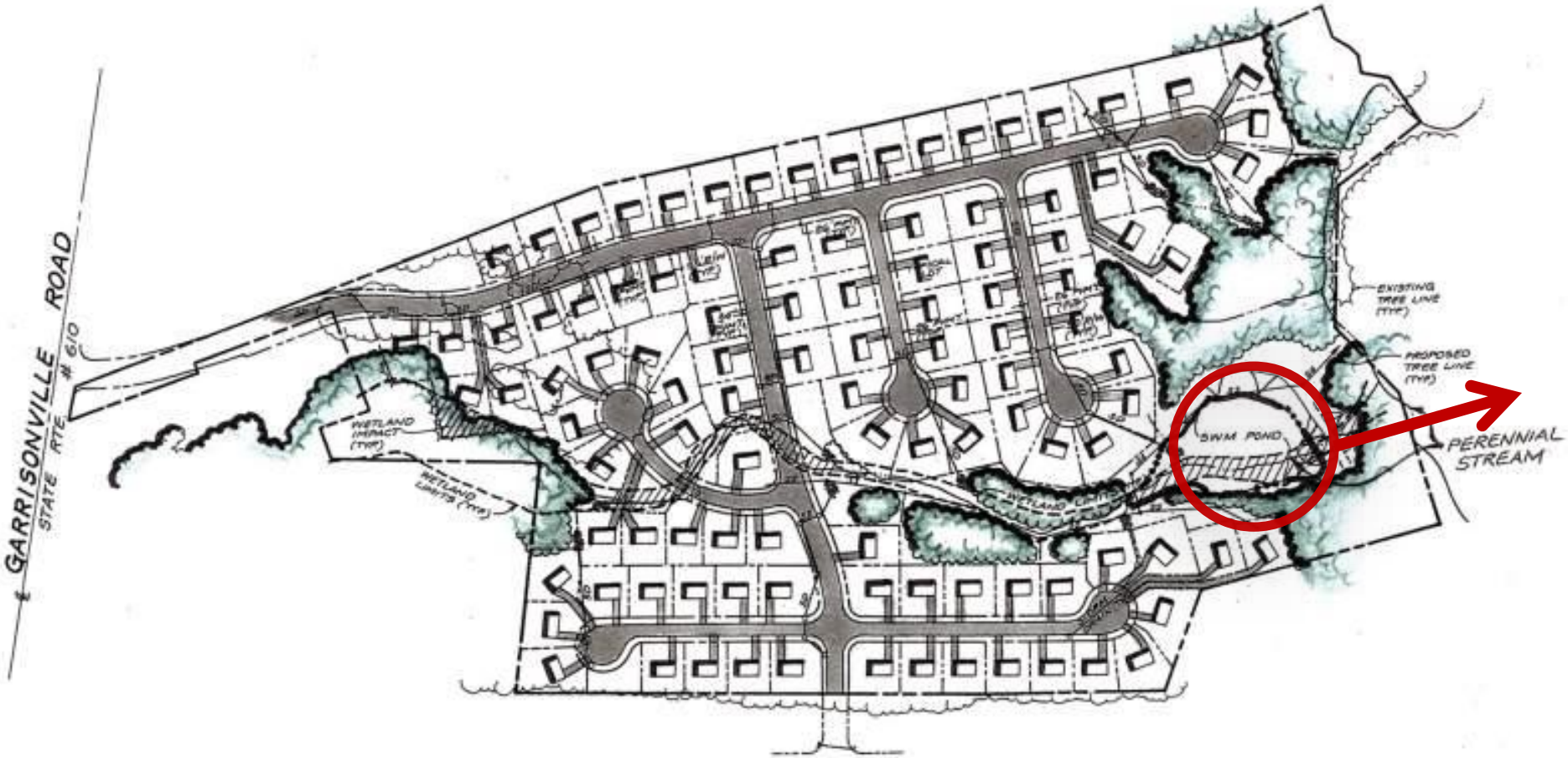
Maintenance Matters Now ! The Changing World of BMP Inspection

MS4 Maintenance Requirements, Legacy BMPs, BMP Verification and the Bay TMDL

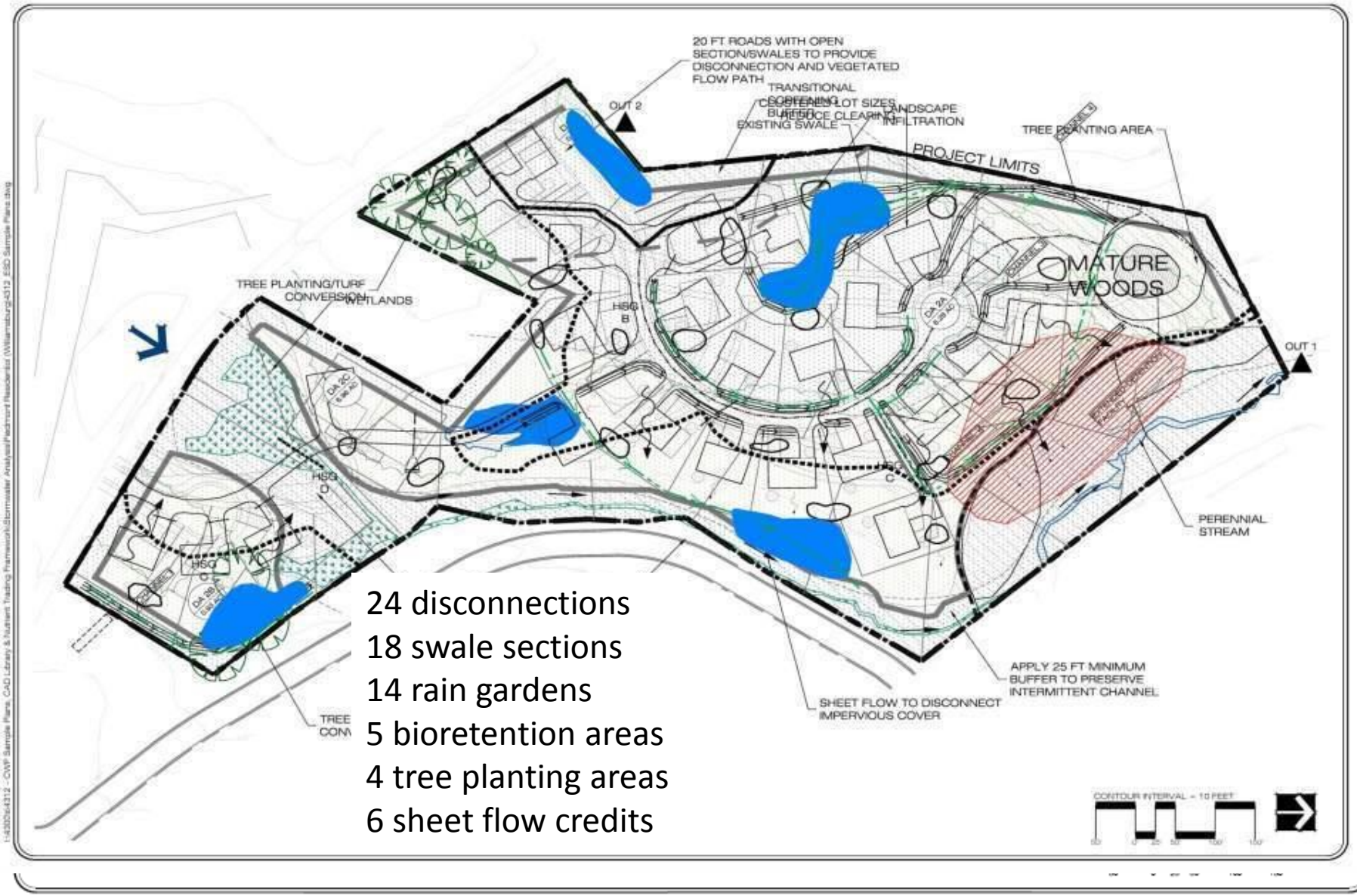
BMP Performance Is Inextricably Linked To Maintenance (which is not very sexy)

The Old BMP Inspection Model Has to Be Modified

One big pond



The New “Many-BMP” Maintenance Model

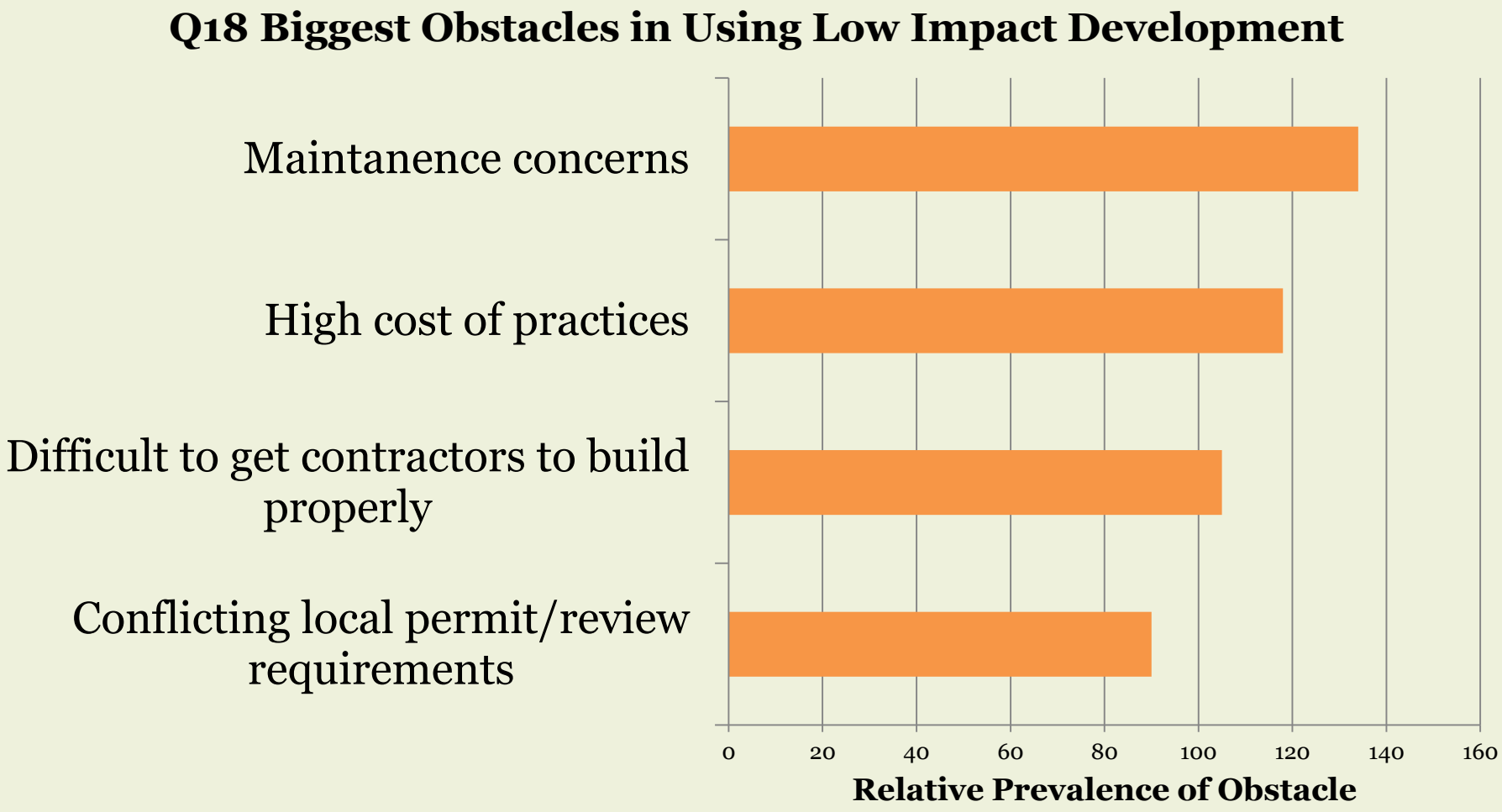


24 disconnections
18 swale sections
14 rain gardens
5 bioretention areas
4 tree planting areas
6 sheet flow credits

The Challenge We Face

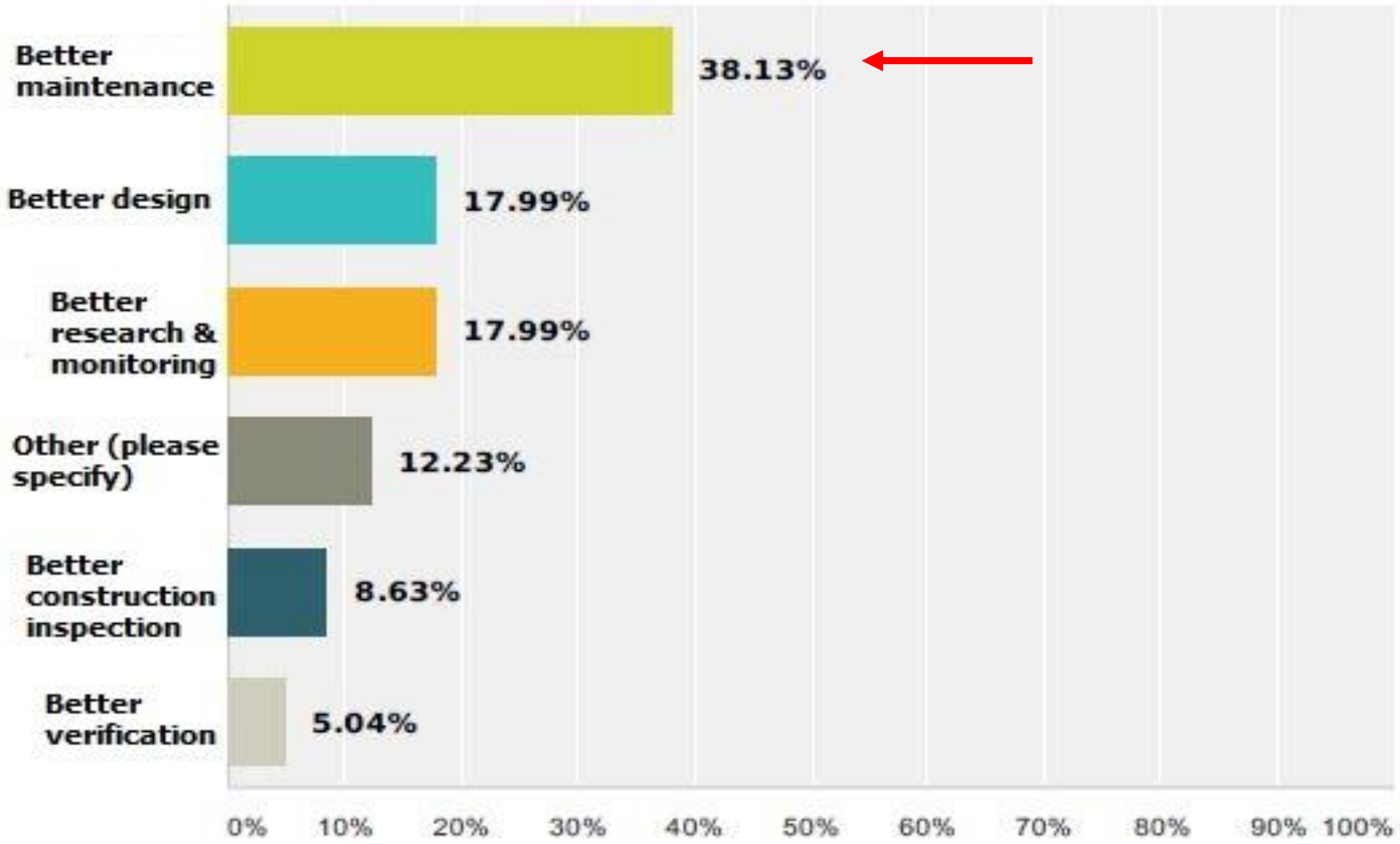
- A lot more practices to deal with
- More prescriptive MS4 requirements for ongoing maintenance inspection
- New BMP reporting, tracking and reporting requirements for TMDL
- Limited staff resources

2014 CSN Network Survey



Q19 Where do you feel the biggest water quality improvements can be achieved in the future with stormwater BMPs?

Answered: 139 Skipped: 105



How to inspect our Legacy BMPs ?

