RANGE	TOWNSHIP	SECTION	QUARTER	100	1/74
04E-	20 N-	28	01		
DOCUMENT NUMBER				SERIAL NUMBER	PAGE NUMBER

CHICAGO TITLE
COMPANY OF WASHINGTON
NATIONAL COMMERCIAL SERVICES

701 5th Avenue, Suite 2700
Seattle, WA 98104
Phone: (206)628-5610 / Fax: (206)628-9717

City Clerk
City of Puyallup
333 South Meridian
Puyallup, WA 98371

Date: April 27, 2023
Order No.: STACCOMM0323-SC-KR
Seller(s):

To Whom It May Concern:

In connection with the above referenced transaction, please find the following enclosed:

- Storm Management & BMP Facilities Agreement (electronically recorded under 202304270102)

We appreciate the opportunity of being of service to you. If we can be of further assistance, please feel free to call upon us.

Sincerely,

Katie Raynor

Katie Raynor
Title Officer
Katie.Raynor@ctt.com

Enclosure(s)

RANGE	TOWNSHIP	SECTION	QUARTER		
04E-	20 N-	28	01	100	2/74
DOCUMENT NUMBER				SERIAL NUMBER	PAGE NUMBER

202304270102
Electronically Recorded
Pierce County, WA ACLARK1
04/27/2023 9:16 AM
Pages: 72 Fee: $274.50

After recording return to:

City Clerk
City of Puyallup
333 South Meridian
Puyallup, WA 98371

info@puyallupwa.gov

CHICAGO TITLE INSURANCE COMPANY has placed the document of record as a customer courtesy and accepts no liability for the accuracy or validity of the document.

Document Title: Stormwater Outfall Management & BMP Facilities Agreement
Grantee: City of Puyallup
Grantor: CENTRAL PUGET SOUND REGIONAL TRANSIT AUTHORITY
Legal Description: S 1/2 OF THE NE 1/4 OF SECTION 28 AND THE SW 1/4 OF THE NW 1/4 AND NW 1/4 OF THE SW 1/4 OF SECTION 27, TOWNSHIP 20N, R4E
Complete Legal Description on 1 **Page of this Document**
Assessor's Tax Parcel or Account Numbers: 5870000110, 5870000140, 5870000130, 5870000120, 0420281171
Reference Number of Related Document(s): *Permit E20-0504 (DP2) Sound Transit Puyallup Station Improvements

Stormwater Management & BMP Facilities Agreement

A. **Parties.** The parties to this agreement are Grantee City of Puyallup, a Washington State municipal corporation (City), and Grantor landowner CENTRAL PUGET SOUND REGIONAL TRANSIT AUTHORITY (Landowner).

B. **Property.** Landowner is the owner of certain real property (Property), which is legally described in this document and is located at the following address: 505 2nd NW, Puyallup, WA 98371.

C. **Development Plan & Stormwater Facilities.** The site, subdivision or other development plan (Plan) for the Property, specifically known, entitled or described as Sound Transit Puyallup Station Parking Garage, provides for detention, retention, treatment or management of stormwater that is associated with the Property through the use of identified stormwater facilities or best management practices (collectively, Stormwater Facilities). Upon approval of the Plan by the City, the Plan shall be incorporated herein by this reference. In accordance with the Plan, Landowner shall adequately construct, operate, use, maintain and repair the Stormwater Facilities.

RANGE	TOWNSHIP	SECTION	QUARTER		
04E-	20 N-	28	01	100	3/74
DOCUMENT NUMBER				SERIAL NUMBER	PAGE NUMBER

After recording return to:

City Clerk
City of Puyallup
333 South Meridian
Puyallup, WA 98371

info@puyallupwa.gov

Document Title: Stormwater Outfall Management & BMP Facilities Agreement
Grantee: City of Puyallup
Grantor: CENTRAL PUGET SOUND REGIONAL TRANSIT AUTHORITY
Legal Description: S 1/2 OF THE NE 1/4 OF SECTION 28 AND THE SW 1/4 OF THE NW 1/4 AND NW 1/4 OF THE SW 1/4 OF SECTION 27, TOWNSHIP 20N, R4E
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RANGE	TOWNSHIP	SECTION	QUARTER	100	4/74
04E-	20 N-	28	01		
DOCUMENT NUMBER				SERIAL NUMBER	PAGE NUMBER

D. Agreement. On the terms and conditions set forth herein, the City and Landowner agree as follows:

1. The Stormwater Facilities shall be constructed, operated, used, maintained and repaired by Landowner in accordance with the requirements of the Plan, and any other applicable law or regulation.
2. Landowner (which expressly includes its agents, successors and assigns, including any homeowners association) shall adequately and properly operate, use, maintain and repair the Stormwater Facilities as described in the maintenance and operations manual, which is on file with the City, and may be attached and recorded herewith as Exhibit A. This duty extends to all associated pipes and channels, as well as all structures, improvements, and vegetation that are provided to control the quantity and quality of the stormwater. Adequate maintenance shall mean maintenance that is sufficient to keep the Stormwater Facilities in good working order and operating so as to satisfy the design and performance standards of the Plan.
3. Landowner shall regularly inspect the Stormwater Facilities and shall submit an inspection report to the City at least once a year on a date prescribed by the City. The purpose of the inspection(s) is to ensure that the Stormwater Facilities are safe and functioning properly. The scope of the inspection shall include the entire Stormwater Facilities, including but not limited to, berms, outlet structures, pond areas, access roads, and so forth. Deficiencies and any performance or other related issues shall be noted by Landowner in the inspection report. The annual report shall be in a form and include content as prescribed from time to time by the City. An example copy of the report form may be attached hereto as Exhibit B.
4. Landowner hereby grants permission to the City to enter upon the Property to inspect the Stormwater Facilities. Except in case of emergency, the City shall provide Landowner with at least forty-eight (48) hours written notice prior to entering on to the Property. Landowner shall be entitled to have a representative accompany the City during such inspection. The City shall provide Landowner with copies of written inspection reports.
5. If Landowner fails to adequately and properly operate, use, maintain or repair the Stormwater Facilities, the City shall notify Landowner in writing and provide Landowner with a reasonable opportunity to cure. If Landowner fails to timely cure, then the City may enter upon the Property and remedy the issue(s) identified in the notice and those reasonably related thereto; Furthermore, if the City performs work of any nature, or expends any funds in performance of said work for labor, use of equipment, supplies, materials, and the like while remedying the identified issues, the City may charge the cost of the remedy to Landowner, and Landowner shall promptly pay the costs to the City. Notwithstanding the foregoing, the City shall be under no obligation to inspect, maintain or repair the Stormwater Facilities.
6. Landowner shall defend, indemnify and hold the City, its officers, officials, employees and volunteers harmless from any and all claims, injuries, damages, losses or suits including attorney fees, arising out of or in connection with activities or operations, performed by Landowner, or on Landowner's behalf, that relate to the Stormwater Facilities and the subject matter of this agreement, except for injuries and damages caused by the negligence of the City.

RANGE	TOWNSHIP	SECTION	QUARTER	100	5/74
04E-	20 N-	28	01		
DOCUMENT NUMBER				SERIAL NUMBER	PAGE NUMBER

E. Covenant. The terms and provisions of this agreement constitute a covenant, which is subject to the following: This covenant is an equitable covenant. It touches and concerns the land that is described as the Property herein. The parties intend that this covenant shall bind the parties' successor and assigns. This covenant shall run with the land that is described as the Property herein, and shall bind whoever has possession of the land, in whole or in part, without regard to whether the possessor has title, or has succeeded to the same estate that granting parties have or had. Possessors shall include, but are not limited to, leasehold tenants, contract purchasers, subtenants, and adverse possessors. This covenant shall run with the land even in the absence of the transfer of some interest in land, other than the covenant itself, between Landowner and the City. This covenant shall not be governed by the mutuality rule. The burden of the covenant can run independently from the benefit of the covenant, and the benefit need not run. The benefit may be in gross or personal to Landowner or the City. Landowner waives its right to assert any defenses to the enforcement of this covenant, including, but not limited to, the change of neighborhood doctrine, laches, estoppel, balancing of hardships, and abandonment. If Landowner breaches any term of this covenant and agreement, then all remedies in equity and at law, including, but not limited to, injunctions, mandamus, declaratory judgments, and damages, shall be available to the City.

F. Governing Law & Venue. This agreement shall be governed by and construed in accordance with the laws of the State of Washington. The venue for any action that arises from or out of this instrument shall be the Pierce County Superior Court.

<signature page to follow>

RANGE	TOWNSHIP	SECTION	QUARTER	100	6/74
04E-	20 N-	28	01		
DOCUMENT NUMBER				SERIAL NUMBER	PAGE NUMBER

Dated: 4/11/2023

Grantor

Dated: 4/11/2023

DocuSigned by:
Hans Hunger
1D7EB0CED63645D...

Grantee: City of Puyallup, Accepted by:
Hans Hunger, PE (City Engineer)

Dated: 3/22/2023

DocuSigned by:
Joseph N Beck
EF5BA5DC2E5544B...

Approved as to form:
Joseph N. Beck (City Attorney)

STATE OF WASHINGTON)
) -ss
COUNTY OF King)

I certify that I know or have satisfactory evidence that Faith A. Roland is the person who appeared before me, and on April 11, 2023 said person acknowledged that he or she signed this instrument, on oath stated that he or she was authorized to execute the instrument and acknowledged it as the Director of Real Property to be the free and voluntary act of such party for the uses and purposes mentioned in the instrument.

Dated: 04/11/2023

Printed Name: Zack Parkins
Notary Public, State of Washington
My appointment expires: 04/22/2026

ZACK PARKINS
NOTARY PUBLIC
STATE OF WASHINGTON
COMMISSION EXPIRES
License No. 22018905
04-22-2026

RANGE	TOWNSHIP	SECTION	QUARTER	100	7/74
04E-	20 N-	28	01		
DOCUMENT NUMBER				SERIAL NUMBER	PAGE NUMBER

Exhibit A

OPERATION AND MAINTENANCE MANUAL

The stormwater runoff from the surface parking lot is collected by drainage structures and routed through underground pipes to media filter treatment facilities and then discharged to the public storm system. The drainage from the parking garage is routed to an on-site bioretention system via roof downspout and discharges to the public storm system via underdrains. See project stormwater report for a more detailed description and facility sizing calculations.

The proposed Vortechs Vault and the flow control manhole in the East abutment parking lot is a replacement in kind for the existing treatment facility and flow control structure, which had to be relocated to accommodate the pedestrian bridge and staircase to the east of the 5th Street NW.

The maintenance standards for stormwater BMPs included in this Attachment are per the City of Puyallup Site Management Plan for Stormwater Operations and Maintenance, including for bioretention, catch basins, oil/water separator, compost amended soils, manholes, flow control structures, conveyance pipes, media filters, hydrodynamic separator's, grounds and vegetation. The manufacturer's recommendations for the maintenance requirements and schedules of the proprietary treatment facilities (Contech Stormfilters) are also included.

Sound Transit will maintain the on-site stormwater facilities and the contact information is as follows,

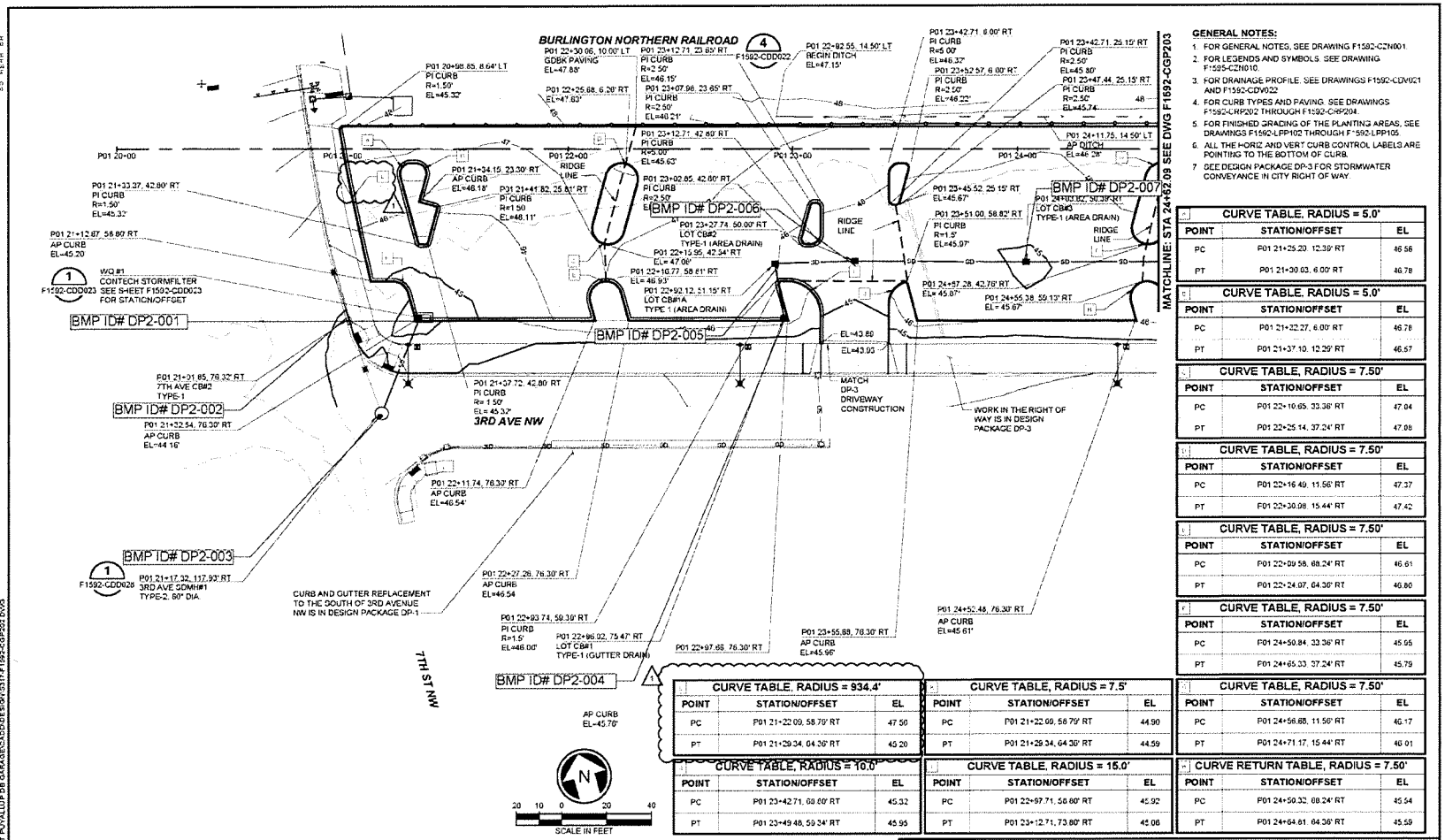
Presley Morrissey
Manager – Facilities Maintenance
Operations Department
Sound Transit
401 S Jackson St
Seattle, WA 98104

Phone: 206-398-5000
facmaintenance@soundtransit.org

The stormwater facilities proposed in the Public right of way as a part of frontage improvements and minor street improvements will be maintained by the City of Puyallup.

See following pages for a list of project stormwater facilities and drainage plan sheets showing the locations of the facilities.

BMP ID#	BMP FACILITY DESCRIPTION	PLAN SHEET
DP2-001	CONTECH STORMFILTER WQ#1	F1592-CGP202
DP2-002	7TH AVE TYPE-1 CB#2	
DP2-003	3RD AVE 60" DIA. TYPE-2 SDMH#1	
DP2-004	LOT COP GUTTER DRAIN TYPE-1 CB#1	
DP2-005	LOT COP AREA DRAIN TYPE-1 CB#1A	
DP2-006	LOT COP AREA DRAIN TYPE-1 CB#2	
DP2-007	LOT COP AREA DRAIN TYPE-1 CB#3	
DP2-008	LOT COP AREA DRAIN TYPE-1 CB#4	F1592-CGP203
DP2-009	LOT COP AREA DRAIN TYPE-1 CB#5	
DP2-010	WEST BIORETENTION UNIT	
DP2-011	LOT CB#10	
DP2-012	2ND AVE WSDOT TYPE-1 CB#2	
DP2-013	EAST BIORETENTION UNIT	
DP2-014	LOT CB#11	
DP2-015	2ND AVE COP GUTTER DRAIN TYPE-1 CB#4	
DP2-016	LOT 48" DIA. TYPE-2 SDMH#1	
DP2-017	LOT 48" DIA. TYPE-2 SDMH#2	
DP2-018	CONTECH STORMFILTER WQ#2	
DP2-019	5TH ST 60" TYPE-2 CB#8	
DP2-020	EAST LOT 60" TYPE-2 SDMH#1	
DP2-021	EAST LOT 60" TYPE-2 SDMH#2	
DP2-022	CONTECH STORMFILTER WQ#4	
DP2-023	EAST LOT 48" TYPE-2 CB#4	
DP2-024	EAST LOT COP FLOW CONTROL W/ FLAT TOP SDMH#5	F1592-CGP204
DP2-025	EAST LOT 72" TYPE-2 CB#3	
DP2-026	VORTECH VAULT	



GENERAL NOTES:

1. FOR GENERAL NOTES, SEE DRAWING F1592-CZN001.
2. FOR LEGENDS AND SYMBOLS, SEE DRAWING F1595-CZN010.
3. FOR DRAINAGE PROFILE, SEE DRAWINGS F1592-CDV021 AND F1592-CDV022.
4. FOR CURB TYPES AND PAVING, SEE DRAWINGS F1592-CRP202 THROUGH F1592-CRP204.
5. FOR FINISHED GRADING OF THE PLANTING AREAS, SEE DRAWINGS F1592-LPP102 THROUGH F1592-LPP105.
6. ALL THE HORIZ AND VERT CURB CONTROL LABELS ARE POINTING TO THE BOTTOM OF CURB.
7. SEE DESIGN PACKAGE DP-3 FOR STORMWATER CONVEYANCE IN CITY RIGHT OF WAY.

