Rockland County Green Infrastructure

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Mission Statement

In order for Rockland County's sources of potable water to remain sustainable to support population growth and economic recovery, the aquifers must be replenished. Potential solutions in the form of green infrastructure will be compared based on criteria as defined by the Rockland County Task Force on Water Resources Management. Implementing green infrastructure will increase infiltration and aims to increase the available potable water for Rockland County as it continues to grow and flourish.

Project Task Schedule Fall 2015 Semester

Date	Objective
September 29th, 2015	Quantify relative infiltration potential of various GI technologies
October 6th, 2015	Identify various Rockland County site and soil conditions
October 6th, 2015	Use EPA Stormwater Calculator
October 22nd, 2015	Initial task force meeting
November 3rd, 2015	Design alternatives quantifying infiltration potential
November 19th, 2015	Task force meeting
January 25th, 2016	Public Presentation to Rockland County

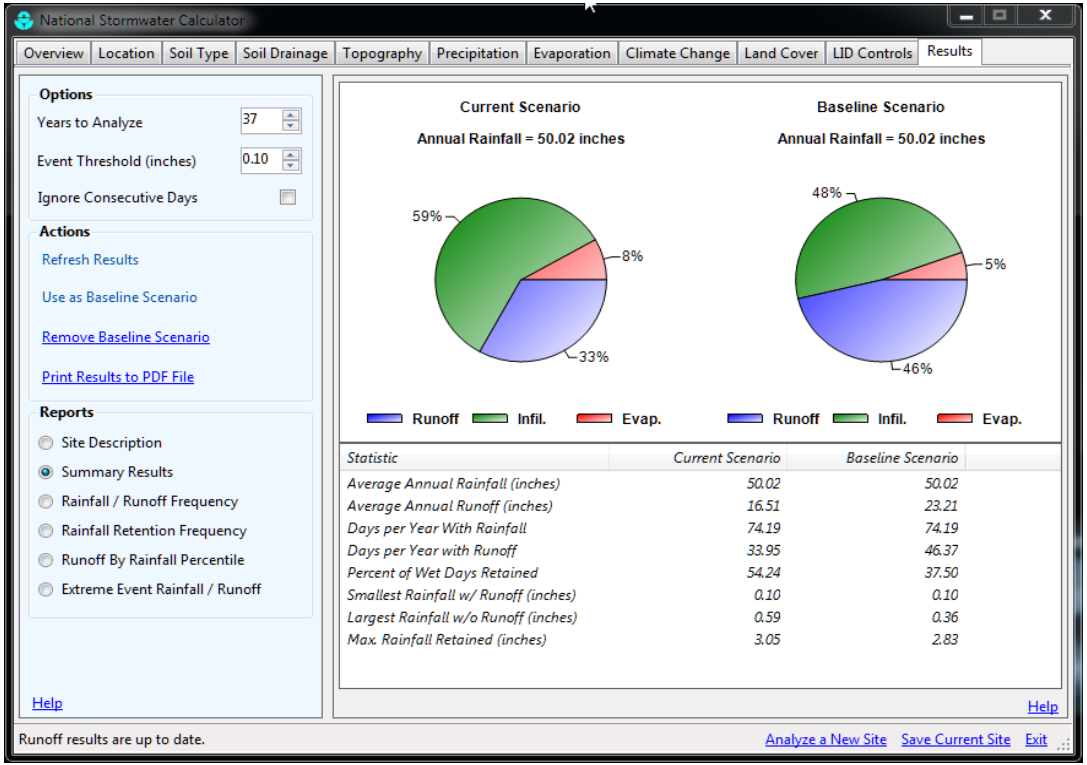
Project Task Schedule Spring 2016 Semester

Date	Objective
February 19th, 2016	Site Visit with Workgroup
March 4th, 2016	GIS Data Analysis
March 29th, 2016	Economic analysis performed
March 29th, 2016	Conceptual level site design
March 31st, 2016	Task Force meeting
April 11th, 2016	Analyze aquifer recharge rate
April 25th, 2016	Final Presentation to Task Force
April 27th, 2016	Design Day Expo at Stevens

Background

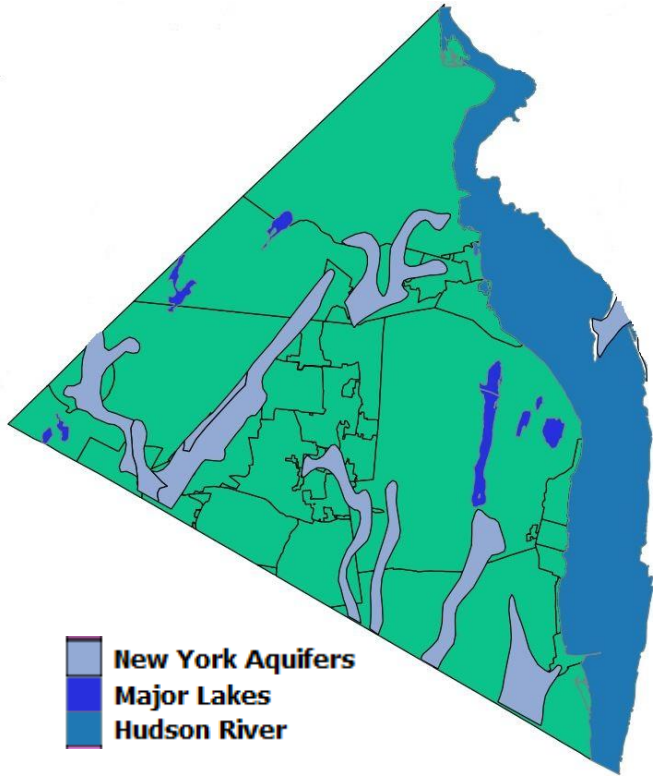
US EPA National Stormwater Calculator

- Desktop application to estimate annual rainwater and frequency of runoff
- Avg. Annual Rainfall of 49.02 inches
- Event Threshold 0.10 inches
- Precipitation data obtained from Ringwood rain gauge
- Data between 1970-2005
- 20 year, continual simulation