Thirty Years of BMPs. The BMP Inventory in a Maryland County (2006)			
Potentially High Performers		*Known Low Performers*	
Bioretention/Dry Swales	49	Underground Detention	270
Sand Filters	279	Dry Ponds	528
Wet pond	212	Oil Grit Separators	805
Pond Wetland	98	Proprietary Practices	239
Infiltration Basin	58	Flow Splitter	321
Infiltration Trench	459	Other (plunge pools)	30
		Grand Total	**3350**

Higher Public Expectations

- New stormwater fees
- Higher level of service expected, but has not really been defined
- Limited homeowner knowledge about purpose of stormwater practices
- Public notices nuisances, not performance
- Public education and outreach

The Bay Pollution Diet

Urban BMP Verification

- BMP Verification a priority for all sectors in the Chesapeake Bay Program
- Urban Stormwater Workgroup adopted its verification protocol in February 2014
- States will implement them thru their existing MS4 BMP reporting efforts

Performance Verification

Ensure BMP still exists and is providing the pollutant removal it was designed to achieve or if it requires major restoration

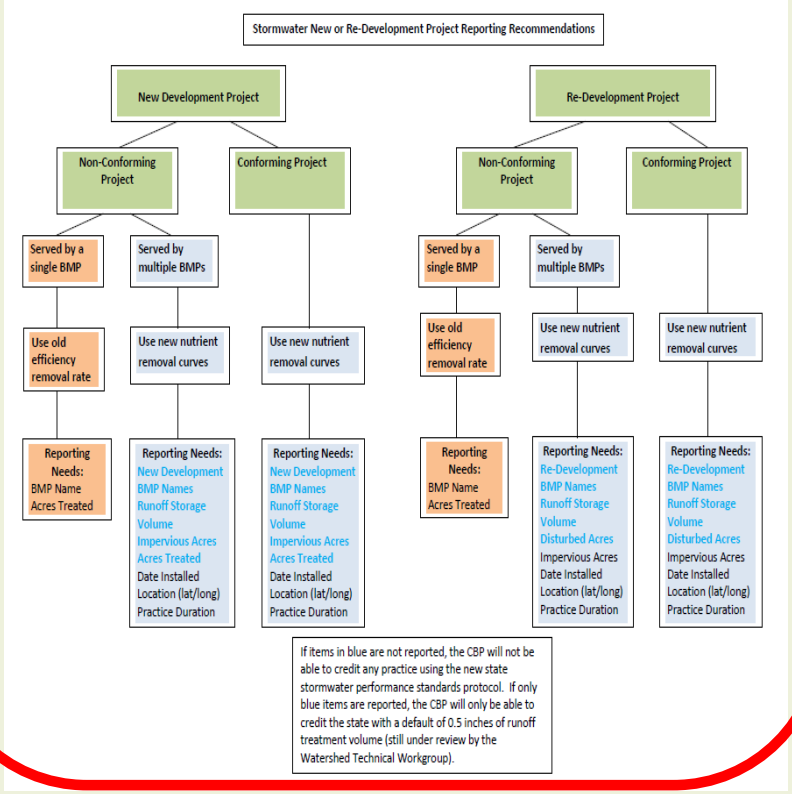
MS-4 Permit/ Bay TMDL

Once every 9 -10 years

Trained evaluator

Facility BMP Inventory

State BMP Reporting for Bay TMDL



Each BMP has unique items that must be reported to get credit in the TMDL

Requires that MS4s and the 7 states have a tracking capability for individual BMPs

BMPs have a fixed duration for credit, which can only be extended based on field verification

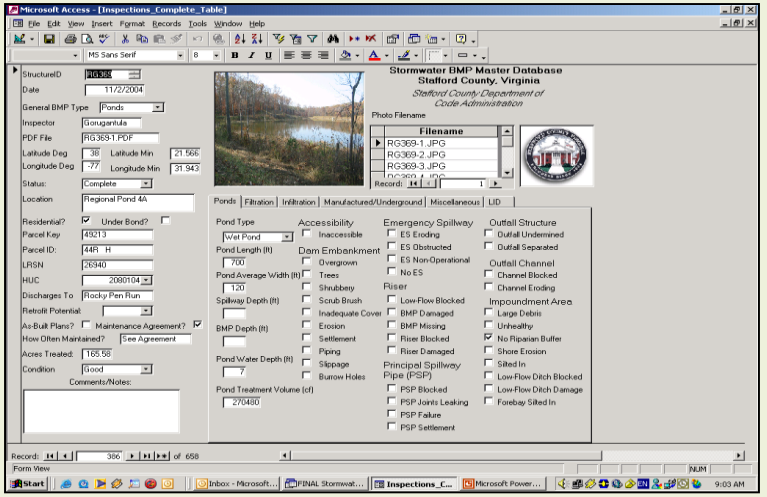
New requirements are expected increase total inspector workload

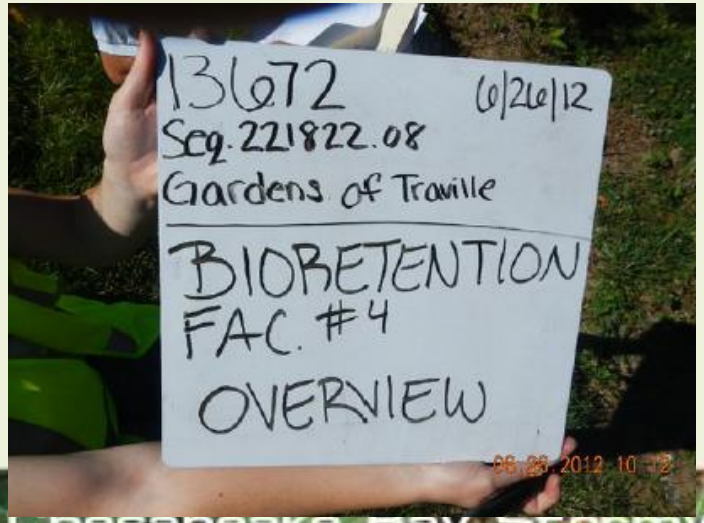
- MS4 requirements to inspect local BMPs
- Need to evaluate older BMPs for retrofit potential
- CBP TMDL BMP performance verification
- Shift to more distributed LID practices as stormwater regs are implemented
- Need for tighter inspection during practice construction
- Forensic BMP investigations to fix failed BMPs
- Verifying Homeowner BMPs

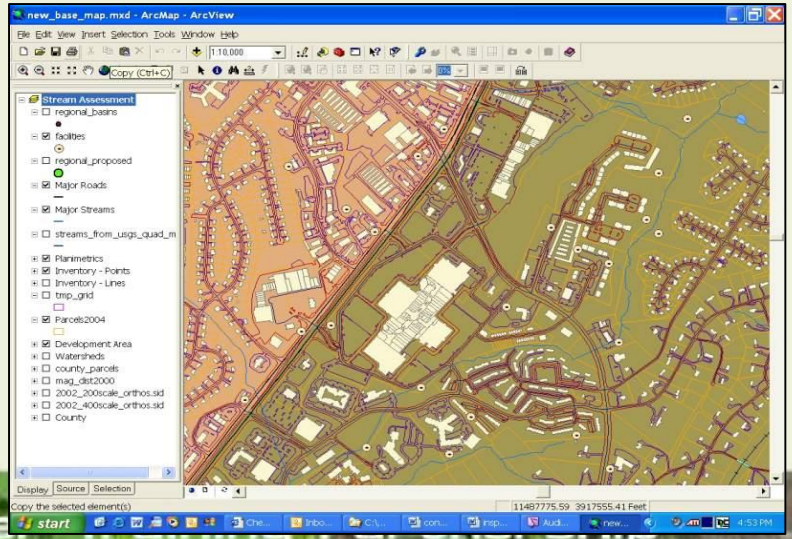
Need to sharply reduce the time for most routine inspections

- Use rapid visual indicators
- Dump the long checklists
- Pass the good facilities quickly and move on
- Flag the bad or failing practices for a more intensive investigation

Need to integrate technology throughout each step of the inspection process







Expand the Inspection Work Force

- Summer BMP field crews
- Landscape maintenance crews
- Erosion and sediment control inspectors
- Third party or private sector inspection
- Homeowner BMP auditors
- Self-reporting inspections for some BMPs
- Forensic BMP investigators and project cost estimators

While enforcement is an essential backstop, most problems stem from owner ignorance

Most of the owners you will be dealing with won't have much understanding of:

- What and where the practices are
- Why they are needed
- How they function
- How they should be maintained

Think of yourself as a stormwater extension agent!

The Visual Indicators Approach to Inspecting and Maintaining Stormwater BMPs

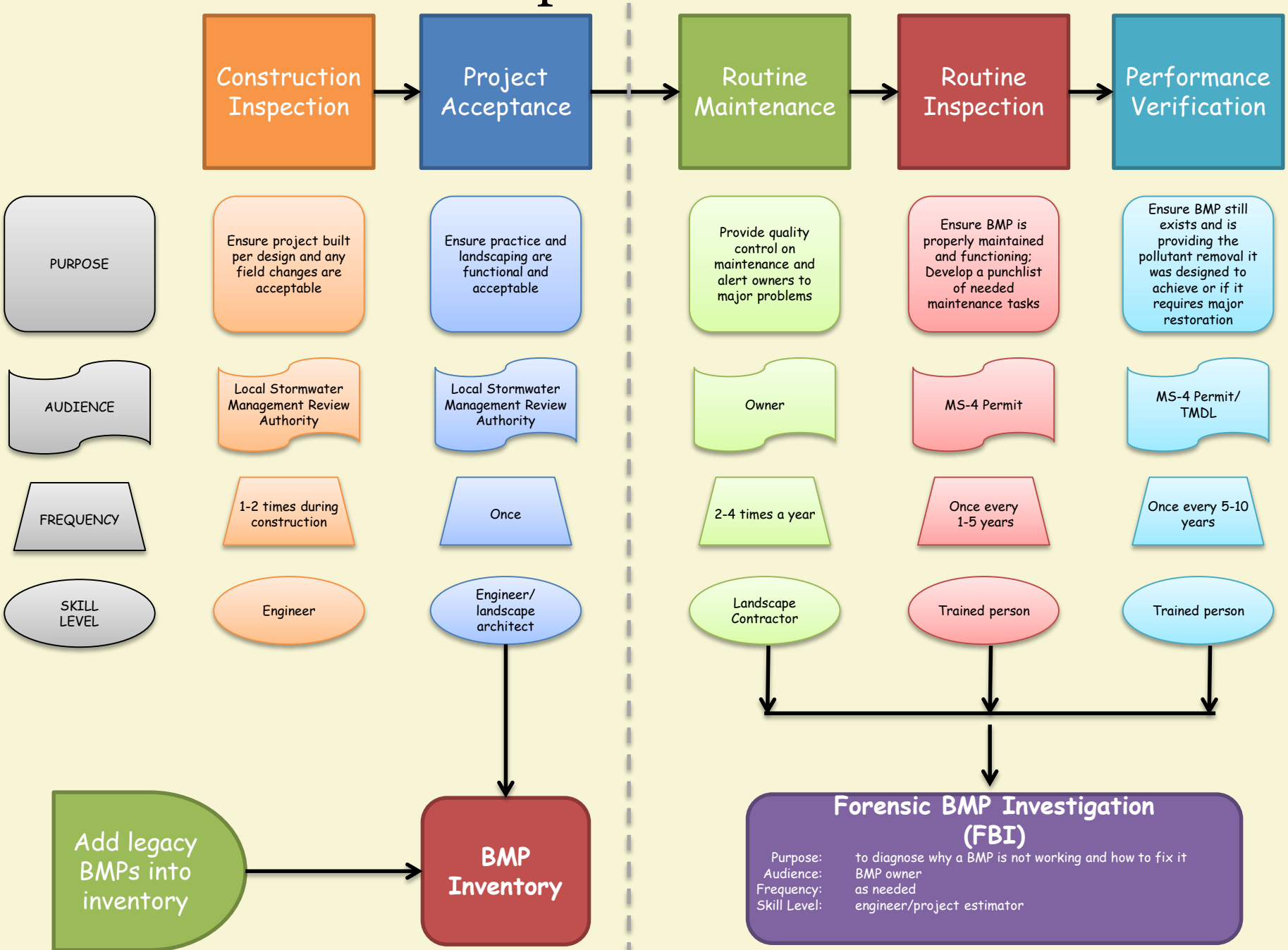
Session Agenda

1. Why Maintenance Matters
2. The Visual Indicators Approach
3. Case-study: Bioretention
    1. Regular Maintenance Inspections and Repair
    2. Forensic BMP Investigations
4. Visual Indicators for Other Practices
    1. Infiltration
    2. Wet Ponds/Wetlands

Visual Indicator Approach

- Use of simple visual indicators in order to conduct rapid investigations of BMPs
- Employing this approach during routine maintenance, inspections and performance verifications
- Results in a punch list of actions to be taken to maintain functionality of the BMP
- More severe cases trigger a more in depth investigation into the problem

Visual Inspection Framework



Visual Indicators

Goal: To evaluate the stormwater BMP in 10 minutes or less

How: Follow a prescribed sequence to assess the performance and functionality of BMP by using numeric triggers to grade each visual indicator from score of Pass, Minor, Moderate or Severe

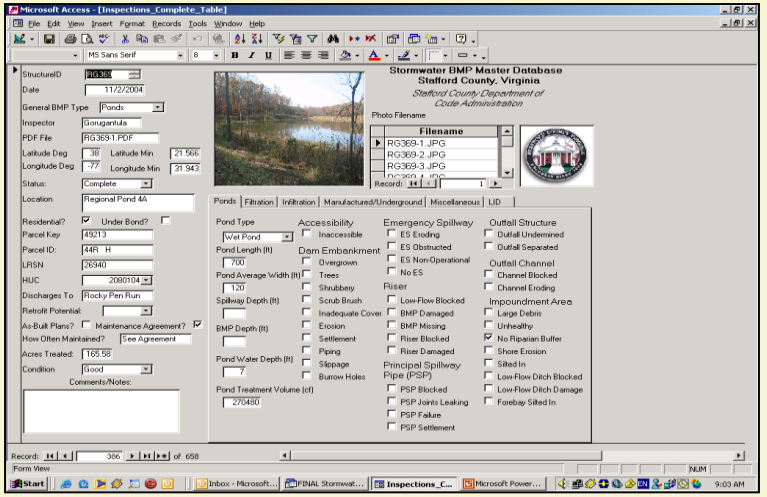
Result: Use of a tablet tool to develop a punch-list of tasks to follow-up on to bring the BMP up to speed

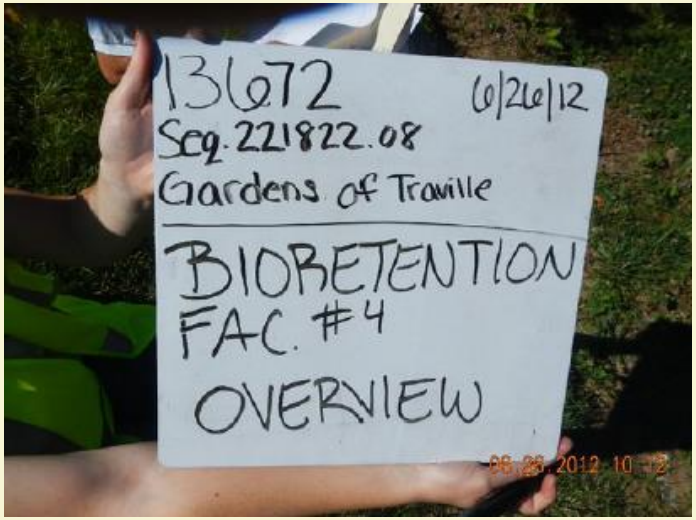
Limit the use of expensive engineer time for the limited inspections where the are really needed