CURVE TABLE, RADIUS = 5.0'		
POINT	STATION/OFFSET	EL
PC	P01 21+25.20, 12.39' RT	46.56
PT	P01 21+30.03, 6.00' RT	46.78

CURVE TABLE, RADIUS = 5.0'		
POINT	STATION/OFFSET	EL
PC	P01 21+32.27, 6.00' RT	46.78
PT	P01 21+37.10, 12.29' RT	46.57

CURVE TABLE, RADIUS = 7.50'		
POINT	STATION/OFFSET	EL
PC	P01 22+10.65, 33.36' RT	47.04
PT	P01 22+25.14, 37.24' RT	47.06

CURVE TABLE, RADIUS = 7.50'		
POINT	STATION/OFFSET	EL
PC	P01 22+16.49, 11.56' RT	47.37
PT	P01 22+30.98, 15.44' RT	47.42

CURVE TABLE, RADIUS = 7.50'		
POINT	STATION/OFFSET	EL
PC	P01 22+09.58, 68.24' RT	46.61
PT	P01 22+24.07, 64.36' RT	46.80

CURVE TABLE, RADIUS = 7.50'		
POINT	STATION/OFFSET	EL
PC	P01 24+50.84, 33.36' RT	45.95
PT	P01 24+65.33, 37.24' RT	45.79

CURVE TABLE, RADIUS = 934.4'		
POINT	STATION/OFFSET	EL
PC	P01 21+22.09, 58.79' RT	47.56
PT	P01 21+29.34, 64.36' RT	45.20

CURVE TABLE, RADIUS = 7.5'		
POINT	STATION/OFFSET	EL
PC	P01 21+22.69, 58.79' RT	44.90
PT	P01 21+29.34, 64.36' RT	44.59

CURVE TABLE, RADIUS = 7.50'		
POINT	STATION/OFFSET	EL
PC	P01 24+56.68, 11.56' RT	46.17
PT	P01 24+71.17, 15.44' RT	46.01

CURVE TABLE, RADIUS = 10.0'		
POINT	STATION/OFFSET	EL
PC	P01 23+42.71, 68.60' RT	45.32
PT	P01 23+49.48, 59.34' RT	45.95

CURVE TABLE, RADIUS = 15.0'		
POINT	STATION/OFFSET	EL
PC	P01 22+97.71, 58.60' RT	45.92
PT	P01 23+12.71, 73.80' RT	45.06

CURVE RETURN TABLE, RADIUS = 7.50'		
POINT	STATION/OFFSET	EL
PC	P01 24+50.32, 68.24' RT	45.54
PT	P01 24+64.81, 64.06' RT	45.59

ISSUED FOR CONSTRUCTION

No.	DATE	DSN	CHK	APP	REVISION
0	03/02/2021	SGR	JGM	JGM	ISSUED FOR CONSTRUCTION

DESIGNED BY: S. GUJULUVA RAJAN
DRAWN BY: J. CURTIS
CHECKED BY: E. MENDEL
APPROVED BY: J. MATTHEWS

kpff — SUBMITTED BY: SARA ROBERTS — DATE: 03/02/2021

HENSEL PHELPS — kpff — REVIEWED BY: GREG SHIMIZU — DATE: 03/02/2021

LINE IS 1" AT FULL SCALE

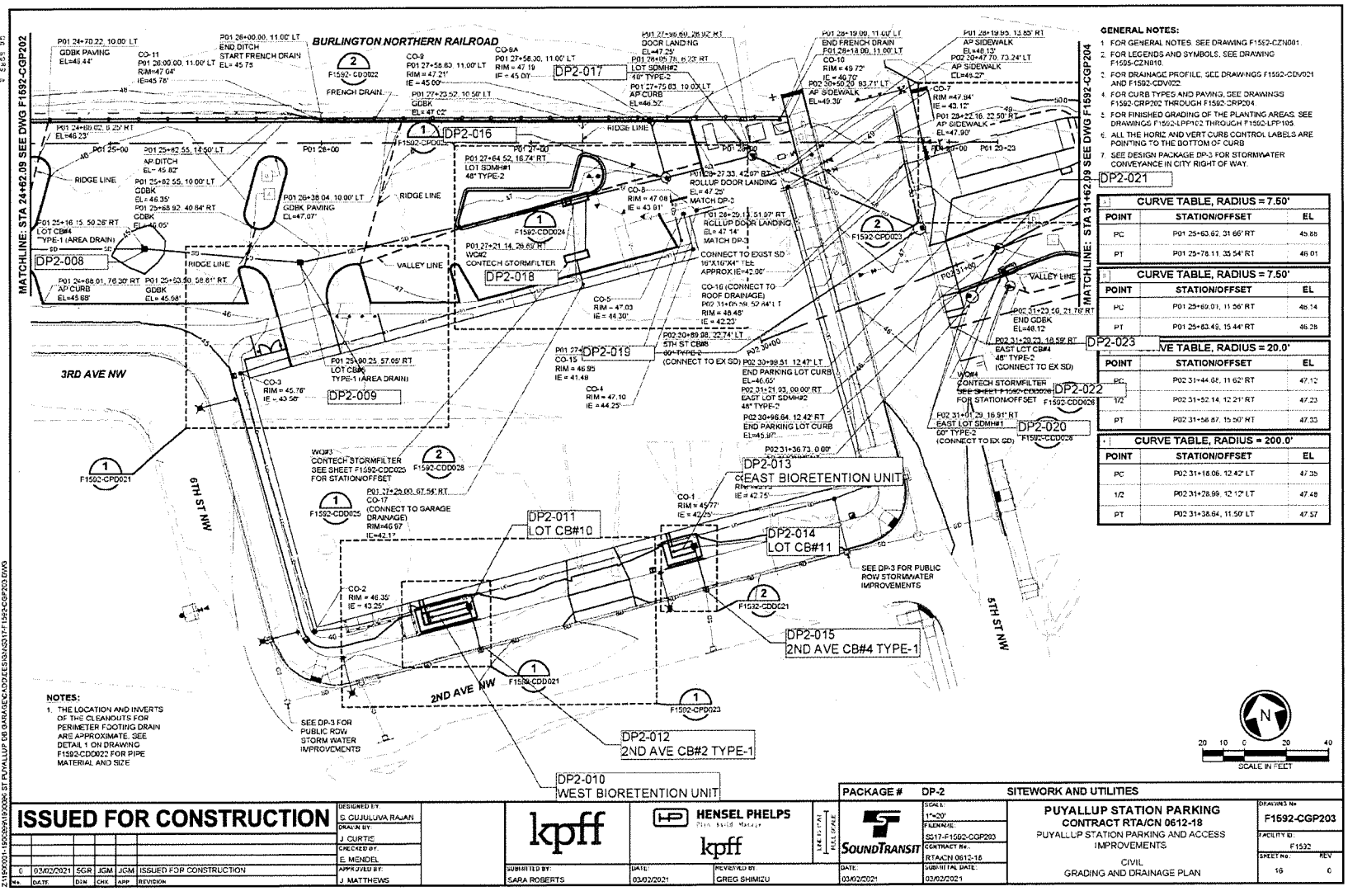
SOUNDTRANSIT — SCALE: 1"=20' — FILENAME: E317-F1592-CGP202 — CONTRACT NO.: RTA/CN 0612-18 — SUBMITTAL DATE: 03/02/2021

PACKAGE # DP-2 SITEWORK AND UTILITIES

PUYALLUP STATION PARKING
CONTRACT RTA/CN 0612-18
PUYALLUP STATION PARKING AND ACCESS IMPROVEMENTS
CIVIL
GRADING AND DRAINAGE PLAN

DRAWING No.: F1592-CGP202
FACILITY ID: F1592
SHEET No.: 15
REV: 0

DOCUMENT NUMBER	RANGE	TOWNSHIP	SECTION	QUARTER	SERIAL NUMBER	PAGE NUMBER
	04E-	20 N-	28	01	100	10/74



GENERAL NOTES:

1. FOR GENERAL NOTES, SEE DRAWING F1592-CZN001.
2. FOR LEGENDS AND SYMBOLS, SEE DRAWING F1592-CZN810.
3. FOR DRAINAGE PROFILE, SEE DRAWINGS F1592-CDV021 AND F1592-CDV022.
4. FOR CURB TYPES AND PAVING, SEE DRAWINGS F1592-CRP202 THROUGH F1592-CRP204.
5. FOR FINISHED GRADING OF THE PLANTING AREAS, SEE DRAWINGS F1592-LPP102 THROUGH F1592-LPP105.
6. ALL THE HORIZ AND VERT CURB CONTROL LABELS ARE POINTING TO THE BOTTOM OF CURB.
7. SEE DESIGN PACKAGE DP-3 FOR STORMWATER CONVEYANCE IN CITY RIGHT OF WAY.

CURVE TABLE, RADIUS = 7.50'		
POINT	STATION/OFFSET	EL
PC	P01 25+63.62, 31.66' RT	45.88
PT	P01 25+78.11, 35.54' RT	46.01

CURVE TABLE, RADIUS = 7.50'		
POINT	STATION/OFFSET	EL
PC	P01 25+69.01, 11.56' RT	46.14
PT	P01 25+83.48, 15.44' RT	46.28

CURVE TABLE, RADIUS = 20.0'		
POINT	STATION/OFFSET	EL
PC	P02 31+44.68, 11.62' RT	47.12
1/2	P02 31+52.14, 12.21' RT	47.23
PT	P02 31+58.87, 15.50' RT	47.33

CURVE TABLE, RADIUS = 200.0'		
POINT	STATION/OFFSET	EL
PC	P02 31+18.06, 12.42' LT	47.35
1/2	P02 31+28.99, 12.12' LT	47.48
PT	P02 31+38.64, 11.50' LT	47.57

NOTES:

1. THE LOCATION AND INVERTS OF THE CLEANOUTS FOR PERIMETER FOOTING DRAIN ARE APPROXIMATE. SEE DETAIL 1 ON DRAWING F1592-CDD022 FOR PIPE MATERIAL AND SIZE

ISSUED FOR CONSTRUCTION

0	03/02/2021	SGR	JGM	JGM	ISSUED FOR CONSTRUCTION	
No.	DATE	DSN	CHK	APP	REVISION	

DESIGNED BY: S. GUJULUVA RAJAN
DRAWN BY: J. CURTIS
CHECKED BY: E. MENDEL
APPROVED BY: J. MATTHEWS

kpff — SUBMITTED BY: SARA ROBERTS — DATE: 03/02/2021

HENSEL PHELPS — kpff — REVIEWED BY: GREG SHIMIZU — DATE: 03/02/2021

SOUNDTRANSIT — SUBMITTAL DATE: 03/02/2021

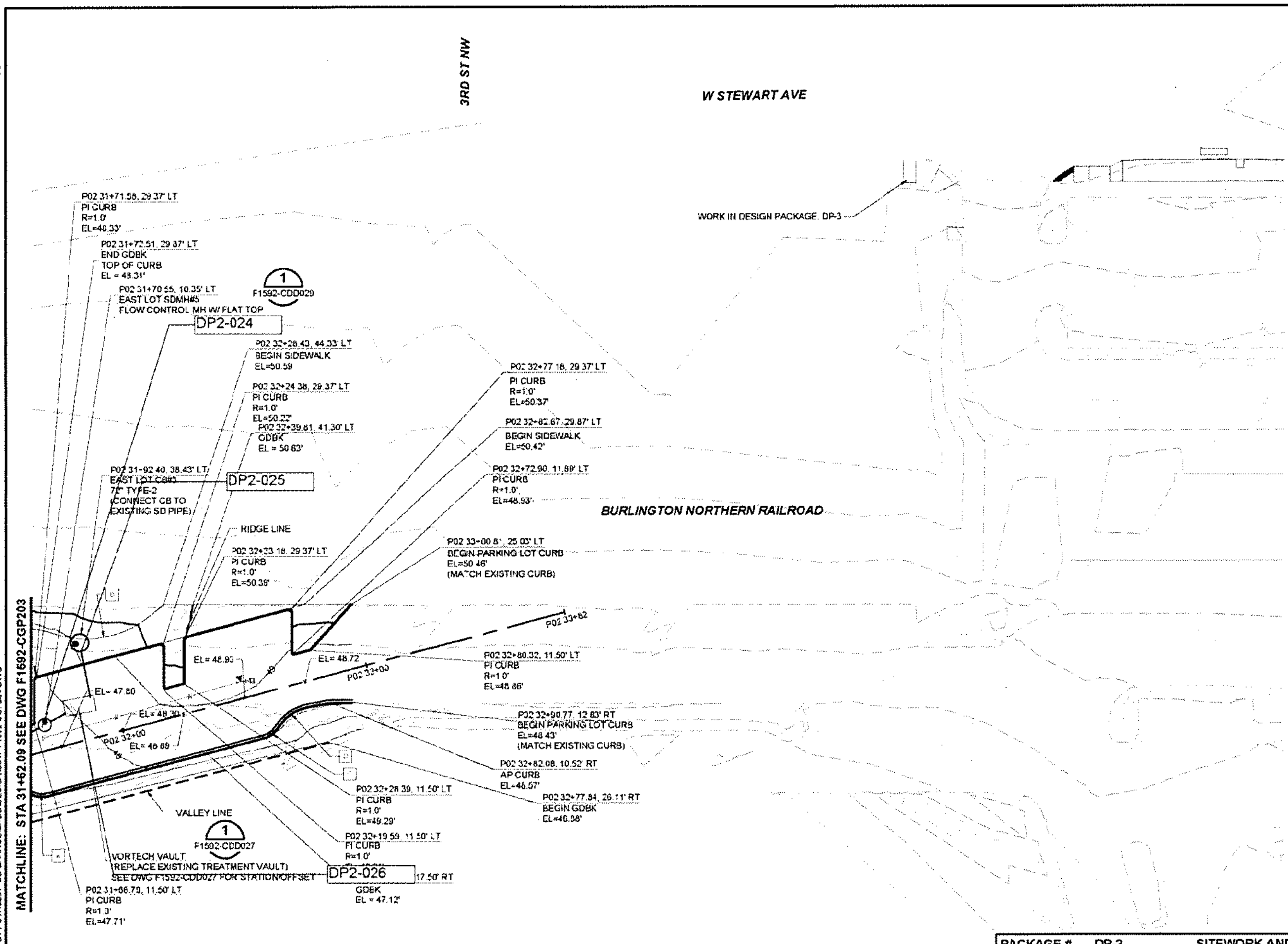
PACKAGE #	DP-2
	SITEWORK AND UTILITIES
SCALE:	1"=20'
FILENAME:	SS17-F1592-CGP203
CONTRACT No.:	RTA/CN 0612-18

PUYALLUP STATION PARKING
CONTRACT RTA/CN 0612-18
PUYALLUP STATION PARKING AND ACCESS IMPROVEMENTS
CIVIL
GRADING AND DRAINAGE PLAN

DRAWING No: F1592-CGP203
FACILITY ID: F1592
SHEET No.: 16
REV: 0

DOCUMENT NUMBER	SERIAL NUMBER	PAGE NUMBER
RANGE: 04E-	TOWNSHIP: 20 N-	SECTION: 28	QUARTER: 01
	100	11/74

RANGE	TOWNSHIP	SECTION	QUARTER		
04E-	20 N-	28	01	100	12/74
DOCUMENT NUMBER				SERIAL NUMBER	PAGE NUMBER



GENERAL NOTES:

1. FOR GENERAL NOTES, SEE DRAWING F1592-CZN001
2. FOR LEGENDS AND SYMBOLS, SEE DRAWING F1595-CZN010
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7. SEE DESIGN PACKAGE DP-3 FOR STORMWATER CONVEYANCE IN CITY RIGHT OF WAY

CURVE TABLE, RADIUS = 10.0'

POINT	STATION/OFFSET	EL
PC	P02 31+58.87, 15.50' LT	47.33
FT	P02 31+04.87, 17.50' RT	47.42

CURVE TABLE, RADIUS = 40.0'

POINT	STATION/OFFSET	EL
PC	P02 31+82.81, 45.04' LT	49.77
1/2	P02 32+02.19, 38.02' LT	49.46
FT	P02 32+22.48, 41.56' LT	50.23

CURVE TABLE, RADIUS = 10.0'

POINT	STATION/OFFSET	EL
PC	P02 32+52.87, 17.30' RT	45.54
FT	P02 32+59.53, 14.95' RT	45.59

CURVE TABLE, RADIUS = 20.0'

POINT	STATION/OFFSET	EL
PC	P02 32+59.53, 14.95' RT	45.59
1/2	P02 32+66.46, 10.91' RT	45.63
FT	P02 32+74.42, 9.92' RT	45.65

PACKAGE # DP-2 SITEWORK AND UTILITIES

ISSUED FOR CONSTRUCTION

NO.	DATE	BY	CHK	APP	REVISION
0	03/02/2021	SGR	JGM	JGM	ISSUED FOR CONSTRUCTION

DESIGNED BY: S GUJULUVA RAJAN
DRAWN BY: J CURTIS
CHECKED BY: E. MENDEL
APPROVED BY: J MATTHEWS

kpff — SUBMITTED BY: SARA ROBERTS — DATE: 03/02/2021

HENSEL PHELPS — kpff — REVIEWED BY: GREG SHIMIZU

SOUNDTRANSIT — DATE: 03/02/2021

SCALE: 1"=20'
FILE NAME: 5317-F1592-CGP204
CONTRACT NO: RTA/CN 0612-18
SUBMITTAL DATE: 03/02/2021

PUYALLUP STATION PARKING
CONTRACT RTA/CN 0612-18
PUYALLUP STATION PARKING AND ACCESS IMPROVEMENTS
CIVIL
GRADING AND DRAINAGE PLAN

DRAWING NO: F1592-CGP204
FACILITY ID: F1592
SHEET NO: 17 REV: 0

APPENDIX A

Operation and Maintenance Standards

- Primarily from Clark County Stormwater Manual, *Book 4 Stormwater Facility Operations and Maintenance* (Clark County, 2021, LINK)
- Supplemental material from:
    - *King County Surface Water Design Manual* (King County, 2021, LINK)
    - *Roadside Ditch Maintenance in Western Washington* (King County, Ecology, and Herrera, 2019, LINK)
    - *Hydraulic Engineering Circular No. 24: Highway Stormwater Pump Station Design* (Federal Highway Administration, 2001, LINK)
    - Inspection Guidelines for Modular Wetland System – Linear (Modular Wetlands, LINK)

Access Road and Easement

Many stormwater facilities have access roads to bring in heavy equipment for facility maintenance. These roads should be maintained for inspection access and ease of equipment access.

