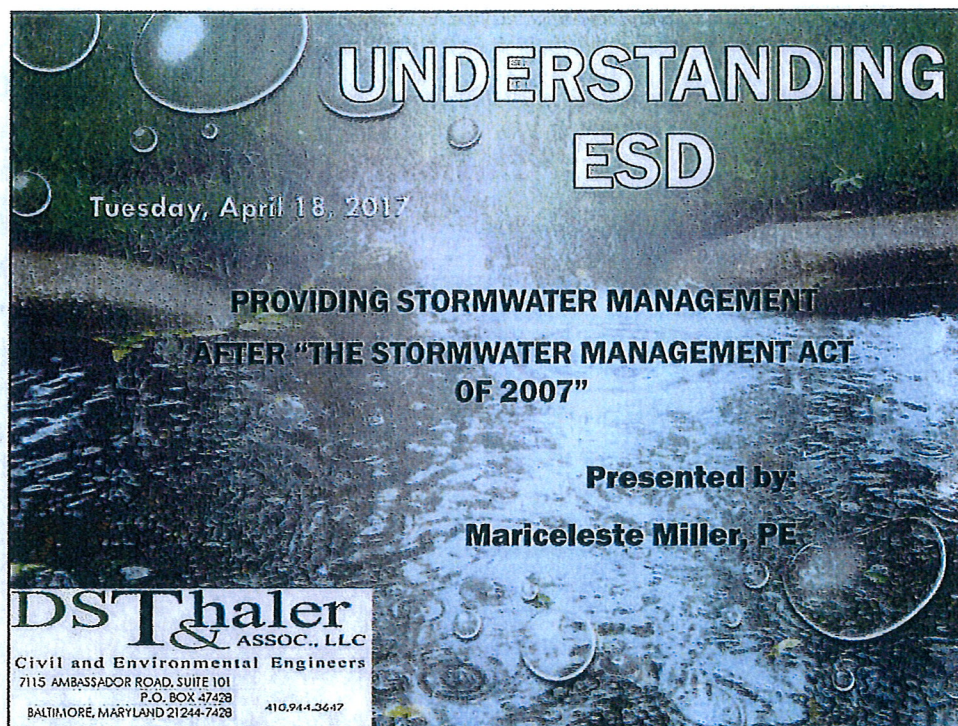




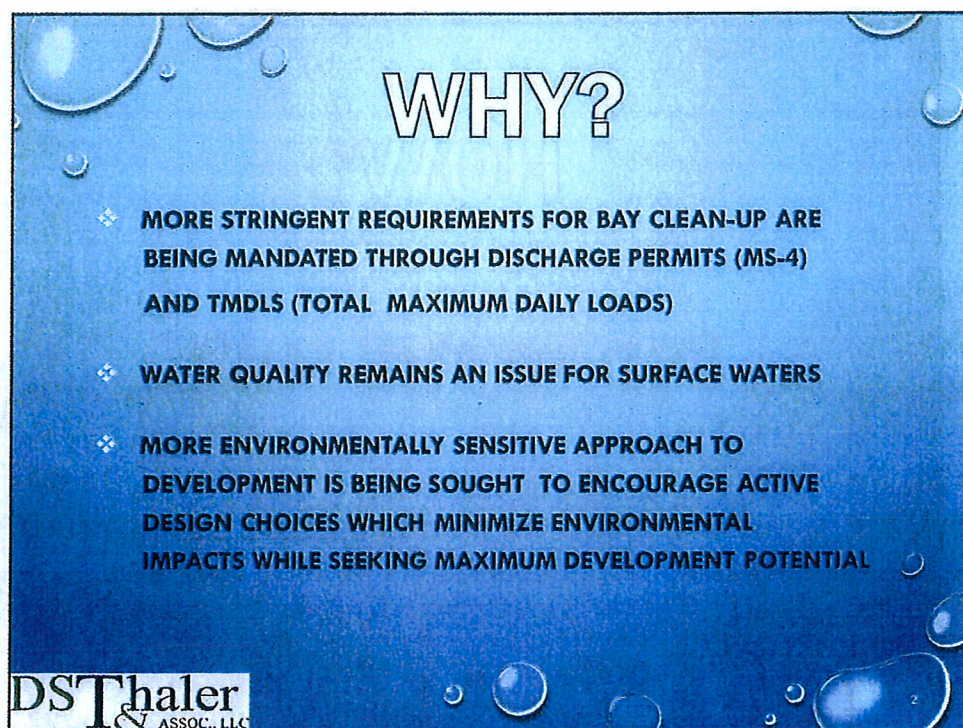
UNDERSTANDING ESD

Tuesday, April 18, 2017

**PROVIDING STORMWATER MANAGEMENT
AFTER "THE STORMWATER MANAGEMENT ACT
OF 2007"**

Presented by:
Mariceleste Miller, PE

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WHY?

- ❖ **MORE STRINGENT REQUIREMENTS FOR BAY CLEAN-UP ARE BEING MANDATED THROUGH DISCHARGE PERMITS (MS-4) AND TMDLS (TOTAL MAXIMUM DAILY LOADS)**
- ❖ **WATER QUALITY REMAINS AN ISSUE FOR SURFACE WATERS**
- ❖ **MORE ENVIRONMENTALLY SENSITIVE APPROACH TO DEVELOPMENT IS BEING SOUGHT TO ENCOURAGE ACTIVE DESIGN CHOICES WHICH MINIMIZE ENVIRONMENTAL IMPACTS WHILE SEEKING MAXIMUM DEVELOPMENT POTENTIAL**

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WHEN?

