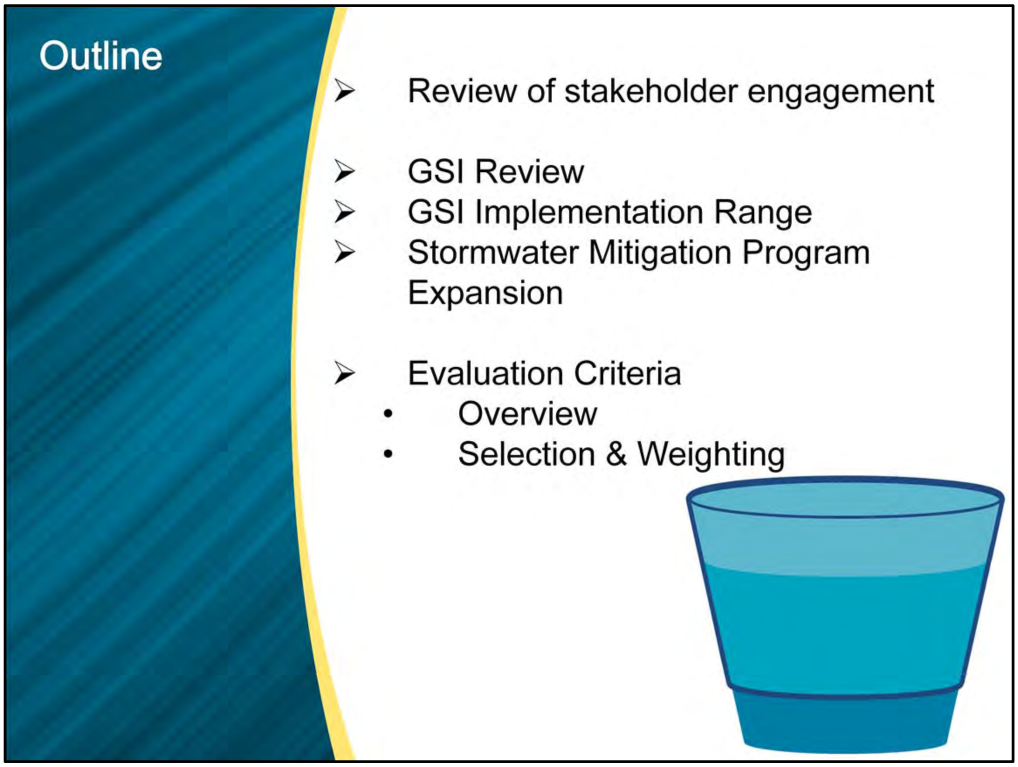
Prepared for
Narragansett Bay Commission

CSO Control Facilities Phase III Reevaluation GSI Part 2 & Evaluation Criteria

19 June 2014

MWH
BUILDING A BETTER WORLD

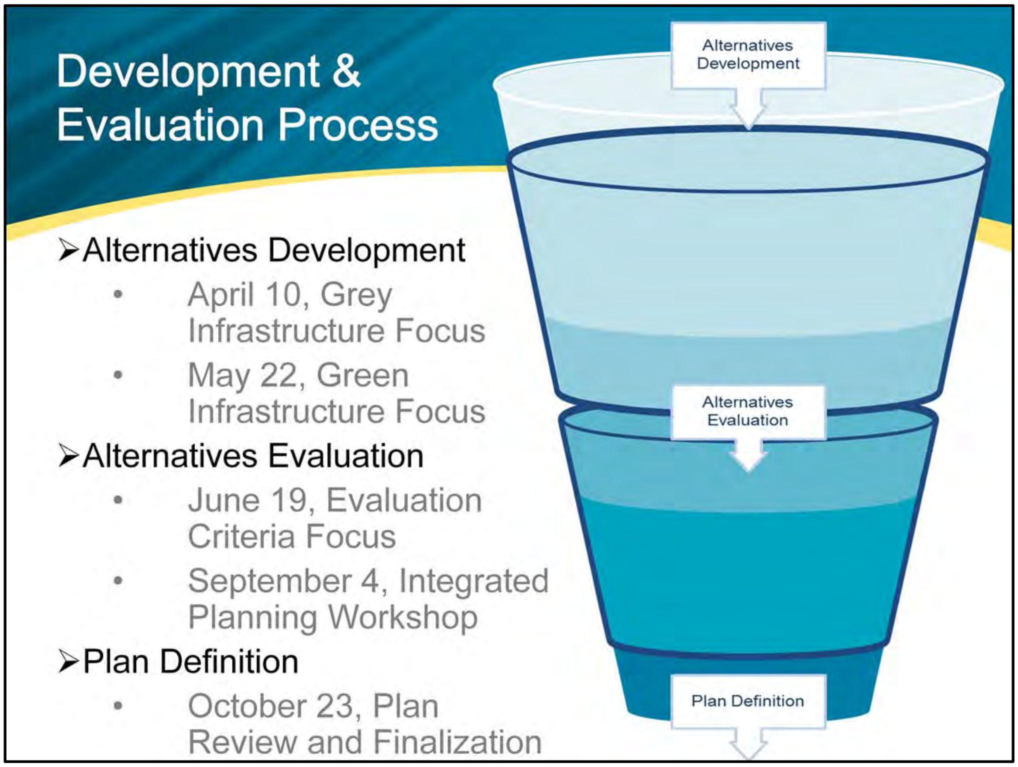
PARE CORPORATION



As we have done before, we will begin today with a quick review of where we are in the stakeholder engagement process.

At our last meeting, we had an interesting but extensive discussion regarding EPA's positions on water quality and affordability. Unfortunately, as a result we were unable to cover all of the Green Infrastructure material we needed to cover. Therefore, we will continue that discussion, beginning with a brief review of highlights from last meeting, and then delving into some more depth on how GSI can be utilized in Phase III. We will finish with a discussion of how the successful NBC stormwater mitigation program could be expanded to increase those benefits.

We will then move on to the headline event – Evaluation Criteria – by providing an overview of the process and then working through example criteria with you to select and weigh the criteria for NBC.



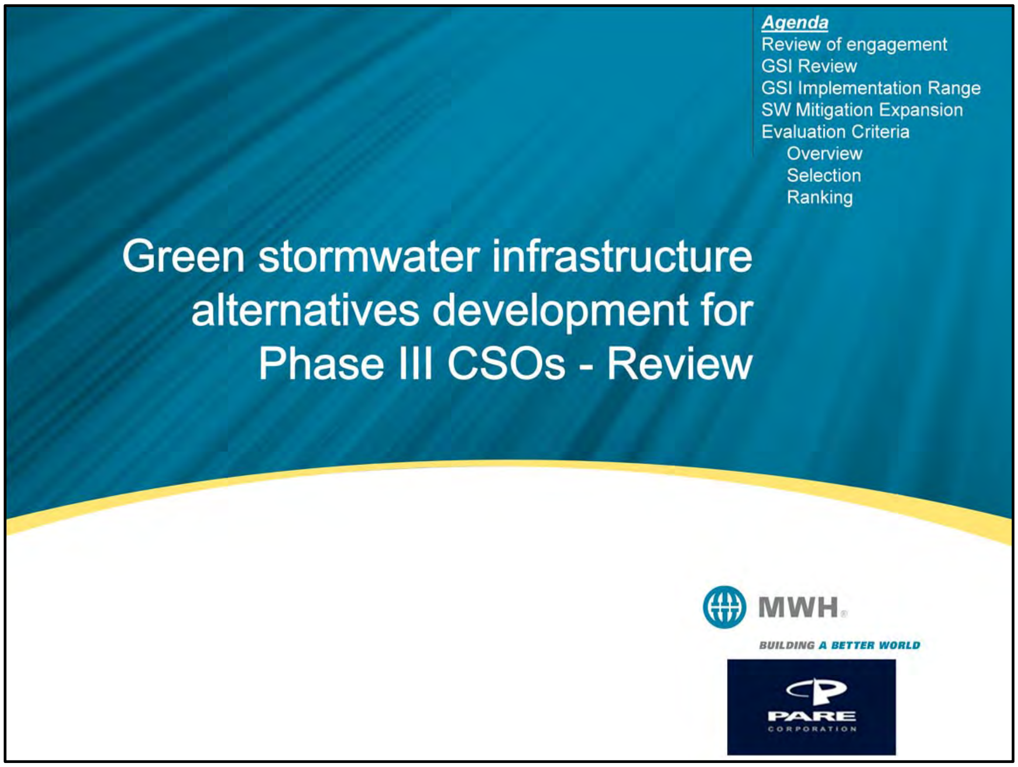
As a quick review of where we are in the process, in April and May, we developed alternatives. The goals of these meetings included:
Defining the consensus opinion of the Stakeholder group for each of the alternative approaches
Identifying roadblocks or even fatal flaws for implementing those alternatives in specific CSO areas
Defining implementation details for technically feasible alternatives to improve the conceptual designs including their costs and benefits.

Because we ran out of time at our last meeting, we will begin today by finishing up that process for the green infrastructure.

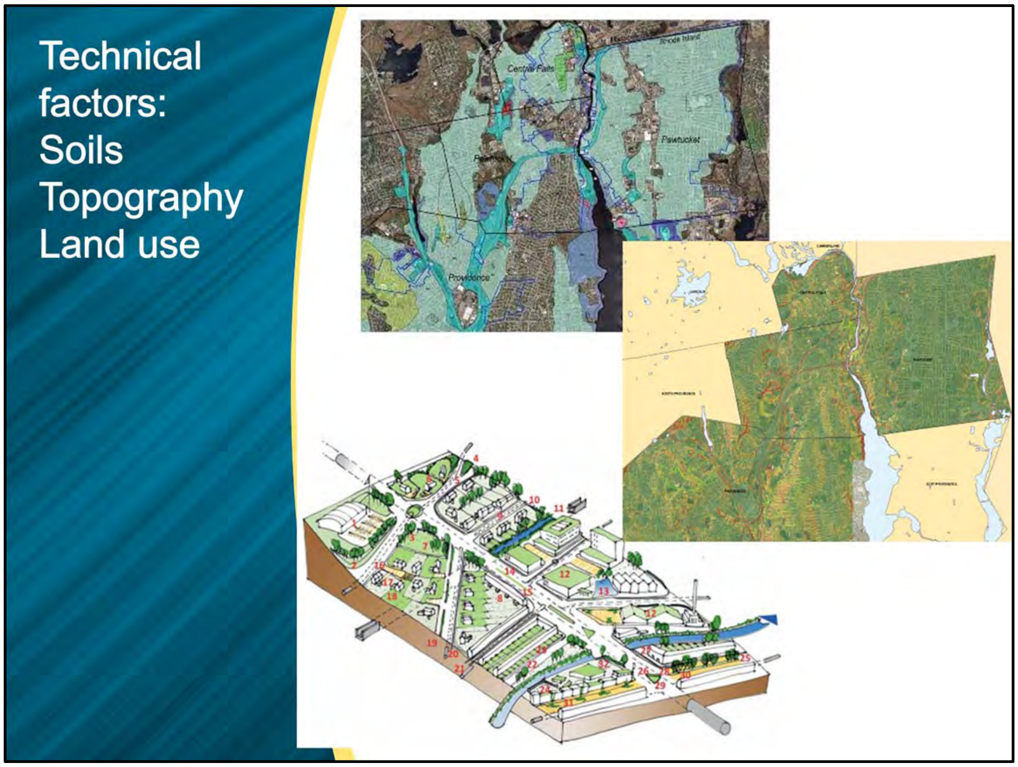
After that, we will select the criteria by which we will judge those alternatives.

In September will then evaluate the long list of components for alternative plans.

Finally, the October meeting will pull together the final details of the revised Phase III plan.



Last month, Scott Lindgren started our discussion of developing Green Stormwater Infrastructure (GSI) alternatives for reducing CSOs.



The technical factors that influence GSI technology selection and define the runoff reduction benefits include:

Soils, and we concluded that much of the Phase III area contains soils that promote infiltration; however, we noted the concern related to the migration of contamination through groundwater;

Topography, and we concluded that much of the Phase III area contains slopes less than 5% which promote construction and effectiveness of GSI; and

Land use, and we highlighted the differences between opportunities in the public way, which could lead to partnerships between NBC and the municipalities, and opportunities on private land.

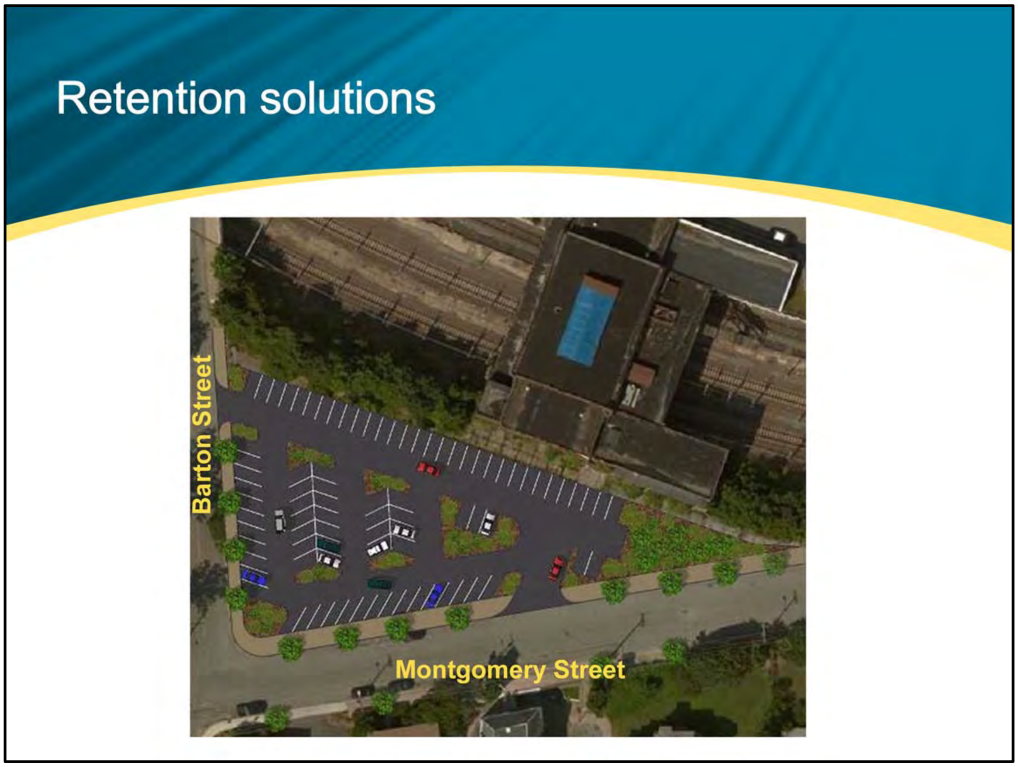
Infiltration solutions

Grand Broadway at Stansbury St

Vanderwater Street

We described conceptual design examples including infiltration solutions like pervious pavement parking lanes, raingarden bumpouts, tree wells and infiltrating catch basins for roadways in the 039/056 CSO areas…

… and blurring the line between green and grey infrastructure, we discussed stormwater detention tanks for CSO 035 that would temporarily detain stormwater for release once surcharging the combined sewers subside.

