec and WWE 2012c).

5. Grass Strips: Grass strips showed statistically significant reductions of total suspended solids, NOx, and total copper. Nearly significant reductions for dissolved copper were identified. A statistically significant increase in total phosphorus was noted. Volume reduction benefits may be present for grass strips, but were not addressed in this report. Analysis of the relationships between selected design parameters (length and slope) and median effluent concentrations did not result in identification of any statistically significant causal relationships. However, research by others (e.g., Caltrans, 2003) indicates that there may be an optimum length for any given slope and vegetation density to achieve consistently low effluent concentrations. Multi-regression analyses on the available BMPDB data could be used to better evaluate the effects these design parameters may have on performance.

6. Grass Swales: Grass swales showed statistically significant reductions of total suspended solids and total copper, but not NOx, total phosphorus or dissolved copper. However, dissolved copper removals were nearly statistically significant ($p=0.13$). Volume reduction benefits may also be present for grass swales, but were not addressed in this report. Analysis of the relationships between selected design parameters and median effluent concentrations showed that increasing swale lengths corresponded to better

**EPA REGION 1 (NORTHEAST)**

#### 4.1.4. BMPDSS Test Results

The calibrated BMPDSS models performances were tested by comparing the model simulated long-term pollutant removal for the 2004–2006 period to the UNHSC reported long-term BMP performances reported for the same period. The calibrated BMPDSS models were run for the 2004–2006 period, and the pollutant removal rates of each BMP were calculated and compared to the UNHSC-reported values (UNHSC 2007). It is important to note that the UNHSC-reported values represent the median pollutant removal of selected storms (approximately 17–20 storms) for each BMP. BMPDSS-simulated pollutant removal reports the cumulative pollutant removal of all storms (34 storms) that occurred during the selected period including those analyzed by UNHSC.

*1. Infiltration system*

The test results of the infiltration system BMPDSS model are shown in Table 4-8. As shown, the BMPDSS model simulation results for TSS, TP, and Zn removal are similar to the UNHSC-reported values.

**Table 4-8. Test results of infiltration system removal efficiencies for 2004–2006**

| Total pollutant load | TSS (lbs) | TP (lbs) | Zn (lbs) |
|---|---|---|---|
| Inflow | 279.29 | 2.81 | 0.45 |
| Outflow | 4.21 | 0.48 | 0.01 |
| Pollutant removal | 98% | 83% | 98% |
| UNHSC-report percentage | 99% | 81% | 99% |

*2. Gravel wetland*

The test results of the gravel wetland BMPDSS model are shown in Table 4-9. As shown, the BMPDSS model simulation results for TSS, TP, and Zn removal are similar to the UNHSC-reported values.

**Table 4-9. Test results of gravel wetland removal efficiencies for 2004–2006**

| Total pollutant load | TSS (lbs) | TP (lbs) | Zn (lbs) |
|---|---|---|---|
| Inflow | 279.29 | 2.81 | 0.45 |
| Outflow | 4.61 | 1.05 | 0.04 |
| Pollutant removal | 98% | 63% | 91% |
| UNHSC-report percentage | 99% | 55% | 99% |

*3. Bioretention area*

The test results of the bioretention area BMPDSS model are shown in Table 4-10. As shown, the BMPDSS model simulation results for TSS and Zn are similar (< 5 percent difference) to the UNHSC-reported values. However, the BMPDSS model simulated a much higher long-term pollutant removal rate for TP than the UNHSC-reported value. The bioretention system at UNHSC has gone through several design and construction related issues during the selected period. The observed data could have been influenced by these uncertainties. A review of bioretention performance data reported by others indicates that the UNHSC-reported TP removal of 5 percent is relatively low for a well-functioning bioretention type of BMP.

Consequently, the bioretention module in the existing BMPDSS, which was calibrated to bioretention performance data from the University of Maryland (Tetra Tech 2007) has resulted in a long-term TP

removal of 64 percent. The BMPDSS model prediction for TP removal appears to be reasonable when compared to the pollutant removal percentages reported by EPA for bioretention systems (USEPA 1999), which is 70–83 percent.

**Table 4-10. Test results of bioretention area removal efficiencies for 2004–2006**

| Total pollutant load | TSS (lbs) | TP (lbs) | Zn (lbs) |
|---|---|---|---|
| Inflow | 279.29 | 2.81 | 0.45 |
| Outflow | 15.82 | 1.13 | 0.02 |
| Pollutant removal | 94% | 60% | 96% |
| UNHSC-reported percentage | 99% | 5% | 99% |

*4. Porous pavement*

The test results of the porous pavement BMPDSS model are shown in Table 4-11. As shown, the BMPDSS model simulation results for TSS, TP, and Zn removal are similar to the UNHSC-reported values.

**Table 4-11. Test results of porous pavement removal efficiencies for 2004–2006**

| Total pollutant load | TSS (lbs) | TP (lbs) | Zn (lbs) |
|---|---|---|---|
| Inflow | 279.29 | 2.81 | 0.45 |
| Outflow | 5.46 | 1.58 | 0.04 |
| Pollutant removal | 98% | 43% | 92% |
| UNHSC-reported percentage | 99% | 38% | 96% |

*5. Grass swale*

The test results of the grass swale BMPDSS model are shown in Table 4-12. As shown, the BMPDSS model simulation results for TSS, TP, and Zn removal are similar to the UNHSC-reported values.

**Table 4-12. Test results of grass swale removal efficiencies for 2004–2006**

| Total pollutant load | TSS (lbs) | TP (lbs) | Zn (lbs) |
|---|---|---|---|
| Inflow | 279.29 | 2.81 | 0.45 |
| Outflow | 87.87 | 2.01 | 0.08 |
| Pollutant removal | 69% | 29% | 83% |
| UNHSC-reported percentage | 60% | NT | 88% |

*6. Wet pond*

The test results of the wet pond BMPDSS model are shown in Table 4-13. As shown, the BMPDSS model simulation results for TSS, TP, and Zn removal are similar to the UNHSC-reported values.

