Phosphorus Control Plan for Charles TMDL under Draft MS4 Permit

Municipal Phosphorus Reduction Training

Natick, MA

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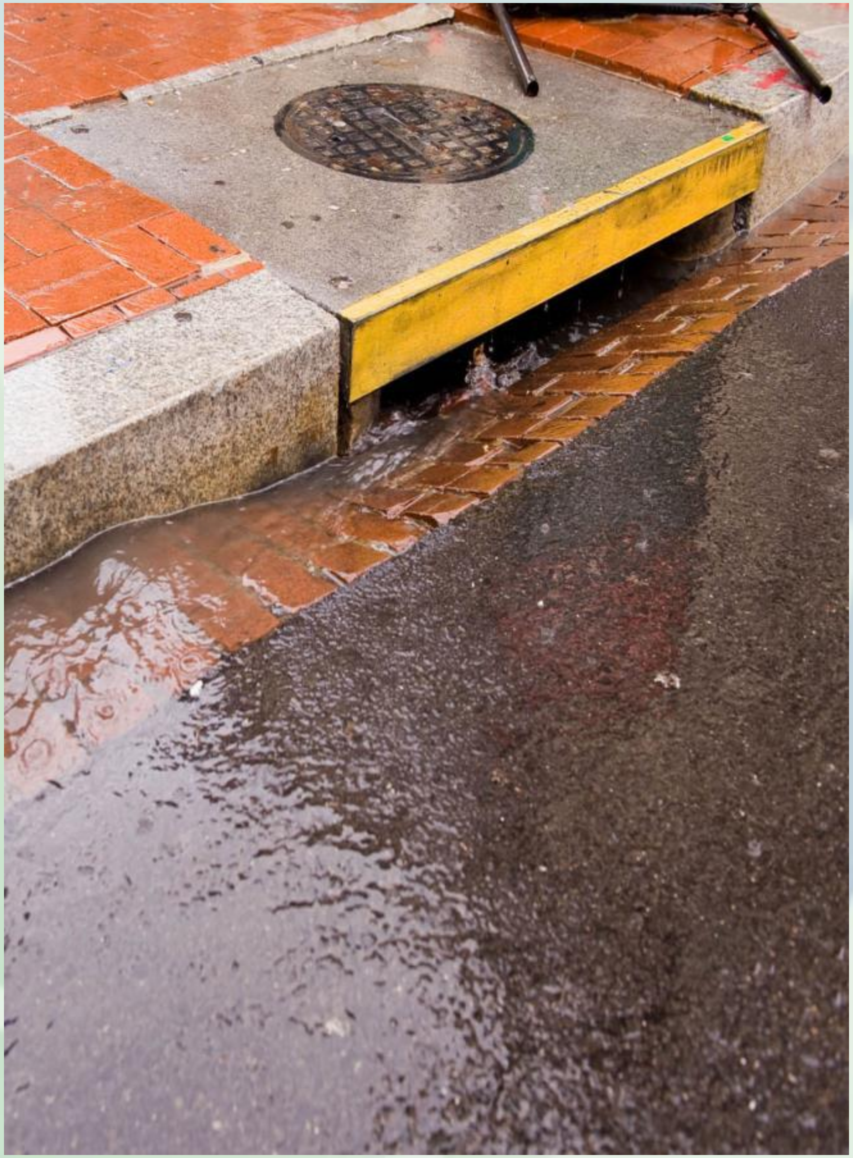
Presentation Outline

- Water quality issues associated with phosphorus
- Stormwater component of Charles phosphorus TMDLs
- Using a Phosphorus Control Plan to meet the TMDL stormwater targets

Urban Stormwater Phosphorus



- Phosphorus is ubiquitous in environment but not naturally mobile
- Phosphorus sources include natural soils, added fertilizer, leaf litter and vehicle exhaust
- Associated with very fine particles ~ 40 microns
- Much is washed from impervious surfaces with small amounts of rainfall (e.g. 0.1-0.3 inches)
- No all stormwater controls are effective

Effects of Excessive Phosphorus

EXCESSIVE PHOSPHORUS

→

- Reduced clarity
- Noxious algae scums
- Toxic algae blooms
- Surface waters choked with aquatic plants
- Low dissolved oxygen for aquatic life (e.g., fish)

Stormwater Component of Charles River TMDLs

- Requires reduction of stormwater phosphorus by about 54%
- Land use based reductions:
  - 0% = forest and water
  - 35% = open and crop land
  - 45% = low density residential
  - 65% = medium and high low density residential, commercial and industrial, transportation

Phosphorus Control Plan (PCP)

Charles River Phosphorus TMDL

"To address the discharge of phosphorus from its MS4, the permittee shall develop a Phosphorus Control Plan (PCP) designed to reduce the amount of phosphorus in stormwater (SW) discharges from its MS4 to the Charles River and its tributaries".