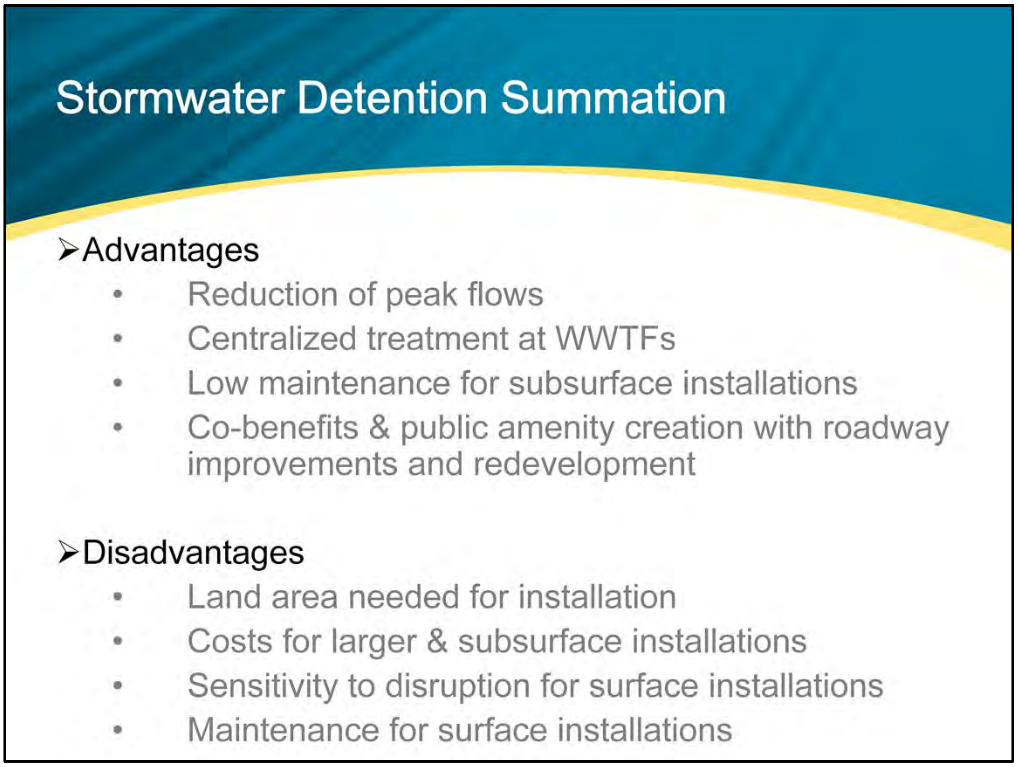


And finally, we discussed potential retention solutions including green roofs, blue roofs, surface depressions and tanks for CSO 206 which would rely on evaporation or water reuse for landscaping or other purposes to remove stormwater from the combined system in areas with poor or contaminated soils.

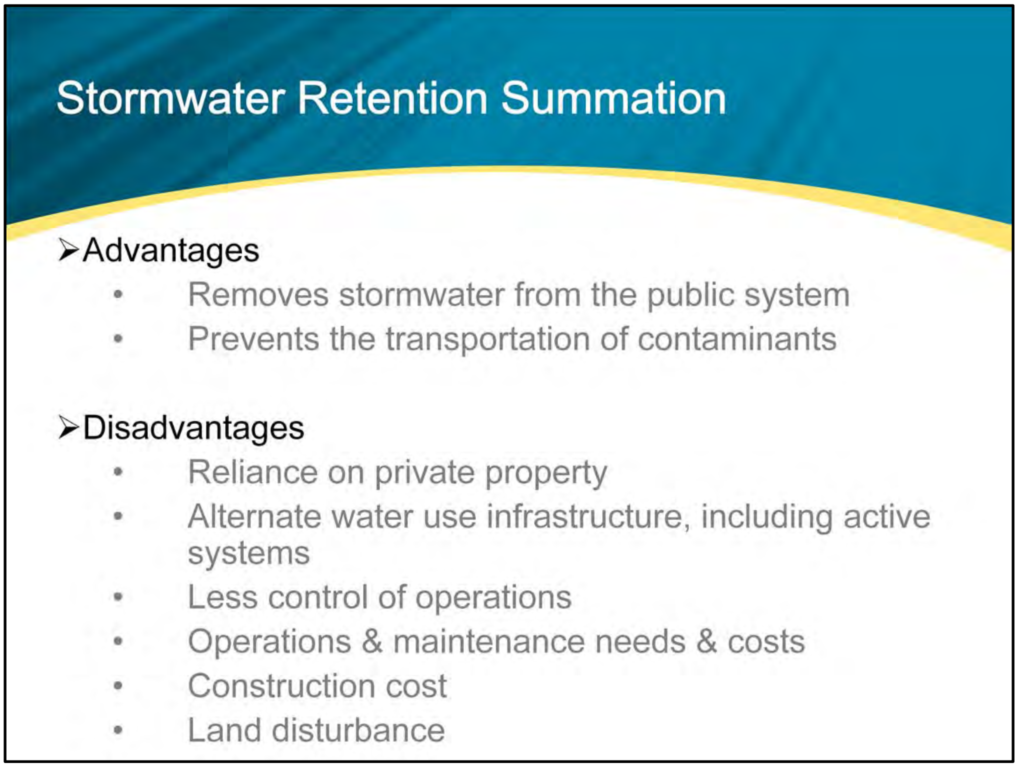
Stormwater Infiltration Summation

- Advantages
  - Provides infiltration and volume reduction
  - Provides water quality improvement
  - Can be installed at a smaller scale
  - Co-benefits & public amenity creation with roadway improvements and redevelopment
- Disadvantages
  - Underlying soils must be permeable
  - Cost for larger pervious pavement & infiltration chamber installations
  - Potential for contamination migration
  - Sensitivity to disruption including vandals
  - Maintenance requirements and cost

At our May meeting we did discuss the advantages and disadvantages of infiltration-based GSI. Specifically, the Stakeholder group identified the co-benefits for GIS as an advantage, and the potential for contamination migration through groundwater as a disadvantage. Before we move on, we should pause and decide if there are any additional factors that should be added to this list. We will do the same for detention and retention in a minute.

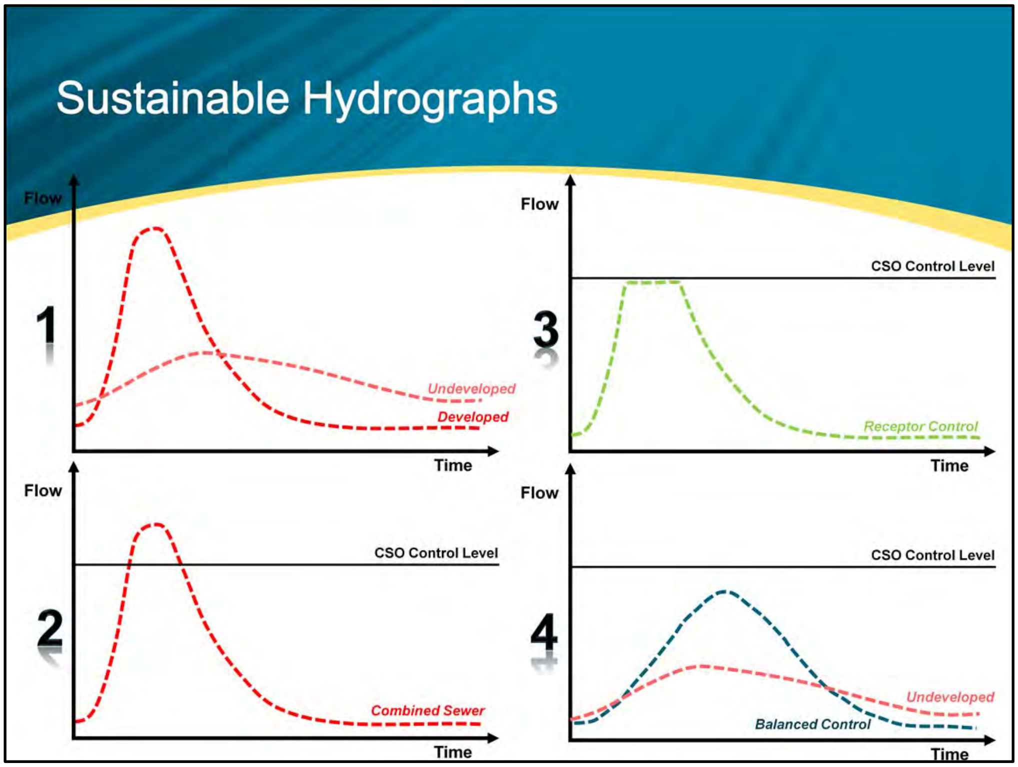


While our discussion of detention-based GSI was truncated, many of the issues raised for infiltration are applicable to detention. Before we move on, we just wanted to provide an opportunity to add any other specific advantages or disadvantages for detention options.

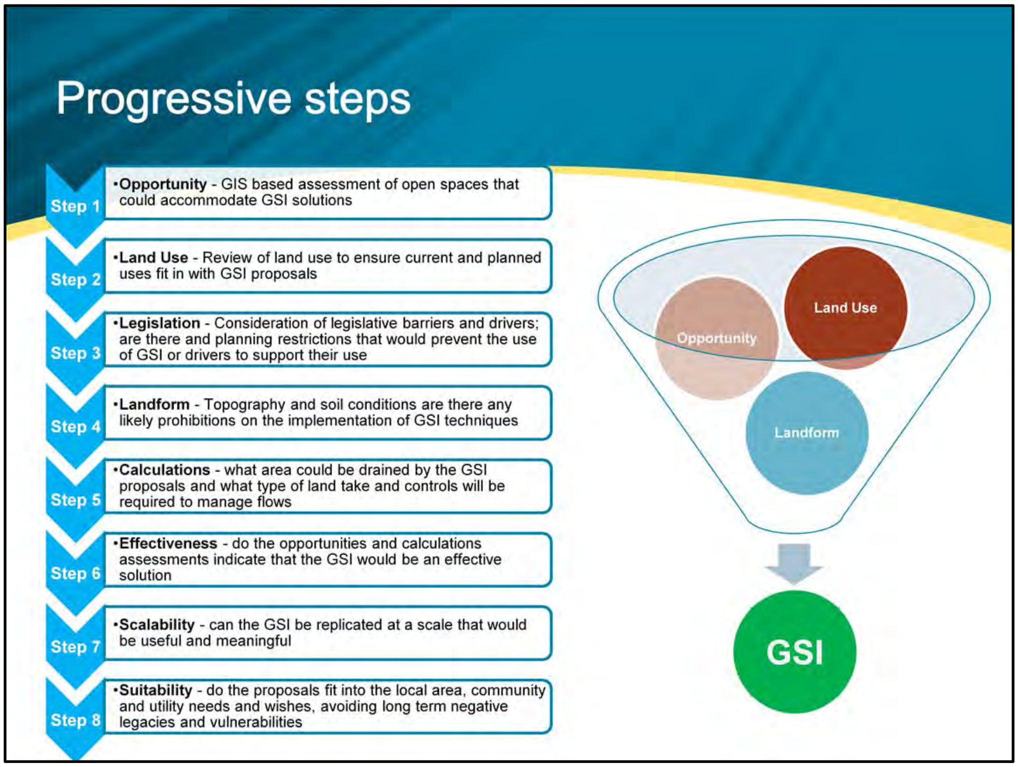


And finally, before we move on, let’s make sure we have a well defined list for retention-based solutions as well, keeping in mind that virtually all of these options require private land.

Last month using CSO 218 and 202 as examples, Nick Anderson illustrated how GSI could translate to CSO benefits. This month, we will dive deeper and define what the maximum GSI benefits are for representative sewersheds.



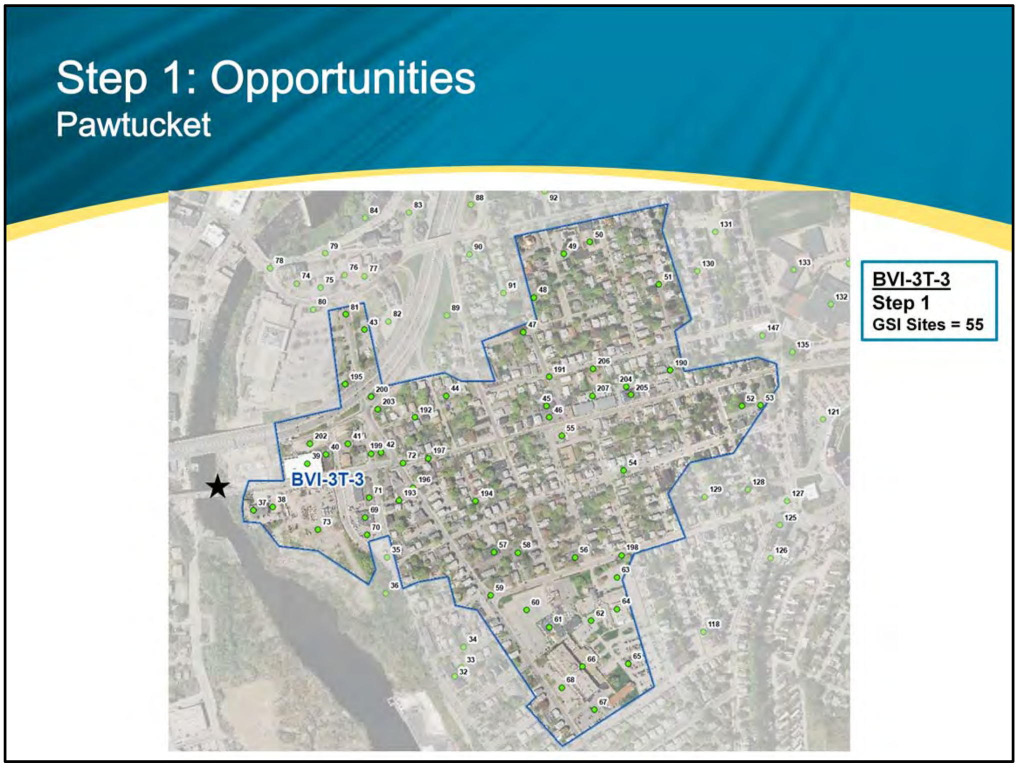
Understanding the hydraulics
This slide begins to explore some of the general hydraulic theory behind wet weather runoff and CSOs.
Graph 1 – shows the difference between undeveloped and developed areas. The main difference being a change in the time to peak of the response hydrograph and dramatic change in the peak flows associated with urbanization.
Graph 2 – Considers only the effects of urbanization and how CSO control the levels of service by controlling peak flows. The understanding for the audience is to demonstrate the important factor is the peak flow not necessarily the overall wet weather volume is the important factor. This graph also shows how we determine CSO overflow volumes.
Graph 3 – the CSO overflow control solution; bringing the hydrograph to just below the CSO control level is a successful solution and how the simplest options are all receptor solutions: tunnels, interceptors and storage tanks. Straightforward understanding, the actual volume to be dealt with is understood and therefore so is the storage. This is how CSOs have been addressed for years, but is expensive and focused only at the ends of pipes.
Graph 4 – the intention of the S-P-R approach is to reshape the hydrographs to a more sustainable and considered shape and size. Integrated solutions across the entire catchment is the only way to achieve this balanced outcome and required understanding of the entire system but offers the greatest opportunity to create a long term viable and sustainable overall solution; this is particularly important when there are multiple CSOs requiring solutions, as is the case for Narragansett Bay.