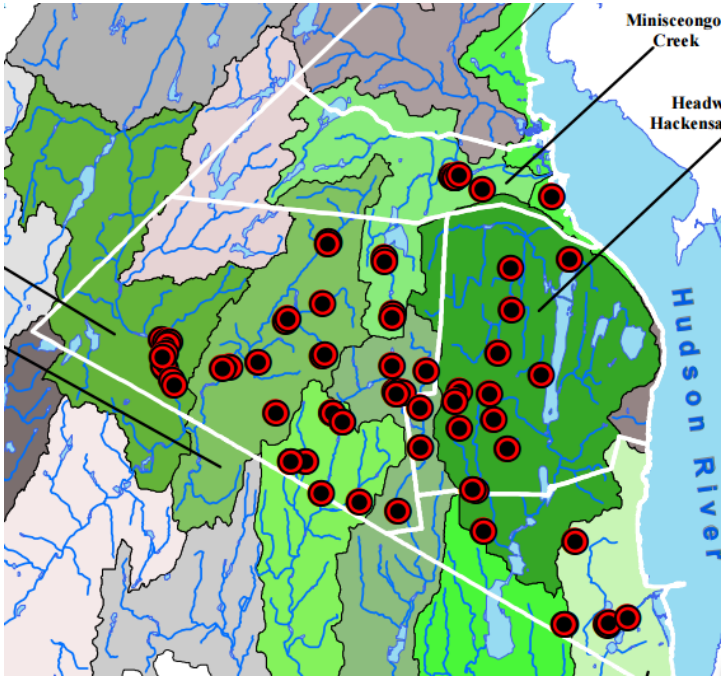


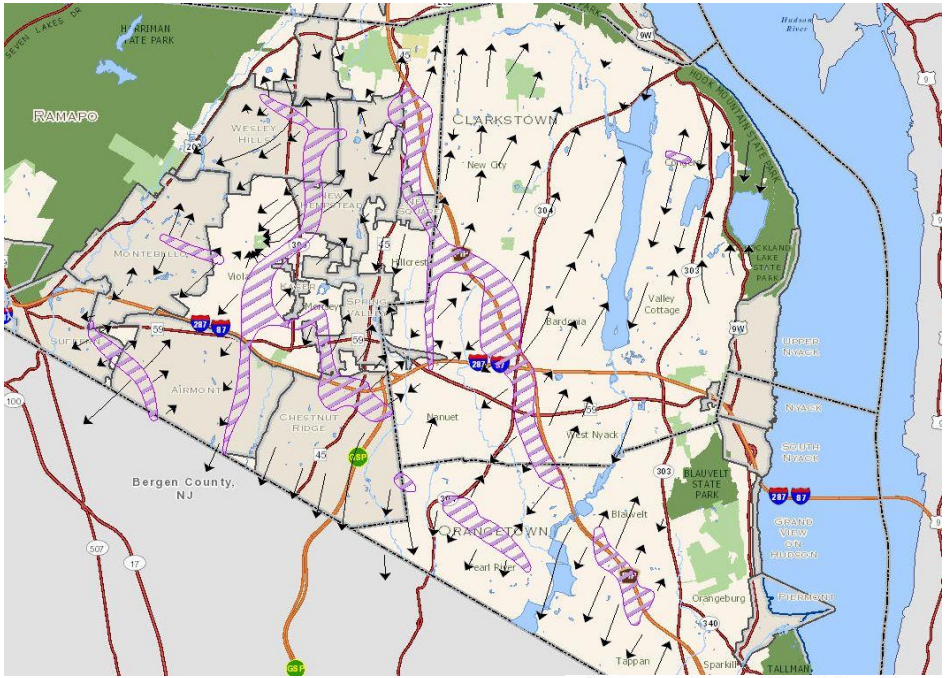
GIS Data

- QGIS
  - Site selection based on maximizing potential infiltration
  - Other Factors
    - Soil and land characteristics
    - Location where recharge is needed
    - Public or private property
    - Aesthetics
    - Functional use of space
    - Potential demonstration site
  - Data obtained from Rockland County GIS Portal, USGS, and United Water New York



United Water New York Wells and Groundwater Flow





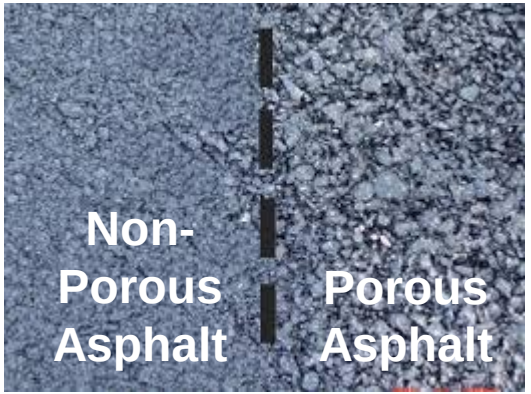
Design Alternatives

- Rain Garden
  - Depressed area filled with vegetation to allow stormwater to infiltrate slowly
- Infiltration Basin
  - Area of highly permeable soils that temporary store water until it can infiltrate
- Permeable Pavement
  - Materials that allow water to flow through rather than turning into runoff

http://www.ecolandscaping.org/03/rain-gardens/native-plant-selection-for-biofilters-and-rain-gardens/
http://www.southwesturbanhydrology.com/solutions/bio-retention-basins/
http://www.stormwaterpartners.com/facilities/basin.html

Permeable Pavement Options

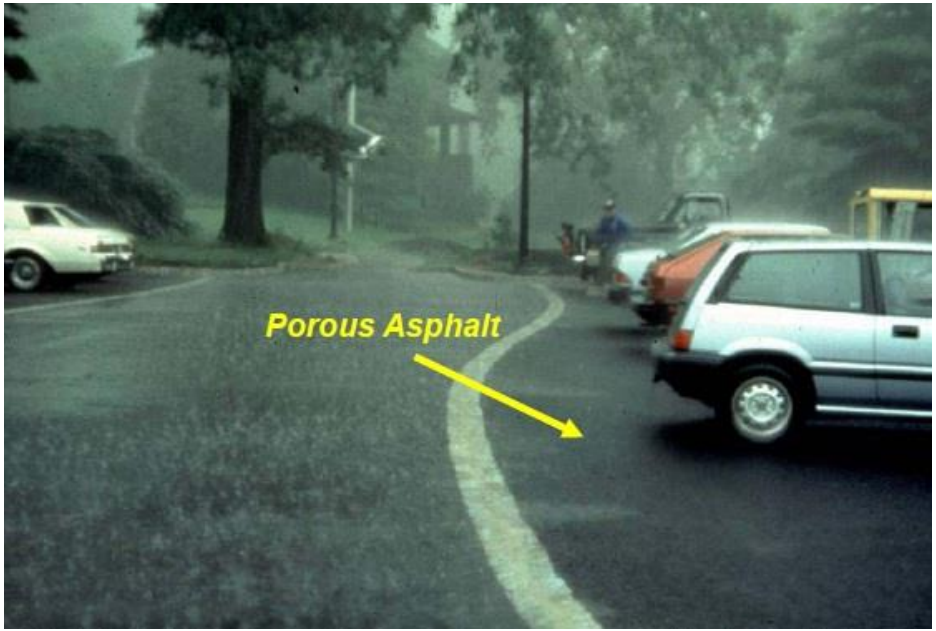
- Porous Concrete
  - Minimum batch size
  - Seven day cure, must be covered
  - Doesn't cure well in cold climates
- Permeable Pavers
  - Labor intensive
  - Maintenance can be extensive
- Selection: Porous Asphalt
  - Lowest construction cost psf
  - No indicated minimum batch size
  - 24 hour cure



http://www.sightline.org/2012/06/26/promise-of-permeable-pavement/
http://creativehardscape.com/projects/picp-permeable-interlocking-concrete-pavements/
http://www.dauphincd.org/swm/BMPfactsheets/Porous%20Asphalt%20fact%20sheet.pdf

Service Life: Non-Porous vs. Porous Asphalt

- Porous asphalt won't ice over
- Ice often remain in pores which reduces need to re-ice
- Reduces erosion
- Non-porous asphalt life of material: 20 years
- Porous asphalt life of material: 25 years



http://www.sustainablecitynetwork.com/topic_channels/transportation/article_27b80b38-1ba7-11e1-b031-0019bb30f31a.html?mode=image&photo=1