PCP – Phased Approach

5 years after permit effective date	5-10 years after permit effective date	10-15 years after permit effective date	15-20 years after permit effective date
Create Phase 1 Plan	Implement Phase 1 Plan		
	Create Phase 2 Plan	Implement Phase 2 Plan	
		Create Phase 3 Plan	Implement Phase 3 Plan

Phase 1 - First 5 Years

Component	Year 1	Year 2	Year 3	Year 4	Year 5
Legal Analysis					
Funding Source Assessment.					
Define PCP Area, Baseline Phosphorus Load and Phosphorus Reduction Requirement and Allowable Phosphorus Load					
Description of Phase 1 Planned Nonstructural Controls					
Description of Phase 1 Planned Structural Controls					
Description of Operation and Maintenance Program for Structural Controls					
Phase 1 Implementation Schedule					
Estimated Cost for implementing Phase 1 of the PCP					
Complete Written Phase 1 PCP					

Choosing a PCP Area

- Community PCP area
  - Entire community within TMDL watershed
- Regulated PCP area
  - MS4 regulated area within TMDL watershed
- Community vs. regulated
  - Community PCP can be easier to manage
  - Same total load reduction (lb/yr)
  - Higher percent load reduction (%) in regulated area because load reduction is applied to smaller extent

Load Reduction Requirement Percent by PCP Area

From 2014 Draft Permit, Tables F-1 & F-2 (lb/yr)

Community	Community - Table F1			Regulated Area - Table F2		
	Baseline (lb/yr)	Reduction (lb/yr)	Reduction (%)	Baseline (lb/yr)	Reduction (lb/yr)	Reduction (%)
Bellingham	2,112	759	36	1,790	670	37
Franklin	5,219	1,916	37	5,146	1,905	37
Medway	2,351	743	32	2,293	723	32
Natick	2,531	946	37	2,276	886	39
Somerville	1,870	300	16	448	95	21
Watertown	2,567	1,352	53	2,567	1,352	53
TOTAL	**14,538**	**5,257**	**36**	**12,729**	**4,961**	**39**