Discuss how following the progressive steps leads to an efficient and replicable evaluation process
The catchment selected as the example of how GSI could be implemented and what impact that would have on CSO reduction is BVI-3T-3. This is a sub-metershed just upstream of CSO 215. The catchment was evaluated at a sub-metershed level in order to match up the area with the hydraulic model that is broken down as such.

The first step taken is to identify all opportunities for GSI in the ideal scenario. This includes potential GSI installation locations such as flat roofs, parking lots, open spaces, medians, roadways wide enough for parking lane GSI such as rain gardens or pervious pavement, roadways too narrow for parking lanes but where drywells or tree pits are possible.

This screening level eliminated 9 sites from further GSI screening.



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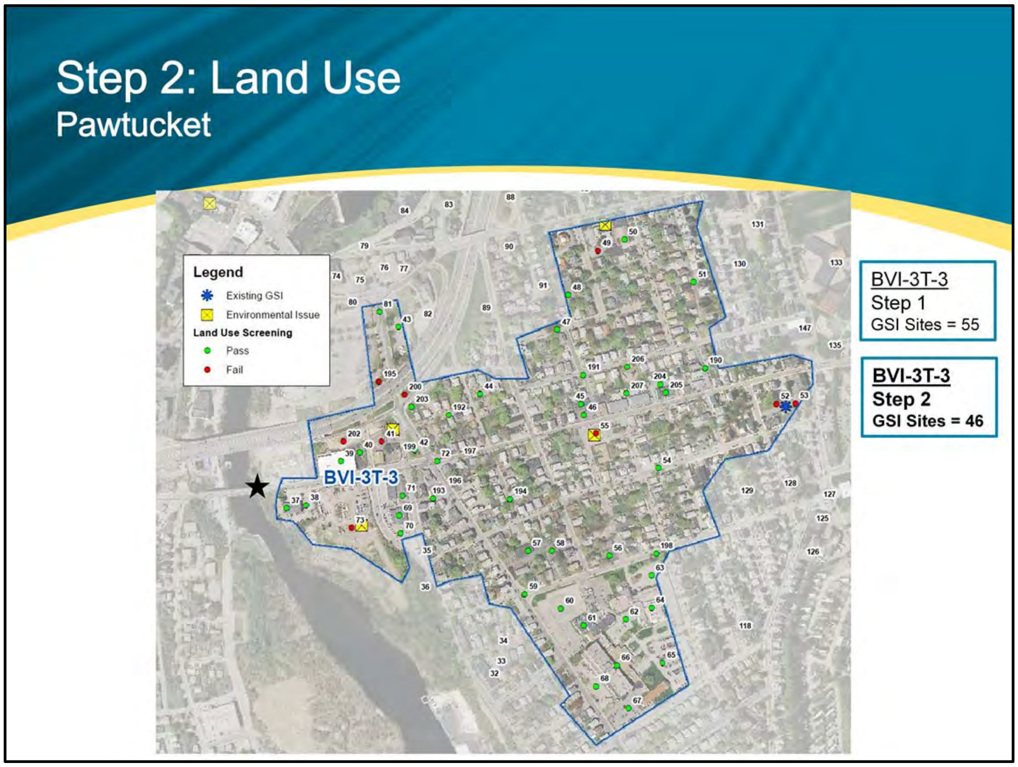
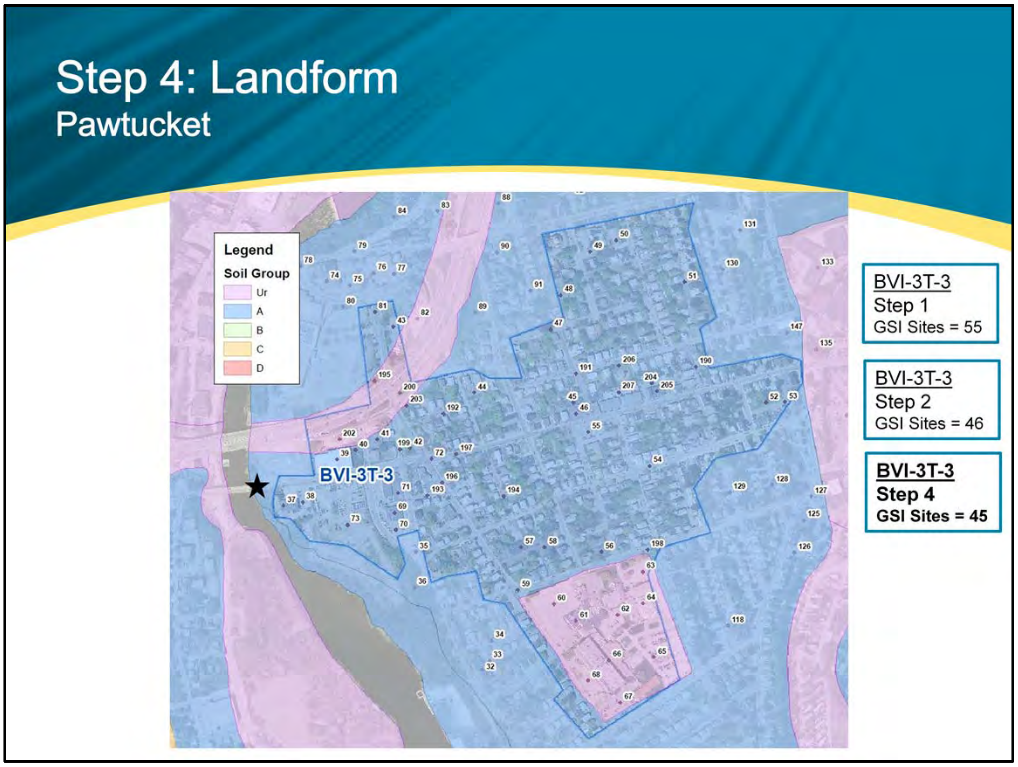
A total of 55 sites have been identified as opportunities for GSI.



The second step of evaluating GSI potential involves looking at site specific land use to confirm that opportunities for GSI are feasible. This includes screening out sites that have been identified as being impacted by an environmental issue (from RIGIS layers) and existing GIS installations (through NBC's stormwater program). Also, land uses that are generally prohibitive to GSI potential such as adjacent to highways or existing heavy use.

NBC Stormwater Program Site – South Bend Condos, 105,000 gallons in 3-month storm thru drywells and infiltration

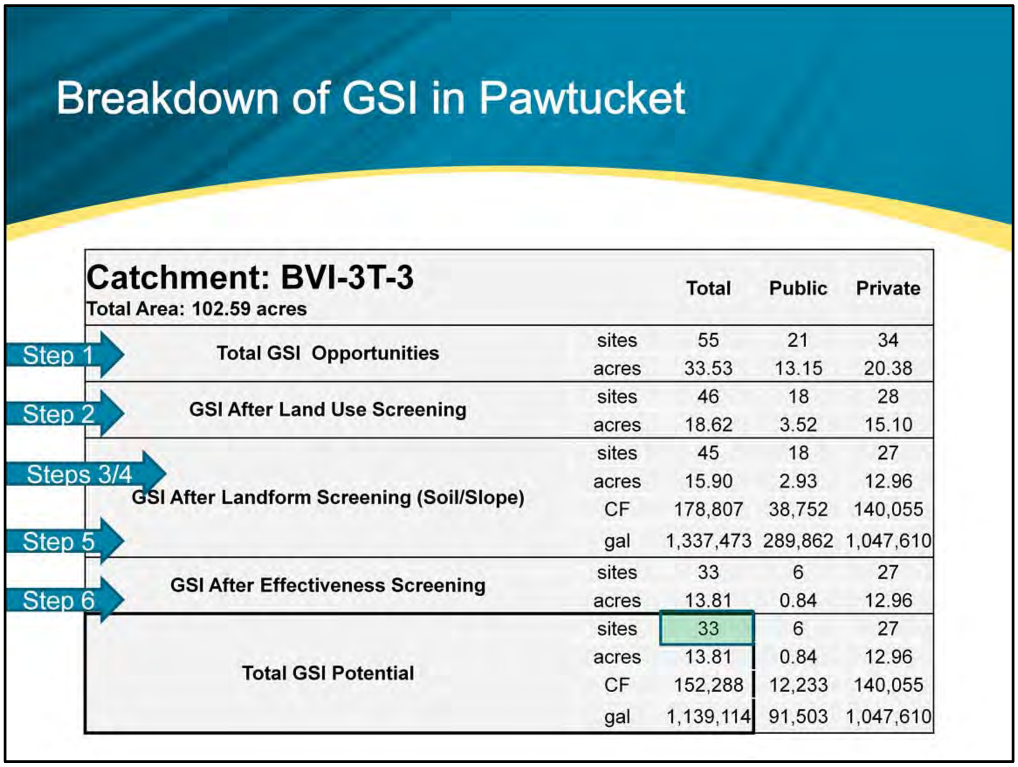
This screening level eliminated 9 sites from further GSI screening.



The third step of evaluating GSI potential involves looking at legislative drivers or barriers that may prohibit or dissuade GSI. This includes screening out areas that may fall within certain FEMA flood zones, specific sites or areas slated for development, or other legislative criteria (*ask for Stakeholder input??).* This screening level is not yet complete, but thus far no sites were eliminated due to FEMA flood zones.

The fourth step of evaluating GSI potential involves looking at existing landform characteristics that would not be conducive to GSI. This includes underlying soil classification and surface slope.

This screening level eliminated just one additional site from further GSI screening.



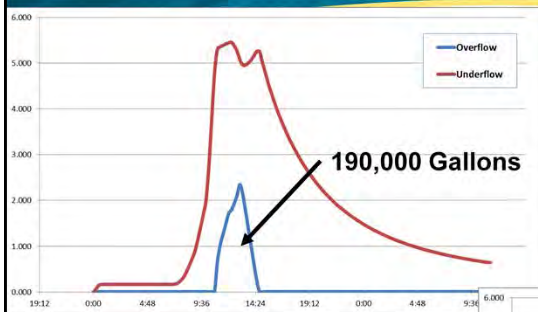
Catchment: BVI-3T-3 (Total Area: 102.59 acres)		Total	Public	Private
Total GSI Opportunities	sites	55	21	34
	acres	33.53	13.15	20.38
GSI After Land Use Screening	sites	46	18	28
	acres	18.62	3.52	15.10
GSI After Landform Screening (Soil/Slope)	sites	45	18	27
	acres	15.90	2.93	12.96
	CF	178,807	38,752	140,055
	gal	1,337,473	289,862	1,047,610
GSI After Effectiveness Screening	sites	33	6	27
	acres	13.81	0.84	12.96
Total GSI Potential	sites	33	6	27
	acres	13.81	0.84	12.96
	CF	152,288	12,233	140,055
	gal	1,139,114	91,503	1,047,610

After screening GSI opportunities for site characteristics in the first four steps, step five involves crunching the numbers on the remaining potential GSI sites to determine how much flow each site could handle. *Do we want to get into how this is done? Gross GSI site area multiplied by landform factors multiplied by the depth of storage for each type of GSI to result in a total volume off storage (shown in the above table as "Step 5)*

Once it is determined how much volume can be stored at each site, the effectiveness of each site can be evaluated as Step 6. Effectiveness in this sense is looking at: does the GSI site capture and hold back at least 75% of the 3-month storm for the rainfall on the site. Anything less than that is assumed at this stage to not be cost-effective enough to carry forward as a potential GSI site.

Step 7 involves evaluating the impact of the remaining potential GSI sites in the hydraulic model to determine the scalability of GSI in each particular area. This

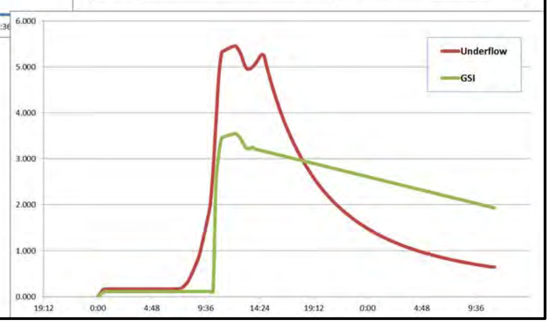
BVI-3T-3 and CSO 215



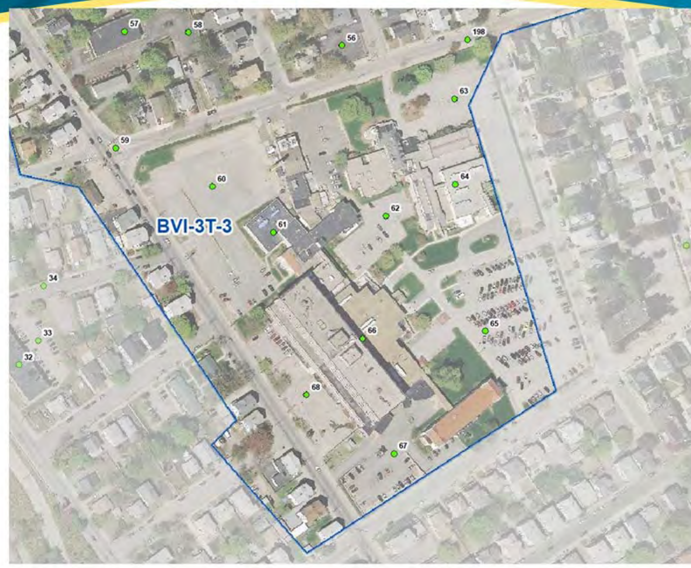
	Total	Public	Private
sites	33	6	27
acres	13.81	0.84	12.96
gal	1,139,114	91,503	1,047,610

