

**PRP Report and Strategy Plan for Willistown Township
MS4 Individual Permit Application 2018**

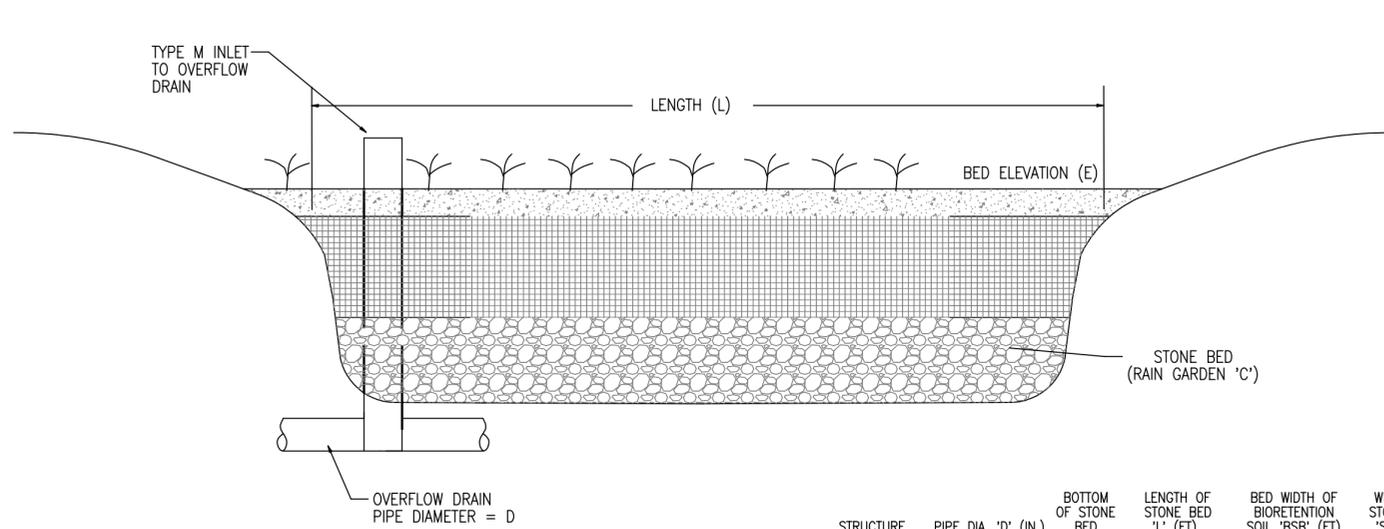
Appendix J

Example BMP Details

(See Appendix F for Subdivision Details)

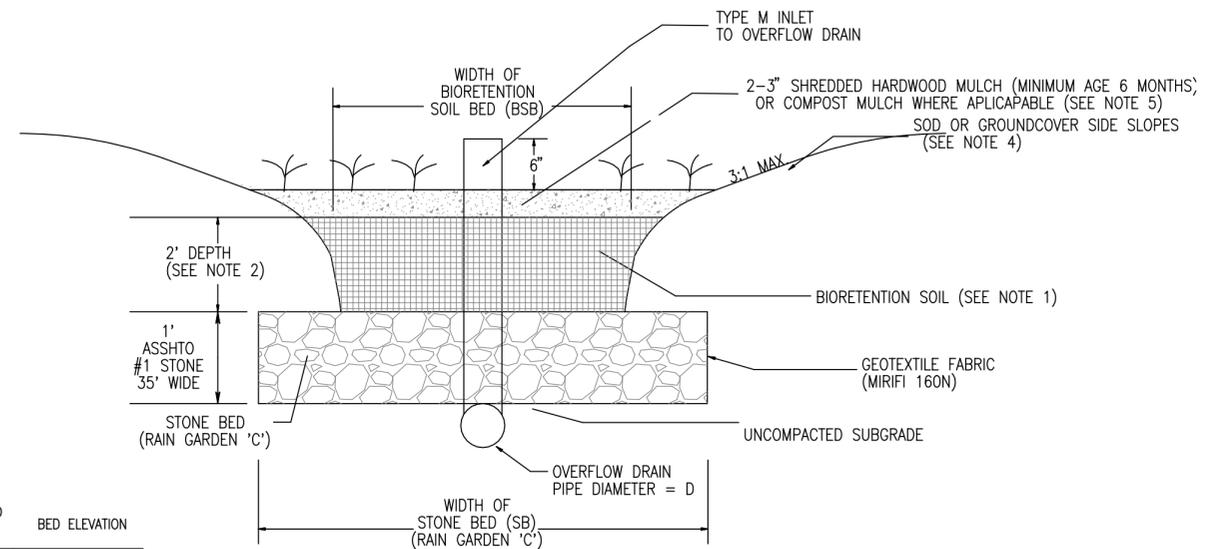
**PRP Report and Strategy Plan for Willistown Township
MS4 Individual Permit Application 2018**

Existing Basin Retrofit to a Bioretention / Raingarden with Under Drain Construction
Detail



PROFILE

STRUCTURE	PIPE DIA. 'D' (IN.)	BOTTOM OF STONE BED	LENGTH OF STONE BED 'L' (FT)	BED WIDTH OF BIORETENTION SOIL 'BSB' (FT)	WIDTH OF STONE BED 'SB' (FT)	BED ELEVATION
RAIN GARDEN A	15"			20		425.0
RAIN GARDEN B	15"			20		426.0
RAIN GARDEN C	15"	420.00	135	8	35	425.0



