Developing and Implementing the Phosphorus Control Plan

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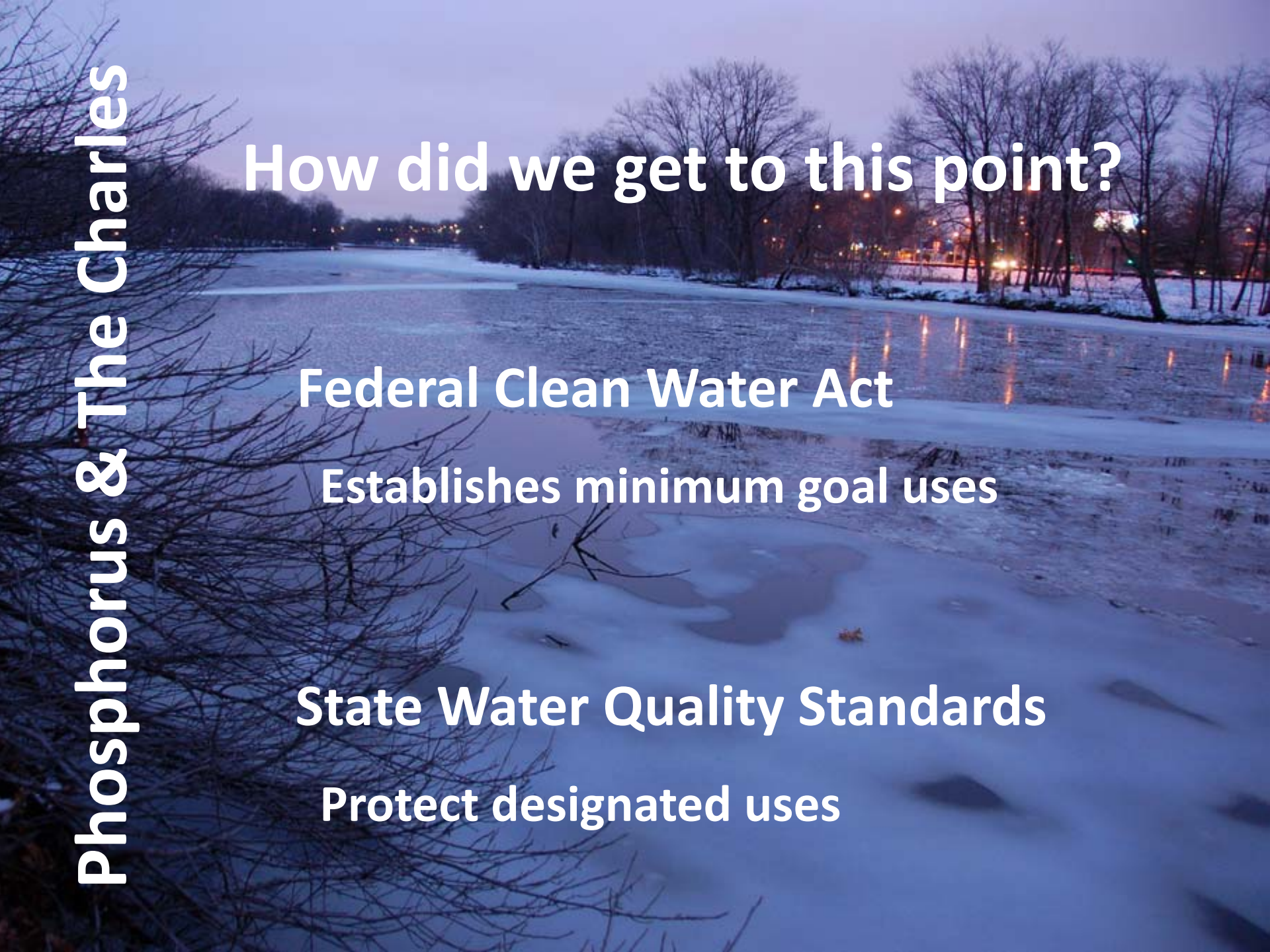
Phosphorus Control Plan

Today's Discussion

Background & Basis for Proposing PCP Requirements

- Lower Charles River Phosphorus TMDL
- Phosphorus sources in stormwater
- Recommended stormwater treatment controls



Phosphorus & The Charles

How did we get to this point?

Federal Clean Water Act

Establishes minimum goal uses

State Water Quality Standards

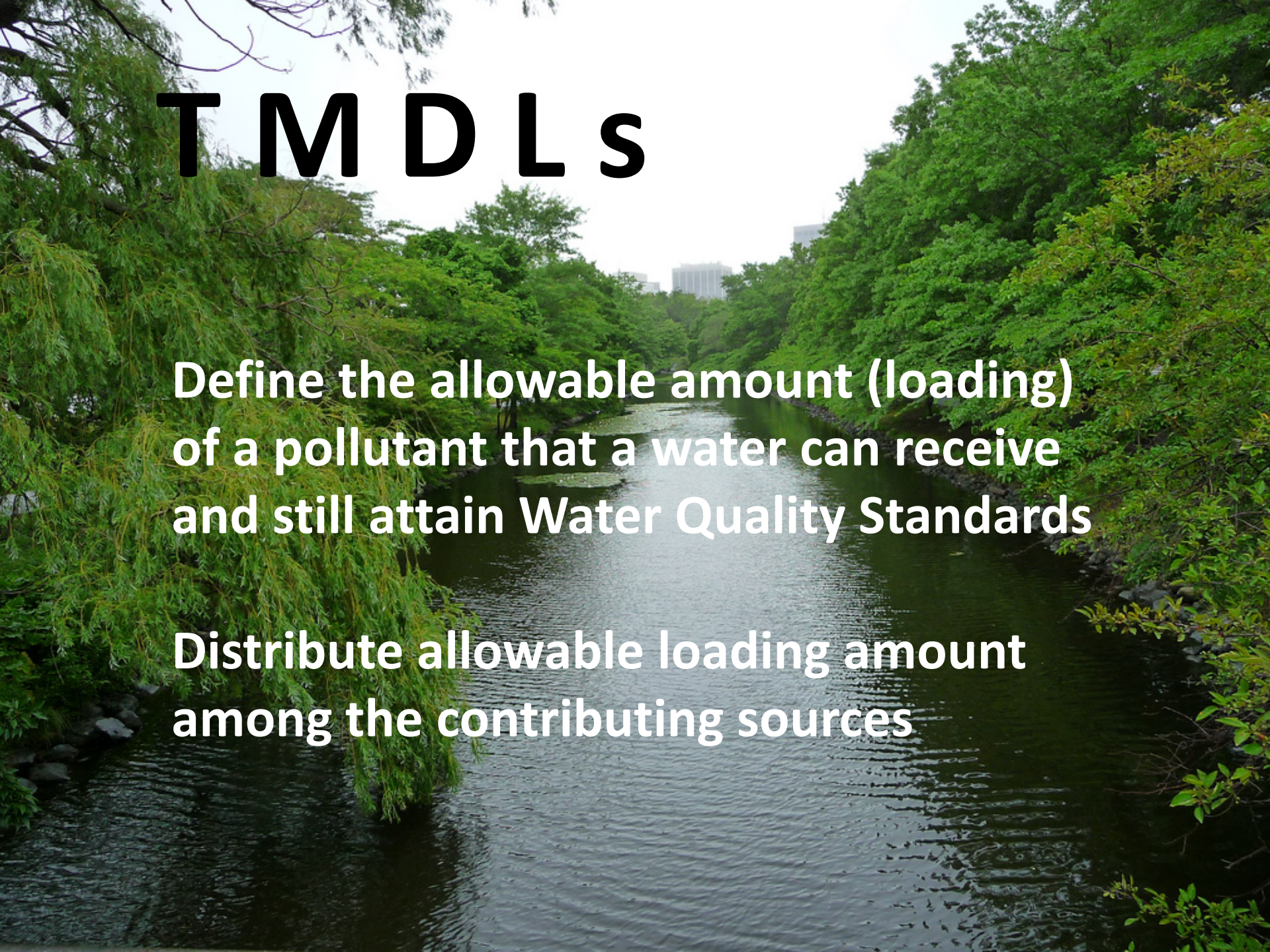
Protect designated uses

State required to assess water quality & determine if waters are:

Attaining State's Water Quality Standards?