All facilities should allow access for the inspection process.

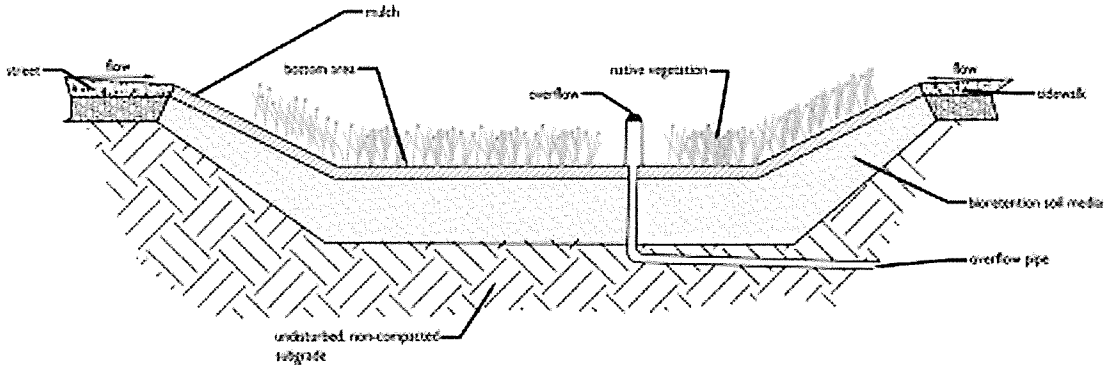
The easement area should not consist of bare soil. Bare soil areas may generate higher levels of stormwater runoff and increase erosion and sedimentation in stormwater facilities. The following checklist gives some general guidance for management.

Bioretention System

Bioretention facilities are engineered facilities that store and treat stormwater by filtering it through a specified soil profile. Water that enters the facility ponds in an earthen depression or other basin (e.g., concrete planter) before it infiltrates into the underlying bioretention soil. Stormwater that exceeds the surface storage capacity overflows to an adjacent drainage system. Treated water is either infiltrated into the underlying native soil or collected by an underdrain and discharged. An underdrain system can be comprised of perforated or slotted pipe, wrapped in an aggregate blanket.

Facility objects that are often associated with a bioretention unit include:

- Inlet
- Overflow
- Underdrains (optional)
- Signage
- Catch Basin
- Drywell



Key Operations and Maintenance Considerations

- Protect the facility from external loads (e.g. trucks, riding mowers, other heavy equipment) to preserve the proper function of bioretention soils. Because the risk of compaction is higher when soils are saturated, any type of loading in the bioretention facility (including foot traffic) should be avoided during wet conditions. All maintenance activities must be performed in a manner to prevent compaction of the bioretention soil.
- Erosion control measures must be maintained in areas of concentrated flows (e.g., pipes inlets or narrow curb cuts). Inspect flow entrances, ponding area, and surface overflow areas periodically, and replace soil, plant material, and/or mulch layer in areas if erosion has occurred. Properly

designed facilities with appropriate flow velocities should not have erosion problems except perhaps in extreme events. If erosion problems occur, the following should be reassessed:

- (1) flow volumes from contributing areas and bioretention cell sizing; (2) flow velocities and gradients within the cell; and (3) flow dissipation and erosion protection strategies in the pretreatment area and flow entrance. If sediment is deposited in the bioretention area, immediately determine the source within the contributing area, stabilize, and remove excess surface deposits.
- Establish and follow a maintenance schedule for visual inspection and remove sediment if the volume of the ponding area has been compromised.
- Corrective maintenance for excessive drawdown times may include clearing underdrain obstructions or tilling the bioretention soil media. Partial or complete replacement of bioretention soil media may be necessary.
- Regular maintenance of vegetation includes weeding and pruning. Plants require irrigation during the first 2 to 3 years of establishment and during extended dry periods. Replace all dead plants and, if specific plants have a high mortality rate, assess the cause and replace with appropriate species.
- The soil mix and plants are selected for optimum fertility, plant establishment, and growth. Nutrient and pesticide inputs should not be required and may degrade the pollutant processing capability of the bioretention area, as well as contribute pollutant loads to receiving waters. If in question, have soil analyzed for fertility.
- Replace mulch annually in bioretention facilities where heavy metal deposition is high (e.g., contributing areas that include gas stations, ports and roads with high traffic loads). In residential settings or other areas where metals or other pollutant loads are not anticipated to be high, replace or add mulch as needed (likely 3 to 5 years) to maintain a 2 to 3-inch depth.
- Soil mixes for bioretention facilities are designed to maintain long-term fertility and pollutant processing capability. Estimates from metal attenuation research suggest that metal accumulation should not present an environmental concern for at least 20 years in bioretention systems, but this will vary according to pollutant load. Replacing mulch media in bioretention facilities where heavy metal deposition is likely provides an additional level of protection for prolonged performance. If in question, have soil analyzed for fertility and pollutant levels.
- Presence of pests such as geese or rodents can generally be corrected by ensuring that drawdown time matches facility design function and plants are spaced at proper densities.
- If an underdrain is present, remove trash, debris, and sediment from the inlet orifice biannually.

- Irrigate or hand-water vegetation as needed to help plants establish in the first few years after installation and as needed after plants are established. The following schedule is recommended:
    - Provide watering weekly for two summers. On average, plants require 1-inch of water weekly to establish. Additional water may be necessary during excessive heat.
    - Provide summer watering every two to four weeks during the summer or as needed during prolonged dry periods.
    - Provided summer watering as needed after plants are established.

Refer to City of Puyallup Engineering and Construction Standards Section 600 for grass specifications and planting requirements.

Bioretention System			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
General	Pests	Signs of pest infestations (IPM protocol threshold(s) are exceeded), including rodent holes or mounds that disturb dispersion flow paths.	Pests are not present or engaged in activities that present a significant public health risk or compromise to the intended design function of the facility. Pests that have exceeded acceptable thresholds have been addressed using appropriate IPM measures. Standing water that may allow mosquito breeding has been removed and cause of standing water has been addressed (see "Ponded Water"). Pest-damaged vegetation has been removed.
Facility Area	Trash and Debris	Trash and debris present in facility area.	Facility area is free of trash and debris.
	Pet Waste	Large volumes of feces from domestic pets are present.	Pet waste removed. Pet waste station or additional signage installed, if appropriate.
	Mulch	Mulch depth is less than 2 inches or the facility has bare spots without mulch cover.	Mulch has been restored to a depth of 2 to 3 inches and is appropriate to the location within the facility (e.g. compost mulch in the bottom and wood chips on side slopes).
Facility Bottom Area	Sediment	Sediment accumulated to extent that infiltration rate is reduced, water can be seen to be ponding, or surface storage capacity is significantly impacted.	Source of sediment has been identified and controlled. Excess sediment has been removed, and damaged vegetation and mulch has been replaced.
	Leaves	After fall leaf drop, leaves have accumulated in the facility in a manner to pose a risk of impeding water flow or clogging the outlet.	Leaves have been removed.
	Ponded Water	Water overflows during storms smaller than the design event, or ponded water remains in the basin more than 48 hours after the end of a storm.	Cause of excessive ponding has been identified by investigating: 1) potential that debris build-up is impeding infiltration; 2) condition of underdrain (if present); 3) potential that other water inputs are present (e.g. groundwater, illicit connections); 4) facility size is appropriate to contributing area; and 5) condition of bioretention soil media.

Bioretention System			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
			Cause of excessive ponding has been corrected. Engineer has been consulted where necessary.
Earthen Side Slopes and Berms	Erosion at Inlets/ Outlets	Erosion (gullies/ rills) greater than 2 inches deep around inlets, outlet, and alongside slopes.	For channels or cuts over 3 inches deep, temporary erosion control measures have been put into place until permanent repairs are made. Source of erosion has been addressed/ eliminated and eroded areas repaired per design specifications, with additional stabilizing material (cobbles, vegetation, etc.) added as necessary.
	Erosion of Side Slopes	Erosion of sides causes slope to become a hazard.	Source of erosion has been addressed and side slopes repaired to design specifications. Slopes have stabilizing material where necessary.
	Settlement	Settlement greater than 3 inches (relative to undisturbed sections of berm).	Slopes and berm have been restored to design elevations/ heights.
	Berm Leaking	Downstream face of berm wet; seeps or leaks evident.	Any seeps or leaks have been plugged and berm material and compaction are per design specifications. Engineer has been consulted where necessary.
	Rodents in Berm	Any evidence of rodent holes or water piping in berm.	Rodents have been eradicated (see "Pests in Facility"). Holes have been filled and berm compacted (see "Berm Leaking").
Amended Soil	Soil Nutrients	Soil not providing plant nutrients.	Soil providing plant nutrients.
	Bare Spots	Bare spots on soil in bioretention area.	No bare spots. Bioretention area covered with vegetation or mulch mixed into the underlying soil.
	Compaction	Poor infiltration due to soil compaction in the bioretention area.	No soil compaction in the bioretention area.
Low Permeability Check Dams and Weirs	Sediment or Other Debris Blocking	Sediment, vegetation, or debris accumulated at or blocking (or having the potential to block) check dam, flow control weir or orifice.	No blockage present of check dam, flow control weir, or orifice. Any likely immediate sources of additional debris or sediment (e.g. additional dead plant material, erosion issue, etc. upstream) addressed or removed.
	Erosion or Undercutting	Erosion and/or undercutting present.	Eroded and/or undercut areas have been repaired and sources of issue addressed to prevent further erosion/undercutting at weir.
	Grade Board Not Level	Grade board or top of weir damaged or not level.	Grade board is undamaged (repaired or replaced) and level.

Bioretention System			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
Inlet	Erosion at Inlet	Concentrated flows are causing erosion at inlet.	A cover of rock or cobbles or other erosion protection measure (e.g., matting) is in place to protect the ground where concentrated water enters the facility (e.g., a pipe, curb cut or swale).
Splash Block Inlet	Water Misdirected from Inlet	Water is not being directed properly to the facility and away from the inlet structure.	Splash block(s) reconfigured/ repaired to direct water to facility and away from structure.
Curb Inlet/Outlet	Leaf Accumulation at Curb Cut	Accumulated leaves or other debris at curb cuts (inlets and outlets) can block water flow and proper function of the facility. Maintenance is particularly important in the fall.	Curb cuts and adjacent gutters are free of leaves and debris, and water can flow freely into (and out of) the facility.
Pipe Inlet/Outlet	Pipe is Damaged	Pipe is damaged.	Pipe repaired or replaced to design specifications.
	Pipe is Clogged	Pipe is clogged, completely or partially. Problem material may include leaves, debris, trash, roots, sediment, or other material.	Pipe is unclogged and free of any obstructions. Pipe functioning at design capacity.
	Access is Blocked	Vegetation is blocking access for inspection.	Area within 1 foot of inlets/outlets is clear of vegetation, and access pathways are clear and maintained where necessary.
Trash Rack	Trash and Debris	Trash or other debris is present on trash rack. Capacity may be reduced by buildup of trash or debris.	Trash rack is free of trash, leaves, debris, or other foreign material.
	Bar Screen Damage	Bar screen on trash rack is damaged or missing.	Bar screen has been repaired/ replaced to design specifications.
Overflow	Overflow Blocked	Overflow capacity is reduced by sediment or debris.	Overflow area is free of sediment and debris and capacity functions per design standards.
Underdrain Pipe	Reduced Capacity	Plant roots, sediment, or debris may reduce the capacity of the underdrain. Symptoms may include ponded water in facility bottom area.	Underdrain pipe is free or plant roots, sediment, and debris. Infiltration and pipe capacity functioning per design function.
Vegetation (continues on next page)	Plant Health	Plants not thriving across at least 80% of the entire design vegetated area within the BMP; overly dense vegetation requiring pruning.	Healthy water tolerant plants in bioretention area, plants thriving across at least 80% of the entire design vegetated area within the facility.

Bioretention System			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
	Diseased Plant Material	Diseased plants or plant material is present in the facility.	Diseased plants and plant parts have been removed and disposed of in an approved location (off-site). Potential sources of and conditions exacerbating disease have been addressed (see Pacific Northwest Plant Disease Management Handbook). Vegetated areas replanted as necessary to maintain vegetative coverage per design.
	Vegetation Needs Pruning	Trees and shrubs need regular maintenance and/or corrective pruning.	Trees and shrubs pruned per routine maintenance schedule, appropriate to individual species and age of plants. All pruning of mature trees done under direct supervision of ISA certified arborist.
	Large Trees and Shrubs Interfering	Large trees and shrubs interfere with operation of the facility or access for maintenance.	Trees and shrubs have been pruned using most current ANSI A300 standards and ISA BMPs. Trees and shrubs removed if necessary for operation of facility per design function.
	Dead Vegetation	Standing dead vegetation is present (particularly in fall and spring).	Standing dead vegetation has been removed from site; gaps in vegetation have been replaced with new plantings where necessary, or appropriate erosion control measures put in place until vegetation replacement is feasible.
	Maintenance Needed Around Mature Trees	If conditions warrant maintenance work or planting of new vegetation around mature trees (within the dripline), appropriate care must be taken to avoid adverse impacts to the mature tree(s).	The most current ANSI A300 standards and ISA BMPs have been followed to the extent practicable (e.g., take care to minimize any damage to tree roots and avoid compaction of soil) when working around and under mature trees. New plantings under mature trees include mainly plants that come as bulbs, bare root or in 4-inch pots; new plants in no larger than 1-gallon containers.
	Stakes or Guys Present	Stakes or guys present in plantings installed for over 1 year.	Stakes or guys have been removed from new vegetation after 1 year since installation. Holes have been backfilled where necessary.
	Vehicular Sight Lines Impaired by Vegetation	Vegetation causes some visibility (line of sight) or driver safety issues.	Vegetation has been pruned to appropriate height and spread to maintain sight clearances. If continued (regular) pruning of a given plant have been necessary, plant(s) have been relocated to a more appropriate location and replaced with plant(s) of appropriate mature size.
	Emergent Vegetation Compromises Conveyance	Emergent vegetation compromises conveyance (may become too dense).	Emergent vegetation has been thinned and does not impede conveyance.

Bioretention System			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
	Noxious Weeds Present	Noxious weeds are present among the site vegetation. Remove, bag, and dispose of Class A & B noxious weeds immediately per WA law. Make reasonable attempts to remove and dispose of Class C noxious weeds. See http://www.nwcb.wa.gov/. Follow Integrated Pest Management (IPM) protocols.	Noxious weeds are not present on site above thresholds established by WA law.

Catch Basin

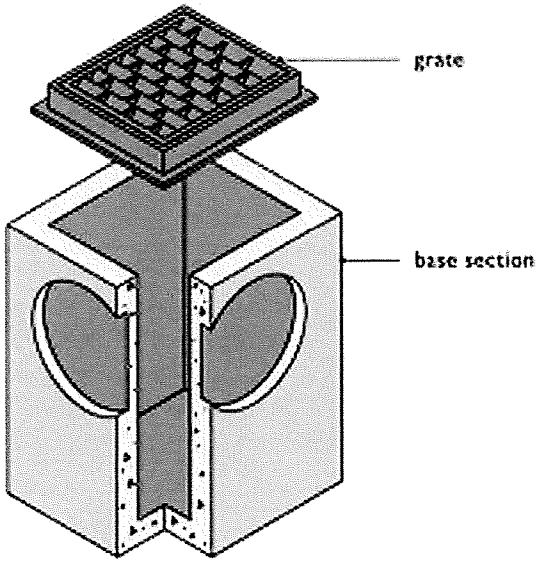
A catch basin is an underground concrete structure typically fitted with a slotted grate to collect stormwater runoff and route it through underground pipes. Catch basins can also be used as a junction in a pipe system and may have a solid lid. There are two types.

A Type 1 catch basin is a rectangular box with approximate dimensions of 3'x2'x5'. Type 1 catch basins are utilized when the connected conveyance pipes are less than 18 inches in diameter and the depth from the gate to the bottom of the pipe is less than 5 feet.

A Type 2 catch basin, also commonly referred to as a storm manhole, is listed separately under "Manhole" in this book.

Catch basins typically provide a storage volume (sump) below the outlet pipe to allow sediments and debris to settle out of the stormwater runoff. Some catch basins are also fitted with a spill control device (inverted elbow on outlet pipe) intended to contain large quantities of grease or debris.

Catch basins are frequently associated with all stormwater facilities.



Type I

Key Operations and Maintenance Considerations

- The most common tool for cleaning catch basins is an industrial vacuum truck with a tank and vacuum hose (e.g. Vactor® truck) to remove sediment and debris from the sump.
- A catch basin may be an enclosed space where harmful chemicals and vapors can accumulate. Therefore, if the inspection and maintenance requires entering a catch basin, it should be conducted by an individual trained and certified to work in hazardous confined spaces.

Catch Basin			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
General	Trash and Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%.	No trash or debris located immediately in front of catch basin or on grate opening.
		Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the catch basin.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin.
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into basin.)	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached.	Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.