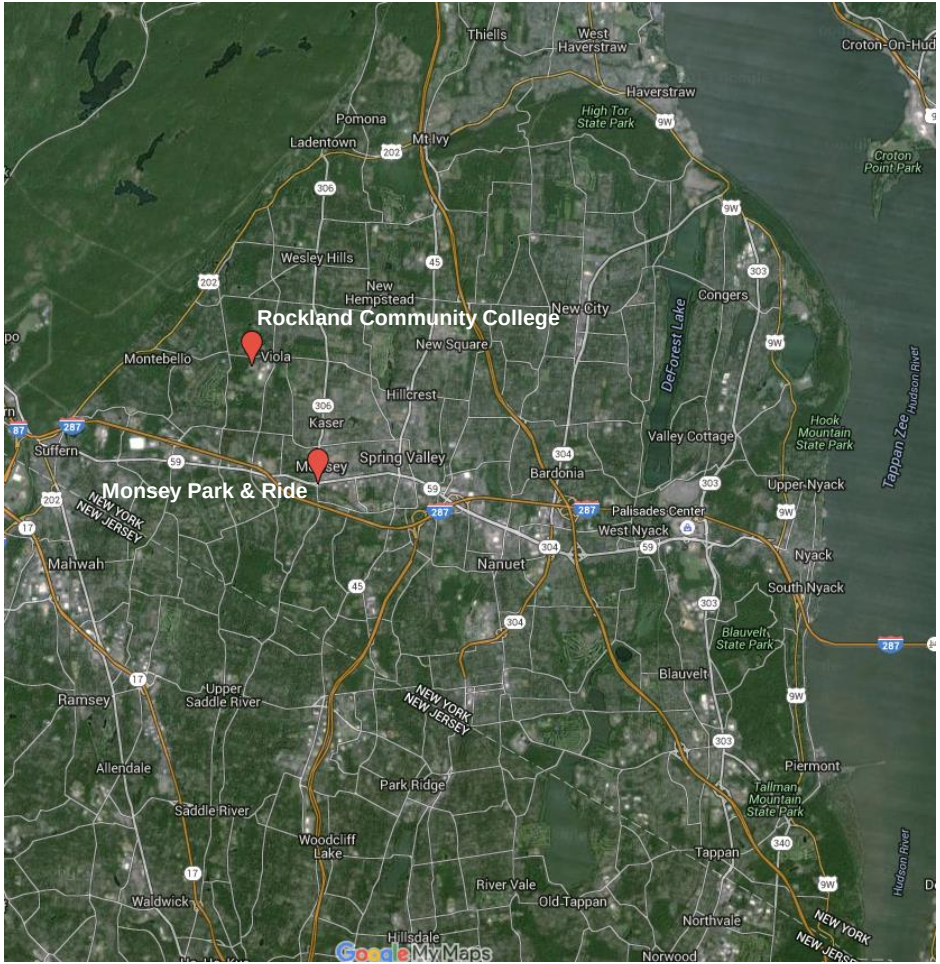
Site Selection Options

Monsey Park & Ride

- Soon to be developed
- Consideration of runoff reduction rather than infiltration increase

Rockland Community College

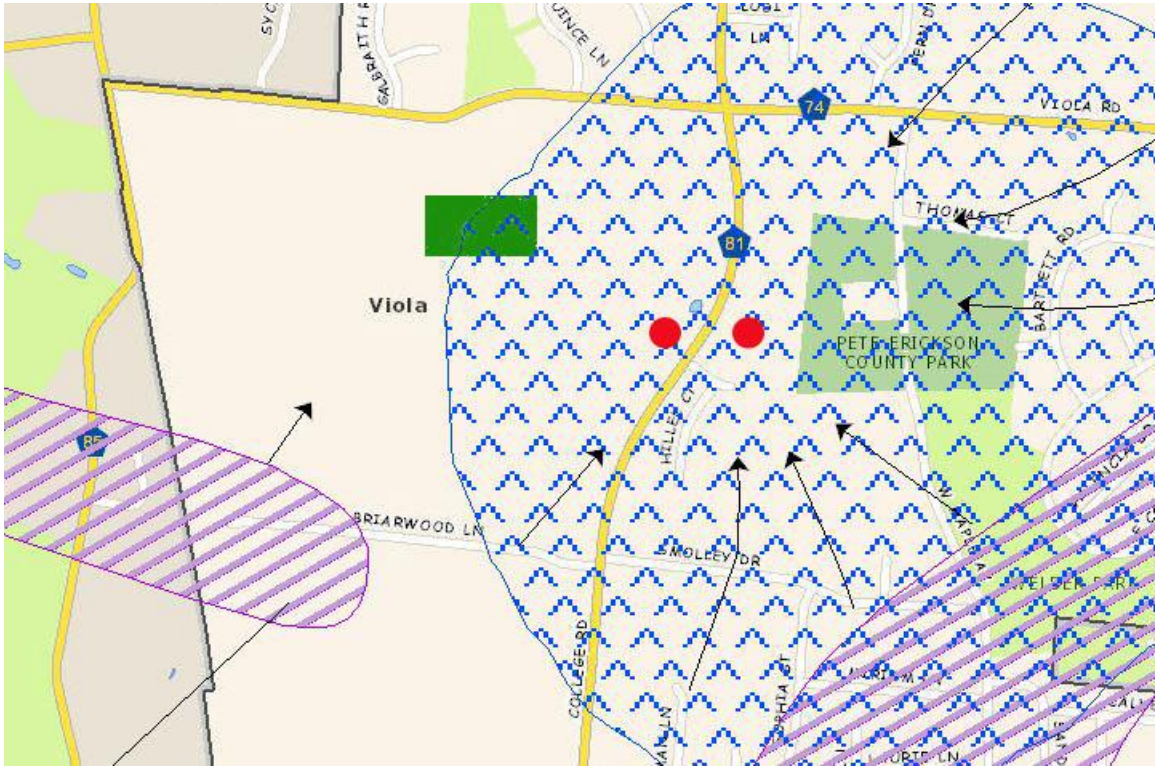
- Retrofit
- Located near Viola Well Field, under-recharging public wells
- Used by Suez for public drinking water
- Vulnerable to drought conditions
- Educational opportunity for students



Rockland Community College Parking Lot

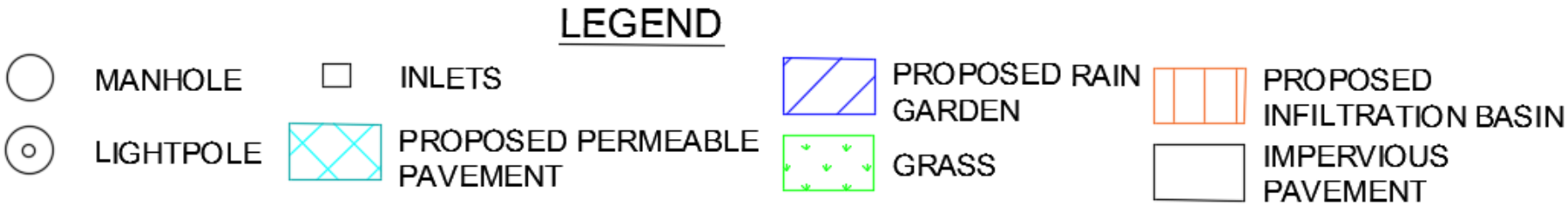
- Size = 7 acres
- Site breakdown:
  - West Lot
  - 4 terraces
- Terraces at 6% slope
- West Lot relatively flat, <2% grade

