

ORDINANCE APPENDIX A

**SIMPLIFIED APPROACH TO
STORMWATER MANAGEMENT
FOR SMALL PROJECTS**

Appendix A

Simplified Approach to Stormwater Management for Small Projects

Appendix A.1 –

Applicability, Submittal and Approval Requirements

Appendix A.2 –

Simplified Approach to Stormwater Management for Small Projects

Appendix A.3 –

Design Procedure for Simplified Approach Stormwater Management BMPs

Appendix A.1

Applicability, Submittal and Approval Requirements

**Borough of Elverson
Chester County, Pennsylvania**

Applicability:

- Small projects with less than 2,000 square feet of Regulated Impervious Surfaces (as defined in the Stormwater Management Ordinance) and with less than 10,000 square feet of proposed Earth Disturbance (as defined in the Ordinance) may apply the “Simplified Approach to Stormwater Management for Small Projects” (Simplified Approach).
- Only projects that meet the above size thresholds as specified in the Municipality’s Stormwater Management Ordinance may use this Simplified Approach and are then not required to submit a fully engineered Stormwater Management Site Plan to the Municipality. However, these projects are still required to address water quality and infiltration requirements as outlined in the Simplified Approach “Handbook”. This Handbook is intended to aid Applicants in addressing these requirements through the installation of a properly sized stormwater management BMP.
- Any project with 2,000 square feet or more of Regulated Impervious Surface or 10,000 square feet or more of proposed Earth Disturbance can NOT apply this Simplified Approach.
- The Applicant should first review the planned project with the Municipal Engineer prior to initiating the Simplified Approach to confirm the following:
 - That the proposed project is not otherwise exempt from the stormwater management control and the engineered Stormwater Management Site Plan requirements of the Municipality’s Stormwater Management Ordinance;
 - That the proposed project is eligible to use this Simplified Approach;
 - Which components of the proposed project must be included in the calculation of “impervious surfaces (areas)”;
 - Whether any local conditions are known to the Municipal Engineer that would preclude the use of any of the techniques included in this Simplified Approach.

Submittal and Approval Requirements:

Use of the Simplified Approach requires:

- The Applicant to submit the following to the Municipality for review and approval prior to beginning construction per the Simplified Approach guidance:
 - Simplified Approach – Stormwater Management Worksheet
 - Simplified Approach – Stormwater Management Checklist
 - Simplified Approach Stormwater Management Site Plan (i.e., sketch plan)
 - A completed, signed, and notarized “Simplified Operation, Maintenance and Inspection Plan and Agreement”.
- The Applicant is to record the “Simplified Approach – Stormwater Best Management Practices Operation, Maintenance and Inspection Plan and Agreement” at the Chester County Office of the Recorder of Deeds after signature by the Municipality.
- Construction can begin only after the Municipality has issued its approval of the proposed project to the Applicant and the Agreement has been recorded.
- Notify the Municipality 5 business days prior to the start of any construction and schedule any needed inspections.

- If the Applicant is using a contractor to construct the project, the approved application including the worksheet and plan must be shared with the contractor to ensure the BMP(s) are properly installed.
- A final inspection conducted by the Municipality after completion of construction.

Appendix A.2

Simplified Approach to Stormwater Management for Small Projects

Contents

- 1. Simplified Approach – Stormwater Management Worksheet**
- 2. Simplified Approach – Stormwater Management Checklist**
- 3. Preparing the Stormwater Management Site Plan**
- 4. Example Simplified Site Plan**
- 5. Simplified Site Plan Form**

Simplified Approach – Stormwater Management Worksheet

Name of Property Owner:		Date:
Name of Applicant [If different than owner(s)]:		
Contact Phone #:	Email Address:	
Address of Project:		
Description of Project:		
Distance from Earth Disturbance to nearest surface water feature (stream, pond, wetland, etc.): <div style="text-align: center;"> <input type="checkbox"/> 50 feet or less <input type="checkbox"/> More than 50 feet </div>		
REGULATED IMPERVIOUS SURFACES		
Description of Proposed Impervious Surface	Dimensions [Length x Width]	Area (square feet)
Total Proposed Impervious Surface (square feet): (If this is less than 1,000 sq. feet, Stormwater Management is not required; if this is more than 2,000 sq. feet, the Simplified Approach may not be used)		
Cumulative Total Impervious Surface Since August 5, 2014:		
Total Proposed Earth Disturbance Area (square feet):		
PROPOSED BMP SIZING		
Proposed Impervious Area to BMP (square feet)	Proposed Dimensions	
1		
2		
Does the project involve new roof area? <input type="checkbox"/> Yes <input type="checkbox"/> No If yes, the downspout must be connected to the proposed BMP and must have measures to prevent clogging by unwanted debris. Indicate the measure proposed: <input type="checkbox"/> Leaf trap <input type="checkbox"/> Gutter guards <input type="checkbox"/> Cleanout <input type="checkbox"/> Other: _____		

Signature: _____ Date: _____

Printed Name: _____

Simplified Approach – Stormwater Management Checklist

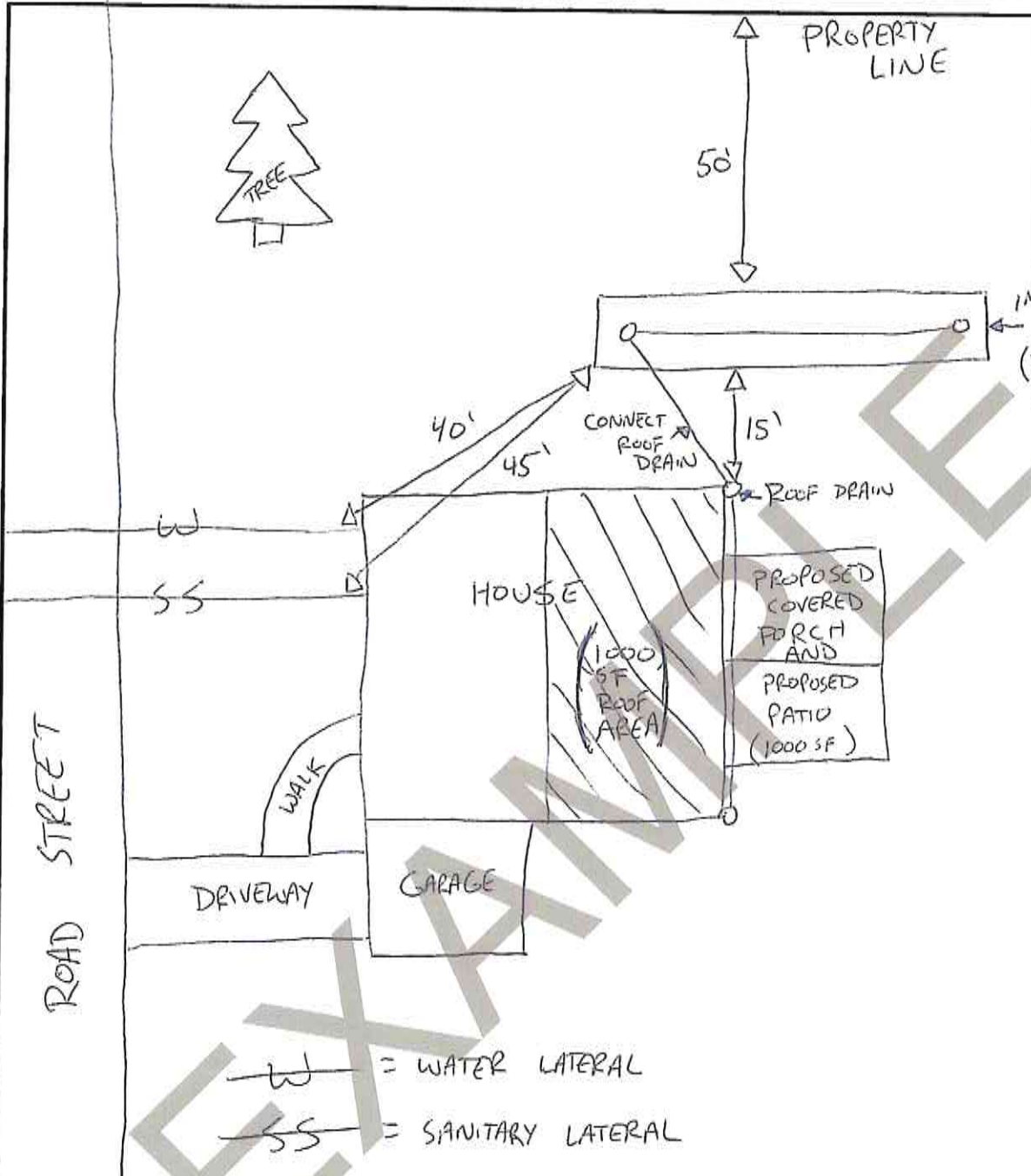

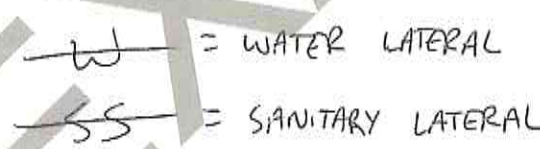

Complete the checklist below to verify all required information is shown on the plan:

Yes	No	Not Applicable	Required Information
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Name and address of the owner of the property.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Name and address of individual preparing the plan (if different).
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Date of plan preparation.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	North arrow.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Location of all existing features within 50 feet of the property, including (if present): <ul style="list-style-type: none"> • Buildings; • Driveways; • Roads; • Water Lines/Wells (or a note that no wells are present within 50 feet of the proposed facility); • Septic Systems/Sewer Mains and Laterals; • Streams, Wetlands, and Floodplains • Existing Stormwater Facilities; and • Easements.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Location and approximate size in square feet of existing roof area to be captured and diverted to the BMP.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Location and approximate size in square feet of proposed: <ul style="list-style-type: none"> • Structures; • Driveways; and
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Location, orientation, and dimensions of the proposed BMP. Length and width must be included on the plan.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Distance from the proposed BMP to any existing surface water features, such as: streams, lakes, ponds, wetlands, or other natural waterbodies. Must be > 50 feet from surface water features or outside of an existing legally described buffer (i.e., deed, covenants, easement, etc.) whichever is greater. Contact the Municipality if this is not possible.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Distance from the proposed BMP to any existing septic system, public sewer line, or lateral.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Distance from the proposed BMP to any existing wells or waterlines.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Distance from the proposed BMP to any existing wells or waterlines.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Show distance from at least two existing fixed features (e.g., house, shed, driveway) to the proposed BMP.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	PA One Call Serial Number (Dial 8-1-1 or 1-800-242-1776) to receive.

Preparing the Stormwater Management Site Plan

STEP 1 – PREPARE THE SIMPLIFIED APPROACH STORMWATER MANAGEMENT SITE PLAN THAT INCLUDES:

1. Name and address of the owner of the property.
2. Name and address of the individual preparing the plan (if different).
3. Date of plan preparation.
4. North arrow.
5. Location of all existing features within 50 feet of the property, including (if present):
 - Buildings;
 - Driveways;
 - Roads;
 - Easements;
 - Septic Systems;
 - Streams;
 - Wetlands;
 - Floodplains; and
 - Existing Stormwater Facilities.
6. Show water supply wells within 50 feet of the proposed BMP facility or add a note that no wells are present within 50 feet of the proposed facility.
7. Location and approximate size of the roof area to be captured and diverted to the proposed BMP.
8. Location and approximate size in square feet of proposed:
 - a. Structures;
 - b. Driveways; and
 - c. Other Impervious Surfaces.
9. Location, orientation, and dimensions of the proposed BMP(s). Length, width, and depth must be included on the plan.
10. Distance from the proposed BMP(s) to any existing surface water features, such as: streams, lakes, ponds, wetlands, or other natural waterbodies (must be greater than 50 feet from surface water features or outside of an existing legally prescribed buffer (i.e., deed, covenants, easement, etc.), whichever is greater).
11. Distance from the proposed BMP(s) to any existing septic system, public sewer line, or service lateral (must be greater than 50 feet unless otherwise approved by Municipal Engineer).
12. Distance from the proposed BMP(s) to any existing wells or water service lines (must be greater than 50 feet unless otherwise approved by Municipal Engineer).
13. Distance from the proposed BMP(s) to nearest property line (must be > 10 feet).
14. Distance from the proposed BMP(s) to all buildings and features with subgrade elements (e.g., basements, foundation walls, etc.) must be > 10 feet.
15. Show distance from at least two existing fixed features to the proposed BMP(s). Fixed features include, but are not limited to, corners of existing buildings, driveways, septic system cleanout pipes, and mailboxes.
16. PA ONE CALL (8-1-1 OR 1-800-242-1776) Identification Number received by calling the PA One Call system.

