MIDS Credits: Dry Swales

May 18, 2012

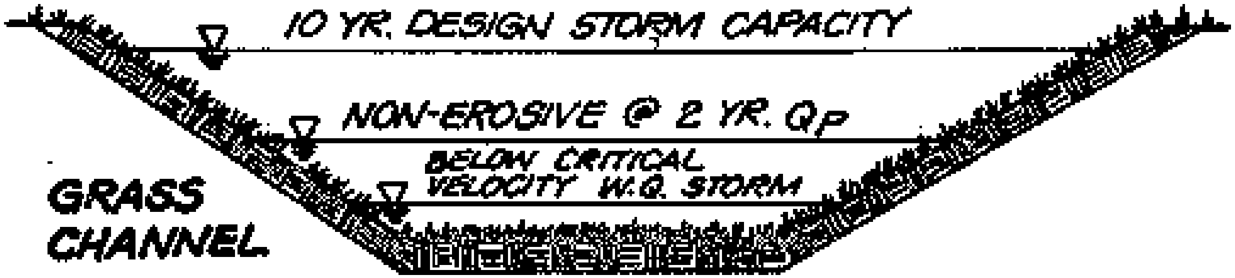
Work Group Meeting

What is a Swale?

- Channel that provides conveyance, water quality treatment and flow attenuation of stormwater runoff

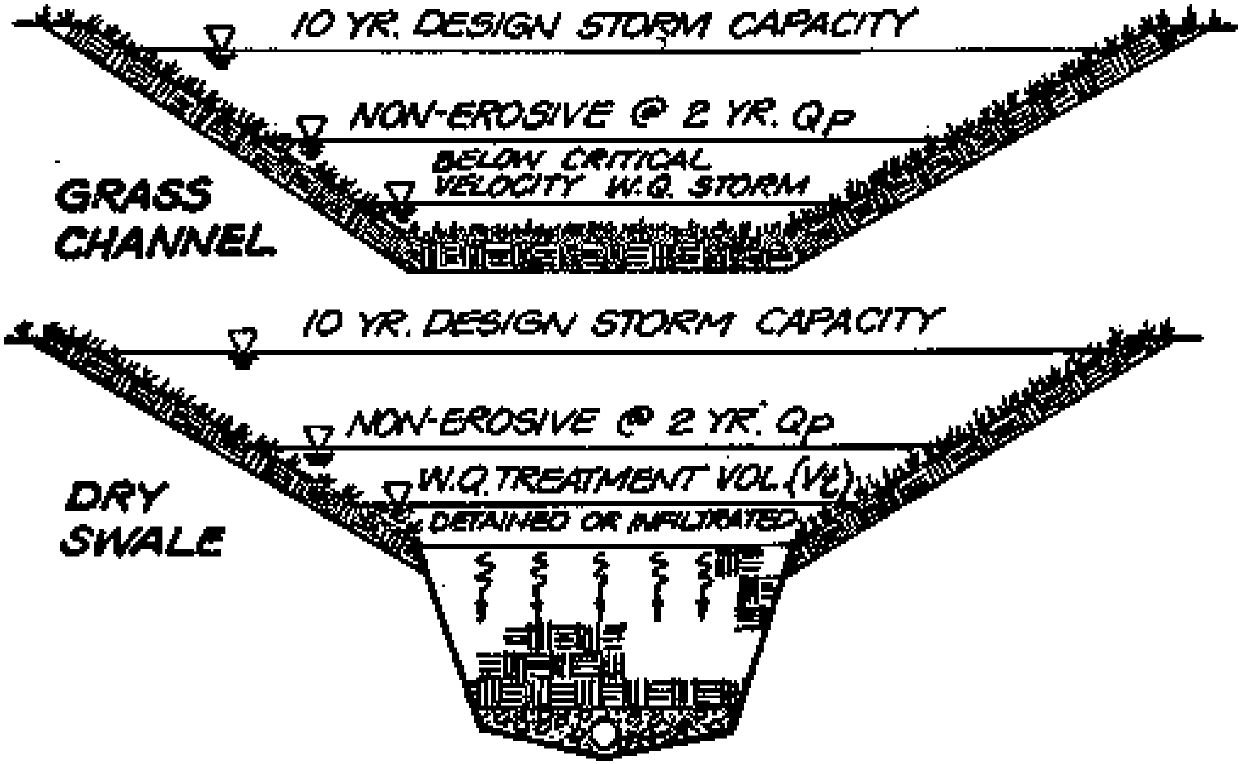
- Removes pollutants through vegetative filtering, sedimentation, biological uptake, and infiltration into the underlying soil media