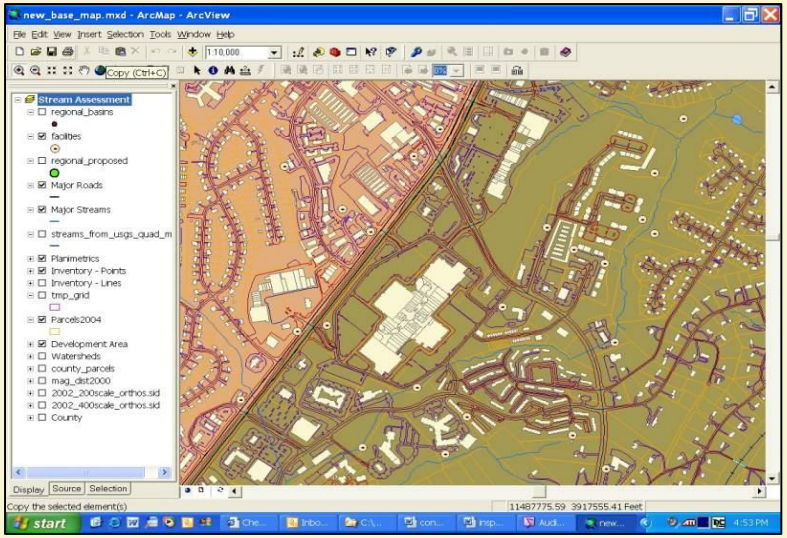
Need to sharply reduce the time for most routine inspections

- Use rapid visual indicators
- Dump the long checklists
- Pass the good facilities quickly and move on
- Flag the bad or failing practices for a more intensive investigation

Need to integrate technology throughout each step of the inspection process

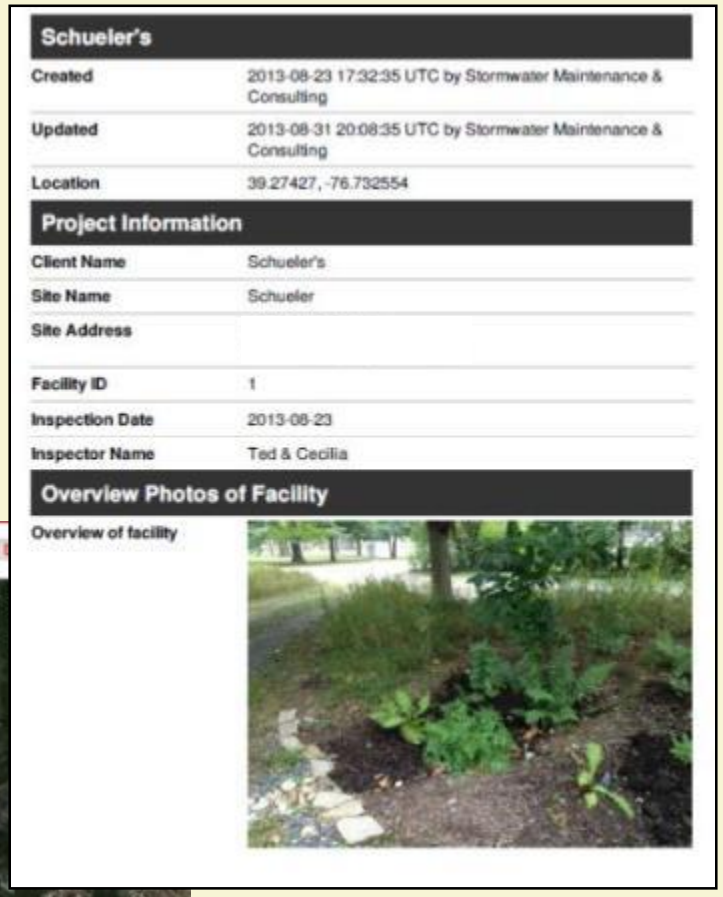






Inspection App

- Online tracking
- Upload photos directly from phone/tablet
- Creates PDF report
- Available for trial period



Schueler's	
Created	2013-08-23 17:32:35 UTC by Stormwater Maintenance & Consulting
Updated	2013-08-31 20:08:35 UTC by Stormwater Maintenance & Consulting
Location	39.27427, -76.732554
Project Information	
Client Name	Schueler's
Site Name	Schueler
Site Address	
Facility ID	1
Inspection Date	2013-08-23
Inspector Name	Ted & Cecilia
Overview Photos of Facility	
Overview of facility	

http://fulcrumapp.com/apps/bioretention-illustrated/

2: Visual Indicator Approach

Routine Regulatory Inspection

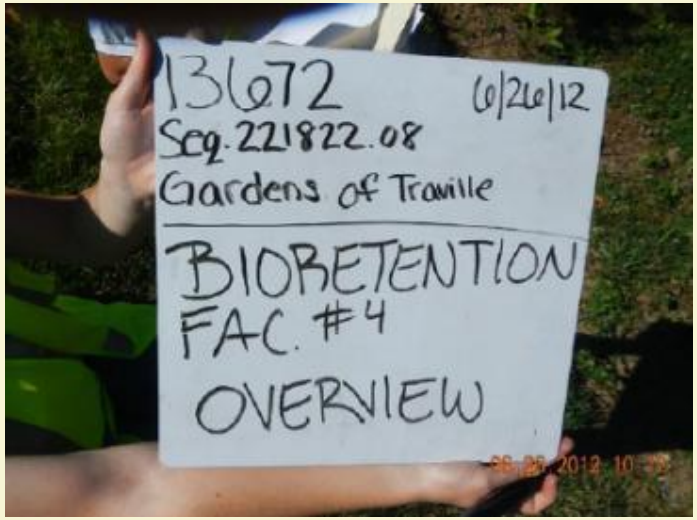
PURPOSE	Ensure BMP is properly maintained and functioning; Develop a punch list of needed maintenance tasks
AUTHORITY	MS-4 Permit
FREQUENCY	Once ever 1-5 years
SKILL LEVEL	Trained person

Tool:
Visual Indicators

NOTE:
Method should be used to quickly evaluate practice during each routine maintenance visit as well

Field Investigations

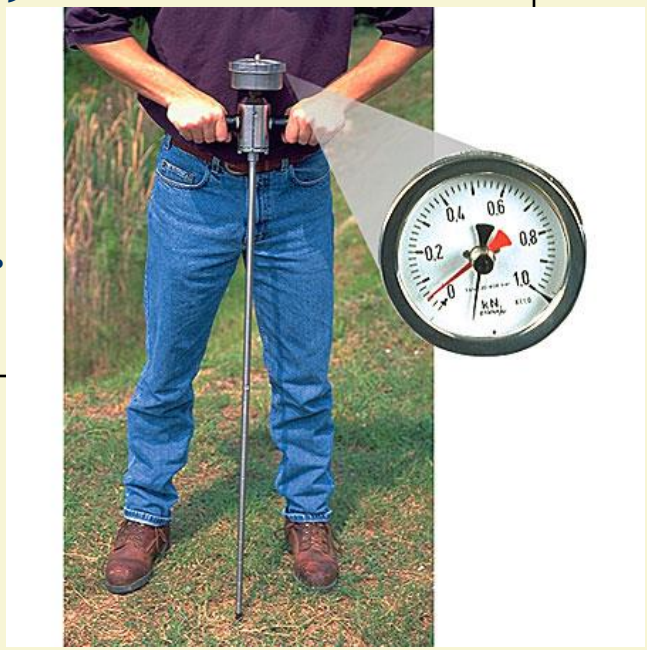
- Take photos, measurements, notes
- Use of a dry erase board and a camera to rapidly document the inspection and note observations on a tablet
- Carry simple tools to inspect facilities from ground surface and perform minor maintenance tasks



Equipment

Equipment

- White board
- Manhole pick
- Digital Camera
- Dip-sticks (sediment)
- Tablet/smart phone with app
- Various tools for opening observation wells (wrenches etc.)
- Shovel, rake
- Measuring tape
- Soil auger
- Plant ID sheet
- Authorization letter



Optional items:

- As-builts/site plans
- Safety vests
- Bug spray
- Flashlight
- Six pack of beer

Using Bioretention as a Case Study…

Warning !

This may be the last pretty bioretention area you see for the next 90 minutes

Bioretention

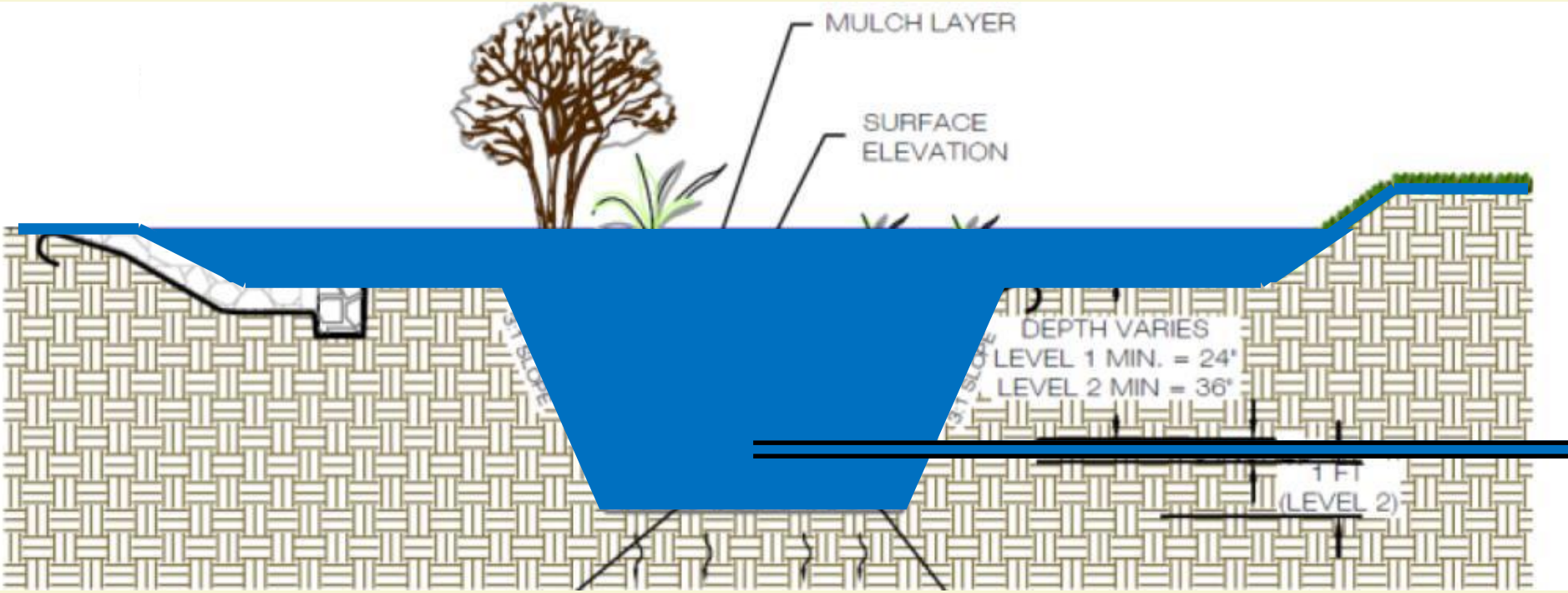
Bioretention

Water Quality Swale

Urban Bioretention

Residential Rain Garden

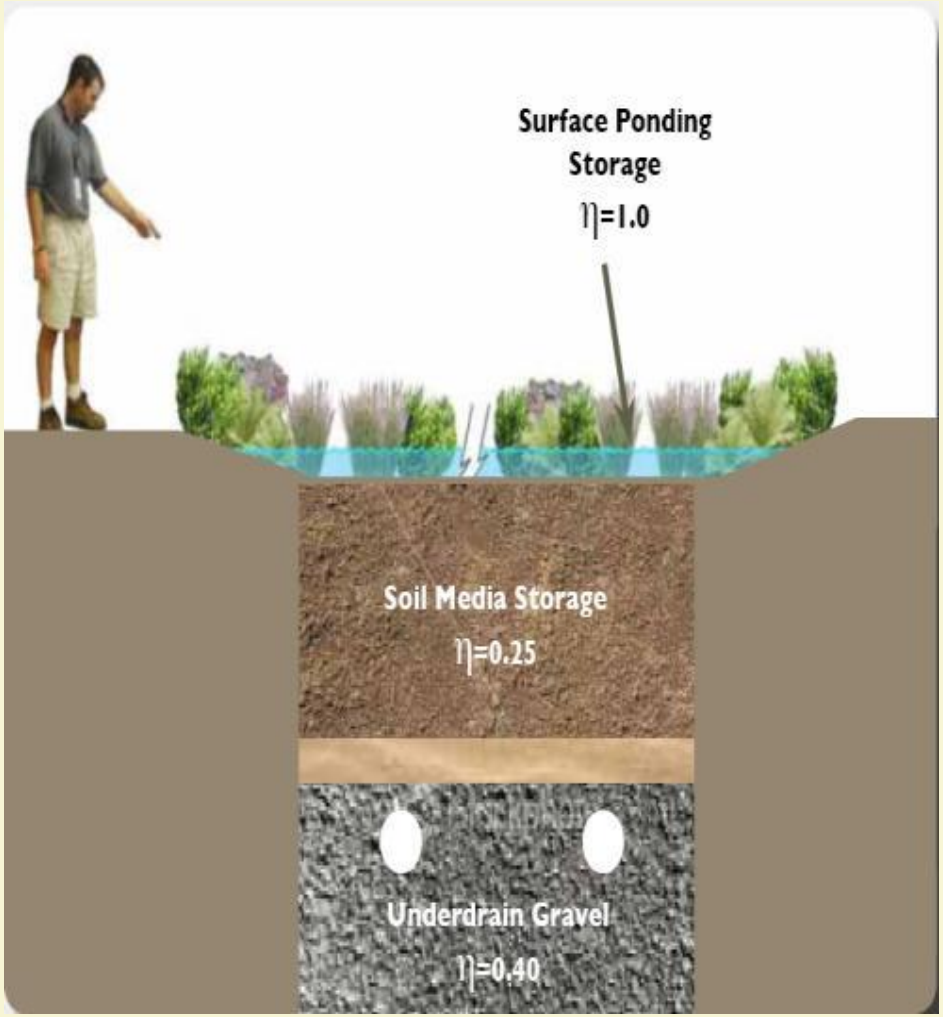
Bioretention: How it Works



Runoff flows into a bioretention facility and temporarily ponds. Water then slowly filters through the filter bed and either is collected by the underdrain and sent to the storm sewer system or infiltrates into the surrounding area.