Pollution solution

Starts with a pollutant loading-budget study called a Total Maximum Daily Load (TMDL)



TMDLs

Define the allowable amount (loading) of a pollutant that a water can receive and still attain Water Quality Standards

Distribute allowable loading amount among the contributing sources

Permit Requirements and Link to Wasteload Allocations in Approved TMDLs

NPDES Permit Regulations

§ 122.44(d)vii(B)

Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with the assumptions and requirements of any available wasteload allocation for the discharge prepared by the State and approved by EPA pursuant to 40 CFR 130.7.

Toxic cyanobacteria “blue-green” bloom

Lower Charles August 2006

Warning Posted Lower Charles River

Summary

EXCESSIVE

PHOSPHORUS

Adverse Water Quality Impacts on Recreation and Aquatic Life

Reduced clarity

Noxious scums

Toxic blooms

Surface waters choked with plant matter

Low dissolved oxygen for aquatic life (e.g., fish)

Slippery (dangerous) cobbles and boulders

Pollutant Load Allocations

Lower Charles River Phosphorus TMDL
Pollutant Load Allocations

Performed model simulations to determine pollutant load (nutrients) allocations that are necessary to attain water quality standards

Allocations were developed for major contributing sources of phosphorus to the Lower Charles River that were quantified using data and modeling

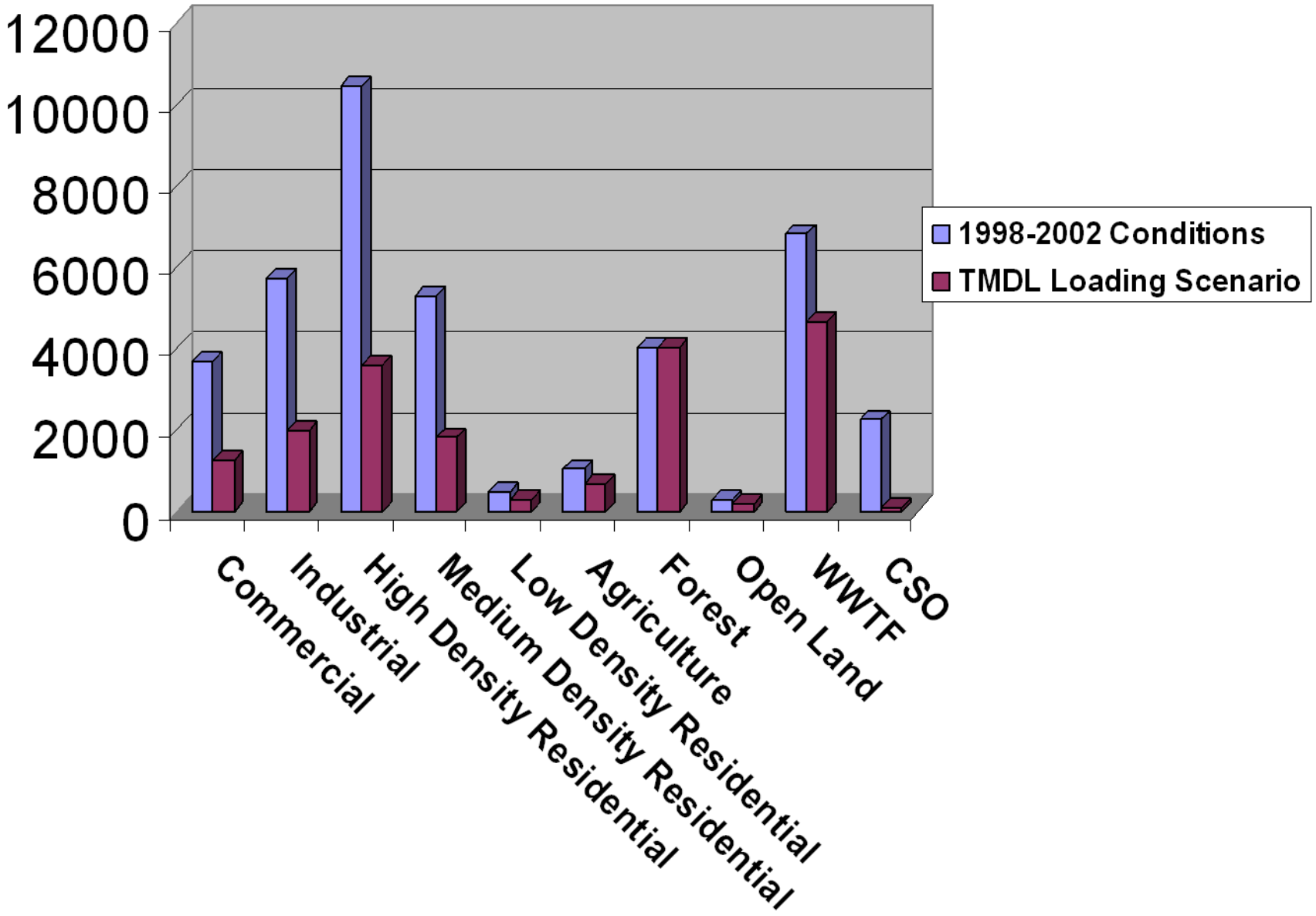
- Upstream watershed at Watertown Dam
- Major tributaries to the Lower Charles
- Combined Sewer overflows

Phosphorus reductions by land cover for entire watershed were also estimated

Lower Charles River Phosphorus TMDL Waste Load Allocations

Source	Existing Load (kg/year) (1998-2002)	Waste Load Allocation (kg/year)	% Reduction
Upstream of Watertown Dam	28,925	15,109	48%
CSOs	2,263	90	96%
Downstream of Watertown Dam	8,836	3,370	62%
TOTAL	40,050	18,565	54%

Average annual Phosphorus loading to the Charles by source category for current TMDL conditions (kg/yr)



Charles River Watershed Community Franklin	Commercial	Industrial	High Density Residential	Medium Density Residential	Low Density Residential	Agriculture	Forest	Open Land	Total	Percent Reduction Required
Drainage Area (ha)	87.5	351.2	110.5	1,455.0	597.6	119.8	2,966.7	600.3	6,288.6	
1998-2002 Loading (kg/yr)	148.6	516.4	125.0	823.5	27.2	60.6	386.8	20.6	2,108.7	
TMDL Loading (kg/yr)	51.2	178.1	43.1	284.0	14.9	39.1	386.8	13.3	1,010.6	52.1%

Source: Excerpt from the Final Total Maximum Daily Load for Nutrients in the Lower Charles River Basin, Massachusetts, CN 301.0, June, 2007

