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Water Budget Mitigation and Enhancement Measures Between SWM Outflow and Ecological Receivers

Natural Resource Solutions Inc.

Presented by: Nathan Miller, David Stephenson and Lillian Knopf

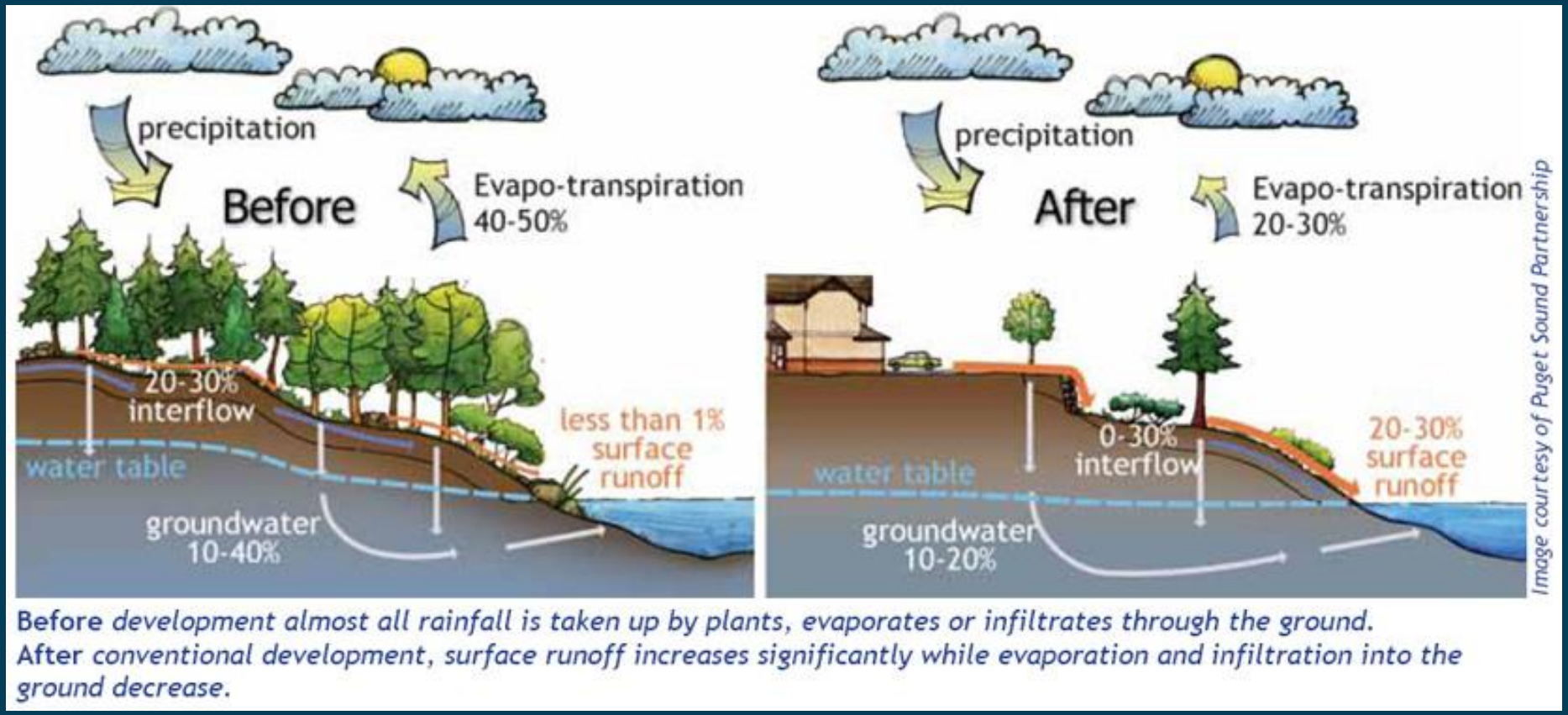
6th Annual TRIECA Conference: March 23, 2017

Overview

- Terminology
- Purpose
- Soil Amendments
- Infiltration Gallery/Spreader Storage
- Vegetation Plantings
- Grade Alterations
- Effectiveness Monitoring

