Low Impact Development/Stormwater Management

in an Ultra Urban Environment

Practices for Design, Engineering, Construction/Installation and Maintenance

May 22, 2007

VHB *Vanasse Hangen Brustlin, Inc.*

City of Boston
State Hospital Redevelopment

- Joint Venture with Lena Park Community Development Corporation and New Boston Development Partners
- Joined to purchase, develop, re-develop, operate, lease and sell mixed use properties
- Affordable housing – teen center – training – elders
- High community involvement and benefits
- Urban Farm
- Low Impact Development Design
- Healthy Homes

NEW BOSTON
Real Estate Investment Funds

Rojas Landscape Architecture

ICON architecture

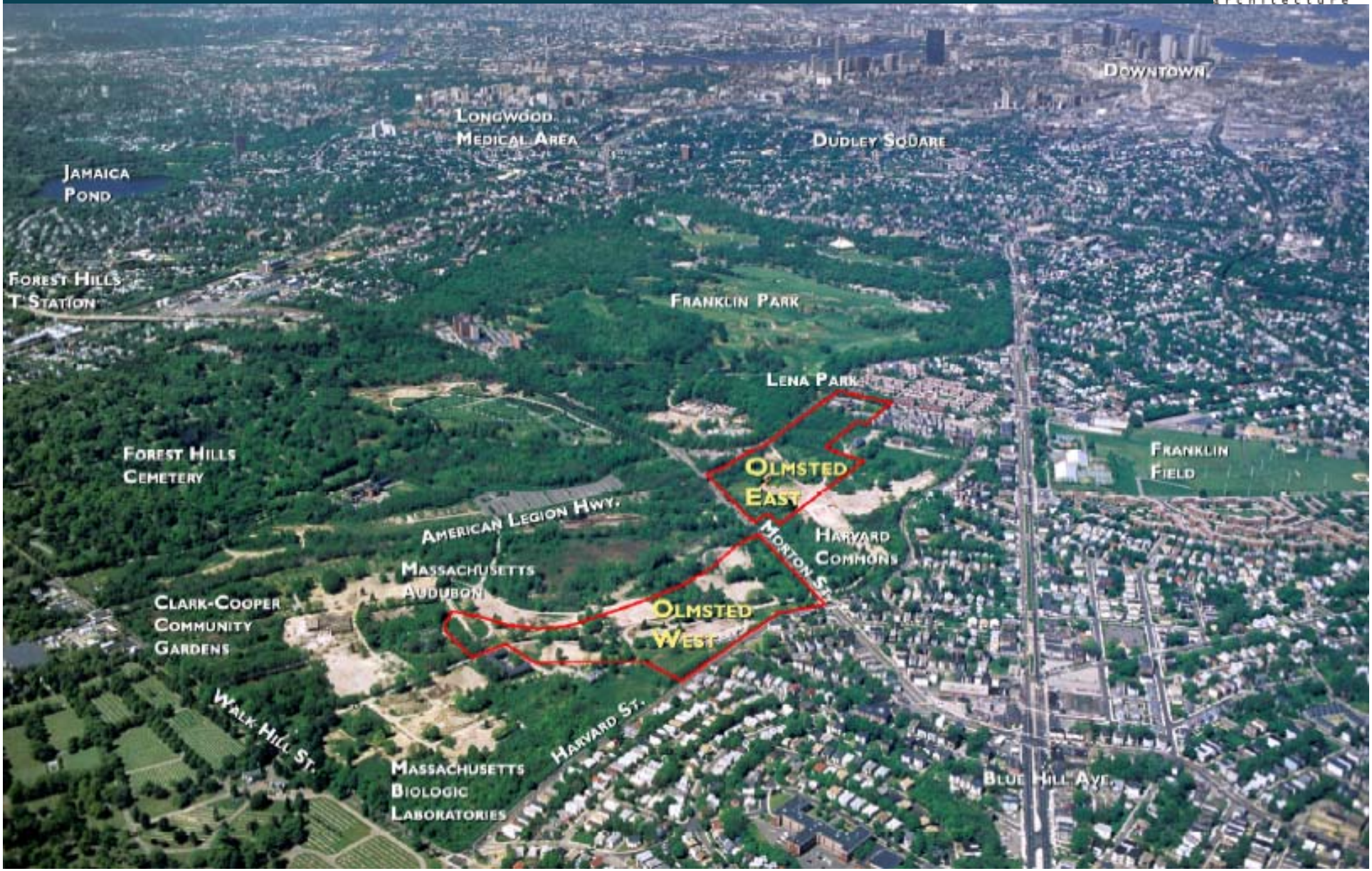
VHB

Olmsted Green
Significance and Scale

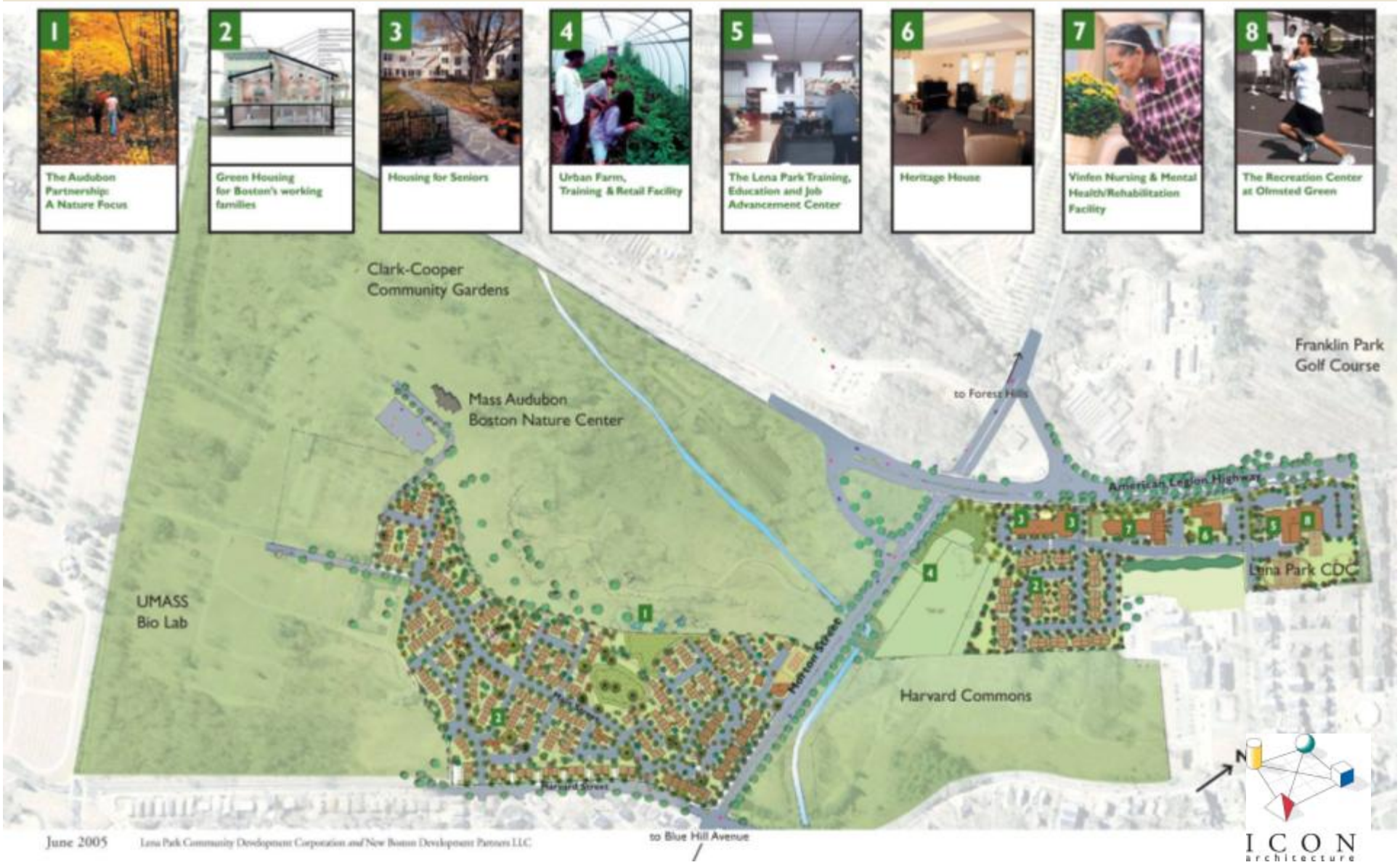
- Largest number of units and land area of any project in Boston over 20 years
- Exemplifies Commonwealth's Smart Growth Principals
- Opportunity to re-knit 6 communities and return blighted state property to productive use
- Unique vision for economic development, affordable and workforce housing and sustainable development