CROSS-SECTION

Rain Garden General Notes:

- Bioretention Soil Mixture.** The Bioretention Soil Mixture (BSM) is a mixture of planting soil, organics (i.e. mulch), and sand consisting of the following:

ITEM	COMPOSITION BY VOLUME	REFERENCE
Planting Soil	30%	See Comment 3 Below
Organics	30%	See Comment 3 Below
Sand	30%	ASTM C33 Fine Aggregate

The remaining 10% shall be made up of any combination of planting soil, organics, and/or sand.
 - At least 45 days prior to the start of construction of bioretention facilities, the Contractor shall submit the source of the Planting Soil for the BSM to the Engineer for approval. No time extensions will be granted should the proposed Planting Soil fail to meet the minimum requirements stated above. Once a stockpile of the Planting Soil has been sampled, no material shall be added to the stockpile. (See Comment 4)

The Bioretention Soil Mixture (BSM) shall be a uniform mix, free of stones, stumps, roots or other similar objects larger than two inches excluding mulch. No other materials or substances shall be mixed or dumped within the bioretention area that may be harmful to plant growth, or prove a hindrance to the planting or maintenance operations.
 - PLANT MATERIAL.** Plants suitable for use in Rain Gardens include: asters (*Aster* spp.) and goldenrods (*Solidago* spp.), beebalm (*Monarda didyma*), bergamot (*Monarda fistulosa*), ironweed (*Vernonia noveboracensis*), blue vervain (*Verbena hastata*), spotted and purple Joe-pye weed (*Eupatorium* spp.), swamp milkweed (*Asclepias incarnata*), switchgrass (*Panicum virgatum*), shrub dogwoods (*Cornus* spp.), swamp rose (*Rosa palustris*), inkberry (*Ilex glabra*), arrowwood (*Viburnum dentatum*), sweet pepperbush (*Clethra alnifolia*), bayberry (*Myrica pennsylvanica*), elderberry (*Sambucus canadensis*), serviceberry (*Amerlanchier arborea*), sweetbay magnolia (*Magnolia virginiana*), green ash (*Fraxinus pennsylvanica*), river birch (*Betula nigra*), sweetgum (*Liquidambar styraciflua*), Ironwood (*Carpinus caroliniana*), eastern red cedar (*Juniperus virginiana*), and red maple (*Acer rubrum*).
- Plant materials shall be able to tolerate saturated soil conditions for the length of time anticipated in the design storm event, as well as drought conditions, snow melt chemicals, and other anticipated runoff constituents.
- Construction. Bioretention facilities shall not be constructed until all contributing drainage areas are stabilized as shown on the Contract Plans and to the satisfaction of the Engineer. Bioretention facilities shall not be used as sediment control facilities. No heavy equipment shall operate within the perimeter of a bioretention facility during excavation, underdrain placement, backfilling, planting, or mulching of the facility.
 - Excavation. The bioretention facility shall be excavated to the dimensions, side slopes, and elevations shown on the Contract Plans. The method of excavation shall minimize the compaction of the bottom of the bioretention facility. Excavators and backhoes, operating on the ground adjacent to the bioretention facility, shall be used to excavate the facility if possible. Low ground-contact pressure equipment may also be used for excavation. No heavy equipment shall be allowed on the bottom of the bioretention facility. (See Comment 6)

Excavated materials shall be removed from the bioretention facility site. Excavated materials shall be used or disposed of in conformance with Section 201. Prior to placing the underdrain and the BSM, the bottom of the excavation shall be roto-tilled to a minimum depth of 6 inches to alleviate any compaction of the facility bottom. Any substitute method for roto-tilling must be approved by the Engineer prior to use. Any ponded water shall be removed from the bottom of the facility and the soil shall be friable before roto-tilling.
 - Placement and Compaction of the Bioretention Soil Mixture. The Bioretention Soil Mixture (BSM) shall be placed and graded using low ground-contact pressure equipment or by excavators and/or backhoes operating on the ground adjacent to the bioretention facility. (See Comment 9) No heavy equipment shall be used within the perimeter of the bioretention facility before, during, or after the placement of the BSM. The BSM shall be placed in horizontal layers not to exceed 12 inches for the entire area of the bioretention facility. The BSM shall be compacted by saturating the entire area of the bioretention facility after each lift of BSM is placed until water flows from the underdrain. Water for saturation shall be applied by spraying or sprinkling. Saturation of each lift shall be performed in the presence of the Engineer. An appropriate sediment control device shall be used to treat any sediment-laden water discharged from the underdrain. If the BSM becomes contaminated during the construction of the facility, the contaminated material shall be removed and replaced with uncontaminated material at no additional cost to the Administration. Final grading of the BSM shall be performed after a 24-hour settling period. Final elevations shall be within 2 inches of elevations shown on the Contract Plans.
 - Plant Installation. Trees, shrubs, and other plant materials specified for Bioretention Facilities shall be planted as specified in the Contract Plans and applicable landscaping standards with the exception that pesticides, herbicides, and fertilizer shall not be applied during planting under any circumstances. Furthermore, pesticides, fertilizer, and any other soil amendments shall not be applied to the bioretention facility during landscape construction, plant establishment, or maintenance.
 - Mulching. Once the plants are in place, the entire bioretention facility shall be mulched to a uniform thickness of 3 inches. Well aged (minimum age of 6 months) shredded hardwood bark mulch is the only acceptable mulch. Mulch should be spread around trees and shrubs, but not over grass.