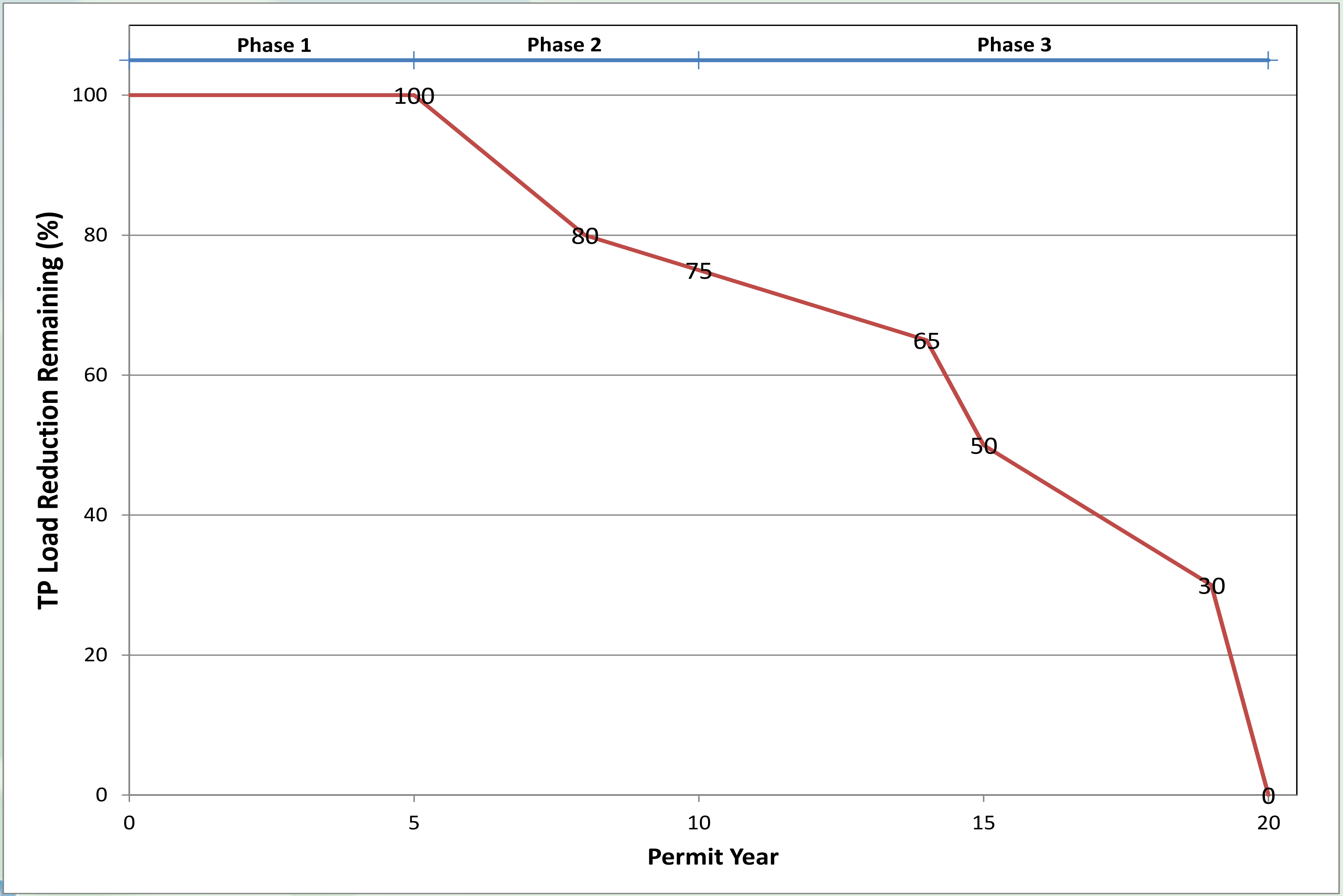
Note that these reduction are lower than those in the Charles TMDL and reported in Appendix G of the 2010 draft MS4 permit. Some credits have been given for the state-wide ban on phosphorus in residential fertilizers and the reduction of phosphorus expected as with the MS4 IDDE program.

Phase 2 and 3

Complete By Year 10 and 15

- Update Legal analysis
- Description of Phase 2 or 3 planned nonstructural controls
- Description of Phase 2 or 3 planned structural controls
- Updated description of Operation and Maintenance Program
- Phase 2 implementation schedule
- Estimated cost for implementing Phase 2 or 3 of the PCP
- Complete written Phase 2 or 3 Plan

Phosphorus Load Reduction Schedule



What About New Development?

- New load from development since 2005 adds to the base load
- New load is added to load reduction requirement i.e. no net increase

Phosphorus Reduction Methods

- Enhanced non-structural stormwater controls
- Structural stormwater controls
- Equivalent terms:
  - Stormwater controls
  - Stormwater practices
  - Best Management Practices (BMPs)

Enhanced Non-Structural Controls/BMPs

- Enhanced non-structural controls/BMPs
  - Enhanced sweeping program
  - Semi-annual catch basin cleaning
  - No application of fertilizers containing phosphorus to lawns
  - Weekly leaf litter and organic debris collection program

Attachment 2 to App. F of MS4 Permit provides methodology for calculating phosphorus reduction credits for enhanced non-structural controls/BMPs

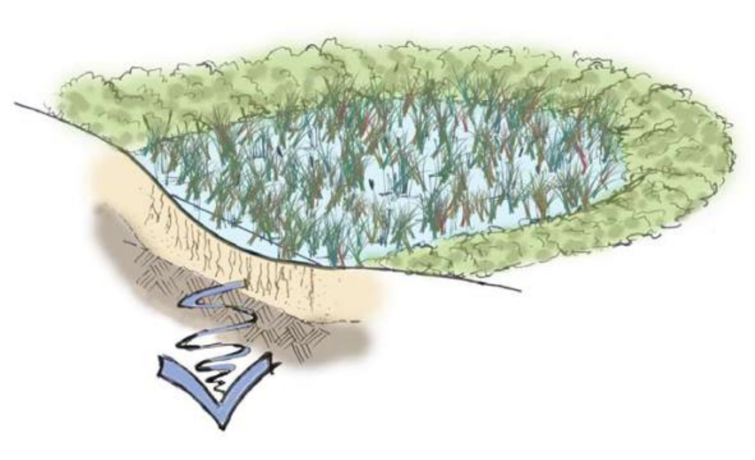
Enhanced Non-Structural Controls/BMPs
Phosphorus Reduction Credits