The Site

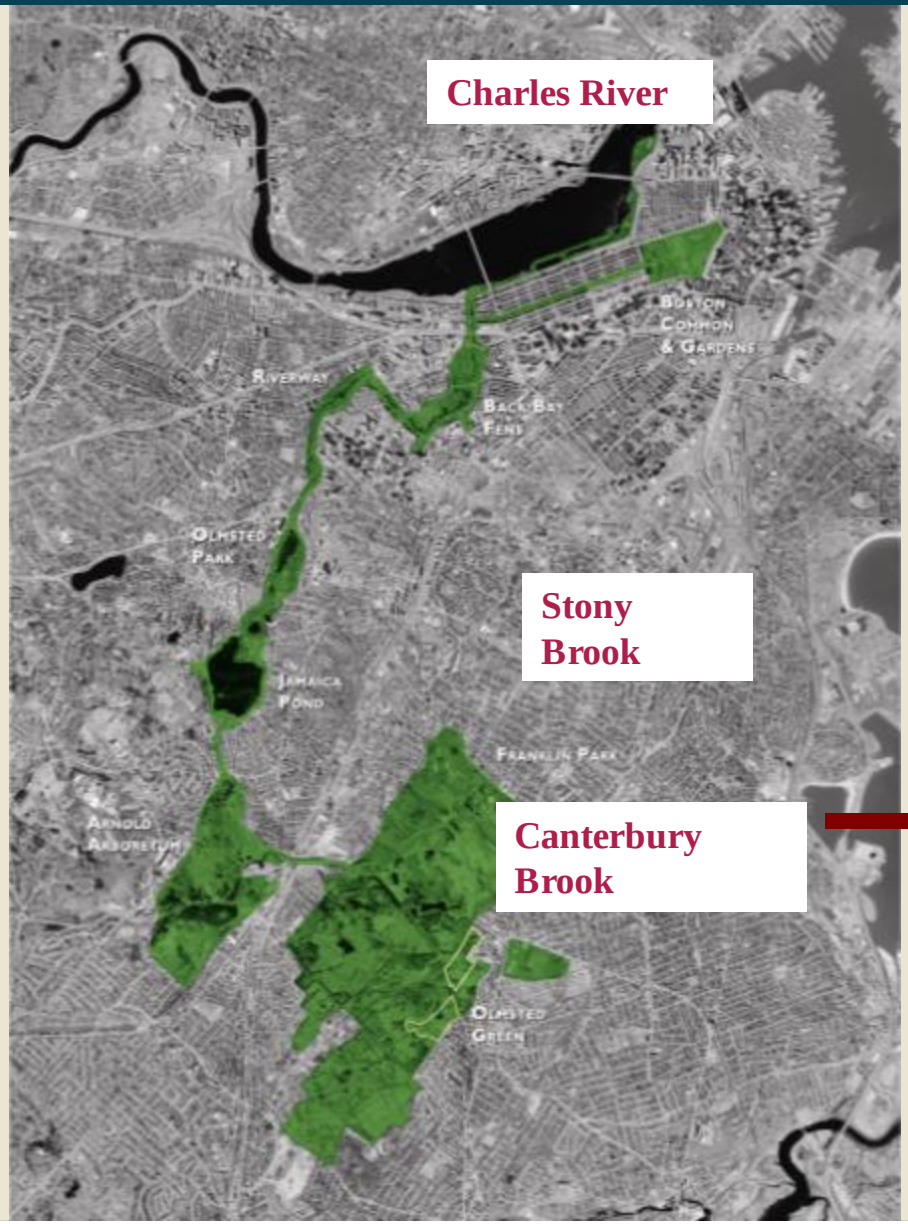
ICON architecture



Olmsted Green



Boston's Emerald Necklace - Olmsted Design Impacted Waterways to Harbor



- Flooding
- Sediment
- Bacteria
- Trash
- Oil/grease

ICON Architecture

VHB

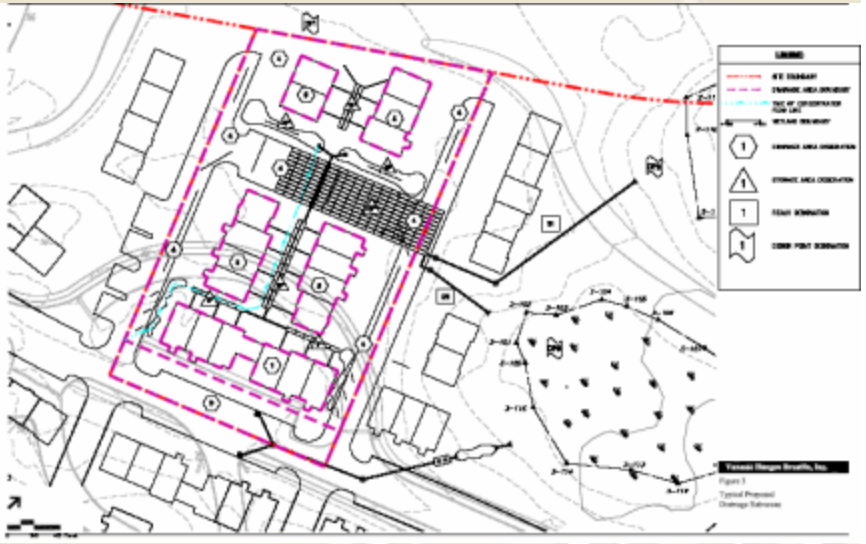
Typical Site Design/Stormwater LID – How Do We Minimize Impacts?

- Minimize impervious area
- Maintain vegetation, slopes, depressions
- Infiltrate/store
- Materials selection

ALL OF THESE ARE DIFFICULT TO ACHIEVE IN A DENSE URBAN ENVIRONMENT

LID in Ultra Urban Setting

- Underground, aboveground and overhead space limitations/constraints
- Site layouts more complicated
- Site design & modeling more complicated
- Technologies – more structures/overflows required
- Specifications – details critical
- Installations – construction management critical
- High public and vehicle traffic use



Low Impact (Re-)Development Choices:
City of Boston State Hospital

- Shared drives, rain gardens, different permeable surfaces, urban farm, native vegetation, minimal lawn surfaces, vegetated embankments, soil amendment, mature tree preservation….do what you can, where you can..