Features of applying GSI

- **Reduced Peak Flow**
- **Slower Regression**
- **No Overflow**



Example 1: Memorial Hospital of RI

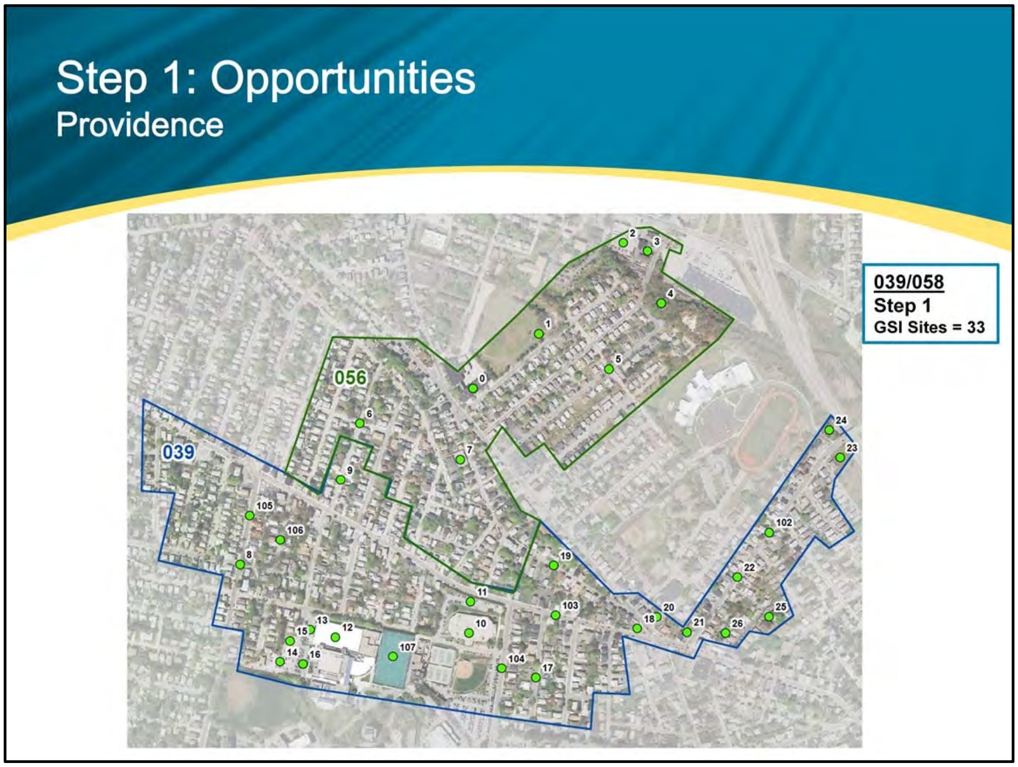


Example 2: Division St Greenspace Area

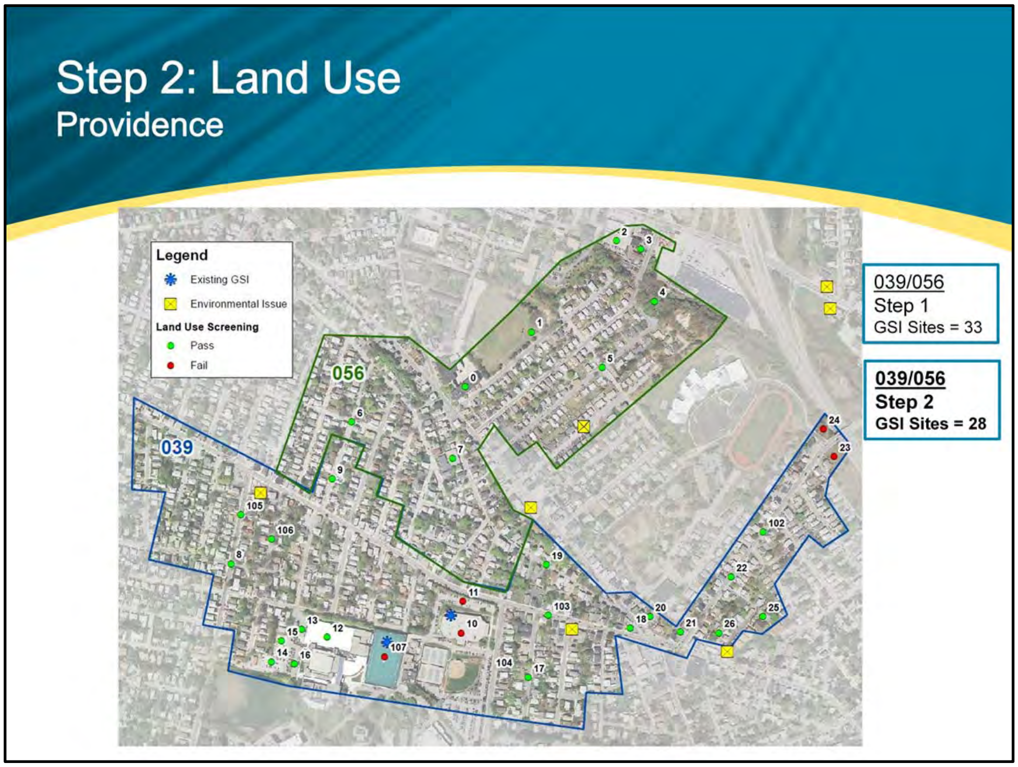
Examples of Public v Private GSI Sites

Example 1: Memorial Hospital of RI		
FID	60 through 68	
Ownership:	**Private**	
Total Area:	9	acres
No. of GSI	9	sites
GSI Storage:	668,170	gal
3-mo Runo	340,086	gal
Effectiveness:	196%	

Example 2: Division St Greenspace Area		
FID	42	
Ownership:	**Public**	
Total Area:	0.07	acres
No. of GSI	1	sites
GSI Storage:	31,497	gal
3-mo Runoff	1,635	gal
Effectiveness:	1,926%	

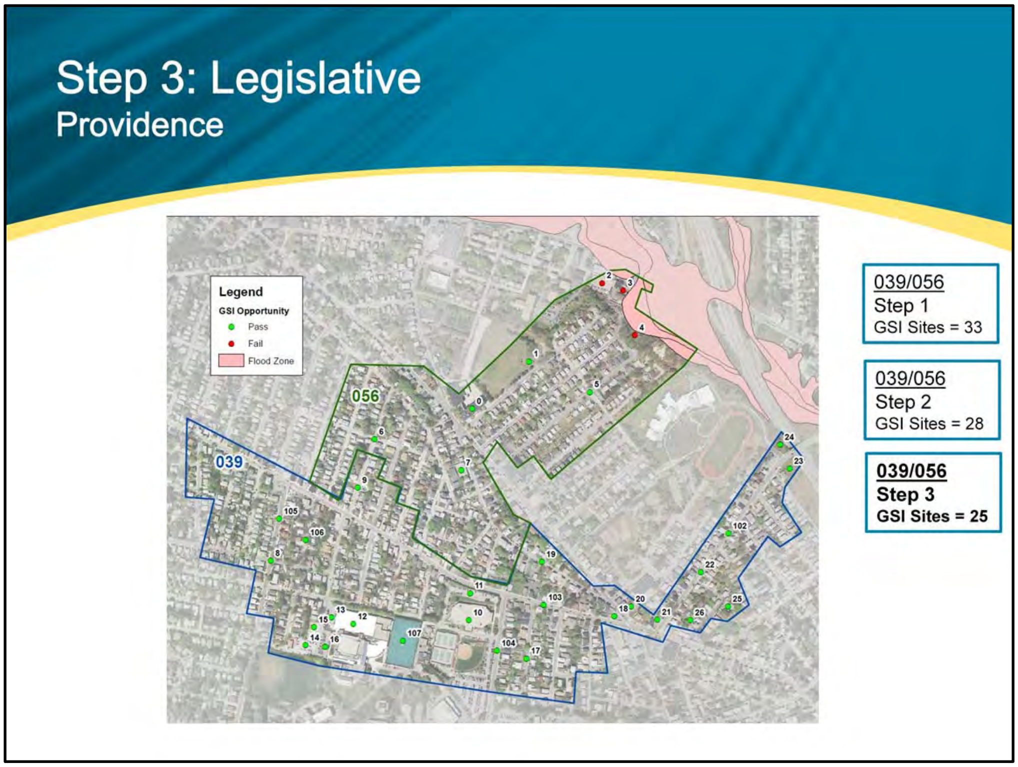


A total of 33 sites have been identified as opportunities for GSI in the CSO catchments of 039 and 056.



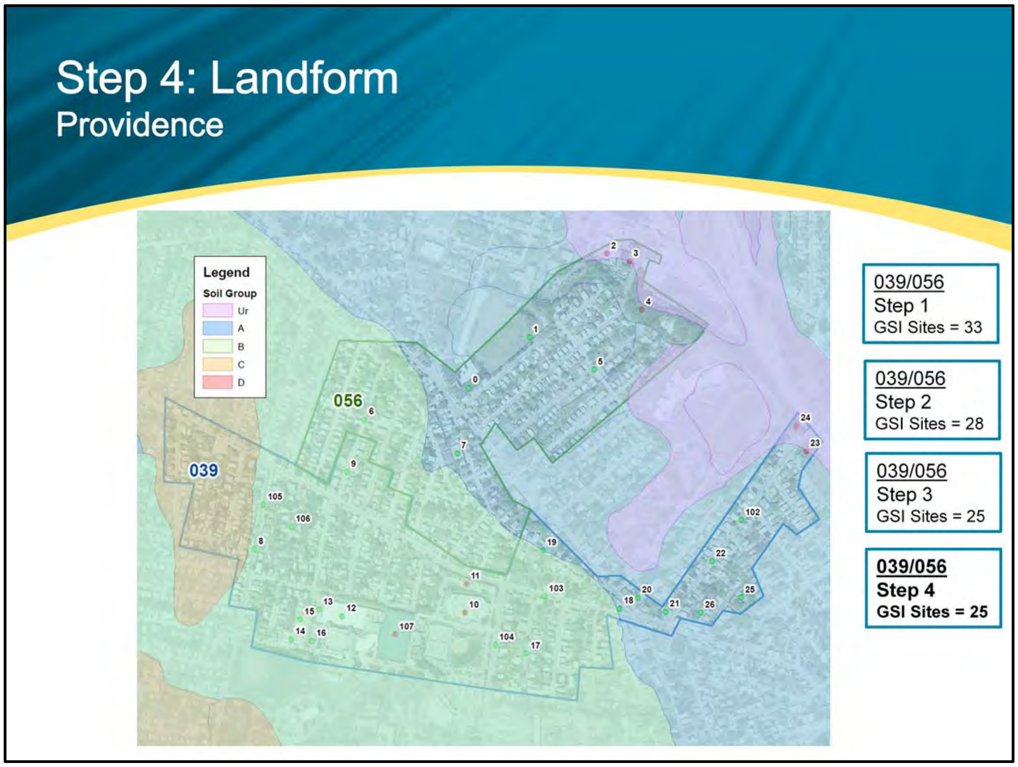
This screening level eliminated 5 sites from further GSI evaluation.

NBC Stormwater Program
- Providence College Athletic Field Huxley Ave
  33,000 gallon reduction in 3-mo storm thru infiltration and reuse
- Providence College Schnider Arena
  42,000 gallon reduction in 3-mo storm thru bioretention and separation



FEMA flood map – 100 yr flood

This screening level eliminated 3 sites from further GSI evaluation.



No additional sites were eliminated at this screening level. Many of the sites, however, had factors applied to them for moderate slope or soil characteristics that reduced the effective GSI area.

A factor of 0-1 is applied to the gross area of each landform characteristic to account for differing site conditions. Sites with underlying soils classified as D or slopes above 12% have a factor of 0 applied to them and are removed from further GSI consideration. Sites with underlying soils classified as A or slopes below 5% have a factor of 1.0 applied to them. Classifications in between are prorated.

*Sites that have been identified for GSI opportunities that are not impacted by slopes, such as flat roofs, are not screened by landform characteristics.

Breakdown of GSI in Areas 039 and 056

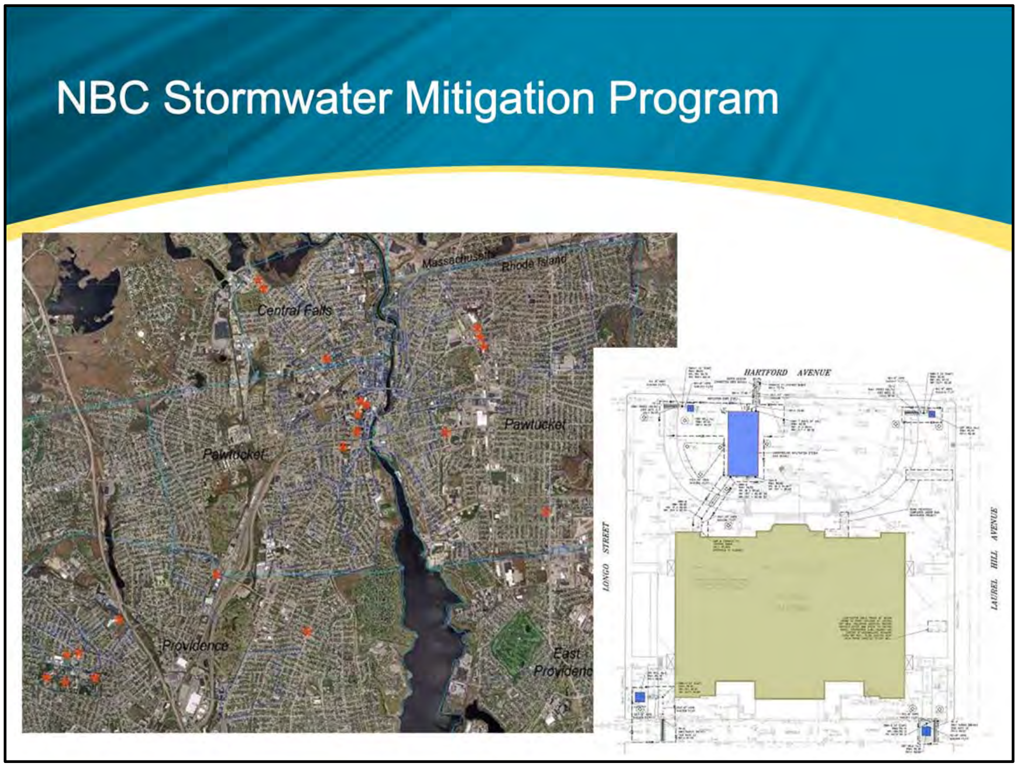
Catchment: 039 Total Area: 102 acres		Total	Public	Private
Total GSI Opportunities	sites	25	12	13
	acres	29.94	17.63	12.31
GSI After Land Use Screening	sites	20	10	13
	acres	9.64	4.23	5.41
GSI After Landform Screening (Soil/Slope)	sites	20	10	10
	acres	8.47	3.64	4.84
	CF	87,033	47,257	39,776
	gal	651,006	353,483	297,523
GSI After Effectiveness Screening	sites	10	0	10
	acres	4.84	0.00	4.84
Total GSI Potential	sites	10	0	10
	acres	4.84	0.00	4.84
	CF	39,776	0	39,776
	gal	297,523	0	297,523

Catchment: 056 Total Area: 69 acres		Total	Public	Private
Total GSI Opportunities	sites	8	5	3
	acres	14.52	13.51	1.01
GSI After Land Use Screening	sites	8	5	3
	acres	9.15	8.15	1.01
GSI After Landform Screening (Soil/Slope)	sites	5	4	1
	acres	4.41	4.22	0.19
	CF	69,059	59,737	9,322
	gal	516,560	446,833	69,728
GSI After Effectiveness Screening	sites	3	2	1
	acres	3.16	2.97	0.19
Total GSI Potential	sites	3	2	1
	acres	3.16	2.97	0.19
	CF	37,428	36,381	1,047
	gal	279,960	272,130	7,830