Site in Relation to Viola Well Field Capture Zone

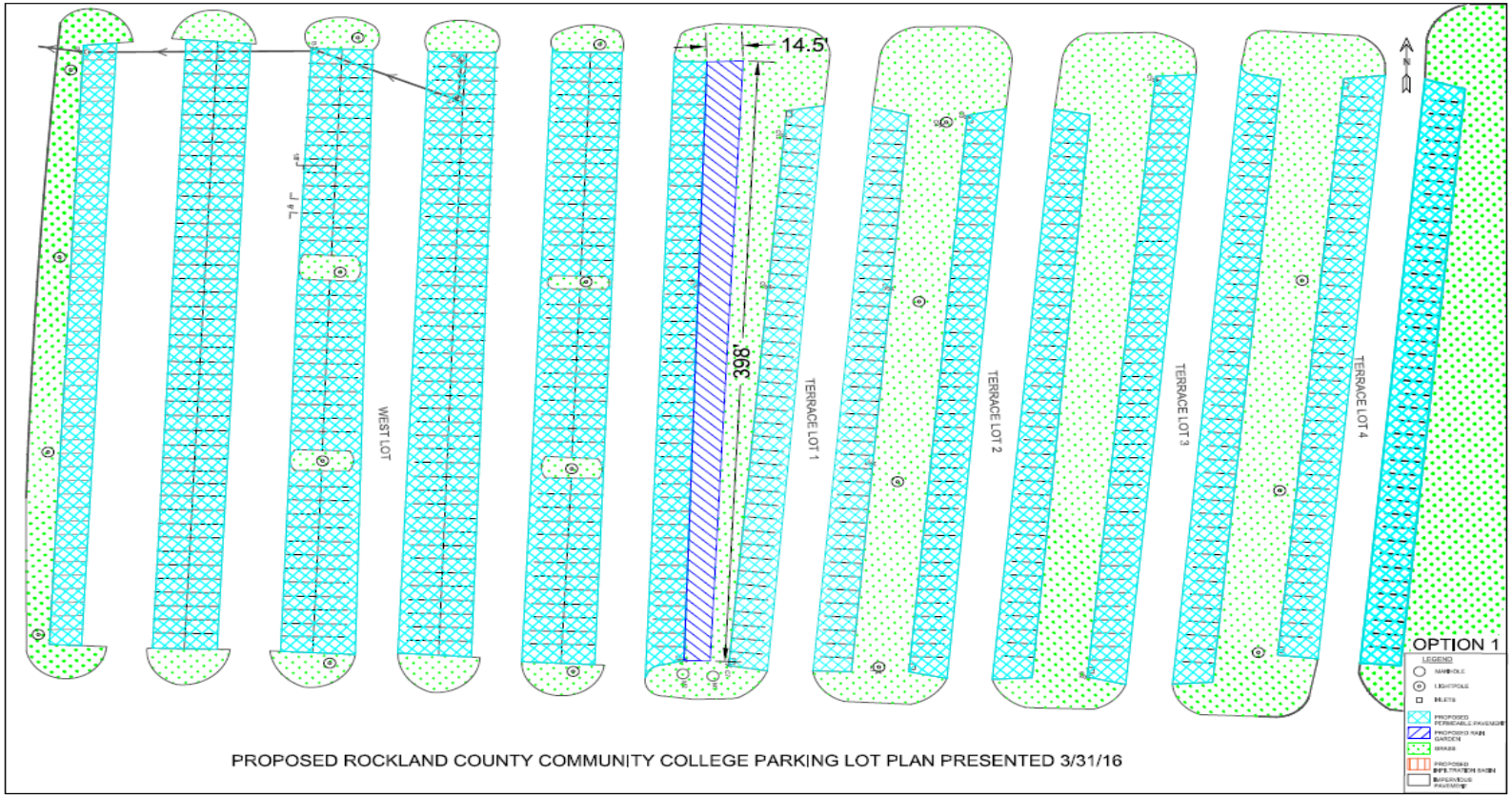


Design Alternatives

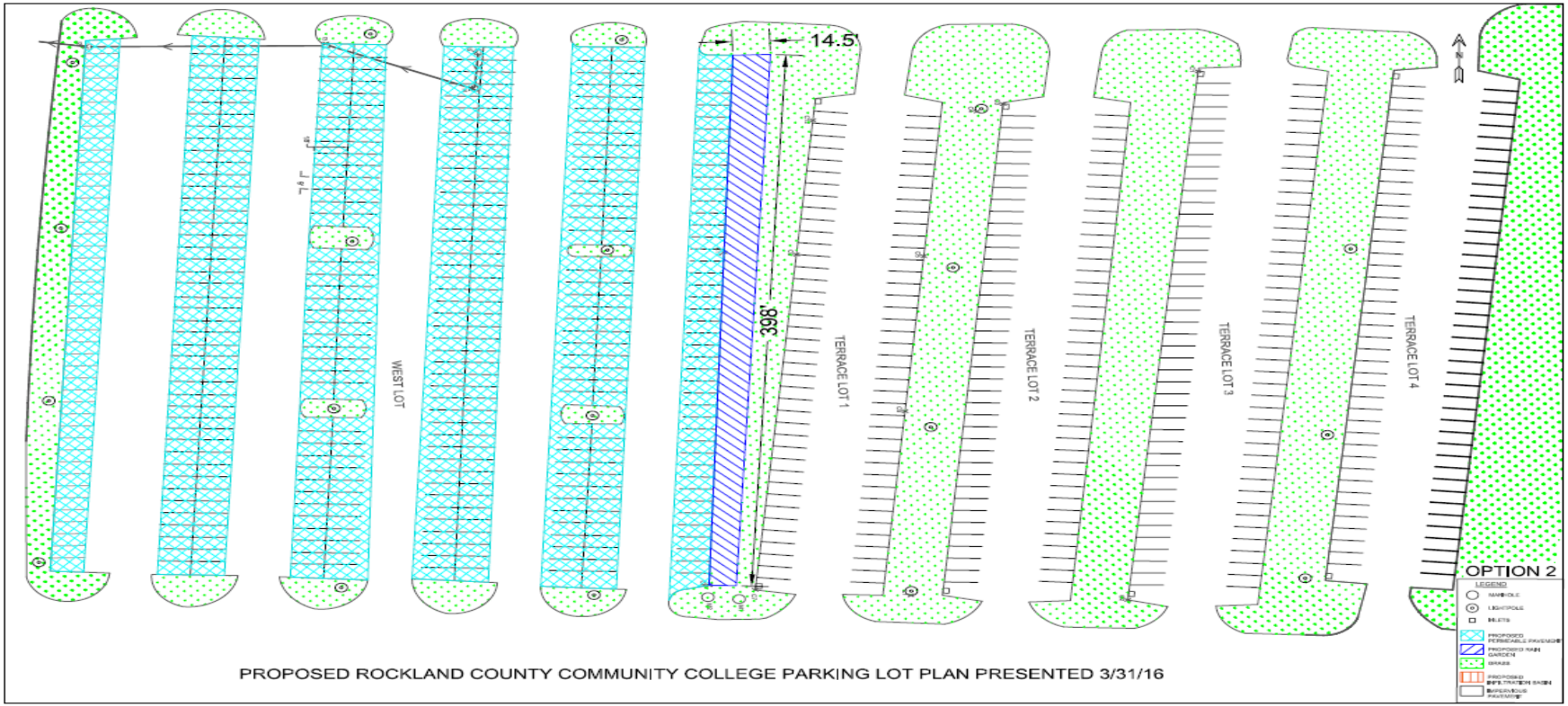
Legend for Option Drawings



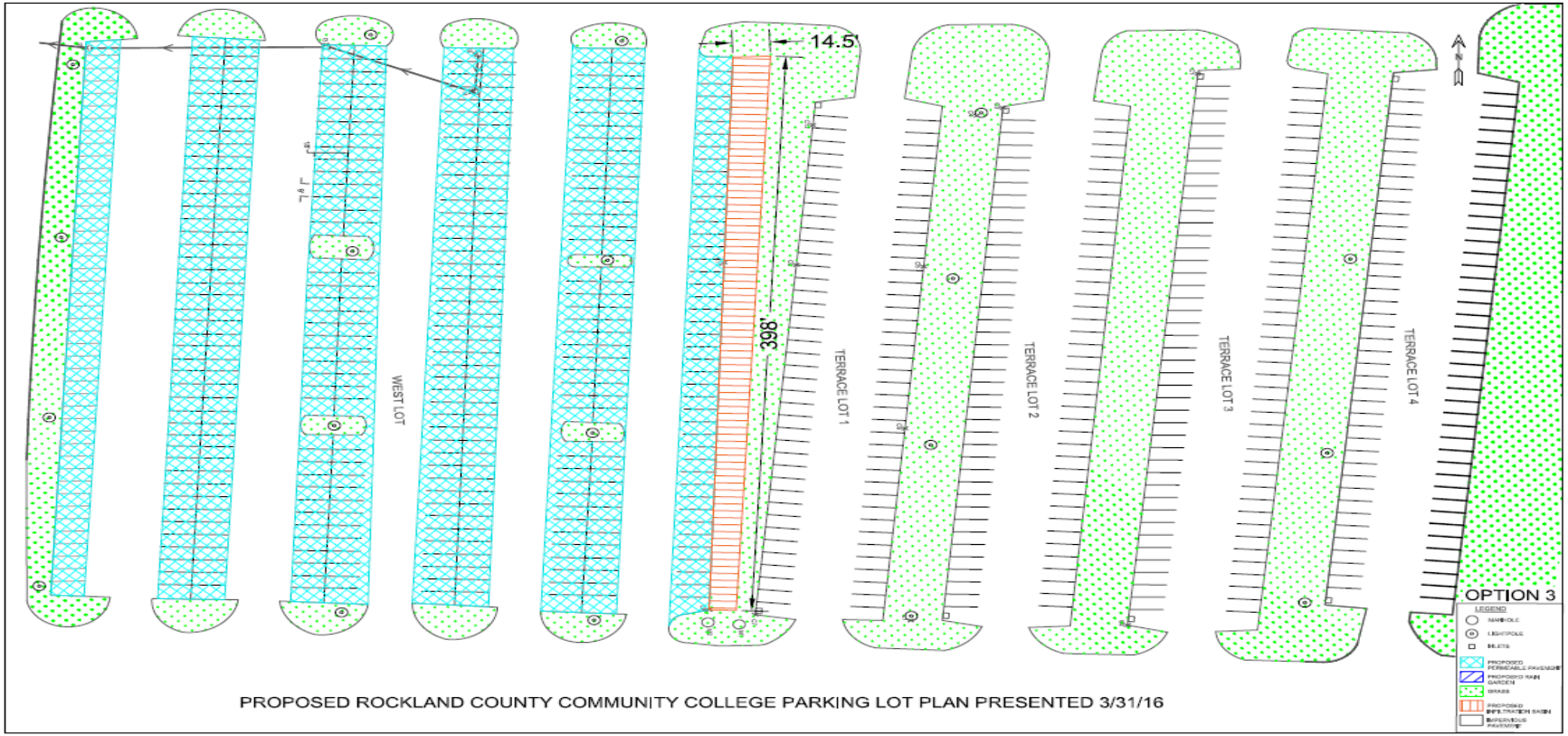
Option 1 Plan: PP in all spots + RG



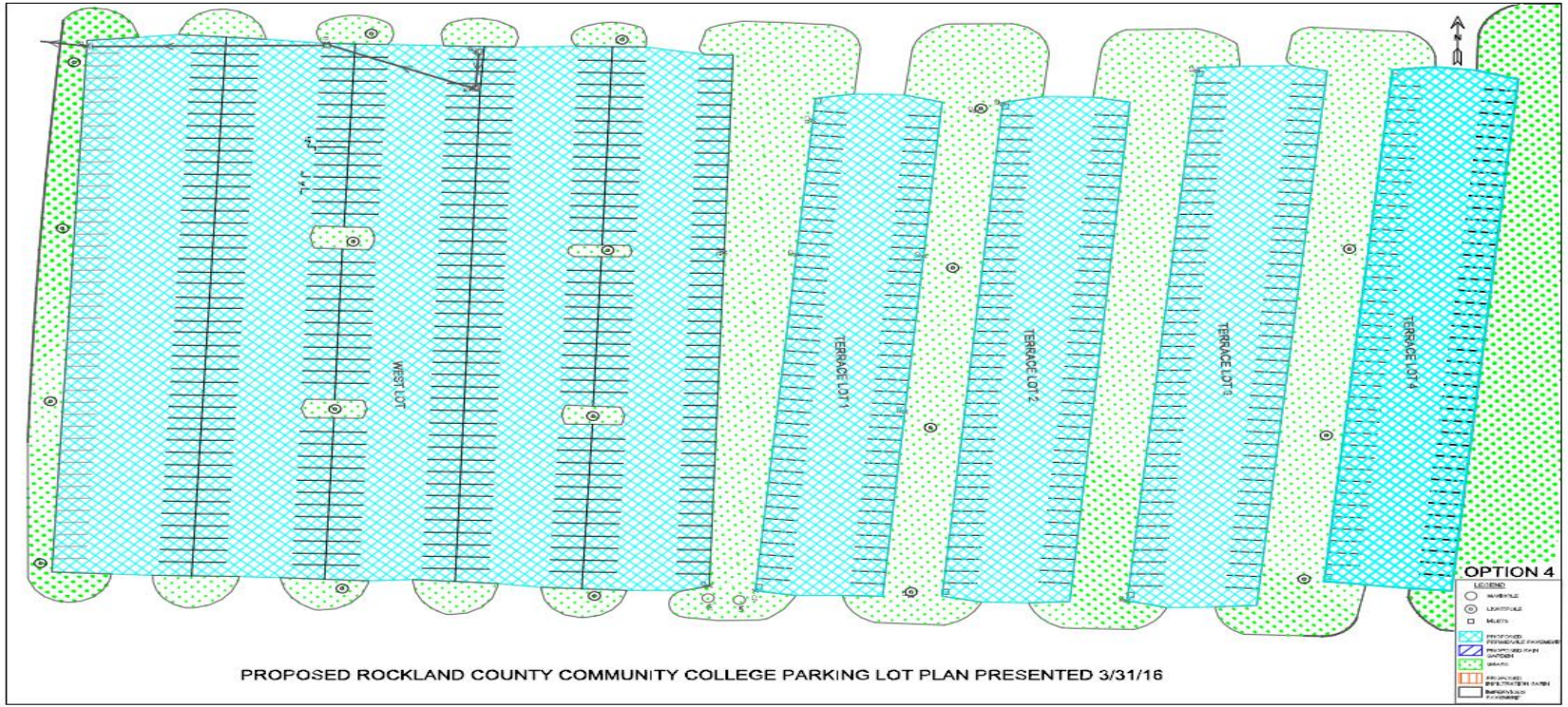
Option 2 Plan: PP spots West Lot + RG



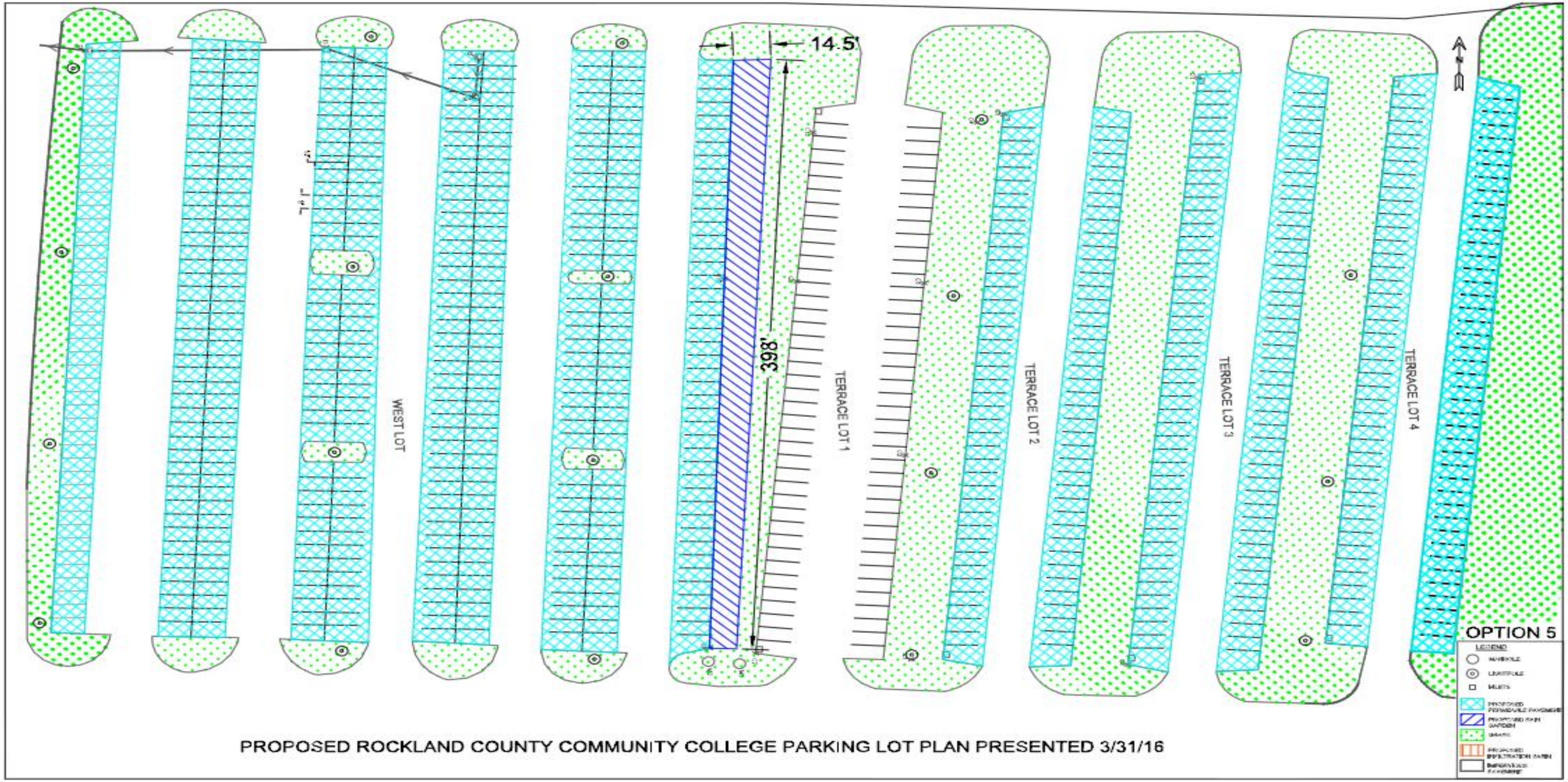
Option 3 Plan: PP spots West Lot + IB



Option 4 Plan: Entirely PP



Option 5 Plan: PP all spots except Terrace 1 + RG



Material Costs

Material	Cost (psf)	Source(s)
Impervious Asphalt	$1.50	Fix Asphalt.com http://www.fixasphalt.com/blog/cost-to-pave-parking-lot