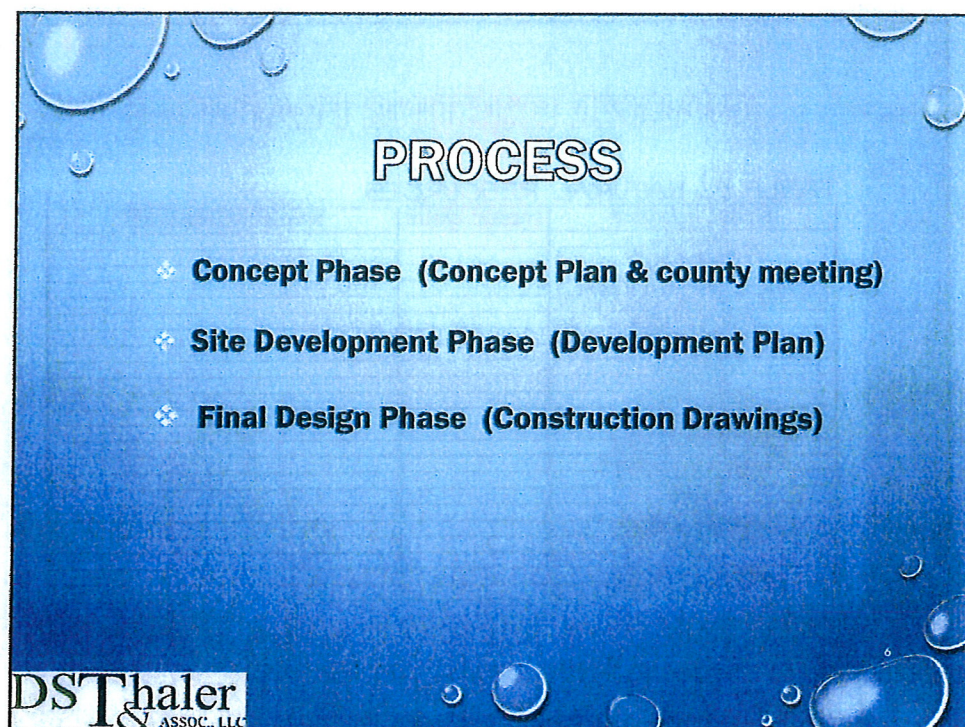
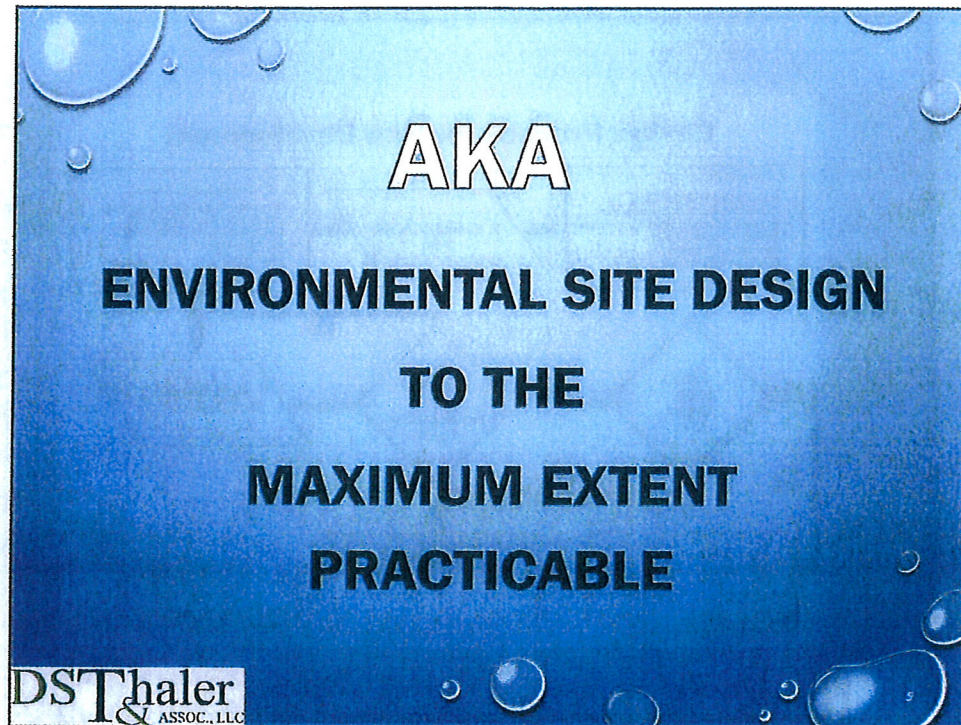
- ❖ **NEW DEVELOPMENT PROJECTS**
(NET INCREASE IN IMPERVIOUS AREA)
- ❖ **REDEVELOPMENT PROJECTS**
(EXISTING LAND USE IS COMMERCIAL, INDUSTRIAL,
OR MULTI-FAMILY RESIDENTIAL WITH EXISTING
IMPERVIOUS AREA EXCEEDING 40%)

