ESC for LID: the Calgary experience

TRIECA 2013

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Personal Background

- Day-to-Day Responsibilities at City of Calgary:
  - Evolution of Calgary's Stormwater Management & Design Manual
  - Practical implementation of LID by development community
  - Support to LID initiative by Water Resources / Services
  - Training and mentoring of junior and intermediate staff
  - Internal and external training
- Founding member and Past-President of the Alberta Low Impact Development Partnership
- (used to be) "Adjunct Professor" at the University of Calgary, Schulich School of Engineering, Department of Civil Engineering

My Credentials …

- Not a CPESC
  - Certified Professional Erosion & Sediment Control
- Not a QWAES
  - Qualified Wetland & Aquatic Environmental Specialist
- but a PEST
  - Problem Experiencing Stormwater Technocrat

These are the rules: City of Calgary Regulations

Drainage Bylaw

- Section 4 states that no person shall release or allow to be released any prohibited material into the storm drainage system
- The storm drainage system includes things used for storage, management and treatment to buffer the effects of the peak runoff or improve the quality of stormwater

These are the rules: City of Calgary Regulations

Drainage Bylaw

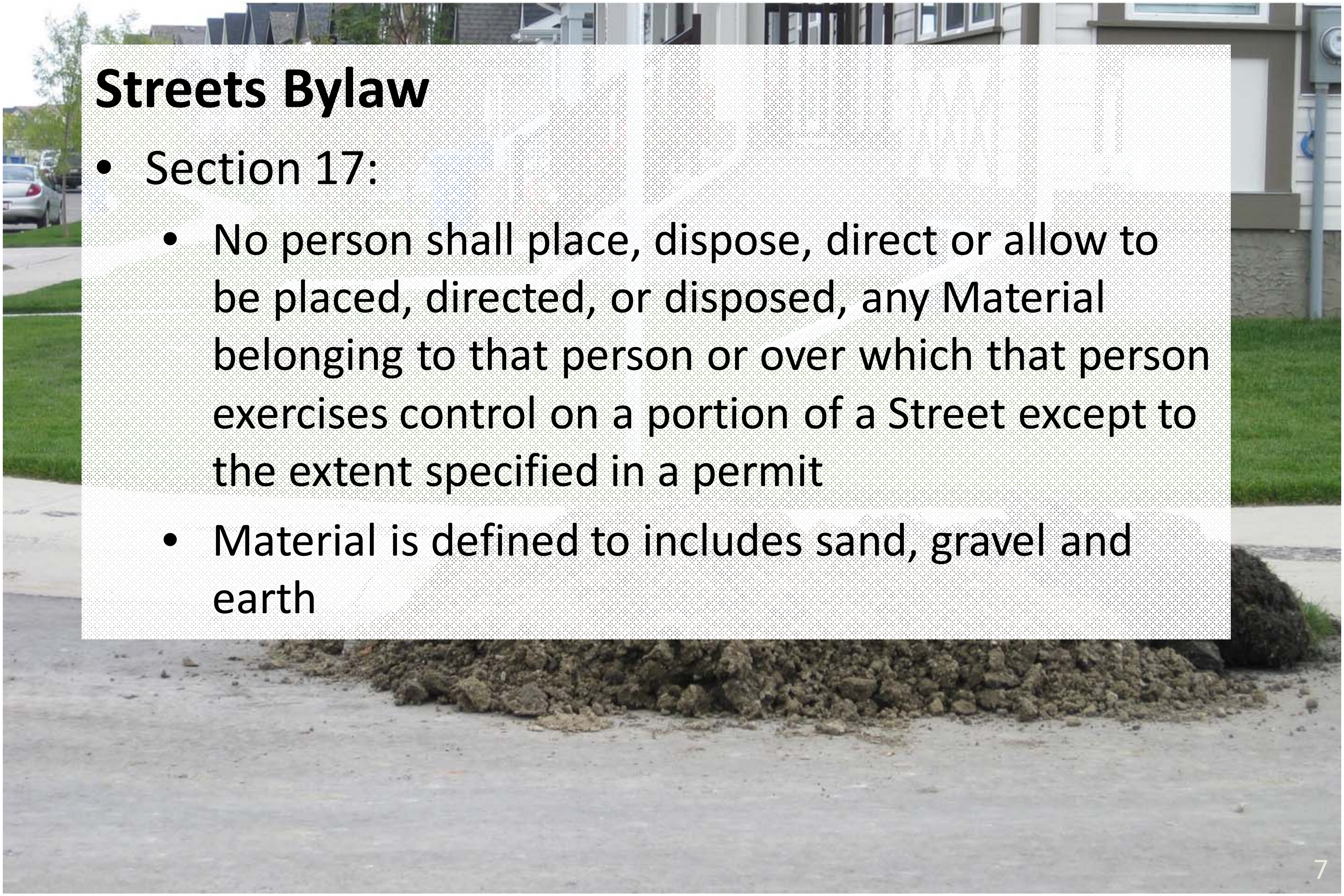
- Section 9 States that any person that occupies a parcel on which a device or practices is installed must keep the device or practice in good working condition at all times

These are the rules: City of Calgary Regulations

Drainage Bylaw

- Service the device or practice so it does not become overloaded
- Keep a maintenance record and provide it to The City upon request