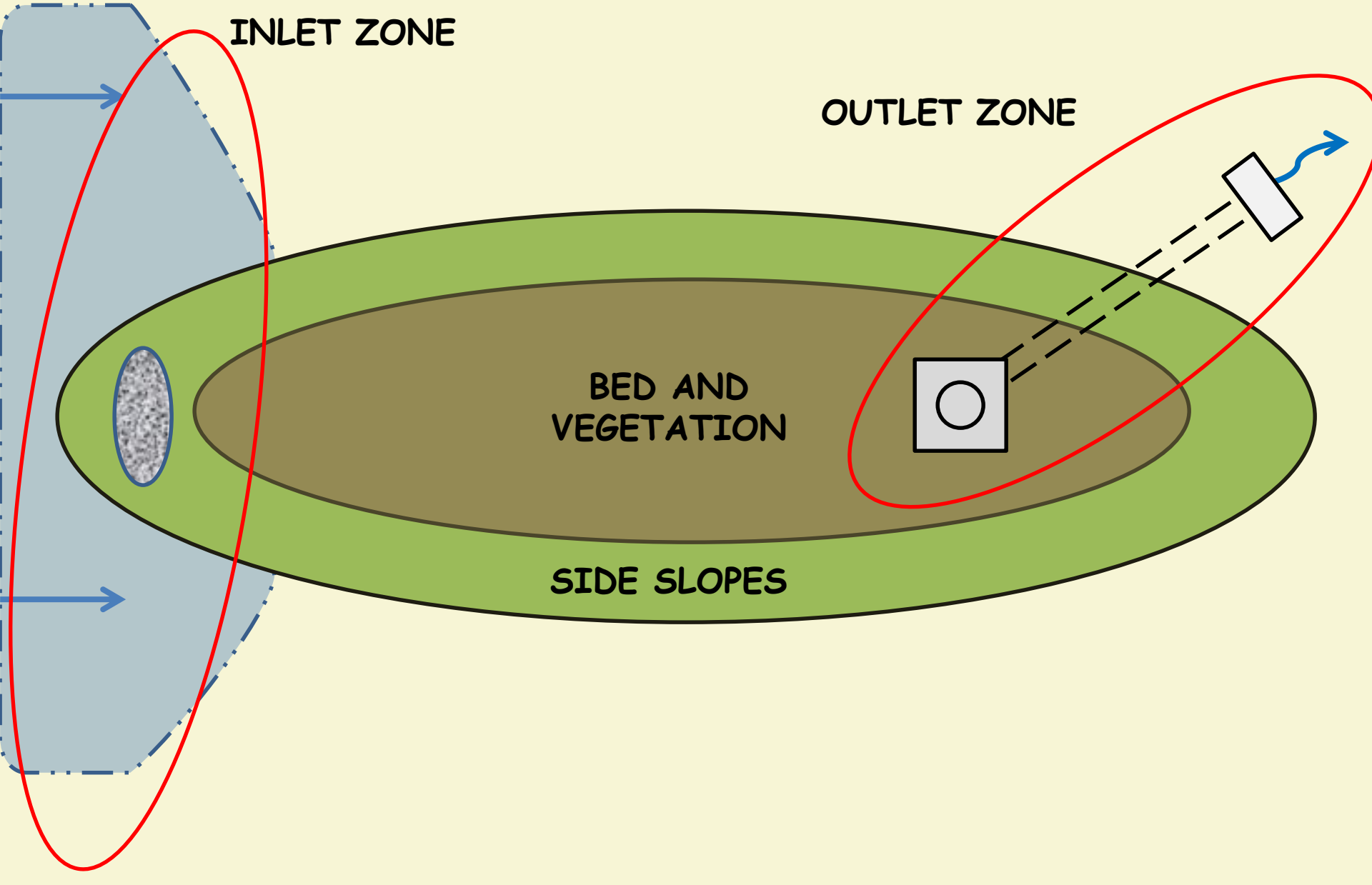
Key Parts of Bioretention

- Ponding area
- Filter media
- Pea gravel
- Overflow
- Vegetation
- Optional:
  - Underdrain + stone
  - Infiltration sump



Visual Indicator Approach for Bioretention

Bioretention from above



Visual Indicators Sequence

No.	Zone	INDICATOR	
1	Inlet	Inlet Obstruction	
2	Inlet	Erosion at Inlet	INLET ZONE
3	Inlet	Pretreatment	
4	Inlet	Structural Integrity, Safety Features	
5	Perimeter	Surface Area	
6	Perimeter	Side slope Erosion	PERIMETER ZONE
7	Perimeter	Ponding Volume	
8	Bed	Bed Sinking	
9	Bed	Sediment Caking	
10	Bed	Standing Water	
11	Bed	Ponding Depth	BED ZONE
12	Bed	Mulch Depth/Condition	
13	Bed	Trash	
14	Bed	Bed Erosion	
15	Vegetation	Vegetative Cover	
16	Vegetation	Vegetative Condition	VEGETATION ZONE
17	Vegetation	Vegetative Maintenance	
18	Outlet	Outlets, Underdrains, Overflows	OUTLET ZONE

Forensic BMP Investigation
FBI

Purpose: to diagnose why a BMP is not working and how to fix it

Audience: BMP owner

Frequency: as warranted by field inspection

Skill Level: engineer/project estimator

Indicate what needs to be checked by private BMP owner in a letter on non-compliance

#1

Inlet Obstruction

INLET ZONE

Good condition

Remove sediment, debris

Removal of sediment, obstruction

Sediment staining = entry problem

#1

Severe Inlet Obstruction

Severe accumulation of sediment, debris

Locate source, mitigate
Evaluate the need for enhanced pretreatment
Design remediation

#2

Erosion @ the Inlet

INLET ZONE

Good condition

Stabilize inlet

Disperse flow, investigate cause

#2

Severe Inlet Erosion

Evaluate inflow protection measure
Repair erosion

#3

Pretreatment

INLET ZONE

Free of sediment/debris

Remove accumulated sand/sediment

Remove accumulated

Locate source, mitigate

#4

Structural Integrity

INLET ZONE

Pass

Good condition

Moderate

Reinforcement needed immediately

#4

Structural Integrity

Problems with adjacent curbs, pavement

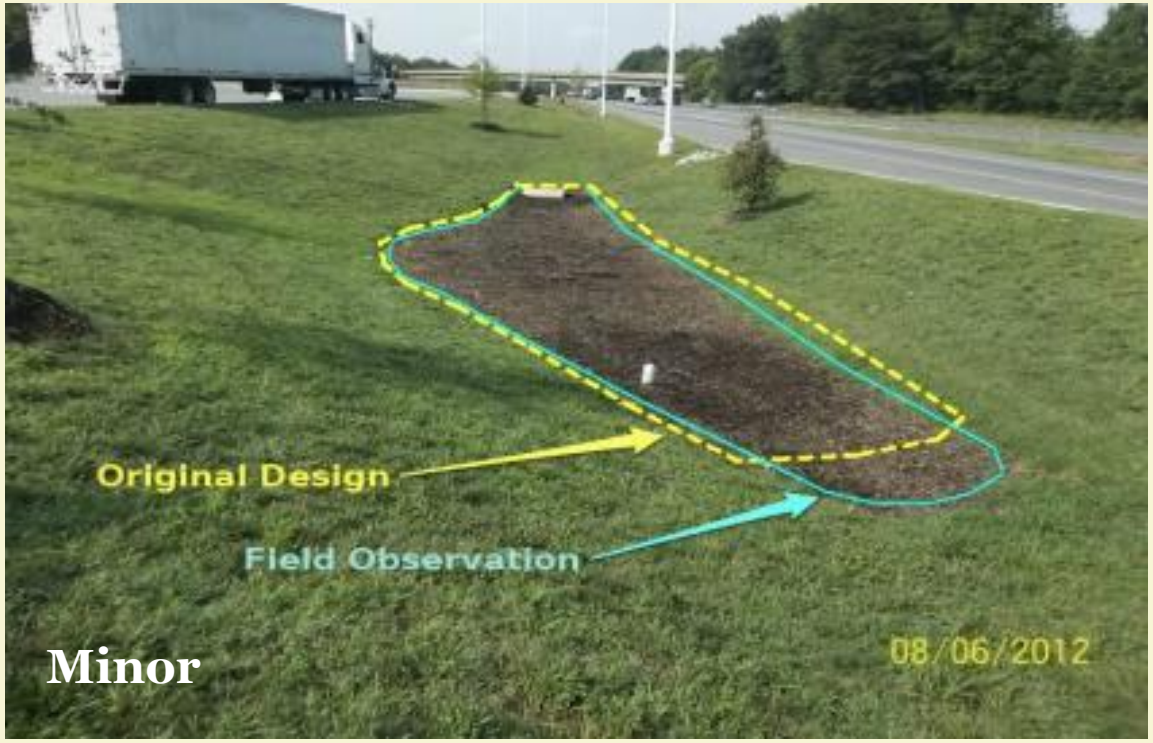
Design repair

#5

Surface Area

PERIMETER ZONE

Does the surface area match the design?



Minor

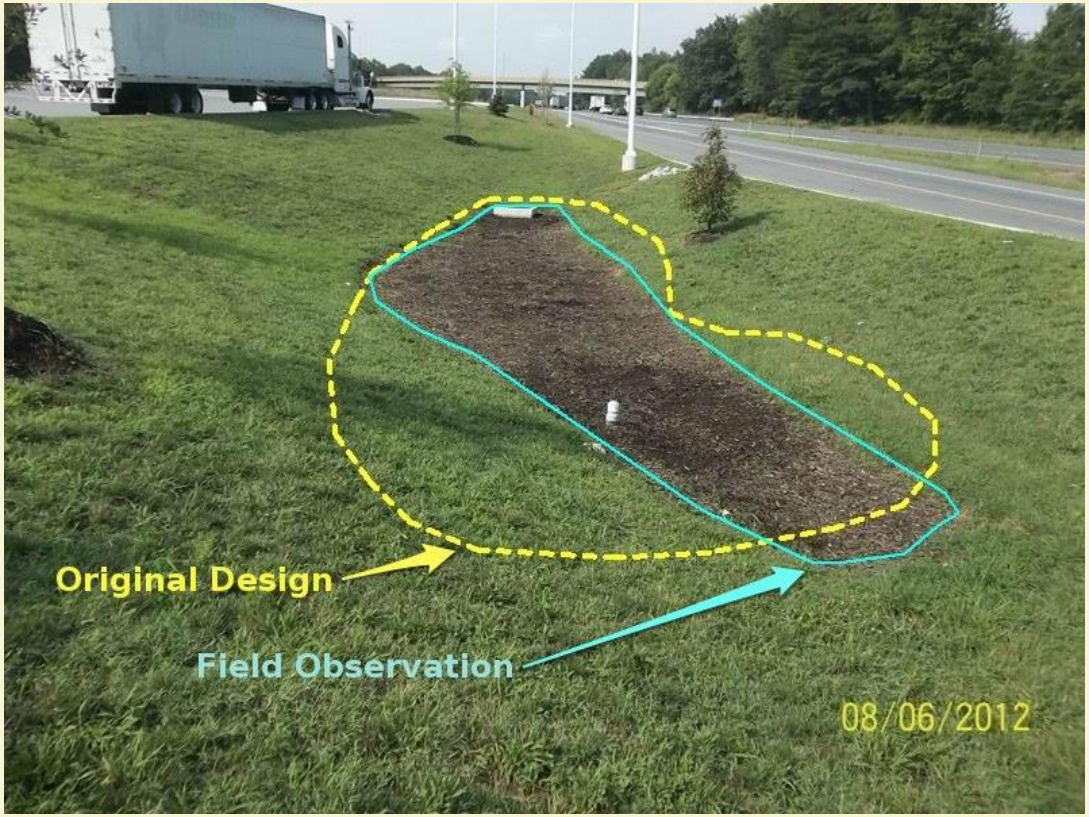
Minor	5% different from design
Moderate	10% different from design
Severe	> 25% different from design

Severe

#5

Severe Design Departures
Surface Area

A greater than 25% departure from the design assumptions for surface area, storage, ponding depth or CDA



Proceed to Topographic Survey

#6

Side slope erosion

PERIMETER ZONE

Pass

Good condition

Spot re-seeding

Minor

Moderate

Vegetative stabilization needed

#6

Severe Side Slope Erosion

FBI

Evaluate topsoil and vegetation
Design erosion repair

#7

Ponding Volume

PERIMETER ZONE

Pass

Water flows through entire facility

Minor

Some short circuiting occurring, mound up outlet

Moderate

Short circuiting occurring, ineffective facility

#7

Severe Design Departures
Ponding Volume

A greater than 25% departure from the design assumptions for surface area, storage, ponding depth or CDA

FBI

Design repair

#8

Sinking Filter Bed

BED ZONE

Even, flat bed

Mulch, media replacement

Mulch, media replacement

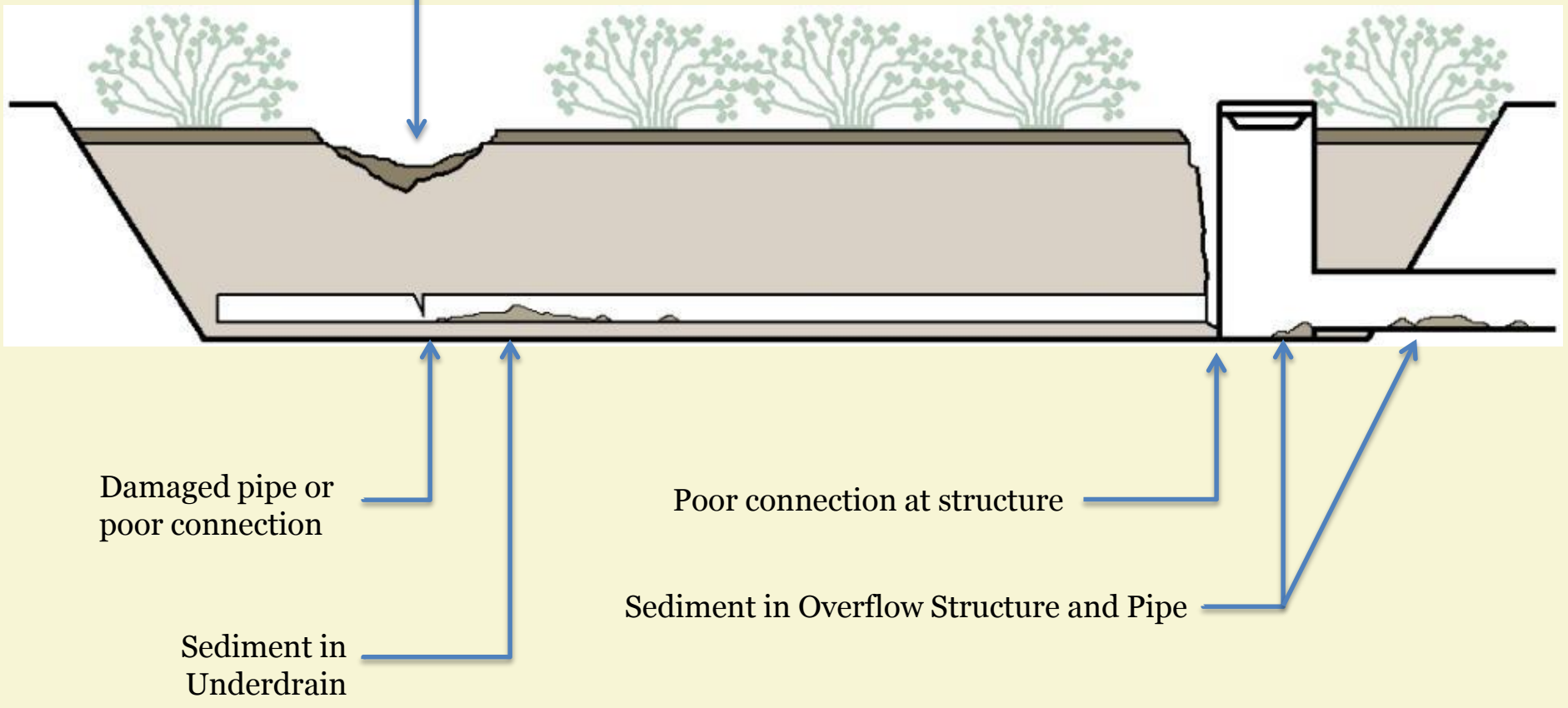
Check underdrain or outfalls for evidence of media migration

#8

Severely Sinking Filter Bed

Proceed to Test Excavation

Potential Causes of a Severely Sinking Filter Bed



#9

Sediment Deposition/ Caking

BED ZONE

Pass

Good condition

Rake the cake

Minor

Moderate

Remove sediment, check pretreatment, find and stabilize source in CDA

#9

Severe Caking and Sedimentation

Determine Sediment Depth and its probable Source in the facility or its contributing drainage areas