- Enhanced sweeping program (0.25-10% credit)
  - Credit (lb/yr) = IA x $PLER_{IA}$ x PRF x AF
  - PRF = 0.01 (mechanical) to 0.10 (HE Vacuum)
  - AF = 1.0 for 12 months, 0.75 for nine months
- Semi-annual catch basin cleaning (2% credit)
  - Credit (lb/yr) = IA x $PLER_{IA}$ x PRF
  - PRF = 0.02
- No lawn application of fertilizers containing phosphorus (25% credit)
  - Credit (lb/yr) = 0.5 * Weighted PLER * Σ(Area ∗ Lawn% ∗ FF)
  - FF = 0.5
- Weekly leaf litter and organic debris collection program (5% credit)
  - Credit (lb/yr) = IA x $PLER_{IA}$ x 0.05

Structural Stormwater Controls/BMPs

For Phosphorus Reduction Credit

- Infiltration practices
  - highly effective at removing phosphorus from stormwater
  - Recharges groundwater
- Surface infiltration
  - basins, rain gardens
- Subsurface infiltration
  - trenches, chambers



Attachment 3 to App. F to the Permit provides a methodology to calculate phosphorus removal credits for structural BMPs based on physical storage capacity

Structural Stormwater Controls/BMPs
For Phosphorus Reduction Credit

- Gravel wetlands
- Stormwater wetlands
- Wet ponds
- Biofiltration systems
- Sand filter systems
- Permeable pavements
- Proprietary treatment systems

Attachment 3 to App. F to the Permit provides a methodology to calculate phosphorus removal credits for several structural BMPs based on physical storage capacity

Calculating Phosphorus Loads

- Baseline load (BL, lb/yr)
- Developed load (PDEV, lb/yr)
- Developed load incr. (PDEVincr, lb/yr)
- Load reduction (LR, lb/yr)
- BMP load reduction (BMPLR, lb/yr)

Baseline & Development Loads

Composite Method (Appendix F, Attachment 1)

- Determine land use areas within drainage area (A, ac)
- Find composite phosphorus load export rate (PLER, lb/ac/yr) in Table F1-1
- Calculate the load (L, lb/yr) for each land use:
  - L = A * PLER for each area
- Calculate total baseline load (BL, lb/yr)
  - Sum baseline loads over all land uses

Composite Coefficients

PLER = Phosphorus Loading Export Rate

Land Use	PLER (lb/ac/yr)
Commercial	1.16
Industrial	1.29
High Density Residential	1.07
Medium Density Residential	0.55
Low Density Residential	0.37
Highway	0.78
Open Land	0.33
Agriculture	0.45
Forest	0.12

Baseline & Development Loads

Composite Method Example - PLERs from Table F1-1

- Site layout
  - Hydrologic Soil Group = B
  - LD Residential 10.0 ac (1.0 ac IA, 9.0 ac PA)
  - Commercial 10.0 ac (8.0 ac IA, 2.0 ac PA)
  - $PLER_{LDR}$ = 0.37 lb/ac/yr
  - $PLER_{COMM}$ = 1.16 lb/ac/yr
- Calculations
  - L_{LDR} = 10.0 ac x 0.37 lb/ac/yr = 3.70 lb/yr
  - L_{COMM} = 10.0 ac x 1.16 lb/ac/yr = 11.60 lb/yr
  - BL = L_{LDR} + L_{COMM} = 3.70 + 11.60 = 15.30 lb/yr

Baseline & Development Loads

Distinct Method (Appendix F, Attachment 1)

- Determine pervious and impervious land use areas and within drainage area (A, ac)
- Find composite phosphorus load export rates ($PLER_{IA}$ and $PLER_{PA}$, lb/ac/yr) in Table F1-2
- Calculate the load (L, lb/yr) for each land use:
  - $L = IA*PLER_{IA} + PA*PLER_{PA}$ for each area
- Calculate total baseline load (BL, lb/yr)
  - Sum baseline loads over all land uses