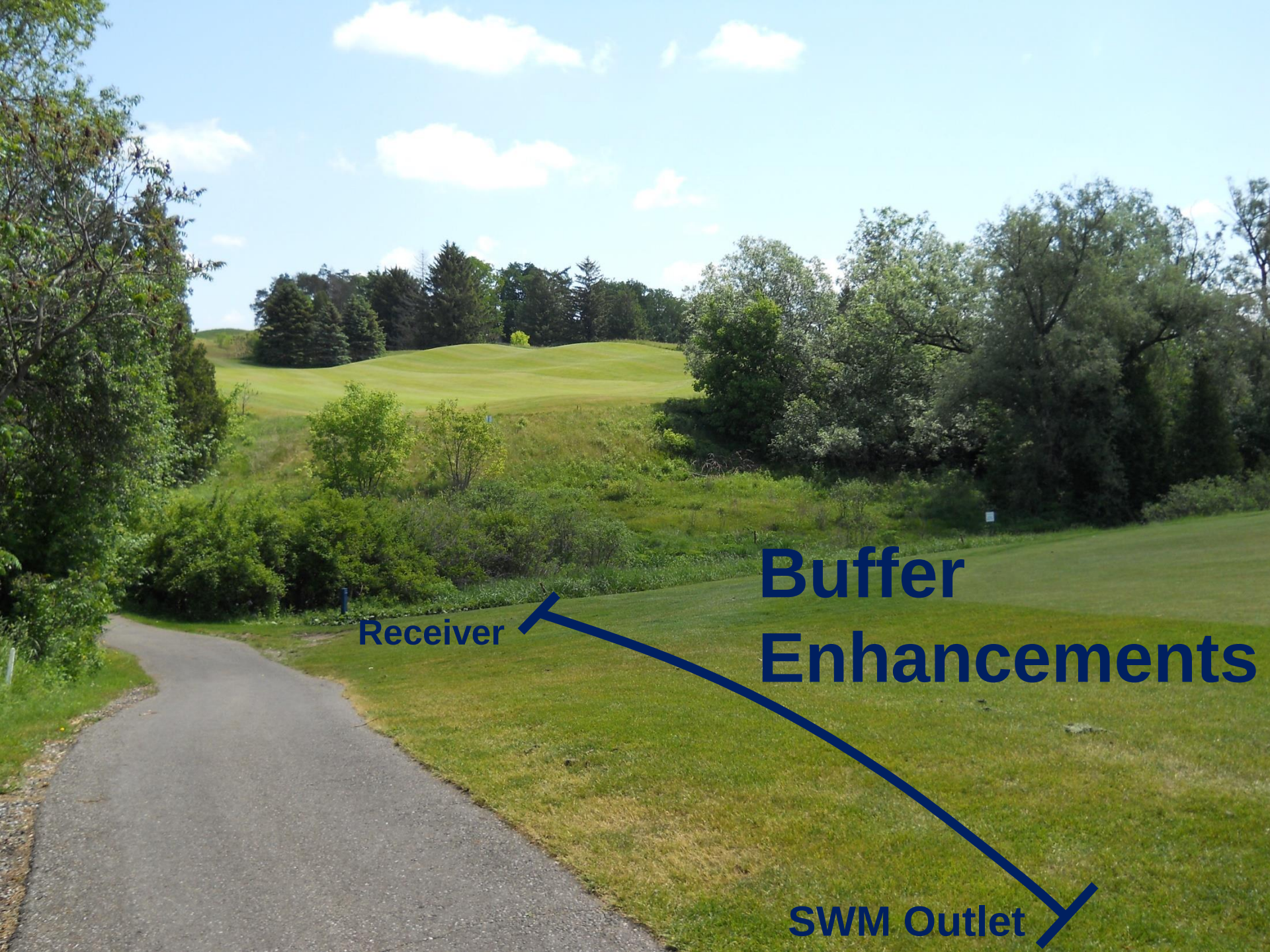
Terminology

- **Buffers** are defined as an area between a feature requiring protection and the proposed undertaking (source of potential impacts).
- **Vegetation Protection Zone (VPZ)**
  - A vegetated buffer area surrounding a key natural heritage/hydrologic feature
  - Becoming a popular term (esp. GTA)
- **Low Impact Development (LID)**
  - At source vs. end of pipe



Before *development almost all rainfall is taken up by plants, evaporates or infiltrates through the ground.*
After *conventional development, surface runoff increases significantly while evaporation and infiltration into the ground decrease.*