#10

Standing Water

BED ZONE

None

Saturated soils

<3” of standing water after 72 hrs

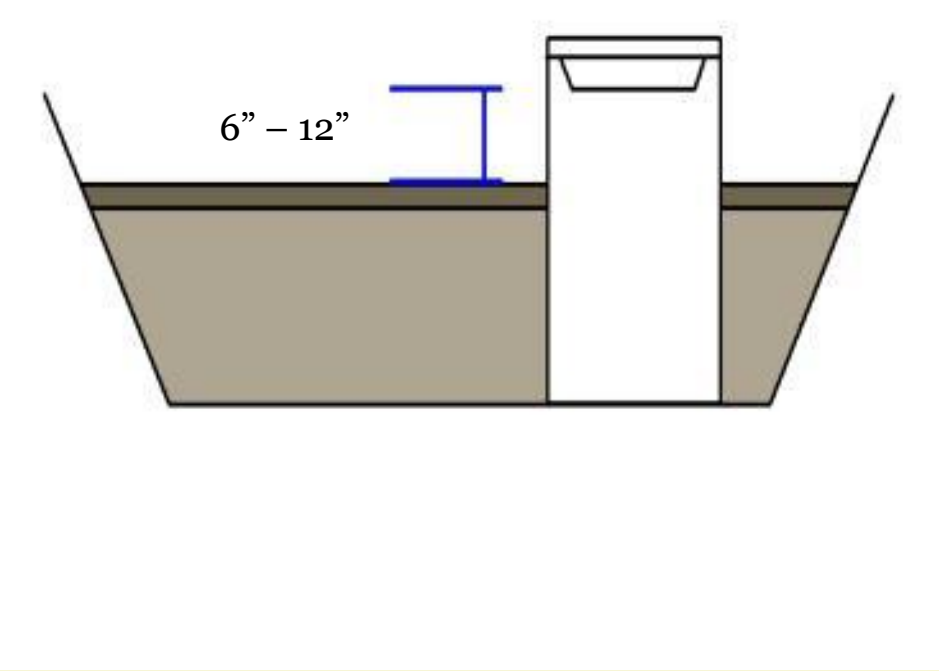
Proceed to pump down and test pit

#11

Ponding Depth

BED ZONE

Pass

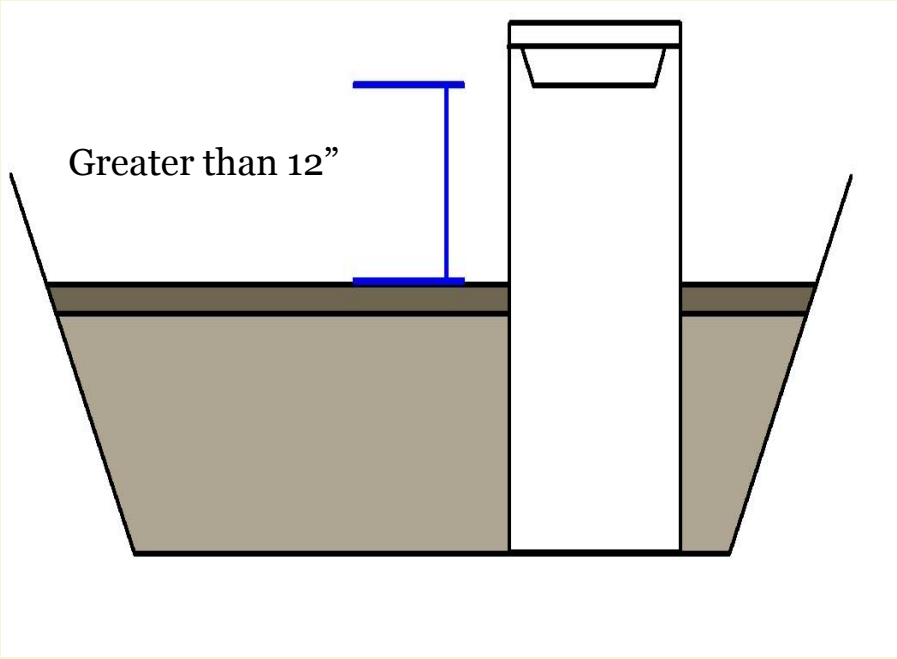


Matches design

#11

Severe Design Departures
Ponding Depth

A greater than 25% departure from the design assumptions for surface area, storage, ponding depth or CDA



Topographic Survey & Adjust grade by removal or addition of mulch, and/or media

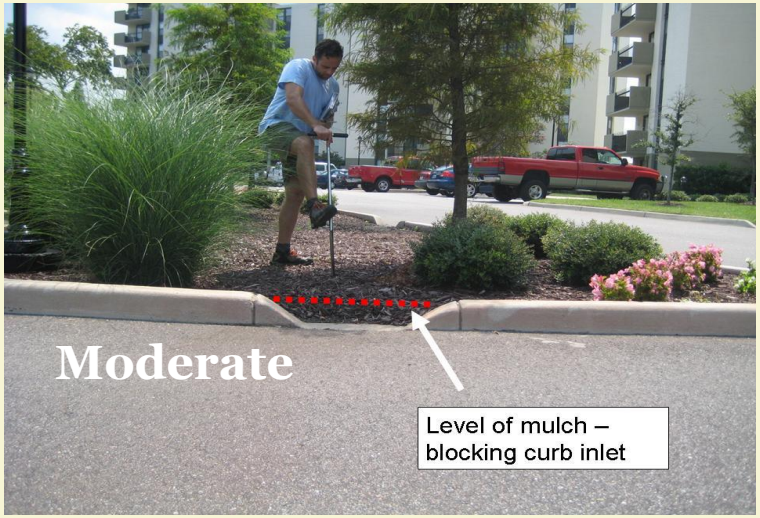
#12

Mulch Depth, Condition

BED ZONE

Good condition

Replace mulch/Add ground cover



Remove mulch to design depth (2”-3”)

#13

Trash

BED ZONE

No trash

Trash

Remove trash

#14

Bed Erosion

BED ZONE

Good condition

Rake

Disperse flow, rake, investigate the cause, evaluate pretreatment

Vegetation

VEGETATION ZONE

Vegetation is Different b/c…

- Vegetation changes over time
- Maintenance depends on landscaping regime

To assess: look at 3 different Visual Indicators:

- Vegetative Cover
- Vegetative Condition
- Vegetative Maintenance

Dynamic Vegetation Management

Year 1

Year 3

Year 10

Original design plan should specify desired plant community through time

Understand the desired landscaping objective

Check Vegetation Indicators During Growing Season
Depending on landscaping Regime, these are all in good shape

#15

Vegetative Cover

VEGETATION ZONE

Good cover

Few bare spots

Tip: more mulch area exposed = more maintenance cost

< 75% coverage

Tip: Routinely split and replant Herbaceous material to reduce mulch area

#15

Vegetative Cover

VEGETATION ZONE

Severe

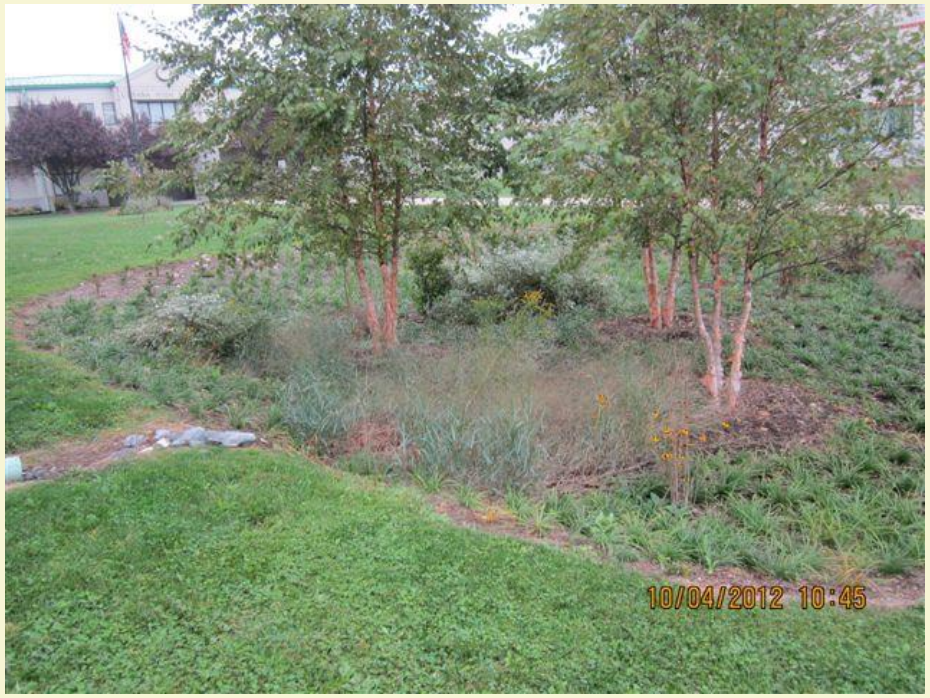
Evaluate planting plan and replant

#16

Vegetative Condition

VEGETATION ZONE

Plants alive and in good condition



Weeding needed

#15-16

Landscaping Detective Work

< 35% coverage

Dead or Diseased Plants

Invasive Plants

Evaluate cause of plant failure (soils, species, design)
Do new planting plan (higher density or fast growing species)

Design and implement eradication plan, Evaluate remaining plants
Design new planting plan with higher density, Institute O & M Procedures

#17

Vegetative Maintenance

VEGETATION ZONE

Well maintained

Tree removal needed

Maintenance needed!

#18

Underdrain

OUTLET ZONE

Free of obstructions and debris

Sediment in underdrain

Check for broken or missing caps

Look for Bed Sinking
Do a test pit

Questions and Answers

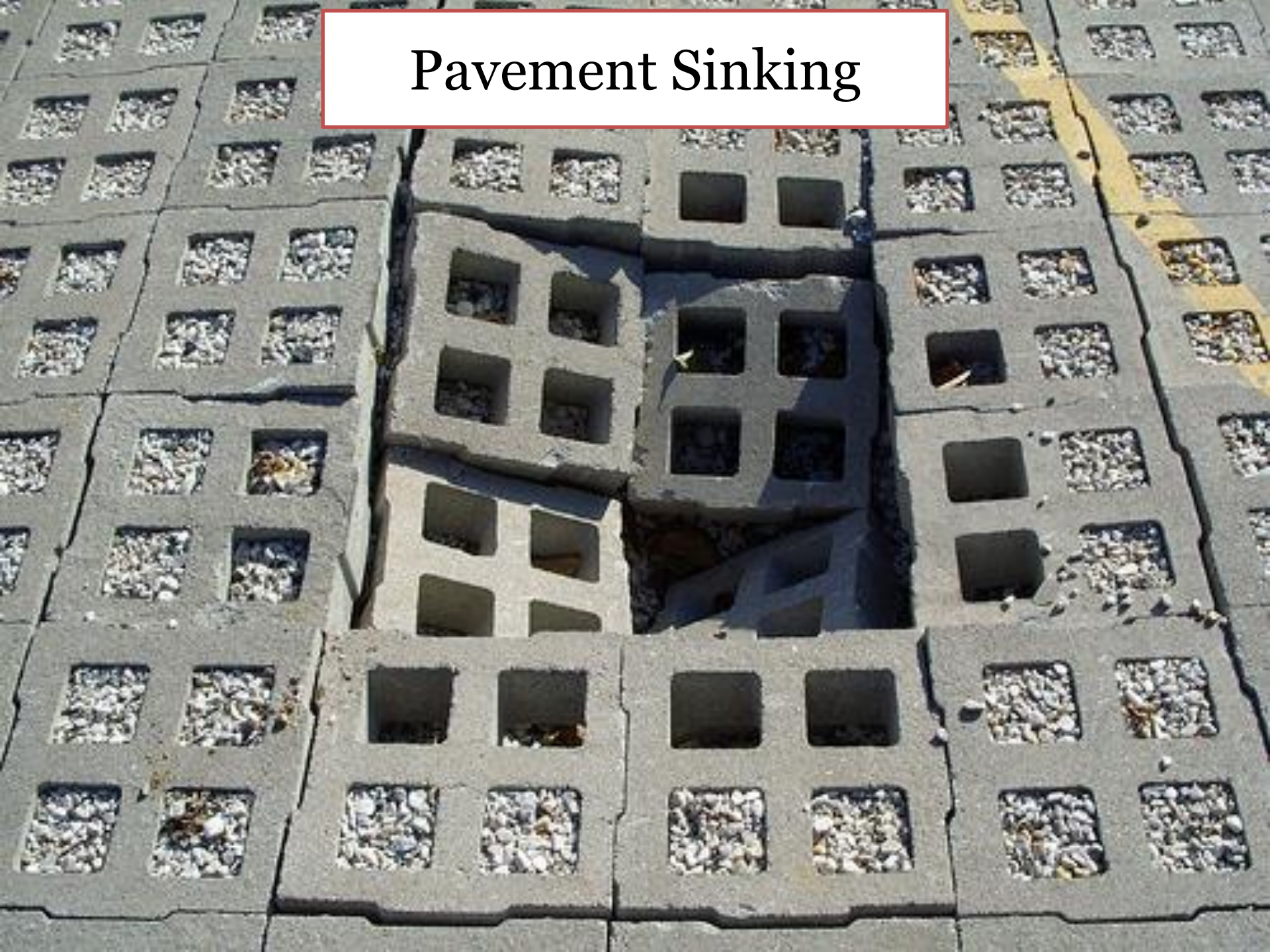
Visual Indicator Approach for Other LID Practices

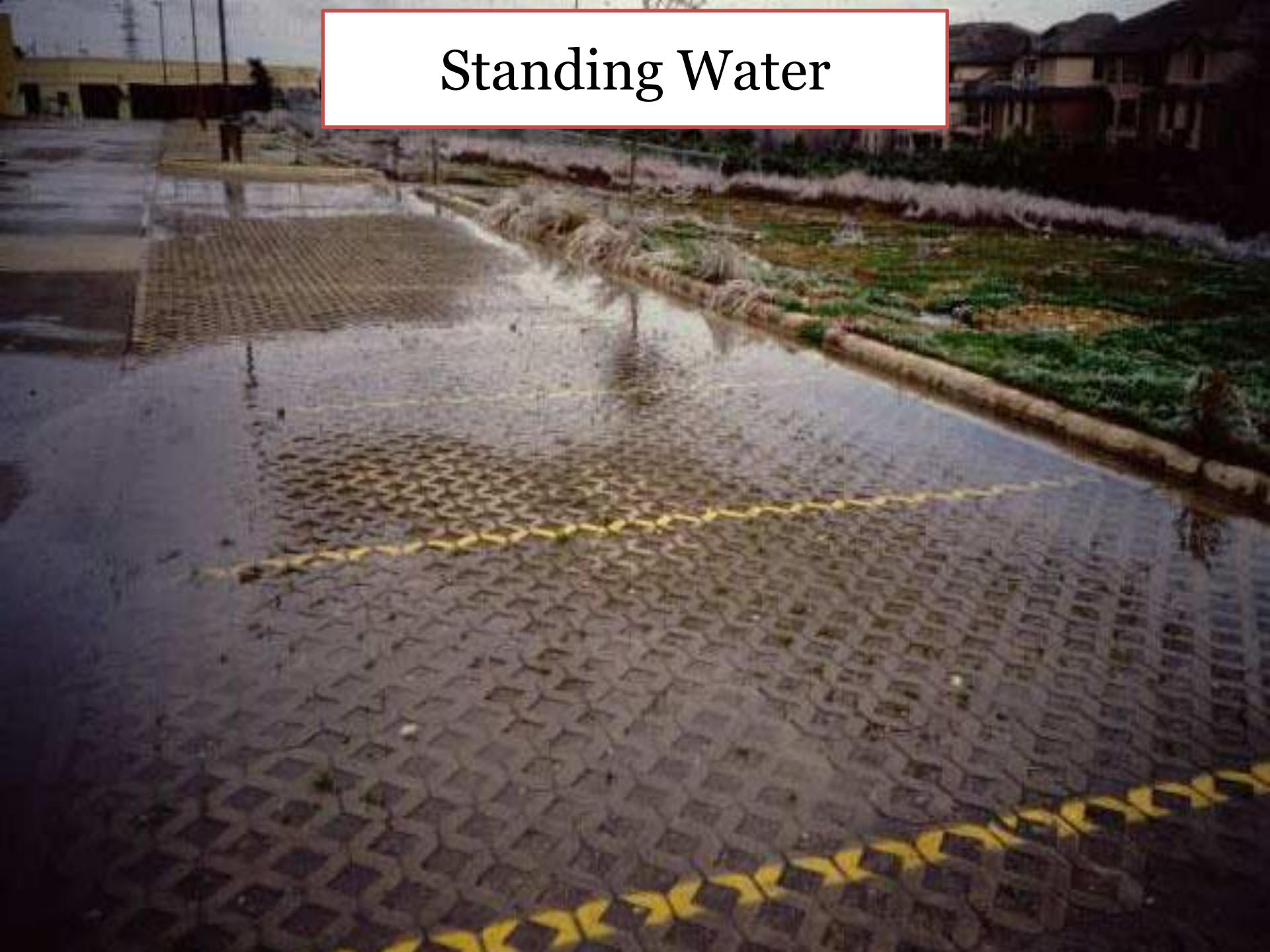
Visual Indicators for Permeable Pavement

#	INDICATOR	Accept	Maintain	Verify	FBI
1	CDA Run-on	X	X	X	X
2	Pavement Area	X		X	
3	Pavement Sinking	X	X		X
4	Surface or Void Clogging	X	X	X	X
5	Standing Water	X	X	X	X
6	Pavement Staining		X	X	X
7	Surface Deterioration	X	X		X
8	Flow Test	X		X	X
9	Overflow Condition	X	X		
10	Underdrain/Observation Wells	X	X	X	X
11	Structural Integrity	X	X		X
12	Parking Mgmt. Practices	X		X	