Composite Coefficients

PLER = Phosphorus Loading Export Rate

Land Use	Impervious PLER (lb/ac/yr)	Pervious PLER (lb/ac/yr)
Commercial and Industrial	1.78	DevPERV*
Multi-Family and High-Density Residential	2.32	DevPERV*
Medium -Density Residential	1.96	DevPERV*
Low Density Residential	1.52	DevPERV*
Highway	1.34	DevPERV*
Forest	1.52	0.13
Open Land	1.52	DevPERV*
Agriculture	1.52	0.5
Developed Land Pervious - HSG A	-	0.03
Developed Land Pervious - HSG B	-	0.12
Developed Land Pervious - HSG C	-	0.21
Developed Land Pervious - HSG C/D	-	0.29
Developed Land Pervious - HSG D	-	0.37
*DevPERV = Developed Land Pervious		

Baseline & Development Loads

Distinct Method Example - PLERs from Table F1-2

- Site layout
  - Hydrologic Soil Group = B
  - LD Residential 10.0 ac (1.0 ac IA, 9.0 ac PA)
  - Commercial 10.0 ac (8.0 ac IA, 2.0 ac PA)
  - $PLER_{LDR,\ IA}$ = 1.52 lb/ac/yr
  - $PLER_{LDR,\ PA}$ = 0.12 lb/ac/yr
  - $PLER_{COMM,\ IA}$ = 1.78 lb/ac/yr
  - $PLER_{COMM,\ PA}$ = 0.12 lb/ac/yr
- Calulations
  - L_{LDR} = 1.0*1.52 + 9.0*0.12 = 1.52+1.08 = 2.60 lb/yr
  - L_{Comm}= 8.0x1.78 + 2.0*0.12 = 14.24+0.24 = 14.48 lb/yr
  - BL = L_{LDR} + L_{Comm} = 2.60 + 14.48 = 17.08 lb/yr

Calculating Development Load Increase
Appendix F, Attachment 1

- Determine baseline load (BL) using 2005 land use data and the composite or distinct PLERs
- Determine developed load (PDEV) using proposed land use data and the composite or distinct PLERs
- Determine the load increase (PDEVinc) by subtracting the baseline load from the developed load
  - PDEVinc = PDEV - BL