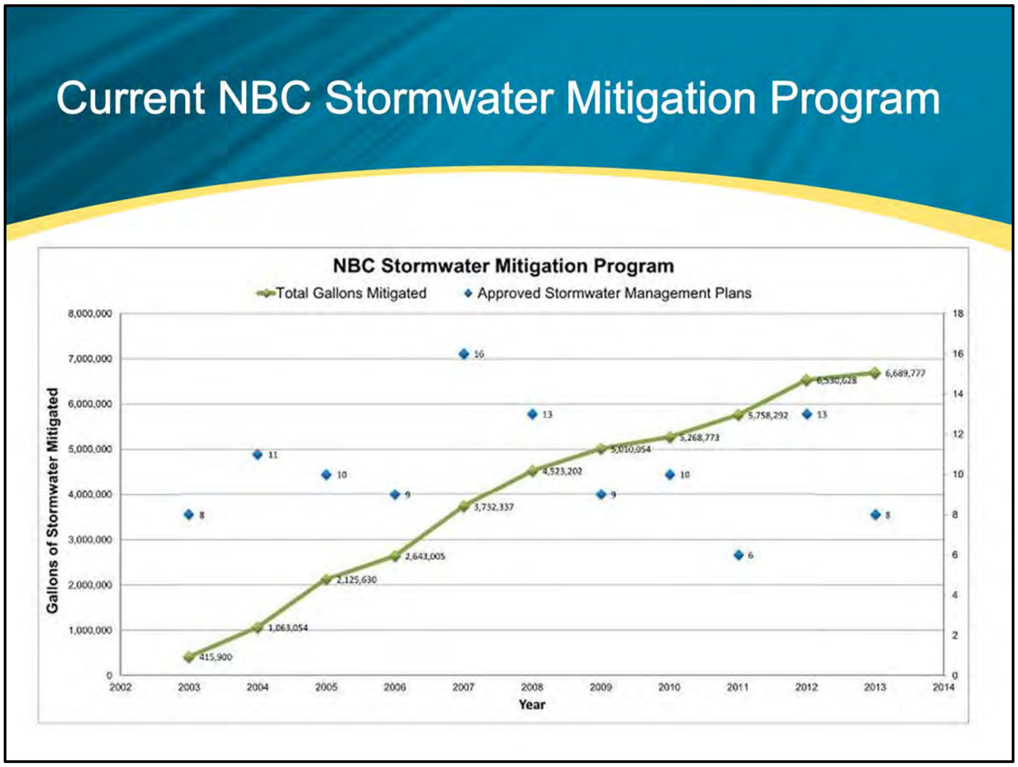
CDRA 3-mo storm:
039 = 0.12 MG
056 = 0.29 MG

Land Use Screening – Acreage drop due to parking lane reduction

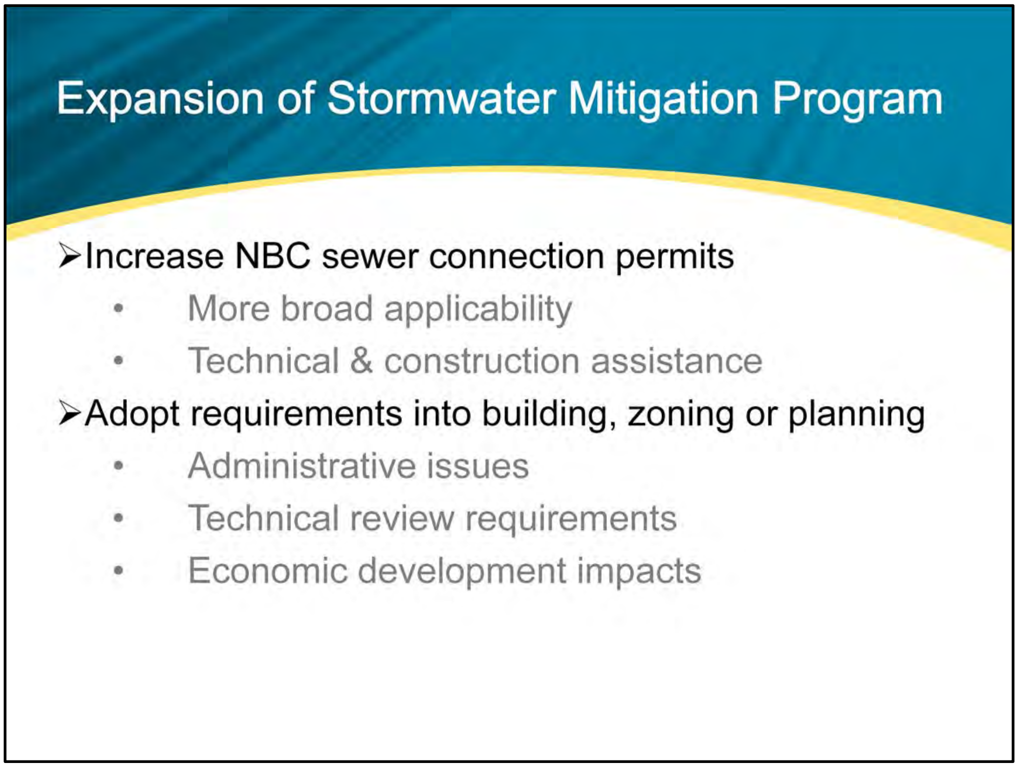
As the analysis indicates, GSI projects in the public way only yield a small portion of the overall potential CSO reduction benefits. To tap the full potential, we need to look to installations on private property.



As Scott discussed last month, NBC currently has a stormwater mitigation program in effect that proves that GSI can successfully be implemented on private property in the combined sewer areas.



While the program has removed a substantial volume of stormwater from the system, it only applies to properties requiring a new sewer connection or increasing its flow by 20 percent, and only captures on average ten properties per year. For GSI to be a serious alternative to grey infrastructure within the timeframe for CSO compliance, something more aggressive in terms of private property GSI implementation may need to be considered.



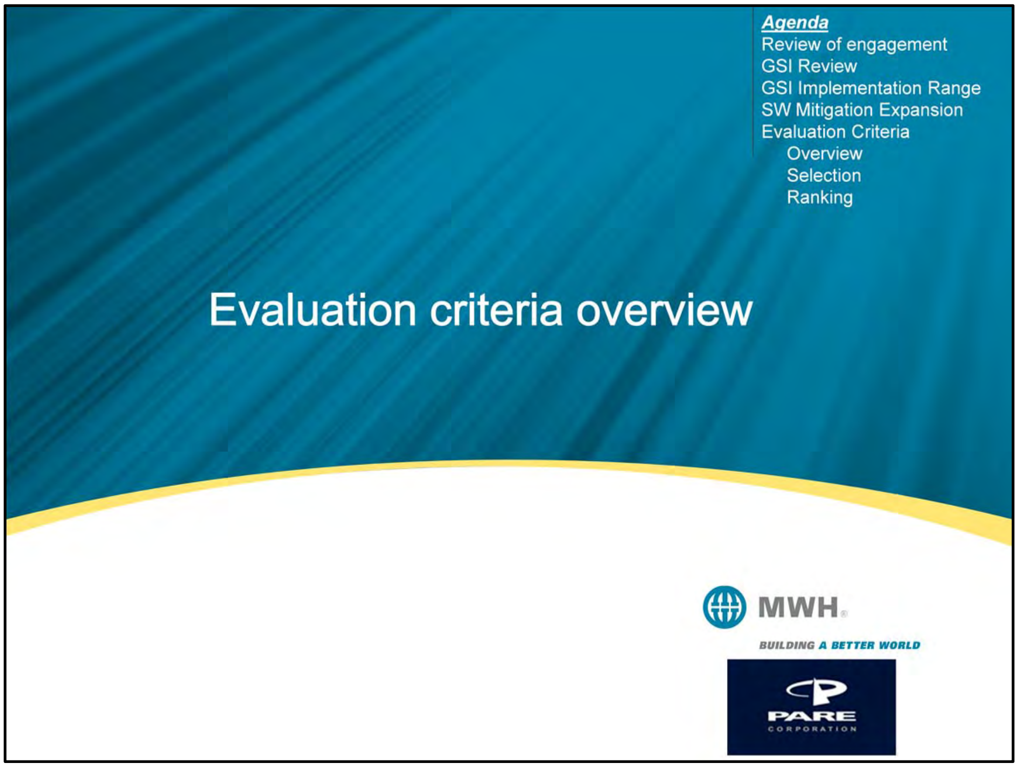
In general, the technical requirements of the mitigation program are well aligned with the area conditions, including soils, topography and land use. So the question becomes how can those requirements be applied to more properties?

One option is for NBC to administer a program that requires mitigation for any property undergoing renovations regardless of wastewater discharge modifications. This could even take the form of an outreach program by which NBC approaches targeted property owners to work collaboratively to apply the standards to properties not otherwise being renovated.

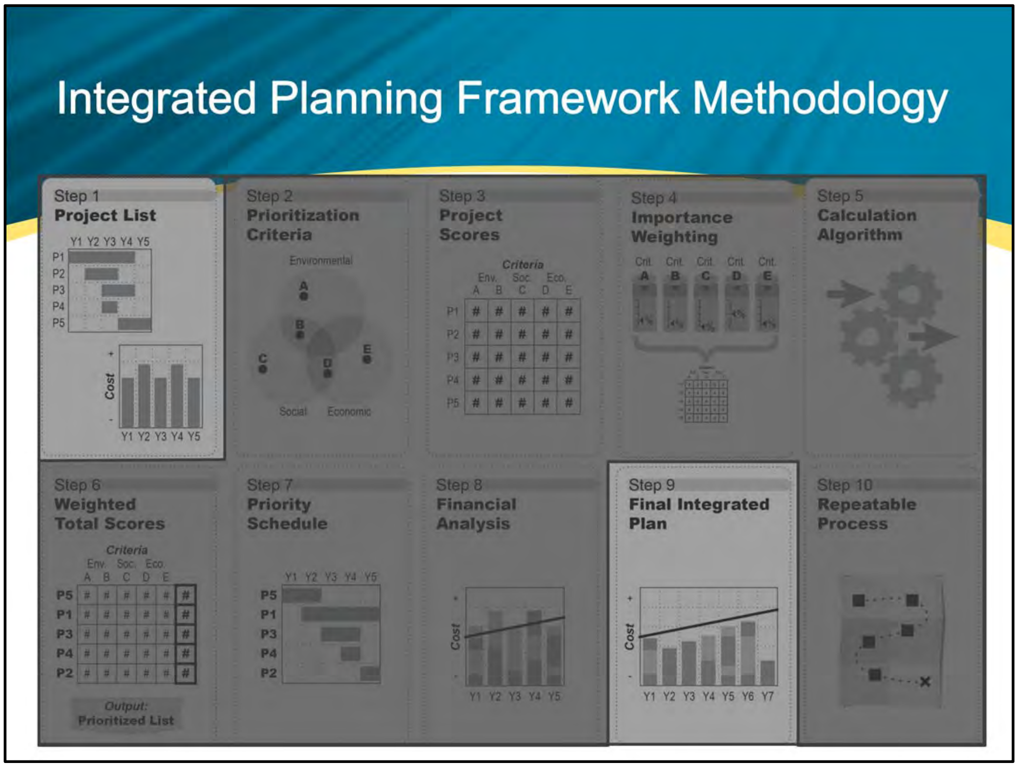
A different option would be for the member communities to adopt those standards into its own building, zoning or planning regulations and administer the program. Similarly, the communities could work with property owners to complete stormwater improvements in the absence of other renovations.

At this time, we would like to pause and discuss these options and the Stakeholder's ideas regarding these or other ideas.

Welcome to the next phase of our Stakeholder process – the establishment of evaluation, or prioritization, criteria.



We will start with an overview of the evaluation process and the introduction of example criteria.

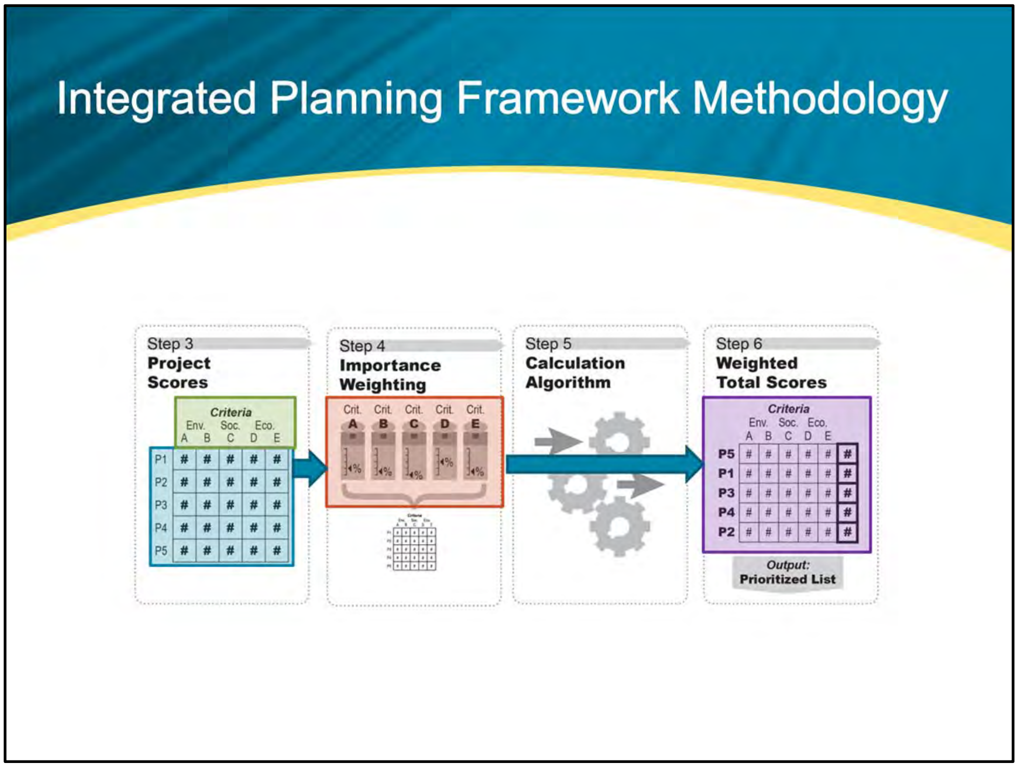


As you hopefully recall from out Kickoff meeting in March, we are using our Integrated Planning Framework methodology to conduct the Phase III reevaluation.

For the last several months, we have been focusing on Step 1, the project list. As we said a couple of meetings ago, the devils are in the details, and it is important to understand how each alternative must be adapted or customized to meet local needs. The feedback and input that you have provided is helping us to define implementable alternatives.

Our goal for the Phase III reevaluation is to define the components of the CSO abatement program, determine the schedule that accommodates affordability, and sequences the individual projects to realize the maximum benefits as soon as possible. That will be the focus of Step 9 and our October Stakeholder meeting.

So how do we get there?