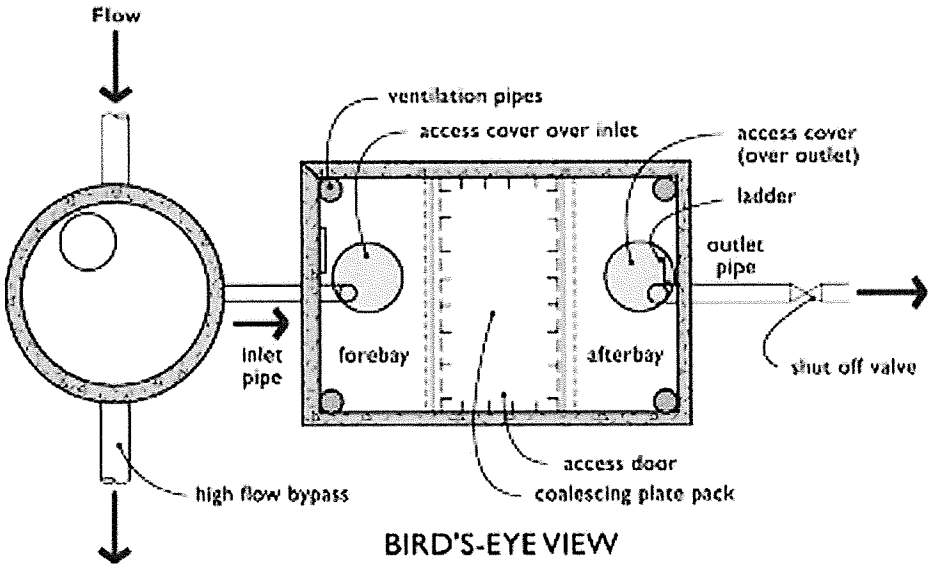
	Basin Walls/ Bottom	Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is regrouted and secure at basin wall.
	Settlement/ Misalignment	Catch basin has settled more than 1 inch or has rotated more than 2 inches out of alignment.	Basin replaced or repaired to design standards.
	Vegetation Inhibiting System	Vegetation growing across and blocking more than 10% of the basin opening.	No vegetation blocking opening to basin.
		Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation or root growth present.
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants, or other pollutants. Sheen, obvious oil, or other contaminants present. • Identify and remove source	No contaminants or pollutants present.
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread. One or more bolts are missing.	Mechanism opens with proper tools. All bolts are seated and no bolts are missing. Cover is secure.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure (Intent is to keep cover from sealing off access to maintenance).	Cover can be removed by one maintenance person.
Metal Grates (If Applicable)	Grate Opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.
Oil/Debris Trap (If Applicable)	Dislodged	Oil or debris trap is misaligned with or dislodged from the outlet pipe.	Trap is connected to and aligned with outlet pipe.

Coalescing Plate Oil/Water Separator

A coalescing plate oil/water separator is generally the same as the API type. The main difference is that coalescing plate separators include a series of parallel plates in the separation bay (2nd bay) that increase the oil removal efficiency of the separator.

Facility objects associated with a coalescing plate oil/water separator may include:

- access road or easement
- control structure/flow restrictor
- conveyance stormwater pipe



Key Operations and Maintenance Considerations

- Prepare, regularly update, and implement an O&M Manual for the oil/water separators.
- Inspect oil/water separators to ensure proper operation monthly during the wet season of October 1 - April 30 and during and immediately after a large storm event of ≥1 inch per 24 hours.
- 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, 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 washwater removal. Replace wash water in the separator with clean water before returning it to service.
- Replace oil absorbent pads before their absorbed oil content reaches capacity.
- Train designated employees on appropriate separator operation, inspection, record keeping, and maintenance procedures.
- Common tools for cleaning and maintaining an oil/water separator are a vacuum truck and/or oil absorbing media materials to remove oils and other sediments that have accumulated in the facility.

Coalescing Plate Oil/Water Separator			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
General	Poor Water Quality	Inspection of discharge water for obvious signs of poor water quality (i.e. obvious oil or other contaminants present).	Effluent discharge from vault clear with no thick visible sheen.
	Sediment Accumulation	Sediment depth in bottom of vault exceeds 6-inches in depth and/or visible signs of sediment on plates.	No sediment deposits on vault bottom and plate media that would impede flow through the vault and reduce separation efficiency.
	Trash and Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Vault and inlet/ outlet piping is free of trash and debris.
	Oil Accumulation	Oil accumulation that exceeds 1-inch at the water surface.	Oil has been extracted from vault. Coalescing plates have been cleaned. No visible oil depth on water.
	Damaged Coalescing Plates	Plate media broken, deformed, cracked and/or showing signs of failure.	A portion of the media pack or the entire plate pack has been replaced (depending on severity of failure).
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe has been repaired and or replaced to design specifications.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles have been repaired or replaced to design specifications.
	Vault Structure Damage – Includes Cracks in Walls, Bottom	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
Access Manhole	Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design specifications. Allows maintenance person safe access.
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into basin.)	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached.	Frame is sitting flush on the riser rings or top slab and firmly attached.

Coalescing Plate Oil/Water Separator			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
Ventilation Pipes	Plugged	Any obstruction to the ventilation pipes.	Ventilation pipes are clear.
Shutoff Valve	Damaged or inoperable	Shutoff valve cannot be opened or closed.	Shutoff valve operates normally.

Compost-Amended Soil

Naturally occurring (undisturbed) soil and vegetation provide important stormwater functions including: water infiltration; nutrient, sediment, and pollutant adsorption; sediment and pollutant biofiltration; water interflow storage and transmission; and pollutant decomposition.

Compaction from construction can reduce the soil's natural ability to provide these functions. Compost-amended soils are intended to replace these lost functions by establishing a minimum soil quality and depth in the post-development landscape.

Sufficient organic content is a key to soil quality. Soil organic matter can be attained through numerous amendments such as compost, composted woody material, biosolids, and forest product residuals. The full benefits of compost-amended soils are realized when desired soil media depths are maintained and soil compaction is minimized.

Key Operations and Maintenance Considerations

- Replenish soil media as needed (as a result of erosion) and address compacted, poorly draining soils.
- Site uses should protect vegetation and avoid soil compaction. Care should be taken to prevent compaction of soils via vehicular loads and/or excessive foot traffic, especially during wet conditions.
- The table below provides the recommended maintenance frequencies, standards, and procedures for compost-amended soils. The level of routine maintenance required and the frequency of corrective maintenance actions may increase for facilities prone to erosion due to site conditions such as steep slopes or topography tending to concentrate flows.

Compost-Amended Soil			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
Soil Media	Soils Waterlogged or Not Infiltrating	Soils become waterlogged, or otherwise do not appear to be infiltrating.	Soils have been aerated or amended such that infiltration occurs and soils to not remain completely saturated, per design specifications.
	Erosion/Scouring	Areas of potential erosion are visible, such as gullies or scouring.	Any eroded areas have been repaired, and sources of erosion addressed to prevent further soil erosion.
Vegetation	Vegetation in Poor Health	Less than 75% of planted vegetation is healthy with a generally good appearance.	At least 75% of planted vegetation is healthy with generally good appearance. Any conditions found that were deleterious to plant health have been corrected where possible. Routine maintenance schedule has been updated as necessary to ensure continued plant health and satisfactory appearance.
	Poisonous Plants and Noxious Weeds	Any poisonous plants or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations.	No danger of poisonous vegetation where maintenance personnel or the public might normally be. Eradication of Class A weeds as required by State law. Control of other listed weeds as directed by local policies. Apply requirements of adopted IPM policy for the use of herbicides.
	Other Weeds Present	Other weeds (not listed on City/State noxious weed lists) are present on site.	Weeds have been removed per the routine maintenance schedule, following IPM protocols.

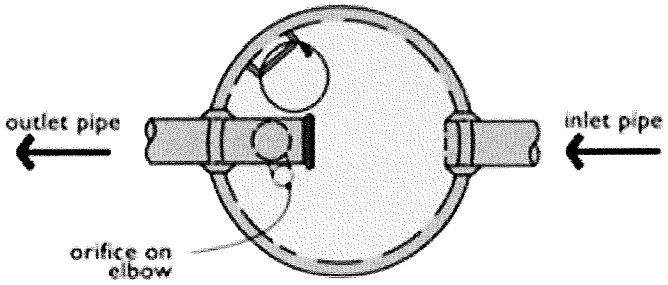
Control Structure/Flow Restrictor

Flow control structures and flow restrictors direct or restrict flow in or out of facility components. Outflow controls on detention facilities are a common example where flow control structures slowly release stormwater at a specific rate. The flow is regulated by a combination of orifices (holes with specifically sized diameters) and weirs (plates with rectangular or "V" shaped notch). Lack of maintenance of the control structure can result in the plugging of an orifice. If these flow controls are damaged, plugged, bypassed, or not working properly, the facility could overtop or release water too quickly.

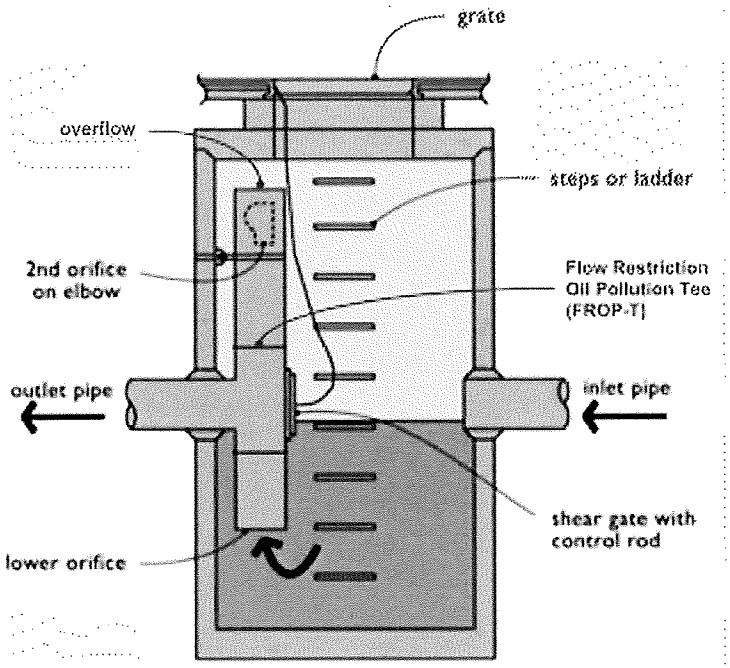
Control structures have a history of maintenance-related problems and it is imperative to establish a good maintenance program for them to function properly. Sediment typically builds up inside the structure, which blocks or restricts flow to the outlet. To prevent this problem, routinely clean out these structures and conduct regular inspections to detect the need for non-routine cleanout.

Facility objects that are typically associated with a control structure/flow restrictor include:

- detention ponds
- media cartridge filters
- closed detention system
- conveyance stormwater pipe



BIRD'S-EYE VIEW



SECTION PROFILE

Key Operations and Maintenance Considerations

- Conduct regular inspections of control structures to detect the need for non-routine cleanout, especially if construction or land-disturbing activities occur in the contributing drainage area.
- The most common tool for cleaning control structures/flow restrictors is a truck with a tank and vacuum hose (Vactor® truck) to remove sediment and debris from the sump.
- A control structure is an enclosed space where harmful chemicals and vapors can accumulate. Therefore, if the inspection and maintenance requires entering a control structure, it should be conducted by an individual trained and certified to work in hazardous confined spaces.

Control Structure/Flow Restrictor			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Minimum Performance Standard**
Structure	Trash and debris	Trash or debris of more than ½ cubic foot which is located immediately in front of the structure opening or is blocking capacity of the structure by more than 10%.	No Trash or debris blocking or potentially blocking entrance to structure.
		Trash or debris in the structure that exceeds 1/3 the depth from the bottom of basin to invert the lowest pipe into or out of the basin.	No trash or debris in the structure.
		Deposits of garbage exceeding 1 cubic foot in volume.	No condition present which would attract or support the breeding of insects or rodents.
	Sediment	Sediment exceeds 60% of the depth from the bottom of the structure to the invert of the lowest pipe into or out of the structure or the bottom of the FROP-T section or is within 6 inches of the invert of the lowest pipe into or out of the structure or the bottom of the FROP-T section.	Sump of structure contains no sediment.
	Damage to frame and/or top slab	Top slab has holes larger than 2 square inches or cracks wider than ¼ inch.	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than ¾ inch of the frame from the top slab.	Frame is sitting flush on top slab.
	Cracks in walls or bottom	Cracks wider than ½ inch and longer than 3 feet, any evidence of soil particles entering structure through cracks, or maintenance person judges that structure is unsound.	Structure is sealed and structurally sound.
		Cracks wider than ½ inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering structure through cracks.	No cracks more than 1/4 inch wide at the joint of inlet/outlet pipe.
	Settlement/ misalignment	Structure has settled more than 1 inch or has rotated more than 2 inches out of alignment.	Basin replaced or repaired to design standards.
	Damaged pipe joints	Cracks wider than ½-inch at the joint of the inlet/outlet pipes or any evidence of soil entering the structure at the joint of the inlet/outlet pipes.	No cracks more than ¼-inch wide at the joint of inlet/outlet pipes.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Ladder rungs missing or unsafe	Ladder is unsafe due to missing rungs, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
FROP-T Section	Damage	T section is not securely attached to structure wall and outlet pipe structure should support at least 1,000 lbs of up or down pressure.	T section securely attached to wall and outlet pipe.
		Structure is not in upright position (allow up to 10% from plumb).	Structure in correct position.
		Connections to outlet pipe are not watertight or show signs of deteriorated grout.	Connections to outlet pipe are water tight; structure repaired or replaced and works as designed.
		Any holes—other than designed holes—in the structure.	Structure has no holes other than designed holes.
Shear Gate	Damaged or missing	Shear gate is missing.	Replace shear gate.
		Shear gate is not watertight.	Gate is watertight and works as designed.

		Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
		Chain/rod leading to gate is missing or damaged.	Chain is in place and works as designed.
Orifice Plate	Damaged or missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
	Deformed or damaged lip	Lip of overflow pipe is bent or deformed.	Overflow pipe does not allow overflow at an elevation lower than design
Inlet/Outlet Pipe	Damaged	Cracks wider than ½-inch at the joint of the inlet/outlet pipes or any evidence of soil entering at the joints of the inlet/outlet pipes.	No cracks more than ¼-inch wide at the joint of the inlet/outlet pipe.
Metal Grates (If Applicable)	Unsafe grate opening	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and debris	Trash and debris that is blocking more than 20% of grate surface.	Grate free of trash and debris.
	Damaged or missing	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.
Manhole Cover/Lid	Cover/lid not in place	Cover/lid is missing or only partially in place. Any open structure requires urgent maintenance.	Cover/lid protects opening to structure.
	Locking mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts cannot be seated. Self-locking cover/lid does not work.	Mechanism opens with proper tools.
	Cover/lid difficult to Remove	One maintenance person cannot remove cover/lid after applying 80 lbs. of lift.	Cover/lid can be removed and reinstalled by one maintenance person.

Conveyance Pipe

Storm sewer pipes convey stormwater. Inlet and outlet stormwater pipes convey stormwater in, through, and out of stormwater facilities.

Pipes are built from many materials. Pipes are cleaned to remove sediment or blockages when problems are identified. Stormwater pipes must be clear of obstructions and breaks to prevent localized flooding. All stormwater pipes should be in proper working order and free of the possible defects listed below.

Key Operations and Maintenance Considerations

- The most common tool for cleaning stormwater conveyance pipes is a truck with a tank, vacuum hose, and a jet hose (Vactor® truck) to flush sediment and debris from the pipes.

Conveyance Pipe			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
General	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants, or other pollutants. Sheen, obvious oil, or other contaminants present. • Identify and remove source.	No contaminants or pollutants present.
	Obstructions, Including Roots	Root enters or deforms pipe, reducing flow.	Roots have been removed from pipe (using mechanical methods; do not put root-dissolving chemicals in storm sewer pipes). If necessary, vegetation over the line removed.
	Sediment and Debris	Sediment depth is greater than 20% of pipe diameter.	Pipe has been cleaned and is free of sediment/ debris. (Upstream debris traps installed where applicable.)
	Debris Barrier or Trash Rack Missing	Stormwater pipes > than 18 inches need debris barrier.	Debris barrier present on all stormwater pipes 18 inches and greater.
	Damage to protective coating or corrosion	Protective coating is damaged; rust or corrosion is weakening the structural integrity of any part of pipe.	Pipe repaired or replaced.
	Damaged	Any dent that decreases the cross section area of pipe by more than 20% or is determined to have weakened structural integrity of the pipe.	Pipe repaired or replaced.

Grounds

Grounds (Landscaping)			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
Site	Trash or litter	Any trash and debris which exceed 1 cubic foot per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size office garbage can). In general, there should be no visual evidence of dumping.	Trash and debris cleared from site.
	Noxious weeds	Any noxious or nuisance vegetation which may constitute a hazard to County personnel or the public.	Noxious and nuisance vegetation removed according to applicable regulations. No danger of noxious vegetation where County personnel or the public might normally be.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Grass/groundcover	Grass or groundcover exceeds 18 inches in height.	Grass or groundcover mowed to a height no greater than 6 inches.
Trees and Shrubs	Hazard	Any tree or limb of a tree identified as having a potential to fall and cause property damage or threaten human life. A hazard tree identified by a qualified arborist must be removed as soon as possible.	No hazard trees in facility.
	Damaged	Limbs or parts of trees or shrubs that are split or broken which affect more than 25% of the total foliage of the tree or shrub.	Trees and shrubs with less than 5% of total foliage with split or broken limbs.
		Trees or shrubs that have been blown down or knocked over.	No blown down vegetation or knocked over vegetation. Trees or shrubs free of injury.
		Trees or shrubs which are not adequately supported or are leaning over, causing exposure of the roots.	Tree or shrub in place and adequately supported; dead or diseased trees removed.