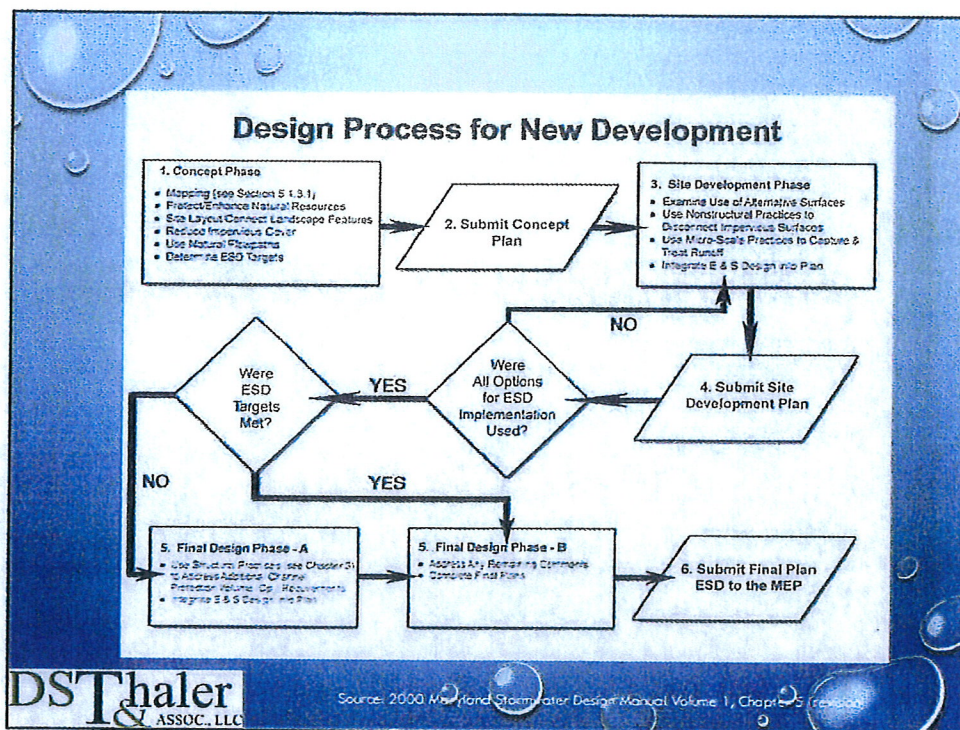
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HOW?

ESD TO THE MEP

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ANALYZE EXISTING FEATURES

TABLE 5.1 NATURAL RESOURCES

NATURAL RESOURCE	PRESENT ONSITE	PROTECTIVE MEASURES
WETLANDS		
MAJOR WATERWAYS		
FLOODPLAINS		
TIDAL AND NONTIDAL WETLANDS		
WETLANDS OF SPECIAL STATE CONCERN		
WETLAND BUFFERS		
STREAM BUFFERS		
PERENNIAL STREAMS		
FLOODPLAINS		
FORESTS		
FOREST BUFFERS		
CRITICAL AREAS		
STEEP SLOPES		
HIGHLY ERODIBLE SOILS		
ENHANCED STREAM BUFFERS		
TOPOGRAPHY / SLOPES		
SPRINGS		
SEEPS		
INTERMITTENT STREAMS		
VEGETATIVE COVER		
SOILS		
BEDROCK / GEOLOGY		
EXISTING DRAINAGE AREAS		

Source: 2000 Maryland Stormwater Design Manual Volume 1, Chapter 5 (revised)