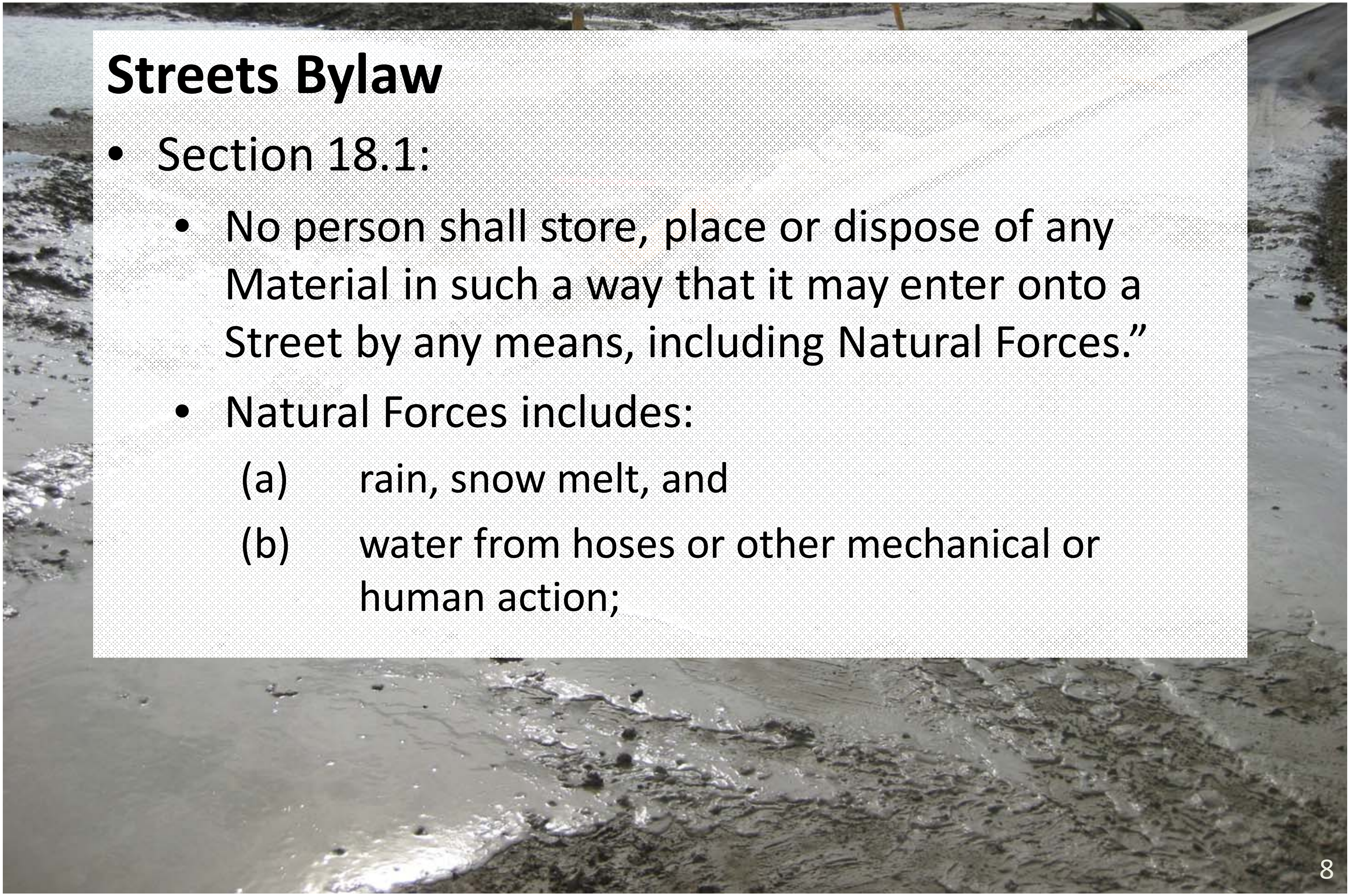
Other City of Calgary Regulations



Streets Bylaw

- Section 17:
  - No person shall place, dispose, direct or allow to be placed, directed, or disposed, any Material belonging to that person or over which that person exercises control on a portion of a Street except to the extent specified in a permit
  - Material is defined to includes sand, gravel and earth

Other City of Calgary Regulations



Streets Bylaw

- Section 18.1:
  - No person shall store, place or dispose of any Material in such a way that it may enter onto a Street by any means, including Natural Forces."
  - Natural Forces includes:
    - (a) rain, snow melt, and
    - (b) water from hoses or other mechanical or human action;

and more City of Calgary Regulations

Community Standards Bylaw

- Section 51(1) of the Bylaw states:
  - "No owner or occupier of a Premises shall allow an excavation, drain, ditch or other depression in the ground to become or remain a danger to public safety."
  - This is important to keep in mind when planning and constructing sediment ponds on a construction site, especially where locations could be accessible to the public.

ESC Submission Requirements:

- Function of parcel size:
  - > 2 ha: large sites - ESC report and drawings mandatory
  - From 0.40 ha to 2ha: medium sites
  - < 0.40 ha: small sites

    For small and medium sites, ESC measures to be implemented but need for ESC report and drawings depends on site conditions
  - See also http://www.calgary.ca/PDA/DBA/Pages/Urban-Development/Publications.aspx

What should it look like and how should it operate?

What kind of problems did we observe?
This may be asking for trouble …

A slightly better approach, as both catchbasin inlet and bottom of raingarden are “protected”

but things went horribly wrong at this bioretention area

We need to be sure that the functionality of these features exists …

However, we are seeing some challenges …

We need to be sure that the functionality of these features exists …

- Bioretention areas, bioswales and permeable pavement are treatment systems that "filter" the runoff
- The permeability of these practices naturally diminishes as a function of sediment build-up

Consequence of extended duration of ponding in bioretention area

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Land. Air. Water.