Calculating Load Reduction Requirement

Appendix F, Attachment 1

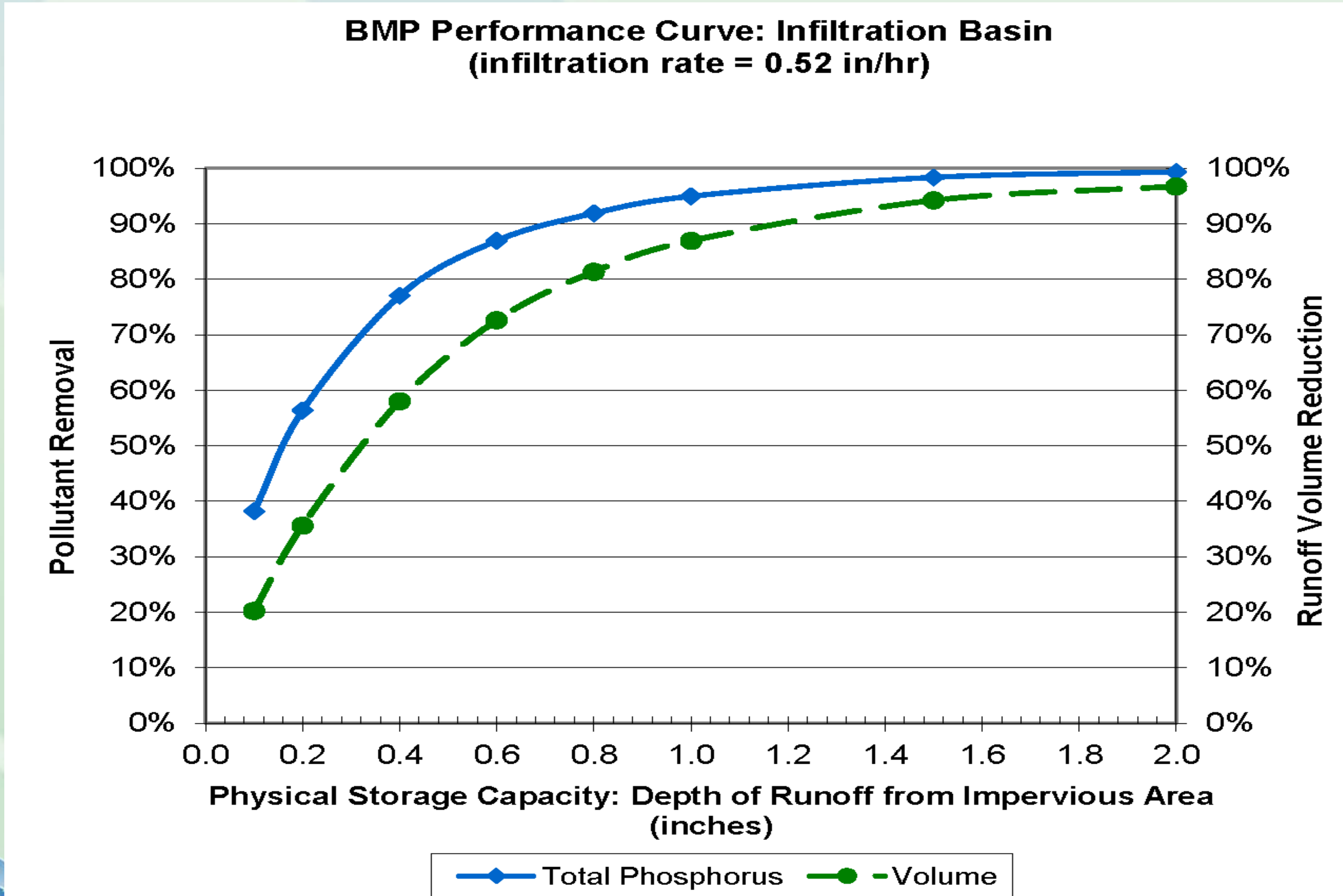
- Look up PCP load requirement percentage (LRP, %) in Table F1 (community) or Table F2 (regulated)
- Calculate baseload reduction (LR, lb/ac):
  - BLR (lb/ac) = BL (lb/ac)* LRP (%)
- Add increased load due to development (PDEVincr)
- Calculated total load reduction (LR, lb/yr)
  - LR = BLR + PDEVincr

Calculating BMP Load Reduction

- Determine total load for drainage area (BL+PDEVincr)
- Determine BMP physical volume (V, cf)
- Determine impervious area draining to the BMP (IA, ft^2)
- Express as a depth over IA (D, in)
  - V / A * 12 in/ft
- Look up long-term percent reduction from BMP performance curve (BMPP, %)
- Calculate load reduction (BMPLR, lb/ac)
  - BMPLR = TL * BMPP