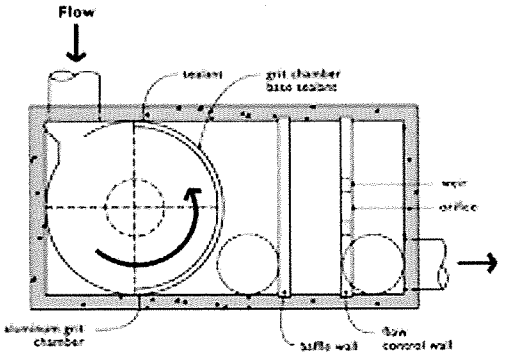
Hydrodynamic Separator System

A hydrodynamic separator is a structure with a cylindrical vessel where the incoming stormwater flow spirals around the perimeter causing the heavier particles to settle out of the stormwater. It uses a vortex-enhanced settling mechanism (swirl-concentration) to capture settleable solids, floatables, and oil and grease.

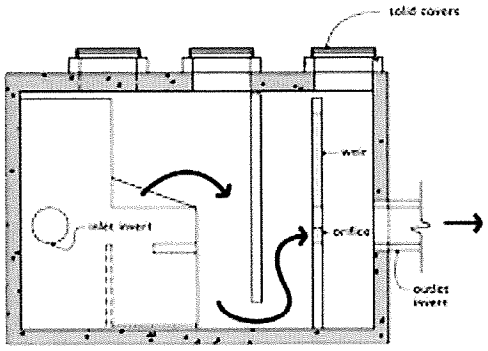
Vortechs® treatment units are an example of a proprietary hydrodynamic separator system. See manufacturer's publications for additional maintenance information.

Facility objects that are often associated with a hydrodynamic separator system include:

- access road or easement
- control structure/flow restrictor
- manufactured media filter (such as a StormFilter® system)
- conveyance stormwater pipe



BIRD'S-EYE VIEW



SIDE PROFILE

Key Operations and Maintenance Considerations

- The most common tool for cleaning hydrodynamic separators is a truck with a tank and vacuum hose (Vactor® truck) to remove sediment and debris from the sediment chamber / sump.
- See manufacturer's publications for additional maintenance information.

Hydrodynamic Separator System			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
General	Sediment Accumulation	Sediment depth exceeds 75% of the total sump depth.	Accumulated sediment has been removed.
	Trash and Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris has been removed from vault, and inlet/outlet piping.
	Oil Accumulation	Oil accumulation that exceeds 1-inch at the water surface.	Oil has been extracted from vault. Coalescing plates have been cleaned. No visible oil depth on water.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe has been repaired and / or replaced.
	Defects in Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to design specifications.
	Vault Structure Damage – Includes Cracks in Walls and/or Bottom	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/ outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/ outlet pipe.
	Sediment in Drain Pipes /Clean-Outs	When drain pipes, clean-outs, become full with sediment and/or debris.	Sediment and debris removed.
Access Manhole	Cover/Lid Not in Place	Cover/lid is missing or only partially in place. Any open manhole requires immediate maintenance.	Manhole access covered.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts cannot be seated. Self-locking cover/lid does not work.	Mechanism opens with proper tools.
	Cover/Lid Difficult to Remove	One maintenance person cannot remove lid after applying 80 lbs. of list.	Cover/lid can be removed and reinstalled by one maintenance person.

Hydrodynamic Separator System			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
	Ladder Rungs Unsafe	Missing rungs, misalignment, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into basin.)	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached.	Frame is sitting flush on the riser rings or top slab and firmly attached.

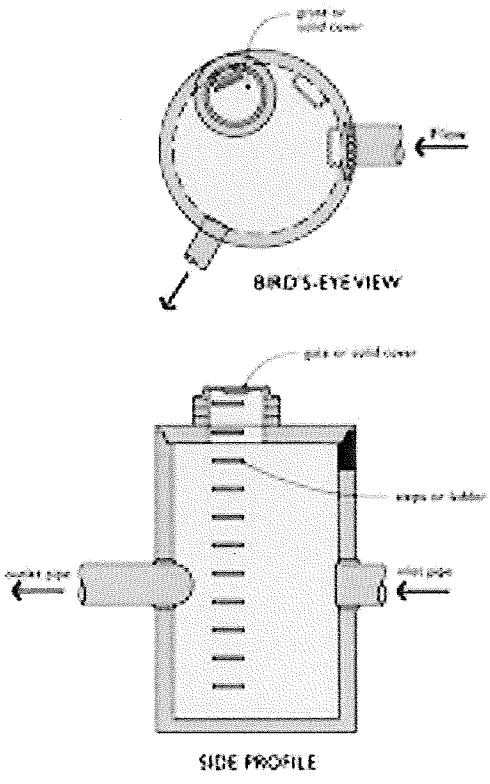
Manhole

A manhole is an underground concrete structure typically fitted with a slotted grate to collect stormwater runoff and route it through underground pipes. Manholes can also be used as a junction in a pipe system and may have a solid lid. A manhole is also known as a Type 2 catch basin.

Manholes are round concrete structures ranging in diameter from 4 feet to 8 feet. They are used when the connecting conveyance pipe is 18 inches or greater or the depth from grate to pipe bottom exceeds 5 feet. Manholes typically have steps mounted on the side of the structure to allow access.

Manholes typically provide a storage volume (sump) below the outlet pipe to allow sediments and debris to settle out of the stormwater runoff. Some manholes are also fitted with a spill control device (inverted elbow on outlet pipe) intended to contain large quantities of grease or oils.

Manholes are often associated with other stormwater facilities.



Type 2

Key Operations and Maintenance Considerations

- The most common tool for cleaning manholes is a truck with a tank and vacuum hose (Vactor® truck) to remove sediment and debris from the sump.
- A manhole may be an enclosed space where harmful chemicals and vapors can accumulate. Therefore, if the inspection and maintenance requires entering a manhole, it should be conducted by an individual trained and certified to work in hazardous confined spaces.

Manhole			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Minimum Performance Standard**
			Note: table spans multiple pages.
General	Trash and Debris	Trash or debris which is located immediately in front of the opening or is blocking inletting capacity of the basin by more than 10%.	No trash or debris located immediately in front of manhole or on grate opening.
		Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the basin.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the basin.
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into manhole.)	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached.	Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
		Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering manhole through cracks.	Pipe is regrouted and secure at basin wall.

	Settlement/ Misalignment	Manhole has settled more than 1 inch or has rotated more than 2 inches out of alignment.	Manhole replaced or repaired to design standards.
	Vegetation Inhibiting System	Vegetation growing across and blocking more than 10% of the opening.	No vegetation blocking opening to manhole.
		Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation or root growth present.
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants, or other pollutants. Sheen, obvious oil, or other contaminants present. • Identify and remove source.	No contaminants or pollutants present.
Manhole Cover	Cover Not in Place	Cover is missing or only partially in place. Any open manhole is a safety hazard and requires immediate maintenance.	Manhole cover is closed.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread. One or more bolts are missing.	Mechanism opens with proper tools. All bolts are seated and no bolts are missing. Cover is secure.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure (Intent is to keep cover from sealing off access to maintenance).	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to manhole wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (If Applicable)	Grate Opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

Media Cartridge Filters

Media cartridge filters are passive, flow-through, stormwater treatment systems. They are comprised of one or more vaults that house rechargeable, media-filled filter cartridges. Stormwater passes through a filtering medium, which traps particulates and/or adsorb pollutants such as dissolved metals and hydrocarbons. Once filtered through the media, the treated stormwater is directed to a collection pipe or discharged into an open channel drainage way.

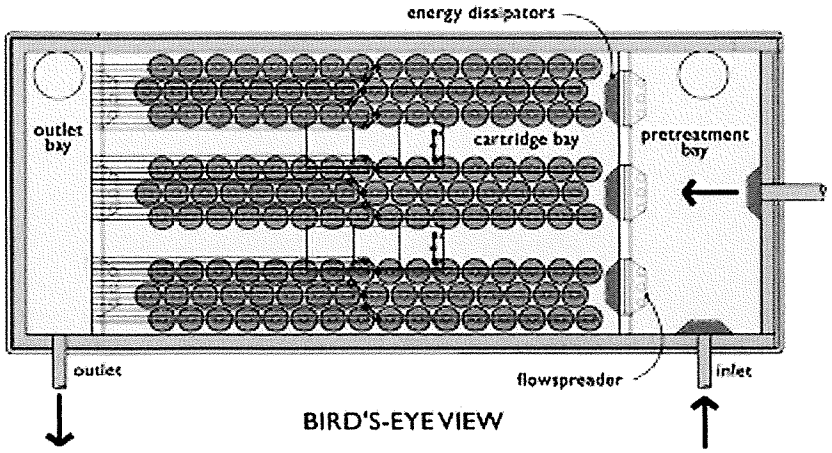
The filter media can be housed in cartridge filters enclosed in concrete vaults or catch basins. Structures will have vault doors or manhole lids (older designs) for maintenance access. Various types of filter media are available from system manufacturers.

StormFilter® units are an example of a proprietary manufactured media cartridge filter system. See manufacturer's publications for additional maintenance information.

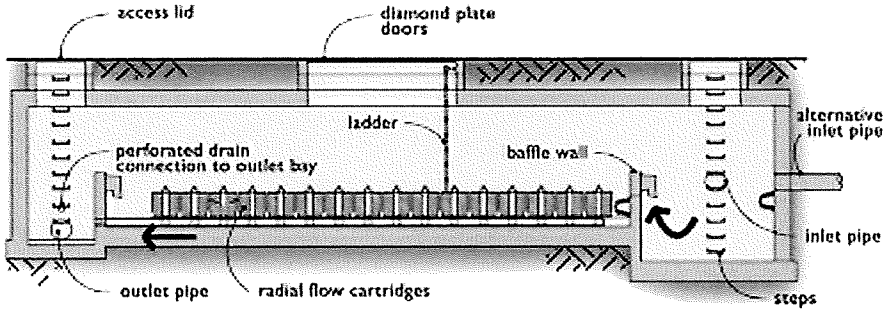
Facility objects that are typically associated with a manufactured media filter system include:

- access road or easement
- control structure/flow restrictor
- conveyance stormwater pipe

Media Cartridge Filter Vault with Accumulated Sediment



BIRD'S-EYE VIEW



SIDE PROFILE

Key Operations and Maintenance Considerations

- The most common tool for cleaning media cartridge filters is a truck with a tank and vacuum hose (e.g.Vactor® truck) to remove sediment and debris from the vault.
- Media cartridge filters are enclosed spaces where harmful chemicals and vapors can accumulate. Therefore, the inspection and maintenance of these facilities should be conducted by an individual trained and certified to work in hazardous confined spaces.
- Cartridges require replacement when the individual cartridges no longer meet the specifications for pollutant removal.

Media Cartridge Filters			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Minimum Performance Standard
			Note: table spans multiple pages.
General	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into vault.)	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached.	Frame is sitting flush on the riser rings or top slab and firmly attached.
Forebay	Sediment Accumulation	Sediment accumulation exceeds 6 inches or 1/3 of available sump.	All sediment removed from storage area.
Media Filter Vault	Sediment Accumulation on Top Media Filters (Cartridges)	Sediment depth exceeds 0.25-inches (on top of filter cartridges).	No sediment deposits which would impede permeability of the compost media. No sediment deposits on top of cartridges. (Sediment on cartridges likely indicates that cartridges are plugged and require maintenance.)
	Sediment Accumulation in Vault	Sediment depth exceeds 4 inches in chamber. Look for other indicators of clogged cartridges or overflow.	No sediment deposits in vault bottom of first chamber. Cartridges have been checked and replaced or serviced as needed.
	Trash and Debris Accumulation	Trash and debris accumulated in vault.	No trash or debris in vault.
	Sediment in Drain Pipes/Clean-Outs	When drain pipes, clean-outs, become full with sediment and/or debris.	Sediment and debris has been removed.
	Damaged Pipes	Any part of the pipes that are crushed or damaged due to corrosion and/or settlement.	Pipe repaired and/or replaced to design specifications.
	Cover/lid not in place	Cover/lid is missing or only partially in place. Any open manhole requires immediate maintenance.	Manhole access covered.
	Locking mechanism not working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts cannot be seated. Self-locking cover/lid does not work.	Mechanism opens with proper tools.
	Cover/lid difficult to remove	One maintenance person cannot remove cover/lid after applying 80 lbs. of lift.	Cover/lid can be removed and reinstalled by one maintenance person.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to	Cracks wider than 1/2 inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.

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	Frame and/or Top Slab	Cracks wider than 1/2 inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4 inch at the joint of the inlet/outlet pipe.
	Baffles Damaged	Baffles corroding, cracking, warping, and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to design specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets design specifications, and is safe to use as determined by inspection personnel.
Below Ground Cartridge Type	Compost Media Clogging	Drawdown of water through the media takes longer than 1 hour, and/or overflow occurs frequently.	Media cartridges have been replaced and drawdown time and overflow frequency are per design standards.
	Short Circuiting	Flows do not properly enter filter cartridges.	Flows are properly entering filter cartridges. Cartridges have been replaced if necessary.
	Filter Cartridges Submerged	Filter vault does not drain within 24 hours following storm. Look for evidence of submergence due to backwater or excessive hydrocarbon loading.	Filter media have been checked and replaced if needed and vault drains down within 24 of a storm event. (If cartridges are plugged with oil, additional treatment or source control BMP may be needed.)

Vegetation

Many stormwater facilities use vegetation as part of the functional design. Vegetation must be maintained to contribute to the function of the facility and to prevent damage to structural elements of the facility (e.g. earthen berms). Another reason to maintain vegetation is aesthetics.

Vegetation maintenance can include trimming, plant replacement, weeding, and pest control. Vegetation maintenance in native vegetation retention areas carries specific requirements.

Objectives for vegetation management in stormwater facilities:

- Maintain healthy plant communities
- Reduce or eliminate sources of pollution related to vegetation care
- Cover bare soil areas with plants
- Control Class A and Class B noxious weeds; control unlisted invasive plants where needed to achieve management objectives
- Tolerance for natural appearance and weeds that do not interfere with facility functions

Key Operations and Maintenance Considerations

- The vegetation management focus is establishing and maintaining healthy low-maintenance native plantings and sustaining the design function of vegetated filters such as biofiltration swales. This includes controlling invasive plants where appropriate, and planting cover on bare soils.
- Use plants appropriate to the facility type, as listed in the City of Puyallup's Engineering and Construction Standards Section 600.
- Consider the use of soil amendments such as compost before using fertilizer.
- Limit mulch use to covering bare soil while establishing plantings.
- When a chemical control method is chosen, carefully follow the manufacturer's label directions for use. When deciding on and using a chemical control, consider stormwater facilities and drainage systems as leading to water bodies and apply chemicals per the label directions for use over or near water.
- Allow a 5-foot buffer from mature established plantings to fence lines and access roads.
- Trees or shrubs that block access roads may be trimmed (or removed if within the access road) when access is required for maintenance by heavy equipment.
- Trees that pose a risk to stormwater structures due to root growth may be removed.

Use Only Appropriate Plants

Use plants that will thrive in the growing conditions of each facility. Growing conditions are affected by moisture, soil conditions, and light. Plants native to western Washington are preferred. Plant lists for biofiltration swales, bioretention systems, rain gardens, and other facility types are given in the City of Puyallup's Engineering and Construction Standards Section 600.

Integrated Pest Management

Landscape management decisions for controlling unwanted vegetation, diseases, and pests in stormwater facilities should follow Integrated Pest Management principles.

An IPM program might consist of the following steps:

Step 1: Correctly identify problem pests and understand their life cycle.

IPM starts with an understanding of the soil, water, natural resources, and human impacts on site. Identify and research the pest species, including basic physiology and best timing for control. Many pests are a problem during certain seasons or can only be treated in specific phases of the life cycle. Local pest identification help can be obtained from WSU Extension Master Gardeners or through online resources such as Washington State Noxious Weed Control Board and Washington Invasive Species Council.

Step 2: Establish tolerance thresholds for pests.

Every landscape has a population of some pest insects, weeds, and diseases. Once the pest has been identified and studied, determine if low levels of the pest are tolerable. Small numbers of certain pests may not be harmful. If this is the case, simply continue to monitor the pest population.

In other cases, the pest may require control. Examples include a pest population that is rapidly increasing in numbers, or an invasive weed that requires control according to state law. Early detection, rapid response (EDRR) plays an important role in the control of pests that are known to be a severe problem in other regions but not yet occurring in ours. In this instance, the tolerance threshold is zero; a quick response to eliminate a future ongoing pest problem is the safest and least expensive control.

Step 3: If pests exceed tolerance thresholds, choose a safe and effective control method.

IPM identifies physical, cultural, biological, and chemical control methods tailored specifically for the pest of concern and the site. Research the available options and choose a control method that is effective. Preferred control methods are economical, low risk to people, and mindful of environmental processes.

Physical control works on a pest directly: digging, hand-pulling, mowing, tilling, trapping, etc.

Cultural control changes the pest's environment: landscape fabric, mulch, soil amendments, altering the irrigation method or duration, crop rotation, crop covers, etc.

Biological control uses natural enemies: beneficial insects, managed grazing, bird boxes and perches, etc.

Chemical control is the use of pesticides: insect bait stations, synthetic and organic foliar herbicides, microbial-based insecticides, oils, soaps, etc.

These control methods should be looked at as tools in a toolbox; IPM selects the right tools for the job at hand. Both short-term control and long-term management is best achieved by using more than one tool. Often, implementing cultural control methods reduces the amount of physical and chemical control needed.

Step 4: Monitor and evaluate.