due to a thin veneer of sediment underneath the mulch layer

We need to be sure that the functionality of these features exists …

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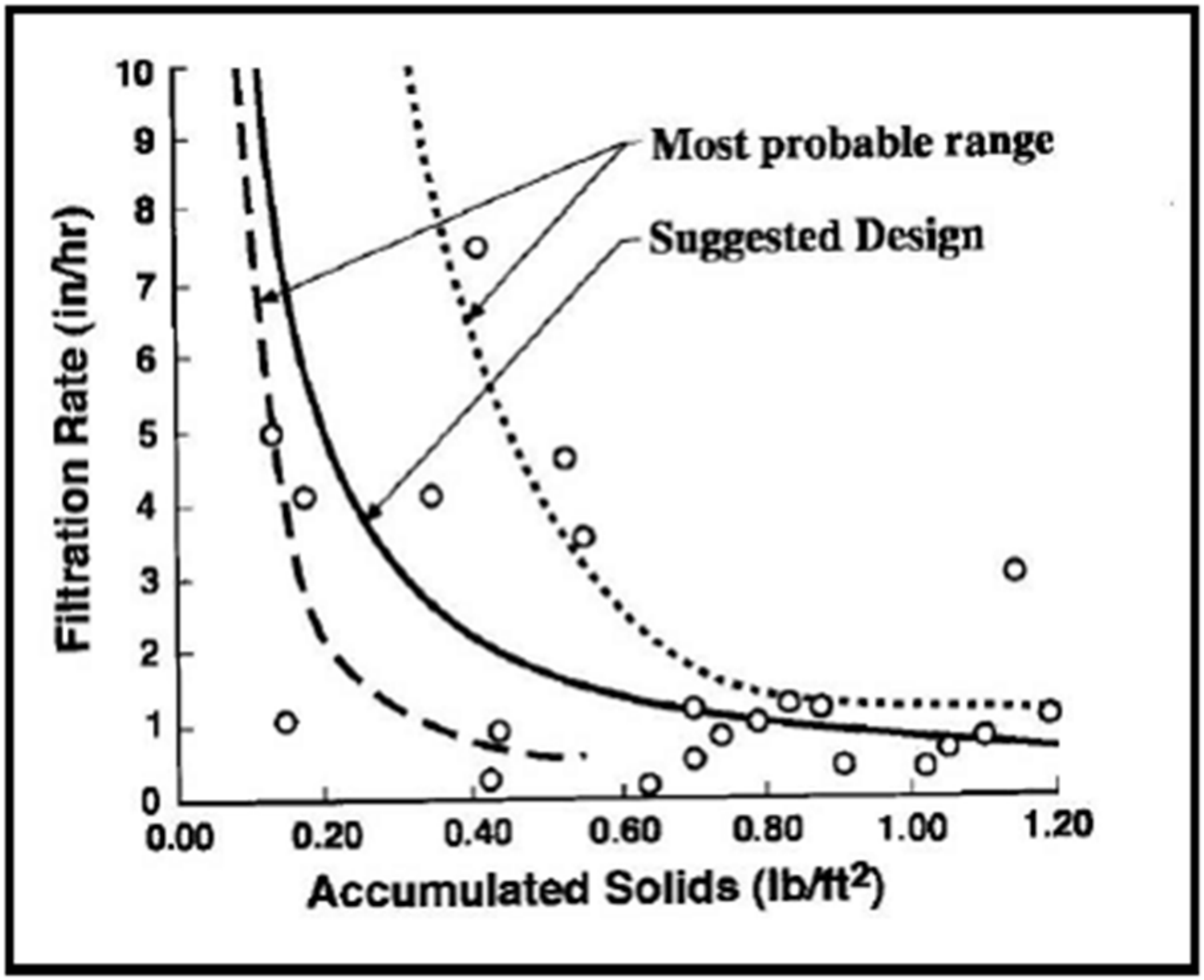


We need to be sure that the functionality of these features exists …

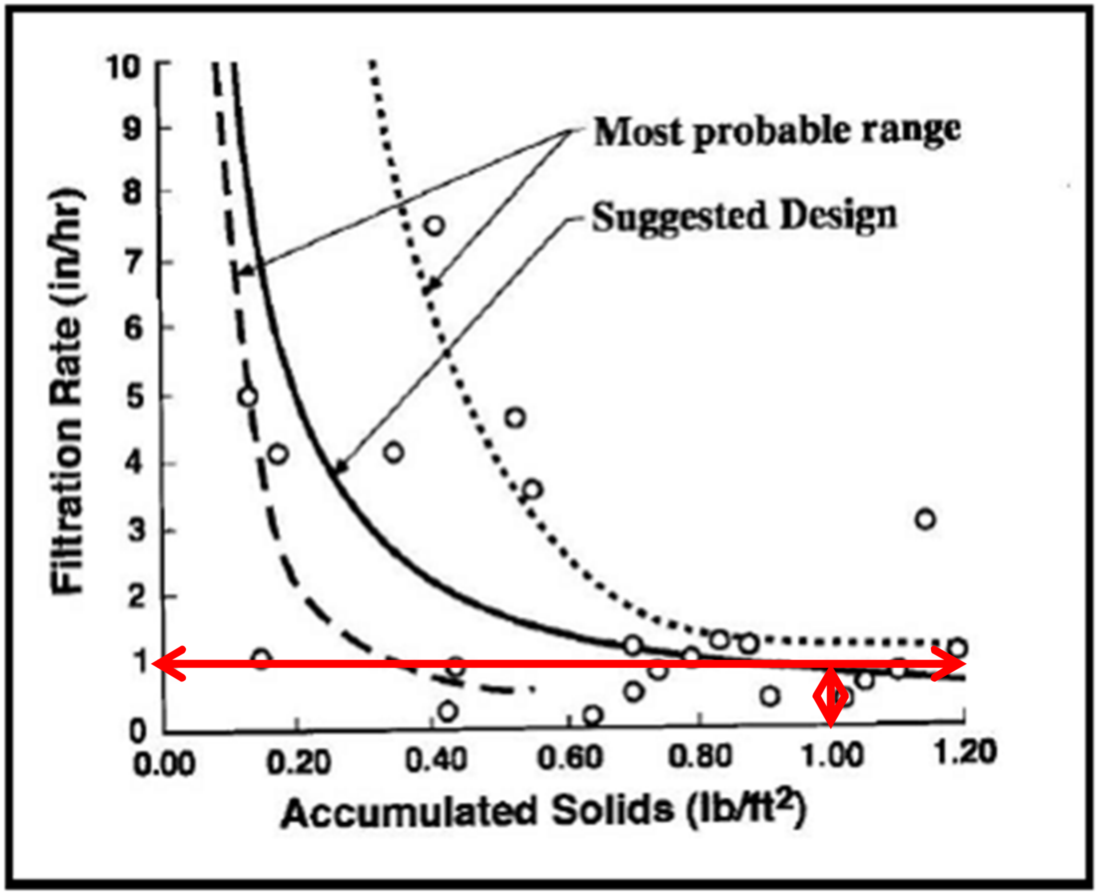
- Bioretention areas, bioswales and permeable pavement are treatment systems that “filter” the runoff
- The permeability of these practices naturally diminishes as a function of sediment build-up
- However, we do not want zero permeability
  - at the time of FAC; or
  - after FAC, until the construction activities are over
  - Need for Performance Verification

Some challenges are inherent to our design, so let's look at an example …

- Say, we have a bioretention area with the following characteristics:
  - Footprint = 50 m^2
  - I/P ratio = 10
  - Ultimate Imperviousness Ratio = 50%
- Potential sediment loadings
  - Stripping & Grading Phase: 2 tonnes/ha/year
  - Home Construction Phase: 2,000 mg/L
  - Ultimate Development: 150 mg/L