- MEASUREMENT AND PAYMENT.** Bioretention Facilities will not be measured but will be paid for at the Contract Bid Lump Sum Price. The payment will be full compensation for all applicable excavation, sheeting, shoring, de-watering, hauling, storing, re-handling of material, removal and disposal of excess and unsuitable material, underdrain, aggregate, underdrain outlet, furnishing, mixing, pH correction, potassium correction, magnesium correction, and placement of the BSM backfill, compaction of the BSM backfill by saturation, grading and slope adjustments, and for all material, labor, equipment, tools, and incidentals necessary satisfactorily complete the work.
- Mulch. Shredded hardwood bark shall consist of the bark from hardwood trees which has been milled and screened to a maximum 4 in. particle size and provide a uniform texture free from sawdust, foreign materials, and any artificially introduced chemical compounds that would be detrimental to plant or animal life.
- Plantings. Plant materials will be measured and paid for at the Contract unit price per each item specified in the Contract Documents. The payment will be full compensation for all supports, watering during the construction period and for all material, labor, equipment, tools, and incidentals necessary to complete the work. If at any time during the Contract period any plants become unacceptable, they shall be replaced at no additional cost to the contracting highway agency.
- Additional Watering of Plants. Additional Watering of Plants within bioretention facilities will be measured and paid for at the Contract unit price per 1000 gallons of water applied to the planting beds. Water will be measured by means of satisfactorily installed meters, or by measurements of tank capacities, or by acceptable documentation of tanks of predetermined capacity. The Contractor shall furnish the Engineer's representative with measurement and capacities to provide a complete and accurate record of the quantity of water furnished and applied. The payment will be full compensation for all water, material, labor, equipment, tools, and incidentals necessary to complete the work. No compensation will be allowed for water wasted or excess watering as determined by the Engineer. (See Comment 11)
- Chester County Conservation District. CCDD inspection and approval is required prior to removal of E & S BMP's and installation of stormwater facilities.

Copyright . 2003 Low Impact Development Center, Inc. All Rights Reserved.

- Comment 1.
Double-washed stone preferred to reduce suspended solids and potential for clogging.
- Comment 2.
This is to supply organic material, other sources can be used. Mulch is preferred because it can be obtained on site and it is relatively stable. Alternatives include compost and peat moss.
- Comment 3.
Avoid high clay content soils. They tend to create hard pans and clumps that reduce filtration and storage.
- Comment 4.
Allow sufficient time for testing. Suggest certified source or laboratory to reduce mobilization time and construction delays.
- Comment 5.
Use of flexible slotted HDPE is preferred. Large openings on PVC pipe may allow sediments and larger materials to migrate into system.
- Comment 6.
Equipment will compact bottom, reducing any infiltration capacity. The structure of the soil and pore space can be restored by aeration/rototill.
- Comment 7.
Wrapping pipe in silt sock or textile is discouraged. Smaller silt particle sizes may clog these systems.
- Comment 8.
The screw cap is used to control the rate of discharge. Larger underdrains and outlet structures. Openings in the orifice can be used to control rate. Cap should be removable for cleaning.
- Comment 9.
Make sure E&S is in place at outfall.
- Comment 10.
This should be done immediately after grading to reduce potential of any silt accumulation on surface.
- Comment 11.
It is suggested that a biodegradable berm constructed on a permeable geotextile tube filled with the bioretention soil and seedstock be left around the perimeter to filter sediment after construction. Other alternatives such as biologs are acceptable. Sediment loads can still be significant, even after permanent vegetation cover is established. These berms can be removed after the maintenance period.

Rain Garden Construction Sequence

- Install sediment control BMPs as shown on the plans.
- Complete site grading. If applicable, construct curb cuts or other inflow entrance but provide protection so that drainage is prohibited from entering construction area.
- Stabilize grading within the limit of disturbance except within the Rain Garden area. Rain Garden bed areas may be used as temporary sediment traps provided that the proposed finish elevation of the bed is 12 inches lower than the bottom elevation of the sediment trap.
- Excavate Rain Garden to proposed invert depth and scarify the existing soil surfaces.
- Install stone bed and overdrain system, as specified.
- Backfill Rain Garden with amended soil as shown on plans and specifications. Overfilling/Overfilling is recommended to account for settlement. Light hand tamping is acceptable if necessary.
- Presoak the planting soil prior to planting vegetation to aid in settlement.
- Complete final grading to achieve proposed design elevations, leaving space for upper layer of compost, mulch, or topsoil as specified on plans.
- Plant vegetation according to planting plan.
- Mulch and install erosion protection at surface flow entrances where necessary.