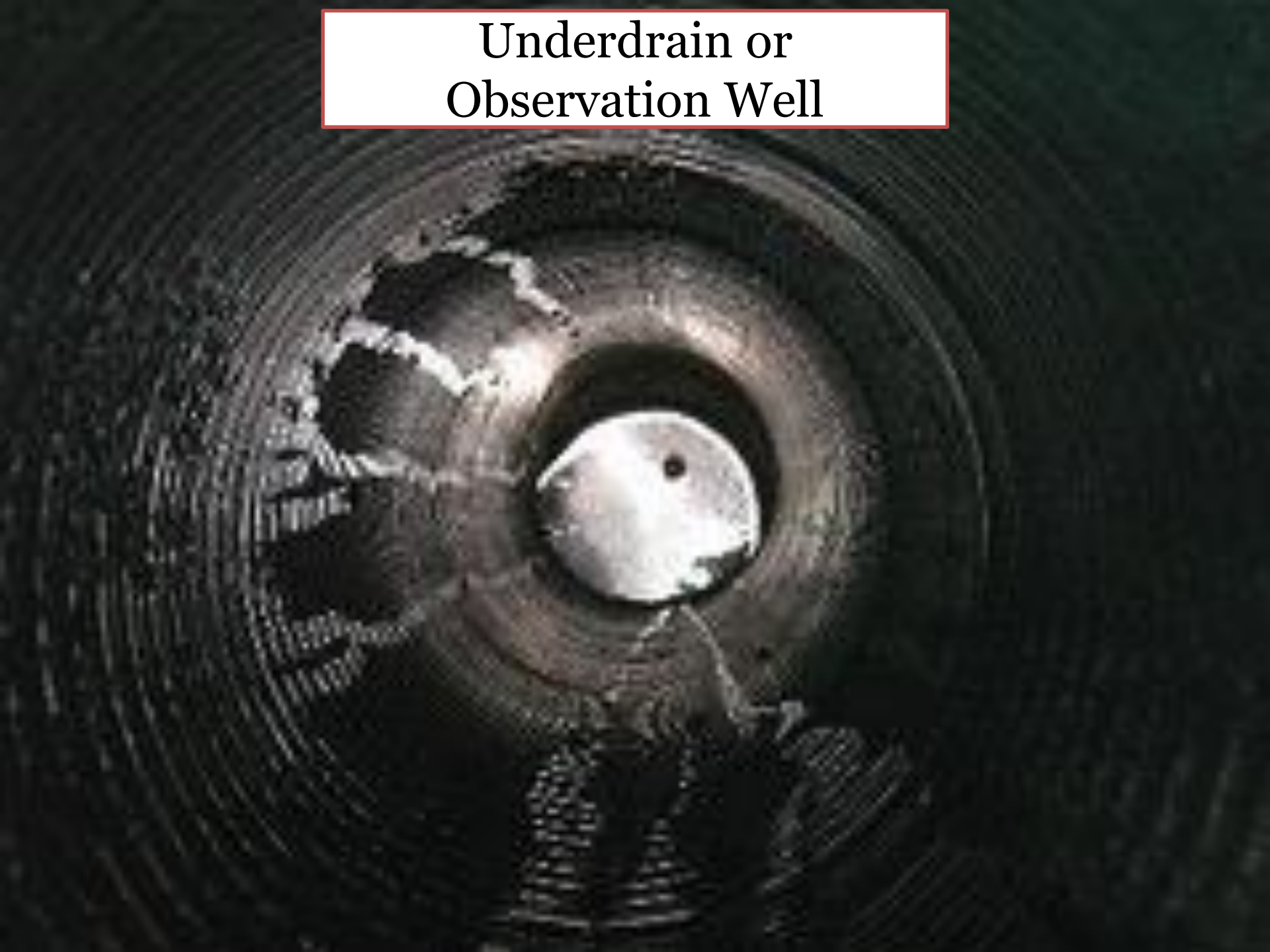
CDA Run-on

Pavement Sinking




Standing Water

Underdrain or Observation Well



Structural Integrity

Infiltration Practices

1. Surface Area
2. CDA Condition
3. Surface Sinking
4. Sedimentation or Plant Growth
5. Standing Water
6. Surface Staining
7. Observation Well Measurement
8. Observation Well and Cap
9. Pretreatment Condition
10. Inlet Condition
11. Underdrain
12. Overflow Condition

Grass Channels

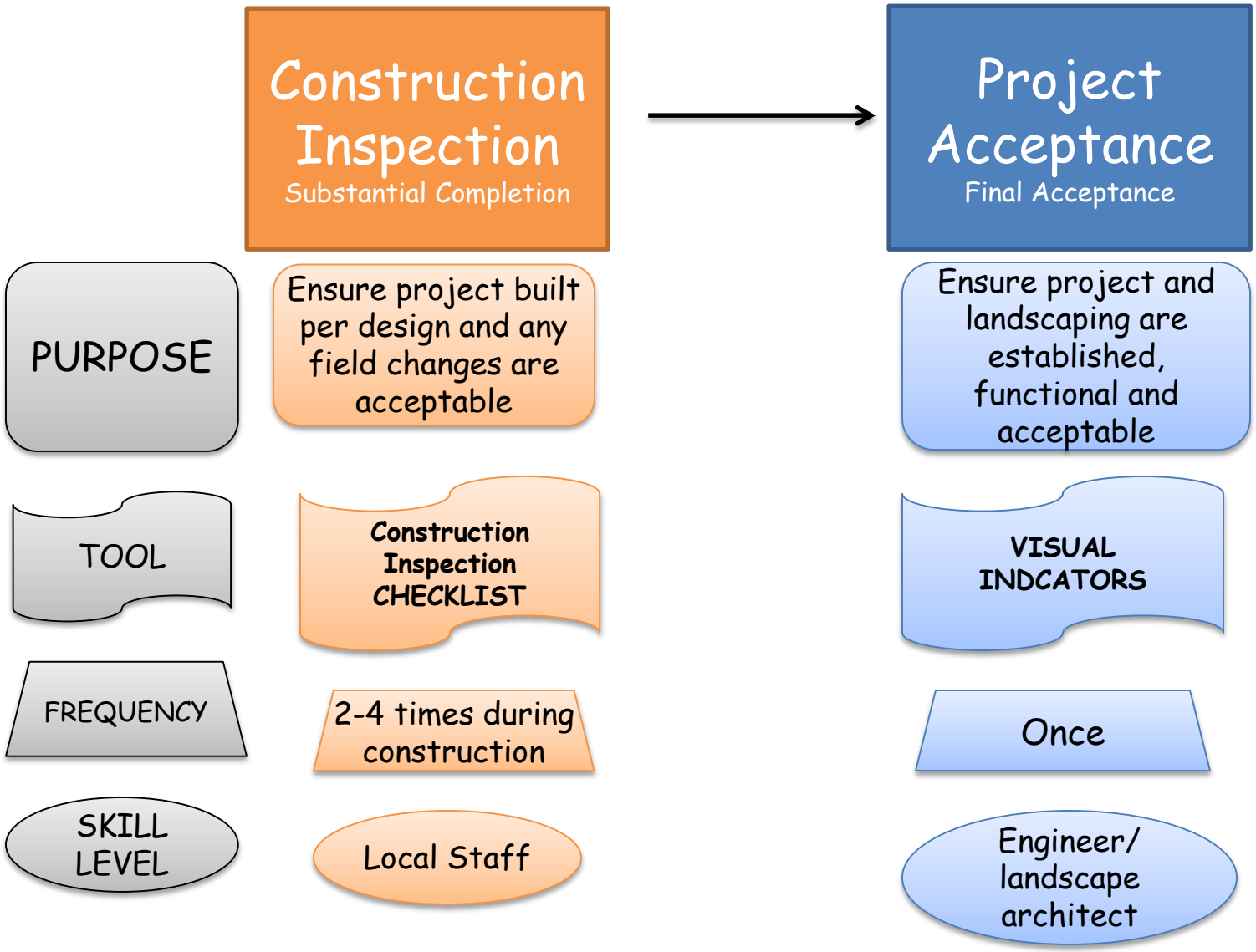
1. CDA Condition
2. Surface Dimensions
3. Flow Distribution
4. Sediment Deposition
5. Standing Water/ Saturated Soil
6. Trash/Illegal Dumping
7. Inlet Obstruction
8. Inlet Erosion
9. Swale Erosion
10. Side Slope Erosion
11. Vegetative Cover
12. Vegetative Condition
13. Check Dams
14. Outflow Obstruction
15. Pavement Edge Integrity

Vegetative Condition

Construction Inspections

Drivers for Inspection

- Procurement regulations
- Grant requirement
- MDE requirement for credit accounting
- Project quality control
- Getting your money's worth



What form can it take?

Inspect at critical times…

to avoid this…

Inspect at critical times…

and this…

Construction Inspection

What is on your checklist…

- Verify the contributing drainage area boundaries
- Confirm inlet and outlet elevations, perforations, and pipe joints
- Confirm inflow actually captures runoff
- Side-slope stabilization
- Full inundation test to inspect underdrain/outflow function

* Subtle changes in grading, paving and drainage can really screw up an otherwise fine design

Other Critical Points for Construction Inspection

- Check quality of filter media (get lab testing data)
  - Project submittal prior to construction
- Make sure stone is washed (get product data)
  - Project submittal and material delivery tickets
- Verify during construction – NOT after filled
- Verify final ponding depth and side slope grading

Construction Sequence

- Step 1:
- Preconstruction material submittals
  - Mix, stone, geotextile, matting, seed, etc
- Mark Utilities and Stakeout
  - Miss Utility
  - Private service (where are you????)

Construction Sequence

Step 2: Ensure E&S Measures are installed

- The E&S measures will help protect the project

Minimize open areas in contributing drainage

- Contract/seasonality etc. may result in having to build before adjacent drainage area is stabilized – balance conflicting demands

Tip: Partner with your contractor, engineer, and ESC inspectors throughout construction

- Use preconstruction meeting to layout expectations and concerns
- Verify E&S install
- Review and modify sequence of construction if needed
- Verify approach regarding vegetative stability

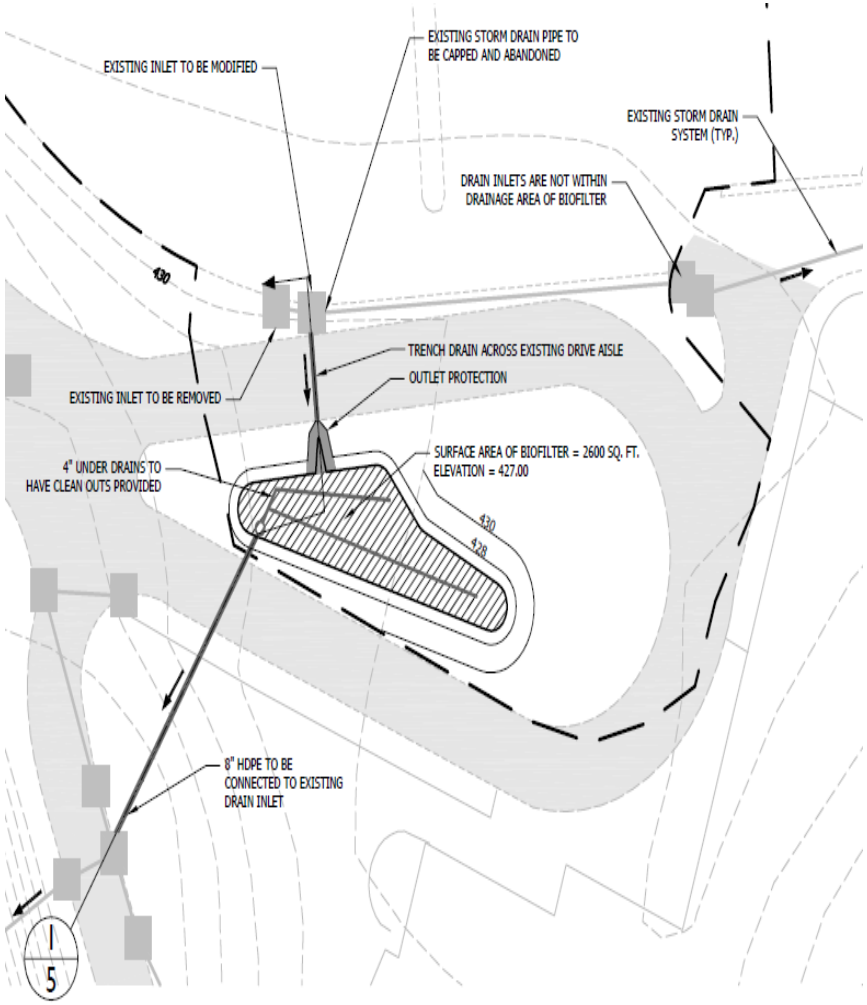
Step 2: Implement Project ESC Controls

A single storm can ruin your project

Tips for Bioretention ESC

- Block inlets to off-line bioretention cells
- Temporary diversion for on-line cells
- Rapidly stabilize cut side-slopes
- Temporary sheeting
- Reduce delays through planning

Step 3: Implementation of Design (aka build it)



Compare design soil borings to actual field conditions

Verify the actual contributing drainage area boundaries

Confirm inlet and outlet elevations

TIP Subtle changes in project grading, paving and drainage can really screw up an otherwise fine design

Step 4: Construction

Minimize compaction:

- Keep equipment time within the footprint of the BMP at a minimum
- If you can build it all from outside the BMP - then keep the equipment outside
- Use low ground pressure equipment
- IF… building a large facility – require low ground pressure equipment

Step 5 Reach and Protect the Bottom

- Verify your elevations and get to proper invert elevation (write it down..)
- Check grades throughout
- Rip existing soils to maintain porosity

Step 6: Tie into storm drain system (overflow and/or underdrain)

- Make sure water can really flow downhill
- Make sure underdrain is flat or with a positive slope
- Check seals at all pipe junctions to make sure they are water-tight
- Check connections to structures to make sure they are water-tight

Step 7 Install Filter fabric on the sides of the structure

When you install filter fabric between the layers it will get clogged and the BMP will stop working!