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SITE DESIGN TECHNIQUES

TABLE 5.2 SUMMARY OF SITE DEVELOPMENT STRATEGIES

BETTER SITE DESIGN TECHNIQUE	RECOMMENDATIONS	SITE APPLICABILITY
USING NARROWER, SHORTER STREETS, RIGHTS-OF-WAY, AND SIDEWALKS	STREETS MAY BE AS NARROW AS 22 FT. IN NEIGHBORHOODS SERVING LOW TRAFFIC VOLUMES. OPEN SPACE DESIGNS AND CLUSTERING WILL REDUCE STREET LENGTHS. RIGHTS-OF-WAY CAN BE REDUCED BY PROVIDING SIDEWALKS WITH PROTRUDING BORDERS ON ONE SIDE OF THE ROAD, AND REDUCING THE BORDER WIDTH BETWEEN THE STREET AND SIDEWALKS.	
CUL-DE-SACS	ALLOW SMALLER RADIUS FOR TURN AROUND AS LOW AS 25 FT. USE A LANDSCAPED ISLAND IN THE CENTER OF THE CUL-DE-SAC AND DESIGN THESE AREAS TO TREAT STORMWATER RUNOFF.	
OPEN VEGETATED CHANNELS	ALLOW GRASS CHANNELS OR BIOFILTERS FOR RESIDENTIAL STREET DRAINAGE AND STORMWATER TREATMENT.	
PARKING RATIOS, PARKING CODES, PARKING LOTS, AND STRUCTURED PARKING	PARKING RATIOS SHOULD BE INTERPRETED AS MAXIMUM NUMBER OF SPACES. USE SHARED PARKING ARRANGEMENTS. MAXIMUM PARKING STALL WIDTH SHOULD BE LESS THAN 8 FT. AND STALL LENGTH LESS THAN 12 FT. PARKING GARAGES ARE ENCOURAGED RATHER THAN SURFACE LOTS.	
PARKING LOT RUNOFF	PARKING LOTS ARE REQUIRED TO BE LANDSCAPED AND SETBACKS ARE RELATED TO ALLOW FOR ROSEBATHING ISLANDS OR OTHER STORMWATER PRACTICES IN LANDSCAPED AREAS.	
OPEN SPACE	FLEXIBLE DESIGN CRITERIA SHOULD BE PROVIDED TO DEVELOPERS WHO WISH TO USE CLUSTERED DEVELOPMENT AND OPEN SPACE DESIGNS.	
SETBACKS AND FRONTAGES	RELAX SETBACKS AND ALLOW HARDENED FRONTAGES TO REDUCE TOTAL ROAD LENGTH. BUNNATE LONG DRIVEWAYS.	
DRIVEWAYS	ALLOW FOR SHARED DRIVEWAYS AND ALTERNATIVE IMPERVIOUS SURFACES.	
ROOFTOP RUNOFF	DIRECT TO PERVIOUS SURFACES.	
BUFFER SYSTEMS	DESIGNATE A HIGHLY BUFFER WIDTH AND PROVIDE MECHANISMS FOR LONG-TERM PROTECTION.	
CLEARING AND GRADING	CLEARING, GRADING, AND EARTH DISTURBANCE SHOULD BE LIMITED TO THAT REQUIRED TO DEVELOP THE LOT.	
TREE CONSERVATION	PROVIDE LONG-TERM PROTECTION OF LARGE TRACTS OF CONTIGUOUS FORESTED AREAS. PROMOTE THE USE OF NATIVE PLANTINGS.	
CONSERVATION INCENTIVES	PROVIDE INCENTIVES FOR CONSERVING NATURAL AREAS THROUGH DENSITY COMPENSATION, PROPERTY TAX REDUCTION, AND FLEXIBILITY IN THE DESIGN PROCESS.	

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Sources: 2000 Maryland Stormwater Design Manual Volume 1, Chapter 5 (revised)

WHAT?

- ❖ **ALTERNATIVE SURFACES**
- ❖ **NONSTRUCTURAL PRACTICES**
- ❖ **MICRO-SCALE PRACTICES**
- ❖ **STRUCTURAL PRACTICES**

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ALTERNATIVE SURFACES

- ❖ **Green Roofs**
- ❖ **Permeable Pavers/Porous Paving**
- ❖ **Reinforced Turf**

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Green Roof



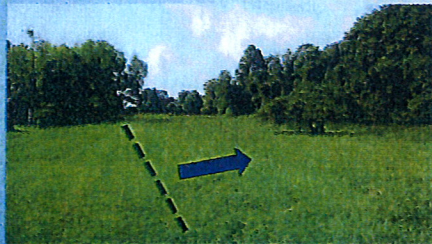
Porous/permeable paving

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NONSTRUCTURAL PRACTICES FKA "NONSTRUCTURAL CREDITS"

- ❖ **Disconnection of Rooftop Runoff**
- ❖ **Disconnection of Nonrooftop Runoff**
- ❖ **Sheet flow to Conservation Areas**

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Sheet Flow to Buffer



**Disconnection of
Rooftop Runoff**

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MICRO-SCALE PRACTICES

- ❖ Rainwater Harvesting (rain barrels & cisterns)
- ❖ Submerged Gravel Wetlands
- ❖ Landscape Infiltration
- ❖ Infiltration Berms
- ❖ Dry Wells
- ❖ Micro-bioretentation
- ❖ Rain Gardens
- ❖ Swales
- ❖ Enhanced Filters

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Micro-bioretentation Areas



Swale



Rain Barrel



Rain Garden



Enhanced Filter



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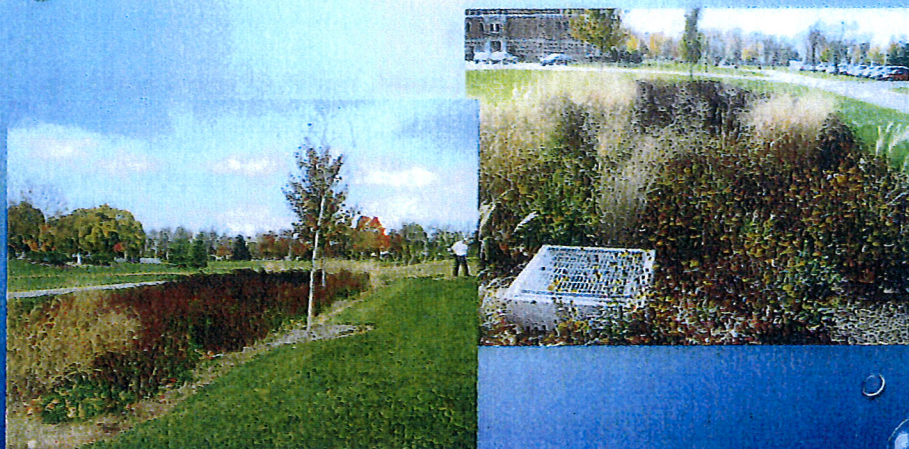
RAIN GARDEN