Source: http://www.ecy.wa.gov/washington_waters/images/WaterCycle.jpg


Buffer
Enhancements
Receiver
SWM Outlet

Soil Amendments

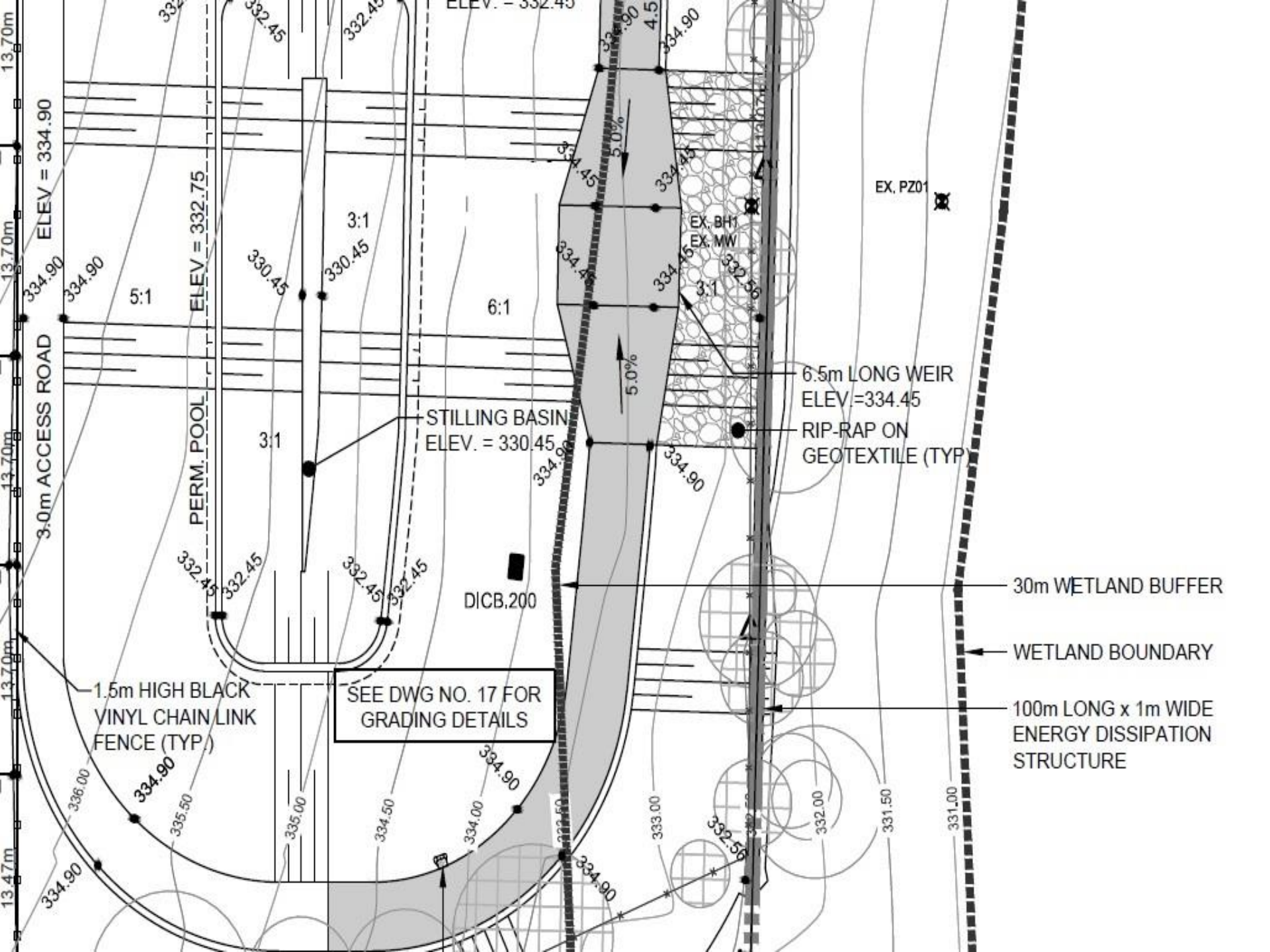
↑ Topsoil Depth

↑ Organic Component

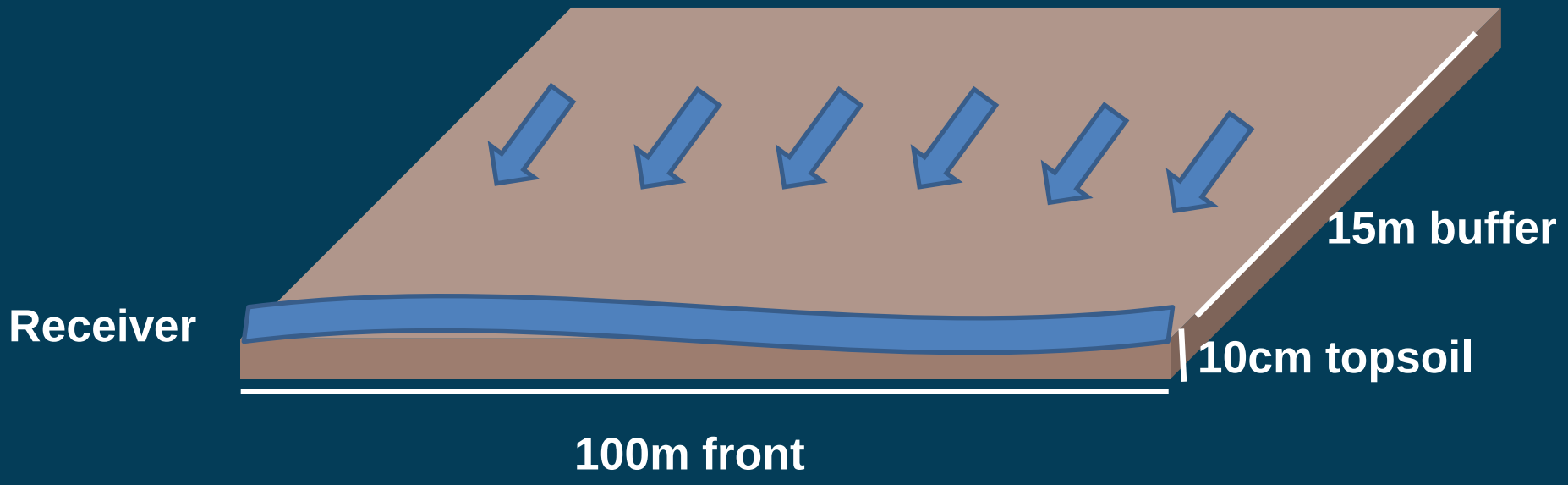
↑ Topsoil Depth to 300mm


wiseGEEK

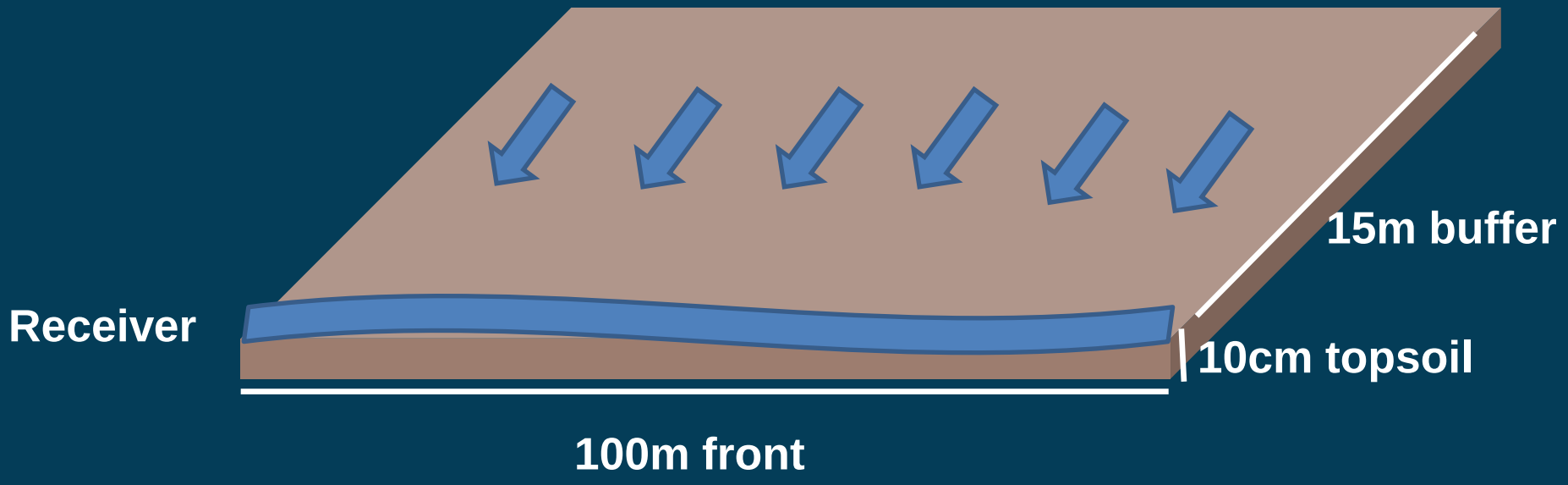

1% ↑ in organic material in soil = 16L more water retained/ per m^2 (within soil 30cm deep)
wiseGEEK


ELEV. = 332.45
ELEV = 334.90
ELEV = 332.75
3.0m ACCESS ROAD
PERM. POOL
5:1
3:1
6:1
5.0%
EX. PZ01
EX. BH1
EX. MW
6.5m LONG WEIR
ELEV.=334.45
RIP-RAP ON
GEOTEXTILE (TYP.)
STILLING BASIN
ELEV. = 330.45
DICB.200
30m WETLAND BUFFER
WETLAND BOUNDARY
100m LONG x 1m WIDE
ENERGY DISSIPATION
STRUCTURE
1.5m HIGH BLACK
VINYL CHAIN LINK
FENCE (TYP.)
SEE DWG NO. 17 FOR
GRADING DETAILS