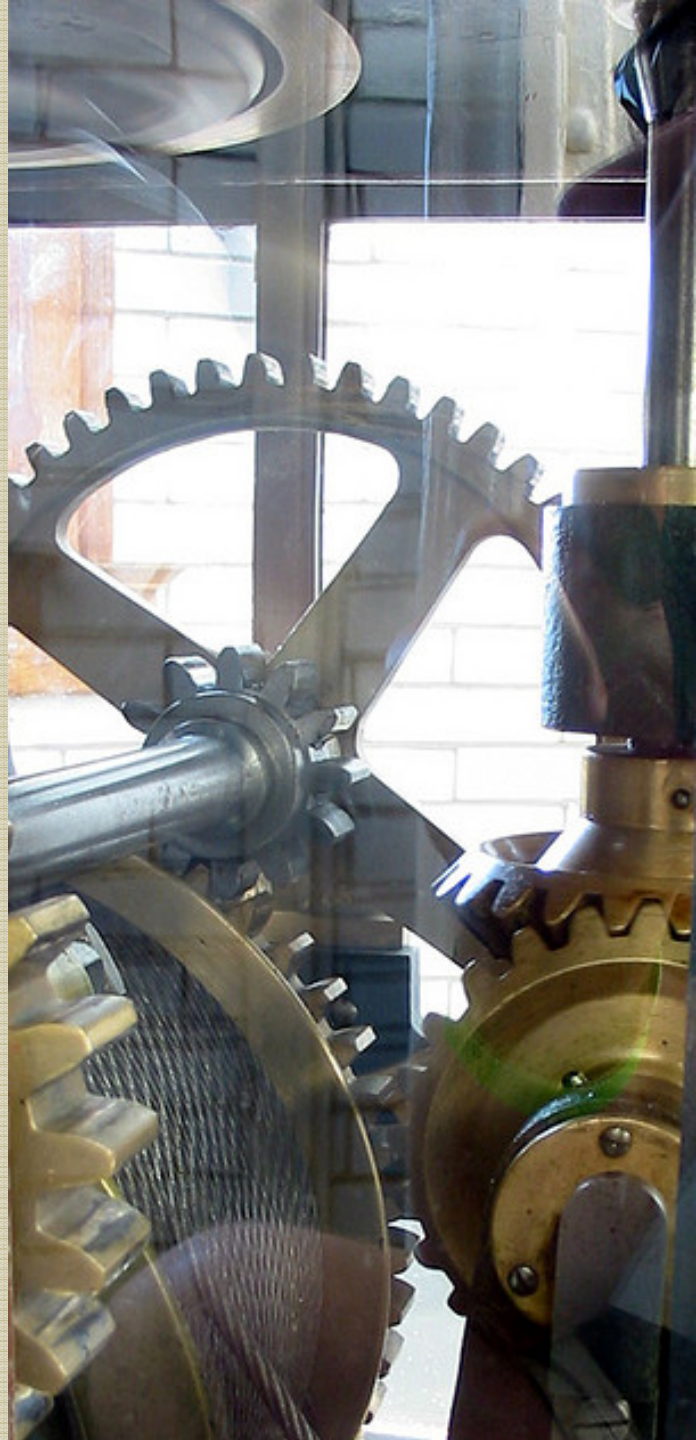
TMDL Implementation Key Components

Storm Water Management

Find and Remove Illicit Sanitary Connections to Storm Drains

Reduce Overflows from Combined Sewers

Year-Round Phosphorus Reductions at Wastewater Facilities



TMDL Implementation

Adaptive Management Process

time and money . . .

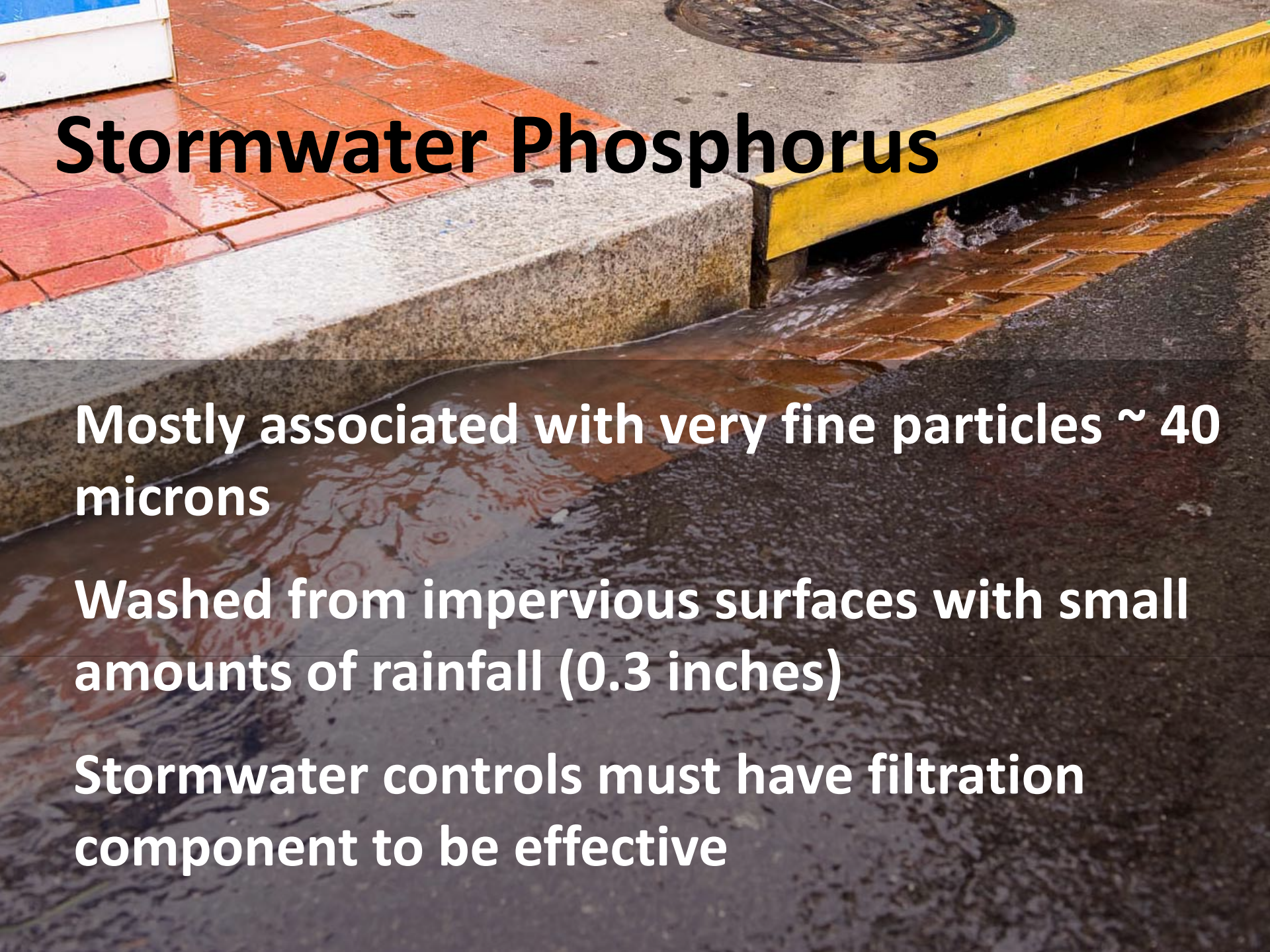
It's an iterative process involving:

Phased implementation of pollution controls

Progress is measured by a monitoring program

Ultimate Goal = reduce algal blooms attain standards

Sources of Phosphorus



Stormwater Phosphorus

- Mostly associated with very fine particles ~ 40 microns
- Washed from impervious surfaces with small amounts of rainfall (0.3 inches)
- Stormwater controls must have filtration component to be effective

Non-Structural BMPs Eligible for Phosphorus Reduction Credits (BMPs)

Enhanced sweeping program

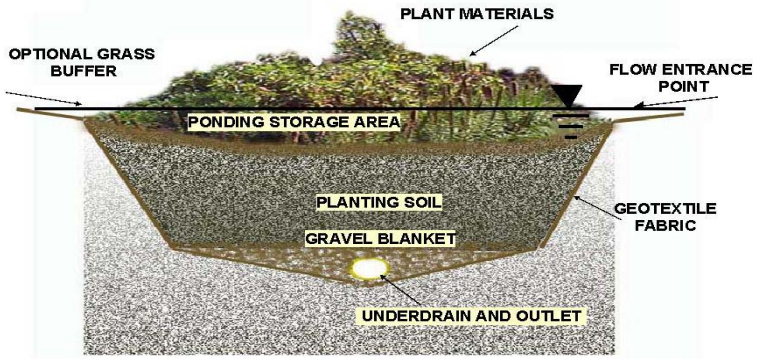
Semi-annual catch basin cleaning

No application of fertilizers containing phosphorus

Weekly leaf litter and organic debris collection program

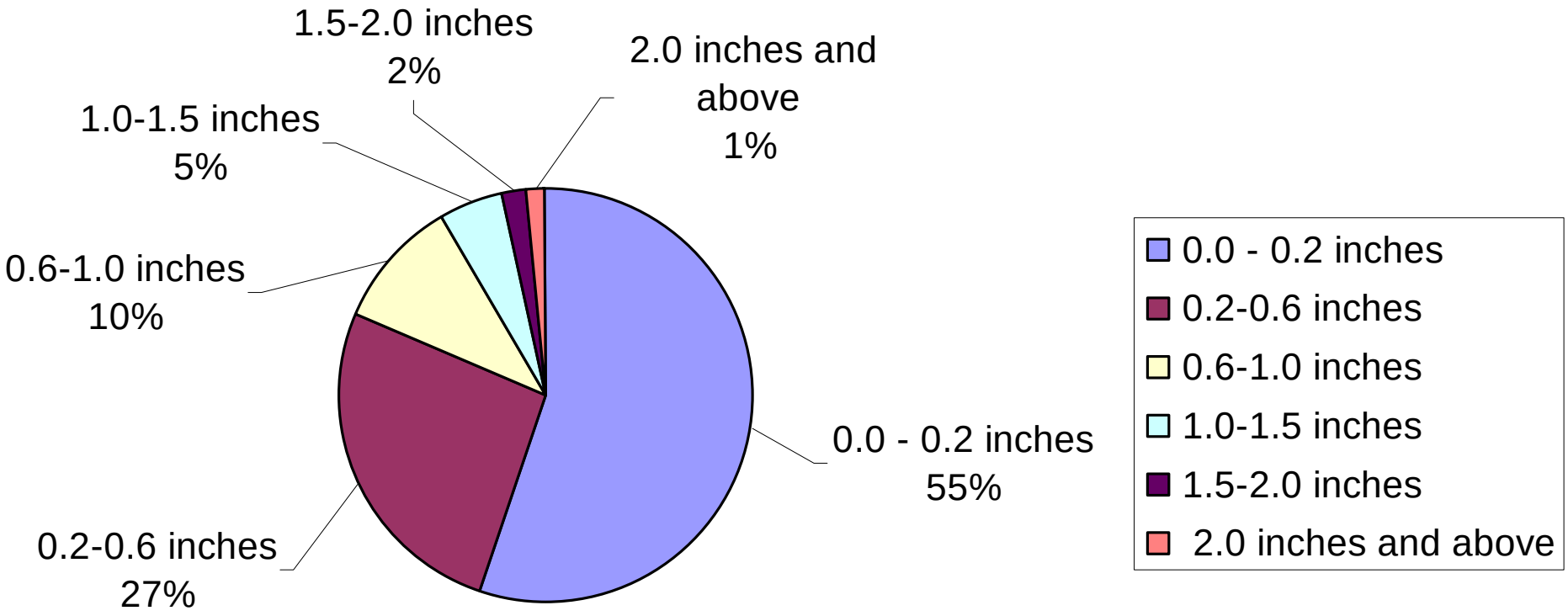
Figure 4. *A*, Pelican Series P mechanical sweeper and *B*, Johnston 605 Series vacuum sweeper, used in the evaluation of sweeper efficiencies.