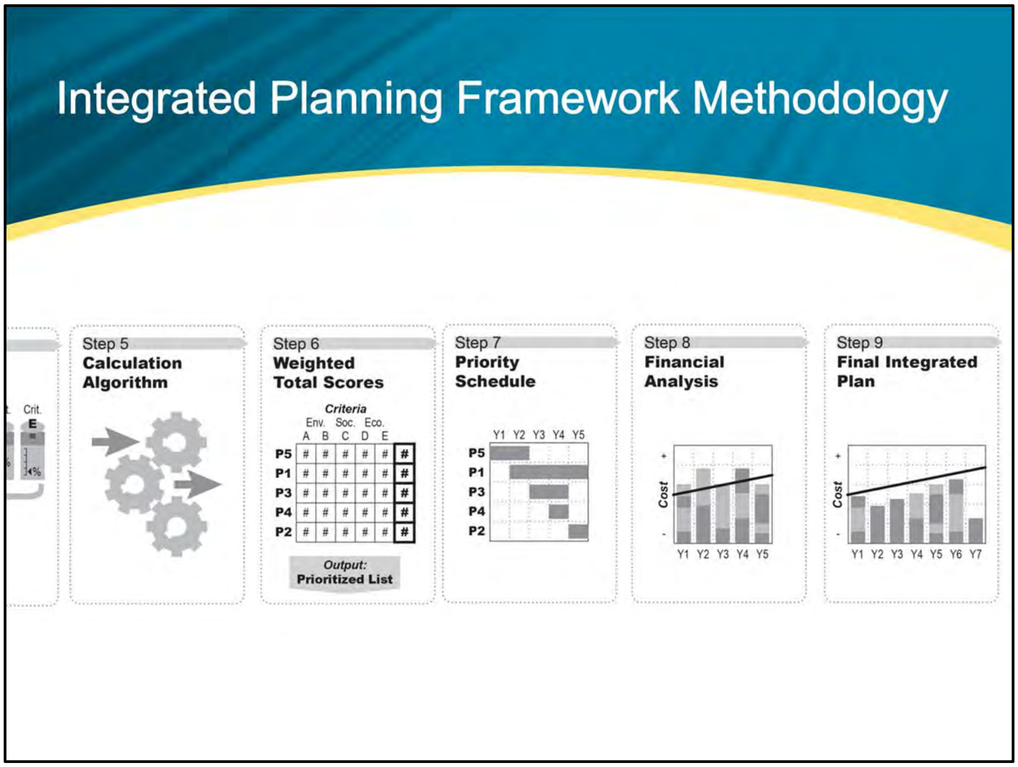


Our next steps over the summer will be to fully define the advantages and disadvantages of each alternative. We will develop costs, calculate CSO reductions, and determine water quality impacts and/or benefits. We will also estimate how well each alternative attains the other goals we have discussed like minimizing construction-phase impacts or improving levels of service.

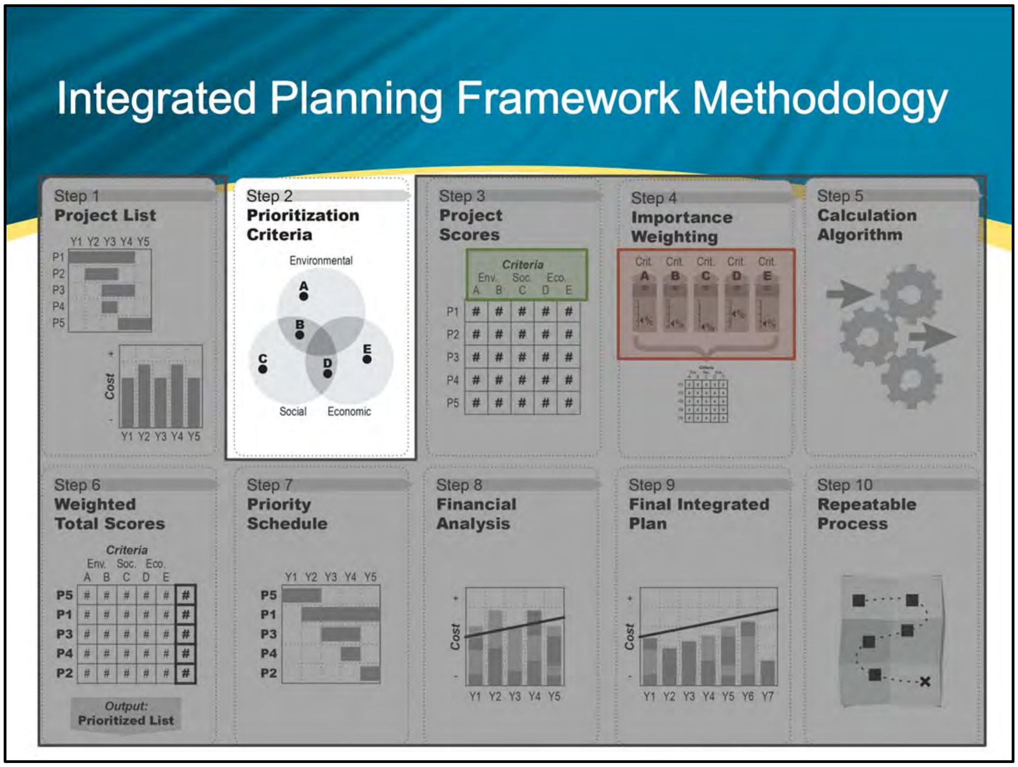
We will essentially be assigning draft scores for each alternative against evaluation or prioritization criteria.

We will likely have some criteria that are of more overall importance than others, so we will have weighting factors that help us calculate total weighted scores for each alternative.

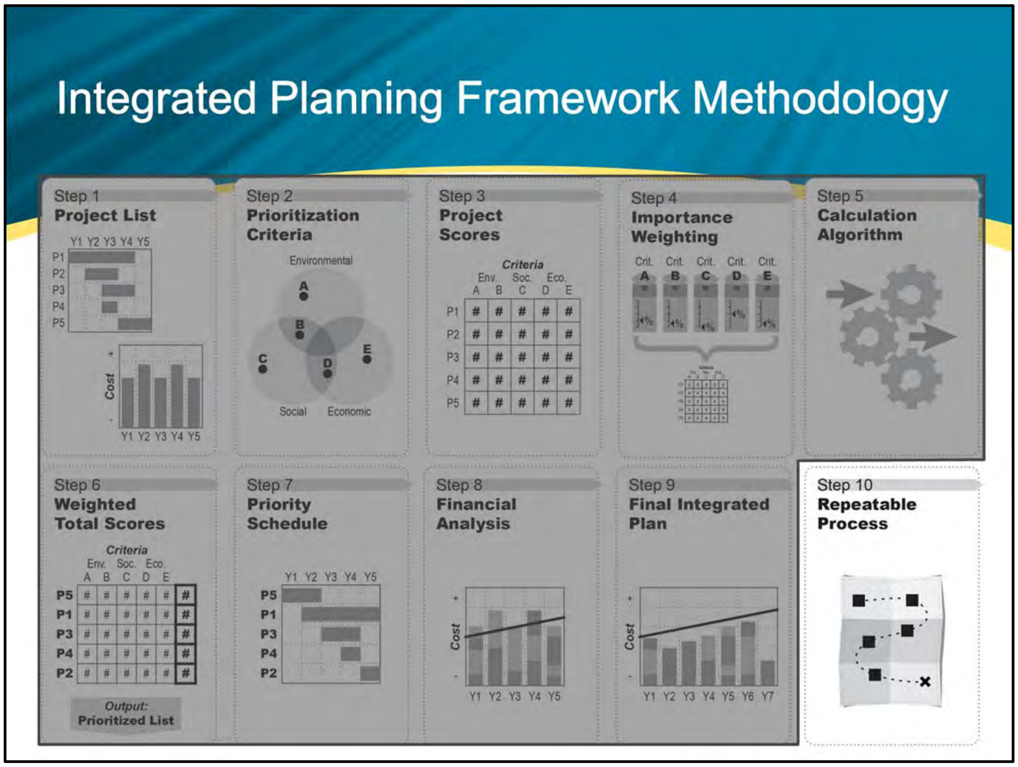
When the Stakeholder group reconvenes in September at the next meeting, we will have a draft of Step 6 for review. The focus of that meeting will be to review and modify if necessary any of the scores against the evaluation criteria and therefore determine each of the alternatives' overall favorability. Through this process, we will select the appropriate technical approach for each CSO and we will provisionally prioritize each of those CSO projects.



I say provisionally sequence since we will follow the September meeting with the financial capacity analysis. That may lead us to some modifications that result in delaying some high-priority projects until they become affordable, and proceeding in the short term with lower-impact but affordable projects. However, I'm getting ahead of myself.

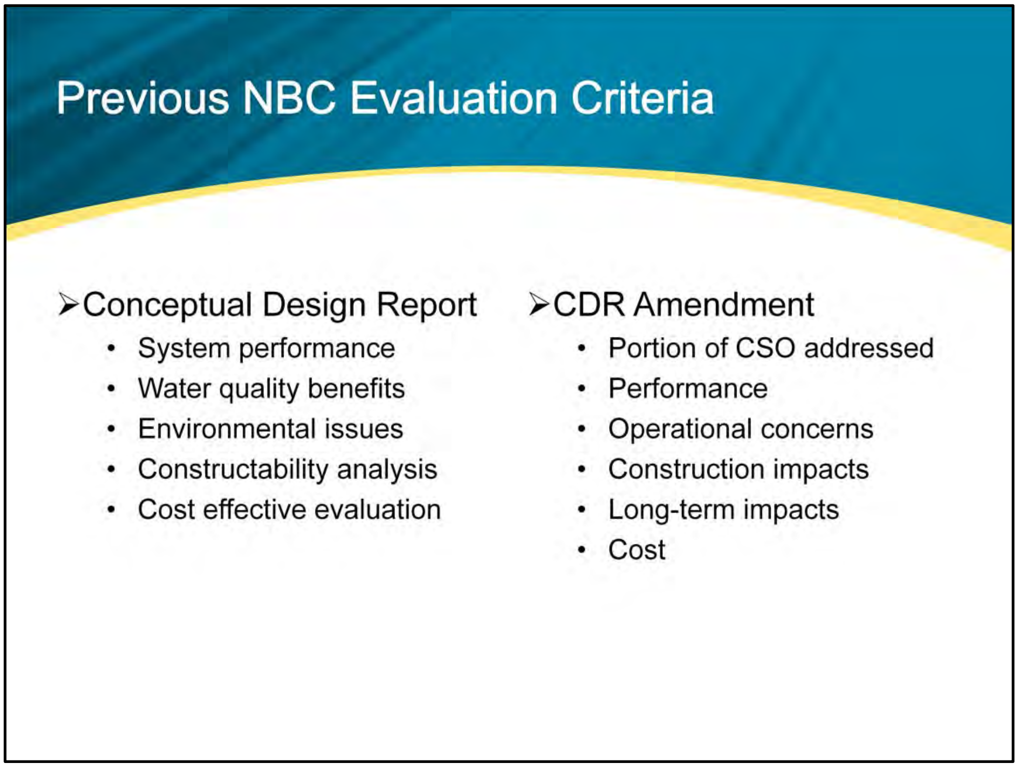


For the remainder of our time today, we will select the evaluation or prioritization criteria for the NBC service area. These criteria must reflect everything that this stakeholder group considers important for evaluating alternatives and projects. We want to develop an exhaustive list so that in September and thereafter when we are reviewing how well each alternative or project achieves our goals, we can clearly see how an overall ranking is established. Today, we will also select weighting factors for each criterion, so that while we can see that level of detail, we will emphasize the most important factors in the overall ranking.



Before we do that, however, there is one more thing to consider. We know that over the next several years several external factors will emerge that will drive other projects and programs with water quality implications that will require funding from the same rate payers as the NBC CSO program. For example, as the new RIPDES MS4 permits are issued, the communities will need to develop stormwater improvement projects that may include retrofitting existing drainage infrastructure to meet the new permit requirements. Unfortunately, we will not have many of those projects sufficiently defined to complete a thorough IPF process that would prioritize and sequence those projects against CSO projects under the limit of affordability within the timeframe of the Phase III reevaluation effort. That is likely fine as high-priority CSO projects would likely take precedence anyway. However, it is important that we establish a repeatable process so that as other programs advance, NBC and the communities can effectively execute Step 10 and repeat the reevaluation and reprioritize projects in the best interest of the Bay and the rate payers.

Therefore, as we think about the prioritization criteria, we should remember that they should have broader implications than evaluating the alternatives we have discussed over the last few meetings.



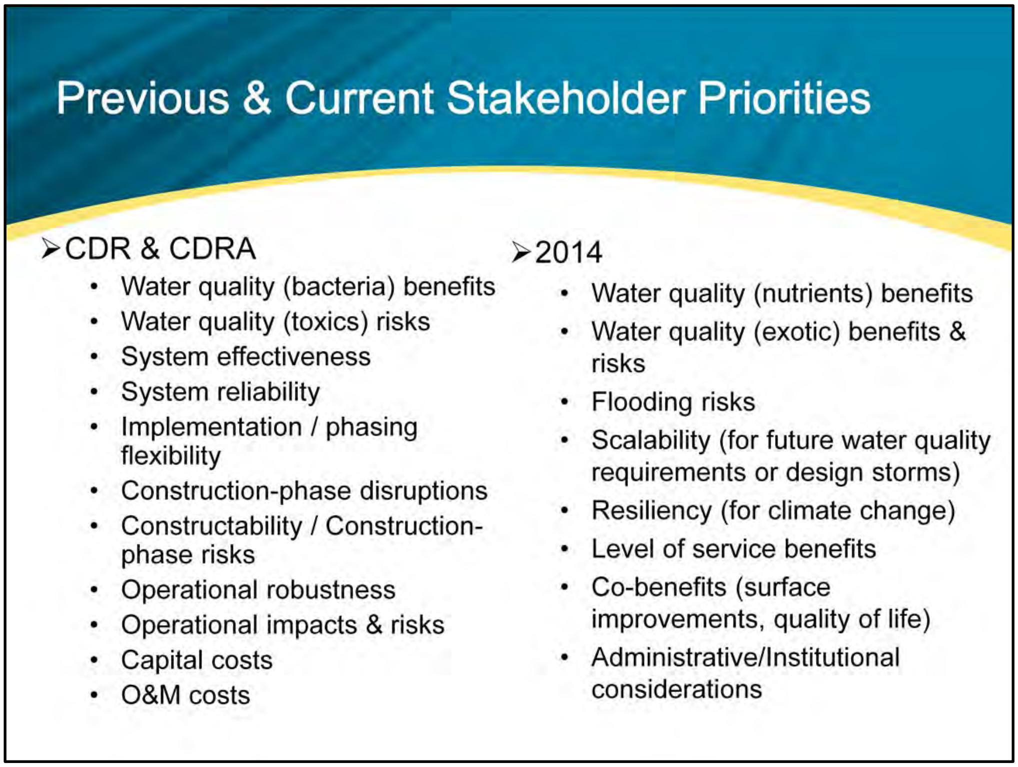
Then the NBC CSO program was first taking shape in the early 1990's, the alternatives were evaluated on a scale of 1 to 3 for their relative advantages and disadvantages relative to five criteria:

- System performance which captured how well the system would operate,
- and its closely related Water quality benefits which reflected CSO reductions;
- Environmental issues which captured both construction-phase and potential operations-phase impacts;
- Constructability analysis which included how well projects could be phased; and
- Cost effective evaluation.

When the plan was refined in the mid 1990's, the alternatives were further ranked against six criteria:

- Portion of CSO addressed which captured how well an alternative would capture large outfalls or consolidations of outfalls to abate large volumes;
- Performance which captured the effectiveness and reliability of pollutant removal;
- Operational concerns which evaluated how robust a solution was and what safety issues might impact NBC staff and the public;
- Construction impacts included land acquisition requirements and short-term disruptions including traffic;
- Long-term impacts to the community such as noise and odor and to the environment such as habitat disruption; and
- Cost including capital and O&M.