Case Study – Existing Conditions



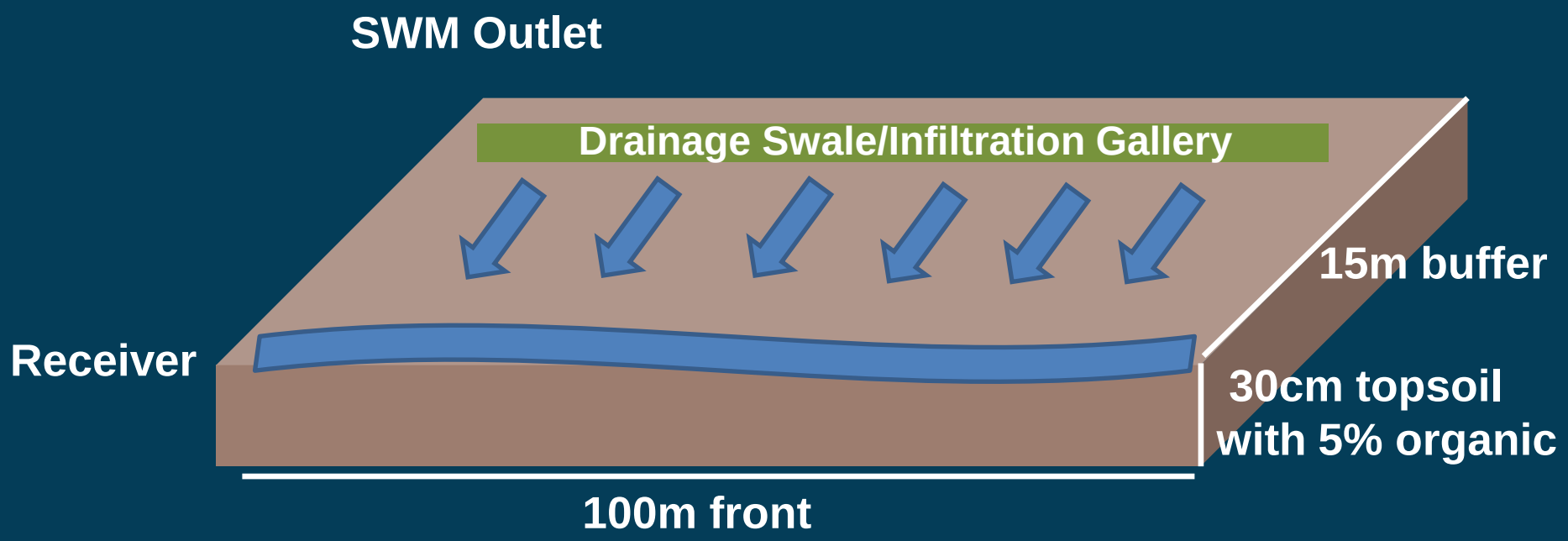
Case Study – Existing Conditions



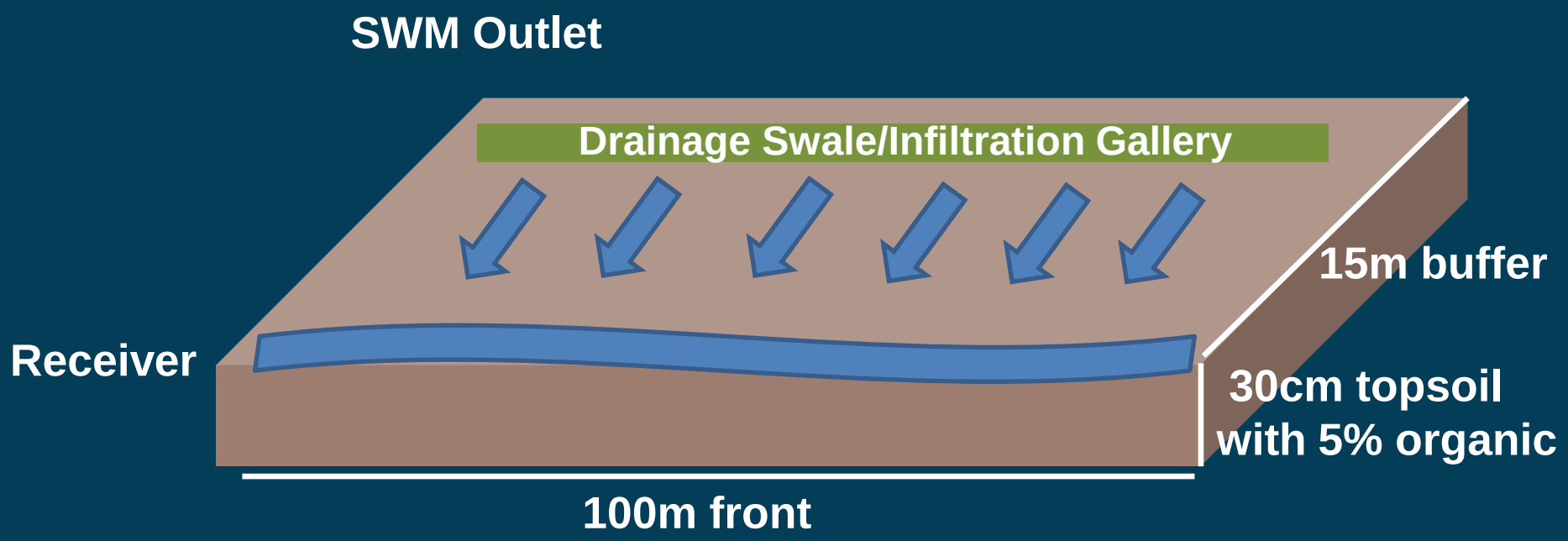
- Soil Porosity
- Soil Compaction
- Field Capacity