Tree Canopy – Vegetation

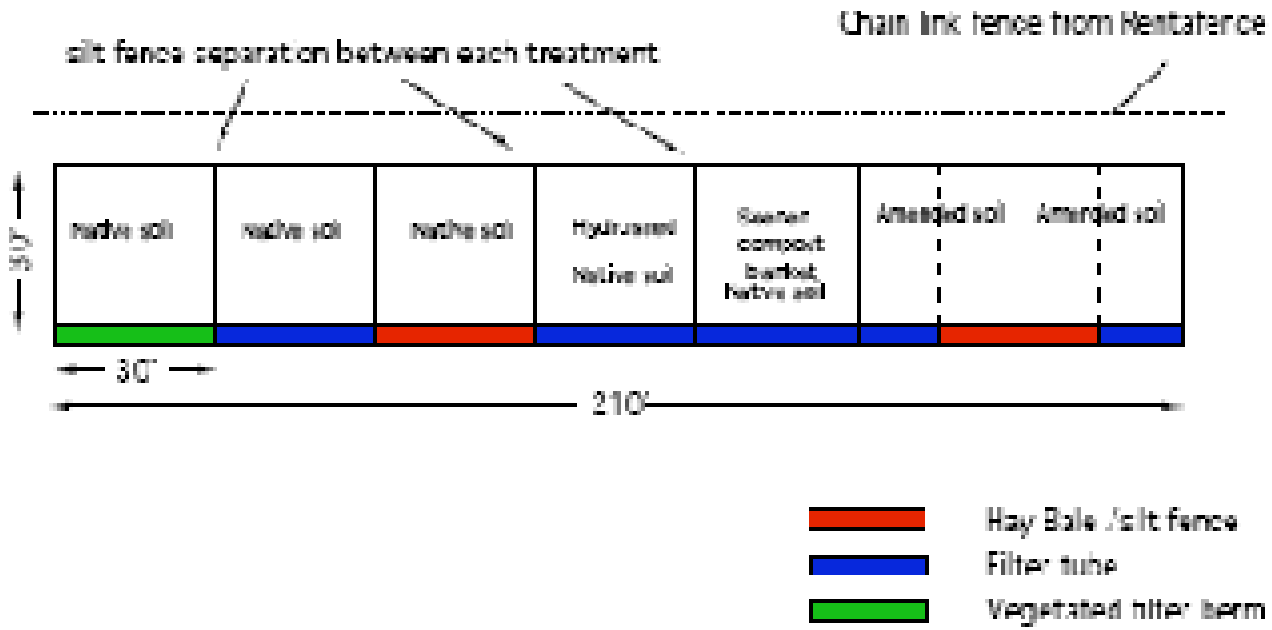
- Preserve significant existing trees and vegetation to reduce runoff
- Canopy maintenance
- Very Dense – “non-lawn” ground covers
- Mostly residential use – not well suited for green roofs
- Tree consultant hired to flag, inspect and provide contractor guidance

Soil Amendment

Source: Groundscapes Express

- Joint 319 Grant to test compost amendments for vegetative growth, infiltration improvement and erosion control