**Table 4-13. Test results of wet pond removal efficiencies for 2004–2006**

| Total pollutant load | TSS (lbs) | TP (lbs) | Zn (lbs) |
|---|---|---|---|
| Inflow | 279.29 | 2.81 | 0.45 |
| Outflow | 85.46 | 2.25 | 0.02 |
| Pollutant removal | 69% | 20% | 96% |
| UNHSC-reported percentage | 72% | 16% | 93% |

#### 4.1.5. BMPDSS Calibration Summary

The BMPDSS model was calibrated and tested for six BMPs using observed data from UNHSC. Three events were selected for calibrating each BMP, and the BMP model performances were tested against the 2004–2006 pollutant reduction percentages documented in the UNHSC 2007 Annual Report.

Calibrations of the BMPDSS model indicate that the model is capable of simulating the hydraulic performances of BMPs, and the models test results show that the long-term prediction of BMP performances are in close agreement with the values reported by UNHSC.

The successful calibration and testing of the BMPDSS models with UNHSC data supports the use of the models to generate credible long-term BMP performance curves for the New England Region (Section 5).

## 4.2. BMPDSS Representation

In developing BMP performance curves, one important step is to represent the selected eight BMPs in the BMPDSS model with appropriate specifications. In this project, BMP specifications were represented by following the *Structural BMP Specifications for the Massachusetts Stormwater Handbook* (MassDEP 2008a). This section provides an overview of the eight BMPs that were represented in BMPDSS. A brief description of design specifications is provided for each BMP, followed by the modeling schematic of that BMP in BMPDSS.

#### 4.2.1. Infiltration System

Infiltration trenches and infiltration basins are two common systems in use. Infiltration trenches are shallow excavations filled with stone. They can be designed to capture sheet flow or piped inflow. The stone and piping or storage units (if applicable) provide underground storage for stormwater runoff so that it can be gradually infiltrated through the bottom or sides of the trench into the subsoil. Infiltration basins are stormwater runoff impoundments that are constructed over permeable soils. Pretreatment is critical for effective performance of infiltration basins. Runoff from the design storm is stored until it infiltrates through the soil of the basin floor. The *Massachusetts Stormwater Handbook* requires 44 percent TSS removal through pretreatment in critical areas for infiltration basins. For developing BMP performance curves, infiltration trenches and infiltration basins were sized according to the Massachusetts standards.

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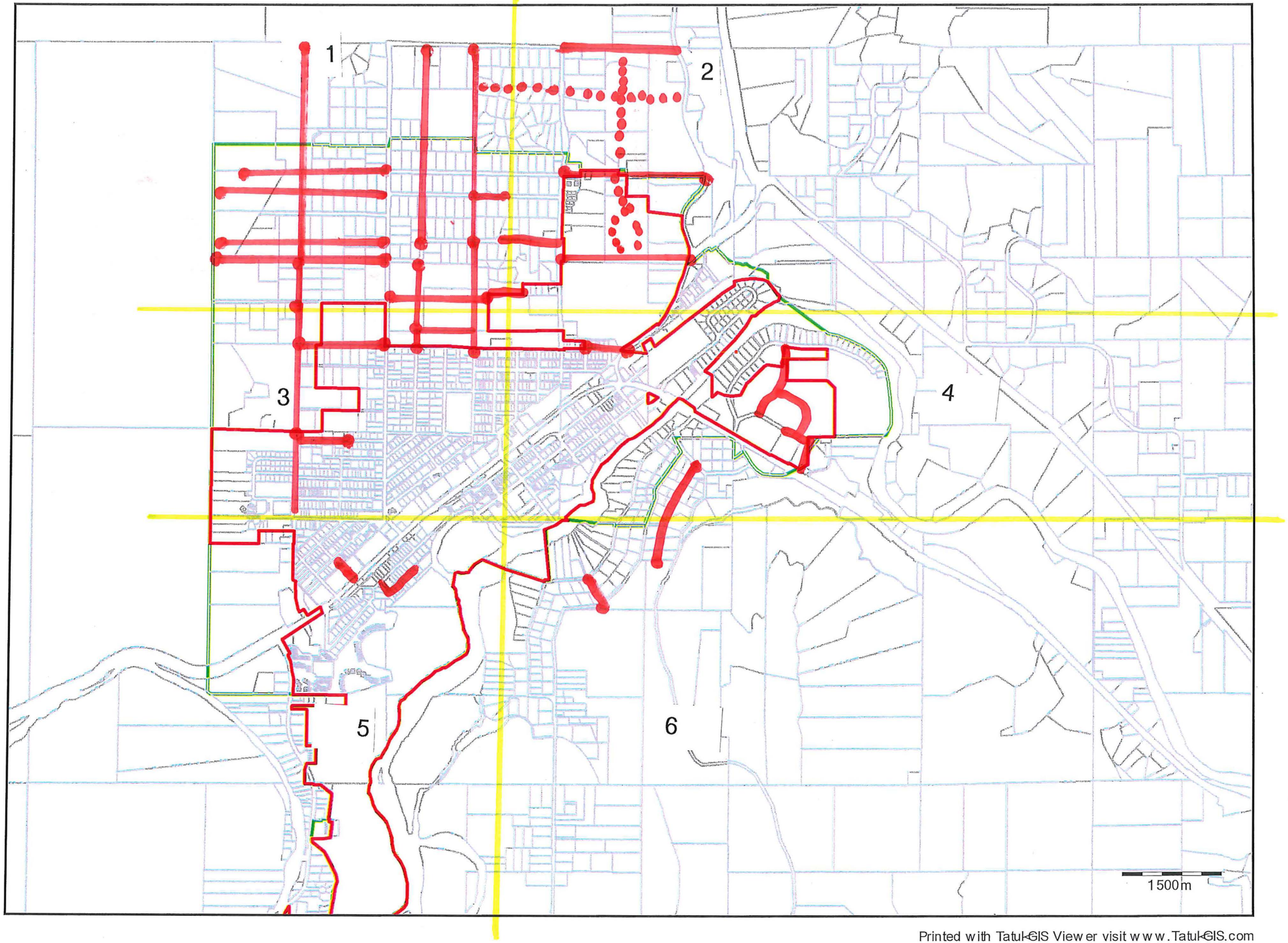