Porous Asphalt	$6.00	Green Values Stormwater Toolbox http://greenvalues.cnt.org/national/cost_detail.php
Infiltration Basin	$1.30*	EPA Cost and Benefits of SW BMPs https://www3.epa.gov/npdes/pubs/usw_d.pdf
Rain Garden	$7.00	Green Values Stormwater Toolbox http://greenvalues.cnt.org/national/cost_detail.php

*cost expressed per cubic foot

Maintenance Costs for each GI Component

Method	Cost (per year)	Source
Rain Garden	6% of initial materials cost	US EPA http://w/porouspavement.pdf
Infiltration Basin	4.5% of initial materials cost	American Rivers Organization http://www.americanrivers.org/green-infrastructure-training/green-infrastructure/cost-considerations/
Porous Asphalt	$200 per acre	US EPA http://www.clermontstorm.net/porouspavement.pdf

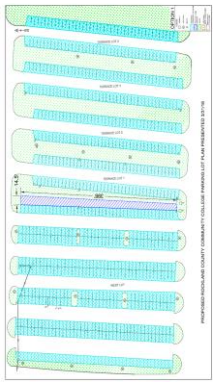
Porous Asphalt Maintenance

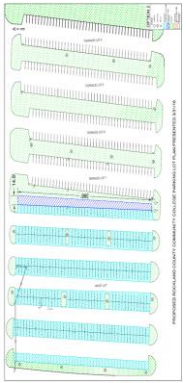
- Regenerative Air Street Sweeper
- Can be used to maintain both porous and impervious asphalt
- Used by employees with commercial driver's licenses
- Recommended use of high-powered vacuum sweeper 4 times a year
- $200,000 cost, with 7-8 year life depending on frequency of use

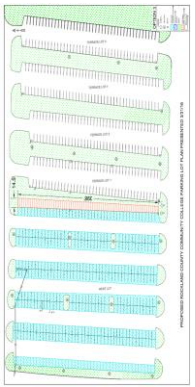
http://www.elginsweeper.com/EnvironmentalInfo/ReducingPollution/PorousPavement/tabid/86/Default.aspx
http://www.flickriver.com/photos/34249366@N03/5458780174/