Test Plot Layout for 319 Grant BMP Treatments on East and West Campus



Source: Bruce Fulford, City Soil and Greenhouse Company

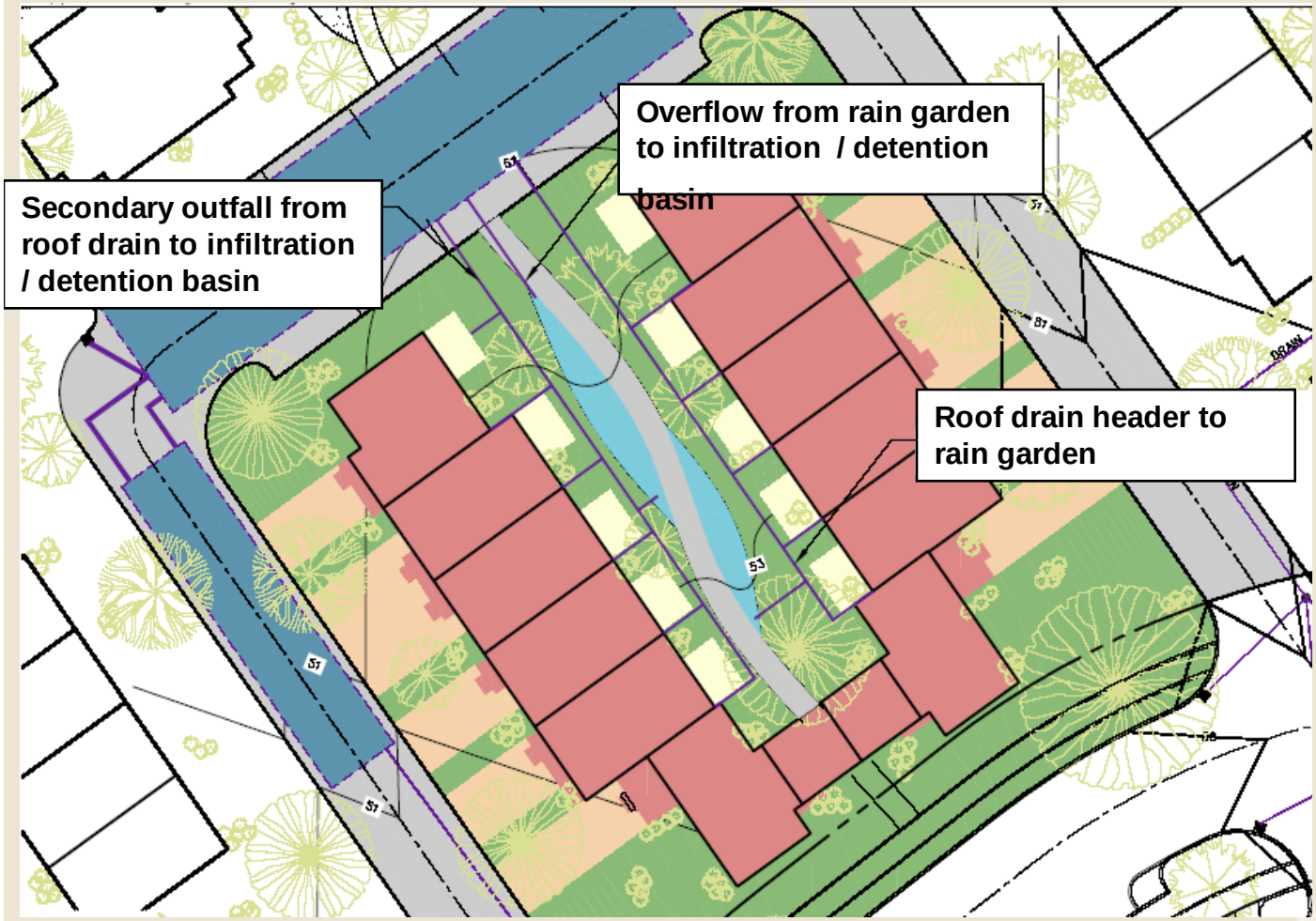
Compost Socks for Sedimentation and Erosion Control

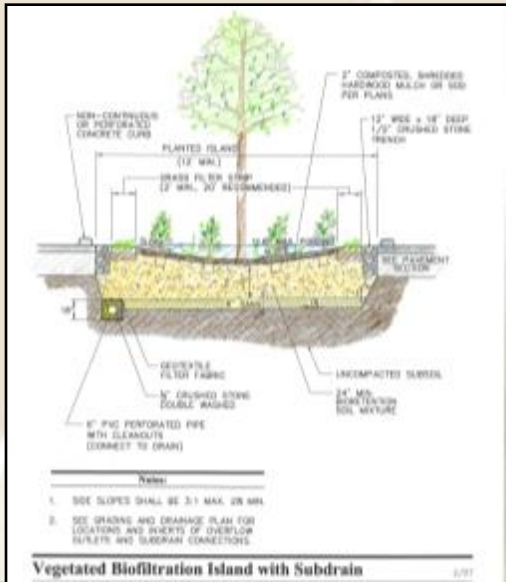
- 319 Grant also used to investigate success of compost filled sock for sedimentation and erosion control

Rain Gardens

- Take roof top runoff
- Treat the small flows from paved areas for quality with pre-treatment for frequent storms
- Site soils with limited infiltration and contamination so under drains needed
- Overflow to subsurface detention
- Still need storage and conveyance for large events

Rain Garden Design – Very Detailed and Tightly Designed





More Geotech Information Early On…

- Preliminary design/location of infiltration systems earlier
- Develop specific Geotechechnical Investigation Plans
- Final designs being requested earlier

The attached plan contains locations for 8 test pits that are requested for the investigation of subsurface conditions at proposed infiltration basins. The following information is requested at each location:

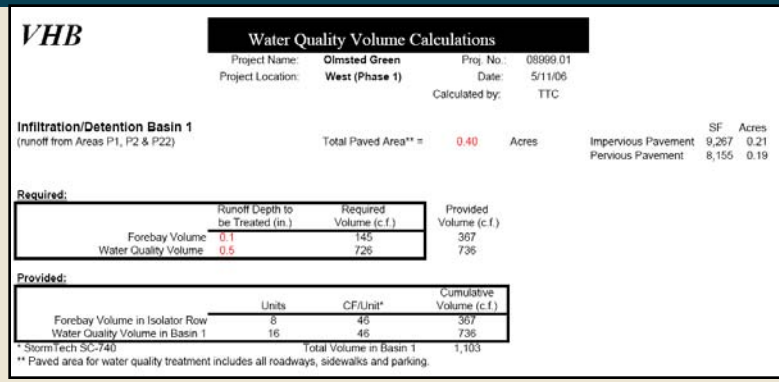
- Depth to groundwater
- Soil gradation analysis at Proposed Infiltration Elevation
- Permeability of soil at Proposed Infiltration Elevation, based on soil gradation analysis- Kozeny Equation
- Excavate 2-3 feet beyond depth of proposed infiltration if groundwater was not encountered. The purpose is to verify that infiltration systems designed will have MA DEP 2-foot required separation from bottom of system to groundwater.