Step 8 Lay Down Stone Layers and Underdrain

Clean washed stone

Depth depends on design

Choker layer of pea gravel

Make sure pipe is perforated

Make sure correct ends are capped

Set vertical cleanout pipes*

Step 9 Add Filter Media

Make sure soil mix meets specs, add in one foot lifts, allow for 10% settlement, hydraulically compact, rake out to final ponding depth

Step 10 Lay Down Surface Layer and Stabilize

Mulch, turf or stone

Inspect thickness of layer

Make sure ponding depth is within 9 to 12" range

Straw and seeding of side slopes

Use biodegradable matting on steeper slopes

Sod is option for instant stabilization

Step 11 Planting Vegetation

- Planting plan – work with pro
- Order plants so they do not spend much time on site
- Match plants to correct places (away from underdrains)

Step 11 Planting Vegetation

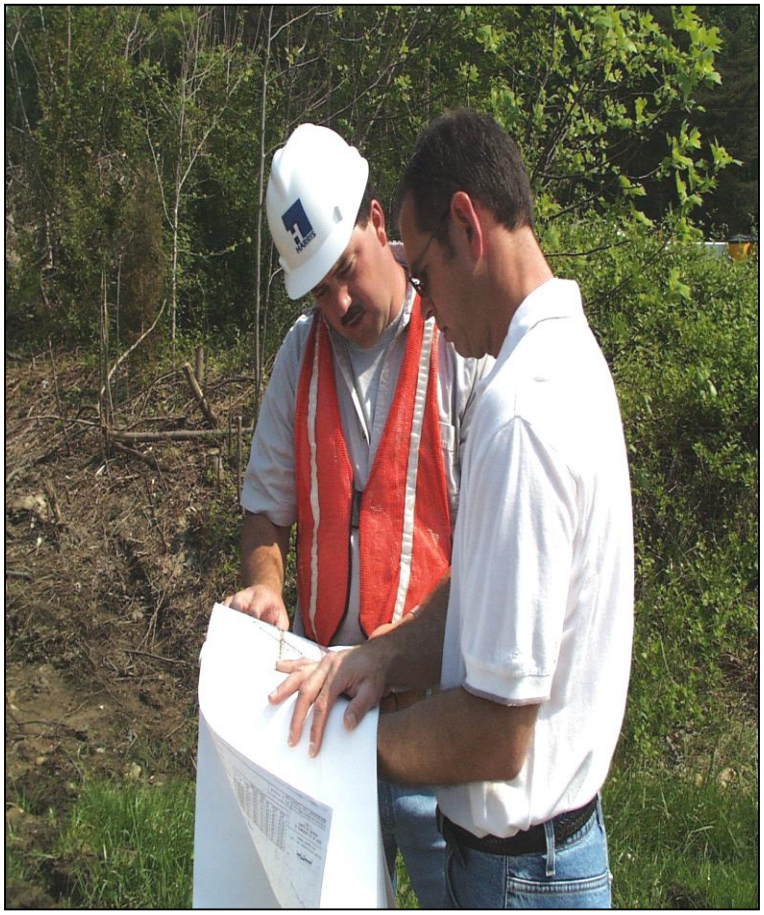
- Make sure water is available
- Stake planting locations
- Initial spot fertilization

Summary of Construction Inspection Elements

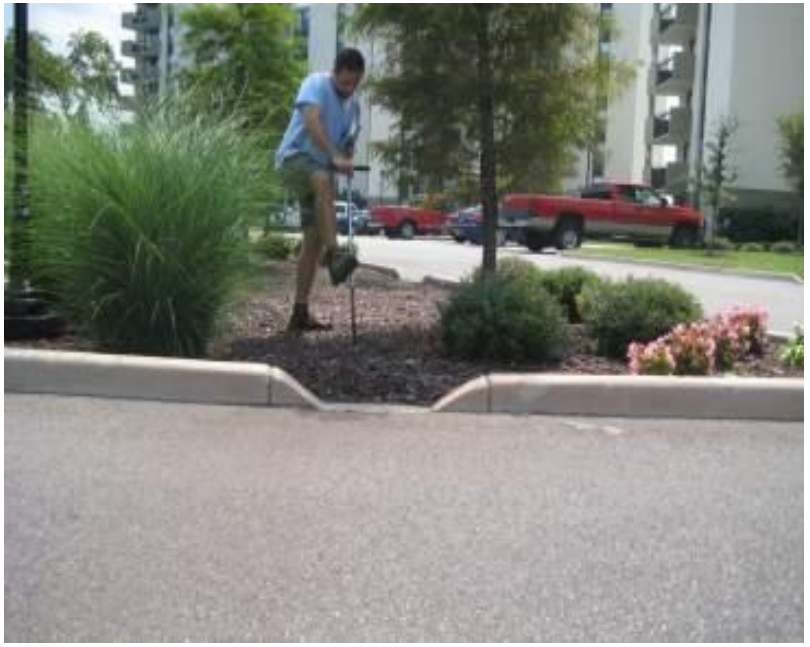
- Under drain and stone sump installation
- Confirm inlet and outlet elevations
- Side-slope stabilization
- Make sure you have a checklist or data collection form

Summary of Construction Inspection Elements

- Check quality of filter media
- Check inverts/elevations @ inlets/Curb Cuts
- Check stone and underdrain (pipe material, perforations)
- Final ponding depth and side Slope Grading



The Landscape Establishment Phase



•Perform final inspection at end of establishment phase

• Usually 6 to 12 months after installation for most vegetative LID practices (check the contract..)

• Developer or builder responsible for this first year of maintenance

The establishment phase through first growing season

Landscaping contract covers first year after installation
Regular watering first few months - who is responsible
Spot re-seeding and remove/replace dead plants
Remove sediment accumulation at inlets
Repair erosion on side-slopes

Final Inspection to Accept Facility

- Use the Full Range of Visual Indicators

- Inspect after a decent storm

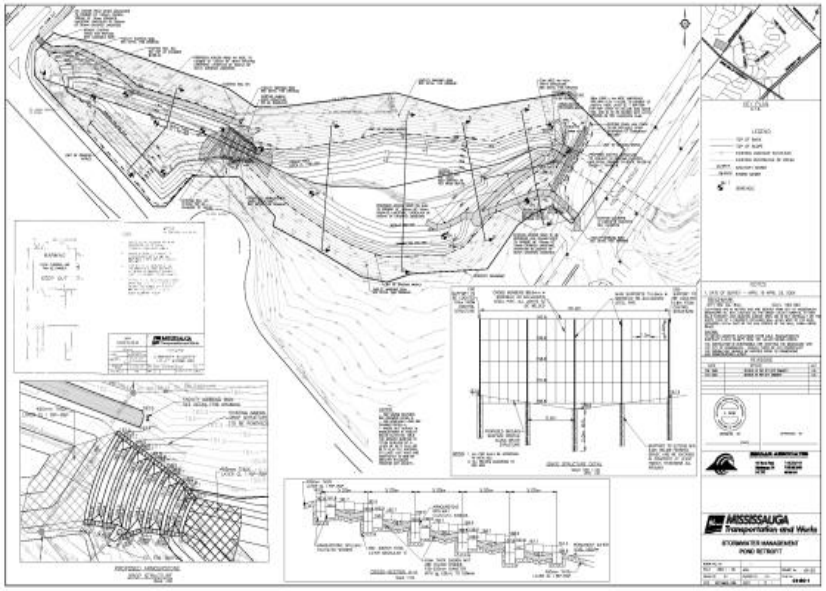
- Last chance to reinforce plantings

- Verify 'As Built' data collected - decide what data should be collected at the start so it can be collected along the way…

Suggested as-builts for micro bioretention (CDA less than 5000 sf)

- Digital photo and GPS coordinates
- Vegetative cover and stability
- Confirm ponding elevation and flow paths
- No survey work

As Built for Larger Bioretention (CDA more than 5000 sf)

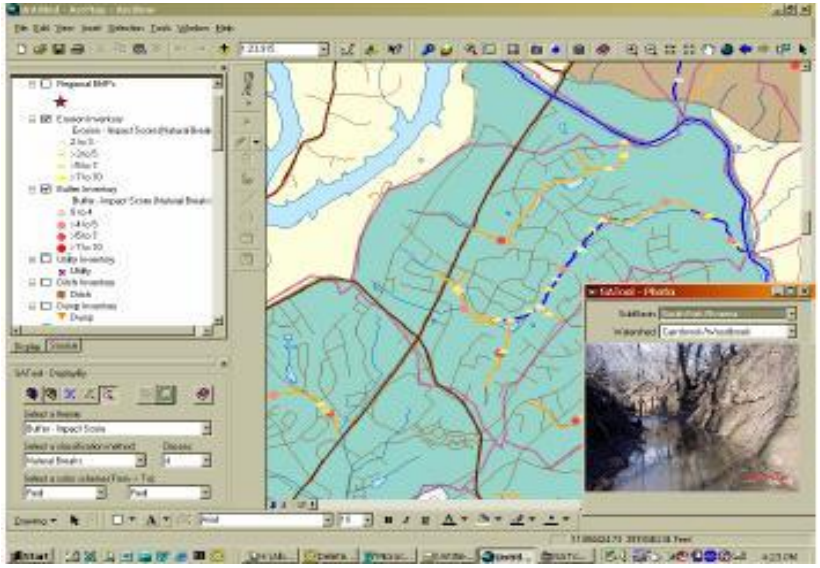


- Limited survey work to confirm inlet and outlet elevations, flow paths and ponding depths
- Confirm underdrain depth and outflow
- Ensure landscaping meets design objectives
- Verify boundaries of stormwater easement
- Check overflow to downstream conveyance system
- Digital photo after establishment phase

Facility Reporting and Tracking

Make sure its working well before releasing performance bond

Log it in to local maintenance tracking system



It's worth the effort

Special Forensic BMP Investigations

Forensic BMP Investigation
FBI

Purpose: to diagnose why a BMP is not working and how to fix it

Audience: BMP owner

Frequency: as warranted by field inspection

Skill Level: engineer/project estimator

Indicate what needs to be checked by private BMP owner in a letter on non-compliance

Key Visual Indicators that Trigger an FBI for Bioretention		
No	Indicator	Status
1	Severe Inlet Obstruction	Most runoff cannot enter the facility
3	Inadequate or Lack of Pretreatment	Severe accumulation of sediment in the facility
4	Structural Integrity	Facility or adjacent infrastructure at risk of failure
2, 6, 14	Severe Inlet Erosion, Sideslope or Bed	A foot or more of gully erosion
5, 7, 11	Severe Design Departures	More than 25% departure from design assumptions for surface area, ponding depth and/or contributing drainage area
8	Severe Bed Sinking	A foot or more of localized bed sinking and/or sediments observed in underdrain
9	Severe Sediment Caking	More than two inches of deposition in the facility
10	Severe Standing Water	More than 3 inches of ponding 72 hours after rain
15	Severe Vegetative Cover	35% of less vegetative cover

#1

Severe Inlet Obstruction

Severe accumulation of sediment, debris

Locate source, mitigate
Evaluate the need for enhanced pretreatment
Design remediation

#4

Structural Integrity

Problems with adjacent curbs, pavement

Design repair

#2

Severe Inlet Erosion

FBI

Evaluate inflow protection measure
Repair erosion

#6

Severe Side Slope Erosion

FBI

Evaluate topsoil and vegetation
Design erosion repair

#14

Severe Bed Erosion

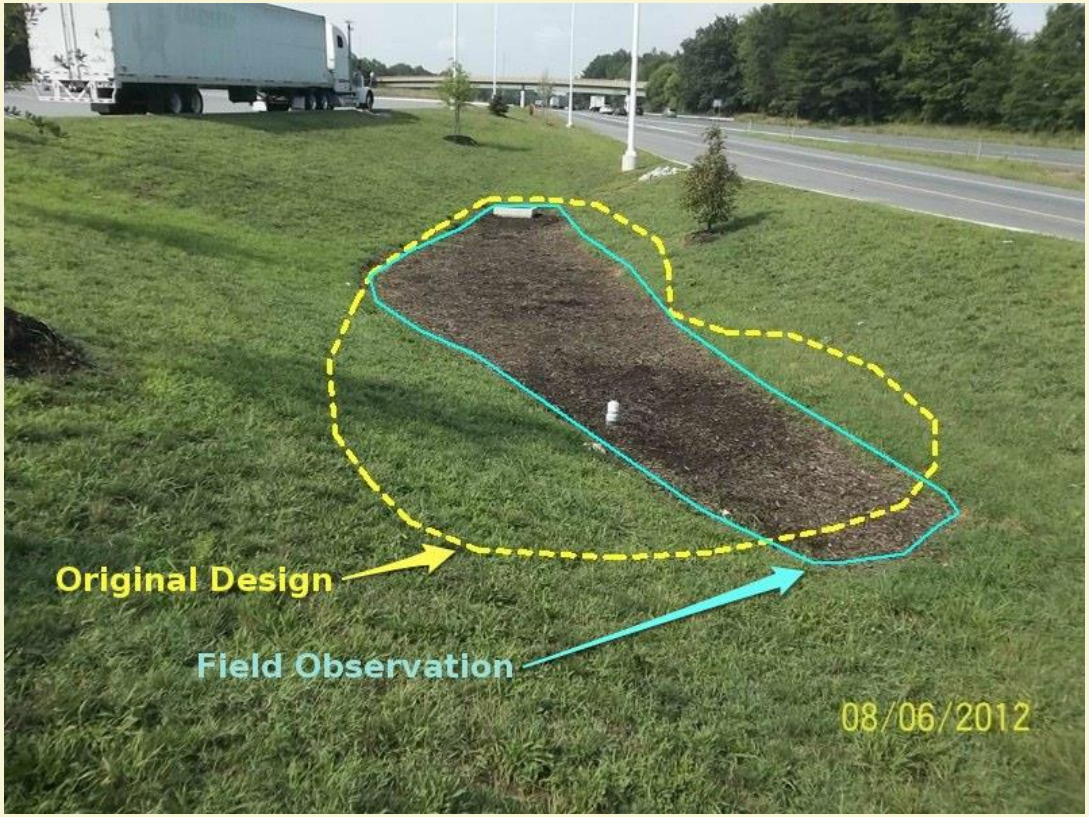
FBI

Evaluate flow patterns and materials
Design repair incorporating erosion control measures

#5

Severe Design Departures
Surface Area

A greater than 25% departure from the design assumptions for surface area, storage, ponding depth or CDA



FBI

Proceed to Topographic Survey

#7

Severe Design Departures
Ponding Volume

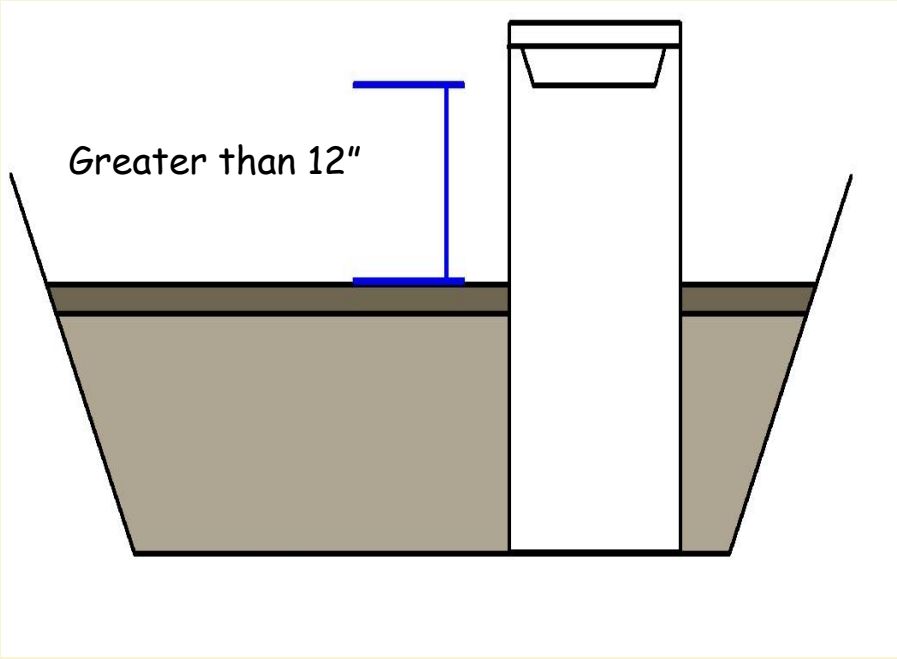
A greater than 25% departure from the design assumptions for surface area, storage, ponding depth or CDA

Design repair

#11

Severe Design Departures
Ponding Depth

A greater than 25% departure from the design assumptions for surface area, storage, ponding depth or CDA



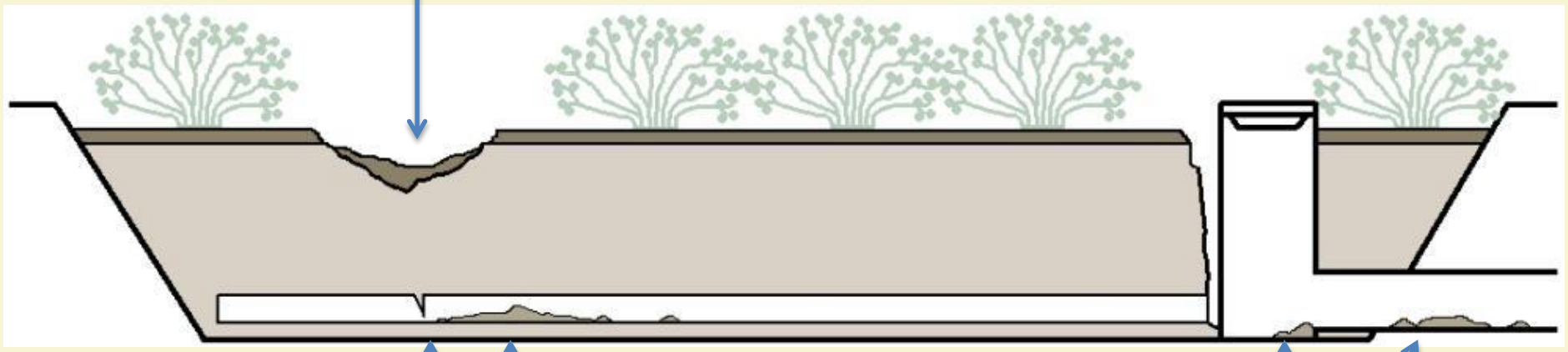
Topographic Survey & Adjust grade by removal or addition of mulch, and/or media

#8

Severely Sinking Filter Bed

Proceed to Test Excavation

Potential Causes of a Severely Sinking Filter Bed



Test Excavation in the Bioretention area

Investigate Mulch, Soil Media, Filter Cloth
Optional: Underdrain Stone and Pipe

Evaluate for voids, loss of material, filter cloth or layer failures, etc.