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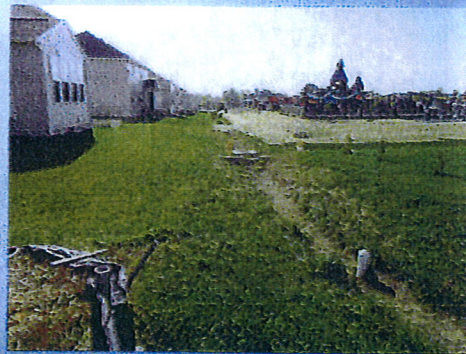
MICRO-BIORETENTION



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BIOSWALE

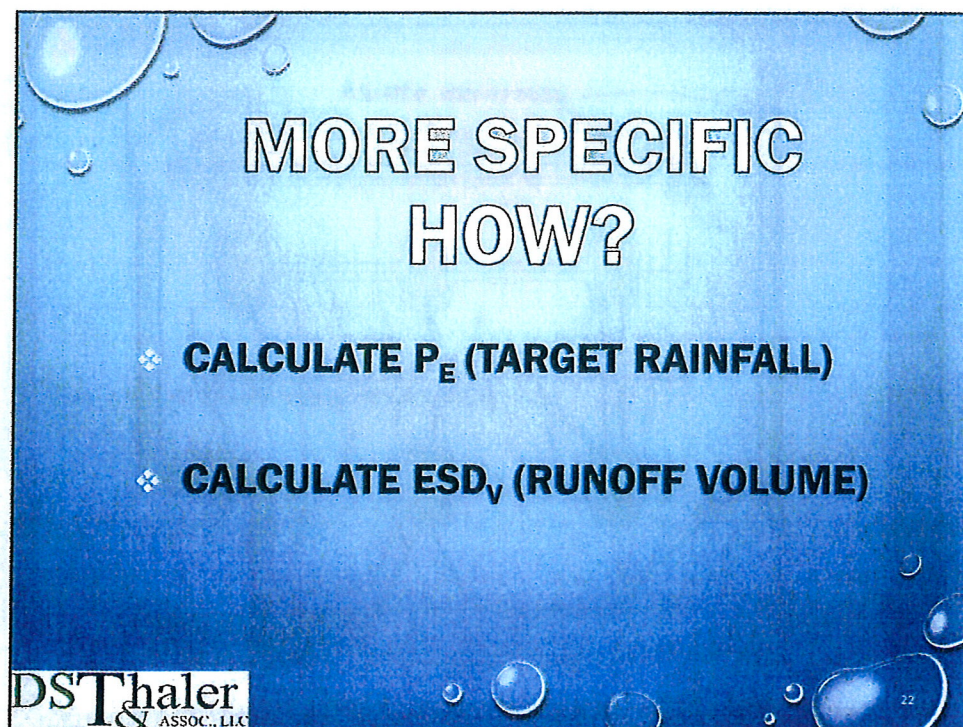
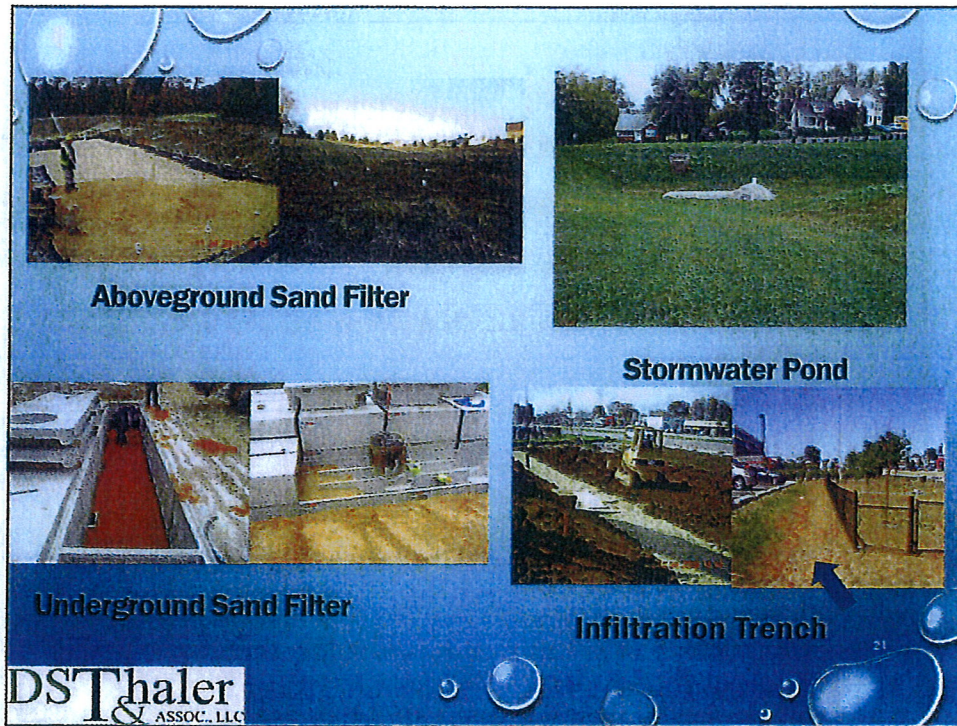