Example Structural BMPs

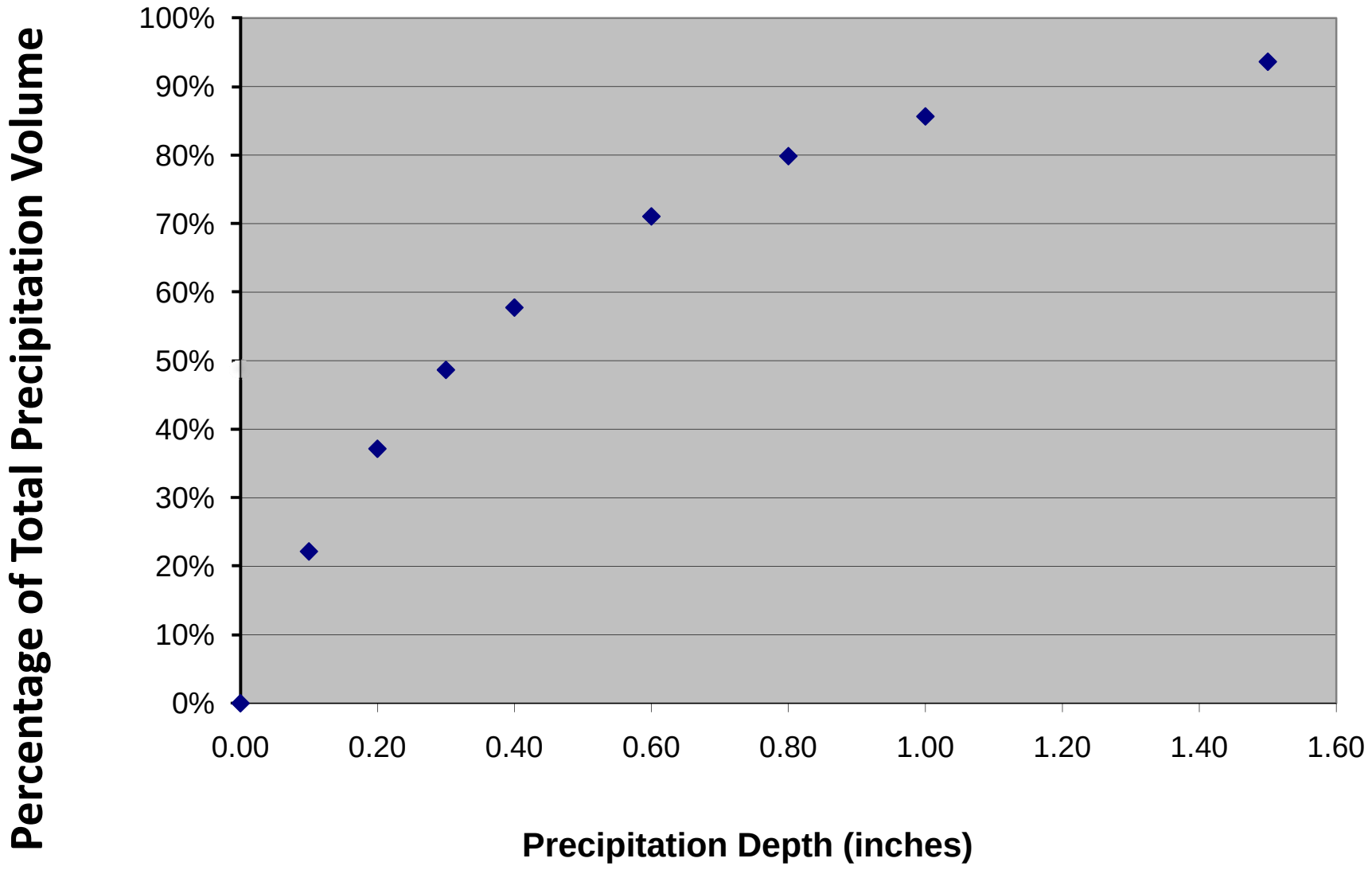


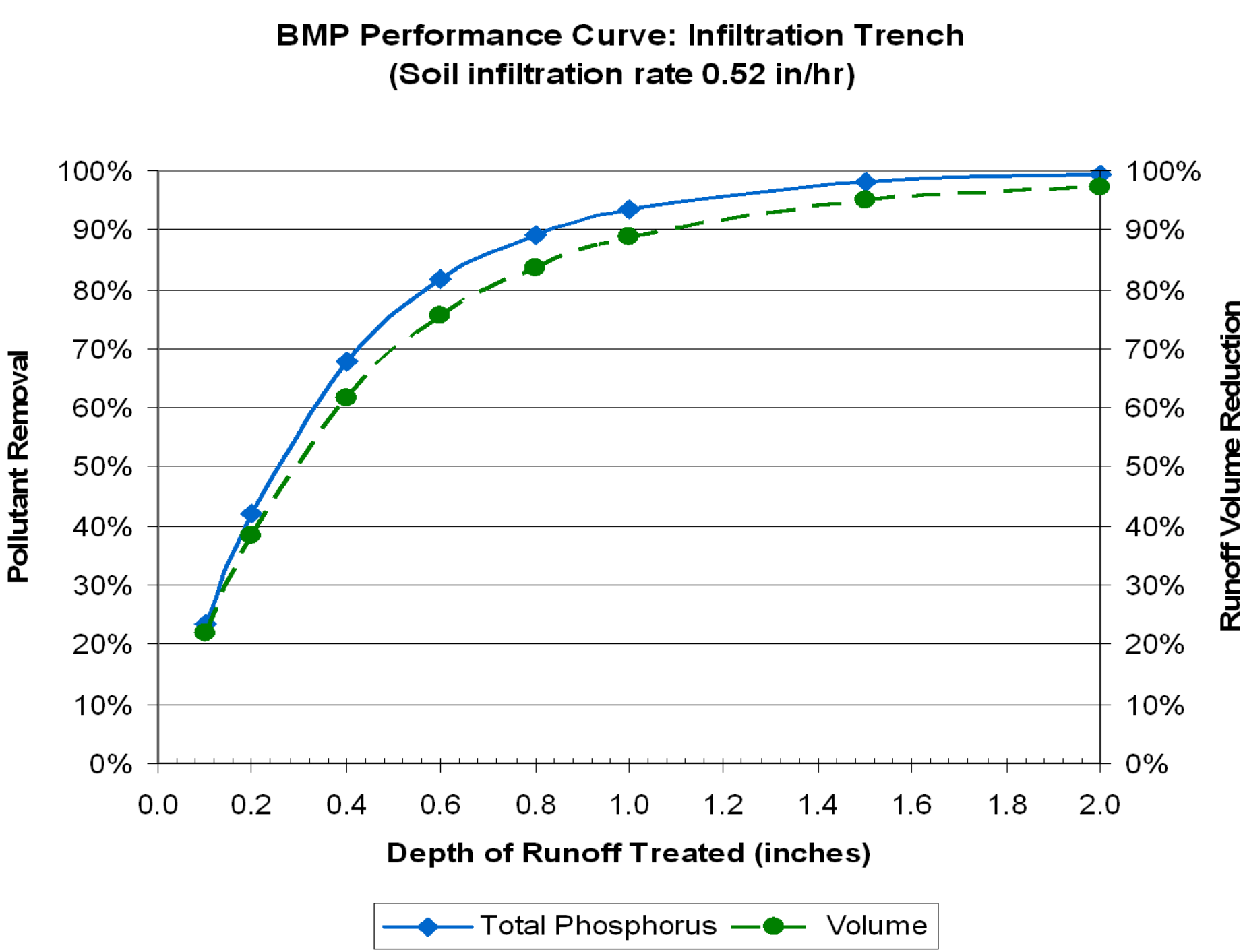
More Structural BMPs

Percentage of Total Number of Rainfall Events Based on Size of Rain Events - Boston, MA (1948-2004)



Precipitation event and cumulative volume (depth) distribution Boston, MA (1948 – 2004)




BMP Performance Curve: Infiltration Trench
(Soil infiltration rate 0.52 in/hr)
Pollutant Removal
Runoff Volume Reduction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
Depth of Runoff Treated (inches)
Total Phosphorus
Volume

Draft North Coastal MS4 Permit
Phosphorus Control Plan (PCP)

Develop phosphorus control plan to meet TMDL pollutant load reduction

PCP to include non-structural and structural control practices

Implement PCP Structural retrofit projects likely in MS4s with high pollutant load reduction requirement

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Charles @ night – Credit: http://www.flickr.com/photos/soelin/5347754045/

Charles Winter – Credit: http://www.flickr.com/photos/cdevers/4288152820/

Rainy Charles walk – Credit:

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Blue-green bloom – Credit: EPA

Warning poster – Credit: CRWA

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Lighthouse gears – Credit:

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Rowers – Credit: http://www.flickr.com/photos/haoli/2962973148/

Stormwater Drain – Credit: EPA

Street sweepers – Credit: USGS

Both Structural Diagrams – Credit : Tetera Tech Inc.

LID sidewalk – Credit: LID sidewalk

http://www.flickr.com/photos/12806078@N04/1336910652/

Both LID streets – Credit: EPA

LID parking lot – Credit: EPA

Charles single rower – Credit:

http://www.flickr.com/photos/cdevers/4666759917/

Developing and Implementing the Phosphorus Control Plan

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Template workbooks are available for download

www.epa.gov/ne/npdes/stormwater/draft_manc_sms4gp.html

- Non-structural Reductions Workbook
- Structural Reductions Workbook
- Reductions Workbooks Manual

Draft Permit part 2.2.1(d)

i. Implementation and completion timeline
ii. Priority ranking of areas
iii. Description of non-structural controls
iv. Description of structural controls
v. Implementation scope (Total vs. MS4-Only)
vi. Calculation of phosphorus loads
vii. Calculation of required percent reduction
viii. Elements of the PCP
ix. Elements of the PCP progress report
x. Reporting of estimated change in phosphorus load

Phosphorus Control Plan Template

Today:

iii. Description of non-structural controls

Wkbk2_Non-Structural Calculator.xls

iv. Description of structural controls

Wkbk3_Structural Calculator.xls

% Effectiveness Approach

Load x % Effectiveness = Reduction

Area = 2 acres

Commercial land use = 1.5 (lb/acre/yr)