		<div style="border: 1px solid black; padding: 2px;"> NORTH ARROW  </div> <div style="border: 1px solid black; padding: 2px; margin-top: 5px;"> DATE 7/8/21 </div>	
<div style="display: flex; justify-content: space-between; align-items: center;"> <div style="text-align: center;">  </div> </div>			
 <p style="font-size: small;">Underground Service Alert Call: TOLL FREE 1-800-242-1776 THREE WORKING DAYS BEFORE YOU DIG</p>	<div style="border-bottom: 1px solid black; margin-bottom: 5px;"> PROPERTY OWNER NAME: JOHN SMITH ADDRESS: 123 ROAD STREET, TOWN PA 07734 </div> <div style="border-bottom: 1px solid black; margin-bottom: 5px;"> PLAN PREPARER NAME: SAME AS ABOVE ADDRESS: SAME AS ABOVE </div>		
FOR USE BY MUNICIPAL ENGINEER		<div style="display: flex; justify-content: space-between;"> CHESTER COUNTY PENNSYLVANIA </div> <div style="text-align: center; font-weight: bold; font-size: 1.2em;">SIMPLIFIED SITE PLAN</div>	SHEET NO. <u>1</u> <u>1 OF 4</u>

NORTH ARROW

DATE



Underground Service Alert
Call: TOLL FREE
1-800-242-1776
**THREE WORKING DAYS
BEFORE YOU DIG**

PROPERTY OWNER

NAME:

ADDRESS:

PLAN PREPARER

NAME:

ADDRESS:

FOR USE BY MUNICIPAL ENGINEER

CHESTER COUNTY

PENNSYLVANIA

SHEET NO. _____

**SIMPLIFIED
SITE PLAN**

OF _____

Appendix A.3

Design Procedure for Simplified Approach Stormwater Management BMPs

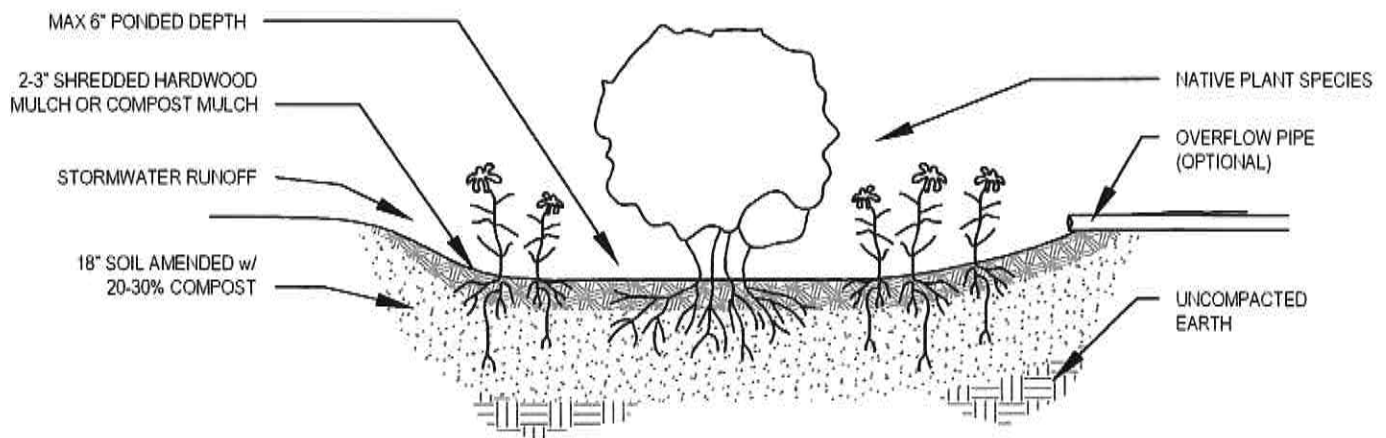
Borough of Elverson

Appendix A.3 – Design Procedure for Simplified Approach Stormwater Management BMPs

Regulated activities that will result in between 1,000 and 2,000 square feet of new impervious surface shall provide an infiltration BMP(s) that will store a volume of water equal to 1 inch of runoff from the entire new impervious surface area. One or more of the following BMPs may be used to accomplish this.

- (a) Rain Gardens - also referred to as “bioretention” or “bioinfiltration” facilities, are a method of treating relatively small volumes of stormwater by allowing water to pond in a surface depression. Native species are planted within the depression to improve water quality as well as aesthetics. Water quality improvements are achieved through filtration and settling of particles through a layer of mulch and through infiltration into the surrounding soil. Plant life also contributes to pollutant uptake and improvement of water quality. Construction of a rain garden shall be performed after all other areas of the site are stabilized to avoid clogging. During construction, compaction of the subgrade soil shall be avoided, and construction shall be performed with only light machinery. Additional resources on rain gardens can be found in Pennsylvania Department of Environmental Protection E&S Resources publications.

TYPICAL RAIN GARDEN CONFIGURATION



Sizing:

STEP 1 – Determine Area of Total New Impervious Surfaces (A)

STEP 2 – Determine Required Infiltration Volume (Rev)

$$\text{Rev (cubic feet)} = 1.0 \text{ (inch)} * A \text{ (square feet)} / 12 \text{ (inches/foot)}$$

STEP 3 – Sizing of Select Infiltration Method

$$(\text{Rev}) = (\text{Depth}) \times (\text{Width}) \times (\text{Length})$$

Example:

STEP 1 – Determine Area of Total New Impervious Surfaces

Suppose total impervious surfaces = 2,000 square feet

STEP 2 – Determine Required Infiltration Volume (Rev)

$$\begin{aligned}\text{Rev (cubic feet)} &= 1.0 \text{ (inch)} * A \text{ (square feet)} / 12 \text{ (inches/foot)} \\ \text{Rev} &= (1.0 \text{ inch}) * (2,000 \text{ square feet}) / (12 \text{ inches/foot}) \\ \text{Rev} &= 166.7 \text{ cubic feet}\end{aligned}$$

STEP 3 – Sizing of Select Infiltration Method

Suppose a ponded depth of 0.5 feet (maximum ponded depth) is desired

$$(\text{Rev}) = (\text{Depth}) \times (\text{Width}) \times (\text{Length})$$

$$(166.7 \text{ cubic feet}) = (0.5 \text{ ft}) \times (\text{Width}) \times (\text{Length})$$

$$(\text{Width}) \times (\text{Length}) = \text{Surface Area} = 333.4 \text{ square feet (possibly 11 feet x 30 feet)}$$

Construction Issues:

The following must be addressed during construction to ensure proper function:

- Do not allow sediment to wash back into the bed during construction.
- Avoid compaction of the bottom. This can limit the infiltration capacity.
- An overflow pipe can be used to direct excess water to a particular location. If an overflow pipe is used, it shall be placed at the top of the depression, such that water is still allowed to pond.
- Plants used in the rain garden must be tolerant of both wet and dry conditions, as well as be suitable for your light and soil conditions. Plant selection guidance can be found in the internet links listed above.

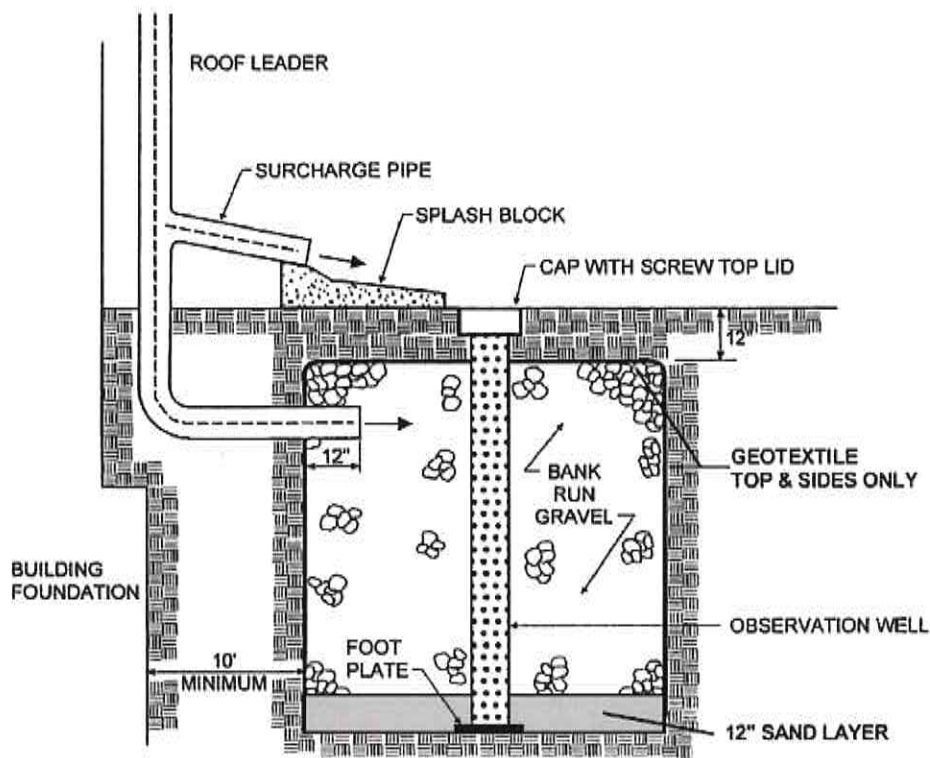
Maintenance Issues:

Rain Gardens require the following regular maintenance:

- While vegetation is being established, watering, pruning, and weeding may be required.
- Dead plant material must be removed every year. Perennial plantings may be cut down at the end of the growing season.
- Mulch shall 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.
- Rain Gardens shall be inspected at least two times per year for sediment buildup, erosion, vegetative conditions, or any other conditions that negatively impact the functionality of the system.
- During periods of extended drought, Rain Gardens may require watering.
- Trees and shrubs shall be inspected twice per year to evaluate health.

- (b) Dry wells - Dry wells are effective methods of infiltrating runoff from roof leaders. These facilities shall be located a minimum of ten (10) feet from the building foundation to avoid seepage problems. A dry well can be either a structural prefabricated chamber or an excavated pit filled with aggregate. Construction of a dry well shall be performed after all other areas of the site are stabilized to avoid clogging. During construction, compaction of the subgrade soil shall be avoided, and construction shall be performed with only light machinery. Depth of dry wells in excess of three and one half (3 ½) feet should be avoided. Gravel fill shall be an average one and one-half to two and one-half (1.5 to 2.5) inches in diameter and shall be homogeneously graded.

TYPICAL DRY WELL CONFIGURATION



Source: Maryland Stormwater Design Manual

Note: Acceptable geotextiles include Mirafi 140N, Amoco 4547, Geotex 451 or approved equal. Bank run gravel should be 1.5" to 2.5" in diameter (AASHTO #2 stone is preferable).

Sizing:

STEP 1 – Determine Area of Total New Impervious Surfaces (A)

STEP 2 – Determine Required Infiltration Volume (Rev)

$$\text{Rev (cubic feet)} = 1.0 \text{ (inch)} * A \text{ (square feet)} / 12 \text{ (inches/foot)}$$

STEP 3 – Sizing of Select Infiltration Method

$$(\text{Rev}) / (0.4) = (\text{Depth}) \times (\text{Width}) \times (\text{Length})$$

Note: Rev is divided by 0.4 to account for the void space in the stone bed

Example:

STEP 1 – Determine Area of Total New Impervious Surfaces

Suppose total impervious surfaces = 2,000 square feet

STEP 2 – Determine Required Infiltration Volume (Rev)

$$\text{Rev (cubic feet)} = 1.0 \text{ (inch)} \times A \text{ (square feet)} / 12 \text{ (inches/foot)}$$

$$\text{Rev} = (1.0 \text{ inch}) \times (2,000 \text{ square feet}) / (12 \text{ inches/foot})$$

$$\text{Rev} = 166.7 \text{ cubic feet}$$

STEP 3 – Sizing of Select Infiltration Method

Suppose a bed depth of 3 feet is desired

$$(\text{Rev}) / (0.4) = (\text{Depth}) \times (\text{Width}) \times (\text{Length})$$

$$(166.7 \text{ cubic feet}) / (0.4) = (3 \text{ feet}) \times (\text{Width}) \times (\text{Length})$$

$$(\text{Width}) \times (\text{Length}) = \text{Surface Area} = 138.9 \text{ square feet (possibly 9 feet x 16 feet)}$$

Construction Issues:

The following must be addressed during construction to ensure proper function:

- Do not allow sediment to wash back into the bed during construction.
- Avoid compaction of the bottom. This can limit the infiltration capacity.
- Observation well shall be constructed of perforated pipe such that the level of water in the well is the same as the level of water in the bed.
- Geotextile shall overlap a minimum of 16 inches at seams.

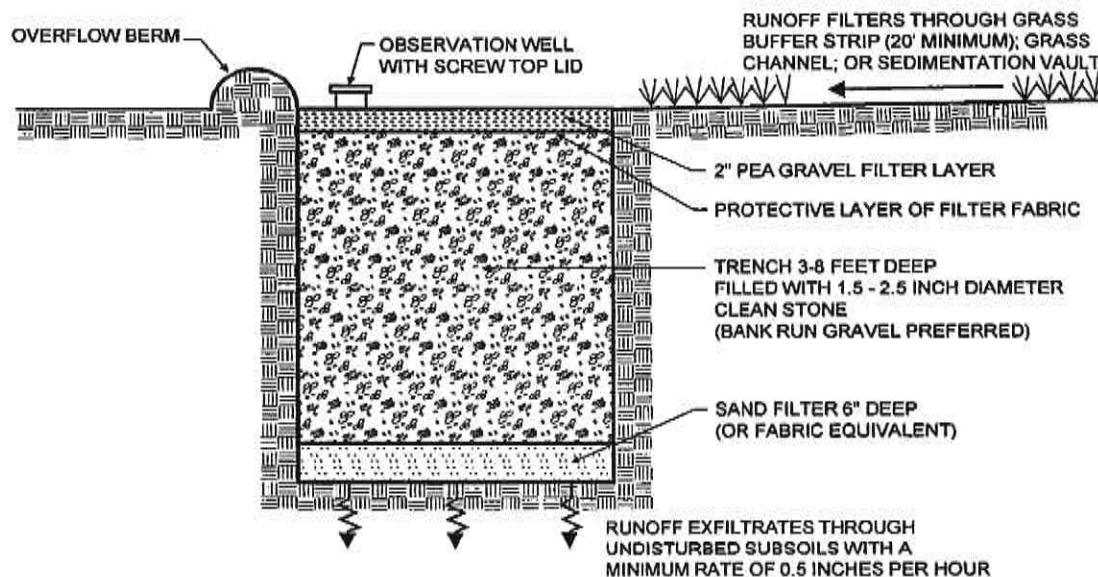
Maintenance Issues:

Dry Wells require the following regular maintenance:

- Inspect Dry Wells at least four times a year, as well as after every storm exceeding 1 inch of rain.
- Dispose of sediment, debris/trash, and any other waste material removed from a Dry Well at suitable disposal/recycling sites and in compliance with local, state, and federal waste regulations.
- Evaluate the drain-down time of the Dry Well to ensure the maximum time of 72 hours is not being exceeded. If drain-down times are exceeding the maximum, drain the Dry Well via pumping and clean out perforated piping, if included.
- Regularly clean out gutters and ensure proper connections to facilitate the effectiveness of the dry well.
- Replace filter screen that intercepts roof runoff as necessary.
- If an intermediate sump box exists, clean it out at least once per year.

- (c) Infiltration Trenches - An infiltration trench is a long, narrow, rock-filled trench with no outlet. Runoff is stored in the void space between the stones and infiltrates through the bottom and into the soil matrix. Infiltration trenches perform well for removal of fine sediment and associated pollutants. Pretreatment using buffer strips, swales, or detention basins is important for limiting amounts of coarse sediment entering the trench. Construction of an infiltration trench shall be performed after all other areas of the site are stabilized. During construction, compaction of the subgrade soil shall be avoided, and construction shall be performed with only light machinery.

TYPICAL INFILTRATION TRENCH CONFIGURATION



Source: Maryland Stormwater Design Manual

Note: Acceptable filter fabrics include Mirafi 140N, Amoco 4547, Geotex 451 or approved equal. Clean stone should be AASHTO #3 stone.