Guidelines and Inspection Points

- Active soil erosion control is the first line of defense against contamination of the bioretention area.
- All sediment control devices must be in place prior to the start of the main construction.
- Grading of any catchment area draining to the facility should be done sparingly and stabilized immediately (within 14 days).
- A bioretention cell should not be placed in service until all of the contributing drainage area has been stabilized and approved by the inspector.
- Soil materials should not be delivered until the bioretention site has been excavated or graded and the underdrain systems are in place. Planting materials should not be delivered until after the soil medium has had time to settle to the proper grade elevation.
- Prior to covering the underdrain system, the inspector must observe the underdrain itself, the connections, gravel bedding, and any filter fabric. Manufacturer's tickets are required for the gravel, pipe and filter fabric material.
- If placing gravel over the underdrain, avoid dropping it from high levels with a backhoe or front-end loader bucket. Spill directly over the underdrain and spread manually.
- Avoid over-compaction of the soil material by allowing time for natural compaction and settlement. No additional manual compaction of soil is necessary. To speed up the natural compaction process, presoaking the placed soil may be performed.
- Overfill above the proposed surface invert to accommodate natural settlement to the proper grade. Depending upon the soil material, up to 20% natural compaction may occur. If construction scheduling permits, it is preferable to allow natural settlement to occur with the help of rain events.
- The mulch layer surface should approximate the final elevation as shown on the design plans.
- All plant materials should be tagged for identification in accordance with the American Standard for Nursery Stock.
- The landscaping work and materials shall be guaranteed for a minimum of 1 growing season and a maximum of 2 years from the date of installation. The warrantee period begins when the as-built construction plan is approved.

(1) The Bioretention Manual, Prince George's County Department of Environmental Resources Programs and Planning Division, Maryland, 2001.

Maintenance

- While vegetation is being established, pruning and weeding may be required.
- Detritus may also need to be removed every year. Perennial plantings may be cut down at the end of the growing season.
- Mulch should be re-spread when erosion is evident and be replenished as needed. once every 2 to 3 years the entire area may require mulch replacement.
- Bioretention areas should be inspected at least two times per year for sediment buildup, erosion, vegetative conditions, etc.
- During periods of extended drought, Bioretention areas may require watering.
- Trees and shrubs should be inspected twice per year to evaluate health.

**PRP Report and Strategy Plan for Willistown Township
MS4 Individual Permit Application 2018**

Stream Restoration Details & Photos

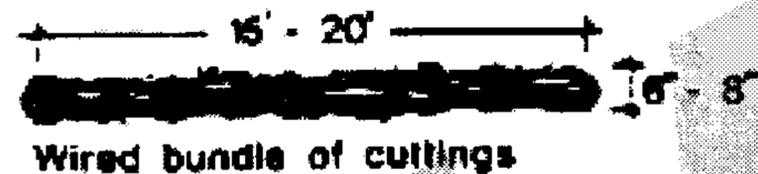
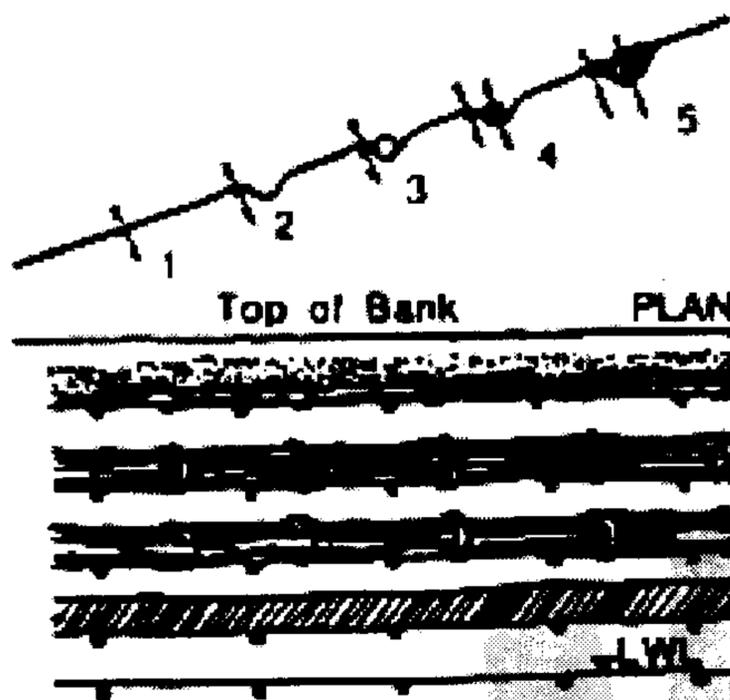
GENERAL PERMIT:

B.D.W.W. GP-3

Bank Rehabilitation and Protection

VEGETATIVE STABILIZATION

Dwg. No. 12



Sizes

- *Fascines can be 15' to 20' long.
- *The bundles are 6" to 8" in diameter when prepared.
- *The branches which are contained in the bundle should be at least 4' long and have a maximum trunk diameter of 1 inch.
- *Wire for bundling should be 1/10" in diameter or larger, or about the size of electrical fencing wire.

Materials

- *Cuttings must be from a species that roots easily, and has long, straight branches. Young willows are ideal for this method.
- *The cuttings are placed in bundles with the butt ends in the same direction, and wired together every 12" to 18".
- *Live stakes should be 2' to 3' long. Live stakes should be placed through the live fascine and below the fascine.