Phosphorus Load Export (PLE) rate

2 acres x 1.5 (lb/acre/yr) = 3 lb/year

% Effectiveness Approach

Load x % Effectiveness = Reduction

Street sweeping with a weekly frequency using regenerative air technology: 8%

3 lb/year

% Effectiveness Approach

Load x % Effectiveness = Reduction

3 lbs/yr x 8% = 0.24 lb/year

= 0.11 kg/year

Required reduction (Franklin) = 1,098 kg/year

Non-structural Calculator

- Introductory worksheet
- Summary worksheet
- Four BMP worksheets:
  - Street sweeping
  - Catch basin cleaning
  - Phosphorus fertilizer elimination
  - Leaf litter pickup
- Constants worksheet

Introduction

- Contents and Instructions
- Color key

	Beige cells: instructions
	Yellow cells: input data
	White cells: constants and coefficients
	Green cells: calculations
	Blue cells: results

Summary

	(lb/yr)	(kg/yr)
Scope of Phosphorus Control Plan		Total
1998-2002 Phosphorus Load	4,648.88	2,108.72
Percent Reduction Required		52.1%
Required Phosphorus Reduction	2,226.82	1,010.08
Street Sweeping	120.42	54.62
Catch Basin Cleaning	52.24	23.70
Phosphorus Fertilizer Elimination	398.01	180.54
Leaf Litter Pickup	209.81	95.17
Total Non-structural Reductions	**780.47**	**354.02**
Percent Non-structural Reductions	**16.8%**	**16.8%**

Summary

Wkbk2_Non-Structural Calculator.xls

Table G-2 in Draft Permit

Charles River Watershed Community	Total	Percent Reduction Required
Franklin		
Drainage Area (ha)	6,288.59	
1998-2002 Loading (kg/yr)	2,108.72	
TMDL Loading (kg/yr)	1,010.58	**52.1%**

Wkbk2_Non-Structural Calculator.xls

Street Sweeping

Step 2:
Input land area data for individual sites performing street sweeping.

Individual Site Street Sweeping

Site Name	Site Land Use Category	Developed Area of Site (acres)	Composite PLE Rate (lb/acre/yr)	Frequency of Sweeping	Technology Used
Company XYZ Grounds	Commercial	2.00	1.50	Weekly	Regenerative Air/Vacuum
Riverside Condos	High Density Residential	9.30	1.00	Weekly	Regenerative Air/Vacuum
	Choose		0.00	Weekly	Regenerative Air/Vacuum

Sweeping Effectiveness	Reduction Credit (lb/yr)	Reduction Credit (kg/yr)
8.0%	0.24	0.109
8.0%	0.74	0.337
8.0%	0.00	0.000

Street Sweeping

Wkbk2_Non-Structural Calculator.xls

BMP Effectiveness:

Frequency	Sweeping Technology	Sweeping Effectiveness	References
2x/year	Mechanical Broom	1%	Center for Watershed Protection. 2008. Deriving Reliable Pollutant Removal Rates for Municipal Street Sweeping and Storm Drain Cleanout Programs in the Chesapeake Bay Basin. N. L. Law, et al.
2x/year	Regenerative Air/Vacuum	2%	
Monthly	Mechanical Broom	3%	http://www.worldsweeper.com/Street/Studies/CWPStudy/CBStreetSweeping.pdf
Monthly	Regenerative Air/Vacuum	4%	
Weekly	Mechanical Broom	5%	Monthly and weekly sweeping effectiveness from CWP report. Biannual sweeping effectiveness is best professional judgement.
Weekly	Regenerative Air/Vacuum	8%	

Street Sweeping

Wkbk2_Non-Structural Calculator.xls

Step 2:
Input land area data for individual sites performing street sweeping.

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Sweeping Effectiveness	Reduction Credit (lb/yr)	Reduction Credit (kg/yr)
8.0%	0.24	0.109
8.0%	0.74	0.337
8.0%	0.00	0.000

Individual Site Credit:	0.98	0.45

Street Sweeping

Wkbk2_Non-Structural Calculator.xls

Programmatic Street Sweeping

Land Use (LU) Category	Areas with Roads Swept (acres)	Composite PLE rate (lb/acre/yr)	Frequency of Sweeping	Technology Used
Commercial	437.52	1.50	Monthly	Mechanical Broom
Industrial	667.88	1.30	Monthly	Mechanical Broom
Freeway	268.95	0.80	Monthly	Mechanical Broom
Low Density Residential	1,491.13	0.27	Monthly	Mechanical Broom
Medium Density Residential	2,947.11	0.50	Monthly	Mechanical Broom
High Density Residential	268.53	1.00	Monthly	Mechanical Broom
Agriculture	140.00	0.45	2x/year	Mechanical Broom
Forest	1,653.00	0.12	2x/year	Mechanical Broom
Open Land	188.18	0.27	2x/year	Mechanical Broom

Street Sweeping

Wkbk2_Non-Structural Calculator.xls

Sweeping Effectiveness	Reduction Credit (lbs/yr)	Reduction Credit (kg/yr)
3%	19.67	8.92
3%	26.02	11.80
3%	6.48	2.94
3%	11.98	5.43
3%	44.19	20.05
3%	8.05	3.65
1%	0.62	0.28
1%	1.92	0.87
1%	0.50	0.23
Programmatic Credit:	119.43	54.17

Street Sweeping

Wkbk2_Non-Structural Calculator.xls

Programmatic Credit:	119.43	54.17
Individual Site Credit:	0.98	0.45
Total Street Sweeping Credit:	120.42	54.62

Street Sweeping

Wkbk2_Non-Structural Calculator.xls

DRAFT

Conversion Factors:

Value	Unit
2.47	acres per hectare
43,560	square feet per
7.4805	gallons per cubic foot
3.7854	liters per gallon
2.2046	pounds per kilogram

Street Sweeping Frequencies

2x/year
Monthly
Weekly

Scope of Phosphorus Control Plan

Total
MS4-only

Phosphorus Load Export rates:

Land Use (LU) Category	Composite PLE rate (kg/ha/yr)	Impervious PLE rate (kg/ha/yr)	Pervious PLE rate (kg/ha/yr)	Composite PLE rate (lb/acre/yr)	Impervious PLE rate (lb/acre/yr)	Pervious PLE rate (lb/acre/yr)	Reference
Choose							
Commercial	1.68	2.5	0.30	1.50	2.23	0.27	2
Industrial	1.46	2.00	0.30	1.30	1.79	0.27	2
Freeway	0.90	1.50	0.30	0.80	1.34	0.27	2
Low Density Residential	0.30	1.00	0.15	0.27	0.89	0.13	3
Medium Density Residential	0.56	1.50	0.30	0.50	1.34	0.27	2
High Density Residential	1.12	2.50	0.30	1.00	2.23	0.27	2
Agriculture	0.50	0.50	0.50	0.45	0.45	0.45	1
Forest	0.13	1.00	0.10	0.12	0.89	0.09	3
Open Land	0.30	1.00	0.25	0.27	0.89	0.22	3

References:

1	Budd, L.F., and D.W. Meals. 1994. Draft Final Report. Lake Champlain Nonpoint Source Pollution Assessment. LCBP Technical Report No. 6A. Lake Champlain Basin Program, Grand Isle, VT.
2	Shaver, E., R. Horner, J. Skupien, C. May, and G. Ridley. 2007. Fundamentals of Urban Runoff Management: Technical and Institutional Issues. North American Lake Management Society, Madison, WI, in cooperation with the U.S. Environmental Protection Agency.
3	Mattson, M.D., and R.A. Isaac. 1999. Calibration of phosphorus export coefficients for Total Maximum Daily Loads of Massachusetts's lakes. Lake Reservoir Management 15:209–219.