Sizing:

STEP 1 – Determine Area of Total New Impervious Surfaces (A)

STEP 2 – Determine Required Infiltration Volume (Rev)

$$\text{Rev (cubic feet)} = 1.0 \text{ (inch)} * A \text{ (square feet)} / 12 \text{ (inches/foot)}$$

STEP 3 – Sizing of Select Infiltration Method

$$(\text{Rev}) / (0.4) = (\text{Depth}) \times (\text{Width}) \times (\text{Length})$$

Note: Rev is divided by 0.4 to account for the void space in the stone bed

Example:

STEP 1 – Determine Area of Total New Impervious Surfaces

Suppose total impervious surfaces = 2,000 square feet

STEP 2 – Determine Required Infiltration Volume (Rev)

Rev (cubic feet) = 1.0 (inch) * A (square feet) / 12 (inches/foot)

Rev = (1.0 inch) * (2,000 square feet) / (12 inches/foot)

Rev = 166.7 cubic feet

STEP 3 – Sizing of Select Infiltration Method

Suppose a bed depth of 3 feet is desired

(Rev) / (0.4) = (Depth) x (Width) x (Length)

(166.7 cubic feet) / (0.4) = (3 feet) x (Width) x (Length)

(Width) x (Length) = Surface Area = 138.9 square feet (possibly 5 feet x 28 feet)

Construction Issues:

The following must be addressed during construction to ensure proper function:

- Do not allow sediment to wash back into the bed during construction.
- Avoid compaction of the bottom. This can limit the infiltration capacity.
- Observation well shall be constructed of perforated pipe such that the level of water in the well is the same as the level of water in the bed.
- Filter fabric shall overlap a minimum of 16 inches at seams.

Maintenance Issues:

Infiltration Trenches require the following regular maintenance:

- Filter layer shall be inspected and cleaned at least 2 times per year.

ORDINANCE APPENDIX B

RUNOFF COEFFICIENTS AND CURVE NUMBERS

TABLE B-1. RUNOFF CURVE NUMBERS

TABLE B-2. RATIONAL RUNOFF COEFFICIENTS

TABLE B-3. MANNING'S 'n' VALUES

TABLE B-1. RUNOFF CURVE NUMBERS

(3 pages)

Source: Table 2-2a, Table 2-2b, and Table 2-2c from U. S. Department of Agriculture, Natural Resources Conservation Service, June 1986, Urban Hydrology for Small Watersheds, Technical Release No. 55 (TR-55), Second Edition.

Table B.1 Runoff Curve Numbers
Table 2-2a Runoff Curve Numbers for Urban Areas¹

Cover Description		Curve Numbers for Hydrologic Soil Group			
Cover Type and Hydrologic Condition	Average Percent Impervious Area ²	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) ³					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) ⁴		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) ⁵		77	86	91	94
Idle lands (CNs are determined using cover types similar to those in table 2-2c).					

NOTES:

¹ Average runoff condition, and $I_a = 0.2S$.

² The average percent impervious area shown was used to develop the composite CNs. Other assumptions are as follows; impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CNs for other combinations of conditions may be computed using Figure 2-3 or 2-4.

³ CNs shown are equivalent to those of pasture. Composite CNs may be computed for other combinations of open space cover type.

⁴ Composite CNs for natural desert landscaping should be computed using Figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CNs are assumed equivalent to desert shrub in poor hydrologic condition.

⁵ Composite CNs to use for the design of temporary measures during grading and construction should be computed using Figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CNs for the newly graded pervious areas.

Table 2-2b Runoff Curve Numbers for Cultivated Agricultural Lands¹

Cover Description			Curve Numbers (CNs) for Hydrologic Soil Group (HSG)			
Cover Type	Treatment ²	Hydrologic Condition ³	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured and terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T + CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T + CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

NOTES:

¹ Average runoff condition and $I_a = 0.2S$.

² Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

³ Hydraulic condition is based on combination factors that affect infiltration and runoff, including:

- (a) Density and canopy of vegetative areas;
- (b) Amount of year-round cover;
- (c) Amount of grass or close-seeded legumes;
- (d) Percent of residue cover on the land surface (good $\geq 20\%$); and
- (e) Degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Table 2-2c Runoff Curve Numbers for Other Agricultural Lands¹

Cover Description		Curve Numbers for Hydrologic Soil Group			
Cover Type	Hydrologic Condition	A	B	C	D
Pasture, grassland, or range – continuous forage for grazing ²	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow – continuous grass, protected from grazing and generally mowed for hay	—	30	58	71	78
Brush – brush-weed-grass mixture with brush the major element ³	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 ⁴	48	65	73
Woods – grass combination (orchard or tree farm) ⁵	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods ⁶	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 ⁴	55	70	77
Farmsteads – buildings, lanes, driveways, and surrounding lots	—	59	74	82	86

NOTES:

¹ Average runoff condition, and $I_a = 0.2S$.

² Poor: < 50% ground cover or heavily grazed with no mulch.

Fair: 50 to 75% ground cover and not heavily grazed.

Good: > 75% ground cover and lightly or only occasionally grazed.

³ Poor: < 50% ground cover.

Fair: 50 to 75% ground cover.

Good: > 75% ground cover.

⁴ Actual curve number is less than 30; use CN = 30 for runoff computations.

⁵ CNs shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CNs for woods and pasture.

⁶ Poor: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.

Fair: Woods are grazed but not burned, and some forest litter covers the soil.

Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

TABLE B-2. RATIONAL RUNOFF COEFFICIENTS

(1 page)

Source: Table F.2 from Delaware County Planning Department, December 2011,
Crum Creek Watershed Act 167 Stormwater Management Plan.

Table B-2. Rational Runoff Coefficients

Source: Table F. 2 from Delaware County Planning Department, December 2011, *Crum Creek Watershed Act 167 Stormwater Management Plan*.

**Table F-2
Rational Runoff Coefficients**

Land Use Description		Hydrologic Soil Group			
		A	B	C	D
Cultivated land					
Without conservation treatment		0.49	0.67	0.81	0.88
With conservation treatment		0.27	0.43	0.61	0.67
Pasture or range land:					
Poor condition		0.38	0.63	0.78	0.84
Good condition		—*	0.25	0.51	0.65
Meadow: good condition		—*	—*	0.44	0.61
Woods:					
Thin stand, poor cover, no mulch		—*	0.34	0.59	0.70
Good cover		—*	—*	0.45	0.59
Open spaces, lawns, parks, golf courses, cemeteries					
Good condition: grass cover on 75% or more of the area		—*	0.25	0.51	0.65
Fair condition: grass cover on 50% to 75% of the area		—*	0.45	0.63	0.74
Commercial and business areas (85% impervious)		0.84	0.90	0.93	0.96
Industrial districts (72% impervious)		0.67	0.81	0.88	0.92
Residential					
Average Lot Size	Average % Impervious				
1/8 acre or less	65	0.59	0.76	0.86	0.90
1/4 acre	38	0.25	0.49	0.67	0.78
1/3 acre	30	—*	0.49	0.67	0.78
1/2 acre	25	—*	0.45	0.65	0.76
1 acre	20	—*	0.41	0.63	0.74
Paved parking lots, roofs, driveways, etc.		0.99	0.99	0.99	0.99
Streets and roads:					
Paved with curbs and storm sewers		0.99	0.99	0.99	0.99
Gravel		0.57	0.76	0.84	0.88
Dirt		0.49	0.69	0.80	0.84

NOTES:

Values are based on SCS definitions and are average values.

Values indicated by —* should be determined by the design engineer based on site characteristics.

Source: New Jersey Department of Environmental Protection, Technical Manual for Stream Encroachment, August 1984

TABLE B-3. MANNING’S ‘n’ VALUES

(3 pages)

Source: Table 3-1 from United States Army Corps of Engineers, January 2010,
HEC-RAS River Analysis System, Hydraulic Reference Manual, Version 4.1.

Table B-3. Manning's 'n' Values

Source: Table 3-1 from United States Army Corps of Engineers, January 2010, *HEC-RAS River Analysis System, Hydraulic Reference Manual*, Version 4.1.

Table 3-1 Manning's 'n' Values

Type of Channel and Description	Minimum	Normal	Maximum
A. Natural Streams			
1. Main Channels			
a. Clean, straight, full, no rifts or deep pools	0.025	0.030	0.033
b. Same as above, but more stones and weeds	0.030	0.035	0.040
c. Clean, winding, some pools and shoals	0.033	0.040	0.045
d. Same as above, but some weeds and stones	0.035	0.045	0.050
e. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
f. Same as "d" but more stones	0.045	0.050	0.060
g. Sluggish reaches, weedy, deep pools	0.050	0.070	0.080
h. Very weedy reaches, deep pools, or floodways with heavy stands of timber and brush	0.070	0.100	0.150
2. Flood Plains			
a. Pasture no brush			
1. Short grass	0.025	0.030	0.035
2. High grass	0.030	0.035	0.050
b. Cultivated areas			
1. No crop	0.020	0.030	0.040
2. Mature row crops	0.025	0.035	0.045
3. Mature field crops	0.030	0.040	0.050
c. Brush			
1. Scattered brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees, in winter	0.035	0.050	0.060
3. Light brush and trees, in summer	0.040	0.060	0.080
4. Medium to dense brush, in winter	0.045	0.070	0.110
5. Medium to dense brush, in summer	0.070	0.100	0.160
d. Trees			
1. Cleared land with tree stumps, no sprouts	0.030	0.040	0.050
2. Same as above, but heavy sprouts	0.050	0.060	0.080
3. Heavy stand of timber, few down trees, little undergrowth, flow below branches	0.080	0.100	0.120
4. Same as above, but with flow into branches	0.100	0.120	0.160
5. Dense willows, summer, straight	0.110	0.150	0.200
3. Mountain Streams, no vegetation in channel, banks usually steep, with trees and brush on banks submerged			
a. Bottom: gravels, cobbles, and few boulders	0.030	0.040	0.050
b. Bottom: cobbles with large boulders	0.040	0.050	0.070

Type of Channel and Description	Minimum	Normal	Maximum
B. Lined or Built-Up Channels			
1. Concrete			
a. Trowel finish	0.011	0.013	0.015
b. Float Finish	0.013	0.015	0.016
c. Finished, with gravel bottom	0.015	0.017	0.020
d. Unfinished	0.014	0.017	0.020
e. Gunite, good section	0.016	0.019	0.023
f. Gunite, wavy section	0.018	0.022	0.025
g. On good excavated rock	0.017	0.020	
h. On irregular excavated rock	0.022	0.027	
2. Concrete bottom float finished with sides of:			
a. Dressed stone in mortar	0.015	0.017	0.020
b. Random stone in mortar	0.017	0.020	0.024
c. Cement rubble masonry, plastered	0.016	0.020	0.024
d. Cement rubble masonry	0.020	0.025	0.030
e. Dry rubble on riprap	0.020	0.030	0.035
3. Gravel bottom with sides of:			
a. Formed concrete	0.017	0.020	0.025
b. Random stone in mortar	0.020	0.023	0.026
c. Dry rubble or riprap	0.023	0.033	0.036
4. Brick			
a. Glazed	0.011	0.013	0.015
b. In cement mortar	0.012	0.015	0.018
5. Metal			
a. Smooth steel surfaces	0.011	0.012	0.014
b. Corrugated metal	0.021	0.025	0.030
6. Asphalt			
a. Smooth	0.013	0.013	
b. Rough	0.016	0.016	
7. Vegetal lining	0.030		0.500
C. Excavated or Dredged Channels			
1. Earth, straight and uniform			
a. Clean, recently completed	0.016	0.018	0.020
b. Clean, after weathering	0.018	0.022	0.025
c. Gravel, uniform section, clean	0.022	0.025	0.030
d. With short grass, few weeds	0.022	0.027	0.033
2. Earth, winding and sluggish			
a. No vegetation	0.023	0.025	0.030
b. Grass, some weeds	0.025	0.030	0.033
c. Dense weeds or aquatic plants in deep channels	0.030	0.035	0.040
d. Earth bottom and rubble side	0.028	0.030	0.035
e. Stony bottom and weedy banks	0.025	0.035	0.040
f. Cobble bottom and clean sides	0.030	0.040	0.050

Type of Channel and Description	Minimum	Normal	Maximum
3. Dragline-excavated or dredged			
a. No vegetation	0.025	0.028	0.033
b. Light brush on banks	0.035	0.050	0.060
4. Rock cuts			
a. Smooth and uniform	0.025	0.035	0.040
b. Jagged and irregular	0.035	0.040	0.050
5. Channels not maintained, weeds and brush			
a. Clean bottom, brush on sides	0.040	0.050	0.080
b. Same as above, highest stage of flow	0.045	0.070	0.110
c. Dense weeds, high as flow depth	0.050	0.080	0.120
d. Dense brush, high stage	0.080	0.100	0.140

Other sources that include pictures of selected streams as a guide to n value determination are available (Fasken, 1963; Barnes, 1967; and Hicks and Mason, 1991). In general, these references provide color photos with tables of calibrated n values for a range of flows.

Although there are many factors that affect the selection of the n value for the channel, some of the most important factors are the type and size of materials that compose the bed and banks of a channel, and the shape of the channel. Cowan (1956) developed a procedure for estimating the effects of these factors to determine the value of Manning's n of a channel. In Cowan's procedure, the value of n is computed by the following equation:

ORDINANCE APPENDIX C

CONSERVATION DESIGN AND LOW IMPACT DEVELOPMENT SITE DESIGN

CONSERVATION DESIGN & LOW IMPACT DEVELOPMENT SITE DESIGN

INTRODUCTION

Traditional approaches to land development often radically alter natural hydrologic conditions by constructing collection and conveyance systems that are designed to remove runoff from a site as quickly as possible and capture it in a detention basin. This approach has often led to the degradation of water quality, reduced groundwater recharge, and increased volumes of stormwater runoff, as well as the imposition of expenditures to detain and manage concentrated runoff downstream. Fortunately, the study of hydrology (the way rainfall interacts with slopes, soils, and vegetation) offers a number of alternative approaches that respect the natural environment and ultimately save money. The accompanying ordinance encourages the use of Conservation Design (CD), Low Impact Development (LID), and green infrastructure to preserve, restore and maintain pre-development hydrology on sites with planned land disturbance and development activity. The site design practices and recommendations included in this appendix provide a framework to assist developers, municipal planning commission members, and others involved in local land use planning with designing and implementing development that minimizes the impacts of stormwater runoff to local streams.