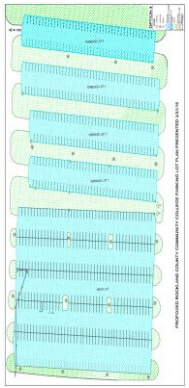
Decision Matrix

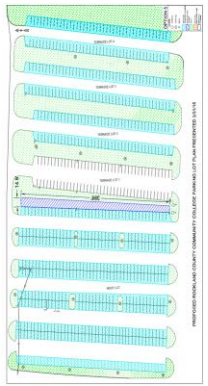
		Option 1		Option 2		Option 3		Option 4		Option 5	
		Value	**Points Awarded**	**Value**	**Points Awarded**	**Value**	**Points Awarded**	**Value**	**Points Awarded**	**Value**	**Points Awarded**
40	**Infiltration (gallons per year)**	9,152,350	40	6,337,270	28	6,435,566	28	9,152,350	40	8,743,680	38
	Cost										
20	Materials (per gallon infiltrated)	$0.10	15	$0.07	20	$0.07	20	$0.16	9	$0.09	16
20	Maintainance (yearly)	$4,034	6	$1,140	20	$1,745	13	$1,140	20	$4,034	6
10	**Life of Materials (years)**	23	9	22	9	22	9	25	10	23	9
10	**Educational Opportunity**	Ideal	10	Ideal	10	-	0	-	0	Ideal	10
Total (100 points possible)			**79**		**86**		**70**		**79**		**78**









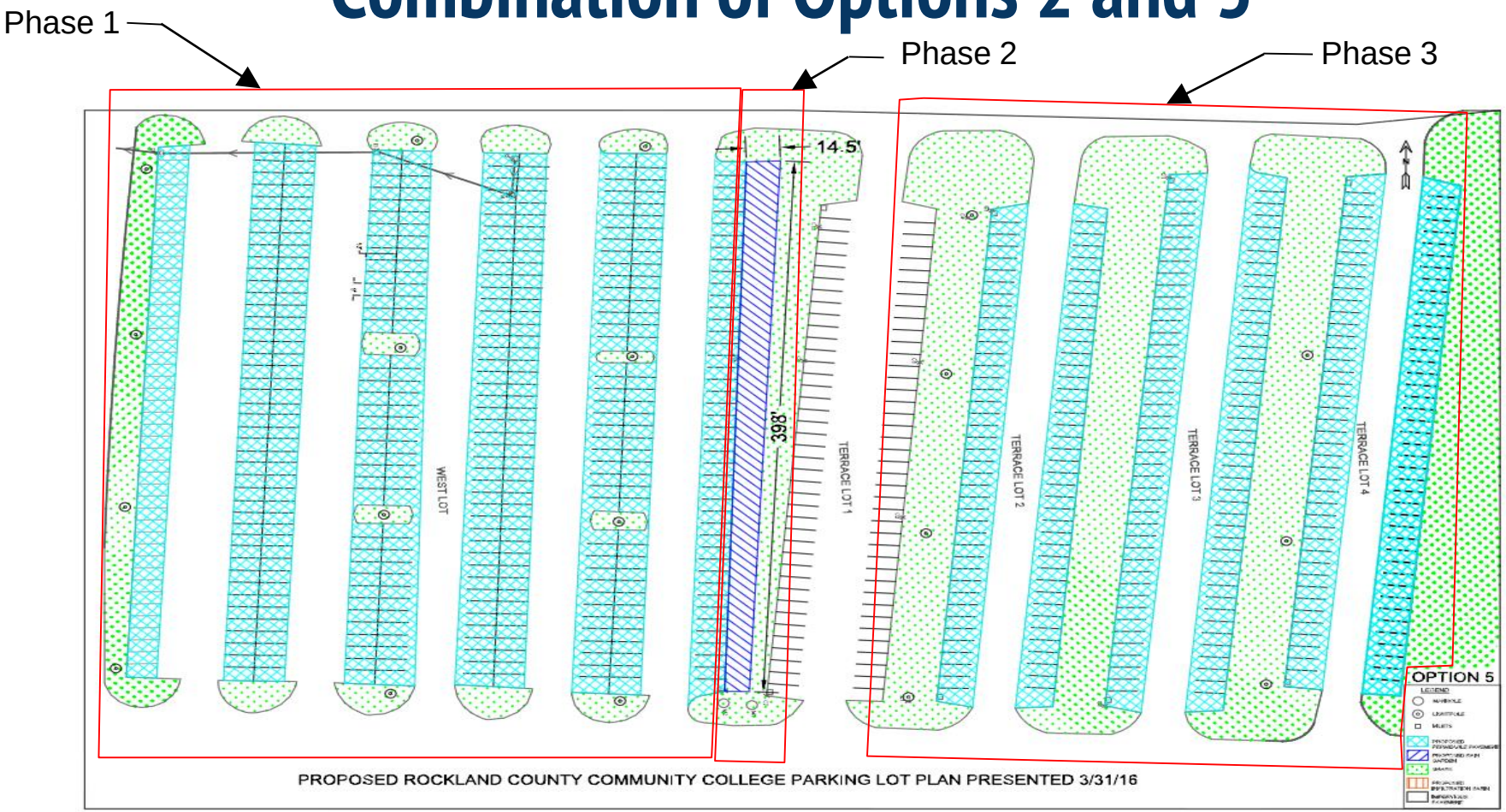


Final Selection

Phased Construction

- “Stages of design and construction overlap, thereby shortening the time necessary to complete the project.”
- Site can be broken down into multiple parts, which are the phases
- Allows site to continue being used as a parking lot throughout construction, since it won’t all be an active site
- Phases designed to allow construction staging as well

Combination of Options 2 and 5



Impact Visualization

- 8,743,680 gallons of infiltration per year

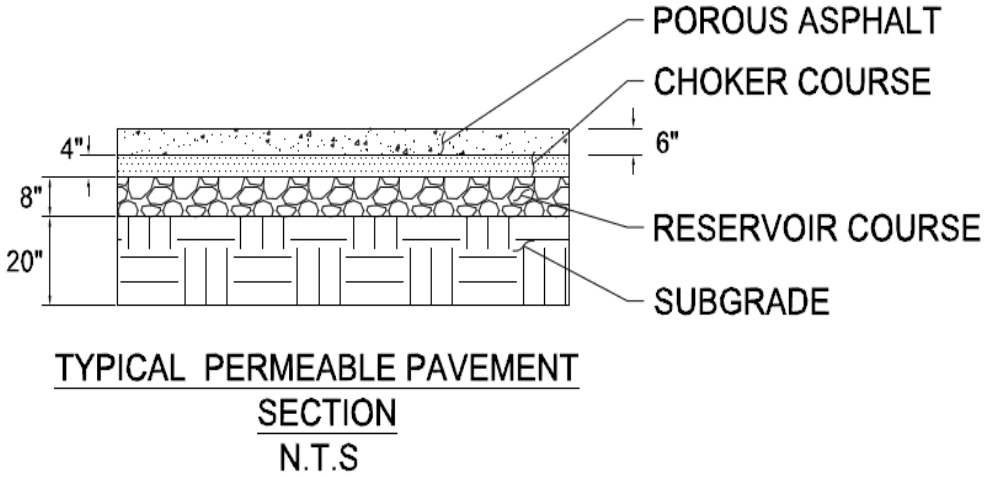
Function	Water Usage (Gallons)	Equivalent Uses Per Year
Average Shower	17.2	508,353
Standard Washing Machine Load	27	323,840
Standard Dishwasher Load	11	794,880
Toilet Flush	1.6	5,464,800
10 Minute Garden Hose Car Wash	100	874,368

http://www.signaturehardware.com/regent-dual-flush-corner-toilet-with-seat.html, http://www.cnet.com/pictures/things-you-can-clean-in-the-washer-other-than-clothes/, http://www.bobvila.com/slideshow/10-stunning-showers-to-give-you-bathroom-envy-44524#.Vx4qxvkrKUk