The "ultimate development" EMC is actually quite low for Calgary

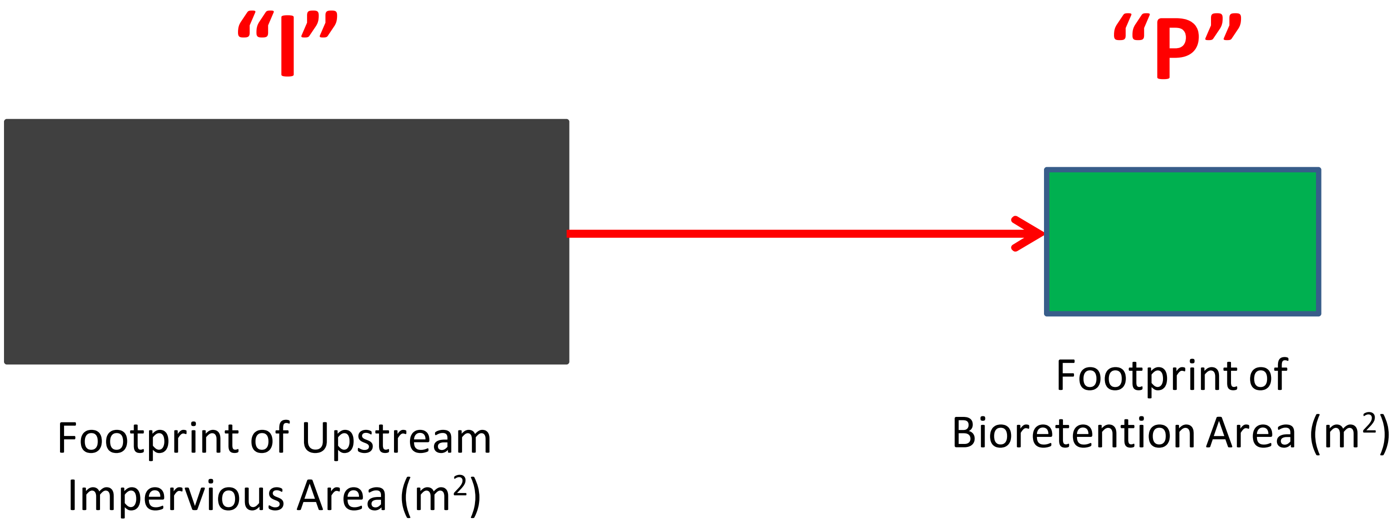
How much sediment can we live with?



Say, we allow a reduction in the filtration rate to 10% of the original rate.

That corresponds to a sediment loading of about 1 lb/ft^2 or
5 kg/m^2

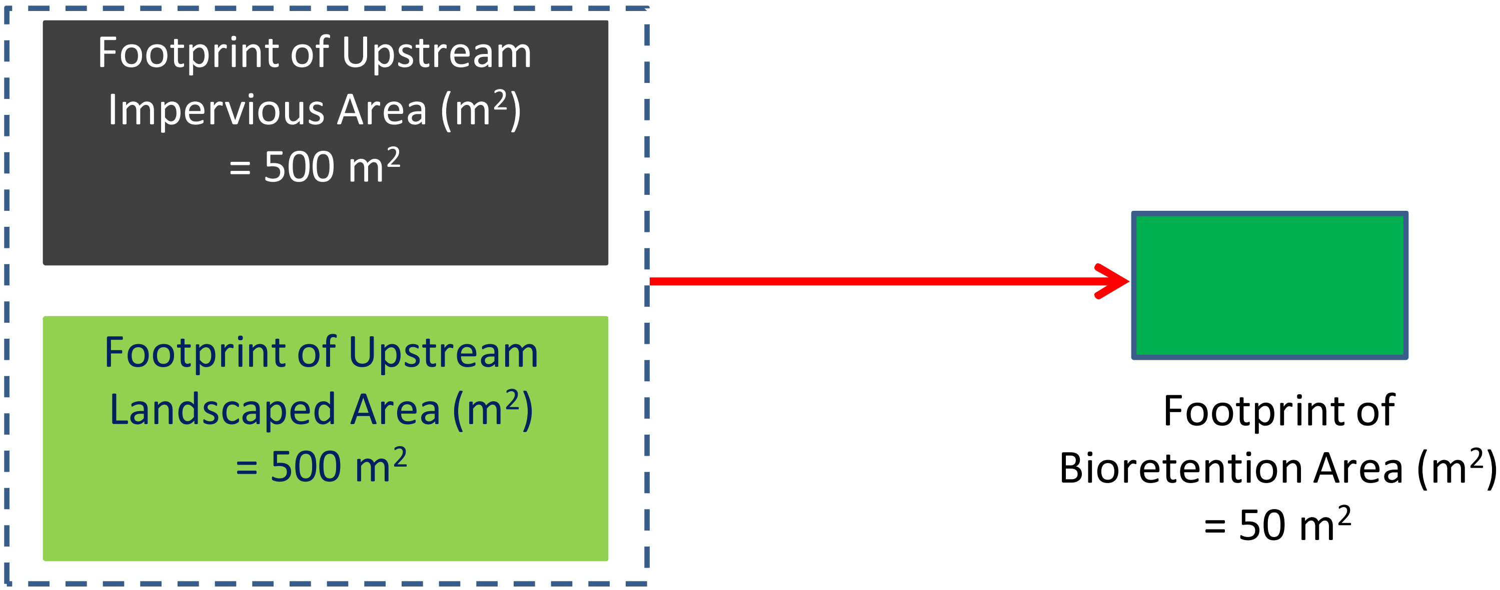
Remember what the I/P ratio stands for?



The larger the I/P ratio, the greater the volumes of runoff and sediment loadings directed to the bioretention area

If P = 50 m^2 and I/P = 10, then I = 500 m^2

What is then the total area draining to the bioretention area?