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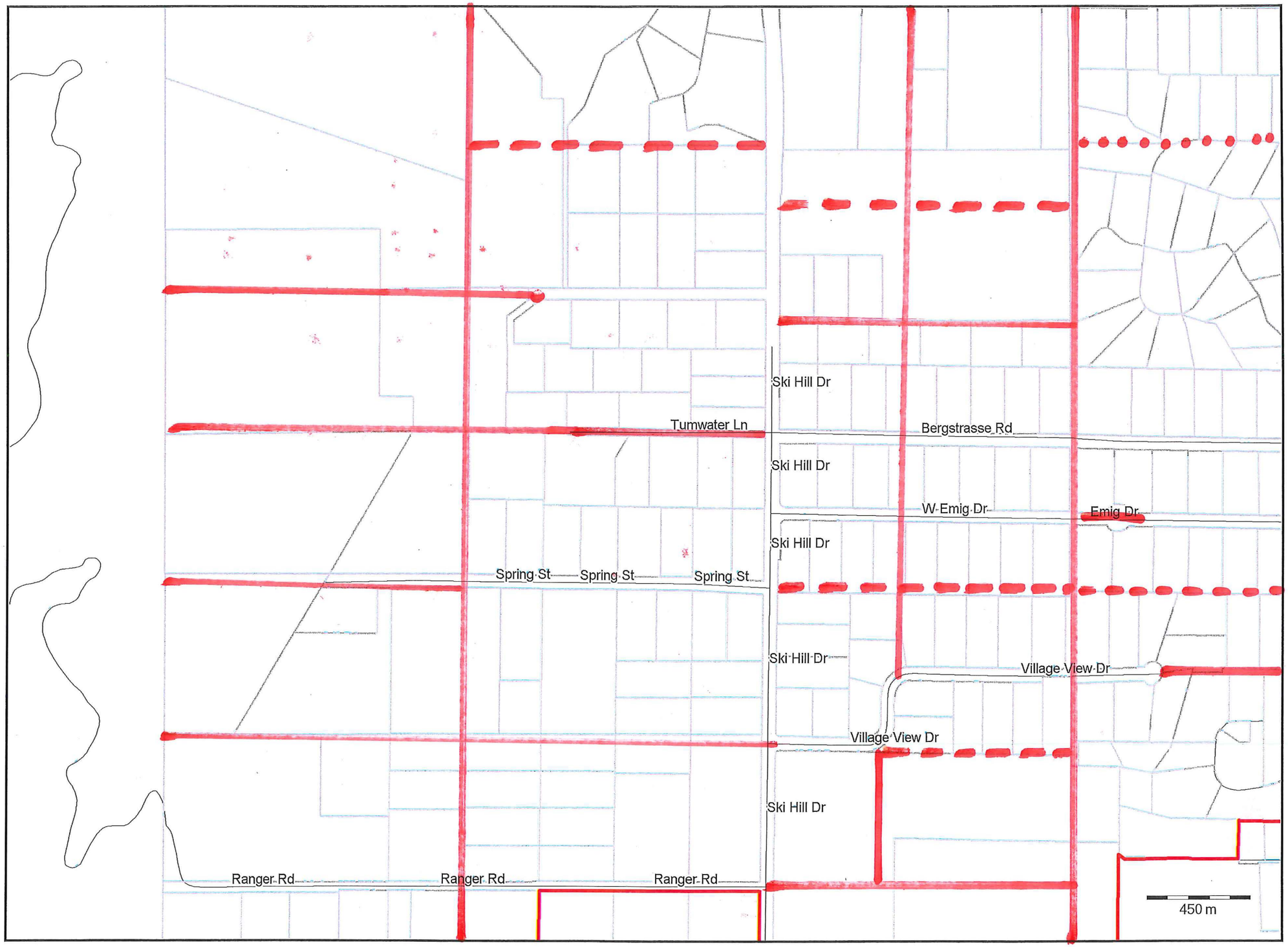