Conventionally designed development often divides a parcel into buildable lots, streets, and parking areas, while only keeping traditionally undevelopable areas (wetlands, floodplains, steep slopes) as open space. Existing site hydrology and natural features are often an afterthought in locating and designing stormwater systems. In contrast, Conservation Design and Low Impact Development practices strive to minimize landscape and natural feature disturbance to maintain a site's natural drainage patterns and flow conditions.

CD is a holistic site design process that aims to protect and maintain a site's unique natural, historic, and cultural features. CD emphasizes the protection of key land and environmental resources to maintain site hydrology; preserves and/or enhances significant concentrations of natural resources, open space, wildlife habitat, biodiversity corridors, and greenways (interconnected open space); incorporates unique natural, scenic, and historic site features into the configuration of the development; preserves the integral characteristics of the site as viewed from adjacent roads; and ensures flexibility in development design to meet community needs for complementary and aesthetically pleasing development.

LID consists of site design approaches and small-scale stormwater management practices that promote the use of natural systems for infiltration, evapotranspiration (returning moisture to the atmosphere through vegetation), and the harvest and reuse of rainwater. LID addresses the root cause of water quality impairment by managing stormwater as close to the point of generation as possible.

Together, CD and LID offer unique opportunities to balance the "carrying capacity" of the land, the human demands on the land (including land economics), and the design constraints and

opportunities of a site, which together allow for a dynamic interaction between people and the natural world. The goal is to produce a design that balances the demands of human use (scale, pattern, autonomy, privacy, views, etc.) with the requirements for a sustainable landscape (reduction in land fragmentation and use conflicts, preservation of watershed hydrology, protection of wildlife corridors and species diversity, conservation of natural resources, etc.). CD and LID are integrated development processes that respect natural site conditions and attempt to replicate and/or improve the natural hydrology of a site. The abundance of Chester County's streams and headwater areas, agricultural land (consisting of prime agricultural soils), unique aquatic and terrestrial habitat, and scenic and historic resources, argue for design approaches responsive to conservation principles.

This appendix provides information on the principles, processes, and common practices of CD and LID to assist designers and planners to achieve site designs that best maintain pre-construction stormwater runoff conditions, protect site amenities, and preserve natural resources. Components of this appendix include:

- Implementation Challenges
- Design Principles and Techniques;
- Design Process;
- Design Practices;
- Benefits of Conservation Design;
- Conclusion; and
- References.

IMPLEMENTATION CHALLENGES

Various techniques exist to accomplish the purposes of CD and LID (see the list of Design Practices starting on Page 12). However, many municipal codes currently prevent creative site design and engineering by requiring mechanical “by the numbers” development of sites. Restrictive zoning, subjective economic concerns, jurisdictional preferences, and personal tastes determine how a site is developed and how stormwater will be managed. These can pose significant impediments to the use of CD and LID. Such issues, left unaddressed, will “fail to comprehensively maintain predevelopment ecological functions at sites and fail to prevent development impacts to overall watershed ecological health” (Low Impact Development, Prince George's County, Maryland). Several examples of practices that may be limited by municipal zoning or subdivision and land development ordinances (SALDO) are presented in the Design Practices section to assist municipalities, developers, and landowners to understand how to improve the development design process to allow or require CD and LID practices.

Dialogue between developers, municipalities, and planners should be encouraged early in the design process to evaluate all potential site design options. Discussions on proposed site layouts often do not occur until after the submission of preliminary/final developments plans. At this point, substantial time and expense have already gone into the development of these plans, resulting in the reduced preference to make substantial changes or re-designs. Thus, discussions of potential site considerations between landowners, developers, municipalities, and planners early in the design process is critical to ensuring CD and LID practices are incorporated. While the

Municipalities Planning Code prevents municipalities from mandating the submission of sketch plans unless they waive preliminary or final plan requirements, voluntary submission of these plans should be encouraged. Other options also exist; for example, municipalities could mandate the sketch plan but permit a one-step preliminary/final plan submission. Moreover, this site design process emphasizes the importance of dialogue. Remaining open minded to alternative site designs, including flexibility of area and bulk standards, building types, lot sizes, and even construction standards, among others, may achieve multiple benefits, not the least of which is the protection of site hydrology and improved management of stormwater.

One of the greatest challenges to reducing the impact of development is to control the volume of stormwater runoff generated from a site. Typically, a development's increase in impervious surface contributes to reduced infiltration, evapotranspiration, and attenuation of stormwater runoff. This can result in reduced groundwater levels and lower stream baseflow during periods of dry weather and higher stream flows during and after precipitation events (which can result in increased occurrences of flooding and the erosion and destabilization of downstream streambanks). CD and LID techniques strive to prevent these problems by encouraging land development site designs that minimize post-development runoff rates and volumes and minimize needs for artificial conveyance and storage facilities. This process attempts to incorporate the desired land development into the natural hydrologic landscape in a manner that maintains and utilizes existing site hydrology features and functions to minimize generation of new stormwater runoff, thus avoiding the cumulative environmental impacts often associated with land development and reducing the need for and size of constructed stormwater facilities.

Site design practices include preserving natural drainage features, minimizing impervious surface area, reducing the hydraulic connectivity of impervious surfaces, and protecting natural depression storage. Applying this site design process helps maintain site hydrology and manage stormwater by:

- minimizing the generation of stormwater runoff (achieved by designing to the land, considering site drainage patterns and infiltration characteristics, reducing grading and compaction, and considering scale and placement of buildings); managing stormwater as close to the point of generation as possible (by disconnecting impervious surfaces, rather than collecting storm flows from all such surfaces, and distributing such flows to landscaped-based BMPs);
- providing open and vegetated channel conveyance (as needed to treat water quality, reduce velocity and infiltrate); and
- managing remaining conveyed stormwater in common open space (as needed to disperse low velocity storm flows, treat water quality, infiltrate, and release).

A well-designed site will contain a mix of all these features.

In some communities, the use of CD and LID will require a paradigm shift in how we think about and regulate development; community education, be that of residents, developers, engineers, or community officials, will be important if we are to achieve the multiple benefits offered through the use of these alternative design principles and practices.

DESIGN PRINCIPLES AND TECHNIQUES

CD and LID place significant emphasis on maintaining, mimicking, or improving the natural hydrology of land undergoing development. A site's natural hydrology refers to the drainage patterns and infiltration characteristics existing on a site. With CD and LID, effort is placed on development design that minimizes the generation of stormwater runoff. This can be achieved by designing to the land, i.e., giving consideration to site drainage patterns and site infiltration characteristics, reducing grading and compaction, and carefully considering the placement and scale of streets and buildings. Consideration of the natural drainage patterns of a site and the capacity of the site to infiltrate water are central to the concept of managing stormwater on-site.

Where stormwater is generated, the next step involves managing such storm flows as close to the source of generation as possible. This is achieved by disconnecting impervious surfaces and distributing storm flows to green infrastructure. Disconnection allows for management near the source of generation rather than the traditional approach of conveying all storm flows to a central "catch and release" facility (expensive to build and expensive to maintain). Where distributed management practices common to LID are insufficient to accommodate storm flows, CD encourages the use of open channel conveyance systems, such as vegetated channels, bioswales, and wet swales, that further manage storm flows in common open space. This multi-management approach (or four-step management process) – minimizing the generation of stormwater, landscape-based management near the point of generation, open channel conveyance, and management in common open space – is a clear advantage of CD (see Figure 1).

It should also be noted that CD is quite effective on sites with limited infiltration capability, principally, because the four-step management process builds redundancies into runoff management, seeking to achieve disconnection, using LID, providing open channel conveyance, and making use of common open space where other tools and techniques are insufficient on their own.

Figure 1

Conservation Design Principles

Maintaining Site Hydrology and Managing Stormwater

Step 1 – Minimize Generation of Stormwater Runoff through Development Design: Achieved by Designing to the Land & Optimizing the Cumulative Benefits of the Site’s Natural Hydrologic Features

- Consider Natural Drainage Patterns and Infiltration Characteristics
- Reduce Grading and Compaction by Utilizing Natural Topography
- Consider Placement and Scale of Streets and Buildings
- Minimize Land Disturbance – both Surface and Subsurface
- Minimize Cumulative Area to be Covered by Impervious and Compacted Surfaces

Step 2 – Manage Stormwater as Close to the Point of Generation as Possible using Distributed LID Practices

- Take Advantage of the Natural Hydrologic Landscape to Achieve Runoff Controls
- Disconnect Impervious Surfaces
- Distribute Storm Flows to Green Infrastructure

Step 3 – Utilize Open Channel Conveyance (as needed)

Step 4 – Management in Common Open Space (or as conveyed to other green infrastructure practices)

- Integrate Management Facilities into the Natural Environment
- Incorporate Natural Site Features into the Design
- Create Site Amenities that can be Enjoyed by Residents and Provide a Community Aesthetic

No single approach is appropriate for all sites; rather, CD is a process by which to assess the appropriateness of different techniques (LID or otherwise) for different sites. The key to making CD and LID work is a willingness on the part of all involved to be flexible in how a particular site is developed. With this in mind, CD makes it possible to achieve multiple objectives, both in terms of site design (controlling peak flows, reducing total volume, and enhancing water quality), as well as those related to community (protecting natural resources, preserving habitat, interconnecting open space, providing greenways, and achieving better designed communities). (See Figure 2)

Figure 2 Common Objectives Of Conservation Design

Conservation Design practices are intended to protect environmental resources, preserve open space, and manage stormwater by respecting natural drainage patterns and infiltration characteristics.

Common Objectives

Site Design Objectives

Maintain Natural Drainage Patterns

Preserve Water Budget and Natural Infiltration

Minimize Grading – Design to the Site (Minimum Disturbance, Minimum Maintenance)

Reduce Need for Traditional Structural Stormwater Management Facilities (incorporate the use of Green Infrastructure)

Reduce Impervious Cover

Preserve Natural Features & Habitat (Contiguous Open Space)

Provide Open Space Linkages with Adjacent Parcels

Community Objectives

Community Commons/Greens

Lots that Front or Back to Open Space

“Neighborhoods” within Neighborhoods

Options for a Variety of Housing Types/Lot Sizes

Incorporate Unique Site Features into the Design (Natural/Scenic/Historic)

Preserve Characteristics of Site as Viewed from Adjoining Roads

Provide Trail Systems and/or Alternative Transportation Options

CD and LID involve identifying and prioritizing natural resources and natural and constructed hydrologic features and incorporating such features into the overall site design to take advantage of their efficiencies in hydrologic performance, their cost efficiencies of reducing the need for or size of constructed stormwater facilities, and their aesthetic amenities.

Techniques to apply Figure 1 design principles are presented in Table 1.

Table 1 – Site Design Process Principles and Techniques

Conservation Design Principles	Select Design Techniques
<p>Development Design that Minimizes the Generation of Stormwater Runoff: Achieved by Designing to the Land & Optimizing the Cumulative Benefits of the Site's Natural Hydrologic Features</p>	<ul style="list-style-type: none"> • Maintain the natural soil structure and vegetative cover that are often critical components of maintaining the hydrologic functions of natural infiltration, bioretention, flow attenuation, evapotranspiration, and pollutant removal. Strive to achieve multiple stormwater objectives (i.e., maintain hydrologic regime including both peak rate and total volume control, water quality control, and temperature control. • Protect, or improve, natural resources to reduce the needs for environmental mitigation, future environmental restoration, and cumulative flow and water quality impacts of unnecessary disturbances within the watershed system. • Minimize the disturbance of natural surface and groundwater drainage features and patterns, discharge points and flow characteristics, natural infiltration and evapotranspiration patterns and characteristics, natural stream channel stability, and floodplain conveyance, etc. • Minimize the size of individual impervious surfaces. • Separate large impervious surfaces into smaller components. • Avoid unnecessary impervious surfaces. • Utilize porous materials where suited in lieu of impervious materials. • Prioritize on-site hydrologic features (i.e., for protection, improvement, utilization, or alteration) and natural site drainage patterns and infiltration characteristics and consider them for the cornerstones of the conceptual site design. Prevent rather than minimize. • Reduce grading and compaction by applying selective grading design methods to provide final grading patterns that preserve existing topography where it most benefits natural hydrologic functions and where needed; this results in graded areas that evenly distribute runoff and minimize concentrated runoff flows. • Consider the scale and placement of buildings and other infrastructure to minimize impact to natural hydrologic features. • Incorporate unique natural, scenic, and historic site features into the configuration of the development, and ensure flexibility in development design to meet community needs for complementary and aesthetically pleasing development.

Conservation Design Principles	Select Design Techniques
Managing Stormwater as Close to the Point of Generation as Possible using Distributed LID Practices	<ul style="list-style-type: none"> • Incorporate natural hydrologic features that have been selected for their available capacity and function into the overall system of site runoff controls (protect their hydrologic and natural ecosystem functions without directing additional stormwater to them). • Disconnect runoff from one impervious surface to another. • Incorporate LID (or similar) green infrastructure and distribute storm flows to: <ul style="list-style-type: none"> ○ Reduce runoff; ○ Manage stormwater at or as close to the point of generation as possible; ○ Disconnect discharges from streets and municipal storm sewer systems; and ○ Select and design BMPs to give first priority to nonstructural and vegetated (landscape-based) BMPs, second priority to surface structural BMPs, third priority to subsurface structural BMPs, and design subsurface BMPs as shallow as possible.
Open Channel Conveyance (as needed)	<ul style="list-style-type: none"> • Convey concentrated flows by means of innovative pervious vegetated channels rather than piped systems • Provide open channel conveyance, as needed, to: <ul style="list-style-type: none"> ○ Treat water quality; ○ Reduce runoff velocity; and ○ Promote infiltration and evapotranspiration of runoff.
Management in Common Open Space (or as conveyed to other green infrastructure practices)	<ul style="list-style-type: none"> • Rely on natural processes within the soil mantle and the plant community to the maximum extent practicable. • Manage remaining conveyed stormwater from small storms in common open space areas to achieve multiple objectives: <ul style="list-style-type: none"> ○ Disperse storm flows and reduce velocity; ○ Treat water quality; and ○ Promote infiltration and evapotranspiration of runoff. • Provide for appropriate conveyance to retention or detention storage facilities as needed for flows from large storm events (as needed). • Maintain open space functions consistent with common area uses (passive recreation, on-site sewage management, scenic vistas, etc). Management practices should be integrated into the natural environment and be site amenities.