Swale Categories



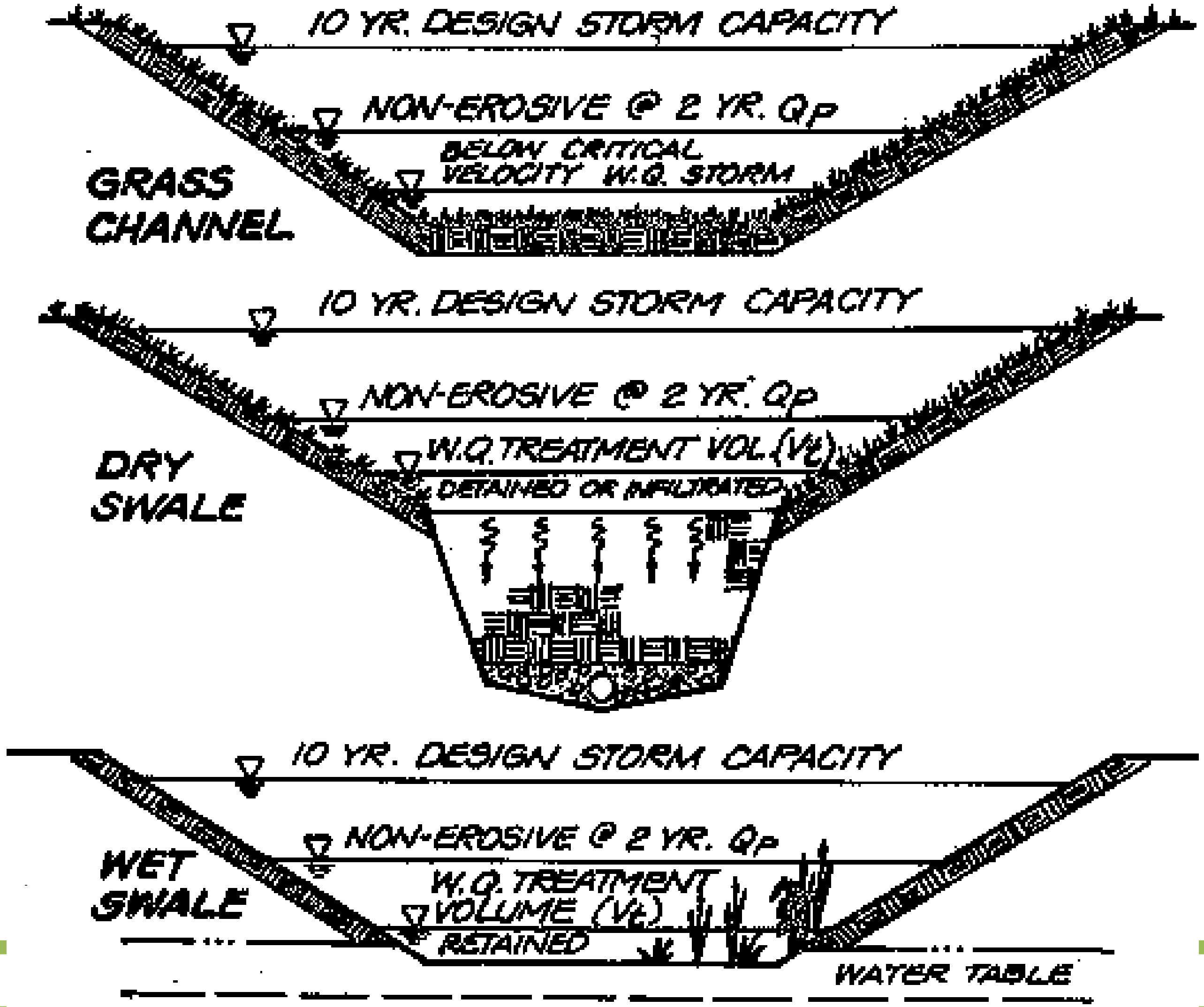
Source: Clayton and Schueler, 1996

Swale Categories



Source: Clayton and Schueler, 1996

Swale Categories



Source: Clayton and Schueler, 1996

Grass Channel

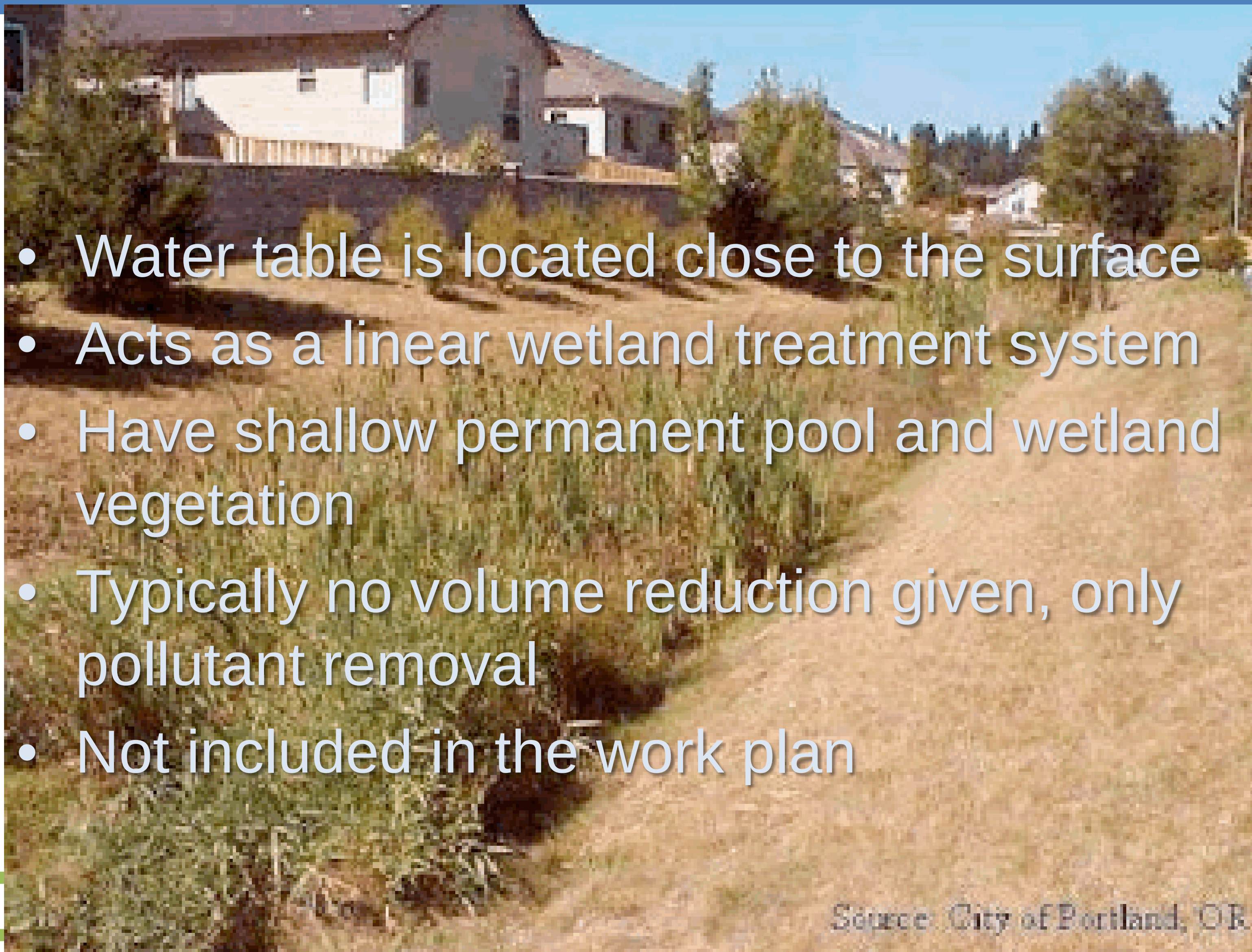
- Broad and shallow earthen channel vegetated with erosion resistant and flood tolerant grasses
- Designed to slow flow velocities to encourage settling and filtering through the grass lining
- Can have check dams, (underdrains), and amended soils