Observe and record the results of the control treatment. Evaluate the effectiveness. If necessary, modify maintenance practices to support a healthy landscape and prevent recurrence of the pest.

IPM emphasizes that pest control is not a one-time proposition; the pest control process should be viewed as a cycle that rotates through planning, control, and evaluation. As pest issues change over time, the IPM plan adapts.

- Proper planning and management decisions begin the IPM process. All control methods are considered during the information-gathering and planning process. Often a combination of methods is best.
- Cultural methods of vegetation and pest control are preferred.
- Mechanical means of vegetation and pest control are next in line of preference and are utilized where appropriate.
- Biological methods of vegetation and pest control are considered before chemical means, where they are appropriate.
- Botanical and synthetic pesticides are used in an appropriate manner when other control methods are deemed ineffective or not cost-efficient.

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CONTECH®
ENGINEERED SOLUTIONS

ON-SITE TREATMENT FACILITIES - CONTECH STORMFILTERS

StormFilter Inspection and Maintenance Procedures

The Stormwater Management StormFilter®

Maintenance Guidelines

The primary purpose of the Stormwater Management StormFilter® is to filter and prevent pollutants from entering our waterways. Like any effective filtration system, periodically these pollutants must be removed to restore the StormFilter to its full efficiency and effectiveness.

Maintenance requirements and frequency are dependent on the pollutant load characteristics of each site. Maintenance activities may be required in the event of a chemical spill or due to excessive sediment loading from site erosion or extreme storms. It is a good practice to inspect the system after major storm events.

Maintenance Procedures

Although there are many effective maintenance options, we believe the following procedure to be efficient, using common equipment and existing maintenance protocols. The following two-step procedure is recommended::

1. **Inspection**
   - Inspection of the vault interior to determine the need for maintenance.
2. **Maintenance**
   - Cartridge replacement
   - Sediment removal

Inspection and Maintenance Timing

At least one scheduled inspection should take place per year with maintenance following as warranted.

First, an inspection should be done before the winter season. During the inspection the need for maintenance should be determined and, if disposal during maintenance will be required, samples of the accumulated sediments and media should be obtained.

Second, if warranted, a maintenance (replacement of the filter cartridges and removal of accumulated sediments) should be performed during periods of dry weather.

In addition to these two activities, it is important to check the condition of the StormFilter unit after major storms for potential damage caused by high flows and for high sediment accumulation that may be caused by localized erosion in the drainage area. It may be necessary to adjust the inspection/ maintenance schedule depending on the actual operating conditions encountered by the system. In general, inspection activities can be conducted at any time, and maintenance should occur, if warranted, during dryer months in late summer to early fall.

Maintenance Frequency

The primary factor for determining frequency of maintenance for the StormFilter is sediment loading.

A properly functioning system will remove solids from water by trapping particulates in the porous structure of the filter media inside the cartridges. The flow through the system will naturally decrease as more and more particulates are trapped. Eventually the flow through the cartridges will be low enough to require replacement. It may be possible to extend the usable span of the cartridges by removing sediment from upstream trapping devices on a routine as-needed basis, in order to prevent material from being re-suspended and discharged to the StormFilter treatment system.

The average maintenance lifecycle is approximately 1-5 years. Site conditions greatly influence maintenance requirements. StormFilter units located in areas with erosion or active construction may need to be inspected and maintained more often than those with fully stabilized surface conditions.

Regulatory requirements or a chemical spill can shift maintenance timing as well. The maintenance frequency may be adjusted as additional monitoring information becomes available during the inspection program. Areas that develop known problems should be inspected more frequently than areas that demonstrate no problems, particularly after major storms. Ultimately, inspection and maintenance activities should be scheduled based on the historic records and characteristics of an individual StormFilter system or site. It is recommended that the site owner develop a database to properly manage StormFilter inspection and maintenance programs..

Inspection Procedures

The primary goal of an inspection is to assess the condition of the cartridges relative to the level of visual sediment loading as it relates to decreased treatment capacity. It may be desirable to conduct this inspection during a storm to observe the relative flow through the filter cartridges. If the submerged cartridges are severely plugged, then typically large amounts of sediments will be present and very little flow will be discharged from the drainage pipes. If this is the case, then maintenance is warranted and the cartridges need to be replaced.

Warning: In the case of a spill, the worker should abort inspection activities until the proper guidance is obtained. Notify the local hazard control agency and Contech Engineered Solutions immediately.

To conduct an inspection:

Important: Inspection should be performed by a person who is familiar with the operation and configuration of the StormFilter treatment unit and the unit's role, relative to detention or retention facilities onsite.

1. If applicable, set up safety equipment to protect and notify surrounding vehicle and pedestrian traffic.
2. Visually inspect the external condition of the unit and take notes concerning defects/problems.
3. Open the access portals to the vault and allow the system vent.
4. Without entering the vault, visually inspect the inside of the unit, and note accumulations of liquids and solids.
5. Be sure to record the level of sediment build-up on the floor of the vault, in the forebay, and on top of the cartridges. If flow is occurring, note the flow of water per drainage pipe. Record all observations. Digital pictures are valuable for historical documentation.
6. Close and fasten the access portals.
7. Remove safety equipment.
8. If appropriate, make notes about the local drainage area relative to ongoing construction, erosion problems, or high loading of other materials to the system.
9. Discuss conditions that suggest maintenance and make decision as to whether or not maintenance is needed.

Maintenance Decision Tree

The need for maintenance is typically based on results of the inspection. The following Maintenance Decision Tree should be used as a general guide. (Other factors, such as Regulatory Requirements, may need to be considered).

Please note Stormwater Management StormFilter devices installed downstream of, or integrated within, a stormwater storage facility typically have different operational parameters (i.e. draindown time). In these cases, the inspector must understand the relationship between the retention/detention facility and the treatment system by evaluating site specific civil engineering plans, or contacting the engineer of record, and make adjustments to the below guidance as necessary. Sediment deposition depths and patterns within the StormFilter are likely to be quite different compared to systems without upstream storage and therefore shouldn't be used exclusively to evaluate a need for maintenance.

1. Sediment loading on the vault floor.
   a. If >4" of accumulated sediment, maintenance is required.
2. Sediment loading on top of the cartridge.
   a. If >1/4" of accumulation, maintenance is required.
3. Submerged cartridges.
   a. If >4" of static water above cartridge bottom for more than 24 hours after end of rain event, maintenance is required. (Catch basins have standing water in the cartridge bay.)
4. Plugged media.
   a. While not required in all cases, inspection of the media within the cartridge may provide valuable additional information.
   b. If pore space between media granules is absent, maintenance is required.
5. Bypass condition.
   a. If inspection is conducted during an average rain fall event and StormFilter remains in bypass condition (water over the internal outlet baffle wall or submerged cartridges), maintenance is required.
6. Hazardous material release.
   a. If hazardous material release (automotive fluids or other) is reported, maintenance is required.
7. Pronounced scum line.
   a. If pronounced scum line (say ≥ 1/4" thick) is present above top cap, maintenance is required.

Maintenance

Depending on the configuration of the particular system, maintenance personnel will be required to enter the vault to perform the maintenance.

Important: If vault entry is required, OSHA rules for confined space entry must be followed.

Filter cartridge replacement should occur during dry weather. It may be necessary to plug the filter inlet pipe if base flows is occurring.

Replacement cartridges can be delivered to the site or customers facility. Information concerning how to obtain the replacement cartridges is available from Contech Engineered Solutions.

Warning: In the case of a spill, the maintenance personnel should abort maintenance activities until the proper guidance is obtained. Notify the local hazard control agency and Contech Engineered Solutions immediately.

To conduct cartridge replacement and sediment removal maintenance:

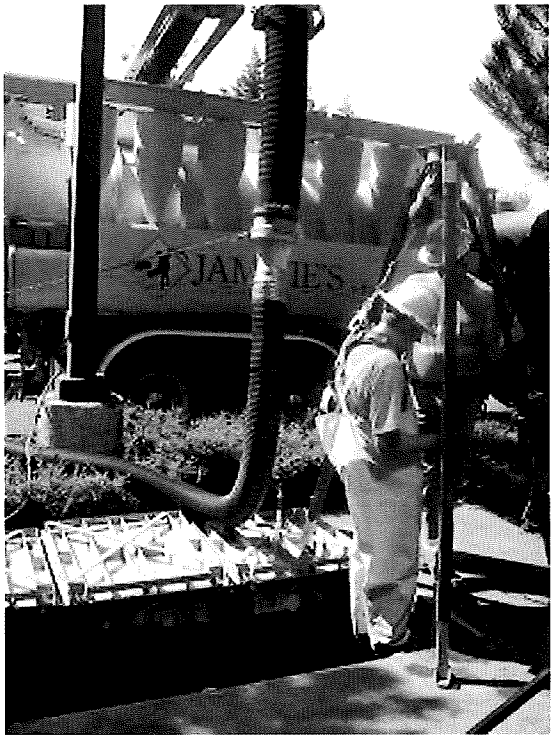
1. If applicable, set up safety equipment to protect maintenance personnel and pedestrians from site hazards.
2. Visually inspect the external condition of the unit and take notes concerning defects/problems.
3. Open the doors (access portals) to the vault and allow the system to vent.
4. Without entering the vault, give the inside of the unit, including components, a general condition inspection.
5. Make notes about the external and internal condition of the vault. Give particular attention to recording the level of sediment build-up on the floor of the vault, in the forebay, and on top of the internal components.
6. Using appropriate equipment offload the replacement cartridges (up to 150 lbs. each) and set aside.
7. Remove used cartridges from the vault using one of the following methods:

Method 1:

A. This activity will require that maintenance personnel enter the vault to remove the cartridges from the under drain manifold and place them under the vault opening for lifting (removal). Disconnect each filter cartridge from the underdrain connector by rotating counterclockwise 1/4 of a turn. Roll the loose cartridge, on edge, to a convenient spot beneath the vault access.

   Using appropriate hoisting equipment, attach a cable from the boom, crane, or tripod to the loose cartridge. Contact Contech Engineered Solutions for suggested attachment devices.

B. Remove the used cartridges (up to 250 lbs. each) from the vault.



Important: Care must be used to avoid damaging the cartridges during removal and installation. The cost of repairing components damaged during maintenance will be the responsibility of the owner.

C. Set the used cartridge aside or load onto the hauling truck.

D. Continue steps a through c until all cartridges have been removed.

Method 2:

A. This activity will require that maintenance personnel enter the vault to remove the cartridges from the under drain manifold and place them under the vault opening for lifting (removal). Disconnect each filter cartridge from the underdrain connector by rotating counterclockwise 1/4 of a turn. Roll the loose cartridge, on edge, to a convenient spot beneath the vault access.

B. Unscrew the cartridge cap.

C. Remove the cartridge hood and float.

D. At location under structure access, tip the cartridge on its side.

E. Empty the cartridge onto the vault floor. Reassemble the empty cartridge.

F. Set the empty, used cartridge aside or load onto the hauling truck.

G. Continue steps a through e until all cartridges have been removed.

8. Remove accumulated sediment from the floor of the vault and from the forebay. This can most effectively be accomplished by use of a vacuum truck.
9. Once the sediments are removed, assess the condition of the vault and the condition of the connectors.
10. Using the vacuum truck boom, crane, or tripod, lower and install the new cartridges. Once again, take care not to damage connections.
11. Close and fasten the door.
12. Remove safety equipment.
13. Finally, dispose of the accumulated materials in accordance with applicable regulations. Make arrangements to return the used **empty** cartridges to Contech Engineered Solutions.

Material Disposal

The accumulated sediment found in stormwater treatment and conveyance systems must be handled and disposed of in accordance with regulatory protocols. It is possible for sediments to contain measurable concentrations of heavy metals and organic chemicals (such as pesticides and petroleum products). Areas with the greatest potential for high pollutant loading include industrial areas and heavily traveled roads.

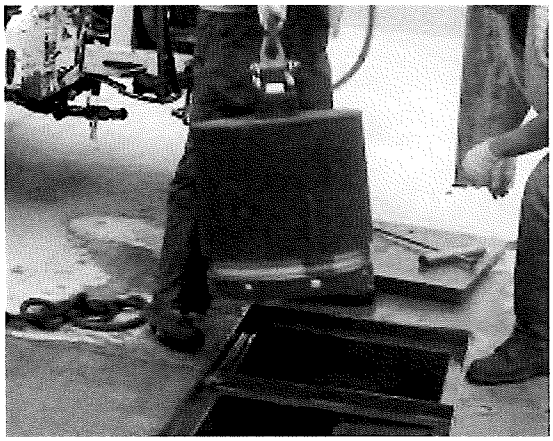
Sediments and water must be disposed of in accordance with all applicable waste disposal regulations. When scheduling maintenance, consideration must be made for the disposal of solid and liquid wastes. This typically requires coordination with a local landfill for solid waste disposal. For liquid waste disposal a number of options are available including a municipal vacuum truck decant facility, local waste water treatment plant or on-site treatment and discharge.

Related Maintenance Activities - Performed on an as-needed basis

StormFilter units are often just one of many structures in a more comprehensive stormwater drainage and treatment system.

In order for maintenance of the StormFilter to be successful, it is imperative that all other components be properly maintained. The maintenance/repair of upstream facilities should be carried out prior to StormFilter maintenance activities.

In addition to considering upstream facilities, it is also important to correct any problems identified in the drainage area. Drainage area concerns may include: erosion problems, heavy oil loading, and discharges of inappropriate materials.



CONTECH® ENGINEERED SOLUTIONS

OPERATION AND MAINTENANCE

CatchBasin StormFilter™

Maintenance Guidelines

Maintenance procedures for typical catch basins can be applied to the CatchBasin StormFilter (CBSF). The filter cartridges contained in the CBSF are easily removed and replaced during maintenance activities according to the following guidelines.

1. Establish a safe working area as per typical catch basin service activity.
2. Remove steel grate and diamond plate cover (weight 100 lbs. each).
3. Turn cartridge(s) counter-clockwise to disconnect from pipe manifold.
4. Remove 4" center cap from cartridge and replace with lifting cap.
5. Remove cartridge(s) from catch basin by hand or with vactor truck boom.
6. Remove accumulated sediment via vactor truck (min. clearance 13" x 24").
7. Remove accumulated sediment from cartridge bay. (min. clearance 9.25" x 11").
8. Rinse interior of both bays and vactor remaining water and sediment.
9. Install fresh cartridge(s) threading clockwise to pipe manifold.
10. Replace cover and grate.
11. Return original cartridges to Contech for cleaning.

Media may be removed from the filter cartridges using the vactor truck before the cartridges are removed from the catch basin structure. Empty cartridges can be easily removed from the catch basin structure by hand. Empty cartridges should be reassembled and returned to Contech as appropriate.

Materials required include a lifting cap, vactor truck and fresh filter cartridges. Contact Contech for specifications and availability of the lifting cap. The vactor truck must be equipped with a hose capable of reaching areas of restricted clearance. the owner may refresh spent cartridges. Refreshed cartridges are also available from Contech on an exchange basis. Contact the maintenance department of Contech at 503-258-3157 for more information.

Maintenance is estimated at 26 minutes of site time. For units with more than one cartridge, add approximately 5 minutes for each additional cartridge. Add travel time as required.

Mosquito Abatement

In certain areas of the United States, mosquito abatement is desirable to reduce the incidence of vectors.

In BMPs with standing water, which could provide mosquito breeding habitat, certain abatement measures can be taken.

1. Periodic observation of the standing water to determine if the facility is harboring mosquito larvae.
2. Regular catch basin maintenance.
3. Use of larvicides containing Bacillus thuringiensis israelensis (BTI). BTI is a bacterium toxic to mosquito and black fly larvae.

In some cases, the presence of petroleum hydrocarbons may interrupt the mosquito growth cycle.

Using Larvicides in the CatchBasin StormFilter

Larvicides should be used according to manufacturer's recommendations.

Two widely available products are Mosquito Dunks and Summit B.t.i. Briquets. For more information, visit http://www.summitchemical.com/mos_ctrl/d efault.htm.

The larvicide must be in contact with the permanent pool. The larvicide should also be fastened to the CatchBasin StormFilter by string or wire to prevent displacement by high flows. A magnet can be used with a steel catch basin.

For more information on mosquito abatement in stormwater BMPs, refer to the following: http://www.ucmrp.ucdavis.edu/publications/managingmosquitoesstormwater8125.pdf

Inspection Report

Date: _____ Personnel: _____

Location: _____ System Size: _____ Months in Service: _____

System Type: Vault ☐ Cast-In-Place ☐ Linear Catch Basin ☐ Manhole ☐ Other: _____

Sediment Thickness in Forebay: _____ Date: _____

Sediment Depth on Vault Floor: _____

Sediment Depth on Cartridge Top(s): _____

Structural Damage: _____

Estimated Flow from Drainage Pipes (if available): _____

Cartridges Submerged: Yes ☐ No ☐ Depth of Standing Water: _____

StormFilter Maintenance Activities (check off if done and give description)

☐ Trash and Debris Removal: _____

☐ Minor Structural Repairs: _____

☐ Drainage Area Report _____

Excessive Oil Loading: Yes ☐ No ☐ Source: _____

Sediment Accumulation on Pavement: Yes ☐ No ☐ Source: _____

Erosion of Landscaped Areas: Yes ☐ No ☐ Source: _____

Items Needing Further Work: _____

Owners should contact the local public works department and inquire about how the department disposes of their street waste residuals.

Other Comments:

_____

_____

_____

_____

_____

_____

_____

_____

Review the condition reports from the previous inspection visits.