For an overall imperviousness ratio of 50%, the size of the upstream landscaped area = size of upstream impervious area = 500 m^2 for a total upstream area of 1,000 m^2

Loadings for Ultimate Conditions

- In Calgary ~ 400 mm average annual precipitation
- 50% imperviousness of which half drains into absorbent landscaping
  - 25% of lots generate 300 mm of runoff per year
  - 75% of lots generate 50 mm of runoff per year
- Per hectare, this yields
  - 1,125 m^3 of runoff per year; and
  - at 150 mg/L (= 0.150 kg/m^3), 170 kg/year of sediment
- The 50 m^2 bioretention area annually receives
  - runoff from 0.10 ha or 112.5 m^3 with
  - 17 kg of sediment,
  - which equates to **0.34** kg/m^2
- The "servicing time" would then be 5 kg/m^2 divided by 0.34 kg/m^2/ha = **15** years

Loadings during Stripping & Grading Phase

- In Calgary: 400 mm average annual precipitation
- Assume average annual runoff of 100 mm
- Per hectare, this yields
  - 1,000 m^3 of runoff per year; and
  - at 2 tonnes/ha/year, 2,000 kg/year of sediment
- The 50 m^2 bioretention area annually receives
  - runoff from 0.10 ha or 100 m^3 with
  - 200 kg of sediment,
  - which equates to **4.0** kg/m^2
- The "servicing time" would then be 5 kg/m^2 divided by 4.0 kg/m^2/ha = **1.25** years

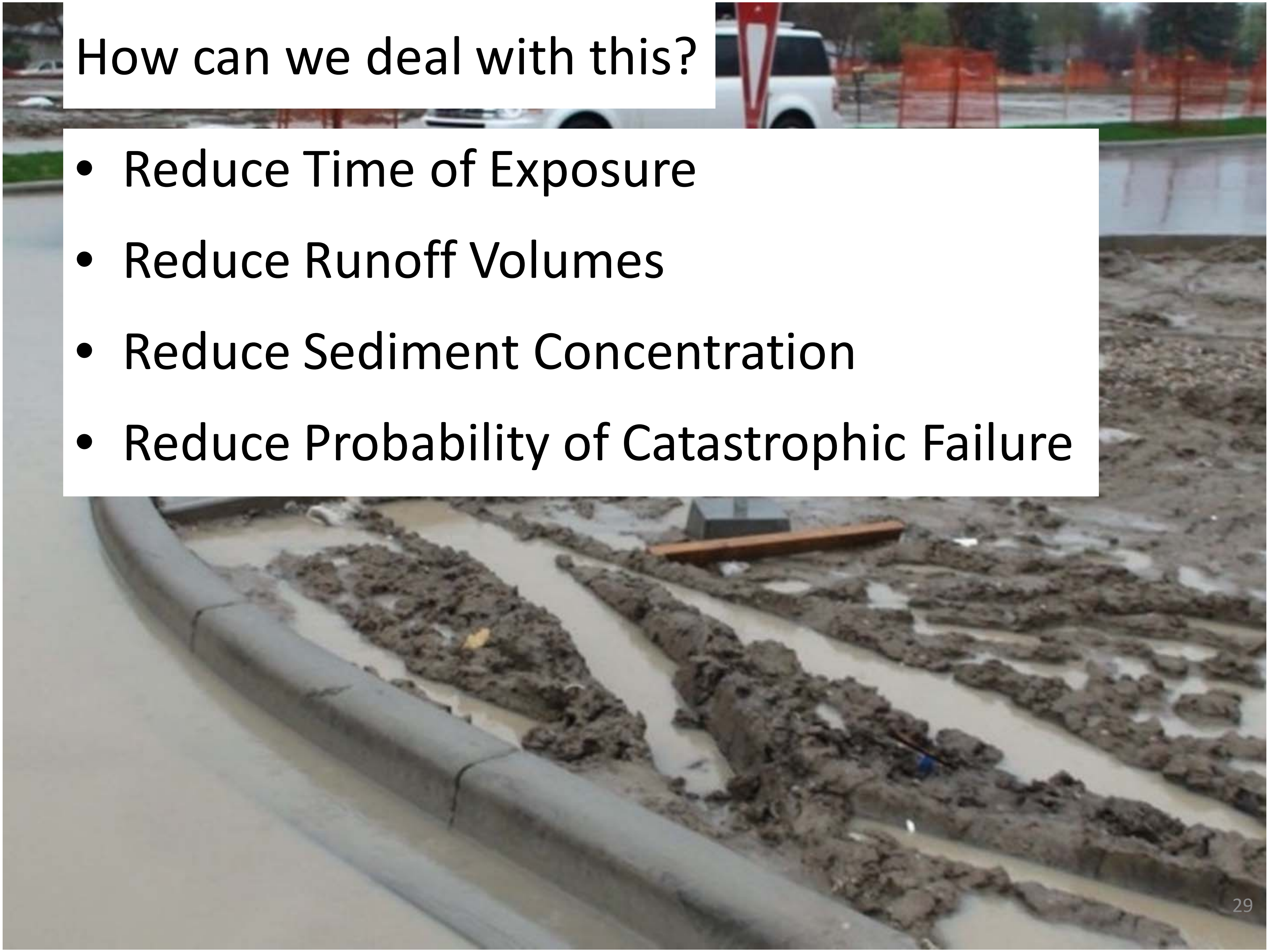
Loadings for Home Construction Phase

- In Calgary: 400 mm average annual precipitation
- 50% imperviousness
  - 50% of lots generate 300 mm of runoff per year
  - 50% of lots generate 100 mm of runoff per year
- Per hectare, this yields
  - 2,000 m^3 of runoff per year; and
  - at 2,000 mg/L (= 2.0 kg/m^3), 4,000 kg/year of sediment
- The 50 m^2 bioretention area annually receives
  - runoff from 0.10 ha or 200 m^3 with
  - 400 kg of sediment,
  - which equates to **8.0** kg/m^2
- The "servicing time" would then be 5 kg/m^2 divided by 8.0 kg/m^2/ha = << **1** years

Should we then be surprised to see this?

How can we deal with this?