Proposed Test Pit #	Proposed Basin #	Existing Ground Surface Elevation	Depth to Proposed Infiltration Elevation	Proposed Infiltration Elevation
TP-1	2-1	51.0	FILL	51.5
TP-2	2-2	52.0	0.5	51.5
TP-3	2-3	51.5	4.5	47.0
TP-4	2-3	51.5	4.5	47.0
TP-5	2-3	51.5	4.5	47.0
TP-6	2-4	56.5	7.0	49.5
TP-7	2-5	55.0	5.5	49.5
TP-8	2-6	55.0	7.5	47.5

Based on the results of the test pits, it is requested that GZA provide recommended quantities and locations for borings to determine the groundwater elevation determination on the proposed site, and complete borehole permeability tests, if necessary.

Rain Gardens – LID Measures
Different Design Parameters

- Analyze/Design two separate models
- LID Measures (Model #1)
  - Rain gardens, swales, pavers, etc.
    - Treat small storm events (1” over 12-hrs)
    - Treat for water quality and small volume
- Typical Stormwater Mgt. (Model #2)
  - Infiltration/detention chambers
    - Provide additional treatment and Storage
    - Manage higher volume storm events (10, 25, 50 & 100-yr)



VHB

Water Quality Volume Calculations

Project Name: Olmsted Green — Proj. No.: 08999.01
Project Location: West (Phase 1) — Date: 5/11/06
Calculated by: TTC

Infiltration/Detention Basin 1
(runoff from Areas P1, P2 & P22)

Total Paved Area** = 0.40 Acres

	SF	Acres
Impervious Pavement	9,267	0.21
Pervious Pavement	8,155	0.19

Required:

	Runoff Depth to be Treated (in.)	Required Volume (c.f.)	Provided Volume (c.f.)
Forebay Volume	0.1	145	367
Water Quality Volume	0.5	726	736

Provided:

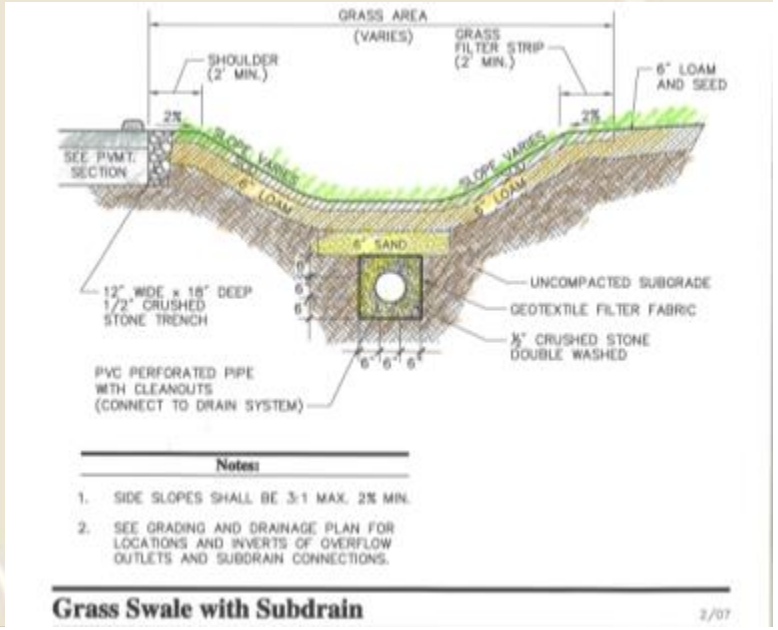
	Units	CF/Unit*	Cumulative Volume (c.f.)
Forebay Volume in Isolator Row	8	46	367
Water Quality Volume in Basin 1	16	46	736