StormFilter Maintenance Report

Date: _____ Personnel: _____

Location: _____ System Size: _____

System Type: Vault ☐ Cast-In-Place ☐ Linear Catch Basin ☐ Manhole ☐ Other: _____

List Safety Procedures and Equipment Used: _____

System Observations

Months in Service: _____

Oil in Forebay (if present): Yes ☐ No ☐

Sediment Depth in Forebay (if present): _____

Sediment Depth on Vault Floor: _____

Sediment Depth on Cartridge Top(s): _____

Structural Damage: _____

Drainage Area Report

Excessive Oil Loading: Yes ☐ No ☐ Source: _____

Sediment Accumulation on Pavement: Yes ☐ No ☐ Source: _____

Erosion of Landscaped Areas: Yes ☐ No ☐ Source: _____

StormFilter Cartridge Replacement Maintenance Activities

Remove Trash and Debris: Yes ☐ No ☐ Details: _____

Replace Cartridges: Yes ☐ No ☐ Details: _____

Sediment Removed: Yes ☐ No ☐ Details: _____

Quantity of Sediment Removed (estimate?):

Minor Structural Repairs: Yes ☐ No ☐ Details: _____

Residuals (debris, sediment) Disposal Methods: _____

Notes:

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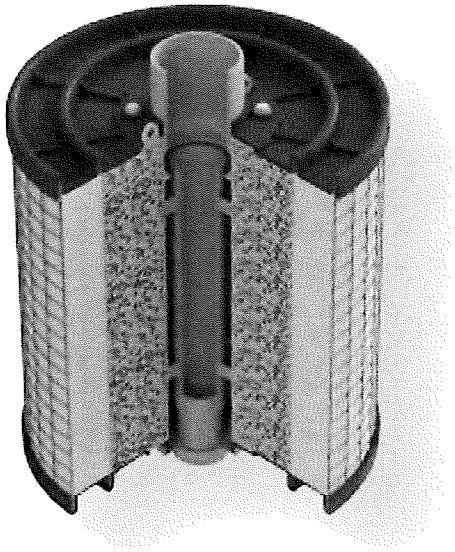
Oldcastle Infrastructure
A CRH COMPANY

TREATMENT FACILITIES IN PUBLIC ROW- OLDCASTLE PERK FILTERS

PERKFILTER®

Inspection and Maintenance Guide



Water

PerkFilter Media Filtration System

Description

The PerkFilter is a stormwater treatment device used to remove pollutants from urban runoff. Impervious surfaces and other urban and suburban landscapes generate a variety of contaminants that can enter stormwater and pollute downstream receiving waters. The PerkFilter is a media-filled cartridge filtration device designed to capture and retain sediment, gross solids, metals, nutrients, hydrocarbons, and trash and debris. As with any stormwater treatment system, the PerkFilter requires periodic maintenance to sustain optimum system performance.

Function

The PerkFilter is a water quality treatment system consisting of three chambers: an inlet chamber, a filter cartridge treatment chamber, and an outlet chamber (Figure 1). Stormwater runoff enters the inlet chamber through an inlet pipe, curb opening, or grated inlet. Gross solids are settled out and floating trash and debris are trapped in the inlet chamber. Pretreated flow is then directed to the treatment chamber through an opening in the baffle wall between the inlet chamber and treatment chamber. The treatment chamber contains media-filled filter cartridges (Figure 2) that use physical and chemical processes to remove pollutants. During a storm event, runoff pools in the treatment chamber before passing radially through the cylindrical cartridges from the outside surface, through the media for treatment, and into the center of the cartridge. At the center of the cartridge is a center tube assembly designed to distribute the hydraulic load evenly across the surface of the filter cartridge and control the treatment flow rate. The center tube assembly discharges treated flow through the false floor and into the outlet chamber. A draindown feature built into each cartridge allows the treatment chamber to dewater between storm events.

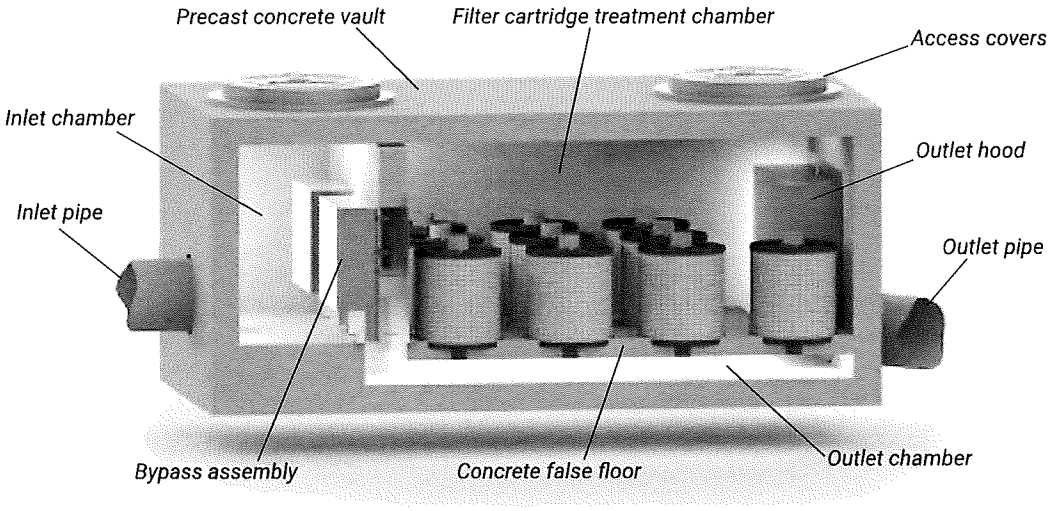
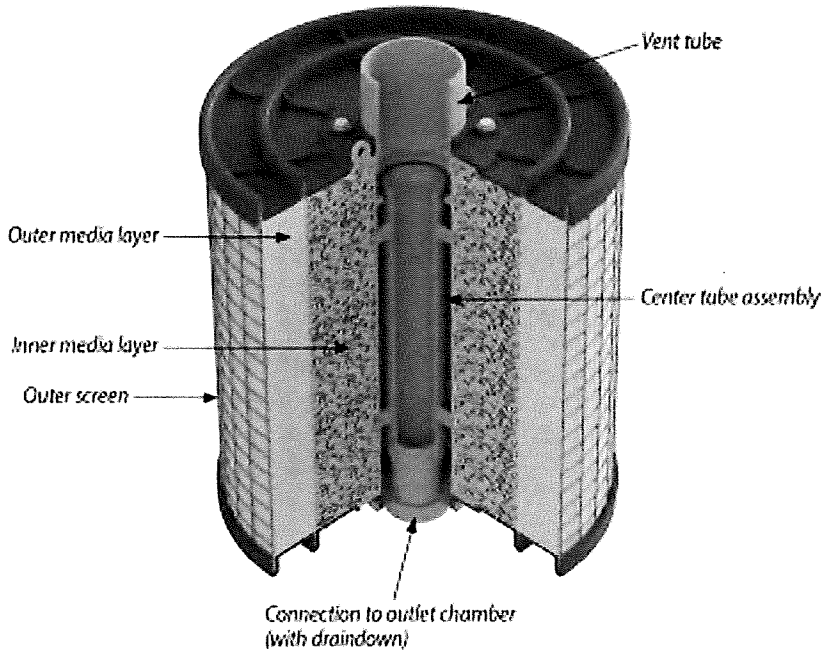


Figure 1. Schematic of the PerkFilter System.

All PerkFilter systems include a high flow bypass assembly to divert flow exceeding the treatment capacity of the filter cartridges around the treatment chamber. The bypass assembly routes peak flow from the inlet chamber directly to the outlet chamber, bypassing the treatment chamber to prevent sediment and other captured pollutants from being scoured and re-entrained by high flow. Treated flow and bypass flow merge in the outlet chamber for discharge by a single outlet pipe.



Configuration

The PerkFilter structure may consist of a vault, manhole, or catch basin configuration. Catch basin units may be fabricated from concrete or steel. Internal components including the PerkFilter cartridges are manufactured from durable plastic and stainless steel components and hardware. All cartridges are 18 inches in diameter and are available in two heights: 12-inch and 18-inch. Cartridges may be used alone or may be stacked (Figure 3) to provide 24-inch and 30-inch combinations. The capacity of each cartridge or cartridge combination is dictated by the allowable operating rate of the media and the outer surface area of the cartridge. Thus, taller cartridges have greater treatment capacity than shorter cartridges but they also require more hydraulic drop across the system. Cartridges may be filled with a wide variety of media but the standard mix is composed of zeolite, perlite and carbon (ZPC).

Access to an installed PerkFilter system is typically provided by ductile iron castings or hatch covers. The location and number of access appurtenances is dependent on the size and configuration of the system.

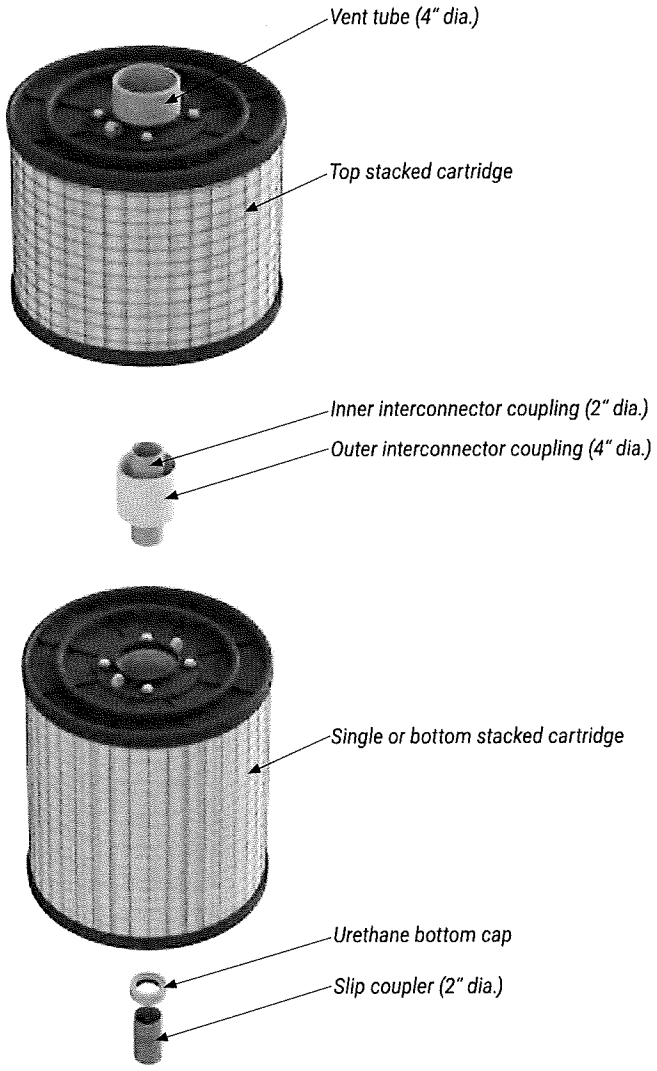


Figure 3. Schematic of stacked cartridges and connector components.

Maintenance Overview

State and local regulations require all stormwater management systems to be inspected on a periodic basis and maintained as necessary to ensure performance and protect downstream receiving waters. Maintenance prevents excessive pollutant buildup that can limit system performance by reducing the operating capacity and increasing the potential for scouring of pollutants during periods of high flow.

Inspection and Maintenance Frequency

The PerkFilter should be inspected on a periodic basis, typically twice per year, and maintained as required. Initially, inspections of a new system should be conducted more frequently to help establish an appropriate site-specific inspection frequency. The maintenance frequency will be driven by the amount of runoff and pollutant loading encountered by a given system. In most cases, the optimum maintenance interval will be one to three years. Inspection and maintenance activities should be performed only during dry weather periods.

Inspection Equipment

The following equipment is helpful when conducting PerkFilter inspections:

- Recording device (pen and paper form, voice recorder, iPad, etc.)
- Suitable clothing (appropriate footwear, gloves, hardhat, safety glasses, etc.)
- Traffic control equipment (cones, barricades, signage, flagging, etc.)
- Socket and wrench for bolt-down access covers
- Manhole hook or pry bar
- Flashlight
- Tape measure
- Measuring stick or sludge sampler
- Long-handled net (optional)

Inspection Procedures

PerkFilter inspections are visual and may be conducted from the ground surface without entering the unit. To complete an inspection, safety measures including traffic control should be deployed before the access covers are removed. Once the covers have been removed, the following items should be checked and recorded (see form provided at the end of this document) to determine whether maintenance is required:

- Inspect the internal components and note whether there are any broken or missing parts. In the unlikely event that internal parts are broken or missing, contact Oldcastle Infrastructure at (800) 579-8819 to determine appropriate corrective action.
- Note whether the inlet pipe is blocked or obstructed. The outlet pipe is covered by a removable outlet hood and cannot be observed without entering the unit.
- Observe, quantify and record the accumulation of floating trash and debris in the inlet chamber. The significance of accumulated floating trash and debris is a matter of judgment. A long-handled net may be used to retrieve the bulk of trash and debris at the time of inspection if full maintenance due to accumulation of floating oils or settled sediment is not yet warranted.

- Observe, quantify and record the accumulation of oils in the inlet chamber. The significance of accumulated floating oils is a matter of judgment. However, if there is evidence of an oil or fuel spill, immediate maintenance by appropriate certified personnel is warranted.
- Observe, quantify and record the average accumulation of sediment in the inlet chamber and treatment chamber. A calibrated dipstick, tape measure, or sludge sampler may be used to determine the amount of accumulated sediment in each chamber. The depth of sediment may be determined by calculating the difference between the measurement from the rim of the PerkFilter to the top of the accumulated sediment and the measurement from the rim of the PerkFilter to the bottom of the PerkFilter structure. Finding the top of the accumulated sediment below standing water takes some practice and a light touch, but increased resistance as the measuring device is lowered toward the bottom of the unit indicates the top of the accumulated sediment.
- Finally, observe, quantify and record the amount of standing water in the treatment chamber around the cartridges. If standing water is present, do not include the depth of sediment that may have settled out below the standing water in the measurement.

Maintenance Triggers

Maintenance should be scheduled if any of the following conditions are identified during the inspection:

- Internal components are broken or missing.
- Inlet piping is obstructed.
- The accumulation of floating trash and debris that cannot be retrieved with a net and/or oil in the inlet chamber is significant.
- There is more than 6" of accumulated sediment in the inlet chamber.
- There is more than 4" of accumulated sediment in the treatment chamber.
- There is more than 4" of standing water in the treatment chamber more than 24 hours after end of rain event.
- A hazardous material release (e.g. automotive fluids) is observed or reported.
- The system has not been maintained for 3 years (wet climates) to 5 years (dry climates).

Maintenance Equipment

The following equipment is helpful when conducting PerkFilter maintenance:

- Suitable clothing (appropriate footwear, gloves, hardhat, safety glasses, etc.)
- Traffic control equipment (cones, barricades, signage, flagging, etc.)
- Socket and wrench for bolt-down access covers
- Manhole hook or pry bar
- Confined space entry equipment, if needed
- Flashlight
- Tape measure
- 9/16" socket and wrench to remove hold-down struts and filter cartridge tops
- Replacement filter cartridges
- Vacuum truck with water supply and water jet

Contact Oldcastle Infrastructure at (800) 579-8819 for replacement Filter cartridges. A lead time of four weeks is recommended.

Maintenance Procedures

Maintenance should be conducted during dry weather when no flow is entering the system. Confined space entry is necessary to maintain vault and manhole PerkFilter configurations. Only personnel that are OSHA Confined Space Entry trained and certified may enter underground structures. Confined space entry is not required for catch basin PerkFilter configurations. Once safety measures such as traffic control are deployed, the access covers may be removed and the following activities may be conducted to complete maintenance:

- Remove FLoating trash, debris and oils from the water surface in the inlet chamber using the extension nozzle on the end of the boom hose of the vacuum truck. Continue using the vacuum truck to completely dewater the inlet chamber and evacuate all accumulated sediment from the inlet chamber. Some jetting may be required to fully remove sediment. The inlet chamber does not need to be reFilled with water after maintenance is complete. The system will Fill with water when the next storm event occurs.
- Remove the hold-down strut from each row of Filter cartridges and then remove the top of each cartridge (the top is held on by four 9/16" bolts) and use the vacuum truck to evacuate the spent media. When empty, the spent cartridges may be easily lifted off their slip couplers and removed from the vault. The couplers may be left inserted into couplings cast into the false FLoor to prevent sediment and debris from being washed into the outlet chamber during washdown.
- Once all the spent cartridges have been removed from the structure, the vacuum truck may be used to evacuate all accumulated sediment from the treatment chamber. Some jetting may be required to fully remove sediment. Take care not to wash sediment and debris through the openings in the false FLoor and into the outlet chamber. All material removed from the PerkFilter during maintenance including the spent media must be disposed of in accordance with local, state, and/or federal regulations. In most cases, the material may be handled in the same manner as disposal of material removed from sumped catch basins or manholes.
- Place a fresh cartridge in each cartridge position using the existing slip couplers and urethane bottom caps. If the vault is equipped with stacked cartridges, the existing outer and inner interconnector couplers must be used between the stacked cartridges to provide hydraulic connection. Transfer the existing vent tubes from the spent cartridges to the fresh cartridges. Finally, reFIt the struts to hold the fresh cartridges in place.
- Securely replace access covers, as appropriate.
- Make arrangements to return the empty spent cartridges to Oldcastle Infrastructure.

