# *Rain Gardens – Top 10 Design Considerations*

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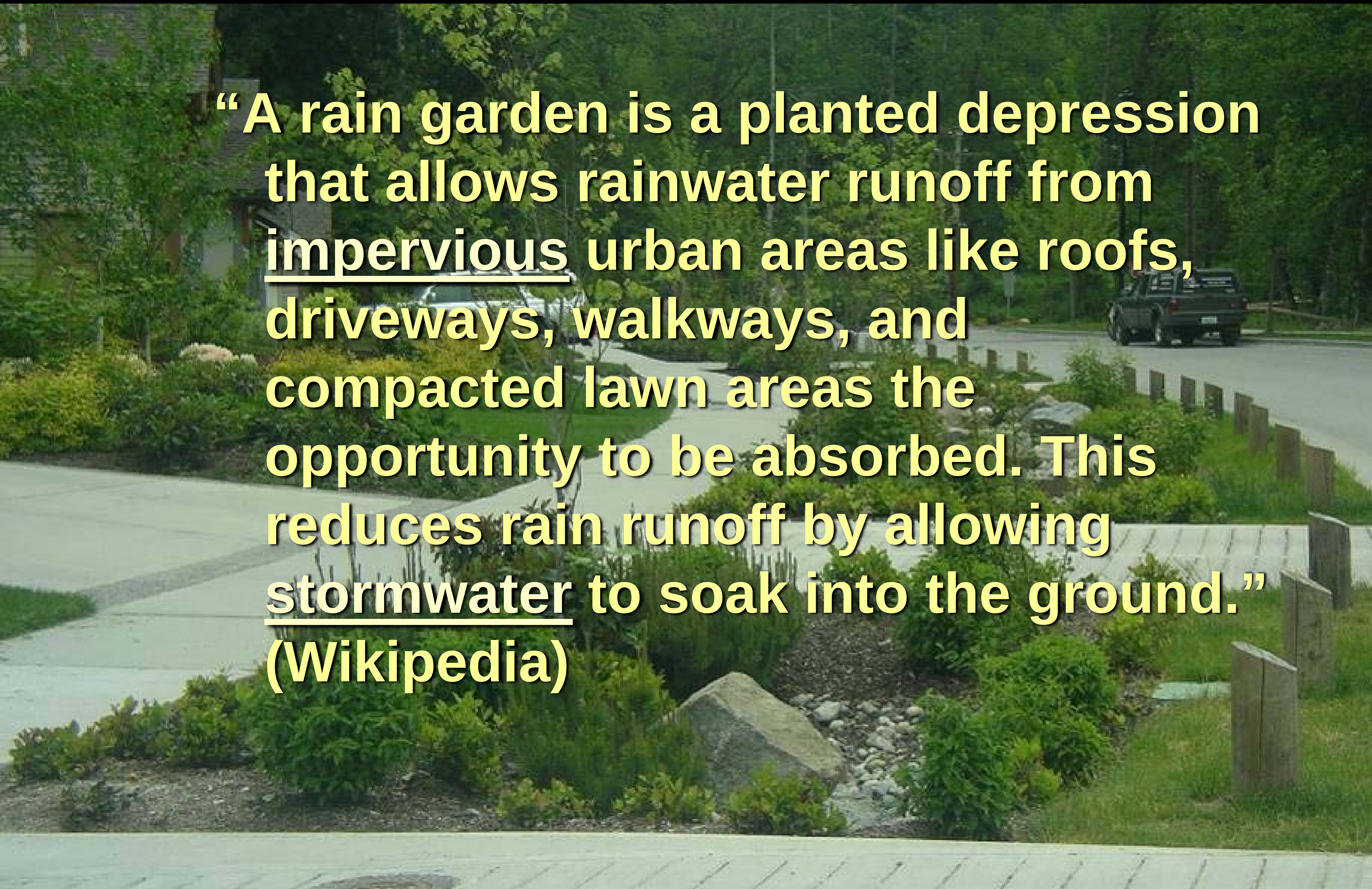
# What is a Rain Garden?



"A rain garden is a planted depression that allows rainwater runoff from impervious urban areas like roofs, driveways, walkways, and compacted lawn areas the opportunity to be absorbed. This reduces rain runoff by allowing stormwater to soak into the ground." (Wikipedia)