What to Look for in the Overflow or Underdrain

Indicator:
Sediment or Soil Media in Underdrain or downstream structures

Secondary Investigation Techniques to Explore Pipes

#9

Severe Caking and Sedimentation

Determine Sediment Depth and its probable Source in the facility or its contributing drainage areas

#10

Standing Water

Investigate Mulch, Soil Media, Filter Cloth

Optional: Underdrain Stone and Pipe

Evaluate materials, signs of sediment, saturation

FBI

Proceed to Pump Down & Test Pit

#15

Landscaping Detective Work

< 35% coverage

Dead or Diseased Plants

Invasive Plants

Evaluate cause of plant failure (soils, species, design)
Do new planting plan (higher density or fast growing species)

Design and implement eradication plan, Evaluate remaining plants
Design new planting plan with higher density, Institute O & M Procedures

Wet Ponds/Wetlands

Wet Ponds/Wetlands

- Pool capacity
- Forebay deposition
- Plumbing problems
- Short-circuiting
- Vegetation
- Side-slope erosion
- Pool draw-down

Pool Capacity

Loss of Pool Capacity

Forebay Deposition

Clogged forebay

Plumbing Problems

Clogged orifice

Short-circuiting

Vegetation

Side-slope Erosion

Pool Draw-Down

Bad Boyz

Permeable Pavement

Bad Boyz

Just a few sink holes

Bad Boyz

20 years of neglect

Bad Boyz

20 years of neglect

Bad Boyz

LID
20 years of neglect

Bad Boyz

State & Federal Sites

Bad Boyz

In the woods out back…

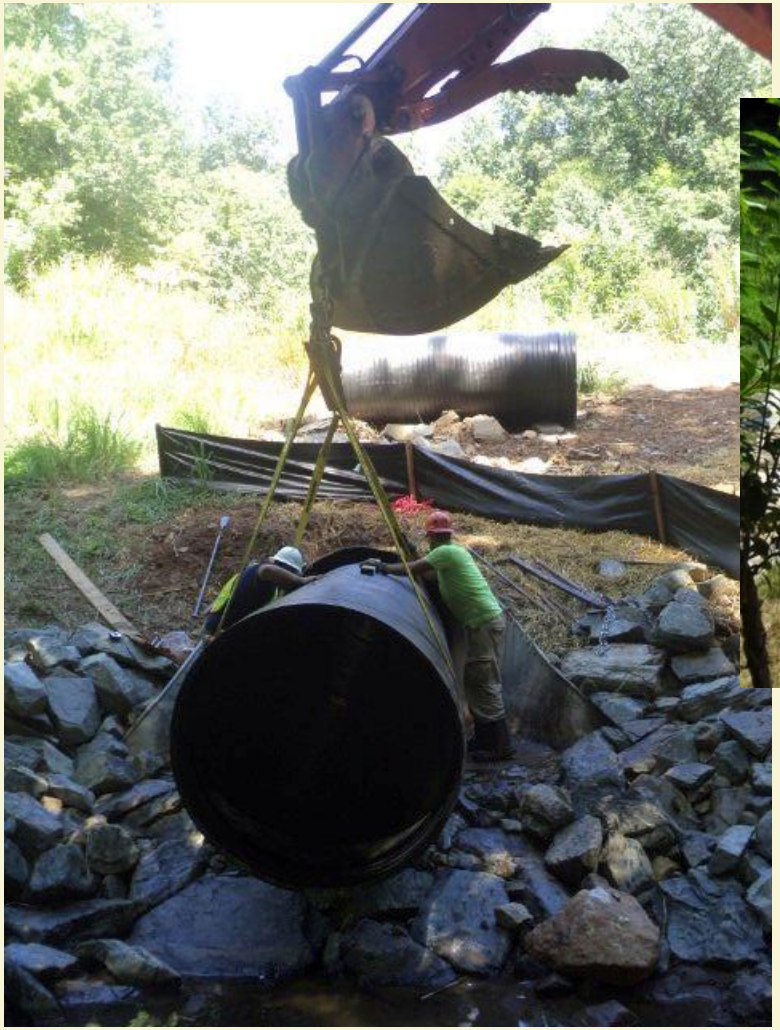
Bad Boyz

200k Drive-by

Bad Boyz

200k Drive-by

Bad Boyz



200k Drive-by

Bioretention Maintenance

In the Trenches

Theodore (Ted) E. Scott, PE, CPESC, LEED AP

Maintenance Types

Routine Maintenance

- Scheduled Routes
- Production Oriented
- Set Crews, Light Equipment

Non-Routine Maintenance

- Individual Dispatches
- Design Consideration in Advance
- Variable, Skilled Crews, Heavier Equipment

Routine Maintenance

Routine Maintenance Inflows

What to Maintain - Inflows

Trash & debris removal (Quarterly)

What to Maintain - Inflows

Erosion repair (Quarterly)

What to Maintain - Inflows

Sediment removal (Quarterly)

What to Maintain - Inflows

Adjust protection (Quarterly)

Routine Maintenance
Filter Bed

What to Maintain – Filter Bed

Trash and debris removal (Quarterly)

What to Maintain – Filter Bed

Rake & distribute mulch (Quarterly)

What to Maintain – Filter Bed

Sediment Cleanout (Quarterly)

What to Maintain – Filter Bed

Check for sinkholes or settling (Quarterly)

What to Maintain – Filter Bed

Check Ponding Depth (Quarterly)

Routine Maintenance
Side Slopes

What to Maintain – Side Slopes

Trash and debris removal (Quarterly)

What to Maintain – Side Slopes

Seed or stabilize as needed (Quarterly)

What to Maintain – Side Slopes

Erosion repair (Quarterly)

What to Maintain – Side Slopes

Where erosion ends up:

What to Maintain – Side Slopes

Check for settling at toe of slope (Quarterly)

Routine Maintenance
Vegetation

What to Maintain - Vegetation

Mow turf grass if present (Quarterly)

What to Maintain - Vegetation

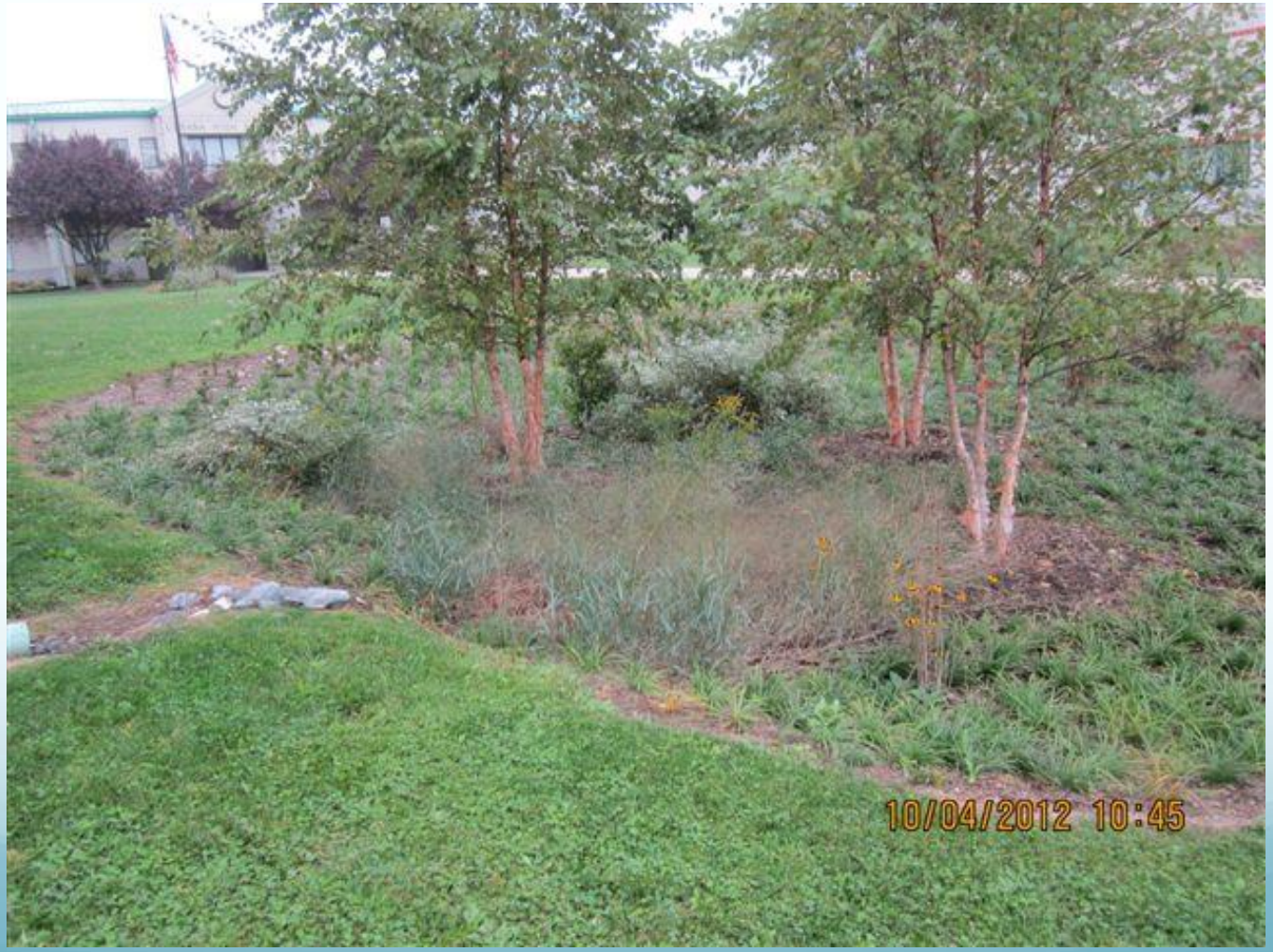
Prune/thin woody vegetation (Seasonal)

What to Maintain - Vegetation

Thin and re-plant perennials & ground cover (Seasonal)

What to Maintain - Vegetation

Apply pre-emergent herbicide to mulch bed areas and post-emergent herbicide to weeds as needed.



What to Maintain - Vegetation

Evaluate need for additional or replacement plants

What to Maintain - Vegetation

Supplement mulch (Spring) and replace mulch (Triennially)

Remove

Routine Maintenance Outlet

What to Maintain - Outlet

Check dewatering (Quarterly)

What to Maintain - Outlet

Clear debris from Overflow (Quarterly)

What to Maintain - Outlet

Repair erosion (Quarterly)

What to Maintain - Outlet

Check for sediment (Quarterly)

What to Maintain - Outlet

Check for Illicit Discharges

Maintenance-Level Inspections

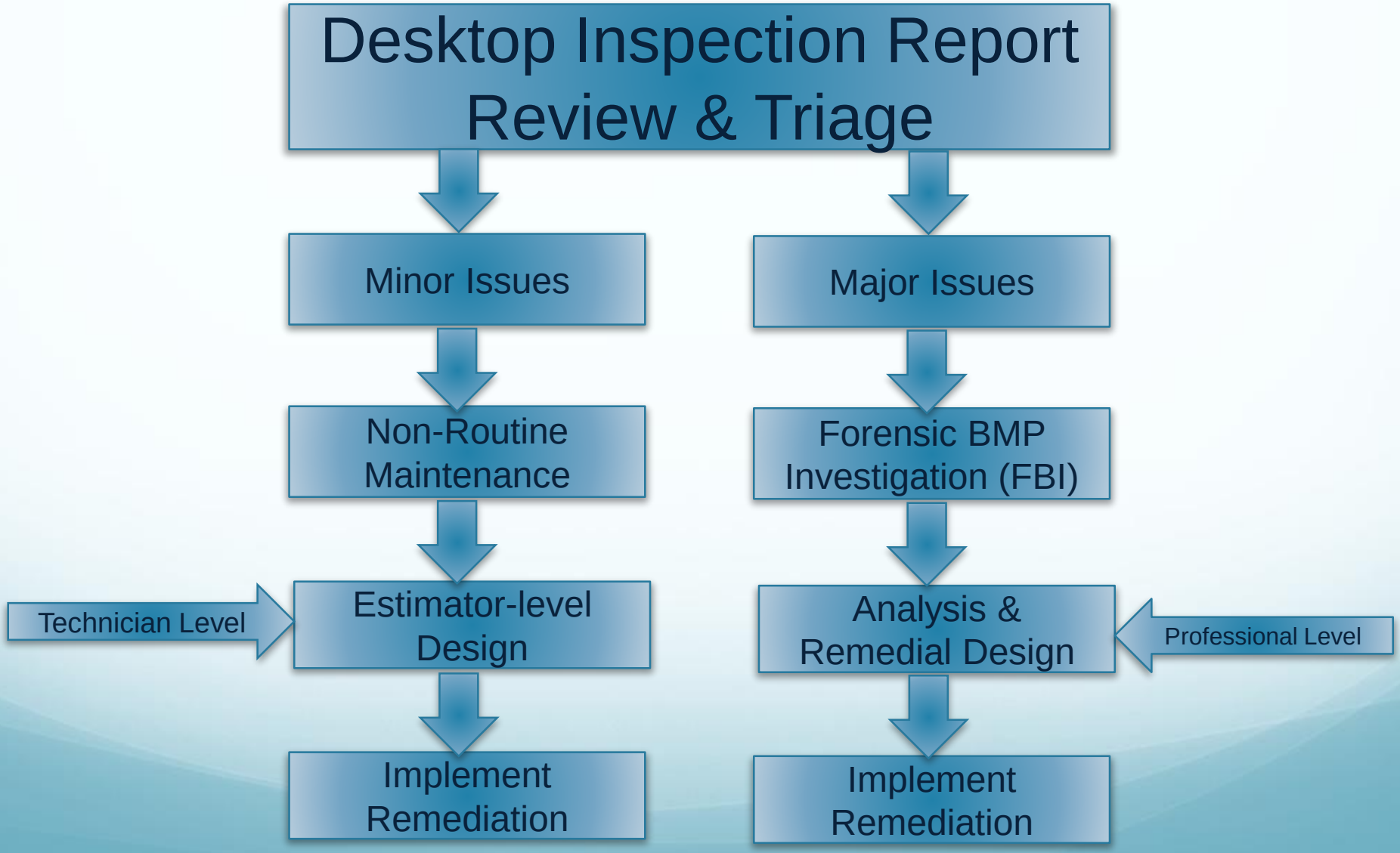
Sub-Technician Level Maintenance Crew

Quick Photo Documentation

- Document Maintenance Activities with Before and After Photos
  - Smartphone Application
  - White boards
- Review facility for specific issues
  - Sinking or obvious sinkholes (Do NOT Fill!)
  - Depth to overflow
  - Erosion
  - Sedimentation
  - Distressed vegetation
  - Overflow issues

Non-Routine Maintenance

Maintenance Inspection Results



Non-Routine Maintenance

More Routine Maintenance = Less Non-Routine Maintenance

Non-Routine Maintenance

Inflows – Sheet Flow

Non-Routine Maintenance

Inflows – Concentrated Flow

Non-Routine Maintenance

Filter Bed – Sinking / Failure

Non-Routine Maintenance

Filter Bed - Dewatering

Non-Routine Maintenance

Side Slopes

Non-Routine Maintenance

Vegetation - Invasives

Non-Routine Maintenance

Vegetation - Distress

Non-Routine Maintenance

Outlet

Operational Structure

Routine Maintenance

- Scheduled Routes
- Production Oriented
- Set Crews, Light Equipment

Non-Routine Maintenance

- Individual Dispatches
- Design Consideration in Advance
- Variable, Skilled Crews, Heavier Equipment

Thanks!

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