Clearly a lot of analysis and deliberation went into evaluating each of the alternatives, and the actual issues considered go beyond a simple reading of the criteria titles. As Brian pointed out a few meetings ago, the previous planning effort took place over the course of many years. This time, we have only a few months. Consequently, we would advise that this time, we use more criteria so that we can more easily hone in on specific issues as we evaluate alternatives in September.

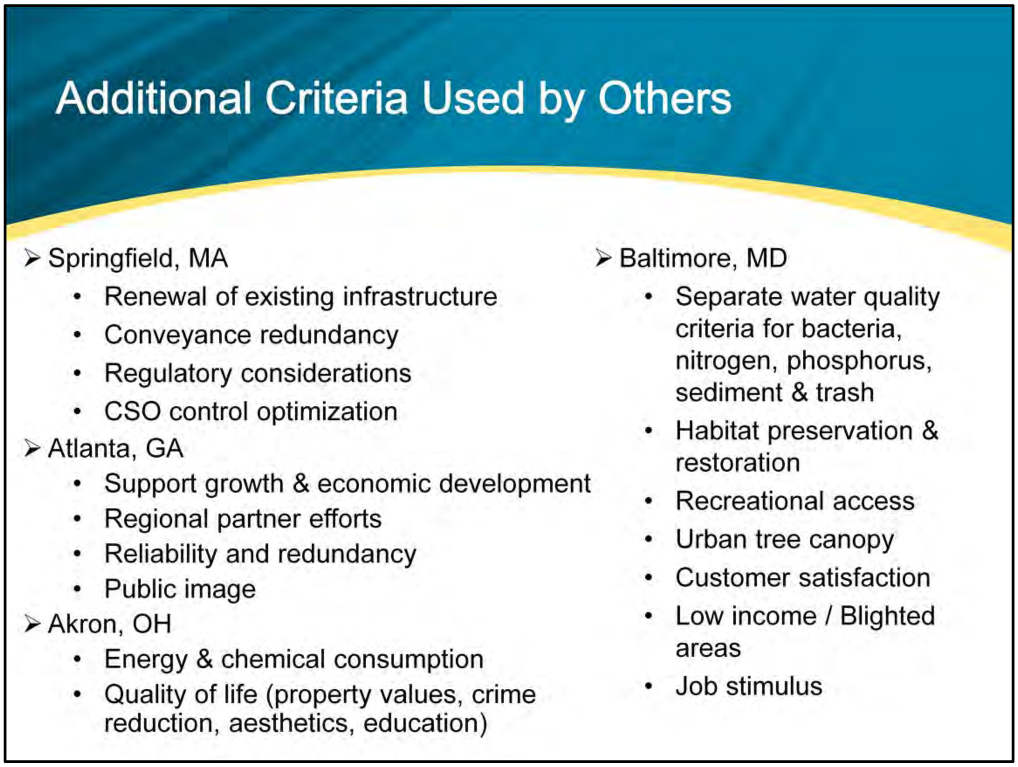


Splitting out the issues contained within the previous evaluation criteria, we see certain priorities:

- Water quality benefits, particularly related to bacteria, from CSO reduction;
- The risks of new water quality impacts, in that instance chlorine from disinfection, but the same logic could apply to other toxic releases;
- How efficient a system is at controlling CSOs, how targeted is it a creating the greatest CSO reduction, and how reliable the system is;
- How flexible the system is both in terms of operations and in terms of how parts of it can be phased;
- The minimization of construction-phase disruptions that can be defined now such as traffic and noise impacts to residents and businesses
- The minimization of construction phase risks that would include avoiding areas of known contamination, minimization of the construction footprint, avoiding easement or land acquisition, minimizing construction depth, particularly in areas of uncertain geotechnical conditions, and overall avoidance of uncertainty;
- How robust the system is without the need for intervention or active operations
- The minimization of impacts to residents and businesses for regular operations and maintenance, and the minimization of risks to people and the environment from those activities;
- And finally cost.

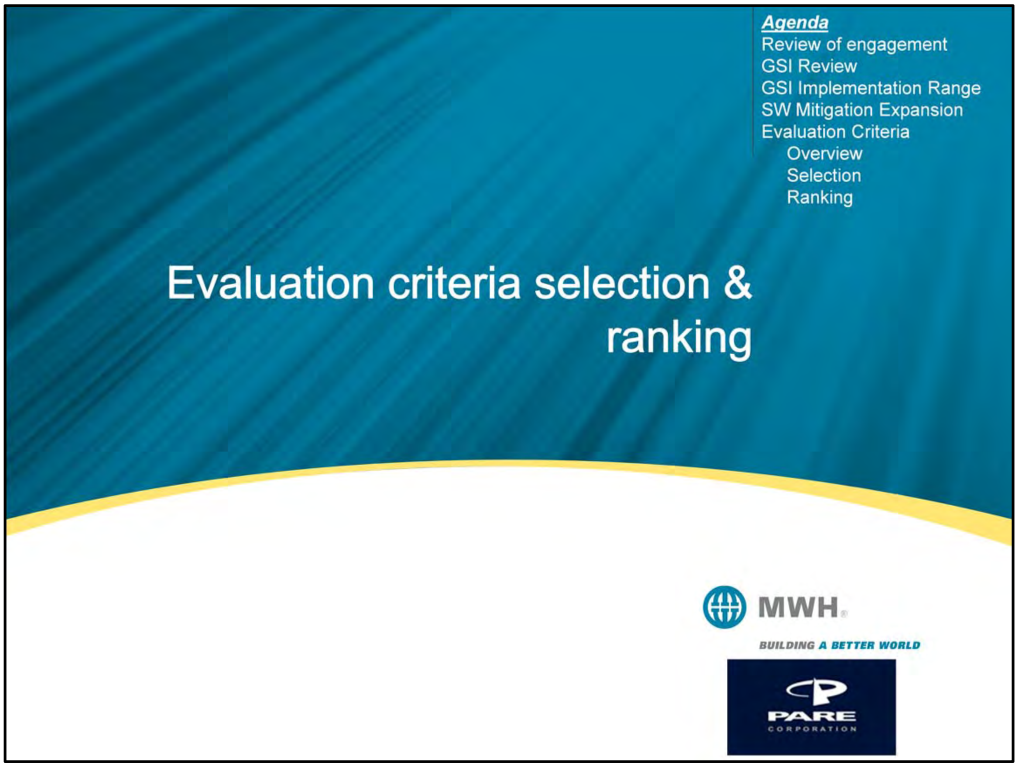
In our discussions thus far with this stakeholder group, a few additional priorities have become clear:

- Other water quality indicators beyond bacteria and residuals, including nutrients and possibly other more exotic pollutants;
- Flooding risks;
- Scalability considering potential changes in future water quality requirements or design storms;
- Somewhat related is resiliency for climate change;
- The potential to increase levels of service for sanitary and storm drainage in the service areas; and
- The co-benefits of any solutions that could produce surface, roadway or quality of life improvements.
- Unlike the previous planning effort that focused on Receptor solutions clearly within the control of NBC, this time we are evaluating Source solutions, like GSI, that are distributed throughout the communities. Therefore, we will need to consider the responsible parties for implementation, including operations and maintenance. That is caught here under the banner of Administrative/Institutional limitations.

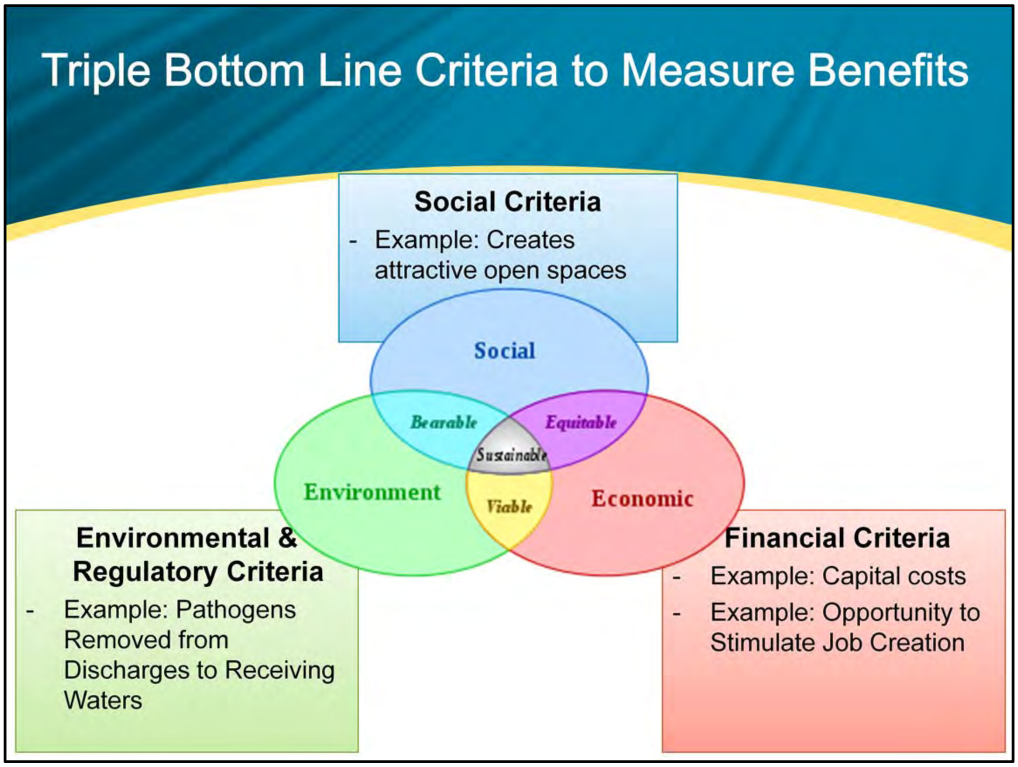


A few other criteria that have been used by others that are worth considering include:

- Springfield has an old system, much of which they know will require rehabilitation or replacement. They placed a priority on CSO facilities that would replace older existing infrastructure
- Similarly, they favored alternatives that the hydraulic model indicated would afford them redundancy for both operational flexibility and to facilitate other repairs or upgrades
- Springfield acknowledged that regulatory requirements may change in the future, so alternatives that offered flexibility to meet changing CSO limits, treatment plant limits, stormwater discharge requirements and design storm changes
- Similarly, Springfield favored solutions that could optimize CSO controls due to changed conditions in the future and be adaptable or expandable at a relatively low cost
- In Baltimore, they adopted separate water quality criteria for different contaminants including bacteria, nitrogen, phosphorus, sediment & trash
- Baltimore favored habitat preservation and restoration, as well as creation of recreational facilities and urban tree canopy
- Baltimore placed an emphasis on projects that would improve low income or blighted area
- Similarly, Baltimore favored options that would create jobs
- In Atlanta, their infrastructure spending is focused on projects that support growth and economic development
- Atlanta also favors projects that include regional partnerships
- Like others, reliability and redundancy is preferred in Atlanta
- Atlanta also seeks to enhance the public's perception and expectations of their wet utility provider.
- Akron is also considering lifecycle costs including reduced energy and chemical consumption
- And finally, Akron is including a suite of quality of life issues that include considerations for increasing education, aesthetics and property values while reducing crime, noise and odors.



Given the makeup of this Stakeholder group, I'm sure the majority of you are no strangers to developing evaluation criteria, so I hope that review was not too pedantic and will help this next effort. We have compiled the past criteria, those that have surfaced during our discussions in this room, and the others introduced from other IPF efforts, and sorted them into the Environmental, Economic and Social groups. Let's now select the ones we wish to use for the Phase III effort, possibly adding others, and define what they mean for NBC.



When evaluating alternatives, historically that assessment has been done in terms of costs and benefits. For CSO projects in simplest terms, benefits are quantified as water quality improvements, and costs are the sum of capital and O&M present worth equating to a "bottom line". The previous NBC criteria mostly fall into those categories.

Proponents of sustainability have championed expanding the range of those criteria and adding a third criterion that evaluate social impacts. Interesting, the CDRA effort's criterion for Construction Impacts started to make a foray into social impacts. This approach includes using specific measures like pathogen removal, job creation and improvement to services to arrive at a "triple bottom line" that scores alternatives against regulatory, economic and social impacts. The concept is that using only economic and environmental factors, you may arrive at viable solutions, but by adding social measures, you find solutions that are bearable, equitable or even sustainable.

The triple bottom line approach also provides a framework for us to classify evaluation criteria.

Environmental Criteria

- Water quality (bacteria) benefits
- Water quality (nutrients) benefits
- Water quality (toxics & exotic) benefits & risks
- Flooding risks
- Scalability (for future water quality requirements or design storms)
- Resiliency (for climate change)
- Administrative / Institutional considerations
- System reliability / Operational robustness
- Implementation / phasing flexibility
- Habitat preservation & restoration

Economic Criteria

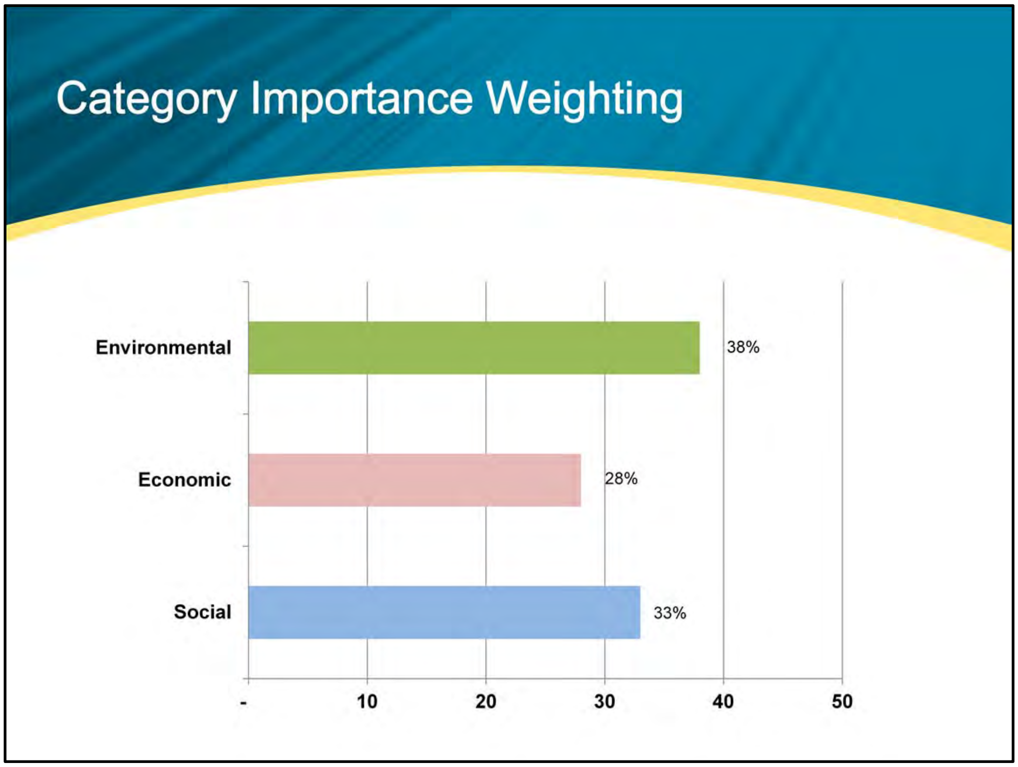
- Capital costs
- O&M costs
- Cost effectiveness / efficiency
- Constructability / Construction-phase risks
- Operational flexibility for optimization
- Renewal of existing infrastructure
- Support growth & economic development
- Regional partnering potential