Installations

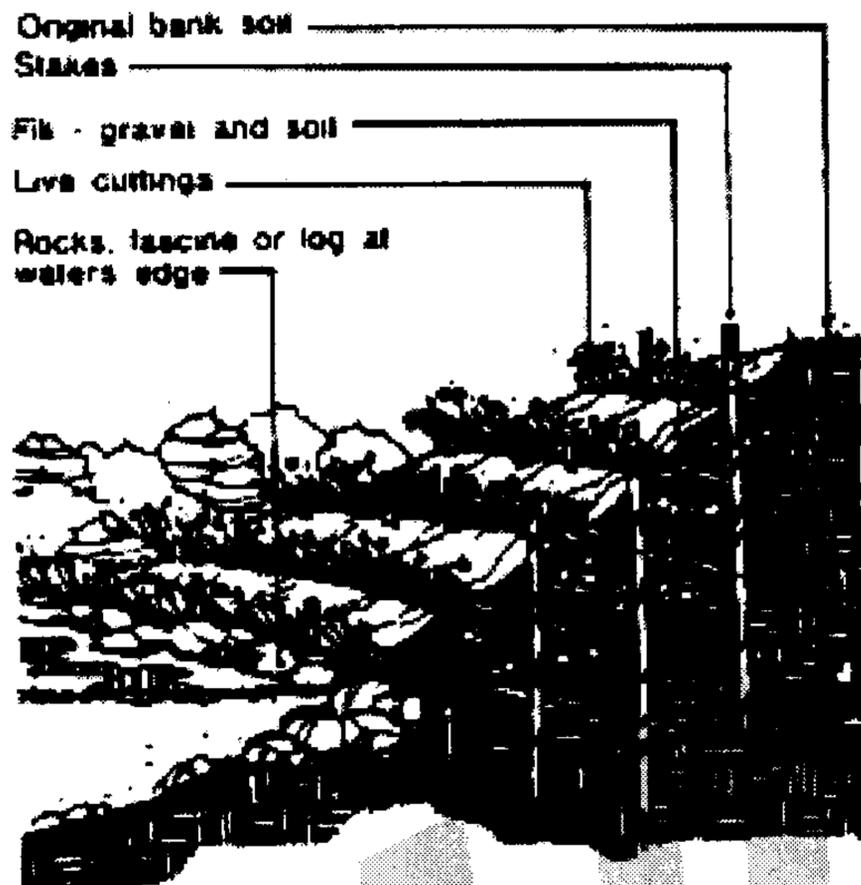
- *Beginning at the base of the bank at mean low water level, tamp stakes in a row across the slope.
- *A shallow trench as deep as the diameter of the fascine is dug above the stakes.
- *Place the bundles in the trench.
- *Tamp more stakes through the bundles.
- *Live stakes should be spaced approximately 12" apart. Extra stakes should be used at joints. Leave the tips of the stakes 6" above the soil.
- *Cover the bundles with soil from above and tamp firmly.
- *Walk on top of the bundles eliminating any air.
- *To minimize drying of the soil, trenching should not precede placement of the bundles by more than one hour.
- *Fascines should be prepared immediately before installation and must be stored in a moist, shady location.
- *The sequence proceeds layer by layer up on the slope with trenches above 3' apart. Twigs at the top of the bundles should protrude above the soil.

GENERAL PERMIT:

B.D.W.W. GP-3

Bank Rehabilitation and Protection
VEGETATIVE STABILIZATION

Dwg. No. 13



BRANCH PACKINGS

CONSTRUCTION GUIDELINES FOR 'BRANCH PACKING' METHOD



Sizes

- *Branches may be 1/2" to 3" in diameter, and long enough to reach original bank soil with 12" left exposed on the stream side.
- *Stakes should be 6' to 8' long.

Materials

- *Live cuttings are required.
- *Soil and gravel is mixed and used as alternate layers between brush layers.

Installation

- *Starting below the low water line, tamp stakes vertically into the soil 3 feet apart.
- *First, a layer of compressed branches 3" to 4" thick is placed in the bottom of the washout between the vertical stakes and covered with an 8" to 12" layer of soil and gravel.
- *The following layers of branches are installed with the basal ends angled down into the streambank so that they are at least 12" lower than the tip of the branches.
- *Each layer of branches must be followed by a layer of soil mix and compacted thoroughly, tamping by foot, in order to insure soil contact with the branch cuttings.
- *Succeeding layers of branches and fill are alternated until the washout is completely filled.
- *The top layer should be soil and gravel fill.
- *From the stream bottom up to the average water level large rocks (do not use rocks from the stream) capable of resisting the current may be placed over the layers to prevent scour.
- *Tips of the branches must extend beyond the soil layers to grow. The basal ends must extend into undisturbed soil.

PLUM RUN STREAM RESTORATION 2010/2015

This project restored four separate sites on Plum Run over a five year period. The restored stream length totaled 5,100 feet and included individual and multiple landowners and a golf course. The restorations used in-stream structures such as cross vanes, J-hooks, mud sills, root wads and toe rock as well as stream bank grading and channel realignment. More than 1,000 trees and shrubs were planted at the four sites.