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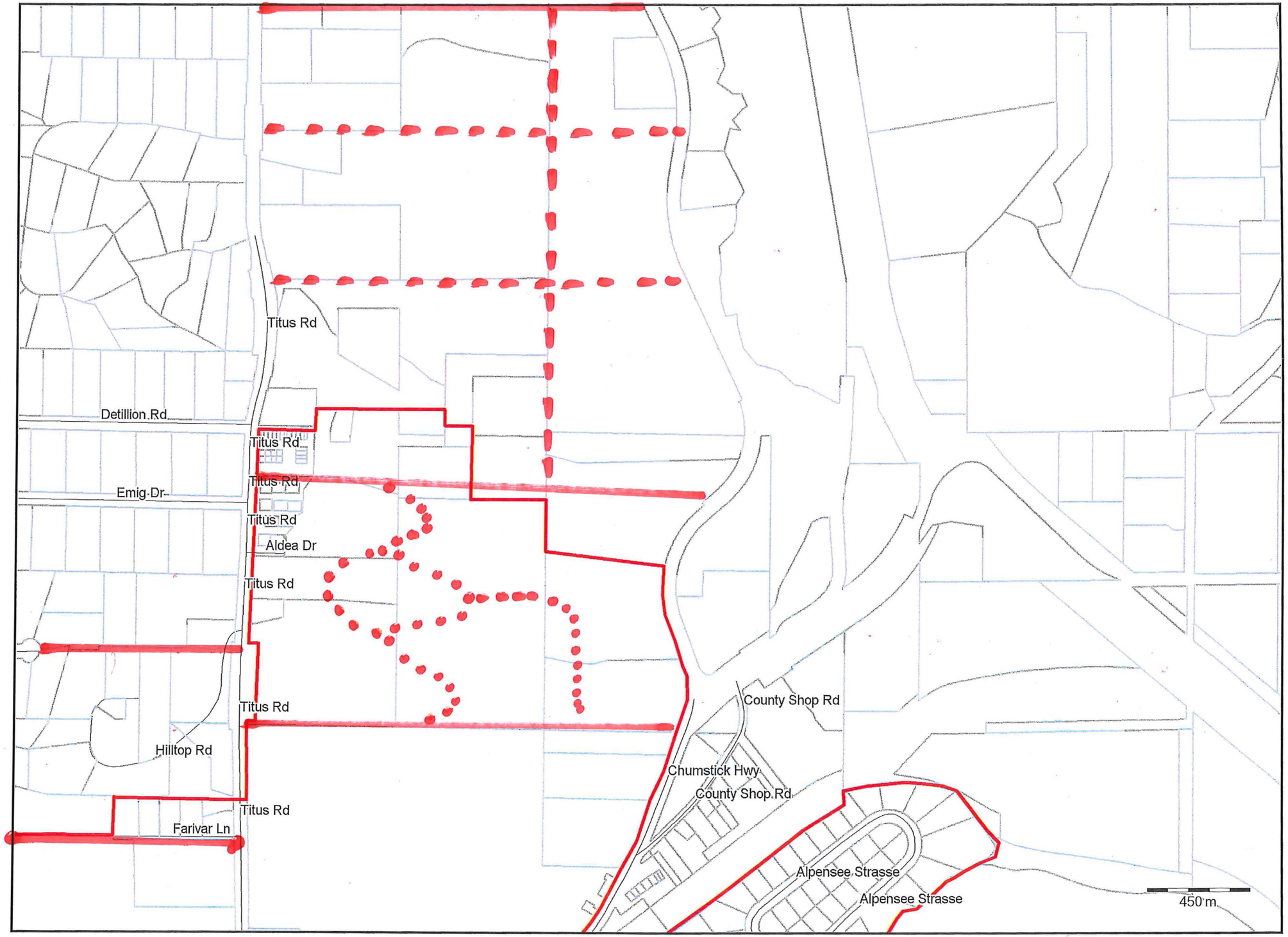


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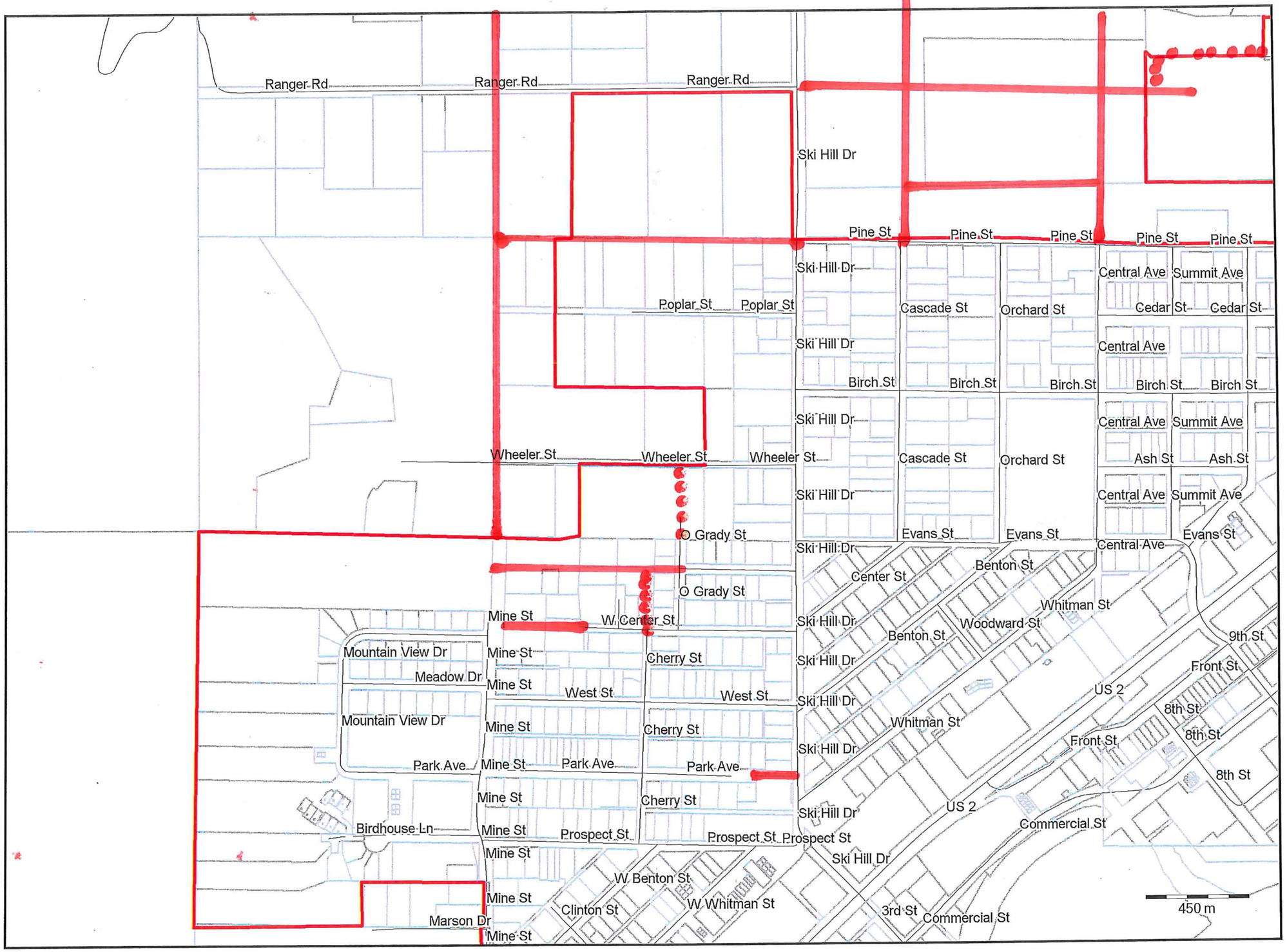