Social Criteria

- Co-benefits (surface improvements, quality of life)
- Level of service benefits
- Construction-phase disruptions
- Impacts & risks to residents, businesses and environment from operations & maintenance
- Quality of life (property values, crime reduction, aesthetics, education)
- Recreational access
- Customer satisfaction
- Targeting of improvements to low income / blighted areas
- Public image
- Job stimulus

TBL Criteria Importance Weights

Criteria	Criteria Weight
Environmental	
Regulatory Compliance	69%
Sustainability Initiatives	25%
Regional/Joint Partner Cooperative Efforts	6%
Environmental Subtotal	100%
Economic	
Operational Efficiency	36%
Physical / Performance / Process Condition	45%
Growth and Economic Development	19%
Economic Subtotal	100%
Social	
Level of Service	35%
Reliability and Redundancy	40%
Safety and Security	15%
Public Image	10%
Social Subtotal	100%



Category Importance Weighting
Environmental
38%
Economic
28%
Social
33%
-
10
20
30
40
50

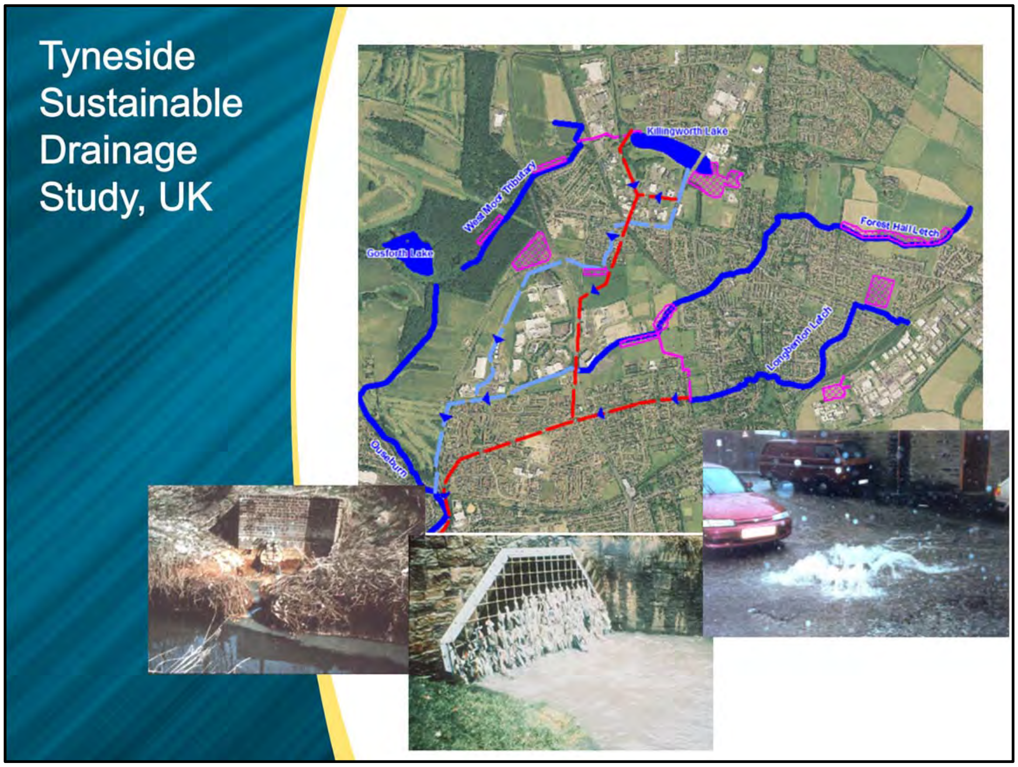
Next Meeting

4 September 2014, 9:00AM
Integrated Planning Workshop

Proponents of GSI highlight their many ancillary benefits that improve the quality of life in the area.

GSI are source controls and are the most decentralized solutions that can be considered. They are also passive controls that must be carefully preserved and maintained to ensure that they function properly when storms occur. Consequently, strong local bye-in and understanding are essential for long-term performance.

New urban watershed



Introducing the Tyneside Study

This is a case study considering the effectiveness of GSI in an urban and semi-urban catchment.

The area suffered with wider spread flooding and poor water quality and which grey solutions were being implemented to the tune of approximately 10MG this was insufficient.

Applying the Source-Pathway-Receptor approach to managing stormwater MWH was able to reshape the water cycle in the area. The drivers and challenges for the study included:

Poor levels of sewer system service through flooding;

Watercourse poor water quality from nutrients, bacteria and aesthetics;

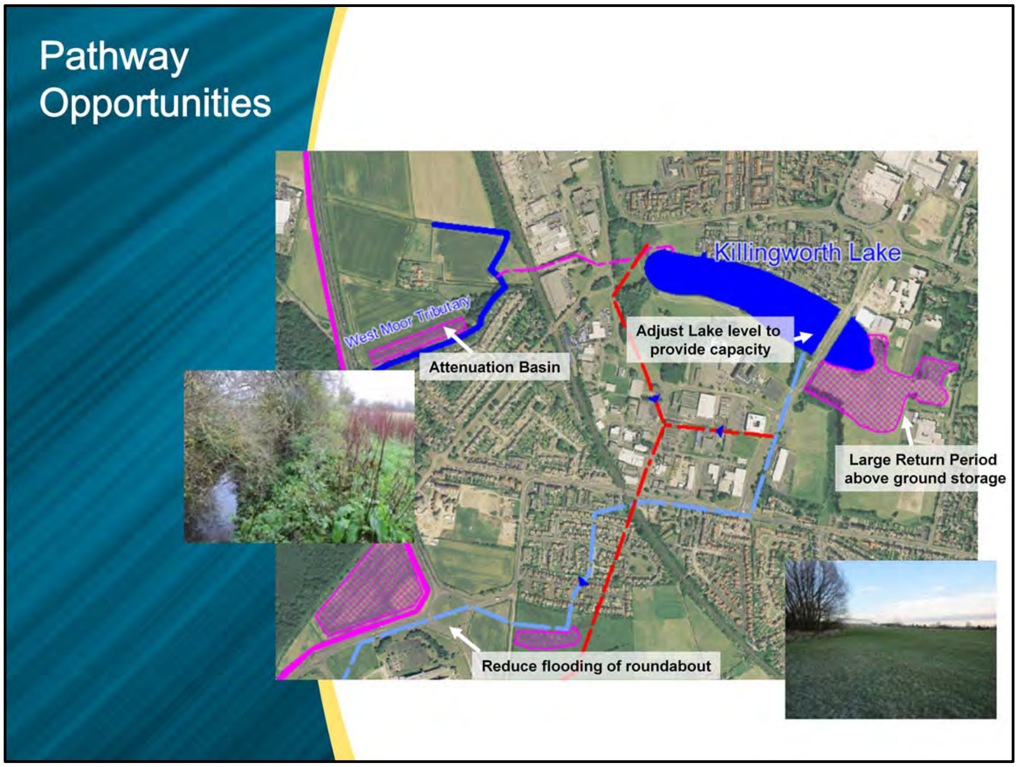
An inability to sustain future growth in the area;

Degrading public amenity through poorly managed waterways; and

No resilience to climate change.

Overall this study identified the need for stakeholder engagement and a new set of ideas to deal with the problems in an integrated fashion. The cost effectiveness of solutions which address only one issue did not meet cost benefit criteria and therefore had to address multiple strands and identify a variety of potential benefits.

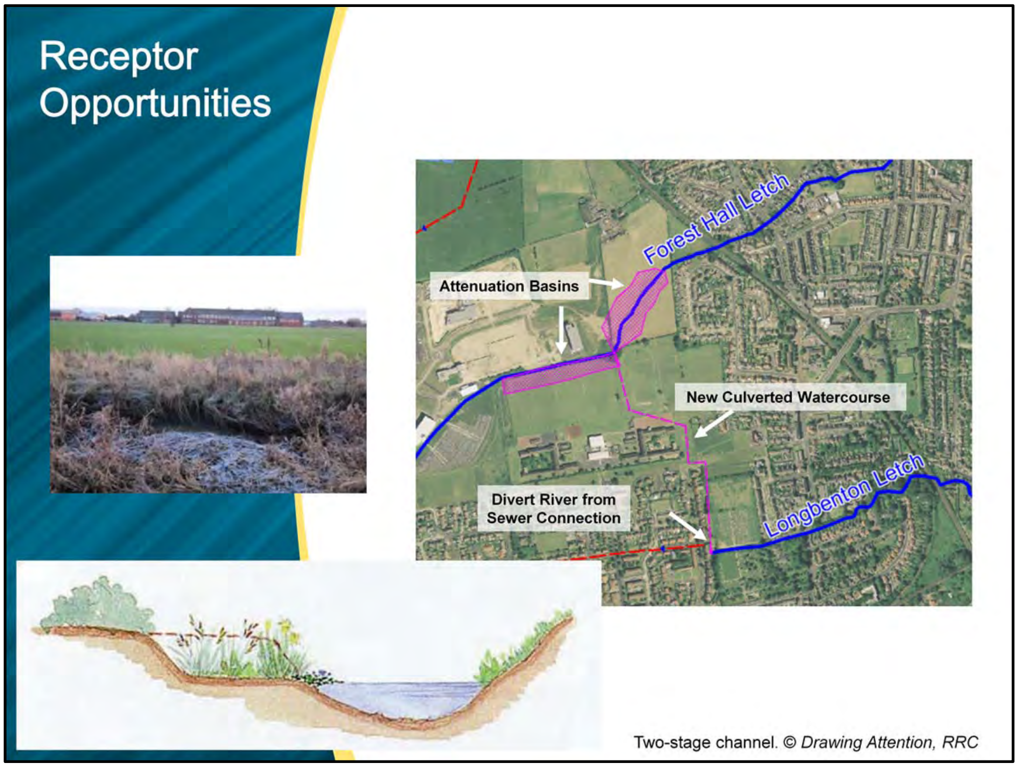
Source Control
A range of source measures were identified to reduce peak stormwater flows in the system. Stormwater flows from the Industrial Estate were attenuated in a wetlands attenuation pond. There is an existing wetlands area for the eastern portion of this estate that could be used as an example. Drainage from these wetlands utilised the existing sewer system beneath the rail line into the combined system. The source control elements were chosen on the ability to fit into the existing landscape and attenuate flows, these typically included:
Rain barrels
Swales and under-drained swales
Porous paving;
Cellular storage facilities;
Above ground exceedance management.



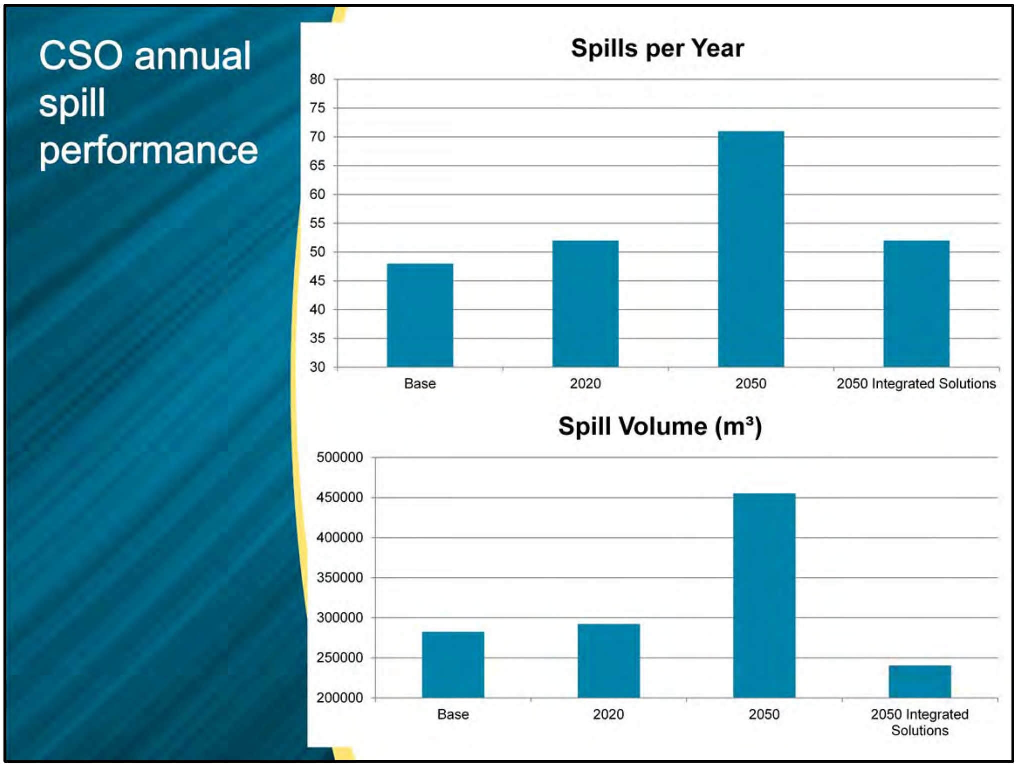
Pathway Opportunities

Central to the entire project was the operation of the Killingworth Lake. Management of the water level and the overflow regime could be adjusted to help reduce flood risk and control flows currently able to spill to the south through the storm water system and then into the combined system or to the north into the foul system. Lowering the Lake level in anticipation of rainfall would provide additional flood protection and if a large event is predicted, then potentially additional lower of the Lake could be done to increase the storage. A new route for spill to the north of the Lake could connect the excess Lake flow to the adjacent river rather than to the sewer system. Attenuation would likely be needed in order not to increase peak flows in the watercourse and this will be achieved from detention basins that are to be enlarged to accept peak flows from the Lake. In large return periods when the overflow systems are full, above ground storage could be provided to the east of the Lake. This area is part of the school grounds and is to be re-profiled to provide storage. Downstream on the storm water system, some storage is to be provided to reduce flooding at the West Moor roundabout. This roundabout is a critical part of the transportation infrastructure in this area and flooding at this roundabout is known to contribute to gridlock that has occurred during large rainfall events.

Overall these strategic measures in addition to improving levels of service also are the primary controlling factor to reduce the CSO spills. The key factor here was that whilst improving the water quality of the watercourse through increased discharges of storm water than had reduced sediment



Receptor Opportunities
Reducing peak flows during wet weather events continued throughout the entire system including the receptors. The addition of stilling basing and diversion which maintaining a relatively fast flowing central channel allowed for both flood risk reduction but also the development of a wildlife corridor which supported biodiversity. The reduced peak flows and stilling areas also facilitated and social and recreational activities.



CSOs and Annual Spills

As stated previously, one the of the key challenges as part of this study was to reduce bacterial loading during wet weather and these graphs show the total CSO reduction as a result of the storm water management at a catchment level. It is only through the increased understanding associated with a catchment wide approach and the addressing of the fundamentals of the problems that this type of reduction can be realized. Overall the project is forecast to have a construction cost of between \$50M and \$55M but the stakeholder ownership, multiple system solutions and 'smart' engineering application are considered 21st Century solutions for 21st Century problems.