Approximately 8-20m^3 of water retained by soil

Case Study – Post Construction



Case Study – Post Construction

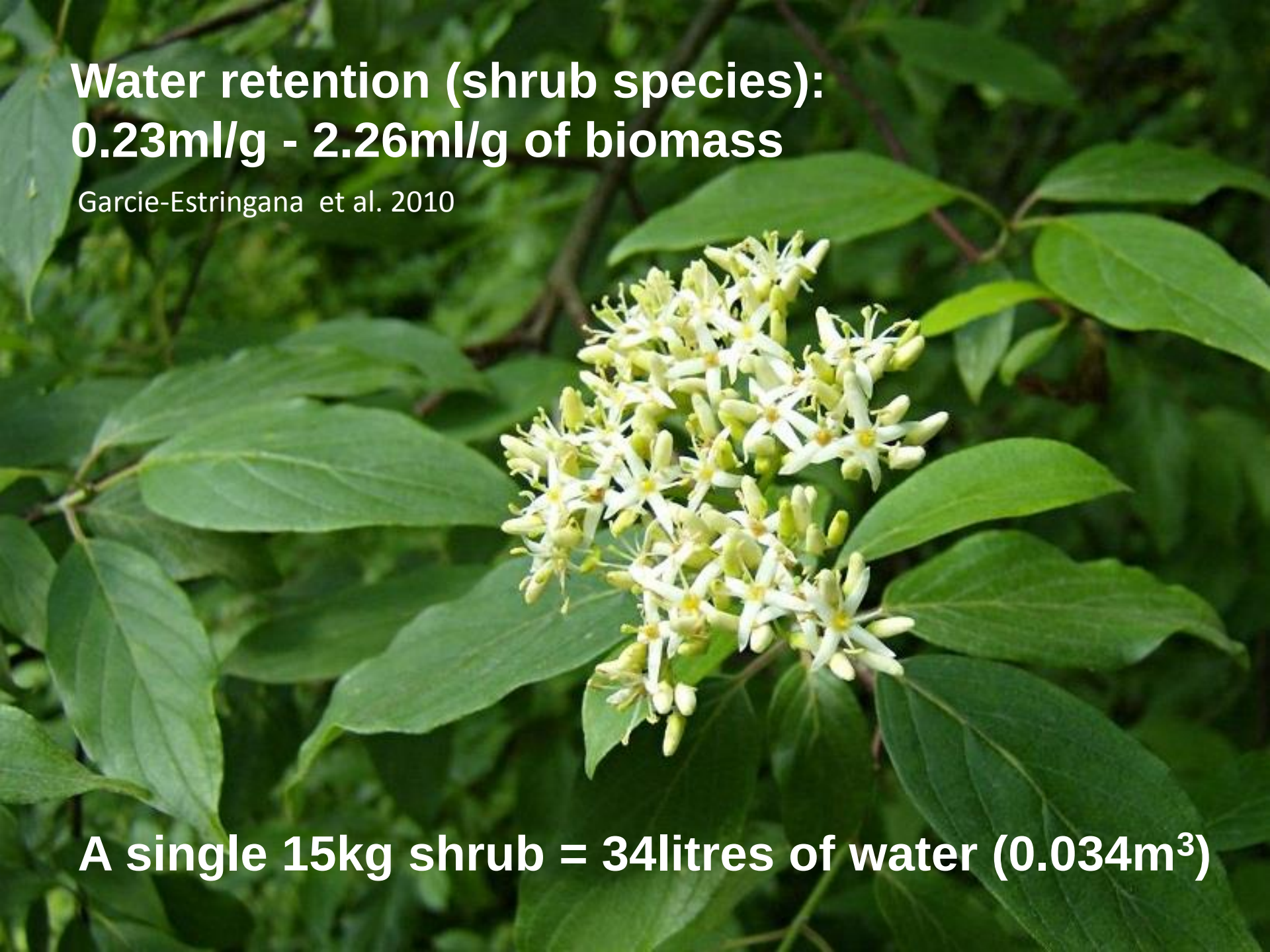


- Increased soil depth
- Enhanced soil porosity
- Increased organic component

Approximately 120m^3 of water retained by soil

Vegetation Plantings

- Evapotranspiration
- Uptake/Retention of Runoff
- Interception of rain water
- Increased soil pore space



Water retention (shrub species):
0.23ml/g - 2.26ml/g of biomass

Garcie-Estringana et al. 2010

A single 15kg shrub = 34litres of water (0.034m^3)