Proposed Site Plan Costs

	Ft^2	Acres	Cost of Material per ft^2	Total Cost	Maintenance	Additional Maintenance Cost (per year)
Rain Garden	6,890	0.16	$7	$48,230	6% of total	$2,894
Porous Asphalt	128,252	294	$6	$769,512	$200 per acre	$1,140
Non-Porous Asphalt	118,710	2.73	$1.5	$178,065	-	-
Total	253,852	5.83	-	$817,742	-	$4,034

Permeable Pavement Cross Section

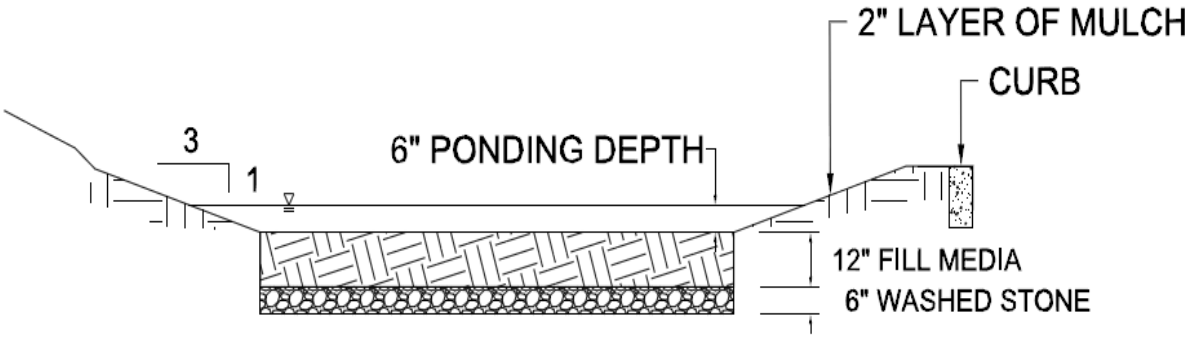


TYPICAL PERMEABLE PAVEMENT SECTION
N.T.S

NYS Stormwater Manual Design Requirements:

- Porous Asphalt depth: 3 in. - 7 in.
- Choker course: 4 in. - 8 in.
- Reservoir course: minimum 8 in.
- Subbase Course: minimum 20 in.

Rain Garden Cross Section

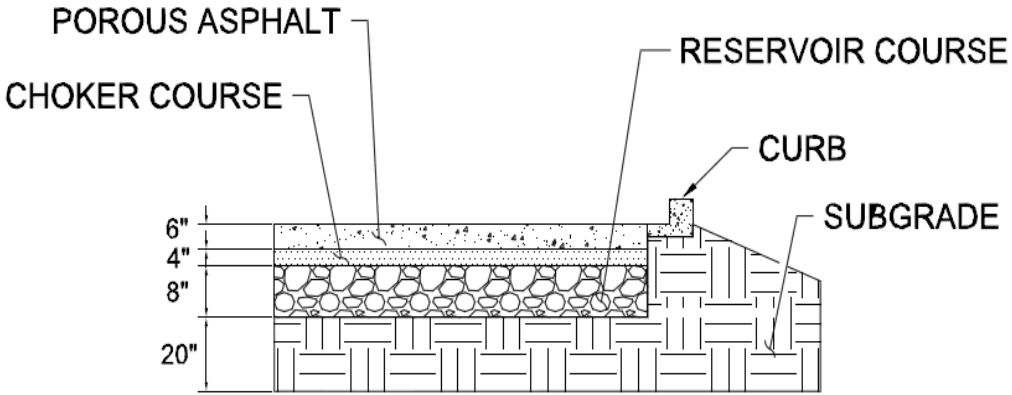


TYPICAL RAIN GARDEN SECTION
N.T.S

NYS Stormwater Manual Design Requirements:

- Recommended max ponding depth: 6 in.
- Fill Media minimum depth: 12 in.
- Washed stone layer: 6 in. - 12 in.
  - 1.5 in - 2 in. stone size

Terrace Lot Permeable Pavement Cross Section



TYPICAL PERMEABLE PAVEMENT
TERRACE LOT SECTION
N.T.S

NYS Stormwater Manual Design Requirements:

- Porous Asphalt depth: 3 in. - 7 in.
- Choker course: 4 in. - 8 in.
- Reservoir course: minimum 8 in.
- Subbase Course: minimum 20 in.

Lessons Learned

- Balancing stakeholder input
- Sometimes it’s better to pick up the phone instead of email
- It’s easy to get wrapped up in “engineer talk”
- Real experience working with a client

http://www.myfrugalbusiness.com/2015/08/30-lessons-business-life-age-30.html

Acknowledgements

- Rockland County Task Force on Water Resources Management
- Patricie Drake, Task Force Coordinator
- County Department of Planning GIS Team
- Soil and Water Conservation District
- Kevin Maher, P.E.
- Dr. Elizabeth Fassman-Beck and Dr. Leslie Brunell
- Rockland Community College

Questions?

	ft^2	Acres	Cost per material	Total cost	Maintenance	Maintenance Cost (additional, per year)	Infiltration (gal)	Runoff (gal)	Life of Materials (years)
Option 1									
Porous Asphalt	143745	3.30	$6.00	$862,470		$1,140			
Rain Garden	6890	0.16	$7.00	$48,230	6.00%	$2,894			
Pavement	103217	2.37	$1.50	$154,826					
	253852	5.83		$910,700		$4,034	9152350	211800	22.9
Option 2									
Porous Asphalt	76858	1.76	$6.00	$461,148		$1,140			
Pavement	170104	3.91	$1.50	$255,156					
Rain Garden	6890	0.16	$7.00	$48,230					
	253852	5.83		$461,148		$1,140	6337270	3014125	21.6
Option 3									
Infiltration Basin *cubic feet	10335	0.24	$1.30	$13,436	4.50%	$605			
Porous Asphalt	76858	1.76	$6.00	$461,148		$1,140			
Pavement	170104	3.91	$1.50	$255,156					
		0.00		$474,584		$1,745	6435566	2932662	21.6
Option 4									
Porous Pavement	246962	5.67	$6.00	$1,481,772		$1,140			
	246962	5.67	0.00	$1,481,772		$1,140	9152350	211800	25.0
Option 5									
Rain Garden	6890	0.16	$7.00	$48,230	6.00%	$2,894			
Porous Asphalt	128252	2.94	$6.00	$769,512		$1,140			
Pavement	118710	2.73	$1.50	$178,065					
	253852	5.83		$817,742		$4,034	8743680	615860	22.6