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STRUCTURAL PRACTICES

- ❖ **Stormwater Ponds**
(wet pond, pocket pond, multiple pond system)
- ❖ **Stormwater Wetlands**
(shallow wetlands, pocket wetlands, pond/wetland system)
- ❖ **Stormwater Infiltration (trenches & basins)**
- ❖ **Stormwater Filtering Systems**
(sand filter, underground sand filter, pocket sand filter, bioretention)
- ❖ **Open Channel Systems (wet & dry swales)**

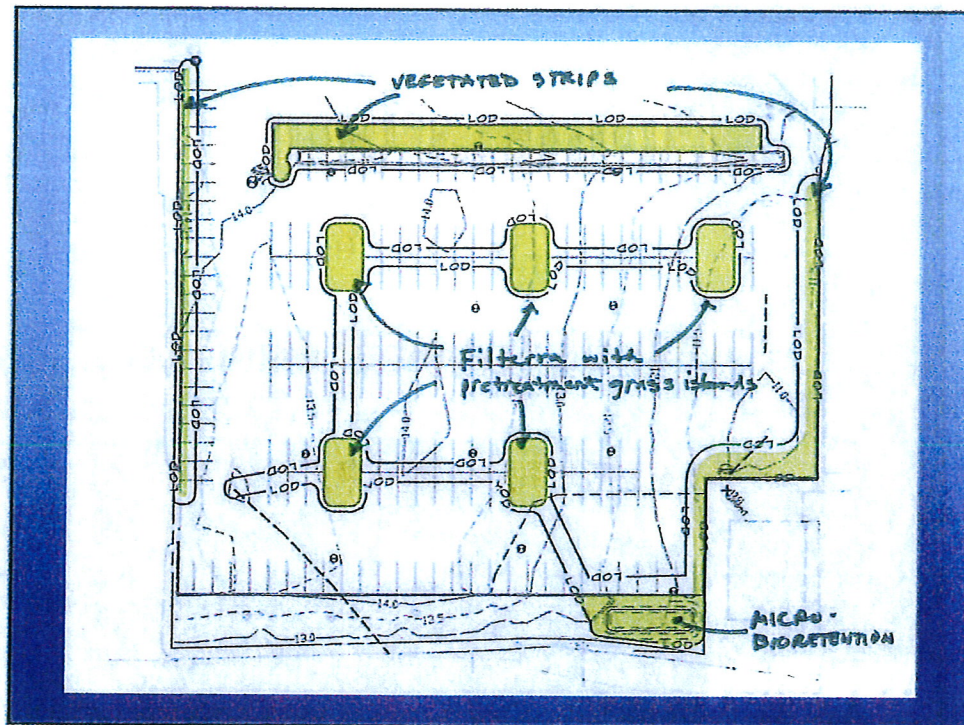
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BASIC PROCEDURE (REDEVELOPMENT)

1. Determine Limit of Study (drainage areas)
2. Determine Soil Types within Limit of Study
3. Calculate impervious area within Limit of Study (need the percentage of coverage)
4. Calculate 50% of impervious area to reduce or treat
5. If necessary, determine P_E (use charts)
6. If necessary, calculate ESD_v
- ★ Q_p or Q_f if necessary

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BASIC PROCEDURE (NEW DEVELOPMENT)

1. Determine Limit of Study (drainage areas)
2. Determine Soil Types within Limit of Study
3. Calculate impervious area within Limit of Study (need the percentage of coverage)

NOTE:

- Calculations based on proposed conditions – existing conditions do not impact this portion of the analysis

4. Determine P_E (use charts)

5. Calculate ESD_v

• Q_p or Q_t if necessary

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P_E / RCN TABLES

A & B SOIL TYPES

Table A.1 Partial Curve Number Reductions used for Unimproved Non-Drainage Areas

Soil	RCN ^a	Hydrologic Soil Group A									
		$P_E = 1"$	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"	
2%	10										
5%	15										
10%	20										
15%	25										
20%	30										
25%	35										
30%	40										
35%	45										
40%	50										
45%	55										
50%	60										
55%	65										
60%	70										
65%	75										
70%	80										
75%	85										
80%	90										
85%	95										
90%	100										
95%	105										
100%	110										

Soil	RCN ^a	Hydrologic Soil Group B									
		$P_E = 1"$	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"	
2%	10										
5%	15										
10%	20										
15%	25										
20%	30										
25%	35										
30%	40										
35%	45										
40%	50										
45%	55										
50%	60										
55%	65										
60%	70										
65%	75										
70%	80										
75%	85										
80%	90										
85%	95										
90%	100										
95%	105										
100%	110										

Soil	RCN ^a	Hydrologic Soil Group C									
		$P_E = 1"$	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"	
2%	10										
5%	15										
10%	20										
15%	25										
20%	30										
25%	35										
30%	40										
35%	45										
40%	50										
45%	55										
50%	60										
55%	65										
60%	70										
65%	75										
70%	80										
75%	85										
80%	90										
85%	95										
90%	100										
95%	105										
100%	110										

Soil	RCN ^a	Hydrologic Soil Group D									
		$P_E = 1"$	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"	
2%	10										
5%	15										
10%	20										
15%	25										
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60%	70										
65%	75										
70%	80										
75%	85										
80%	90										
85%	95										
90%	100										
95%	105										
100%	110										

Soil	RCN ^a	Hydrologic Soil Group E									
		$P_E = 1"$	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"	
2%	10										
5%	15										
10%	20										
15%	25										
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50%	60										
55%	65										
60%	70										
65%	75										
70%	80										
75%	85										
80%	90										
85%	95										
90%	100										
95%	105										
100%	110										