The concepts presented in Figures 1 and 2, and further described in Table 1, are graphically presented below in Figures 3.1, 3.2, 3.3, 3.4, 3.5, and 3.6.

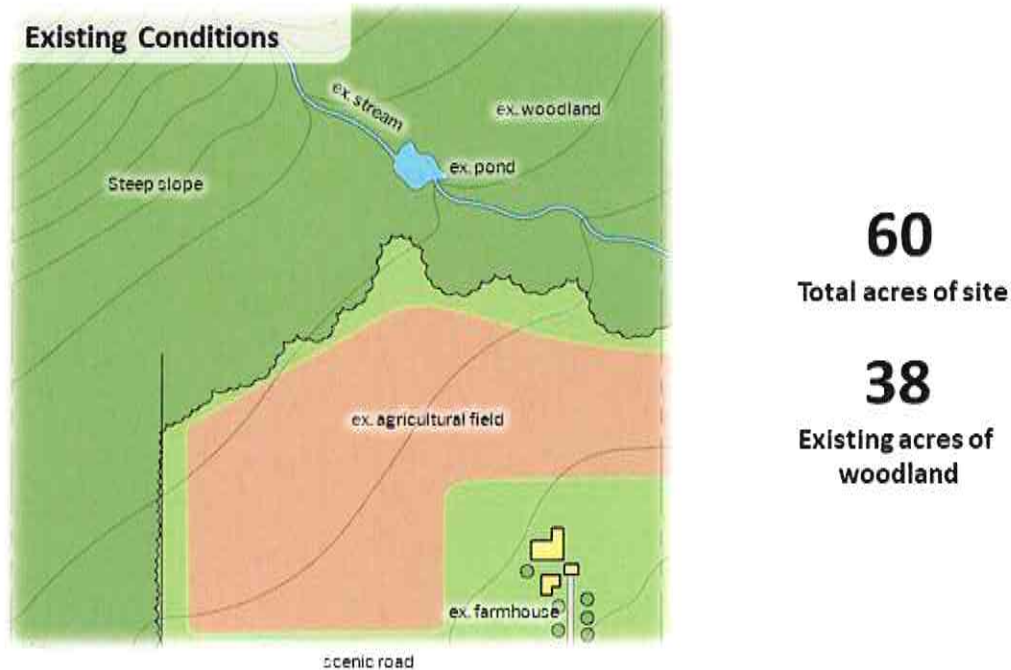


Figure 3.1: Existing conditions on a 60-acre, majority wooded parcel

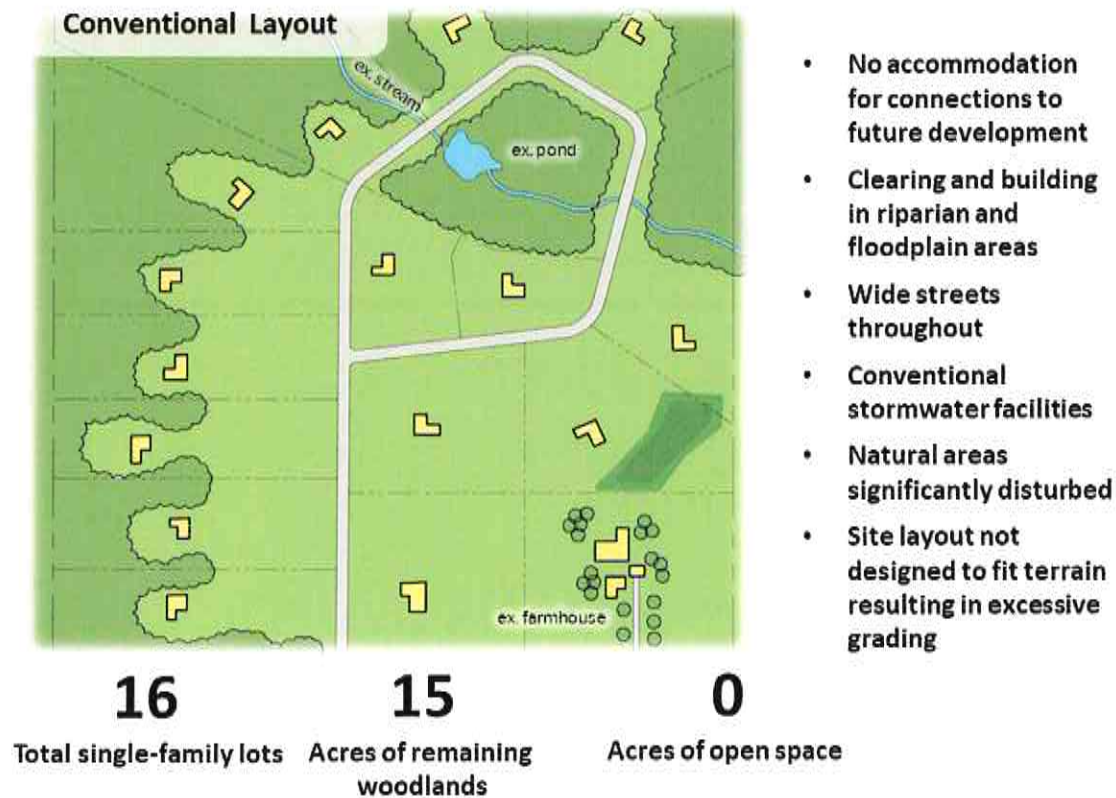
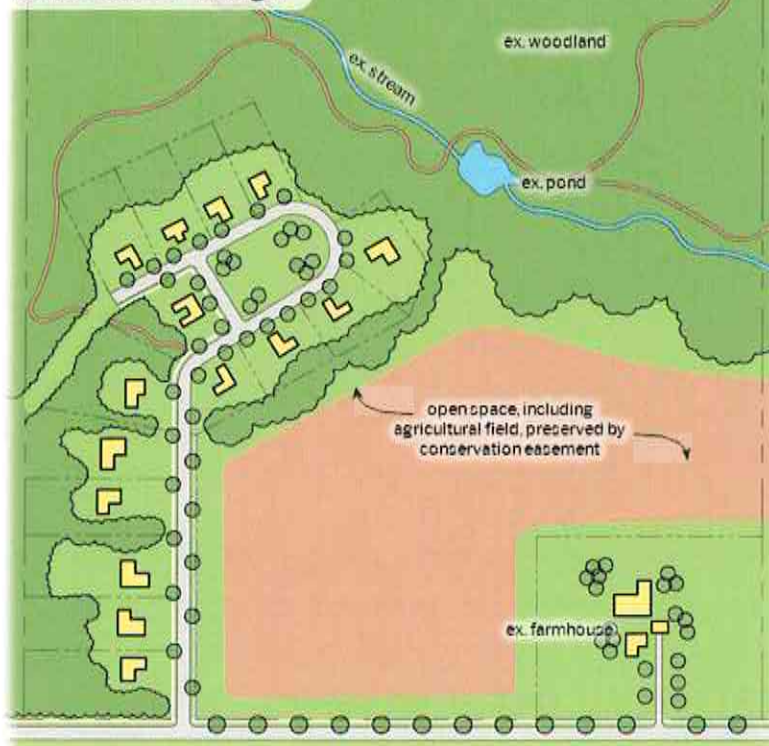


Figure 3.2: Example of how the above parcel may be developed using conventional layout methods

Conservation Design



✓ RECOMMENDED

- **Provides open space linkages with adjacent parcels.** Maintain contiguous open space
- **Minimizes grading:** Design to the site
Minimum disturbance, minimum maintenance
- **Preserves water budget and natural infiltration** Narrow roads, smaller lots
- **Reduces need for traditional structural stormwater management facilities** Incorporate the use of green infrastructure
- **Maintains natural drainage patterns**

60

Total acres of site

16

Total single-family lots

32

Total acres of remaining woodlands

48

Total acres of open space (80%)

- Houses line new road, with all lots adjacent to protected open space
- Trail system
- New road leaves existing stone wall and can connect to future development on adjacent property
- Spatial characteristics of existing farmstead maintained
- Reduced lot size (0.75 acres)

Figure 3.3: Example of a single-family development on the same parcel using the principles of Conservation Design and Low Impact Development



89

Total acres of site

33

Existing acres of woodland



- Large cul-de-sacs
- Clearing and building in riparian corridors
- Wide streets throughout
- Conventional stormwater facilities
- Natural areas significantly disturbed
- Site layout not designed to fit terrain resulting in excessive grading

73

Total single-family lots

8

Acres of remaining woodlands

27

Acres of open space (30%)

Figure 3.4: Example of how a larger parcel with a mix of open meadows, woodlands, scattered fence rows, and stream corridors may be developed using conventional layout methods. Lot sizes are approximately $\frac{3}{4}$ of an acre.

Conservation Design



85

Total Single Family Homes

33

Acres of remaining woodlands

67

Acres of open space (75%)

Conservation Design



- Provides open space linkages with adjacent parcels
- Designed to the site to minimize grading
- Narrower roads and smaller lots to reduce impervious cover
- Maintains natural drainage patterns
- Preserves natural features and habitat
- Community commons and green space
- Trail systems
- Characteristic of site preserved as viewed from adjoining roads

Figure 3.5: Example of single-family development on the same parcel using the principles of Conservation Design and Low Impact Development. Lot sizes are approximately 1/4 of an acre.



96

Total lots, 110 units

33

Acres of
remaining woodlands

67

Acres of
open space (75%)



- Provides open space linkages with adjacent parcels
- Designed to the site to minimize grading
- Narrower roads and smaller lots to reduce impervious cover
- Maintains natural drainage patterns
- Preserves natural features and habitat
- Community commons and green space
- Trail systems
- Characteristic of site preserved as viewed from adjoining roads

Note: While the Conservation Design graphics shown above optimize unit types and lot sizes (and thus allow greater density), it is recognized that this type of mixed use may not be appropriate in some zoning districts. However, Conservation Design works equally well where housing diversity is not appropriate.

Figure 3.6: Example of higher density mixed use site design on the same parcel using the principles of Conservation Design and Low Impact Development.

DESIGN PROCESS

The first step in applying CD is to identify, delineate and assess the functions of all existing natural resources and natural and constructed hydrologic features that: are located within the project site; will receive discharge from the project site; or may be impacted by runoff or disturbance from the proposed land development project. These include:

- Streams, waterways, springs, wetlands, vernal pools, and water bodies;
- Drainage patterns, conveyances, and discharge points;
- Natural infiltration areas and patterns;
- Areas of natural vegetation or woodlands that provide significant evapotranspiration, pollutant removal, bank stabilization, flow attenuation, or riparian buffer functions;
- Floodplains; and
- Other features that contribute to the overall hydrologic function and value of the site and its receiving streams.

Once this inventory and assessment are completed, these identified resources and features are then prioritized for their ability to provide hydrologic function and performance for managing runoff from the proposed site improvements. Specifically, they should be prioritized as follows:

- Those to be incorporated into the site design in a manner that provides for their protection from any disturbance or impact from the proposed land development;
- Those to be protected from further disturbance or impact and for which the proposed land development will provide improvement to existing conditions;
- Those that can be incorporated into and utilized as components of the overall site design in a manner that protects or improves their existing conditions while utilizing their hydrologic function (i.e., for infiltration, evapotranspiration, or reducing pollutant loads, runoff volume or peak discharge rates, etc.) to reduce the need for or size of constructed BMPs; and
- Those that may be considered for alteration, disturbance, or removal.

These prioritizations are then applied as the basis on which to begin the site design lay-out, grading, construction, and permanent ground cover designs to achieve the CD Principles outlined above.

Evaluating a Site Using Conservation Design Principles

The following is a suggested series of steps that landowners, developers, and municipalities can take to achieve CD goals and work together in a more effective manner. While this approach places significant emphasis on the initial phases of project design, it will strengthen support for the plan and substantially reduce the time needed for preliminary and final plan review and approval.

As stated above, the sketch plan process encouraged herein cannot be mandated by municipalities in Pennsylvania under Act 247 (Municipalities Planning Code) unless requirements for either the preliminary plan or final plan are waived. Some municipalities are doing just this by requiring sketch plans and preliminary/final plan submissions while others

“strongly encourage” sketch plans in their subdivision/land development ordinances. The Chester County Planning Commission (CCPC) reviews sketch plans at no charge and highly recommends their use. Additional information on sketch plans can be found in the Chester County Planning Commission’s “Sketch Plan” eTool. Whichever approach is taken, sketch plans can be of tremendous value to the community and developer alike; in particular, sketch plans offer developers the opportunity to get municipal feedback on design prior to investing large sums in engineering design.

1. Determine Development Goals

- Define what is driving the decision to develop the property.
- Consider the site context – regional, local and site characteristics of land ownership, visual patterns, cultural patterns, roadways, vegetation, wildlife habitat, topography, etc. Consider possibilities for linking other landscapes, stream corridors, critical farmland and distinctive woodland patterns; identify or establish wildlife or recreational trail corridors, etc. Consider the natural hydrology of the site – how water flows over the land (the natural drainage patterns), where vegetation intercepts water, etc.

Note: Further consideration of these issues is suggested after a resource inventory and site analysis are performed.

- Clearly define the goals to work towards – these are the design goals for the project. Goals could be economic and/or personal/family related, as well as visual, ecological, agricultural, historical, and educational.
- Consider the project’s time schedule and that of the municipal review process.

2. Conduct an Inventory of Existing Resources - Examine the Natural/Scenic/Historic Resources and Land Use Patterns

- Determine the site context (defined above)
- Evaluate current and past land use (agriculture, wooded lot, vacant, brownfield, etc.)
- Assess wind patterns and micro-climate
- Delineate steep slopes and general topography
- Identify existing vegetative cover conditions according to general cover type, and label specimen trees and the canopy line of existing woodlands.
- Map hydrologic features and drainage patterns (wetlands, floodplains, streams, drainage swales, etc.)
- Identify scenic viewsheds (interior and exterior)

- Consider potential historic and cultural resources
- Assess soil patterns (hydric soils, prime agricultural soils, infiltration-capable soils, etc.) and vegetation patterns (landscape texture and patterns)
- Consider local zoning regulations
- Review the site for obvious land fragmentation (agricultural, natural habitat, human use, viewsheds)
- Determine the presence of endangered/threatened species and unusual habitats, critical natural areas, etc.