- Reduce Time of Exposure
- Reduce Runoff Volumes
- Reduce Sediment Concentration
- Reduce Probability of Catastrophic Failure



Some challenges are inherent to our design …

- Design for more severe conditions when dealing with sensitive downstream areas:

BTW – these might also be our downstream ponds and wetlands. We have a lot of problems with excessive sediment loadings into ponds and wetlands

Why? Let's look some more at how well we do: some observations in the field

and within a subdivision

Who remotely thought that this is acceptable?

more observations in the field

and more observations in the field

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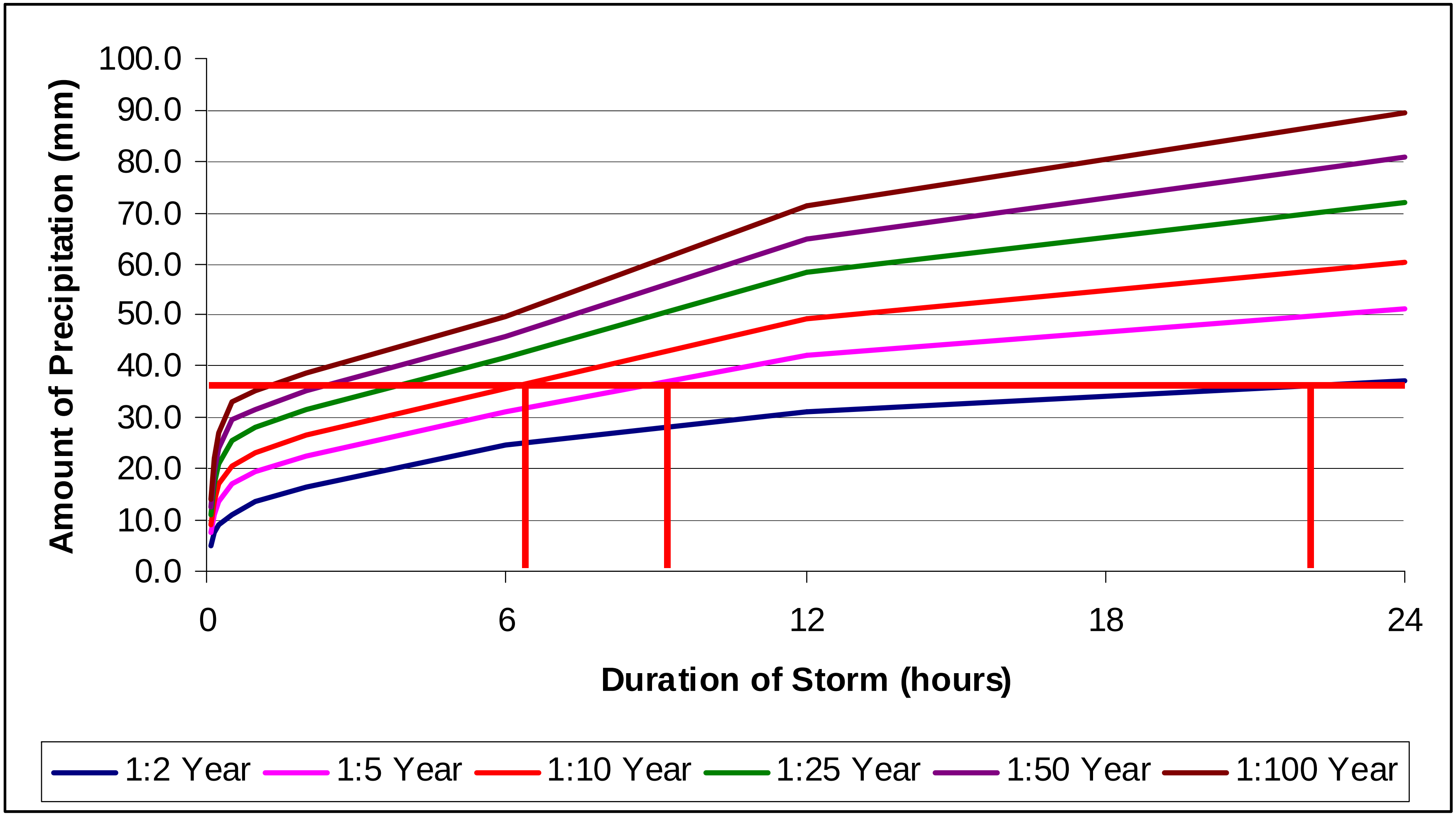
Millions of dollars were spent cleaning out this wetland

Some challenges are inherent to our design …

- Design for more severe conditions when dealing with sensitive downstream areas:
  - look at the risk of any sedimentation basins being overtopped
  - In Calgary, capacity of 150 to 250 m^3/ha

The same amount of runoff is generated by …



50% 20% 10% Probability of Overtopping

Some challenges are inherent to our design …

- Design for more severe conditions when dealing with sensitive downstream areas:
  - look at the risk of any sedimentation basins being overtopped
  - In Calgary, capacity of 150 to 250 m^3/ha
  - This corresponds to the runoff generated by a
    - 2 to 6 hour, 1:10 year event, or
    - 6 to 21 hour, 1:2 year event
  - Should we store more, reflecting how long it might take to empty the basin?

So, where are the challenges?

Design:

- we don’t know how appropriate our assumptions are re amount of sediment produced
- RUSLE does not apply for the home construction phase
- we practice sediment rather than erosion control
- no risk assessment of sensitivity of downstream areas

So, where are the challenges?

- Execution
  - poor at maintenance & poor at record keeping
  - poor at ESC during home construction phase
  - ESC does not stop when the weather turns cold

So, where are the challenges?

- Approvals & Enforcement
  - disconnect between ESC and drainage reviews
  - don't have manpower to be everywhere
  - don't force developers, builders, and/or property owners to re-vegetate in time

- Maybe, we should consider changing or evolving design philosophy

Suggested changes in design philosophy

- Reduce the amount of land stripped and graded
- Practice erosion control
- Reduce runoff volumes

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Suggested changes in design philosophy

- Stay outside of sensitive areas
- Avoid runoff from entering sensitive areas
- Consider failure scenarios

We have to keep in mind that bioretention areas are right away part of the drainage system

Courtesy: David Seeliger, MPE Engineering Ltd.