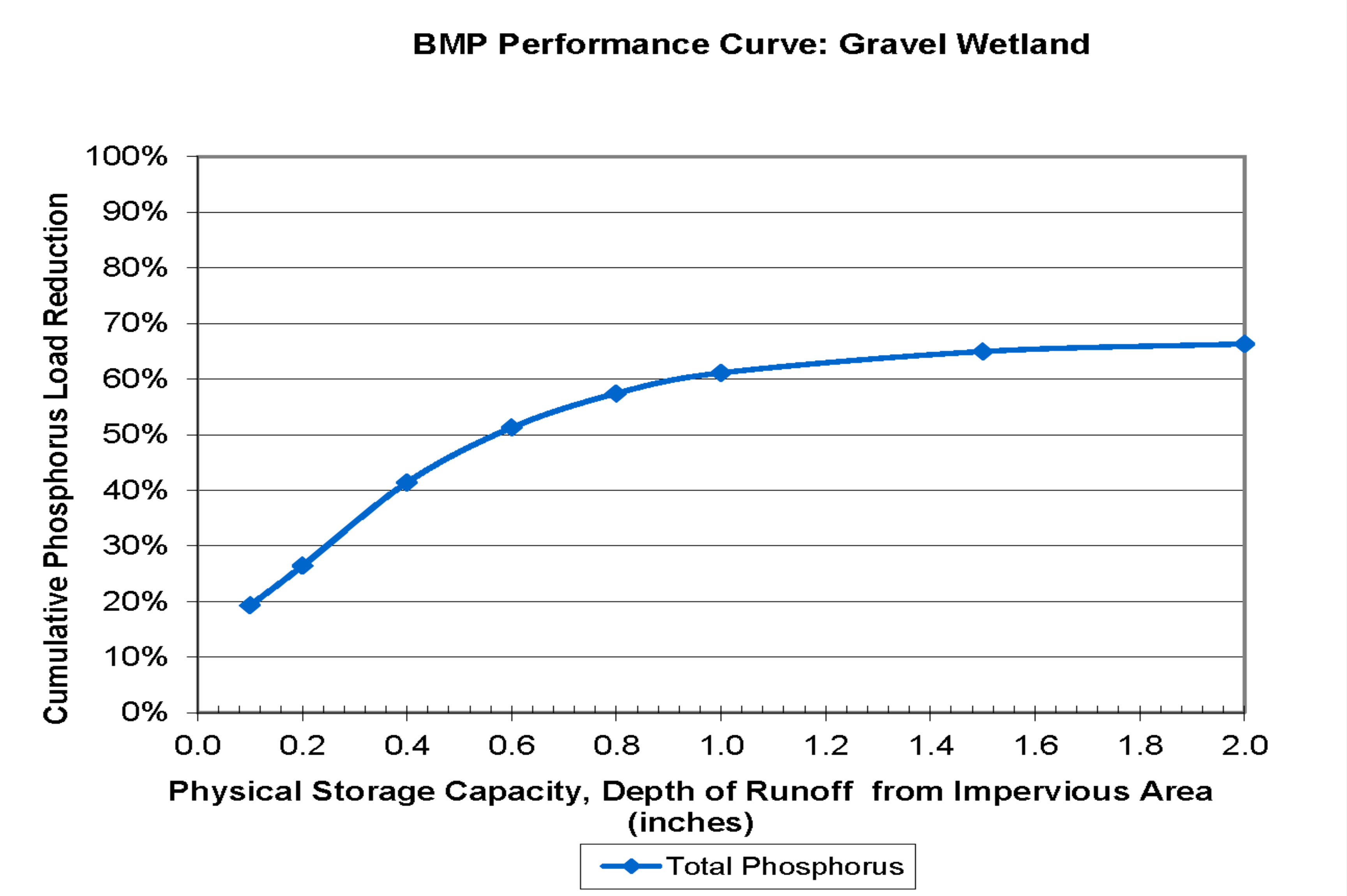
Long-Term Performance of Infiltration Basin

Appendix F, Attachment 3



Long-Term Performance of Gravel Wetland

Appendix F, Attachment 3



Calculating BMP Load Reduction

Example using Gravel Wetland

- Site layout
  - Hydrologic Soil Group = B
  - LD Residential 10.0 ac (1.0 ac IA, 9.0 ac PA)
  - Commercial 10.0 ac (8.0 ac IA, 2.0 ac PA)
  - BL = 17.76 lb/yr
  - PDEVincr = 0.0
  - BMP Volume = 0.75 ac-ft
- Calculations
  - TL = 17.76 + 0.0 = 17.76 lb/yr
  - BMP Depth = 0.75 ac-ft / 9.0 ac IA * 12 in/ft = 1.0 in
  - BMP performance = 61%
  - TP Load reduction = 61% * 17.76 = 10.83 lb/yr

Tracking BMP Load Reductions

- Calculate load reductions for all non-structural stormwater controls implemented after 2005
- Calculate load reductions for all stormwater structural controls installed after 2005
- Sum BMP load reductions (lb/yr)
- Compare to required reduction requirement (lb/ac)