Other design considerations include solar exposure (seasonal changes), light patterns (shadows), sense of space (enclosed, open, mysterious) and sense of scale.

3. Undertake a Site Analysis

- Compare/overlay/combine the natural/scenic/historic resource and land use pattern information to create a general understanding of the site's opportunities and constraints, particularly as they relate to the design goals. Some initial constraints could present opportunities. Particular emphasis should be placed on site contours and existing site hydrology, e.g., drainage patterns, infiltration capability of soils, etc.
- Prepare a site analysis map that outlines the most important opportunities and constraints. The site analysis should identify both the traditionally unbuildable areas (wet, flood-prone, or steep) and the most outstanding aspects of the remaining land (such as scenic vistas, natural meadows, hedgerows, mature woodlands, historic buildings or other structures, stone walls, etc.). It is important to note that CD places significant emphasis on soils (particularly the manner in which water moves across and through them). Disturbance of soils, disturbance of vegetation, and compaction all affect the ability of a site to manage stormwater. For example, while it is imperative that good draining soils be preserved to the maximum extent possible, areas of poor permeability that contain robust vegetation may function quite satisfactorily (a well-developed root zone in conjunction with established vegetation can significantly improve poor soil infiltration and permeability). Conversely, even good soils, if substantially disturbed and compacted, can become far less permeable.

Note: Although reliance on published soils data is acceptable for site analyses and conceptual planning purposes, detailed planning must include soil field sampling.

4. Create Conceptual Designs or Sketch Plans

- Use the site analysis to create conceptual designs. Consider the principles and objectives of Conservation Design as the basis for initially conceptualizing layouts (Note: some

municipalities will have a similar design process codified in their subdivision and land development ordinance referred to as the 4-step design process). List opportunities and constraints of each design element. This component involves four steps:

- i) **Delineate conservation areas (based on the findings of the site analysis) and potential development areas.** Designing to the site, rather than grading to achieve a standardized product, is preferable because it accomplishes the goals of minimum disturbance/minimum maintenance (i.e., respecting the site's natural hydrology, minimizing grading and earth disturbance, etc.); such an approach can also substantially reduce construction costs. Additional emphasis should be given to the site's existing hydrology, such as drainage patterns, the location of natural swales and conveyances, and the infiltration capability of soils.

This step requires careful integration of stormwater management and CD concepts into the design of the site. Engineering stormwater solutions after a design has been selected fails to consider a key component of CD, i.e., design as an integral best management practice. For example, it is better to prevent runoff than to attempt to mitigate it once it is created. Approaches to the site design that can reduce the generation of stormwater from the outset are the most effective approach to stormwater management.

- ii) **Locate desired/permitted structures (housing units, buildings, etc.) on the property (as they relate to Step 1 and the design goals).** Again, Conservation Design principles should be carefully considered here. Will compact development allow for a reduction in road length? Is it possible to interconnect open space, thus permitting stormwater management close to the source of generation and creating biodiversity corridors, etc. (multiple objectives)? Can structures be located so that a majority back or front to open space?
- iii) **Connect buildings or house sites with streets (logical alignment) and trails (where appropriate).** Consider ways to reduce impervious cover (one-way streets where appropriate, planted islands in cul-de-sacs, etc.).
- iv) **Draw in lot lines for the house sites or buildings, where needed.**

- Meet with municipal officials and review plans -- what is liked, not liked, and why.
- Identify a direction for engineering and final design.

5. *Formulate A Final Design (or Sketch Plan) as the Basis for an Engineered Site Plan*

- Synthesize discussion of conceptual designs (sketch plans) and finalize design.
- Develop legal instruments necessary to realize plan objectives, e.g., conservation easements, deed restrictions, homeowners association, estate planning, etc. (Note: these concepts are considered throughout the design process).

6. Obtain Approvals (Follow-up)

- Obtain municipal and County buy-in of master sketch plan, and
- Proceed to Final Engineered Plan approvals.

DESIGN PRACTICES

Numerous practices and strategies can be considered where their aim is to sustain and utilize the benefits of existing site hydrology and minimize the generation of new stormwater runoff. Careful consideration of site topography and implementation of a combination of the design practices described herein may reduce the cost associated with implementing stormwater control measures. Following are brief descriptions of various practices that can be used to achieve the principles of CD and LID.

Site Layout Practices

The following site layout practices are but a few of the methods by which CD and LID can be implemented. Although municipal codes can reflect such practices, they are less functions of regimented codes and procedures than about understanding and recognizing the benefits and values that existing resources can contribute to the desired outcomes of the land development project. In many circumstances, communication among design engineers, land planning and environmental professionals, knowledgeable developers, community representatives, and regulatory authorities can promote a beneficial collective understanding about the most effective path forward to achieve optimum planning outcomes.

Preserving Natural Drainage Features. Protecting natural drainage features, particularly vegetated drainage swales and channels, is desirable because of their ability to infiltrate and attenuate flows and to filter pollutants. Unfortunately, some common land development practices encourage just the opposite pattern -- streets and adjacent storm sewers typically are located in the natural headwater valleys and swales, thereby replacing natural drainage functions with an impervious system. As a result, runoff and pollutants generated from impervious surfaces flow directly into storm sewers with no opportunity for attenuation, infiltration, or filtration. Designing developments to fit site topography retains much of the natural drainage function. In addition, designing with the land minimizes the amount of site grading, reduces the amount of compaction that can alter site infiltration characteristics, and can result in cost savings to the developer.

Protecting Natural Depression Storage Areas. Depressional storage areas have no surface outlet or drain very slowly following a storm event. They can be commonly seen as ponded areas in fields during the wet season or after large storm events. Some development practices eliminate these depressions by filling or draining, thereby eliminating their ability to reduce surface runoff volumes and trap pollutants. The volume and release-rate characteristics of depressions should be protected in the design of the development site to assist in reducing runoff volumes and reducing runoff rates. Designing around the depression or incorporating its storage as additional capacity in required detention facilities, treats this area as a site amenity rather than a detriment.

Avoiding Introduction of Impervious Areas. Reduction of impervious cover is one of the greatest benefits of CD. The combined benefits of setting aside more than half of the buildable land as open space, coupled with the resulting shorter road lengths, result in less impervious cover and less compacted soil. Building footprints, sidewalks, driveways, and other features producing impervious surfaces should be evaluated to minimize impacts on runoff. Designing a site to reduce the overall length and area of roads not only reduces total impervious cover, but also lowers municipal road maintenance and snow removal costs. **In many instances, municipalities have the ability to reduce impervious cover by providing incentives or opportunities in their zoning and subdivision/ land development ordinances to reduce road width, reduce or modify cul-de-sac dimensions, reduce or modify curbing requirements, and reduce or modify sidewalk requirements.** For example, curbing contributes to impervious cover and channels storm flows to inlets, thus further concentrating runoff. An alternative is to consider bioswales and/or infiltration trenches that can treat and attenuate flows coming off roadways. Where curbs are desirable, simply providing curb breaks or openings of 6-12 inches every 2-4 feet can disconnect flows and reduce concentration of runoff. Cul-de-sacs can be replaced with “hammerheads” or be designed with planted islands to reduce impervious cover (both of which can be designed to allow sufficient turning radius for emergency vehicles). In fact, planted islands in cul-de-sacs can be designed to intercept road runoff and contribute to infiltration.

Disconnecting Impervious Surfaces. Impervious surfaces are significantly less of a problem if they are not directly connected to an impervious conveyance system (such as storm sewer). Two basic ways to reduce hydraulic connectivity are routing roof runoff over lawns and reducing the use of storm sewers. Site grading should promote increasing travel time of stormwater runoff from these sources and should help reduce concentration of runoff to a single point within the project site. Along roadways, where feasible, low velocity runoff (i.e., 1-to-2-year storms) can be infiltrated in grass swales.

Routing Roof Runoff Over Lawns. Roof runoff can be easily routed over lawns in most site designs. The practice discourages direct connections of downspouts to “driveway-to-street-to-storm sewers” or parking lots. The practice also discourages sloping driveways and parking lots to the street. Crowning the driveway, to run off to the lawn, uses the lawn as a filter strip.

Reducing Street Widths. Street widths can be reduced by either eliminating on-street parking (where conditions warrant) and/or by designing roads to meet actual demand. Designers should consult with municipal officials and staff to select the narrowest practical street width for the design conditions (speed, curvature, housing density, need for on-street parking, etc.). For example, permitting one-way streets for small loop roads can reduce overall road width. Reduced street widths also can lower maintenance needs and costs. Municipalities should review their ordinances to ensure that their street requirements are not over or under designed. Although there are some situations, such as with higher density development, where on-street parking may be needed, the amount of on-street parking, and hence overall street width, should be gaged to need. For further information, see the Multi-modal Circulation Handbook prepared by the CCPC (or consult other smart street publications). Narrower neighborhood streets should be considered and encouraged under select conditions.

Reducing or Modifying Sidewalk Requirements. A sidewalk on one side of the street may suffice

in low-traffic neighborhoods. The lost sidewalk could be replaced with bicycle/recreational trails that follow back-of-lot lines as an alternative to reduced sidewalks, where appropriate. Where used, consideration should be given to constructing trails with pervious materials.

Reducing or Modifying Parking Requirements. Parking standards, particularly for nonresidential development, can be excessive. Reducing spaces to match actual demand makes sense and can significantly reduce impervious cover. In addition to or in lieu of reductions, alternatives such as shared or reserve parking should be considered. Where appropriate, stall size should also be considered and modified as needed.

Reducing Building Setbacks. Reducing building setbacks (from streets) reduces the size of impervious areas of driveways and entry walks and is most readily accomplished along low-traffic streets where traffic noise is not a problem.

Minimum Disturbance/ Minimum Maintenance. Reducing site disturbance and grading can go a long way towards reducing runoff. Sensitive site design conducive to the natural features of the site, including natural site contours, can reduce the amount of land disturbed during actual development. Often referred to as “fingerprinting,” this approach identifies the limits of disturbance, which are flagged in the field. As is often the case, development sites need some grading in order to achieve development objectives. In these cases, there are often opportunities to make grading part of the solution, rather than part of the problem. Careful grading can capitalize on natural site functions to achieve stormwater management objectives. For example, grading that does occur can be incorporated into terracing or berming near existing vegetation to aid in infiltration, stormwater management and pollutant filtering.

Constructing Compact Developments using Conservation Design Principles: Lower impact, compact CD can reduce the amount of impervious area for a given number of lots. Reductions in overall infrastructure, including reduced street length, width, curbing, and parking, among others, can contribute to a reduction in development and long-term maintenance costs. Reduced site disturbance and preservation of open space help buffer sensitive natural areas and retain more of a site’s natural hydrology. Development can be designed so that areas of high infiltration soils are reserved as stormwater infiltration areas. Construction activity can be focused onto less sensitive areas without affecting the gross density of development. One impediment to the use of smaller lots is where lot area impervious cover standards (as opposed to total impervious cover standards) make it difficult to locate houses, driveways, pools, septic, etc., on small lots. Where this issue arises, municipalities may want to consider reductions in, or waivers to, lot area impervious cover standards where it can be shown that total impervious cover standards can be met and a stormwater management report indicates that the coverage proposed can be managed appropriately on the site.

LID Practices and Stormwater Control Measures

Stormwater Control Measures (SCMs) are intended to supplement natural hydrology site design techniques where needed. Structural in nature, such practices include bioretention facilities, rain gardens, swales, and other engineered stormwater BMPs. Listed here are techniques intended to help manage stormwater predominantly at or near the source, rather than traditional techniques that largely release runoff over an extended period of time to adjacent properties and streams. This list, in no way exhaustive, gives examples of a few of the most common practices. It should be noted that LID aims to mimic the predevelopment site hydrology by using site design techniques

that store, infiltrate, evaporate, and detain runoff. Use of these techniques helps to reduce off-site runoff and ensure adequate groundwater recharge. Since every aspect of site development affects the hydrologic response of a site, LID control techniques focus mainly on site hydrology. LID strives to conserve existing site resources, minimize site impacts, maintain (and even extend) the time of concentration of runoff, utilize distributed management practices, and prevent pollution.

Bioretention. This type of BMP combines open space with stormwater treatment. Soil and plants, rather than sand filters, treat and store runoff. Infiltration and evapotranspiration are achieved, often coupled with an underdrain to collect water not infiltrated or used in the root zone.

Rain Gardens. Typically, rain gardens are shallow depression areas containing a mix of water tolerant native plant species. The intent is to capture runoff for storage and use in the root zone of plants. Intended largely as a way of managing stormwater through evapotranspiration (ET), rain gardens often function as infiltration facilities as well.

Vegetated Open Channel Conveyances. By reducing the use of storm sewers to drain streets, parking lots, and back yards, the potential for accelerating runoff from development can be greatly reduced. This practice requires greater use of natural or vegetated drainage swales and may not be practical for some development sites, especially if there are concerns for areas that do not drain in a “reasonable” time. The practice requires educating local citizens, who may expect runoff to disappear shortly after a rainfall event.

Permeable Paving Materials. These materials include permeable interlocking concrete paving blocks or porous bituminous concrete, among others. Such materials should be considered as alternatives to conventional pavement surfaces, especially for low use surfaces such as driveways, overflow parking lots, and emergency access roads. Surfaces for which seal coats may be applied should refrain from using permeable paving materials. Note: ongoing maintenance is required for some surfaces to minimize potential for clogging.

Residents and municipal officials of communities that utilize LID and other green technology practices often need to be informed of the benefits of such facilities. LID practices can offer enhanced stormwater control in a more naturalized setting, reduce maintenance needs and costs, provide more attractive management options, and provide opportunities for wildlife habitat. Descriptions of the benefits of such practices should be included in homeowners association documents (and conveyed to homeowners in other ways) and signage should be used to convey helpful information about the function and value of such practices.

BENEFITS OF CONSERVATION DESIGN

Studies over the past 25 years have shown that development planned according to CD principles yields significant benefits to homeowners, developers, municipalities, and local communities. Homeowners see tremendous value in the preservation of open space and the protection of natural features, even if it does not exist on their lots (National Association of Home Builders, 1991; DVRPC, 2011). Developers experience reduced construction costs and enjoy the improved marketability. Municipalities see a reduced demand for new municipal parks and receive additional revenue from improved property values. Areas preserved as open space allow for passive and active recreational opportunities and help to preserve the unique character of the site. Common

open spaces also help to foster social cohesion by providing residents with opportunities to get outside and interact with neighbors without having to drive. Ultimately, communities designed using CD planning principles are more desirable places to live, work, and play.