Grade Alterations

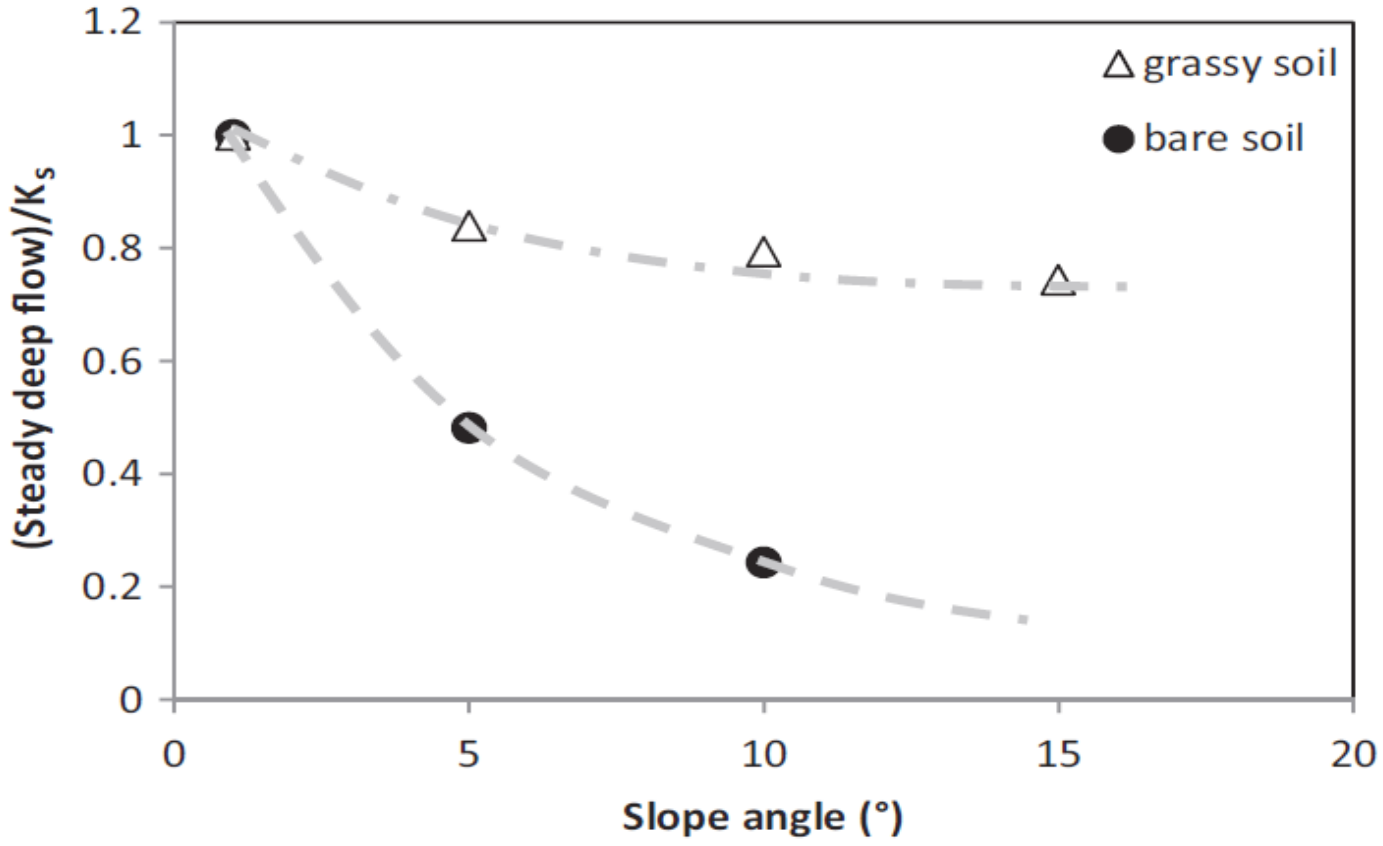
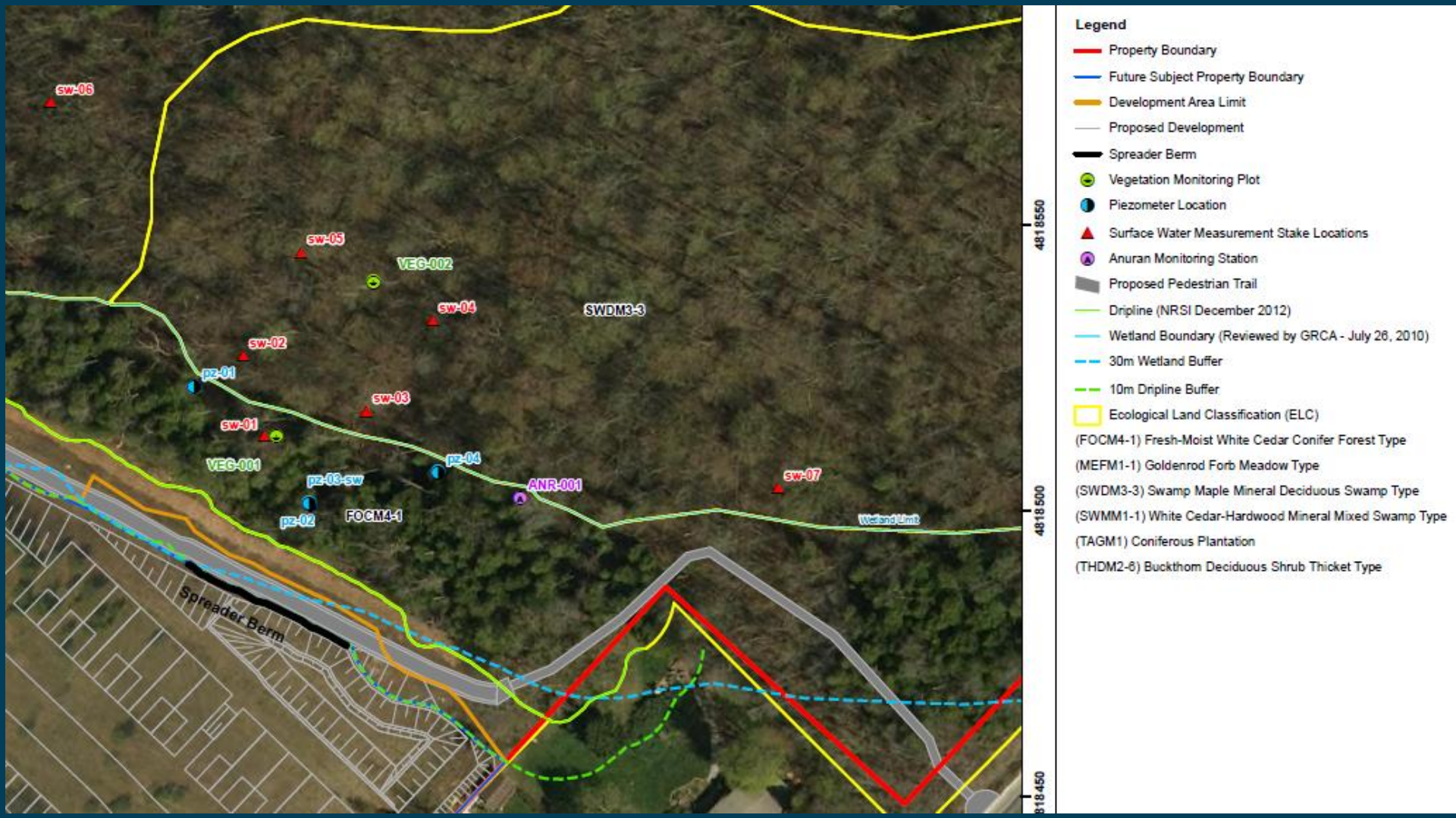


Fig. 5. Ratio between steady deep flow and saturated hydraulic conductivity observed under the maximum rainfall rate generated for each slope angle. The quantities referred to the bare soil are taken from Morbidelli et al. (2015).