* StormTech SC-740 — Total Volume in Basin 1 = 1,103

** Paved area for water quality treatment includes all roadways, sidewalks and parking.

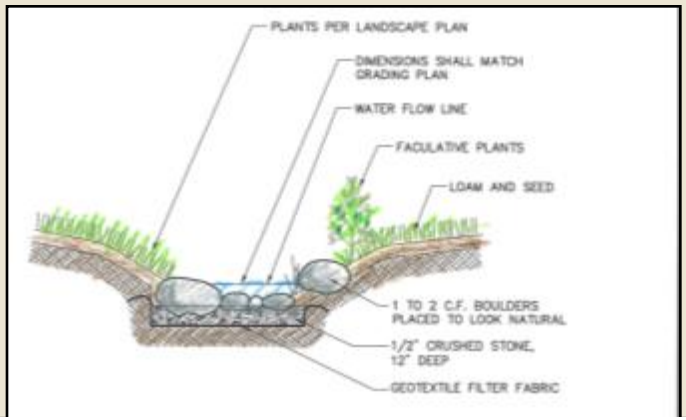
Grass Swales - Surface Infiltration – Delay Runoff - Conveyance

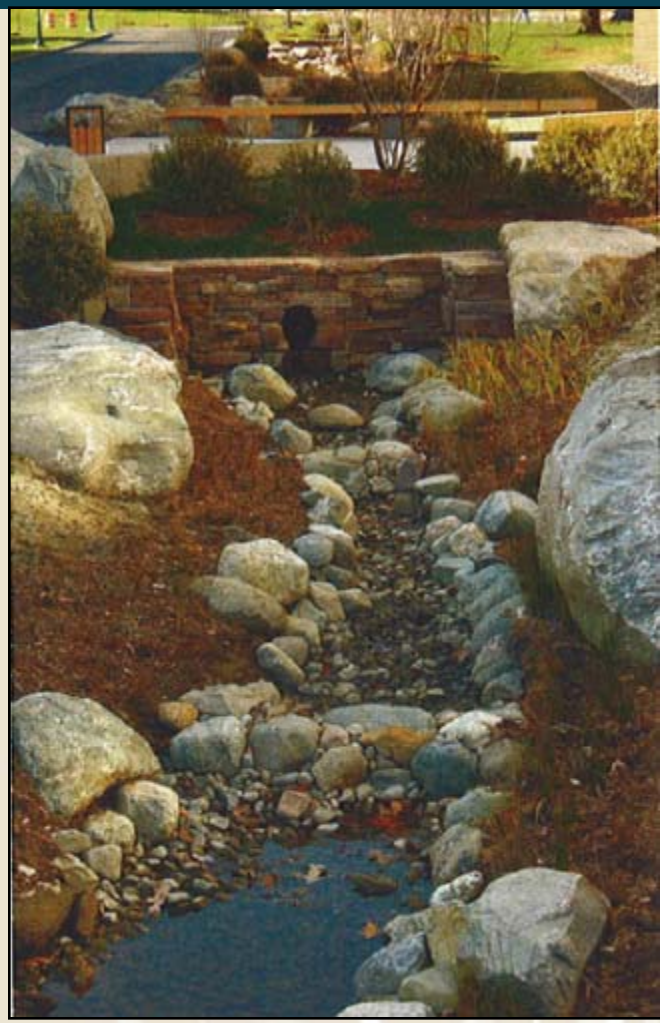
- Water kept on site longer
- Minimal surface area in urban setting
- Do the best you can in poor soils
- Small grass depressions -- provide an overflow and under drain
- Designs more advanced depending on site



Stone Channels/Swales

- New designs – no longer dumped rip rap
- Specific flow regimes – pools and riffles
- Boulders place for natural look and bank stabilization
- More design – very specific construction requirements
- Daylighting in redevelopments





Source: University of Vermont

Sub-Surface Infiltration not always the urban panacea

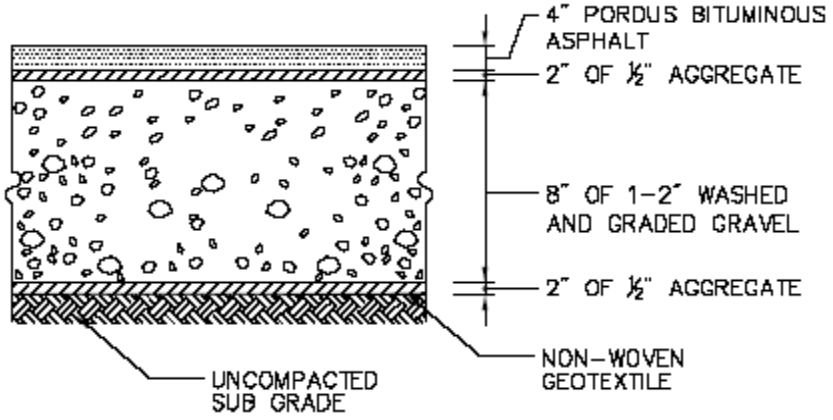
StormTech™ Chambers

- Poor soils
- Recharge not critical
- High groundwater
- Contamination
- Utilities (corridors)
- Public Roadways
- Maintenance