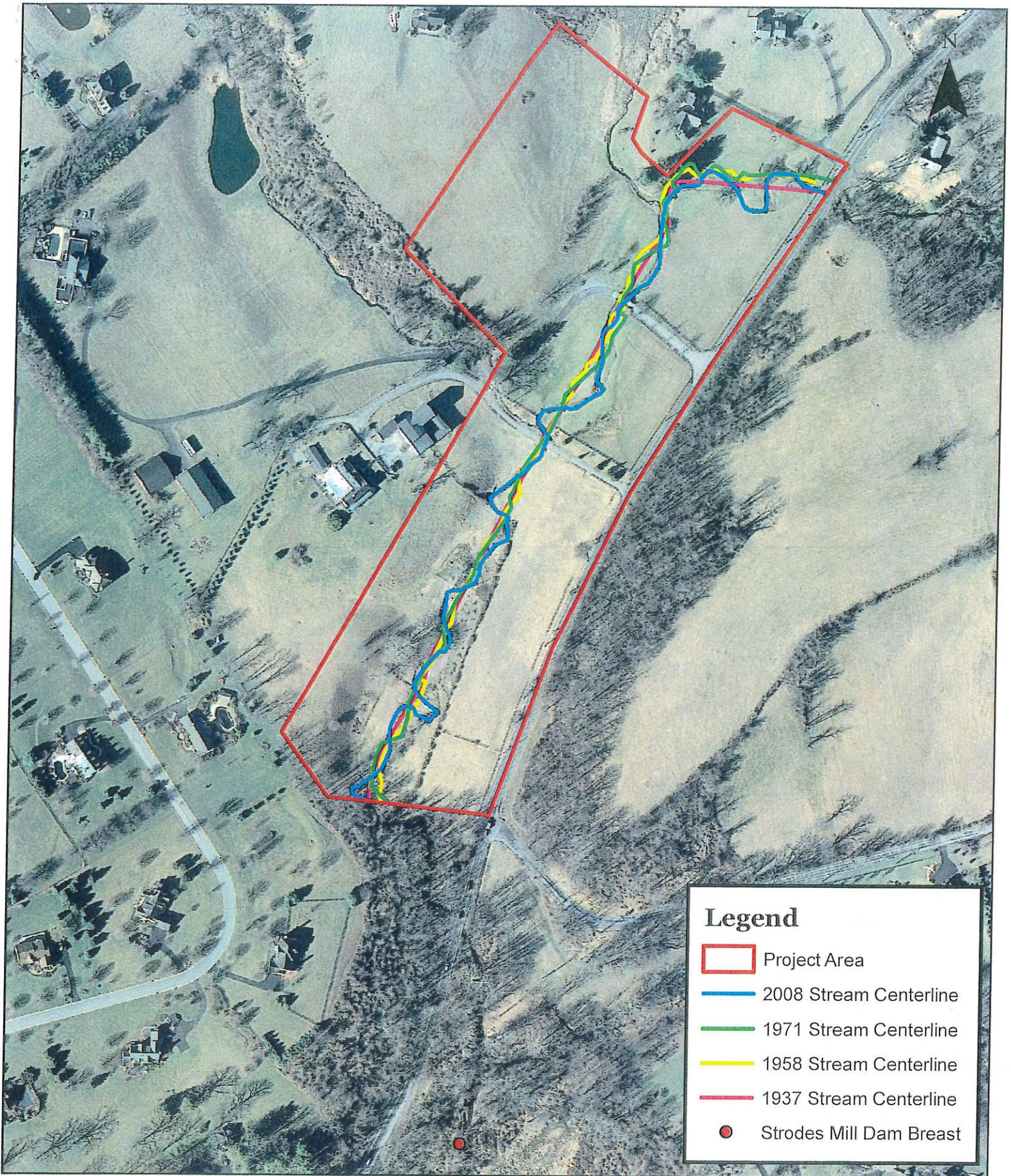
Plum Run begins in West Chester Borough and is impacted by urban runoff. Some sites in this project were also affected by legacy sediment due to past mill dams. The projects are all cited as high priority in the 2008 Plum Run Restoration Plan, funded by William Penn Foundation. The restoration projects were funded by a Watershed Renaissance Initiative Grant from PADEP to the Chester County Conservation District.

Restoration Design: Rettew Associates,
Clauser Environmental
Construction: Flyway Excavating; B&J
Excavating; McDonald

Funding: PADEP Growing Greener,
William Penn Foundation,
TreeVitalize

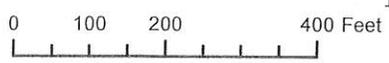
Cost: \$1,072,092





Data Sources:
 Clauser Environmental, LLC
 Penn Pilot
www.pasda.psu.edu

Plum Run Site 19-26
Historic Stream Centerline Map
East Bradford Township
Chester County, PA



REDStreams
BLUE
 A BVA PROGRAM

CLAUSER
 environmental llc

9 of 25
 CHESTER COUNTY
 CONSERVATION DISTRICT



PLUM RUN BEFORE RESTORATION



ONE YEAR AFTER RESTORATION



THREE YEARS AFTER RESTORATION













LUDWIG'S RUN STREAM RESTORATION 2015/2016

This project restored two separate sites on Ludwig's Run over a two year period. The restored stream length totaled 2,000 feet and included eleven individual landowners, a homeowners association (87 homes), and an elementary school. The two restoration sites were in mature forest and used in-stream structures such as cross vanes (both rock and log), root wads, and toe rock as well as stream bank grading.