Given the improved sense of place and community, dollar appreciation of conservation subdivisions outpaces conventional development by upwards of 12% (The Conservation Fund, 2001). In Indiana, the use of conservation subdivision design added \$20,000 in worth to each lot without decreasing the total number of lots (ConservationTools.org). Even more compact development (quarter-acre lots) sells for more than half-acre and larger lots where open space exists. Over a 20-year period, the conservation development homes built on quarter-acre lots sold for an average \$17,000 more than their counterparts built on half-acre lots (Northeastern Illinois Planning Commission, 2003). Analyses completed as a part of Chester County's *Return on Environment* report note that in Chester County, average property values have increased by more than \$11,000 per lot for those homes located near open space (*Return on Environment*, Chester County, 2019). Furthermore, this same report identifies the reduced need for stormwater infrastructure as a major cost savings for conservation design subdivisions.

Developers see value through reduced development costs and increased unit values. In Texas, respect for the natural terrain and existing resources allowed the developer of an 80-lot development to reduce grading costs by 83% (\$250,000) compared to a conventionally-engineered plan (Growing Greening, ConservationTools.org). CD subdivisions typically cost upwards of \$7,400 less per lot to build (Environmental Law and Policy Center, 2011). Examples of cost savings to developers include:

- Reduced Site preparation costs
 - Elimination of mass re-grading
 - Decrease in erosion and sediment control measures
- Reduced Infrastructure costs
 - Reduced need for storm water basins
 - Reduced roadway lengths
 - Reduced drainage pipe installations
- Increased value of units
 - Located adjacent to open space
 - Positioned to coexist with natural resource areas

Conventional development places tremendous burdens on infrastructure and typically does not pay for itself in services provided. CD and compact development reduce the costs of infrastructure and construction, preserve open space, increase the inherent value of units over conventional development, pose greater opportunities for cost efficient housing, and offer greater protection to the environment and our waterways. And while costs to develop go down, value to homeowners and municipalities goes up.

It should also be noted that there is a distinct climate benefit to be gained from the principles of conservation design, among them: providing open land for stormwater infiltration, landscape

restoration, wildlife habitat, heat mitigation, and storm resilience, among others. The tools and techniques described herein offer important techniques by which to implement climate action plans published at the local, county and state levels (see also Chester County's Climate Action Plan and the Pennsylvania Department of Conservation and Natural Resources Climate Change Adaptation and Mitigation Plan).

CONCLUSION

The use of Conservation Design (CD), Low Impact Development (LID), and green infrastructure offers municipalities and developers opportunities to protect and enhance the hydrology of development sites, as well as address other environmental and social issues related to development. In conclusion, development designed using these principles results in a more desirable place to live.

As noted above, land development sites can be evaluated through a consensus-driven stakeholder process that seeks to determine development goals, conduct a resource inventory, undertake a site analysis, create conceptual designs (sketch plans), formulate final designs, and obtain government buy-in and approval. Flexibility by all parties allows each site to be evaluated for its unique resources and potential. Solutions emerge from early and on-going engagement among all stakeholders in a project.

REFERENCES

Appreciating Clusters, Builder Magazine, National Association of Home Builders, 1991.

Better Models for Development in Virginia, The Conservation Fund, 2001.

Conservation Design for Stormwater Management, Delaware Department of Natural Resources and Environmental Control and the Brandywine Conservancy, September 1997.

Conservation Design Resource Manual, Northeastern Illinois Planning Commission and Chicago Wilderness, 2003

Conservation Design: Techniques for Preserving Natural Hydrologic Functions, White Paper prepared for New Castle County, Delaware Drainage Code, John M. Gaadt, AICP, September 2007.

Conservation Design Resource Manual, Northeastern Illinois Planning Commission and Chicago Wilderness, 2003

[Growing Greener: Conservation By Design](http://ConservationTools.org) guide at ConservationTools.org.

Guidelines for Counties and Municipalities to Protect Ecological Features of State Resource Areas, Environmental Resources Management, Inc, Gaadt Perspectives, LLC, Kramer and Associates, Delaware Office of State Planning Coordination, Delaware Department of Natural Resources and Environmental Control, March 2008.

Guidance on MS4 Ordinance Provisions, Document Number 392-0300-003, by the Pennsylvania Department of Environmental Protection.

Impervious Surface Coverage – The Emergence of a Key Environmental Indicator, American Planning Association Journal, Spring, 1996.

Land Use Tools to Protect Groundwater: Conservation Design, Environmental Law and Policy Center, 2011

Low Impact Development Center, <http://www.lowimpactdevelopment.org/>.

Metro, Portland Metropolitan Planning Body, *“Green Streets, Innovative Solutions for Stormwater and Stream Crossings,”* First Edition, June 2002.

Multi-modal Circulation Handbook, Chester County Planning Commission, 2016 Update, <https://www.chescoplanning.org/MuniCorner/MultiModal/ch1-intro.cfm>

PA Department of Environmental Protection, Best Management Practices Manual, 2006.

Prince George’s County Department of Environmental Resources and Maryland Department of Natural Resources, *Low Impact Development*, Prince George’s County, MD, undated.

Rural By Design, Planning for Town and Country, Second edition, Randall Arendt, 2015.

Return on Environment: The Economic Value of Protected Open Space in Chester County, Pennsylvania, May 2019

Return on Environment: The Economic Value of Protected Open Space in Southeastern Pennsylvania, January 2011, DVRPC.

Sustainable Technologies Evaluation Program,
https://wiki.sustainabletechnologies.ca/wiki/Main_Page

ORDINANCE APPENDIX D

WEST NILE VIRUS DESIGN GUIDANCE

WEST NILE VIRUS GUIDANCE

(This source is from the Monroe County, PA Conservation District that researched the potential of West Nile Virus problems from BMPs due to a number of calls they were receiving)

Monroe County Conservation District Guidance: Stormwater Management and West Nile Virus

Source: Brodhead McMichaels Creeks Watershed Act 167 Stormwater Management Ordinance Final Draft 2/23/04

The Monroe County Conservation District recognizes the need to address the problem of nonpoint source pollution impacts caused by runoff from impervious surfaces. The new stormwater policy being integrated into Act 167 stormwater management regulations by the PA Department of Environmental Protection (PADEP) will make nonpoint pollution controls an important component of all future plans and updates to existing plans. In addition, to meet post-construction anti-degradation standards under the state National Pollutant Discharge Elimination System (NPDES) permitting program, applicants will be required to employ Best Management Practices (BMPs) to address nonpoint pollution concerns.

Studies conducted throughout the United States have shown that wet basins and in particular constructed wetlands are effective in traditional stormwater management areas such as channel stability and flood control and are one of the most effective ways to remove stormwater pollutants (United States Environmental Protection Agency 1991, Center for Watershed Protection 2000). From Maryland to Oregon, studies have shown that as urbanization and impervious surfaces increase in a watershed, the streams in those watersheds become degraded (CWP 2000). Although there is debate over the threshold of impervious cover when degradation becomes apparent (some studies show as little as 6% while others show closer to 20%), there is agreement that impervious surfaces cause nonpoint pollution in urban and urbanizing watersheds and that degradation is ensured if stormwater BMPs are not implemented.

Although constructed wetlands and ponds are desirable from a water quality perspective, there may be concerns about the possibility of these stormwater management structures becoming breeding grounds for mosquitoes. The Conservation District feels that although it may be a valid concern, **municipalities should not adopt ordinance provisions prohibiting wet basins for stormwater management.**

Mosquitoes

The questions surrounding mosquito production in wetlands and ponds have intensified in recent years by the outbreak of the mosquito-borne West Nile Virus. As is the case with all vector-borne maladies, the life cycle of West Nile Virus is complicated, traveling from mosquito to bird, back to mosquito, and then to other animals including humans. *Culex pipiens* was identified as the vector species in the first documented cases from New York in 1999. This species is still considered the primary transmitter of the disease across its range. Today there are

some 60 species of mosquitoes that inhabit Pennsylvania. Along with *C. pipiens*, three other species have been identified as vectors of West Nile Virus while four more have been identified as potential vectors.

The four known vectors in NE Pennsylvania are *Culex pipiens*, *C. restuans*, *C. salinarius*, and *Ochlerotatus japonicus*. All four of these species prefer, and almost exclusively use, artificial containers (old tires, rain gutters, birdbaths, etc.) as larval habitats. In the case of *C. pipiens*, the most notorious of the vector mosquitoes, the dirtier the water, the better they like it. The important factor is that these species do not thrive in functioning wetlands where competition for resources and predation by larger aquatic and terrestrial organisms is high.

The remaining four species, *Aedes vexans*, *Ochlerotatus Canadensis*, *O. triseriatus*, and *O. trivittatus*, are currently considered potential vectors due to laboratory tests (except the *O. trivittatus*, which did have one confirmed vector pool for West Nile Virus in PA during 2002). All four of these species prefer vernal habitats and ponded woodland areas following heavy summer rains. These species may be the greatest threat of disease transmission around stormwater basins that pond water for more than four days. This can be mitigated, however, by establishing ecologically functioning wetlands.

Stormwater Facilities

If a stormwater wetland or pond is constructed properly and a diverse ecological community develops, mosquitoes should not become a problem. Wet basins and wetlands constructed as stormwater management facilities should be designed to attract a diverse wildlife community. If a wetland is planned, proper hydrologic soil conditions and the establishment of hydrophytic vegetation will promote the population of the wetland by amphibians and other mosquito predators. In natural wetlands, predatory insects and amphibians are effective at keeping mosquito populations in check during the larval stage of development while birds and bats prey on adult mosquitoes.

The design of a stormwater wetland must include the selection of hydrophytic plant species for their pollutant uptake capabilities and for not contributing to the potential for vector mosquito breeding. In particular, species of emergent vegetation with little submerged growth are preferable. By limiting the vegetation growing below the water surface, larvae lose protective cover, and there is less chance of anaerobic conditions occurring in the water.

Stormwater ponds can be designed for multiple purposes. When incorporated into an open space design, a pond can serve as a stormwater management facility and a community amenity. Aeration fountains and stocked fish should be added to keep larval mosquito populations in check.

Publications from the PA Department of Health and the Penn State Cooperative Extension concerning West Nile Virus identify aggressive public education about the risks posed by standing water in artificial containers (tires, trash cans, rain gutters, bird baths) as the most effective method to control vector mosquitoes.

Conclusion

The Conservation District understands the pressure faced by municipalities when dealing with multifaceted issues such as stormwater management and encourages the incorporation of water quality management techniques into stormwater designs. As Monroe County continues to grow, conservation design, infiltration, and constructed wetlands and ponds should be among the preferred design options to reduce the impacts of increases in impervious surfaces. When designed and constructed appropriately, the runoff mitigation benefits to the community from these design options will far outweigh their potential to become breeding grounds for mosquitoes.

ORDINANCE APPENDIX E

STORMWATER BEST MANAGEMENT PRACTICES AND CONVEYANCES OPERATION AND MAINTENANCE AGREEMENT

SAMPLE AGREEMENT

<p>Prepared By:</p> <p>Name _____</p> <p>Address _____</p> <p>Address _____</p> <p>Phone Number _____</p> <p>Return To:</p> <p>Borough of Elverson Elverson Borough Hall 101 S. Chestnut Street P.O. Box 206 Elverson, PA 19520 (610) 286-6420</p> <p>UPI#: _____ of property with BMPs and/or Conveyances</p> <p>Property Street Address: _____</p> <p>_____</p>	<p>LEAVE BLANK For Recorder's Use Only</p>
---	--

STORMWATER BEST MANAGEMENT PRACTICES (BMPs) AND CONVEYANCES OPERATION AND MAINTENANCE AGREEMENT

THIS AGREEMENT, made and entered into this _____ day of _____, 20____, by and between _____, (hereinafter the "Landowner"), and the Borough of Elverson, Chester County, Pennsylvania, (hereinafter the "Municipality");

WITNESSETH

WHEREAS, the Landowner is the owner of certain real property by virtue of a deed of Conveyance recorded in the land records of Chester County, Pennsylvania, at Deed Book _____ and Page _____, (hereinafter "Property"); and

WHEREAS, the Landowner is proceeding to build and develop the Property; and

WHEREAS, the Stormwater Best Management Practices (hereinafter BMP(s)) and Conveyances Operations and Maintenance Plan OR the Simplified Approach Stormwater Management Site Plan (as applicable) for _____ (title of approved plans for the Regulated Activity) approved by the Municipality on the _____ day of _____, 20____ (hereinafter referred to as the "Plan") for the Property,

which is attached hereto as Appendix A and made part hereof, provides for management of stormwater within the confines of the Property through the use of BMP(s) and Conveyances; and

WHEREAS, the Municipality and the Landowner, for itself and its administrators, executors, successors, heirs, and assigns, agree that the health, safety, and welfare of the residents of the Municipality and the protection and maintenance of water quality require that stormwater BMP(s) and Conveyances be constructed and maintained on the Property; and

WHEREAS, for the purposes of this agreement, the following definitions shall apply:

BMP – “Best Management Practice” – Activities, facilities, designs, measures, or procedures as specifically identified in the Plan, used to manage stormwater impacts from Regulated Activities to provide water quality treatment, infiltration, volume reduction, and/or peak rate control, to promote groundwater recharge, and to otherwise meet the purposes of the Municipality’s Stormwater Management Ordinance. Stormwater BMPs are commonly grouped into one (1) of two (2) broad categories or measures: “structural” or “nonstructural.” Nonstructural BMPs or measures refer to low impact development and conservation design practices used to minimize the contact of pollutants with stormwater runoff. These practices aim to limit the total volume of stormwater runoff and manage stormwater at its source by techniques such as protecting natural systems and incorporating existing landscape features. Nonstructural BMPs include, but are not limited to, the protection of sensitive and special value features such as wetlands and riparian areas, the preservation of open space while clustering and concentrating development, the reduction of impervious cover, and the disconnection of downspouts from storm sewers. Structural BMPs are those that consist of a constructed system that is designed and engineered to capture and treat stormwater runoff. Structural BMPs are those that consist of a physical system that is designed and engineered to capture and treat stormwater runoff. Structural BMPs include, but are not limited to, a wide variety of practices and devices from large-scale retention ponds and constructed wetlands to small-scale underground treatment systems, infiltration facilities, filter strips, bioretention, wet ponds, permeable paving, grassed swales, riparian buffers, sand filters, detention basins, and other manufactured devices designed to mitigate stormwater impacts. The BMPs identified in the Plan are permanent appurtenances to the Property; and

Conveyance – As specifically identified in the Plan, a manmade, existing or proposed facility, feature or channel used for the transportation or transmission of stormwater from one place to another, including pipes, drainage ditches, channels and swales (vegetated and other), gutters, stream channels, and like facilities or features. The Conveyances identified in the Plan are permanent appurtenances to the Property; and

WHEREAS, the Municipality requires, through the implementation of the Plan, that stormwater management BMPs and conveyances, as required by the Plan and the Municipality’s Stormwater Management Ordinance, be constructed and adequately inspected, operated and maintained by the Landowner or their designee.