# Rain Gardens vs. Bioswales

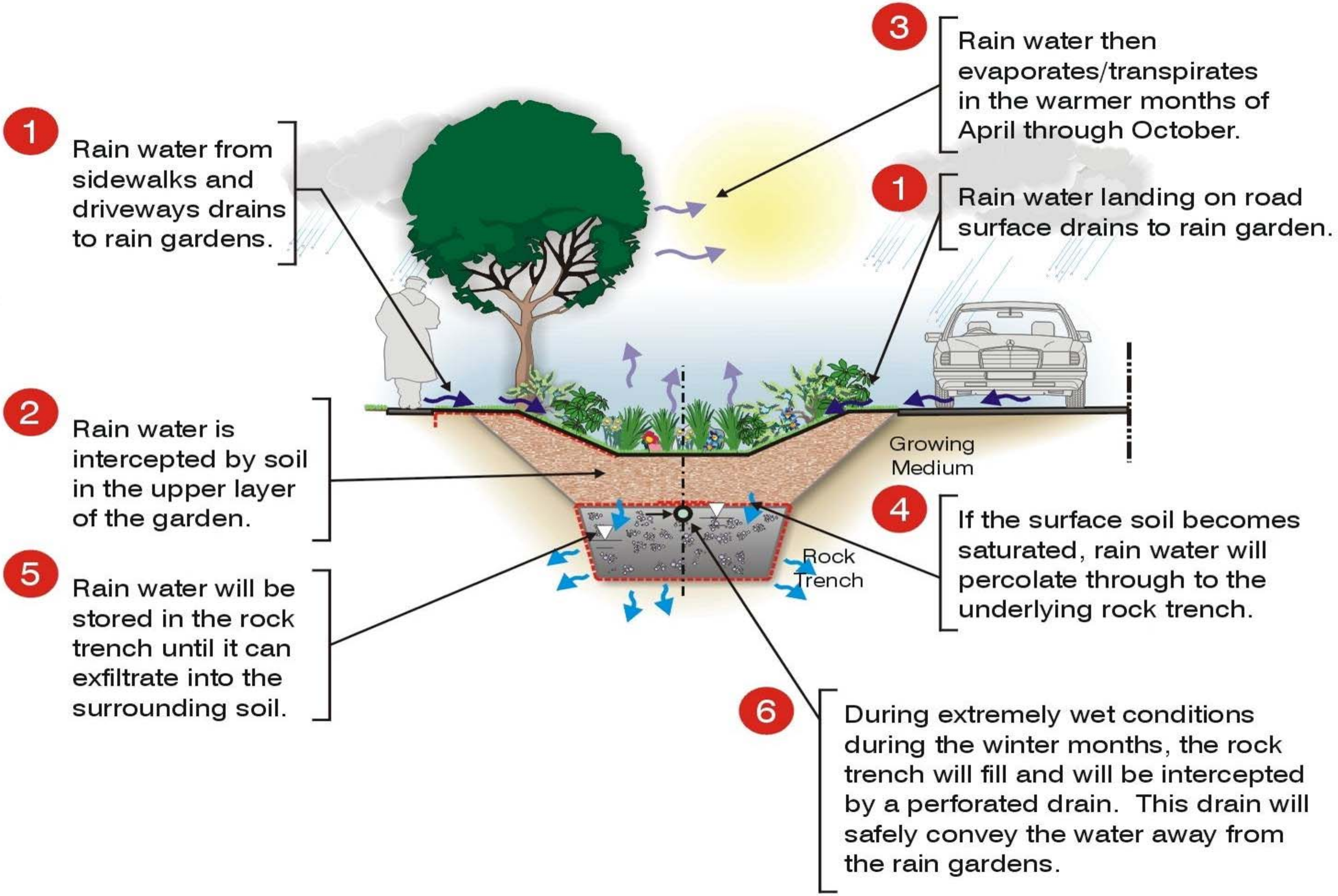
- “Rain gardens are at times confused with bioswales. Swales slope to a destination, while rain gardens do not; however, a bioswale may end with a rain garden.”
- “Vegetated roadside swales, now promoted as “bioswales”, remain the conventional drainage system in many parts of the world from long before extensive networks of cement sewers became the conventional engineering practice in the USA.”

(more Wikipedia)

# Basic Components of a Rain Garden

- **Growing medium** – to support plant growth and retain water to field capacity of soil
- **Vegetation** – to promote regeneration of infiltration surface and assist in the evapor-transpiration process
- **Rock trench** (optional for high permeable soils) – to store infiltrated water and release after storm event
- **Perforated Pipe** (optional for high permeable soils) – to protect plant roots from flooding, to preserve oxygen levels in growing medium, and to safely direct interflow from infrequent events to collection system
- **Overflow** – to protect property/infrastructure from both high intensity rainfall events and rain on frozen ground conditions.

# How Do They Work?



# Example

# Why should you care?


- **Reduction of erosive forces in creeks**
- **Protection of fish habitat**
- **Protection of water quality**
- **Installation of a barrier for point source pollution**

# Top 10 Rain Garden Design Considerations

1. Rainwater Design Criteria
2. Impervious to Rain Garden Area Ratio
3. Soil Selection and Attributes
4. Use of Under-drains
5. Depth of Rain Garden
6. Curb-edge material

# Top 10 Rain Garden Design Considerations

7. Trees or no Trees?
8. Where is the Infiltrated Water Going?
9. Native Soil Infiltration Rates
10. Depth of Rock Trenches

# 1. Rainwater Design Criteria

Focus of Rain Gardens

- **DFO Draft Criteria (2001)(BC)**
- **Stormwater Guidebook (BC)**
- **Other Municipal Criteria**

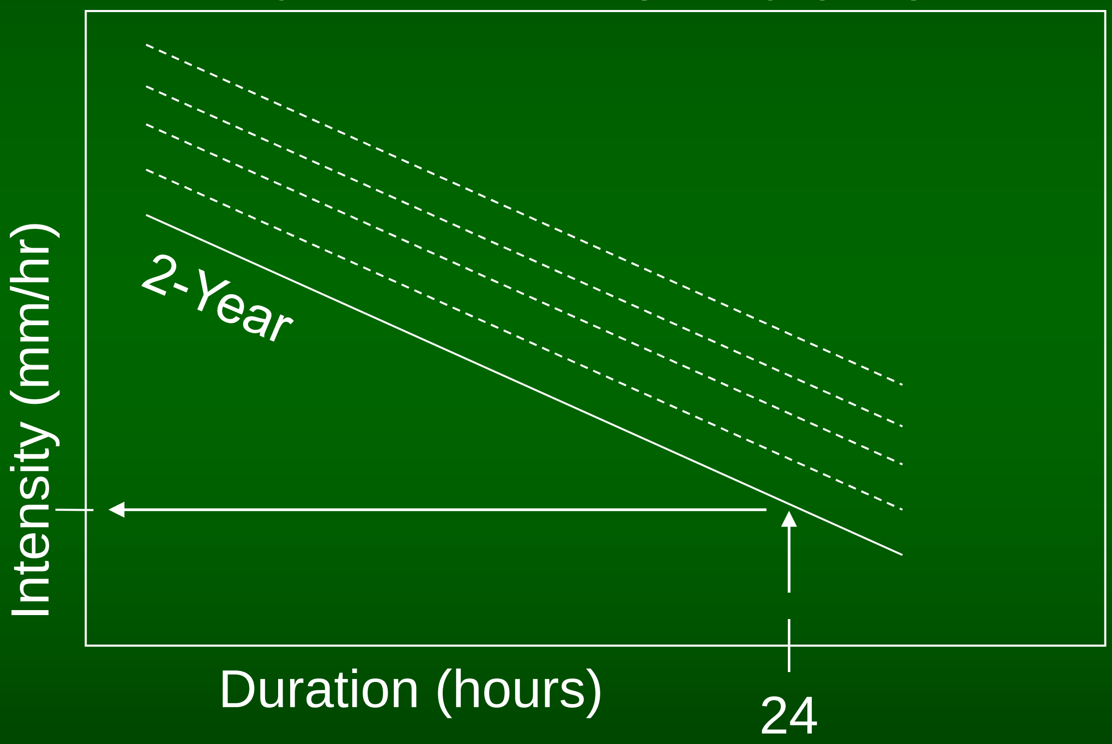
| Typical Criteria Components | | | |
|---|---|---|---|
| **Volumetric Reduction** | **Rate Control** | **Water Quality** | **Major Storms** |
| ***Capture a set amount of rain*** | ***Slow any runoff down*** | ***Reduce suspended solids*** | ***Provide Safe Passage*** |