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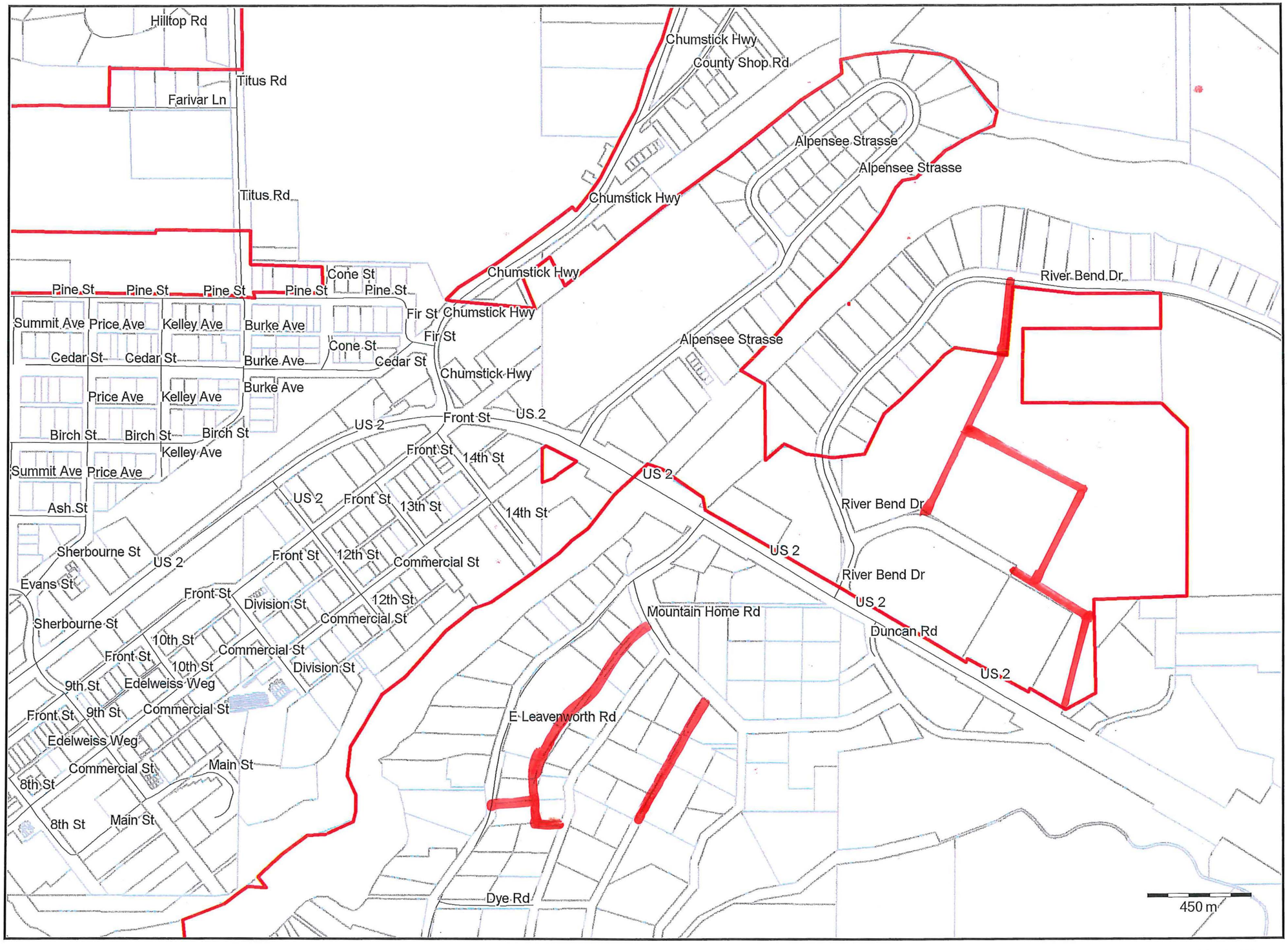