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PerkFilter
Inspection and Maintenance Log

Location_____

Structure Configuration and Size:

Inspection Date_____

☐ Vault ____feet x ____feet
☐ Manhole ____feet diameter
☐ Catch Basin ____feet x ____feet

Number and Height of Cartridge Stacks:

Count____each ☐12" ☐18" ☐24" ☐30"

Media Type:

☐ ZPC ☐ Perlite ☐ Other_____

Condition of Internal Components ☐ Good ☐ Damaged ☐ Missing	Notes:
Inlet or Outlet Blockage or Obstruction ☐ Yes ☐ No	Notes:
Floating Trash and Debris ☐ Significant ☐ Not Significant	Notes:
Floating Oils ☐ Significant ☐ Not Significant ☐ Spill	Notes:
Sediment Depth in Inlet Chamber ☐ Inches of Sediment:_____	Notes:
Sediment Depth in Treatment Chamber ☐ Inches of Sediment:_____	Notes:
Standing Water in Treatment Chamber ☐ Inches of Standing Water:_____	Notes:

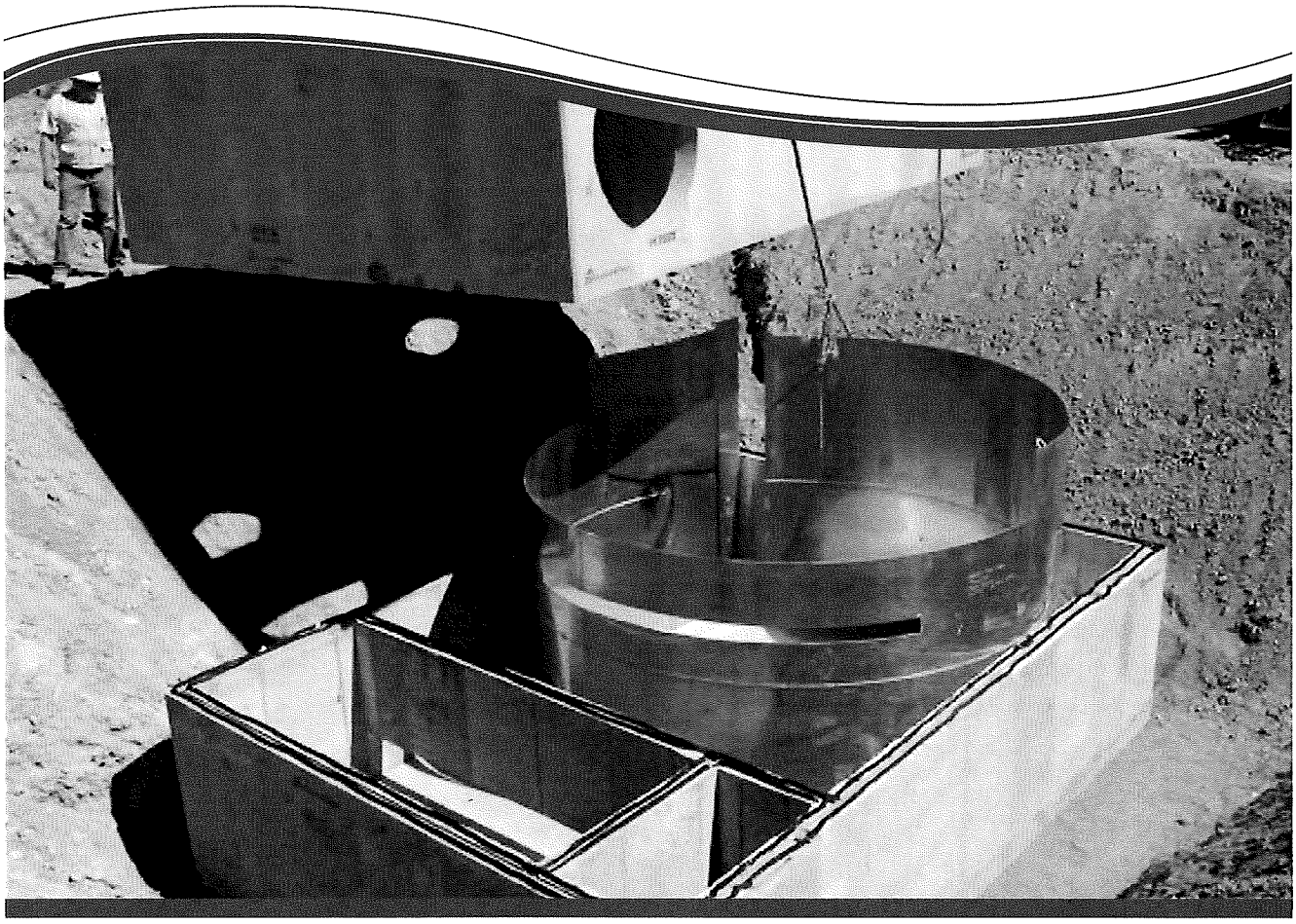
Maintenance Required

☐ **Yes - Schedule Maintenance** ☐ **No - Inspect Again in _____ Months**

CONTECH®
ENGINEERED SOLUTIONS

VORTECHS VAULT - REPLACEMENT IN KIND

Vortechs®
Operation and Maintenance



Vortechs®

Vortechs®

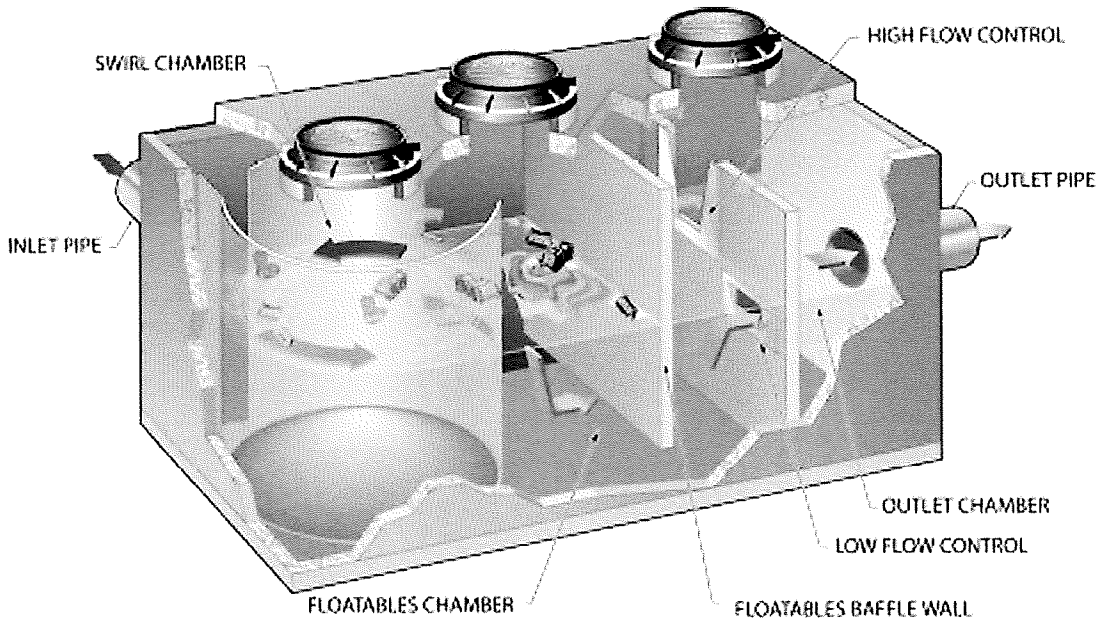
The Vortechs system is a high-performance hydrodynamic separator that effectively removes finer sediment (e.g. 50-microns (μm), oil, and floating and sinking debris. The swirl concentration operation and flow controls work together to minimize turbulence and provide stable storage of captured pollutants. Precast models can treat peak design flows up to 30-cfs (850-L/s); cast-in-place models handle even greater flows. A typical system is sized to provide a specific removal efficiency of a predefined particle size distribution (PSD).

Operation Overview

Stormwater enters the swirl chamber inducing a gentle swirling flow pattern and enhancing gravitational separation. Sinking pollutants stay in the swirl chamber while floatables are stopped at the baffle wall. Vortechs systems are usually sized to efficiently treat the frequently occurring runoff events and are primarily controlled by the low flow control orifice. This orifice effectively reduces inflow velocity and turbulence by inducing a slight backwater that is appropriate to the site.

During larger storms, the water level rises above the low flow control orifice and begins to flow through the high flow control. Any layer of floating pollutants is elevated above the invert of the Floatables Baffle Wall, preventing release. Swirling action increases in relation to the storm intensity, while sediment pile remains stable. When the storm drain is flowing at peak capacity, the water surface in the system approaches the top of the high flow control. The Vortechs system will be sized large enough so that previously captured pollutants are retained in the system, even during these infrequent events.

As a storm subsides, treated runoff decants out of the Vortechs system at a controlled rate, restoring the water level to a dry-weather level equal to the invert of the inlet pipe. The low water level facilitates easier inspection and cleaning, and significantly reduces maintenance costs by reducing pump-out volume.



Maintenance

The Vortechs system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit, e.g., unstable soils or heavy winter sanding will cause the swirl chamber to fill more quickly but regular sweeping will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant deposition and transport may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. Inspections should be performed twice per year (i.e. spring and fall) however more frequent inspections may be necessary in equipment washdown areas and in climates where winter sanding operations may lead to rapid accumulations. It is useful and often required as part of a permit to keep a record of each inspection. A simple inspection and maintenance log form for doing so is provided on the following page, and is also available on conteches.com.

The Vortechs system should be cleaned when inspection reveals that the sediment depth has accumulated to within 12 to 18 inches (300 to 450 mm) of the dry-weather water surface elevation. This determination can be made by taking two measurements with a stadia rod or similar measuring device; one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. Note: To avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile. Finer, silty particles at the top of the pile typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile.

Cleaning

Cleaning of the Vortechs system should be done during dry weather conditions when no flow is entering the system. Clean-out of the Vortechs system with a vacuum truck is generally the most effective and convenient method of excavating pollutants from the system. If such a truck is not available, a "clamshell" grab may be used, but it is difficult to remove all accumulated pollutants using a "clamshell".

In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, an oil or gasoline spill should be cleaned out immediately. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use adsorbent pads to solidify the oil since these pads are usually much easier to remove from the unit individually and less expensive to dispose of than the oil/water emulsion that may be created by vacuuming the oily layer. Floating trash can be netted out if you wish to separate it from the other pollutants.

Cleaning of a Vortechs system is typically done by inserting a vacuum hose into the swirl chamber and evacuating this chamber of water and pollutants. As water is evacuated, the water level outside of the swirl chamber will drop to a level roughly equal to the crest of the lower aperture of the swirl chamber. The water outside the swirl chamber should remain near this level throughout pumping as the bottom and sides of the swirl chamber are sealed to the tank floor and walls. This "water lock" feature prevents water from migrating into the swirl chamber, exposing the bottom of the baffle wall and creating excess pump-out volume. Floating pollutants will decant into the swirl chamber as the water level is drawn down. This allows most floating material to be withdrawn from the same access point above the swirl chamber. Floating material that does not decant into the swirl chamber during draw down should be skimmed from the baffle chamber. If maintenance is not performed as recommended, sediment may accumulate outside the swirl chamber. If this is the case, it may be necessary to pump out other chambers. It is advisable to check for sediment accumulation in all chambers during inspection and maintenance.

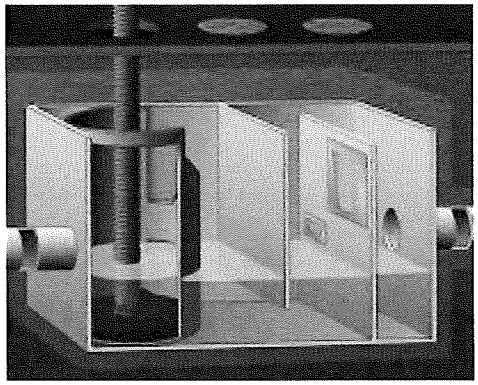
These maintenance recommendations apply to all Vortechs systems with the following exceptions:

1. It is strongly recommended that when cleaning systems larger than the Model 16000 the baffle chamber be drawn down to depth of three feet prior to beginning clean-out of the swirl chamber. Drawing down this chamber prior to the swirl chamber reduces adverse structural forces pushing upstream on the swirl chamber once that chamber is empty.
2. Entry into a Vortechs system is generally not required as cleaning can be done from the ground surface. However, if manned entry into a system is required the entire system should be evacuated of water prior to entry regardless of the system size.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure proper safety precautions. If anyone physically enters the unit, Confined Space Entry procedures need to be followed.

Disposal of all material removed from the Vortechs system should be done in accordance with local regulations. In many locations, disposal of evacuated sediments may be handled in the same manner as disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal.

Contech has created a network of Certified Maintenance Providers (CCMP's) to provide maintenance on Vortechs systems. To find a CCMP in your area please visit www.conteches.com/maintenance.

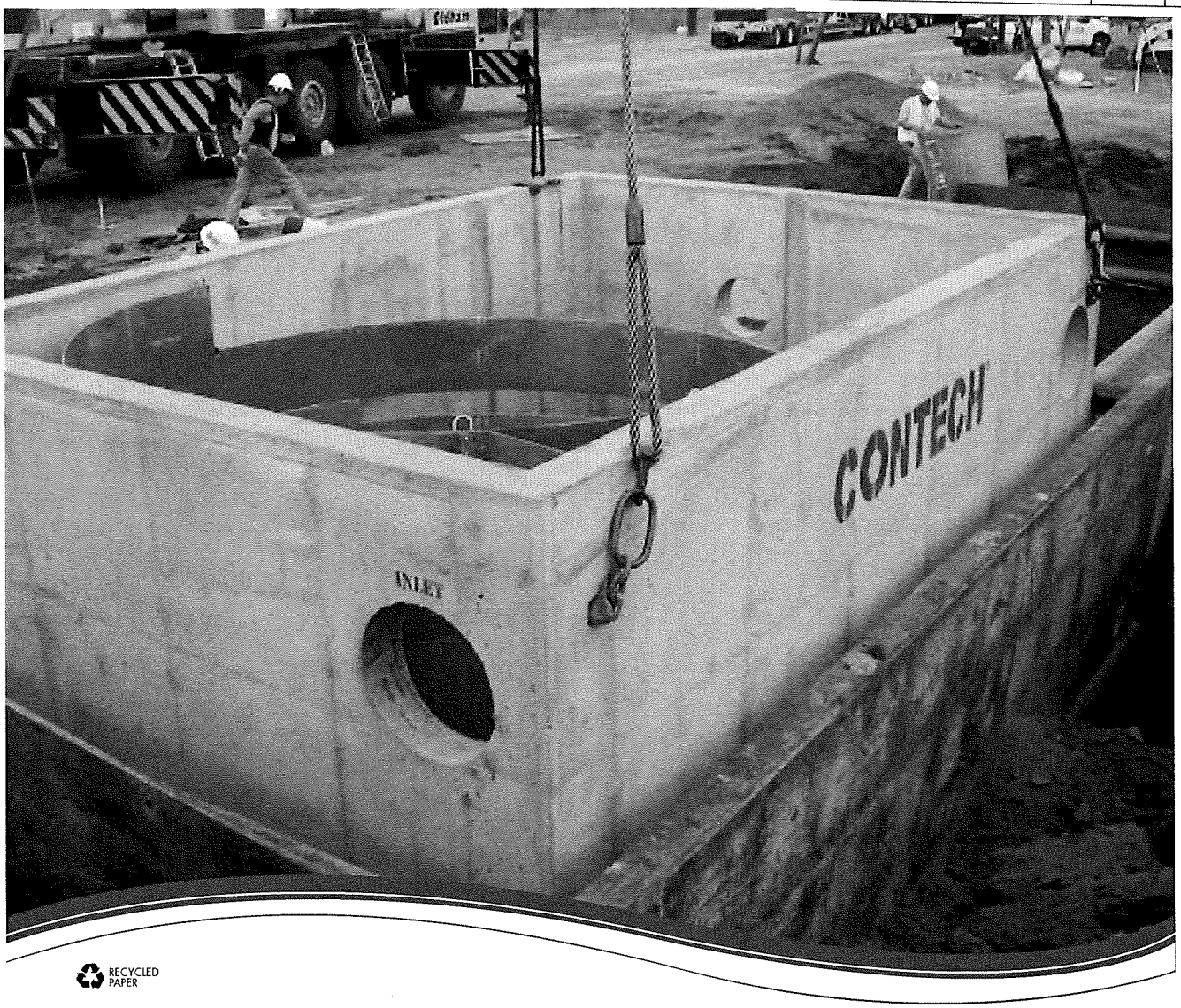


Vortechs Inspection & Maintenance Log

Vortech Model: _____ **Location:** _____

Date	Water depth to sediment	Floatable layer thickness	Describe maintenance performed	Maintenance personnel	Comments

1. The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than eighteen inches the system should be cleaned out. Note: To avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile.
2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.



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va_manual 04/15 PDF Revision

RANGE	TOWNSHIP	SECTION	QUARTER	100	72/74
04E-	20 N-	28	01		
DOCUMENT NUMBER				SERIAL NUMBER	PAGE NUMBER

Exhibit B

Annual Inspection Report

City of Puyallup - Stormwater BMP Facilities Inspection and Maintenance Log

Facility Name _____

Address _____

Begin Date _____ End Date _____

Date	BMP ID#	BMP Facility Description	Inspected by:	Cause for Inspection	Exceptions Noted	Comments and Actions Taken

Instructions:

Record all inspections and maintenance for all treatment BMPs on this form. Use additional log sheets and/or attach extended comments or documentation as necessary. Submit a copy of the completed log with the Annual Independent Inspectors' Report to the City, and start a new log at that time.

BMP ID# — Always use ID# from the Operation and Maintenance Manual.
Inspected by — Note all inspections and maintenance on this form, including the required independent annual inspection.
Cause for inspection — Note if the inspection is routine, pre-rainy-season, post-storm, annual, or in response to a noted problem or complaint.
Exceptions noted — Note any condition that requires correction or indicates a need for maintenance.
Comments and actions taken — Describe any maintenance done and need for follow-up.

Return Form to: Stormwater Engineer/City of Puyallup
333 South Meridian
Puyallup, WA 98371

Annual Inspection Report

City of Puyallup - Stormwater BMP Facilities Inspection and Maintenance Log

Facility Name _____

Date	BMP ID#	BMP Facility Description	Inspected by:	Cause for Inspection	Exceptions Noted	Comments and Actions Taken