The project also included the repair and retrofitting of a failed, 30 year old stormwater basin. The work included enlarging the basin, new inlet and outlet structures, and a concrete, cable mat emergency spillway.

Ludwig's Run begins in the Foxcroft development in Uwchlan Township and is impacted by suburban runoff. The projects are all cited as high priority in the 2010 Shamona Creek Restoration Plan, funded by Williams Companies, which also funded the restoration work.

Restoration Design: Clauser
Environmental

Construction: Flyway Excavating

Funding: Williams Companies

Cost: \$550,000





LUDWIG'S RUN - BEFORE AND AFTER







LUDWIGS RUN BASIN - BEFORE AND AFTER



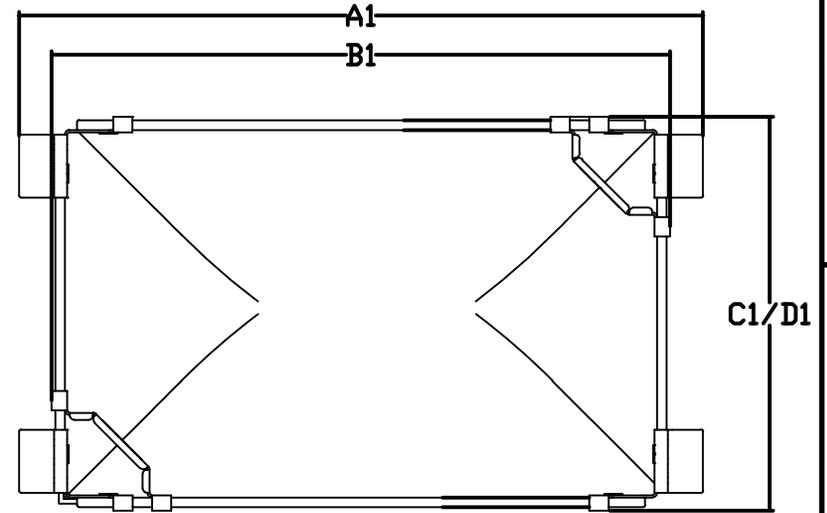
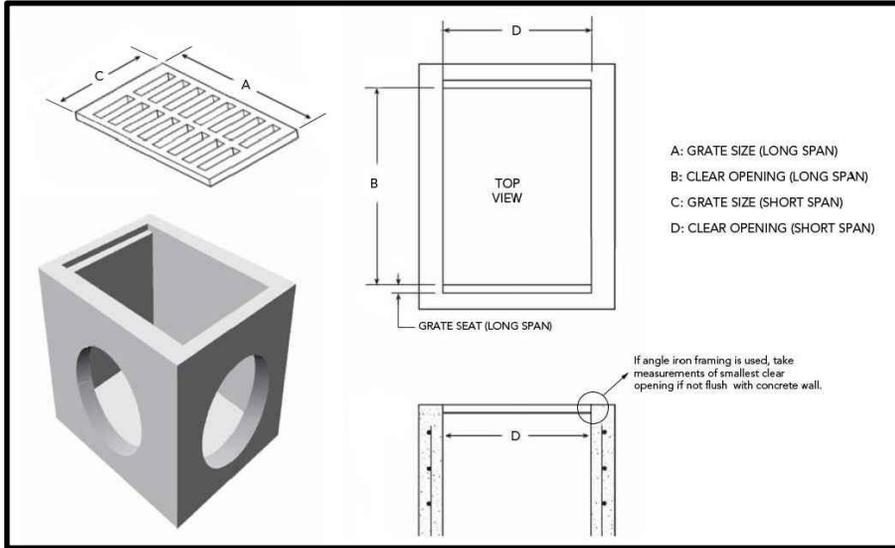


**PRP Report and Strategy Plan for Willistown Township
MS4 Individual Permit Application 2018**

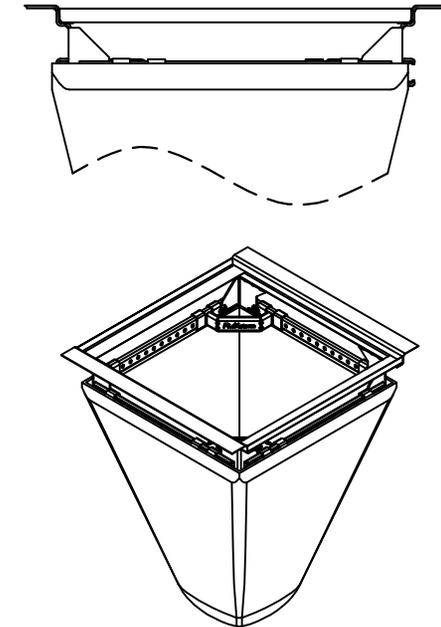
Inlet Sediment Filter Bags Detail

FLEXSTORM P/Ns 62' SQFX

HD2L INLET TYPE: RECTANGULAR PRECAST OPENING WITH 2 SEAT GRATE SUPPORTS ON SHORT LEDGES (LONG SPAN)