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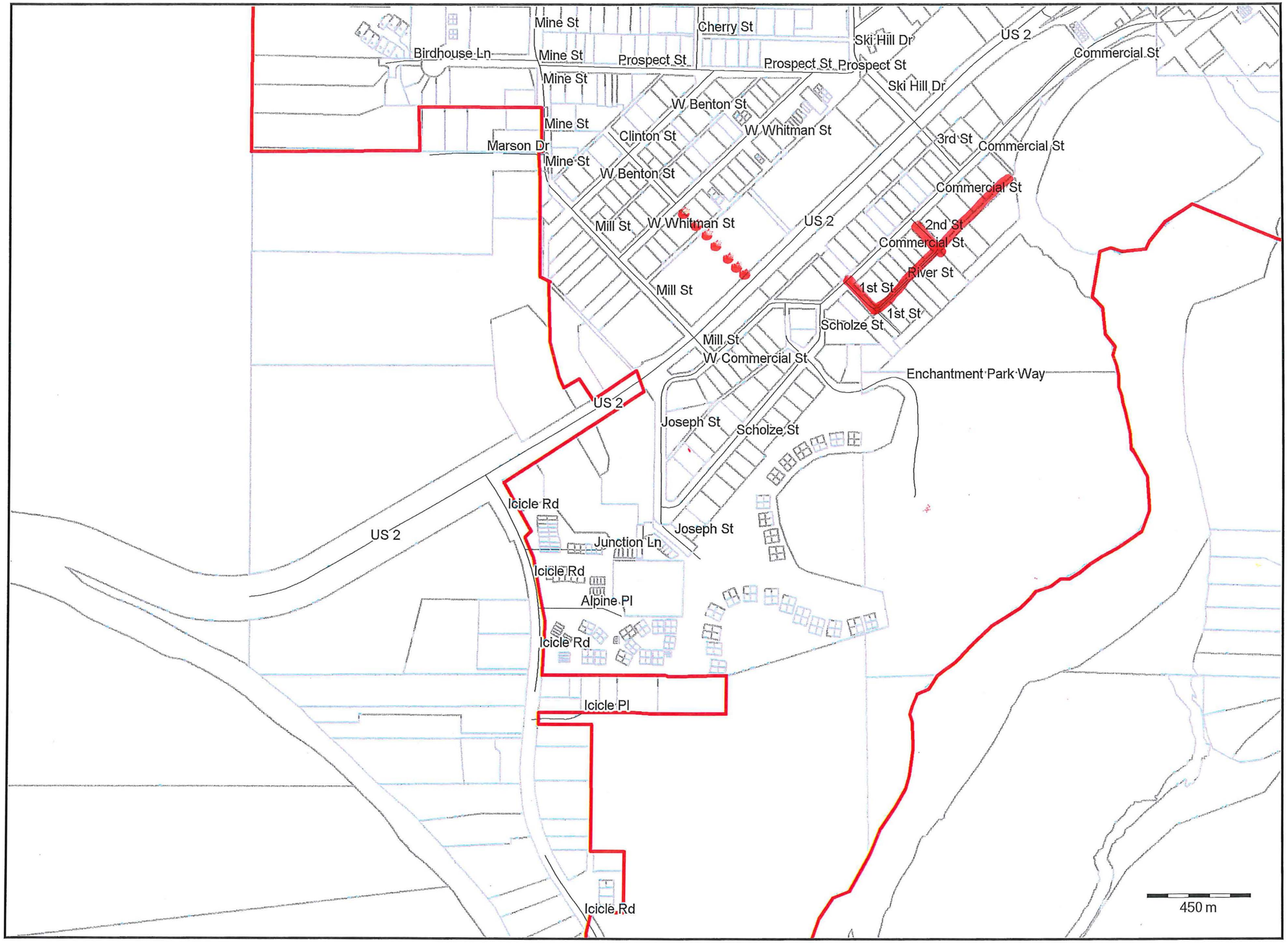


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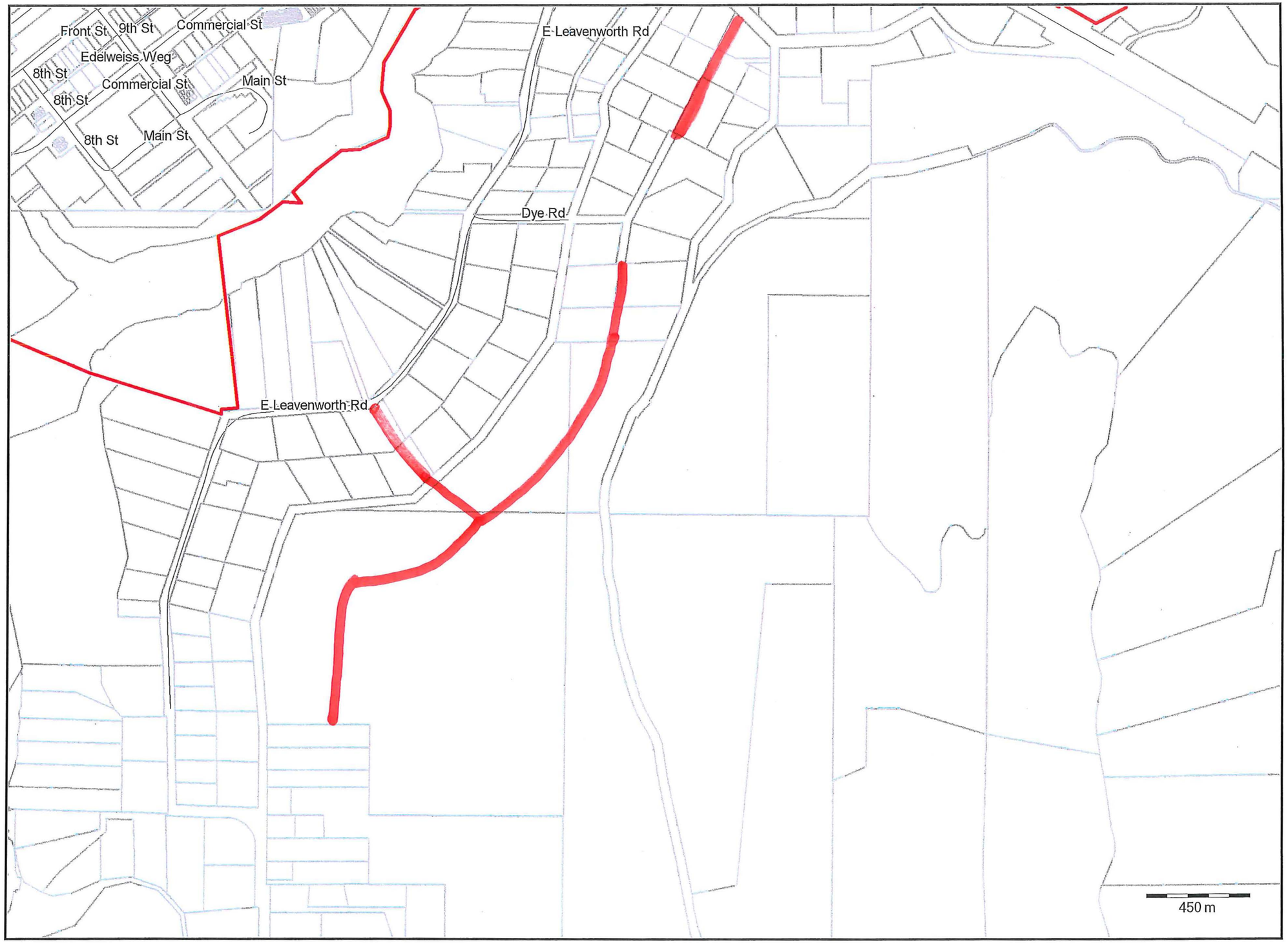