Use of sacrificial areas and physical protection measures has proven to be effective

Focus needed on builders and trades:

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with better communications among all parties

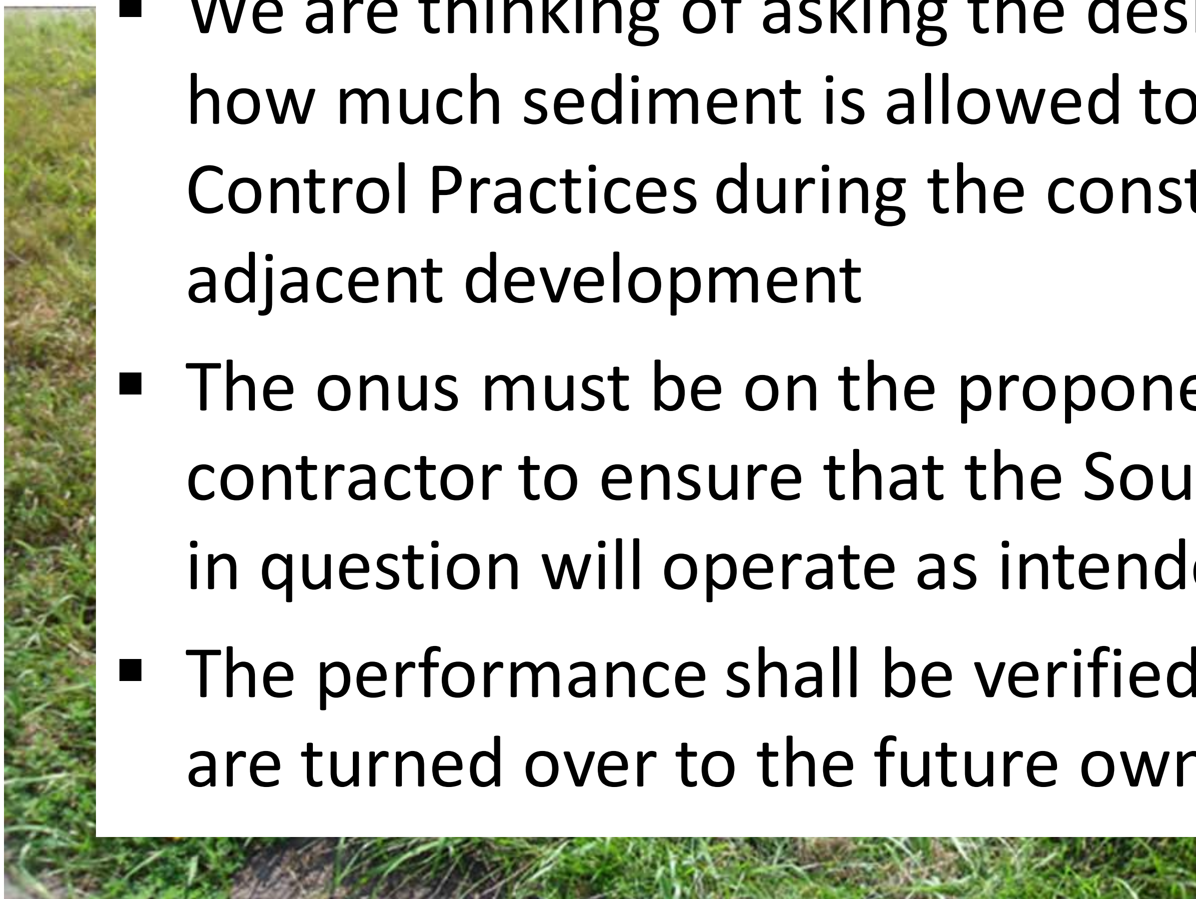
For example, the City of Calgary Water Resources is moving on the following:

- Performance Verification Testing
- Training
- LID design guidelines, standards, specifications
- ESC for LID fact sheets
- Policy and bylaw development
- Ongoing communications with industry …

- But, in the meantime, have your LID designers communicate with your field staff

Performance Verification Testing:

- We are thinking of asking the designer to quantify how much sediment is allowed to enter Source Control Practices during the construction period of adjacent development
- The onus must be on the proponent , consultant and contractor to ensure that the Source Control Practice in question will operate as intended
- The performance shall be verified before the features are turned over to the future owner