Soil	RCN ^a	Hydrologic Soil Group F									
		$P_E = 1"$	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"	
2%	10										
5%	15										
10%	20										
15%	25										
20%	30										
25%	35										
30%	40										
35%	45										
40%	50										
45%	55										
50%	60										
55%	65										
60%	70										
65%	75										
70%	80										
75%	85										
80%	90										
85%	95										
90%	100										
95%	105										
100%	110										

Soil	RCN ^a	Hydrologic Soil Group G									
		$P_E = 1"$	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"	
2%	10										
5%	15										
10%	20										
15%	25										
20%	30										
25%	35										
30%	40										
35%	45										
40%	50										
45%	55										
50%	60										
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60%	70										
65%	75										
70%	80										
75%	85										
80%	90										
85%	95										
90%	100										
95%	105										
100%	110										

Soil	RCN ^a	Hydrologic Soil Group H									
		$P_E = 1"$	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"	
2%	10										
5%	15										
10%	20										
15%	25										
20%	30										
25%	35										
30%	40										
35%	45										
40%	50										
45%	55										
50%	60										
55%	65										
60%	70										
65%	75										
70%	80										
75%	85										
80%	90										
85%	95										
90%	100										
95%	105										
100%	110										

Soil	RCN ^a	Hydrologic Soil Group I									
		$P_E = 1"$	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"	
2%	10										
5%	15										
10%	20										
15%	25										
20%	30										
25%	35										
30%	40										
35%	45										
40%	50										
45%	55										
50%	60										
55%	65										
60%	70										
65%	75										
70%	80										
75%	85										
80%	90										
85%	95										
90%	100										
95%	105										
100%	110										

Soil	RCN ^a	Hydrologic Soil Group J									
		$P_E = 1"$	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"	
2%	10										
5%	15										
10%	20										
15%	25										
20%	30										
25%	35										
30%	40										
35%	45										
40%	50										
45%	55										
50%											

C & D SOIL TYPES

Table A.2 Partial Curve Number Reductions used for Unimproved Non-Drainage Areas

Soil	RCN ^a	Hydrologic Soil Group C									
		$P_E = 1"$	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"	
2%	10										
5%	15										
10%	20										
15%	25										
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35%	45										
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45%	55										
50%	60										
55%	65										
60%	70										
65%	75										
70%	80										
75%	85										
80%	90										
85%	95										
90%	100										
95%	105										
100%	110										

Soil	RCN ^a	Hydrologic Soil Group D									
		$P_E = 1"$	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"	
2%	10										
5%	15										
10%	20										
15%	25										
20%	30										
25%	35										
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35%	45										
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45%	55										
50%	60										
55%	65										
60%	70										
65%	75										
70%	80										
75%	85										
80%	90										
85%	95										
90%	100										
95%	105										
100%	110										

Legend:
 C_p , Addressed (RCN = Woods in Good Condition)
 RCN Applied to C_p , Calculations