# Tools for Calculations:

- ***Water Balance Model*** **(www.waterbalance.ca)**
- **Stormwater Models (i.e. XP-SWMM, PC SWMM, etc.)**
- **Manual Methods (see next slides)**

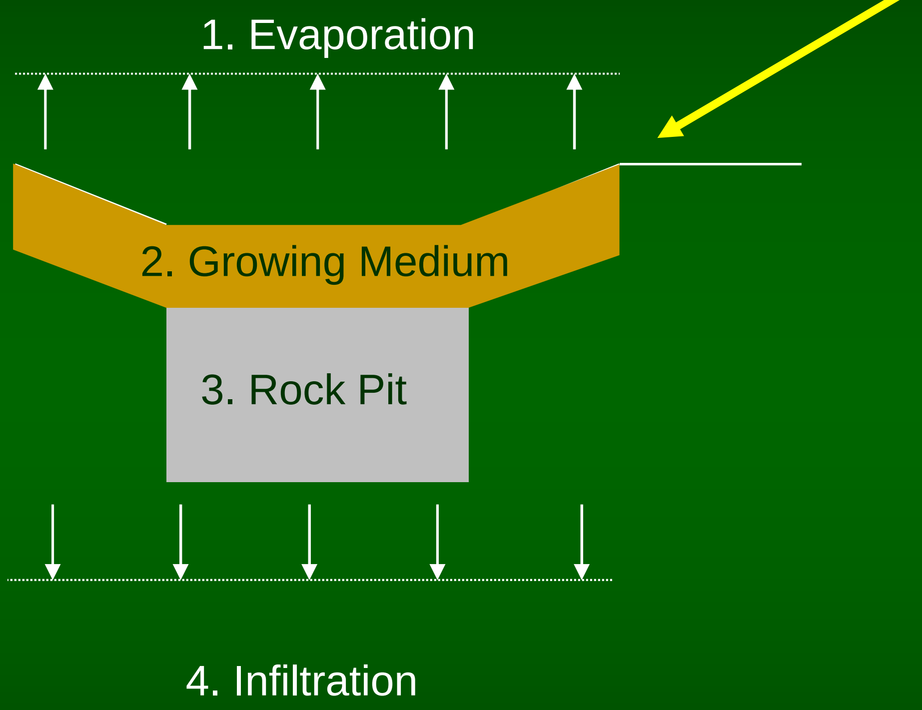
# How do you calculate capture amount?

Intensity-Duration-Frequency (IDF) Curve




- **Select local IDF curve**
- **Pick intensity at 24-hour duration for 2-year storm**
- **Multiply by 50% for Guidebook or 72% for DFO (6-month)**
- **Equals “x” mm of rain**

# Capturing the Rainfall




Input Volume should equal capture volume

(assume dry soils i.e. moisture content at wilting point)

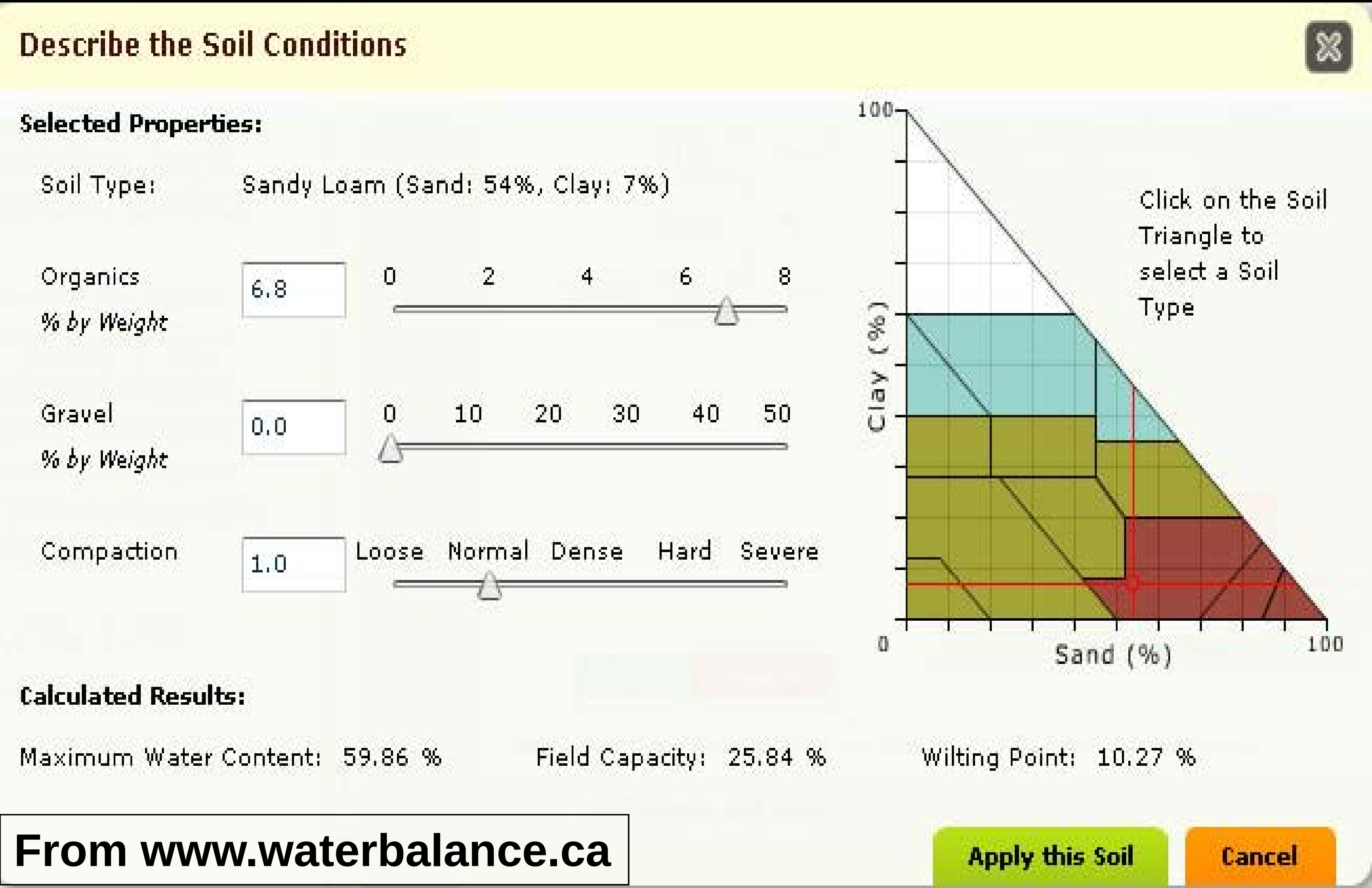
Input Volume:

- Tributary Area x Capture Rainfall Amount = Volume (cu.m.)

Capture Volume (sum):

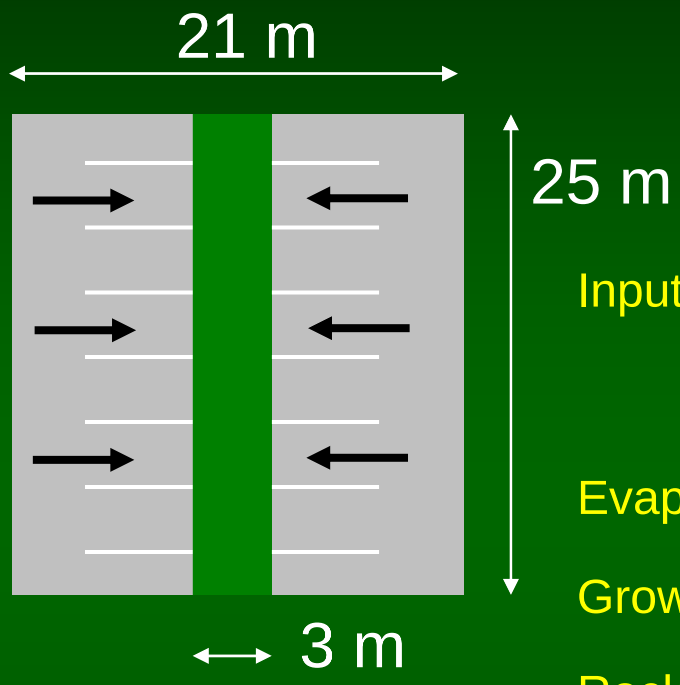
1. 24 hour evaporation x surface area
2. Volume of growing medium x (field capacity – wilting point)
3. Volume of rock pit x available water content
4. 24 hour infiltration x surface area

# Selecting the Soil Type




From www.waterbalance.ca

# Example Calc.: Port Moody Parking Lot




Port Moody 6-month rainfall event

72% x 76.8 mm (2-yr, 24 hr) = 55mm

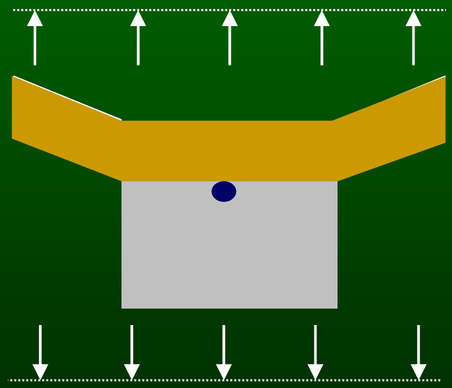
Input volume: 21 x 25 x 55mm rain = 28.9 $m^3$

Evaporation: 3 x 25 x 1mm/day = 0.1 $m^3$

Growing Med.: 3 x 25 x 0.45 x (.25 - .05) = 6.8 $m^3$

Rock Pit: 3 x 25 x 0.8 x (.35) = 21.0 $m^3$

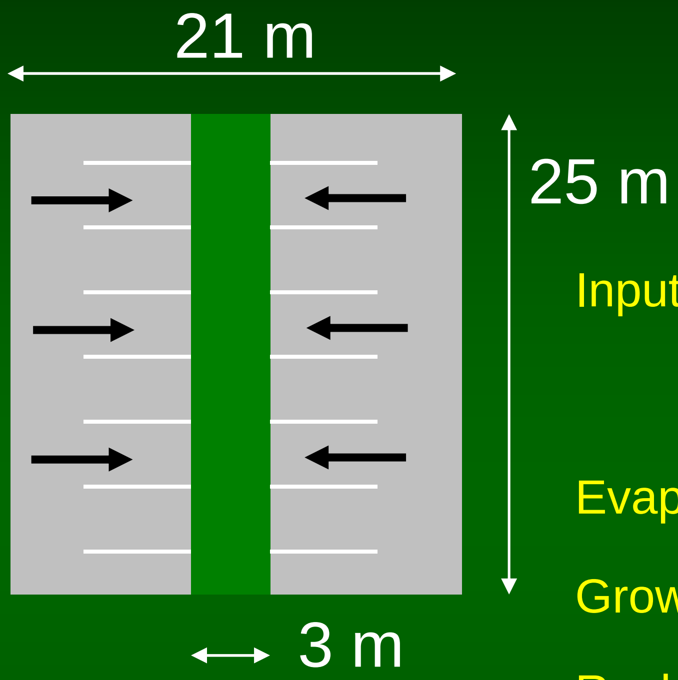
Infiltration: 3 x 25 x 1mm/hr x 24 hr = 1.8 $m^3$