Pictures courtesy of http://stormwater.safl.umn.edu/

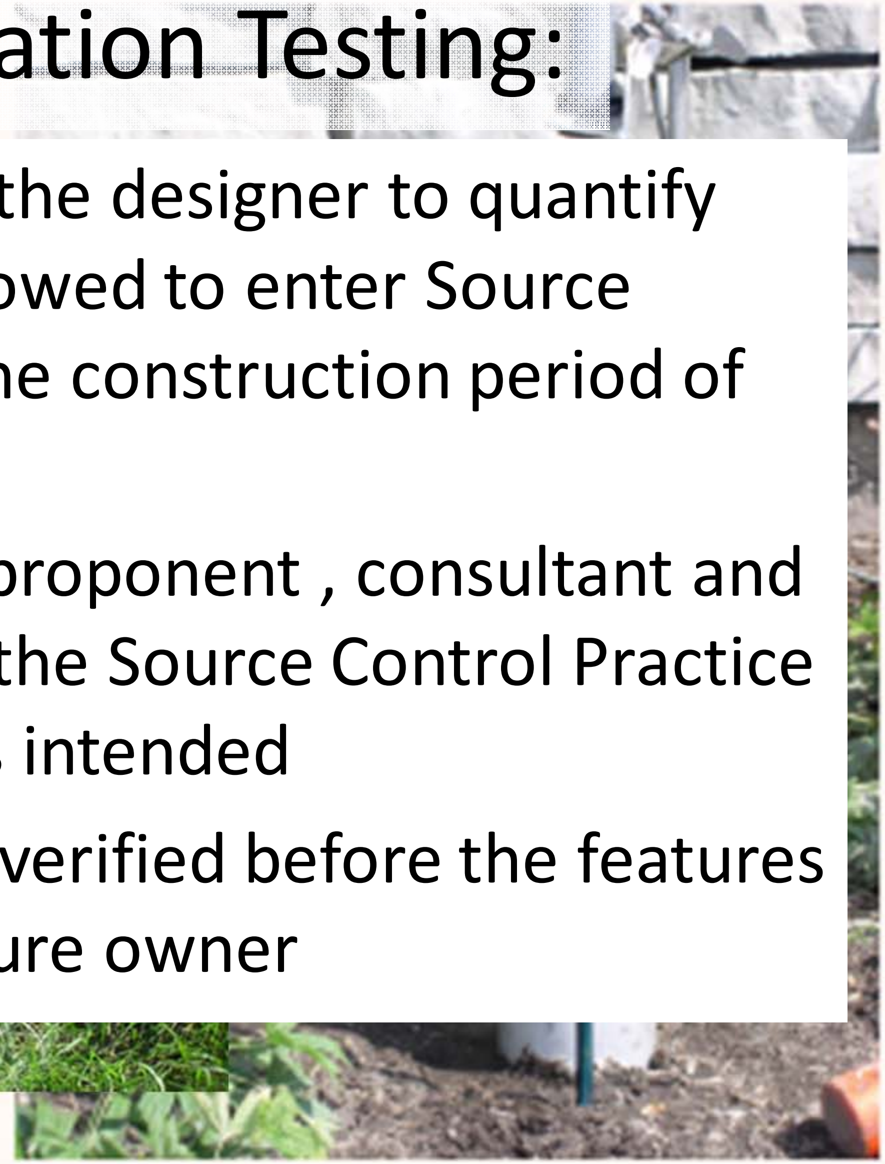


Figure 3.3: Permeability testing with a Modified Philip-Dunne Permeameter in St. Paul, MN.

Training:

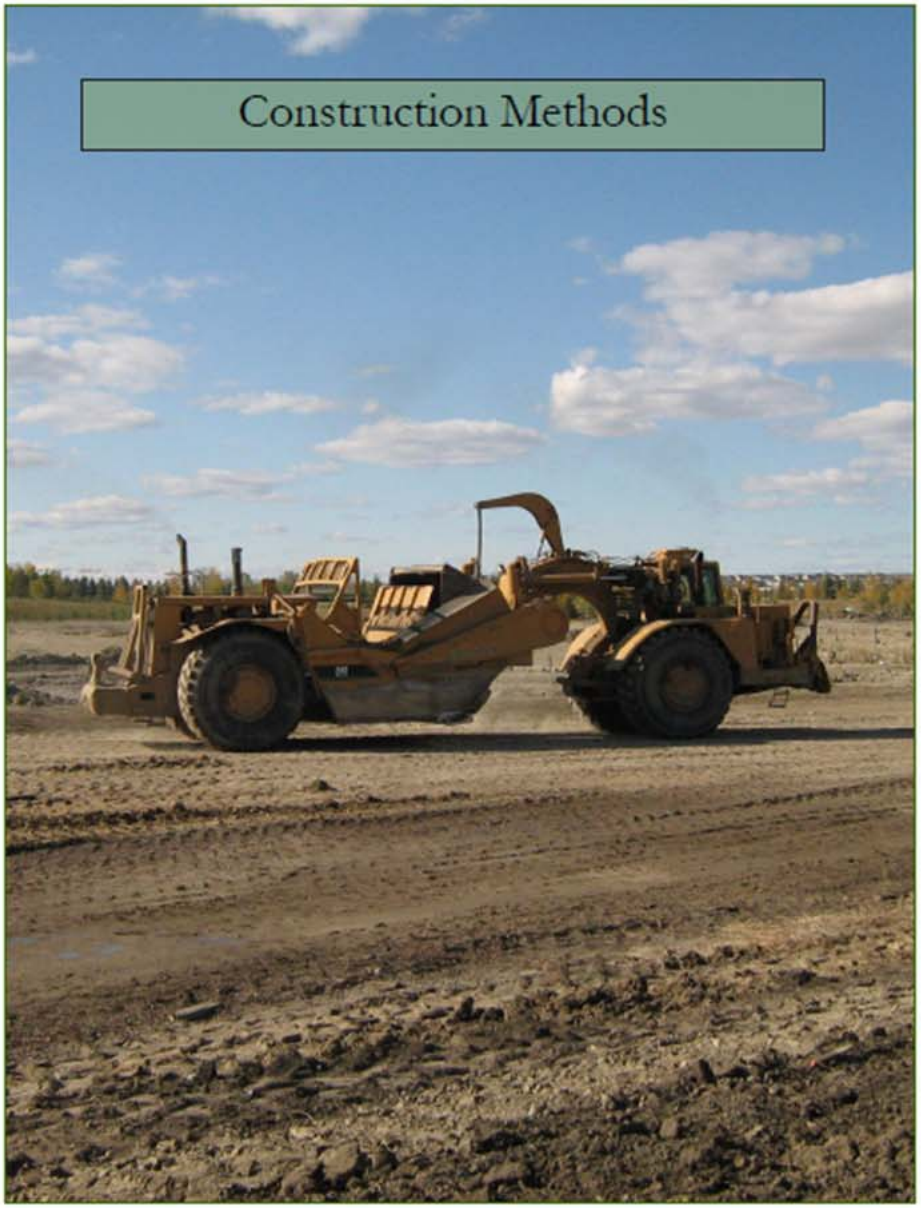
- Stormwater management is still an evolving field. Therefore, level of training offered by colleges and universities, and professional organizations has been found to be insufficient
- Erosion & Sediment Control courses have been offered since 2001, including CPESC exams
- Program has been expanded over time with stormwater management and LID courses
- In 2012 specific “ESC for LID” course

LID design guidelines, standards and specifications:

- Geotechnical and Hydrogeological Considerations
- Vegetative and Absorptive Practices:
  - (a) Bioretention/Biofiltration areas, Bioswales;
  - (b) Absorbent Landscaping;
  - (c) Suspended Pavement Structures
- Green Roof Systems
- Stormwater Capture and Re-use
- Rainwater Harvesting and
- Permeable Pavement Structures

- ESC requirements are very much a consideration in construction guidance!

ESC for LID fact sheets



Policy and bylaw development:

- Potential approaches:
  - Developer(s) responsible for removal of sediment in excess of ESC targets, up to completion of development
  - Implementation of landscape bylaw requiring timely landscaping of lots
  - Temporary relaxation of Drainage Bylaw requiring that downspouts need to discharge at least 2 m from the property line

Some early success stories …


and …

- Last message: our consultants are still looking for fresh blood! The “Go West, Young Man” adagium still applies in their mind.
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  - Senior Development Engineer
  - Water Resources, Infrastructure Planning, Development Approvals
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  - bert.vanduin@calgary.ca

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