- May choose to have solid systems for just storage

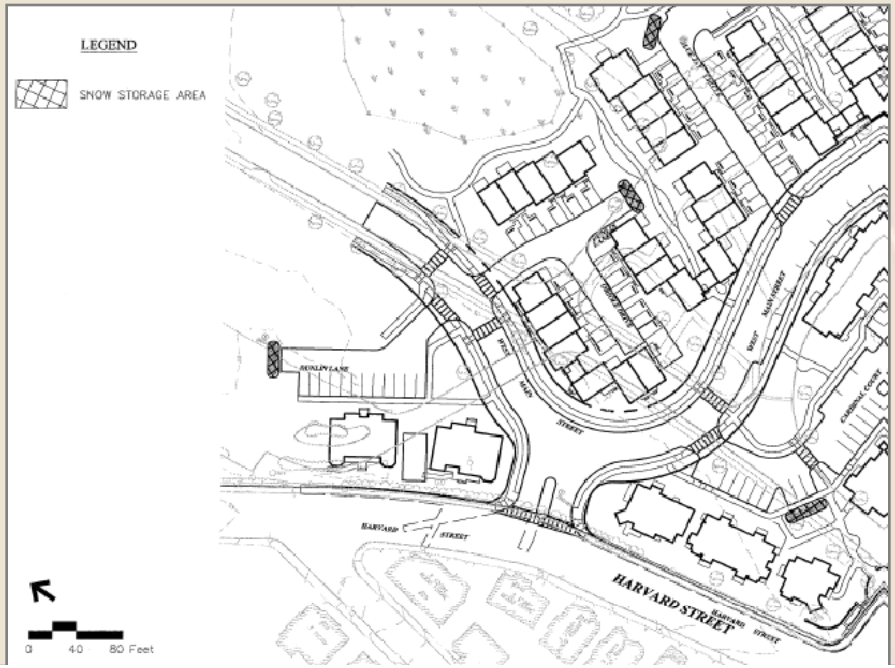
Porous Pavement

- Main roadways – high sanding concerns (not used on City of Boston Roadways)
- Contaminated soils
- Poor underlying soils
- High groundwater – reservoir depth not effective for storage
- High urban use – fear of clogging even with good maintenance



Snow Management –

- Need to include in plans early on
- Difficult to accommodate in Urban Environment if not trucking off-site
- Evaluate options for dual uses (snow storage winter, open space, damage from debris etc.)



Long-Term Maintenance Requirements

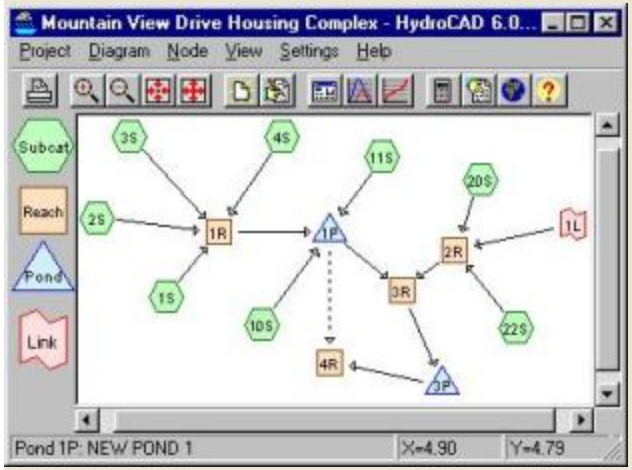
Project Name – City, State

Best Management Practice	Minimum Maintenance and Key Items to Check	Inspection Frequency	Date Inspected	Inspector Initials	Cleaning Frequency	Cleaning or Repair Needed Yes/No	Date of Cleaning or Repair	Performed by:
Street Sweeping	Vacuum sweeper	4X per year	/ /		4X per year* minimum		/ /	
Permeable Pavement	Vacuum sweeper	4X per year	/ /		4X per year* minimum		/ /	
Permeable Pavers	Vacuum sweep or pressure wash	1X per year	/ /		as necessary		/ /	
Outfall Structures	Remove debris and excess vegetation, replace any dislodged riprap	1X per year	/ /		1X per year		/ /	
Deep Sump and Hooded Catch basins	Remove sediment 1X per year or if >6 inches	4X per year	/ /		1X per year or as necessary		/ /	
Subsurface Infiltration Basins	Remove sediment 1X per year or if >6 inches	1X per year	/ /		1X per year		/ /	
Rain Gardens	Inspect inlets, vegetation, overflow discharge pipes, drain time less than 4 days	2X per year first year, annually thereafter	/ /		2X per year first year, annually thereafter		/ /	

* Recommend sweeping oct/nov, feb/mar, apr/may july/aug with late winter most important

Stormwater Control Manager _____

Permitting - Engineering - Design - Construction
Making sure it all works…



Assess Existing Conditions Early on to See What You Can Do

- Assess hydrology & discharge points: minimal infiltration, wetlands are “surface” fed, existing flooding downstream, water quality concerns to receiving water body
- Assess soils & geotech info EARLY: urban fill, poorly drained, shallow bedrock, high groundwater, contamination
- Assess key factors and opportunities for LID with preliminary information
- Important factors for THIS site -- timed storage, water quality