- **The capture volume needed is 28.9 $m^3$. The capture volume available prior to overflow is 29.7 $m^3$. Therefore OK**

**Assume dry conditions**

# Example Calc.: Kelowna Parking Lot




Kelowna 6-month rainfall event

72% x 22.9 mm (2-yr, 24 hr) = 16.5mm

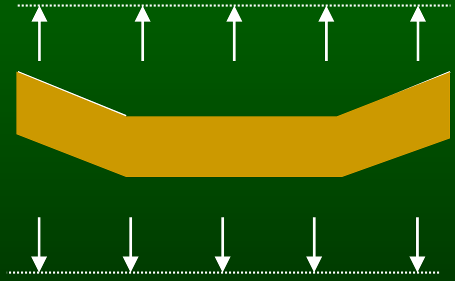
Input volume: 21 x 25 x 16.5mm rain = 8.7 $m^3$

Evaporation: 3 x 25 x 1mm/day = 0.1 $m^3$

Growing Med.: 3 x 25 x 0.45 x (.25 - .05) = 6.8 $m^3$

Rock Pit: Not Required

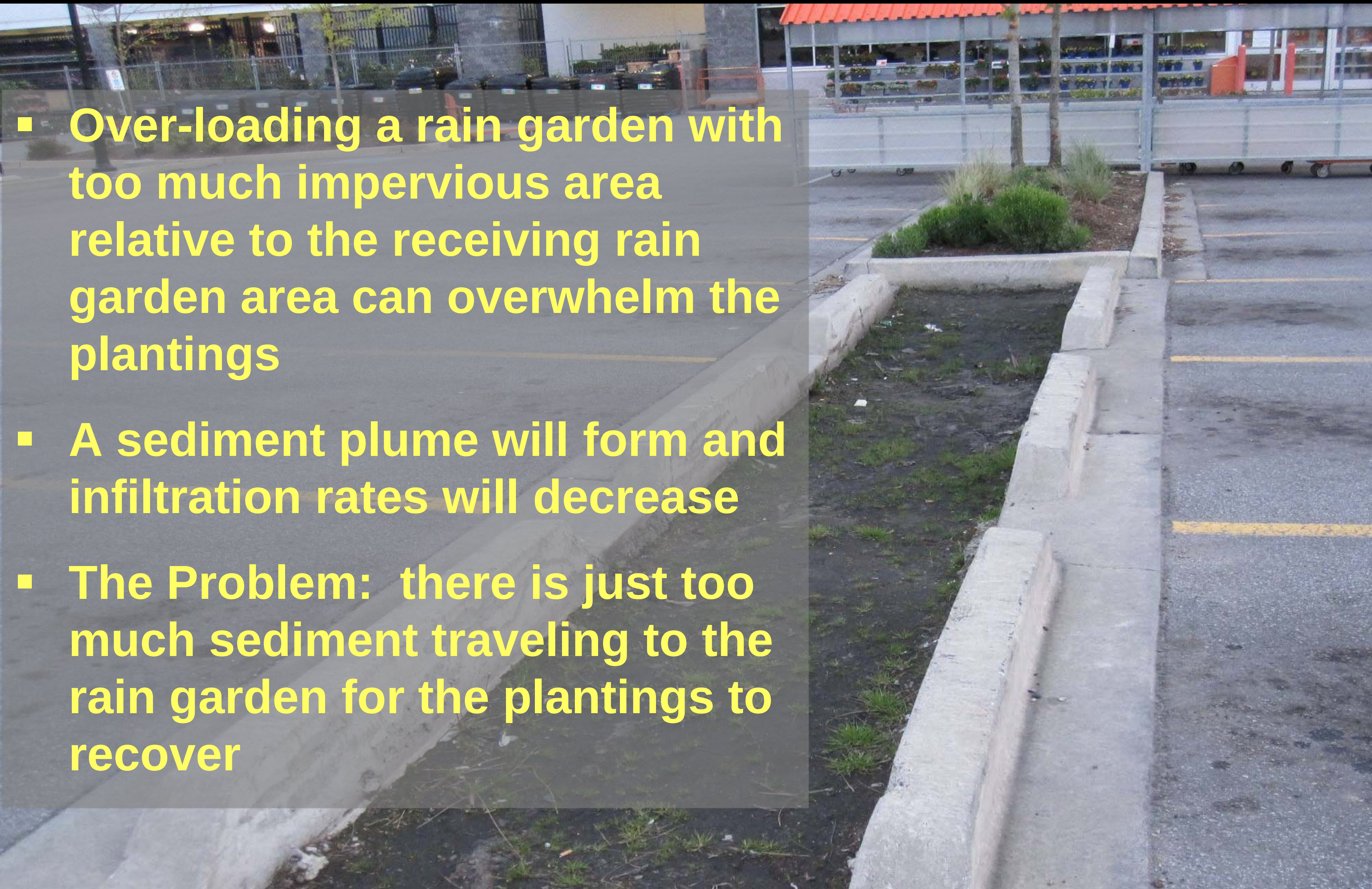
Infiltration: 3 x 25 x 1mm/hr x 24 hr = 1.8 $m^3$



**Assume dry conditions**

- **The capture volume needed is 8.7 $m^3$. The capture volume available is 8.7 $m^3$. Therefore OK**

# 2. Impervious to Rain Garden Area Ratio



- **Over-loading a rain garden with too much impervious area relative to the receiving rain garden area can overwhelm the plantings**
- **A sediment plume will form and infiltration rates will decrease**
- **The Problem: there is just too much sediment traveling to the rain garden for the plantings to recover**