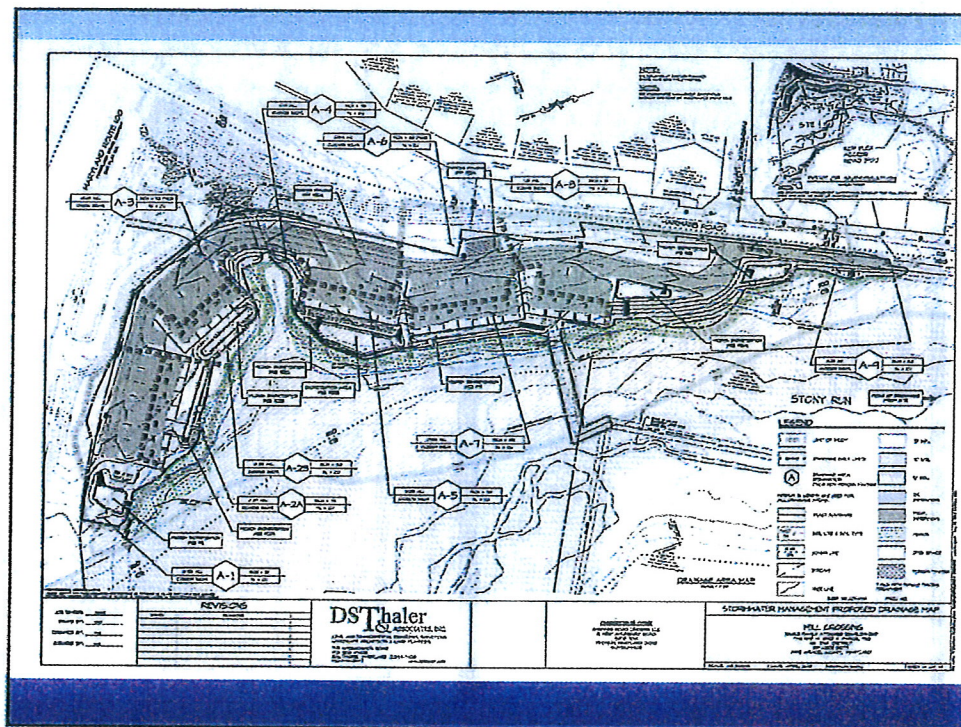
$$ESD_V = \frac{(P_E)(R_V)(A)}{12}$$

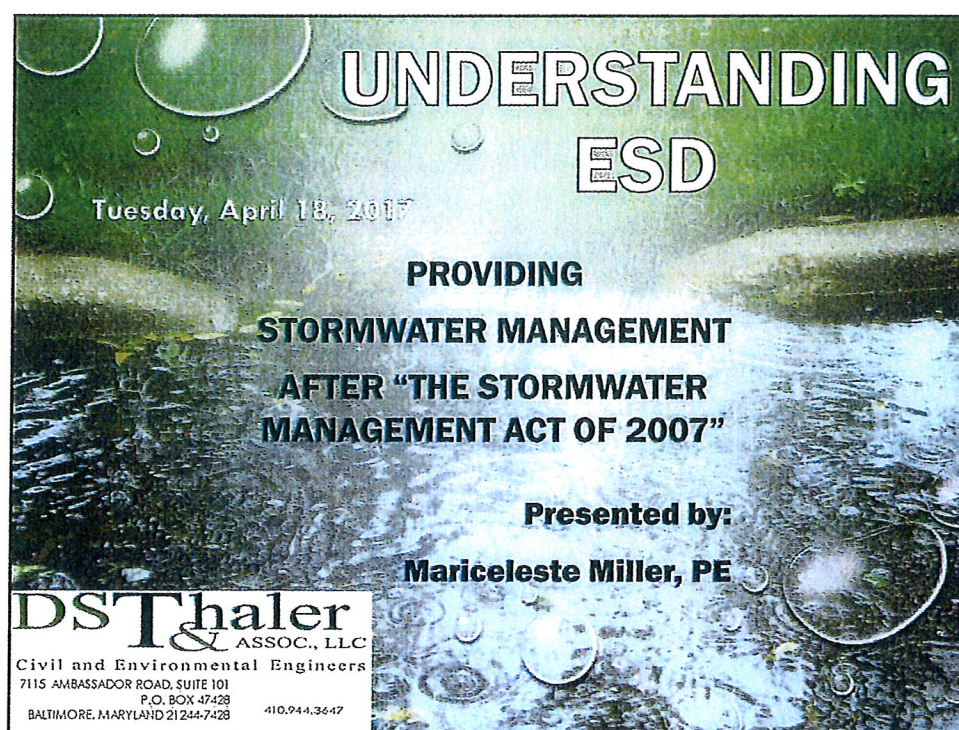
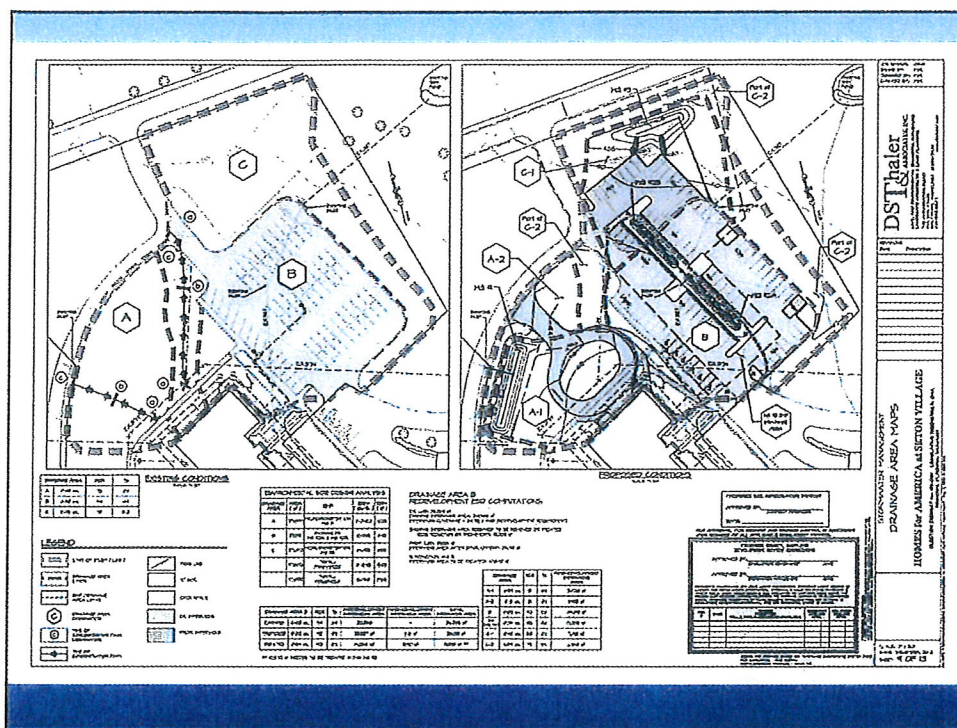
P_E = rainfall target (1" - 2.6")

$R_V = 0.05 + 0.009 (I)$ (I = percent impervious cover)

A = drainage area (sf or ac.)

DSThaler
ASSOC., LLC





**UNDERSTANDING
ESD**

Tuesday, April 18, 2017

**PROVIDING
STORMWATER MANAGEMENT
AFTER "THE STORMWATER
MANAGEMENT ACT OF 2007"**

**Presented by:
Mariceleste Miller, PE**

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