Dry Swale (water quality swale)

- Engineered soils similar to bioretention basins
- Can be planted with turf grass, tall meadow grasses, decorative herbaceous cover, or trees
- Can have underdrains and check dams
  - Beta MIDS Calculator defines Dry Swales as needing check dams

Wet Swale

- Water table is located close to the surface
- Acts as a linear wetland treatment system
- Have shallow permanent pool and wetland vegetation
- Typically no volume reduction given, only pollutant removal
- Not included in the work plan



Literature Review

Literature Review

Objective:

Conduct a basic review of 31 research documents identified by the dry swale tech squad, highlighting the following information

- Volume, total phosphorus, dissolved phosphorus, and TSS reduction

Volume Reduction Summary

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Reference	Grass Channel	Dry Swale
Virginia Design specifications (Grass Channels)	**10% - HSG Soils C and D** **20% - HSG Soils A and B** **30% - with Compost Amended Soils**	
Virginia Design specifications (Dry Swales)		**40% - L[illegible]ve[illegible] Des[illegible]n 1** **[illegible]% - [illegible]vel Desi[illegible]n 2**
Weiss, Gulliver and Erickson (2010).	**50%** (Barrett 200[illegible] [illegible]miari[illegible] [illegible]egions) **30%** [illegible]ushton 200[illegible] FL)	
CSN (2009) Virginia Calculator	**0%** (Schueler 19[illegible] VA) **40%** (Strecker et al. 20[illegible]) **[illegible]%** (UNHSC 2007, NH) **[illegible]7 - 41%** [illegible]ptan a[illegible] Murase 2000[illegible]	**98%** (Horner et al. 2003, WA) **46 to 54%** (Stagge 2006, MD) **90%?** (Barrett et al, 1998, TX)
Rossman (2009) SWMM model (K_{sat} 1.0 in/hr, slope 1.3%, I inch precip)	**[illegible]1%**	
International Stormwater Database (2011)	**48%** = Average (13 studies, 84 events) **41%, 85%** (Yu et al. 1993, VA) **19%, 27%, 35%, 42%, 65%** (City of Portland 1999, OR) **60%** (Wa State 1999, WA) **27%, 41%, 46% 65%, 76%** (CA DOT, 2002)	

0-98%

Total Phosphorus Summary

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References	Grass Channel	Dry Swale
Minnesota Stormwater Manual	**0 %** (-51%, -1%, 35% for Grass; 28%, 48%, 56% Media Filter/Dry Swale)	
Virginia Design specifications (Grass Channels)	**23 - 32%** (15% EMC)	
Virginia Design specifications (Dry Swales)		**52%** - Level Design 1 (20% EMC) **76%** - Level Design 2 (40% EMC)
Nara and Pitt (2005)	**5%** (Goldberg 1993) **9%** (EPA 1999) **29 to 45%** (Seattle Metro 1992) **58 to 72%** (Fletcher et al. 2002)	**18%** (Dorman et al 1989) **50%** (Daniels, Gilliam 1996) **61 to 79%** (Dillaha et al. 1989) **99%** (Kercher et al. 1983)
Arika et al. (2006)		83%
CSN (2009) Virginia Calculator	**0%** (OWML 1983, MD) **34 - 44%** (Walsh et al, 1995, TX) **negative** (Welborn 1987, TX) **1[illegible]%** (Harper 19[illegible]8, FL) **25%** (Yousef et al 1986, FL) **negative** (CALTRANS 2004, CA) **29%** (Schueler and Holland, USA)	**65%** (Fletcher et al. 2002, AUS) **31%** (Barret et al 1997, TX)
Clayton and Schueler (1996)	**25%**	**65%**
Barrett et al (1998)	**44%, 34%**	
International Stormwater Database (2010)	**negative** (Average of 17 studies)	
CWP (2007)	**24%** (Average of 24 studies)	