Morbidelli et al. 2016

Effectiveness Monitoring



2011 Analysis	Plot 1		Plot 2		Plot 3	
	2011	2012	2011	2012	2011	2012
Trees (10 cm DBH or greater) (Entire Plot)						
Dominant Tree Species (>=10 cm DBH) (No. of individuals)	Eastern Hemlock (9)	Eastern Hemlock (9)	Balsam Poplar (4)	Balsam Poplar (4)	Eastern White Cedar (5)	Eastern White Cedar (5)
Total Number of Trees	20	20	8	8	8	8
Number of Dead Trees	0	0	0	0	4	4
Tree Density (trees/m^2)	0.20	0.20	0.08	0.08	0.08	0.08
Total Tree Surface Area (m^2)	0.46	0.46	0.45	0.45	0.15	0.15
Basal Area (m^2/ha)	46.4	46.4	44.8	44.8	14.7	14.7
Proportion of Flood Tolerant Species[1, 2]	100%	100%	100%	100%	100%	100%
Understory/Regeneration Trees (<10 cm DBH) (Across Subplots)						
Dominant Understory/Regeneration Tree Species (<10 cm DBH) (No. of individuals across sub-plots)	Eastern White Cedar (10)	Eastern Hemlock (14) (including seedlings)	Balsam Poplar (34) (including seedlings)	Balsam Poplar (19) (including seedlings)	Red Maple (44) (including seedlings)	Red Maple, (20) (including seedlings)
Number of Dead Understory Trees (among subplots)	1	1	0	0	0	0
Proportion of Flood Tolerant Species (among subplots)[1, 2]	100%	100%	100%	100%	100%	100%
Proportion of Non-Native Species (among subplots)	0%	0%	25%	0%	0%	0%
Shrubs (Across Subplots)						
Dominant Shrub Species (No. of individuals across sub-plots)	None	Dogwood sp. (2)	Common Buckthorn (250) (seedlings)	Common Buckthorn (277) (predominantly seedlings)	None	None
Number of Dead Shrubs (among subplots)	0	0	0	0	0	0
Proportion of Flood Tolerant Species (among subplots)[1, 2]	100%	100%	100%	100%	100%	100%
Proportion of Non-Native Species (among subplots)	0%	0%	100%	66.7%	0%	0%
Herbaceous Vegetation (Entire Plot)						
Dominant Herbaceous Flora Species (Average percent cover across sub-plots)	Spring: Cinnamon Fern, Skunk Cabbage (6%) Summer: Moss sp. (27%)	Spring: Skunk Cabbage (11%) Summer: Moss sp. (9%)	Spring: False Solomon's Seal (2%) Summer: Sensitive Fern (6%)	Spring: Sensitive Fern (9%) Summer: Moss sp. (5%)	Spring: Skunk Cabbage (55%) Summer: Skunk Cabbage (31%)	Spring: Skunk Cabbage (56%) Summer: Wild Sarsaparilla (13%)
Proportion of Flood Tolerant Species[1, 2]	100%	93.3%	100%	94.1%	100%	96%
Proportion of Non-Native Species	7.1%	6.7%	17.6%	11.8%	11.5%	4.0%
Floristic Indices (Entire Plot)						
Natural Area Index (FQAI)	22.9	26.0	17.9	19.0	27.6	28.2
	5.1	5.0	3.8	4.1	4.7	4.8