# Impervious Area to Rain Garden Area Ratios

- Parking <1 car/d use 40:1
- Parking >1 car/d use 20:1
- Collector Rd use 30:1
- Loading areas use 20:1
- Low traffic areas use 50:1

# 3. Overflow Drain Heights and Soil Selection

**Be careful to match the expected infiltration rate with the incoming rainfall intensities without limiting vegetation growth. Use temporary surface ponding to store balance.**

**Example: MMCD "low traffic" soil can take up to 20 mm/hr. Using the parking lot example in the previous slides, this translates to a maximum intensity of 2.9 mm/hr. Any intensities above this will need to pond on the surface.**

# MMCD Mixes

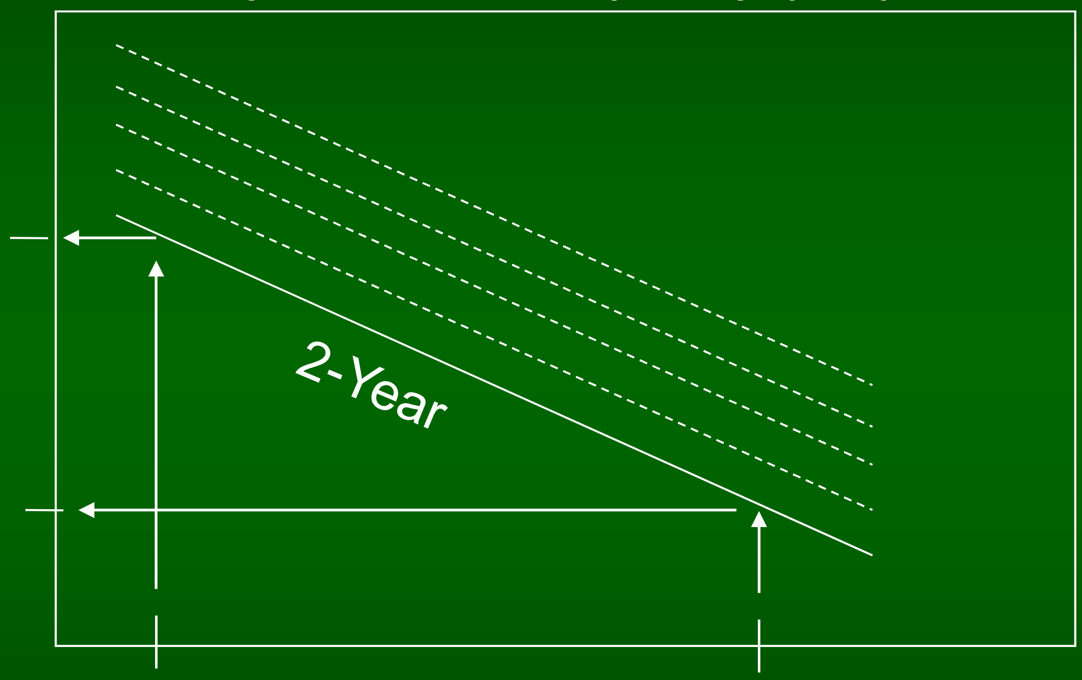


TABLE 2: Properties of Growing Medium for Different Applications

| Properties | Low Traffic Lawn Areas, Trees and Large Shrubs | High Traffic Lawn Areas | Planting Areas, Planters, Shrub and Groundcover Areas |
|---|---|---|---|
| TEXTURE: Particle size classes by Canadian System of Soil Classification | Percent of Dry Weight Mineral Fraction (%) | | |
| Gravel greater than 2 mm less than 75 mm | 0 - 10 | 0 | 0 |
| Sand greater than 0.05 mm less than 2 mm | 50 - 70 | 80 - 90 | 50 - 70 |
| Silt greater than 0.002 mm less than 0.05 mm | 10 - 30 | 5 - 20 | 10 - 30 |
| Clay less than 0.002 mm | 7 - 20 | 2 - 5 | 7 - 20 |
| ACIDITY (pH) | 6.0 - 6.5 | 6.0 - 6.5 | 5.0 - 6.0 |
| DRAINAGE: Minimum saturated hydraulic conductivity (cm/hr) in place | 2.0 | 7.0 | 2.0 |
| ORGANIC CONTENT: Percent of Dry Weight (%) | 5 - 10 | 3 - 5 | 25 - 30 |

# Determining Above Ground Ponding Volumes

Intensity-Duration-Frequency (IDF) Curve




- **Check that there is a sufficient ponding volume to hold high intensity events until water can infiltrate**

- **Use 72% of 2-year return period for 6-month event then subtract infiltrated water to yield temporary ponding depth**

# Set Overflow Drain Height

- **Set overflow drain height above rain garden invert to allow for temporary ponding during high intensity events**