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**City of Leavenworth**
**Planning Commission Meeting**
**February 3, 2016 (Wednesday)**
**7:00 PM**
**City Hall – Council Chambers**

# MINUTES

The meeting was called to order at 7:00 PM

**Commission Members Present:** Andy Lane, Anne Hessburg, Chuck Reppas, Pete Olsen, Larry Hayes & Scott Bradshaw

**Staff Present:** Nathan Pate, Development Services

**PC Minutes**: October 21, 2015, Commissioner Hessburg moved to approve, Commissioner Lane seconded. November 18, 2015, Commissioner Hessburg moved to approve, Commissioner Lane seconded, and December 2, 2015, Commissioner Lane moved to approve, Commissioner Hessburg seconded. All in favor, none opposed.

**2016 Docket -** Reviewed the 2016 Docket with the changes from the joint Council and Commission meeting; and minor clarifications / arrangement. In addition, the Planning Commission received testimony from Alan Johnson, Executive Vice President of Recreational Adventures Co. Mr. Johnson is the owner of the Pine Village KOA, along with the property manager, Danielle Acke, and asked that the Commission modify the Docket to include minor amendments to address the existing park as compliant. Mr. Johnson hopes to have the KOA annexed by the end of the current year. Although included, generally, in the Docket, the PC agreed, and updated the Docket to reflect this clarification. RV parks within the LMC - CUP criteria can be updated.

Commissioners discussed the joint meeting with the City Council.

Commissioners agreed with the 2016 Docket but wanted to switch a couple topics from high, medium and low priorities.

**Third reading - Amendment to LMC 18.20.020 (B) (3) -** The Planning Commission conducted the third reading of the amendment to LMC 18.20.020 (B) (3) - update and modify the accessory dwelling unit standards and specifications. Final edits were discussed; and although the basic elements are done, the PC wanted feedback from the Public Works Committee regarding mandating (or not) separate utility connections. The topic will be added to the PWC agenda. (continued from the November 18, 2015 and December 2, 2015 hearings. Feedback provided by Council on January 26, 2016). Commissioners discussed separate trash services for the approved ADU's and primary residences and also assigning separate addresses for emergency services.

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Commissioner Hayes asked what the difference is between ADU's and duplexes. Manager Pate replied that the difference is permitting. For instance, if it is an ADU and is not above the garage, the fire code may not require sprinklers systems, where if it is a duplex, regardless of garage location, sprinklers would be required.

Continue LMC - Residential uses review and update. Schedule of "workshops / community outreach" and what types. Review and accept "questions to consider" for residential neighborhoods and vacation / overnight rentals. Commissioners and staff decided if a homeowner does not conform and is not legal, they have very few rights. Commissioner Hessburg stated that the opening of the door with the size threshold being the same as the County and that she likes that the City doesn't have a minimum size because that opens the door for people that want permanent tiny homes. Manager Pate agreed. A commissioner asked if the City had setbacks between buildings on the same property. Manager Pate responded that the Fire Code had setbacks.

Commissioners asked to take the ADU subject to the public.

Regional Stormwater / Wetland Master Plan preliminary discussion and "homework."

Green Infrastructure Master Plan Preliminary Outline

List of BMPs for application to Leavenworth

Upcoming Meetings

Public Hearing (continued from the November 18, 2015 and December 2, 2015 hearings) - Amendment to LMC 18.20.020 (B) (3) - update and modify the accessory dwelling unit standards and specifications. ADU update is necessary to address trends and encourage life / safety review and permitting.

Public Hearings (continuation from December 2, 2015): Amendment to LMC 21.09.030 and 18.08.385 - creating site development permit. Site development permits are issued for work such as limited clearing, grading, landscaping, parking lots, drainage, private streets and groundwork related to new subdivisions, commercial, or residential site preparation, where no building or structure is altered, moved or constructed

Continue LMC - Residential uses review and update. Moved to April 6th meeting.

LMC - Titles 21 and 18-Consolidation of Definitions (incorporated the update to resolve "Commercial and Family Amusement Centers/ Facilities.")

Regional Stormwater / Wetland Master Plan feedback and comments to begin structuring the document. Commissioner Hessburg suggested using BMP's (Best Management Practices). Manager Pate agreed and would like to get a professional opinion from the consultant. Manager Pate asked the Commissioners to study the information given.

Commissioner Hessburg motioned to adjourn. Commissioner Reppas seconded. All agreed, none opposed. Meeting was adjourned at 8:29 pm.

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**City of Leavenworth**
**Planning Commission Meeting**
**April 6, 2016 (Wednesday)**
**7:00 PM**
**City Hall – Council Chambers**

# MINUTES

The meeting was called to order at 7:00 PM

**Commission Members Present:** Andy Lane, Anne Hessburg, Chuck Reppas, Pete Olsen, Larry Hayes & Scott Bradshaw

**Staff Present:** Nathan Pate, Development Services

## Introduction:

- Planning Commission seeking feedback on the topic of short term rentals in the residential areas.
- Short term rental means occupancy for less than 30days (nightly, daily, or weekly rental)
- Short term rentals are not currently allowed in the Residential Zoning Districts in the City or UGA.
- Short term rentals are allowed in the Commercial Zoning Districts.
- Excepting Manson, Chelan County allows short term rentals in the residential districts.

## Questions to spark a dialogue:

The meeting included questions to spark conversation, and are being explored which included:

- Should short term rentals be allowed in residential neighborhoods?
- What does a neighborhood look like? Is there a concern for the loss of community character with the addition of this use?
- What implications are there with short term rentals; noise, parties, and parking/too many vehicles.
- If short term / overnight rentals are allowed with a Business License, what needs to be included in licensing? For example, regular inspection for rental properties, with penalties for landlords who crowd more occupants in than the City allows?
- Are there areas within the community that would be more appropriate for short-term / overnight rentals?