Conversions and Coefficients

Wkbk2_Non-Structural Calculator.xls

MassGIS Land Use to PCP Template Land Use Categories:

Mass GIS LU_CODE	Description	Template Land Use Category
1	Crop Land	Agriculture
2	Pasture (active)	Agriculture
3	Forest	Forest
4	Non-Forested Wetland	Forest
5	Mining	Open Land
6	Open Land (includes inactive	Open Land
7	Participation Recreation	Agriculture
8	Spectator Recreation	Open Land
9	Water Based Recreation	Open Land
10	Multi-Family Residential	High Density Residential
11	High Density Residential	High Density Residential
12	Medium Density Residential	Medium Density Residential
13	Low Density Residential	Low Density Residential
14	Saltwater Wetland	Water
15	Commercial	Commercial
16	Industrial	Industrial
17	Urban Open	Open Land
18	Transportation	Freeway
19	Waste Disposal	Open Land
20	Water	Water
23	Cranberry Bog	Agriculture
24	Powerline / Utility	Open Land
25	Sandy Beach	Open Land

Mass GIS LU_CODE	Description	Template Land Use Category
26	Golf Course	Open Land
29	Marina	Commercial
31	Urban Public / Institutional	Commercial
34	Cemetery	Open Land
35	Orchard	Forest
36	Nursery	Agriculture
37	Forested Wetland	Forest
38	Very Low Density Residential	Low Density Residential
39	Junkyards	Industrial
40	Brushland / Successional	Forest

Land Use Category	Mass GIS LU_CODE
Commercial	15, 29, 31
Industrial	16, 19, 39
Freeway	18
Low Density Residential	13, 38
Medium Density Residential	12
High Density Residential	10, 11
Agriculture	1, 2, 7, 23, 36
Forest	3, 4, 35, 37, 40
Open Land	5, 6, 7, 8, 9, 17, 19, 24, 25, 26, 34
Water	14, 20

Wkbk2_Non-Structural Calculator.xls

	(lb/yr)	(kg/yr)
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1998-2002 Phosphorus Load	4,648.88	2,108.72
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Catch Basin Cleaning	52.24	23.70
Phosphorus Fertilizer Elimination	398.01	180.54
Leaf Litter Pickup	209.81	95.17
Total Non-structural Reductions	**780.47**	**354.02**
Percent Non-structural Reductions	**16.8%**	**16.8%**

Summary

Structural Calculator

- Introductory worksheet
- Summary worksheet
- Six BMP worksheets:
  - Infiltration
  - Biofiltration
  - Other filtration
  - Stormwater wetlands
  - Detention
  - Rain water harvesting
- BMP effectiveness worksheet
- Constants worksheet

Introduction

- Contents and Instructions
- Color key

	Beige cells: instructions
	Yellow cells: input data
	White cells: constants and coefficients
	Green cells: calculations
	Blue cells: results

Wkbk3 Structural Calculator.xls

Structural BMP Summary	(lb/yr)	(kg/yr)
Scope of Phosphorus Control Plan		Total
1998-2002 Phosphorus Load	4,648.88	2,108.72
Percent Reduction Required		52.1%
Percent Non-structural Reduction		16.8%
Infiltration	529.10	240.00
Biofiltration	463.37	210.18
Other Filtration	155.30	70.45
Stormwater Wetlands	388.04	176.01
Detention	73.64	33.40
Rainwater Harvesting	40.16	18.22
Total Structural Reductions	**1,649.60**	**748.26**
Structural Reduction Required		35.3%
Structural Reduction Achieved		**35.5%**

Summary

Wkbk3 Structural Calculator.xls

Infiltration

Input Infiltration BMPs

Site Name	BMP Type	Land Use	Impervious PLE rate (lb/acre/yr)	Impervious Catchment Area (acres)	Water Quality Depth (in)
Town Garage	Infiltration trench / subsurface retention	Commercial	2.23	15.00	0.50
Smith Driveway	Porous pavement	Medium Density Residential	1.34	0.03	1.00
About 3,000 driveways	Porous pavement	Medium Density Residential	1.34	90.00	1.00
Town Library	Infiltration basin / raingarden / bioretention areas	Commercial	2.23	10.00	0.50
School	Infiltration basin / raingarden / bioretention areas	Commercial	2.23	5.00	0.50

Infiltration

Wkbk3 Structural Calculator.xls

Input Infiltration BMPs

Impervious Catchment Area (acres)	Water Quality Depth (in)	Water Quality Volume (yd^3)	Treatment Effectiveness	Reduction Credit (lbs/yr)	Reduction Credit (kg/yr)
15.00	0.50	1,008	75%	25.10	11.39
		4	90%	0.04	0.02
		12,100	90%	108.44	49.19
		672	80%	17.85	8.10
		336	80%	8.93	4.05
		Infiltration BMPs Credit:		529.10	240.00