Optimization Requirement

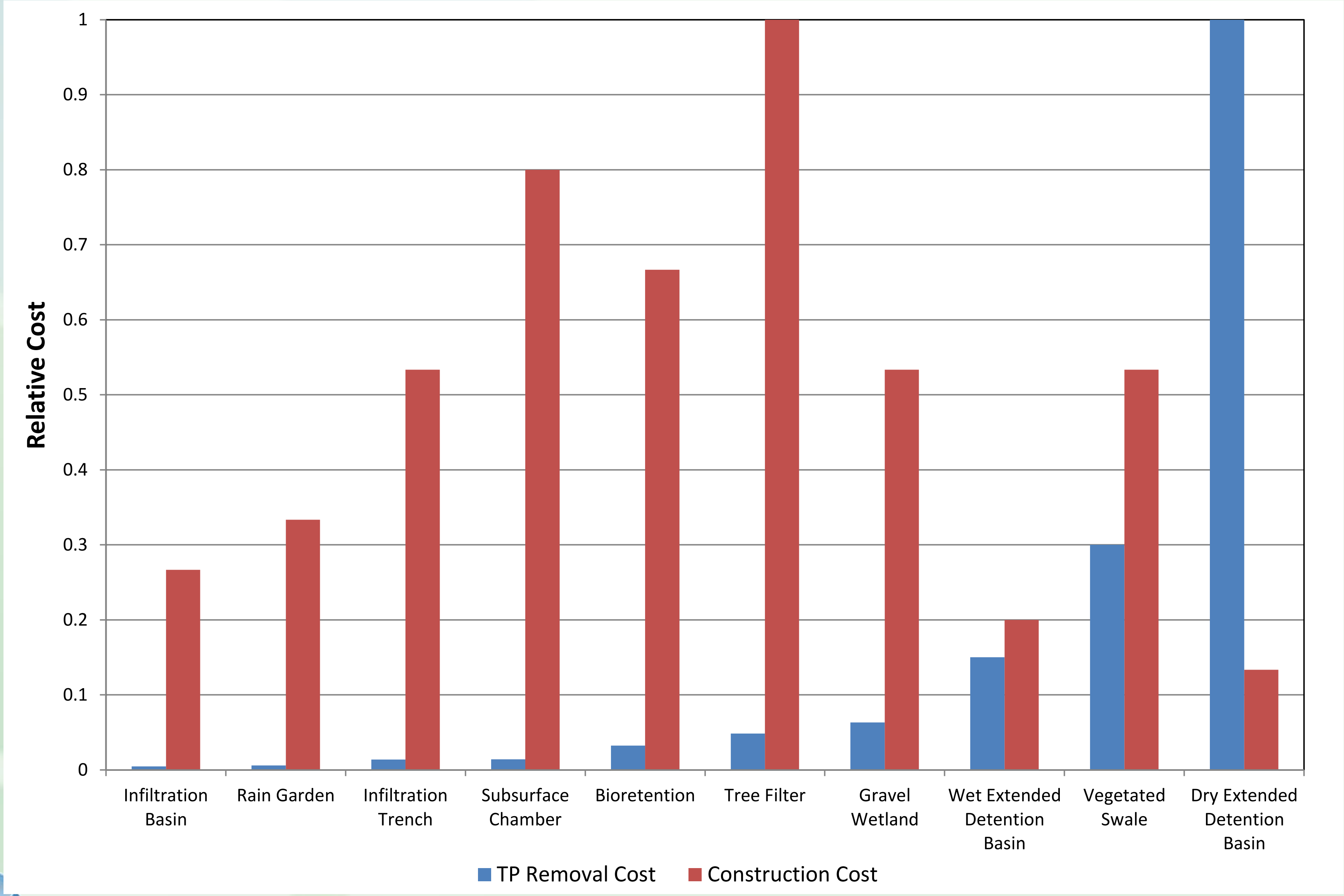
Appendix F, Section B2.1.i.2

"Part 2.3.6, Stormwater Management in New Development and Redevelopment: the requirement for adoption/amendment of the permittee's ordinance or other regulatory mechanism shall include a requirement that new development and redevelopment stormwater management BMPs be optimized for phosphorus removal; retrofit inventory and priority ranking under 2.3.6.1.b shall include consideration of BMPs that infiltrate stormwater where feasible".

Optimization Options

- Simple approach based on relative costs of BMPs (see chart)
- Custom spreadsheet approach using Excel optimization (CRWA, 2010)
- BMPDSS/Sustain model with optimization (TetraTech, 2008, 2015)
- Opti tool by TetraTech for EPA (2016):
  - Simple spreadsheet approach
  - Routing approach like BMPDSS

Relative Costs of Structural BMPs



Summary

- Phosphorus Control Plan is required for Charles Phosphorus TMDL by the draft 2015 MS4 permit
- Original TMDL phosphorus reduction requirements have been lowered
- Three phases
  - Phase 1 - 5 years of planning
  - Phase 2&3 – 15 years of implementation and tracking