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**Public Comments:**

- Enforce the existing Code. Why bother with new regulations if no strong enforcement occurs.
- Owner occupied. This adds a level of self-policing.
- No snow removal.
- Hire maintenance service.
- Need off-street parking. No street parking. There is a parking shortage.
- Cap the maximum number of occupancy.
- Notice control.
- Must meet fire standards and be safe.
- Residential short term rentals in single family residence updates to meet the IBC for commercial use.
- Possible loss of services.
- Enforcement – strong penalties and fines for violations
- Property management.
- The owner wants a showcase for the property to be inviting for rental. Seen as kept up and pleasant to visit – encouraging the rental of the property.
- Rentals pay their share, and funds / revenue to pay for enforcement, inspections, and public improvements (streets and more) … Tax the operations to pay their way to protect neighborhoods.
- Inspections – safety and meeting standards, and violators.
- The Building Codes must be met for this use with codes that control impacts. Require that the home is owner occupied (30% or more).
- If vesting is available, such will need to be addressed.
- Comment on case law. (follow-up: cases (Chiwawa Communities Assn. and Acquavela) confirmed that the two cases relate to CC&Rs (a private restriction on land use), not to city regulation of land use. In other words, the City can regulate vacation rentals - as stated - that the City Attorney has already determined).
- There should not be cars on the streets, and increased traffic will need to be the responsibility of the new rental uses.
- Neighborhood character is made up of: families, kids, maintained property, consideration for neighbors, little noise, available parking, sense of community and vested interest, long term renters or property owners, access to emergency services (safe community), controlled traffic, communications between neighbors, and diversity.
- With renters on "vacation," the attitude is that of being on "vacation," and is disruptive in a residential neighborhood. These are strangers to the area who do not have respect for

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the folks living there, need to wake early to go to work, have children playing (and seeing "peeing in the bushes"), and have the attitudes of "what happens in Vegas stays in Vegas" rather than behaving as good neighbors at their home. It is a differing attitude and behavior (drunkenness, loud, discourteous, belligerent, profanity).

- It is unsafe (strangers, trespass, and altered behavior).
- This new market of short term rentals will be an economic driver to housing. This will create an incentive to convert residential housing (with very limited existing stock) to short term rentals pushing the community living in Leavenworth out.
- Today it is hard to purchase a home due to high housing prices. With short term rental option (which is a money maker for outside entities), the housing prices could skyrocket outside of the range of folks working and living here. The wages here (in Leavenworth and the valley) cannot compete with wages from Seattle…. So, outside buyers that are looking for commercial (money making property) property with a good tourist economy will look to our neighborhoods…. Rather than Commercially Zoned and appropriate lands.
- Short term rentals will erode our neighborhood, and (allowing new regulations) will exacerbate this impact.
- Short term rental units will create a "lack of community."
- High housing prices will just be higher.
- Enforcement is critical. Permit tracking and monitory needs to be responsive (current and useful) and available to public. License or permit is needed.
- Coordination with the Police and follow-up (consequences) for violations are necessary.
- Police can be called 24-7. Property owners can't be called, no one knows how to get hold of them, or they simply do not care.
- Property owners do want to be good neighbors.
- There is damage and litter from short term rentals that neither the renter or owner are accountable. (trash – broken bottles)
- Bad neighbors and bad behavior can occur regardless of the time living in a home. The remedies already exist with disturbances by calling the Sheriff's Office.
- This can be solved – don't allow short term rentals.
- Limiting the size of lots does not make sense. This is an equality topic.
- If smaller lot sizes to add to housing densities that encourage stronger residential neighborhoods are in place to encourage long term home owners is the question, than that makes sense. There needs to be more incentives to encourage long term housing and strengthen neighborhoods. (opposite of that of short term rental).
- On-site parking must be required, and this will limit short term rental density as lots will need to be large enough to have the parking. Parking related to occupancy must be enforced, and the owner responsible.
- Health aspects need to be strong and enforced.

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- There needs to policy for homes full of long term residency that builds stability and a sense of “neighborhood”
- The market will change, and there is no way to hold back this trend for “air B&B” or other short term rental. It is change.
- Support the commercial enterprise where it works. If you open this commercial activity in neighborhoods, there will be folk buying up homes and converting them to short term rentals. Also, the infrastructure for commercial areas can support commercial uses. For example, streets, sidewalks and more.
- Seniors and folks with fixed income are in jeopardy of losing their home or being able to live here. Priced out of their home. Don’t create new laws that will infringe upon folks who live here. I live in a residential neighborhood, bought (chose) a home in an area that is for residents, expect and enjoy typical residential activity, and not of commercial (ruckus??). I know and choose to live in a residential area. If you want commercial property, buy and choose commercial land.
- Property rights need to be maintained.
- Empty nesters need income, and renting a room or two allows for income to keep the house.
- Permit fees can be revenue for the City.
- Enforce what is existing, and keep the regulations as they are. There is a process for B&Bs. This is an option. Update the B&B codes.
- As levies are passed absentee owners vote where their primary residence is located, and have to pay taxes of the levy. 40% of housing in the Leavenworth area is absentee or second homes.
- If you want be to commercial, rezone your property rather than just allowing short term rentals in residentially zoned areas.
- Balance between residential and commercial uses.
- Leavenworth is unique. The residential codes that protect long term housing is an island in Chelan County. Protect this uniqueness.
- Does your bank loan change when you convert from a residential loan to a short term rental property (commercial loan)? City has no jurisdiction regarding finances or sales of lands.

Commissioner Hessburg motioned to adjourn. Commissioner Reppas seconded. All agreed, none opposed. Meeting was adjourned at 8:30 pm.

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