Facing northeast

Facing northeast

Facing east

Facing east

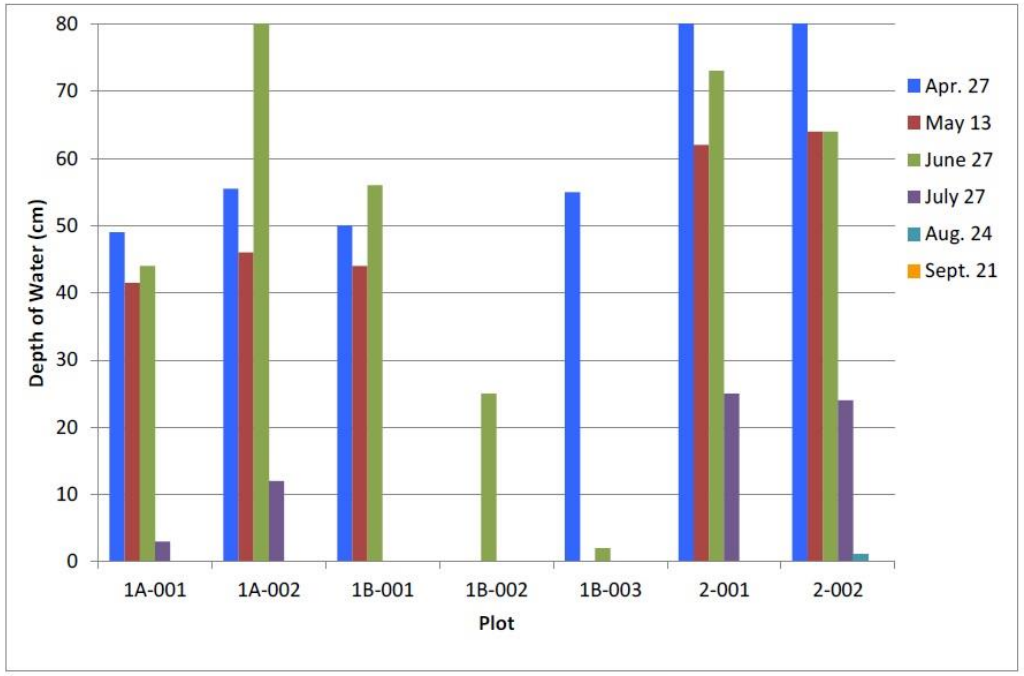


Figure 5. Water Depths Recorded at Each Plot in 2011

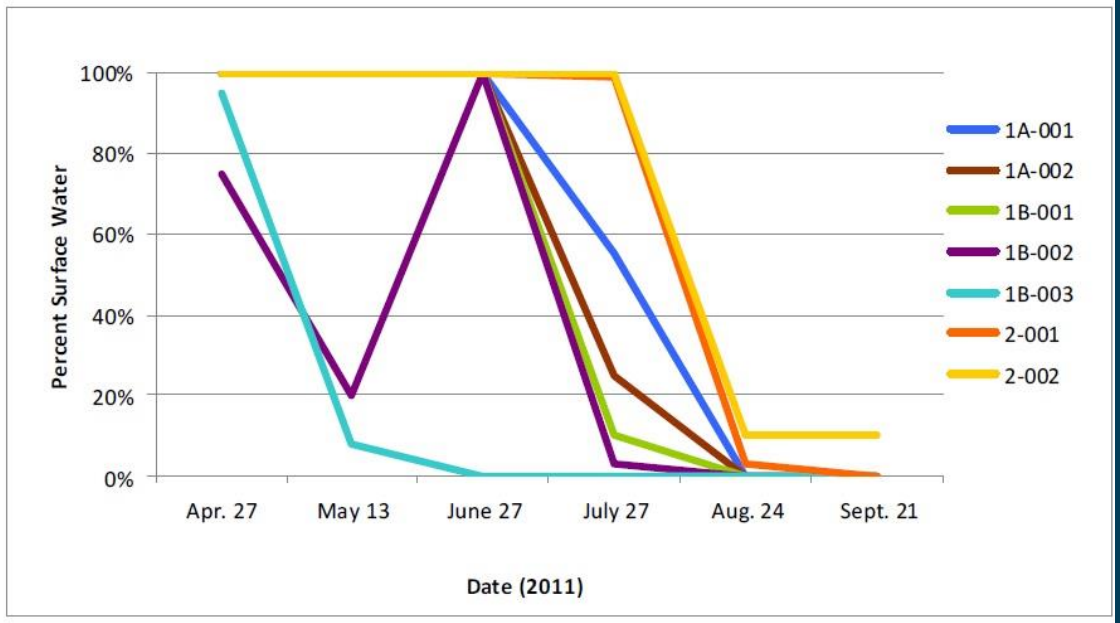


Figure 6. Percent Water Coverage at Each Plot in 2011

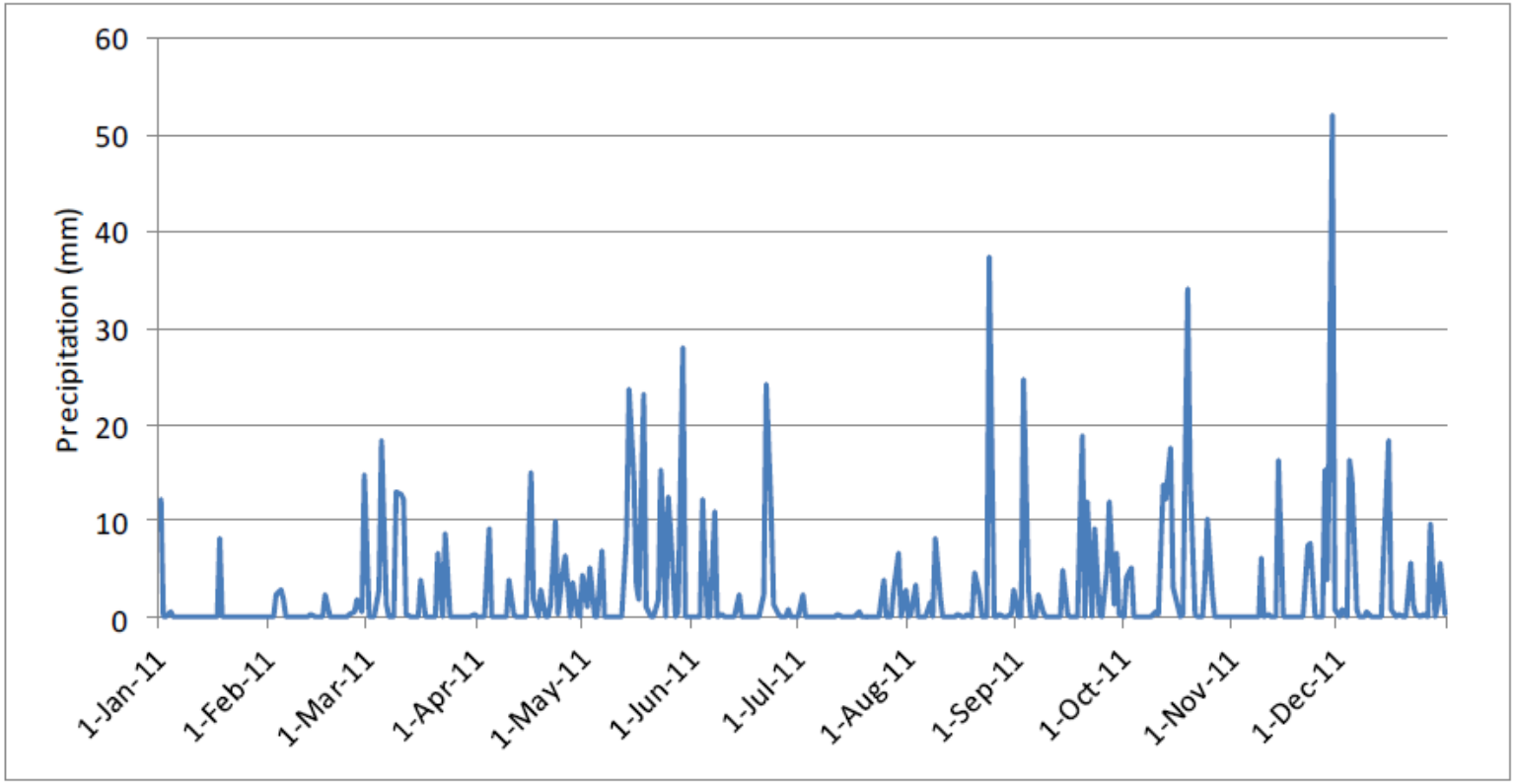


Figure 7. Daily Precipitation Data, Region of Waterloo International Airport (Environment Canada 2012)

Challenges

- Quantification
- Confounding Variables
- Site Specificity
- Municipal Policies

Questions or Comments?

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