51 to 99%

Dissolved Phosphorus Summary

References	Grass Channel	Dry Swale
Minnesota Stormwater Manual	0 %	
International Stormwater Database (2010)	negative (Average of 6 studies)	
CWP (2007)	negative (Average of 14 studies)	

Negative to 0%

TSS Summary

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References	Grass Channel	Dry Swale
Minnesota Stormwater Manual	**70%** (39, 73, 81%)	**85%** (39, 68[illegible] 78%)
Nara and Pitt (2005)	**68%** (Goldberg 1993) **81%** (EPA 1999) **60 to 83%** (Seattle Metro 1992) **73 to 94%** (Fletcher et al. 19[illegible]3)	**80%** ([illegible]ng e[illegible]al. 1981) **98%** [illegible]orm[illegible]n [illegible]t a[illegible] 198[illegible]) **99[illegible]** (Kercher [illegible]t al. [illegible]) **6[illegible] to [illegible]%** (Dan[illegible]els, Gilliam 1996) **70 to 8[illegible]%** (Dillaha et al. 1989)
Weiss, Gulliver and Erickson (2010)	**80 - 90%** ([illegible]ckstrom 2002) **79 - 98[illegible]** (Back[illegible]rom 2[illegible]) **87[illegible], 85%** (Barr[illegible] et al. 1998) **7[illegible]** (Caltra[illegible] 20[illegible]) **69%** (Simulated) **[illegible]%** (UNHSC)	
TetraTech (2010)		
Clayton and Schueler (1996)	**65%**	**90%**
International Stormwater Database (2011)	**52%** (average of 17 studies)	
CWP (2007)	**81%** (average of 17 Studies)	

52-99%

Suggested Approach for Determining Reductions

Several Combinations

Option	Features/Variables						
	Check Dams		Under-Drain		Swale Bottom Media		
	Without Enhanced Filter	With Enhanced Filter	Without Enhanced Filter	With Enhanced Filter	In-Place Soils	Amended Soils	Bioretention Base
1					X		
2	X				X		
3	X		X		X		
4	X		X			X	
5	X		X				X
6			X		X		
7			X			X	
8			X				X
9				X	X		
10				X		X	
11				X	X		X
12						X	
13							X
14		X			X		
15		X	X		X		
16		X		X	X		
17		X	X			X	
18		X		X			X

Volume Reduction Method

- Break into components
  - side slope
  - main channel
  - bioretention base
  - check dams
  - underdrain

- Make each component additive for volume reductions


Side Slope Reductions
Bottom/Main
Channel Reductions

Grass Channel: Side Slope

- Use P8 to model side slopes
- Run ~50 years of Twin Cities precipitation and 1.1 inch event storm over side slopes
- Vary significant parameters (total of ~96 model runs)
    - Side slope
    - Infiltration rate
    - Impervious area
    - Manning's n

Grass Channel: Main Channel

- Use P8 to model main channel
- Run ~50 years of Twin Cities precipitation and 1.1 inch event storm through channel
- Vary significant parameters (total of ~128 model runs)
    - Channel slope
    - Infiltration rate
    - Impervious area
    - Manning's n

Grass Channel: Volume

- Volume reduction for Grass Channel = Volume reduction from side slopes + Volume reduction from main channel

- Amended soils can increase infiltration rates

Grass Channel: Pollutants

- TP, DP, and TSS reductions can be estimated using P8 results
- Compare results with observed data to come up with %TP and %TSS reduction

Water Quality Swale (Dry Swale): Volume

Bioretention Base

Volume reduction from side slopes + water stored in pores of engineered soil media

Check Dams

Volume reduction from side slopes + water stored behind check dams

Bioretention Base and Check Dams

Volume reduction from side slopes + water stored behind check dams + water stored in pores of soil media

Bioretention Base and Underdrain

Volume reduction from side slopes + fraction of water stored in the pores of the engineered soils media based on evapotranspiration

Next Steps

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- Run models to develop algorithms for grass channel and dry swale credits
- Develop documentation
  - design guidelines
  - specifications for construction and maintenance
  - limitations
  - cost estimates for capital and maintenance
- Feedback from Dry Swale Tech Squad June 4
- Present to Work Group on June 15