NOW, THEREFORE, in consideration of the foregoing promises, the mutual covenants contained herein, and the following terms and conditions, the parties hereto, intending to be legally bound hereby, agree as follows:

1. The foregoing recitals to this Agreement are incorporated as terms of this Agreement as if fully set forth in the body of this Agreement.
2. The Landowner shall construct the BMP(s) and Conveyance(s) in accordance with the final stormwater management site plans and specifications.
3. Upon completion of construction, the Landowner shall be responsible for completing final As-Built Plans of all BMPs, Conveyances, or other stormwater management facilities included in the approved stormwater management site plan as per the requirements of §225-33 of the Stormwater Management Ordinance.
4. The Landowner shall inspect, operate and maintain the BMP(s) and Conveyance(s) as shown on the Plan in good working order acceptable to the Municipality and in accordance with the specific inspection and maintenance requirements in the approved Plan and the current version of the Pennsylvania Stormwater BMP Manual, as amended.
5. The Landowner hereby grants permission to the Municipality, its authorized agents and employees, to enter upon the Property from a public right-of-way or roadway, at reasonable times and upon presentation of proper identification, to inspect the BMP(s) and Conveyance(s) whenever it deems necessary for compliance with this Agreement, the Plan and the Municipality's Stormwater Management Ordinance. Whenever possible, the Municipality shall notify the Landowner prior to entering the Property.
6. The Landowner shall inspect the BMP(s) and Conveyance(s) to determine if they continue to function as intended.
7. The BMP(s) and Conveyance(s) shall be inspected according to the following frequencies, at a minimum:
 - a. Annually for the first 5 years.
 - b. Once every 3 years thereafter.

Written inspection reports shall be created to document each inspection. The inspection report shall contain the date and time of the inspection, the individual(s) who completed the inspection, the location of the BMP, facility or structure inspected, observations on performance, and recommendations for improving performance, if applicable. Inspection reports shall be submitted to the Municipality within 30 days following completion of the inspection.

Landowners must notify the Municipality of BMP(s) and Conveyance(s) that are no longer functioning as designed and must coordinate with the Municipality to determine a schedule to repair or retrofit these systems to restore designed functionality.

8. The Landowner acknowledges that, per the Municipality's Stormwater Ordinance, it is unlawful, without written approval of the Municipality, to:
 - a. Modify, remove, fill, landscape, alter or impair the effectiveness of any BMP or Conveyance that is constructed as part of the approved Plan;
 - b. Place any structure, fill, landscaping, additional vegetation, yard waste, brush cuttings, or other waste or debris into a BMP or Conveyance that would limit or alter the functioning of the BMP or Conveyance;
 - c. Allow the BMP or Conveyance to exist in a condition which does not conform to the approved Plan or this Agreement; and
 - d. Dispose of, discharge, place or otherwise allow pollutants including, but not limited to, deicers, pool additives, household chemicals, and automotive fluids to directly or indirectly enter any BMP or Conveyance.
9. In the event that the Landowner fails to operate and maintain the BMP(s) and Conveyance(s) as shown on the Plan in good working order acceptable to the Municipality, the Landowner shall be in violation of this Agreement, and the Landowner agrees that the Municipality or its representatives may, in addition to and not in derogation or diminution of any remedies available to it under the Stormwater Ordinance or other statutes, codes, rules or regulations, or this Agreement, enter upon the Property and take whatever action is deemed necessary to maintain said BMP(s) and Conveyance(s). It is expressly understood and agreed that the Municipality is under no obligation to maintain or repair said facilities, and in no event shall this Agreement be construed to impose any such obligation on the Municipality.
10. In the event that the Municipality, pursuant to this Agreement, performs work of any nature or expends any funds in performance of said work for inspection, labor, use of equipment, supplies, materials, and the like, the Landowner shall reimburse the Municipality for all expenses (direct and indirect) incurred within fifteen (15) days of delivery of an invoice from the Municipality. Failure of the Landowner to make prompt payment to the Municipality may result in enforcement proceedings, which may include the filing of a lien against the Property, which filing is expressly authorized by the Landowner.
11. The intent and purpose of this Agreement is to ensure the proper maintenance of the on-site BMP(s) and Conveyance(s) by the Landowner; provided, however, that this Agreement shall not be deemed to create or affect any additional liability on any party for damage alleged to result from or be caused by stormwater runoff.
12. The Landowner, for itself and its executors, administrators, assigns, heirs, and other successors in interest, hereby releases and shall release the Municipality's employees, its agents and designated representatives from all damages, accidents, casualties, occurrences, or claims which might arise or be asserted against said employees, agents or representatives arising out of the construction, presence, existence, or maintenance of the BMP(s) and Conveyance(s) either by the Landowner or Municipality. In the event that a claim is asserted or threatened against the Municipality, its employees, agents or designated representatives, the Municipality shall notify the Landowner, and the Landowner shall defend, at his own expense, any claim, suit, action or proceeding, or any threatened claim, suit, action or proceeding against the Municipality, or, at the request of the Municipality, pay the cost, including attorneys' fees, of defense of the same undertaken on behalf of the Municipality. If

any judgment or claims against the Municipality's employees, agents or designated representatives shall be allowed, the Landowner shall pay all damages, judgments or claims and any costs and expenses incurred by the Municipality, including attorneys' fees, regarding said damages, judgments or claims.

13. The Municipality may enforce this Agreement in accordance with its Stormwater Ordinance, at law or in equity, against the Landowner for breach of this Agreement. Remedies may include fines, penalties, damages or such equitable relief as the parties may agree upon or as may be determined by a Court of competent jurisdiction. Recovery by the Municipality shall include its reasonable attorneys' fees and costs incurred in seeking relief under this Agreement.
14. Failure or delay in enforcing any provision of this Agreement shall not constitute a waiver by the Municipality of its rights of enforcement hereunder.
15. The Landowner shall inform future buyers of the Property about the function of, operation, inspection and maintenance requirements of the BMP(s) prior to the purchase of the Property by said future buyer, and upon purchase of the Property the future buyer assumes all responsibilities as Landowner and must comply with all components of this Agreement.
16. This Agreement shall inure to the benefit of and be binding upon the Municipality and the Landowner, as well as their heirs, administrators, executors, assigns and successors in interest.

This Agreement shall be recorded at the Office of the Recorder of Deeds of Chester County, Pennsylvania, and shall constitute a covenant running with the Property, in perpetuity.

WITNESS the following signatures and seals:

ATTEST:

(SEAL)

The Borough of Elverson:

(SEAL)

For the Landowner:

ATTEST:

_____ (Borough)

By Individual:

State of _____

County of _____

On this _____ day of _____, 20____, before me, the undersigned officer, personally appeared _____, known to me (or satisfactorily proven) to be the person whose name(s) is/are subscribed to the within instrument and acknowledged that _____ executed the same for the purpose therein contained.

IN WITNESS WHEREOF, I hereunto set my hand and official seal.

Notary Public

My commission expires:

By the Company:

State of _____

County of _____

On this _____ day of _____, 20____, before me, the undersigned officer, personally appeared _____, who acknowledged himself/herself to be _____ of _____, a _____, and that he/she being authorized to do so, executed the forgoing instrument for the purpose therein contained by signing the name of the Company by herself/himself as _____.

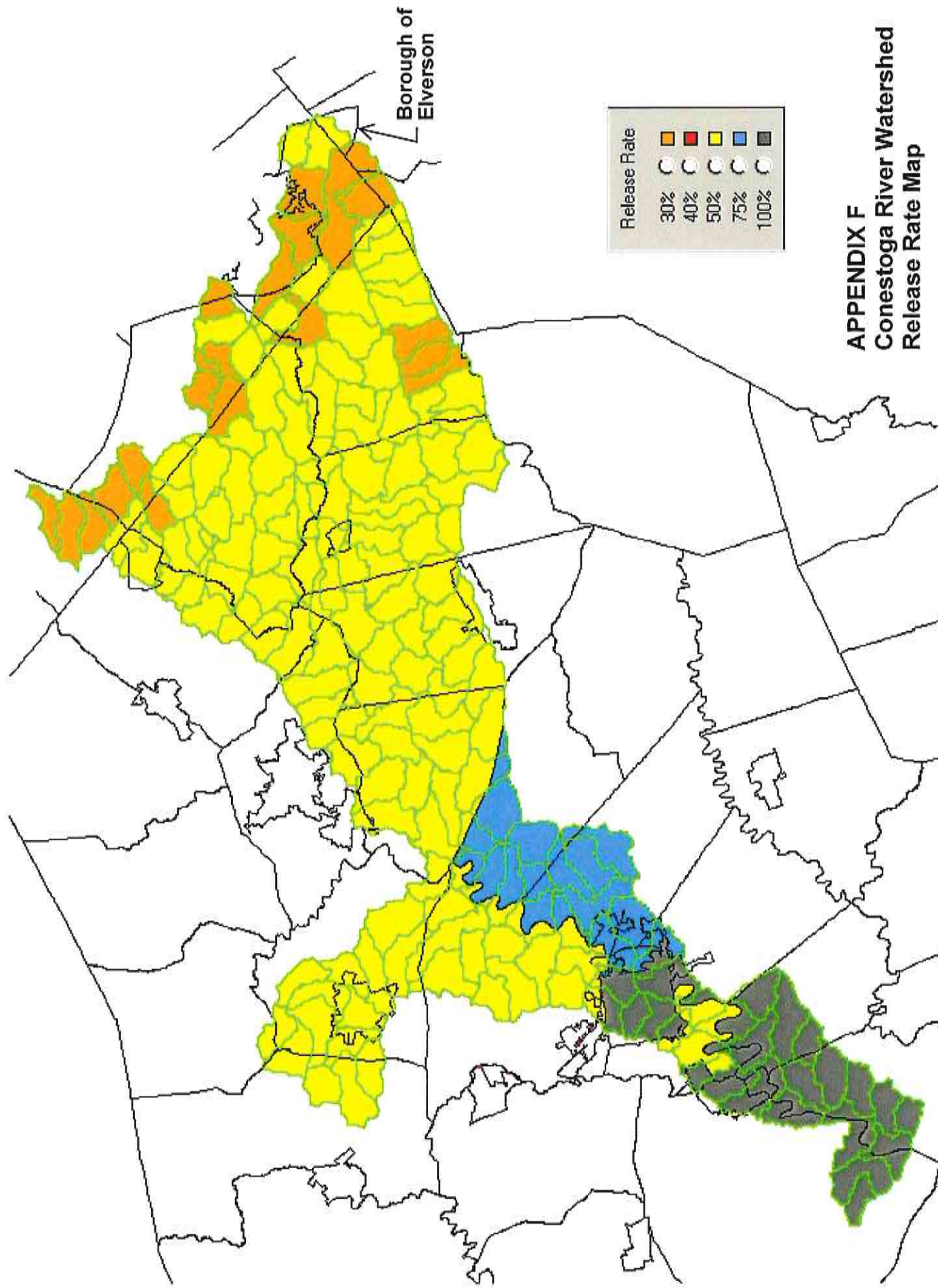
IN WITNESS WHEREOF, I hereunto set my hand and official seal.

Notary Public

My commission expires:

ORDINANCE APPENDIX F

**CONESTOGA RIVER
WATERSHED RELEASE RATE MAP**



APPENDIX F
Conestoga River Watershed
Release Rate Map

ORDINANCE APPENDIX G

SWM SITE PLAN APPLICATION

Appendix G – SWM Site Plan Application

(To be submitted with all SWM Site Plans that are not part of a subdivision or land development plan)

Borough of Elverson Stormwater Site Plan Application

Application is hereby made for review of the Stormwater facilities submitted herewith and more particularly described below:

1. Name of Applicant(s): _____
Address: _____
_____ Phone No. _____
2. Name of Owner(s): _____
(If other than Applicant)
Address: _____
_____ Phone No. _____
3. Applicant's interest, if other than owner: _____
4. Location of Parcel: _____

5. Engineer or Surveyor responsible for plan: _____
Address: _____
_____ Phone No. _____
6. Total Parcel Acreage: _____ Proposed New Impervious Area (Sq. Ft.): _____
7. Lot Use Proposed:
_____ Single Family _____ Commercial
_____ Two Family _____ Industrial
_____ Townhouse _____ Other (specify) _____
_____ Multi-Family
8. Size of proposed structure (footprint): _____

Signature of Applicant

Filing Fee Amount _____

Received by _____

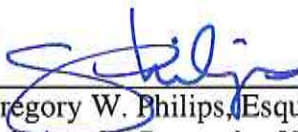
For Borough Use Only

<input type="checkbox"/> Exempt < 1,000 ft ² Impervious Area and < 5,000 ft ² Disturbance	<input type="checkbox"/> Small Project 1,000 to < 2,000 ft ² Impervious Area and < 10,000 ft ² Disturbance	<input type="checkbox"/> Other ≥ 2,000 ft ² Impervious Area or ≥ 10,000 ft ² Disturbance*
Fee - None	Required Fee \$ Required escrow \$	Required Fee \$ Required escrow \$

Note: If greater than One Acre of disturbance is proposed, Chester County Conservation District approval of an Erosion & Sediment Control Plan is required.

CERTIFICATION AND ATTESTATION

I hereby certify and attest that the attached is a true and correct copy of an Ordinance to be considered for enactment by the Borough Council of the Borough of Elverson at a regularly scheduled meeting on May 2, 2023, at 7 p.m. at the Elverson Borough Hall, 101 S. Chestnut Street, Elverson, Pennsylvania



Gregory W. Philips, Esquire
Solicitor for Borough of Elverson