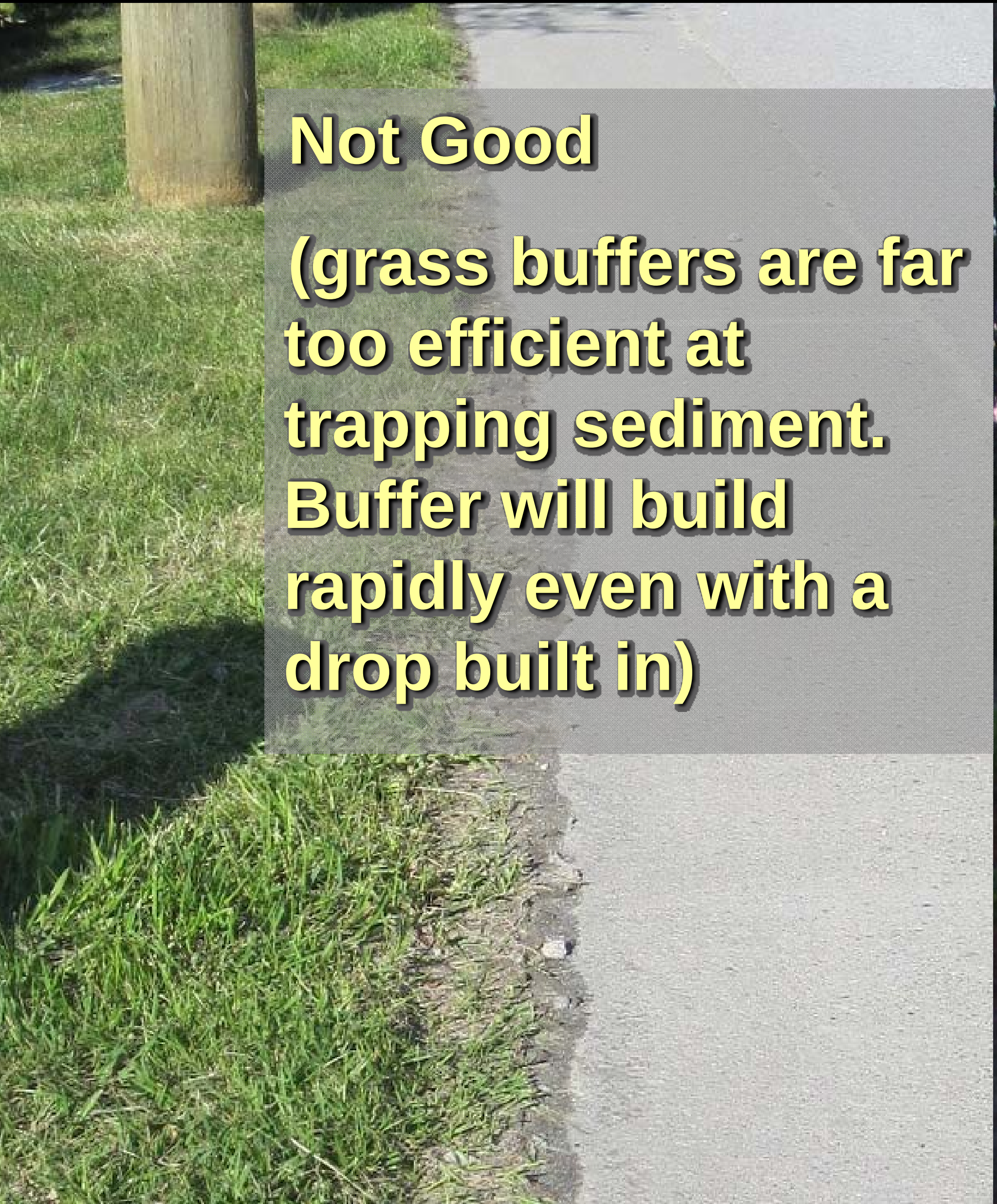
# 4. Use of Under Drains

- Don't drown the plantings! Unless you're meaning to!
- Use an under-drain system in low permeable soils
- Ensures sufficient oxygen remains in the growing medium

# 5. Allowance for Sediment Accumulation

- Depth of Rain Garden (it will fill up quickly)
- Typical residential road generated 1,200 kg/ha/yr in sediment load
- This translates to a mm/yr rise in sediment based on area
- How long before you need to dig out and re-plant? (25 years? Make it deep enough)