Infiltration

Wkbk3 Structural Calculator.xls

Input Infiltration BMPs

BMP Type	Water Quality Depth (in)	Water Quality Volume (yd^3)	Treatment Effectiveness	Reduction Credit (lbs/yr)	Reduction Credit (kg/yr)
Infiltration trench / subsurface retention	0.50	1,008	75%	25.10	11.39
		4	90%	0.04	0.02
		12,100	90%	108.44	49.19
		672	80%	17.85	8.10
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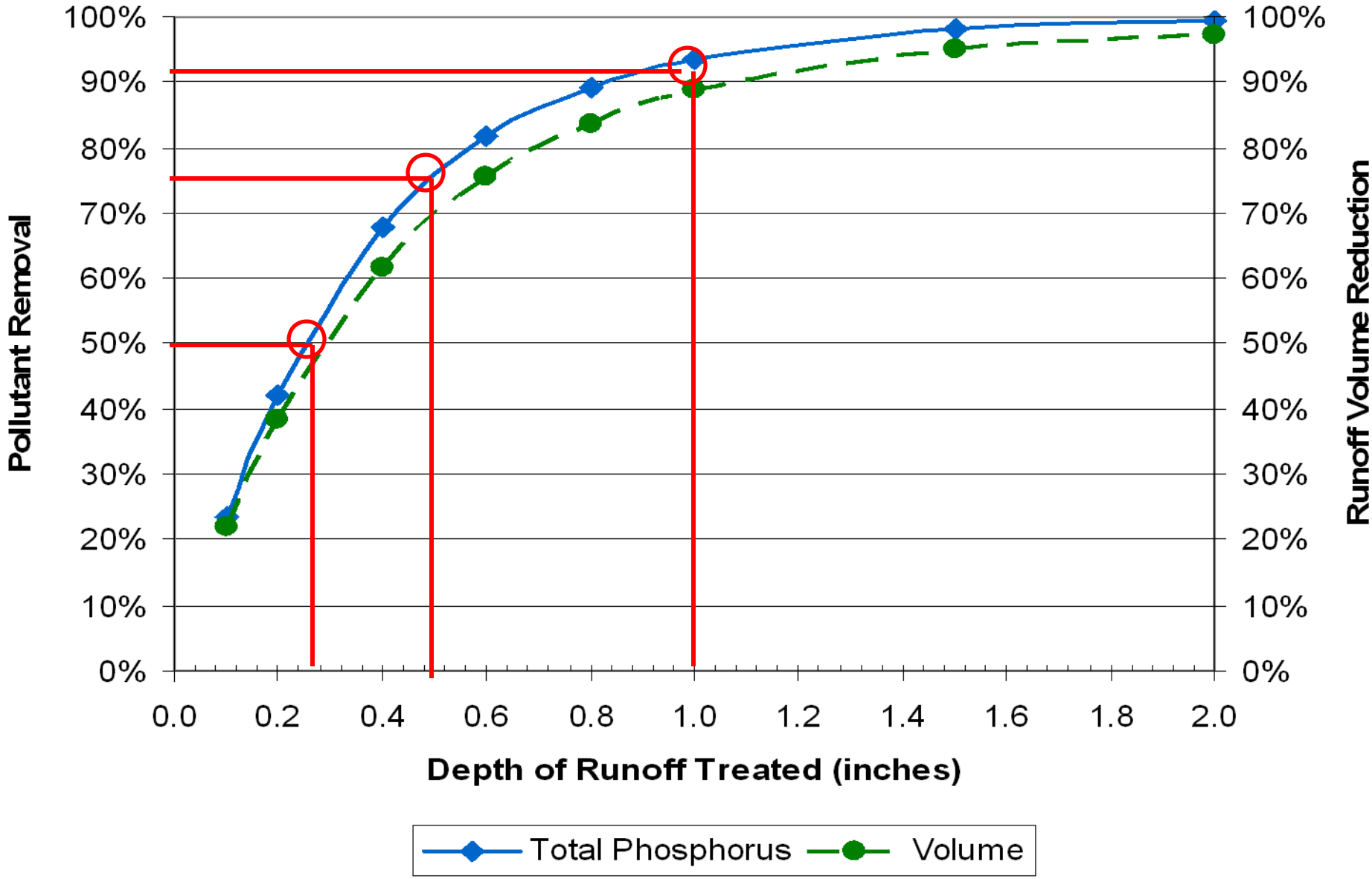
Infiltration


BMP Performance Curve: Infiltration Trench
(Soil infiltration rate 0.52 in/hr)
Pollutant Removal
Runoff Volume Reduction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
Depth of Runoff Treated (inches)
Total Phosphorus
Volume

Wkbk3 Structural Calculator.xls

BMP (no underdrain)	Effectiveness (0.25" treatment depth)	Effectiveness (0.5" treatment depth)	Effectiveness (1.0" treatment depth)	References
Infiltration basin / raingarden / bioretention areas	60%	80%	95%	See Spreadsheet 9: Structural BMP Effectiveness Matrix
Infiltrating water quality swale	60%	80%	95%	
Infiltration trench / subsurface retention	50%	75%	90%	
Porous pavement	50%	75%	90%	

Infiltration

Wkbk3 Structural Calculator.xls

BMP Effectiveness		Water Quality Depth		
	BMP type	0.25"	0.5"	1.0"
Infiltration BMPs (no underdrain)	Infiltration basin / raingarden / bioretention areas	60%	80%	95%
	Infiltrating water quality swale	60%	80%	95%
	Infiltration trench / subsurface retention	50%	75%	90%
	Porous pavement	50%	75%	90%
Biofiltration BMPs (with underdrain)	Raingarden / biofiltration	40%	60%	75%
	Dry water quality swale	40%	60%	75%
Other filtration	Tree box filters	35%	45%	60%
	Sand filter	35%	45%	60%

BMP Effectiveness

Wkbk3 Structural Calculator.xls

Reference 1				Reference 2		
Effectiveness	Source	WQD	Comments	Effectiveness	Source	WQD
61%	TetraTech	0.25"	B soils (0.52 in/hr infiltration)	82%	TetraTech	0.5"
75%	Mid-Atlantic Water Program	1.0"	+/-15%	20% to 90%	MassDEP	0.5"
48%	TetraTech	0.25"	B soils (0.52 in/hr infiltration)	74%	TetraTech	0.5"
80%	Mid-Atlantic Water Program	1.0"	A/B soils; +/-15%			
38%	TetraTech	0.25"		58%	TetraTech	0.5"
83%	CWP Database 2000	N/A	Median, few data points	20% to 90%	MassDEP	0.5"
9% to 70%	Filterra 2010	N/A	See comment	50% to 68%	MaSTEP	Referencing Universi of Virginia study
60%	Mid-Atlantic Water Program	1.0"	+/-15%	59%	CWP Database 2007	N/A

BMP Effectiveness

Wkbk3 Structural Calculator.xls

Reports looked at:	
Center for Watershed Protection. 2000. National Pollutant Removal Performance Database for Stormwater Treatment Practices. 2nd ed.	http://www.stormwatercenter.net/Library/STP-Pol
Center for Watershed Protection. 2007. National Pollutant Removal Performance Database for Stormwater Treatment Practices. 3rd ed.	http://www.stormwaterok.net/CWP%20Documen 07%20Natl%20Pollutant%20Removal%20Perfo
Lenth, J. et al. 2010. White Paper. Filterra® Bioretention Systems: Technical Basis for High Flow Rate Treatment and Evaluation of Stormwater Quality Performance	http://www.filterra.com/images/uploads/2010-09- 20_Filterra_High_Flow_Rate_Treatment_Whitep
Massachusetts Department of Environmental Protection. 2008. Volume 2, Chapter 2: Structural BMP Specifications for the Massachusetts Stormwater Handbook.	http://www.mass.gov/dep/water/laws/v2c2.pdf
Massachusetts Stormwater Evaluation Project (MaSTEP). 2011. "Stormwater Technologies Clearinghouse." Accessed May 5, 2011.	http://mastep.net/index.cfm
Mid-Atlantic Water Program. 2009. Developing Best Management Practice Definitions and Effectiveness Estimates for Nitrogen, Phosphorus and Sediment in the Chesapeake Bay Watershed.	http://archive.chesapeakebay.net/pubs/BMP_ASS
TetraTech. Stormwater Best Management Practices (BMP) Performance Analysis. 2010.	http://www.epa.gov/ne/npdes/stormwater/assets Analysis-Report.pdf

BMP Effectiveness

Wkbk3 Structural Calculator.xls

Input Infiltration BMPs

	Water Quality Volume (yd^3)	Treatment Effectiveness	Reduction Credit (lbs/yr)	Reduction Credit (kg/yr)
	1,008	75%	25.10	11.39
	4	90%	0.04	0.02
	12,100	90%	108.44	49.19
	672	80%	17.85	8.10
	336	80%	8.93	4.05
	Infiltration BMPs Credit:		529.10	240.00

Infiltration

Wkbk3 Structural Calculator.xls

Treated Area Summary	Impervious Area (acre)	Impervious Area Treated (acre)	% Impervious Treated
Commercial	289.41	265.00	92%
Industrial	455.50	425.00	93%
Freeway	148.07	120.00	81%
Low Density Residential	454.72	410.00	90%
Medium Density Residential	568.23	520.03	92%
High Density Residential	136.92	115.10	84%
Agriculture	57.90	50.00	86%
Forest	187.28	150.00	80%
Open Land	103.92	100.00	96%
Total area	2,401.95	2,155.13	90%

Summary

Thank you

Questions ?

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