Catch-IT Frame with FX Bag		Field Inlet Dimensions		Flexstorm Framing Dim				Flexstorm Ratings (Flow at 50% max)		
ADS P/N	Flexstorm Item Code	Grate Size (A x C)	Clear Opening (B x D)	B1	D1	A1	C1	Bag Capacity (ft³)	FX/FX+ Flow Rate (CFS)	Bypass (CFS)
62SSQFX	C-HD2L-140-120-120-120-FX	14x12	12x12	10.5	11.0	14.0	11.0	0.7	0.9	3.5
62SSQFX	C-HD2L-190-160-160-160-FX	19x16	16x16	15.5	15.0	19.0	15.0	1.5	1.3	4.9
62MSQFX	C-HD2L-200-180-180-180-FX	20x18	18x18	16.5	17.0	20.0	17.0	1.8	1.4	5.4
62MSQFX	C-HD2L-263-230-240-233-FX	26.25 x 23	24 x 23.25	22.5	22.5	26.0	22.5	3.2	1.9	7.3
62MSQFX	C-HD2L-263-230-240-233-FX	26.25 x 23	24 x 23.25	22.5	22.5	26.0	22.5	3.2	1.9	7.3
62MSQFX	C-HD2L-263-230-240-233-FX	26.25 x 23	24 x 23.25	22.5	22.5	26.0	22.5	3.2	1.9	7.3
62MSQFX	C-HD2L-260-160-240-160-FX	26x16	24x16	22.5	15.0	26.0	15.0	2.1	1.6	6.1
62MSQFX	C-HD2L-270-240-240-240-FX	27x24	24x24	23.5	23.0	27.0	23.0	3.4	2.0	7.5
62MSQFX	C-HD2L-278-180-253-180-FX	27.75 x 18	25.25 x 18	24.0	17.0	27.5	17.0	2.6	1.7	6.6
62MSQFX	C-HD2L-283-170-265-181-FX	28.34 x 17	26.5 x 18.25	24.5	17.0	28.0	17.0	2.7	1.8	6.7
62MSQFX	C-HD2L-283-170-265-183-FX	28.34 x 17	26.5 x 18.25	24.5	17.5	28.0	17.5	2.7	1.8	6.8
62MSQFX	C-HD2L-288-170-265-183-FX	28.75 x 17	26.5 x 18.25	25.0	17.5	28.5	17.5	2.8	1.8	6.9
62LSQFX	C-HD2L-340-300-300-300-FX	34x30	30x30	29.5	29.0	33.0	29.0	5.4	2.5	9.5
62LSQFX	C-HD2L-350-150-300-150-FX	35x15	30x15	29.5	14.0	33.0	14.0	2.6	1.8	7.0
62LSQFX	C-HD2L-338-190-314-194-FX	33.75 x 19	31.375 x 19.375	30.0	18.5	33.5	18.5	3.5	2.1	7.8
62LSQFX	C-HD2L-338-218-314-214-FX	33.75 x 21.75	31.375 x 21.375	30.0	20.5	33.5	20.5	3.9	2.1	8.2
62LSQFX	C-HD2L-400-180-360-180-FX	40x18	36x18	35.5	17.0	39.0	17.0	3.8	2.2	8.5
62LSQFX	C-HD2L-400-240-360-240-FX	40x24	36x24	35.5	23.0	39.0	23.0	5.2	2.5	9.5
62XLSQFX	C-HD2L-400-360-360-360-FX	40x36	36x36	35.5	35.0	39.0	35.0	7.9	3.0	11.4
62XLSQFX	C-HD2L-540-480-480-480-FX	54x48	48x48	47.5	47.0	51.0	47.0	14.2	4.0	15.3



NOTES:

1. RATINGS SHOWN ARE FOR STANDARD 22" BAG DEPTH; "SHORT" 12" DEPTH BAGS ARE AVAILABLE WITH -S SUFFIX; RATINGS REDUCED BY ~50%.

2. THE FOLLOWING REQUIRES ADDITIONAL REVIEW

- GRATES WITH EXTENDED BOTTOMS
- ANY OBSTRUCTED INLET OPENINGS

CATCH-IT®

ALL PRODUCTS MANUFACTURED BY INLET & PIPE PROTECTION, INC A DIVISION OF ADS, INC.
WWW.INLETFILTERS.COM
 (866) 287-8655 PH
 (630) 355-3477 FX
INFO@INLETFILTERS.COM

THIS PRINT DISCLOSES SUBJECT MATTER IN WHICH FLEXSTORM HAS PROPRIETARY RIGHTS. THE RECEIPT OR POSSESSION OF THIS PRINT DOES NOT CONVEY, TRANSFER, OR LICENSE THE USE OF THE DESIGN OR TECHNICAL INFORMATION SHOWN HEREIN. REPRODUCTION OF THIS PRINT OR ANY INFORMATION CONTAINED HEREIN, OR MANUFACTURE OF ANY ARTICLE HEREFROM, FOR THE DISCLOSURE TO OTHERS IS FORBIDDEN, EXCEPT BY WRITTEN PERMISSION FROM FLEXSTORM. ©2013 ADS, INC.	SIZE: C	FRAME TYPE: HDSQ2	DWG NO: HD2L-62_25	REV: A
SCALE:	SHEET 1 OF 1			REV: A