# 6. Careful Selecting Curb Edge Material



**Not Good**

**(grass buffers are far too efficient at trapping sediment. Buffer will build rapidly even with a drop built in)**

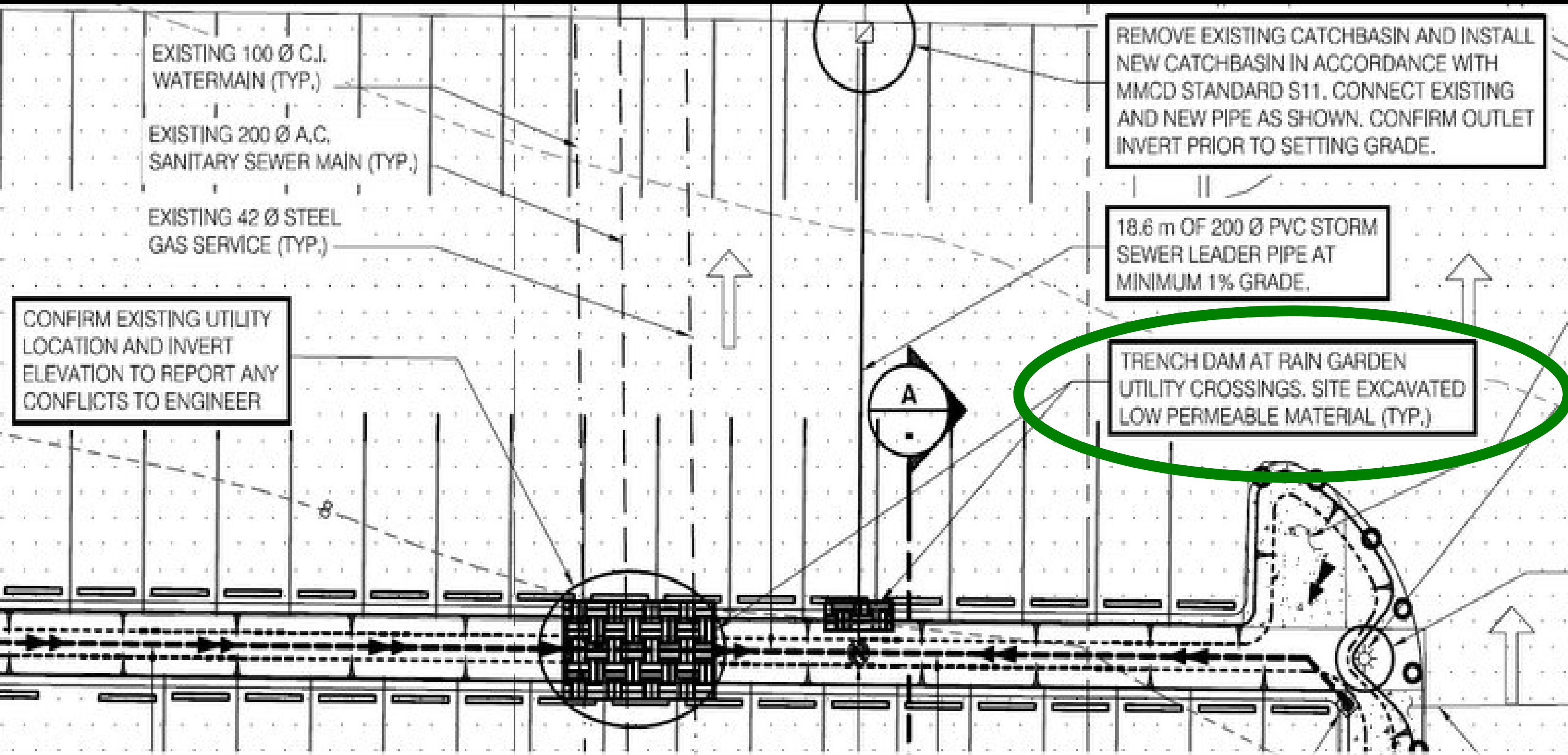
**Good**

**(drop and slope after asphalt. Non erodible material)**

# 7. Avoid Use of Tree Canopy

- Minimize deciduous trees above rain gardens – (watch out for leaves!)
- Leaves will reduce infiltration rates and interfere with vegetation used to regenerate surface.

# 8. Where’s the Infiltrated Water Going?



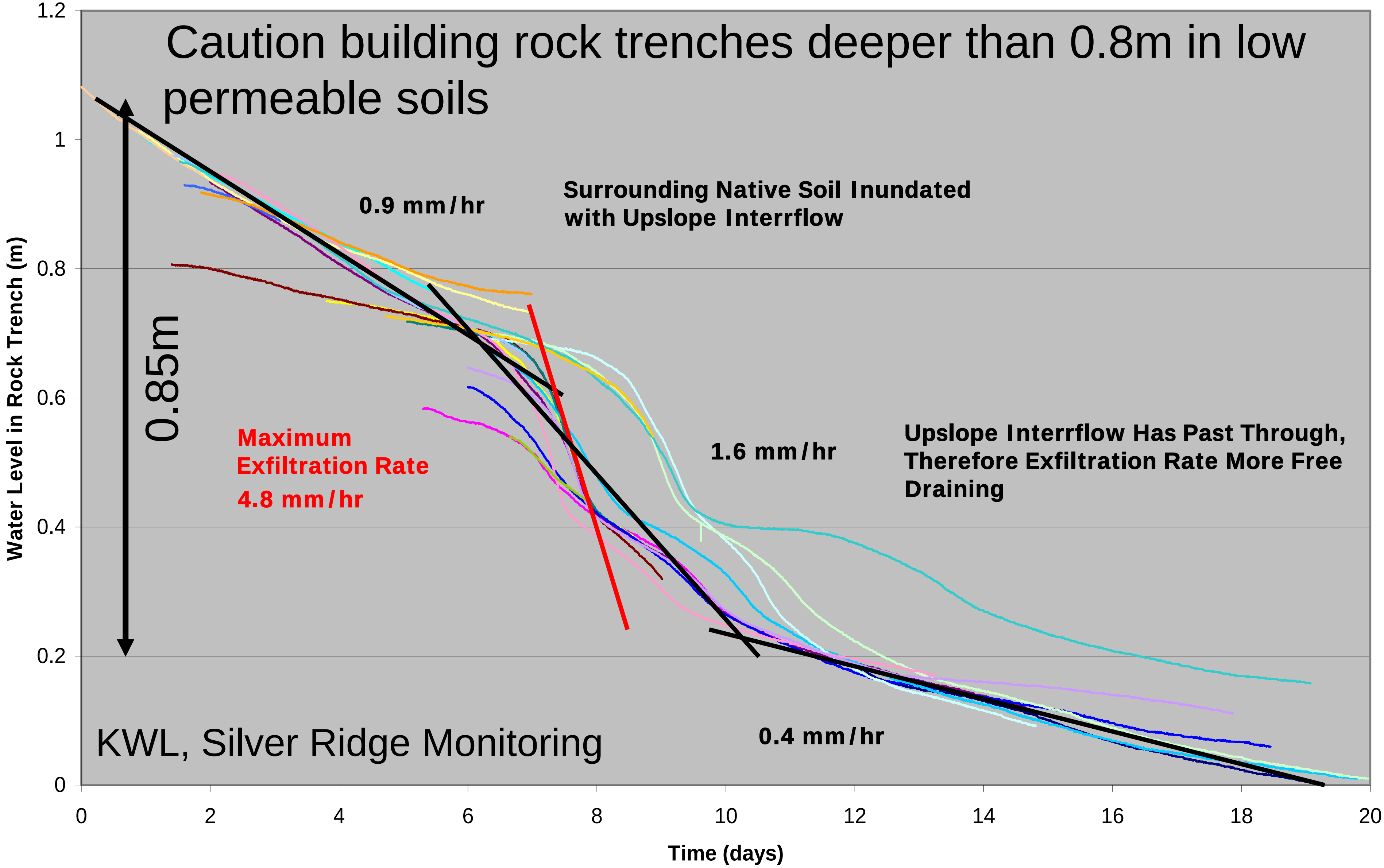

- Where’s the infiltrated water going? Will it pop the road? Will it end up at a foundation wall?) Use trench dams to contain water.

# 9. Native Soil Infiltration Rates

- Water <u>does</u> infiltrate into rock, clay, and glacial till…just slowly.
- Rain Gardens are focusing on the small storms, not the large infrequent storms
- An infiltration test on the native soil before development starts may show extremely low rates – but rates will change with the development of the land

| Soil Type | Saturated Hydraulic Conductivity (mm/hr) |
|---|---|
| Clay | 0.7 to 1.0 |
| Glacial Till | 0.9 to 1.6 |

# 10. Rock Trench/Pit Depths



# Questions ?

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