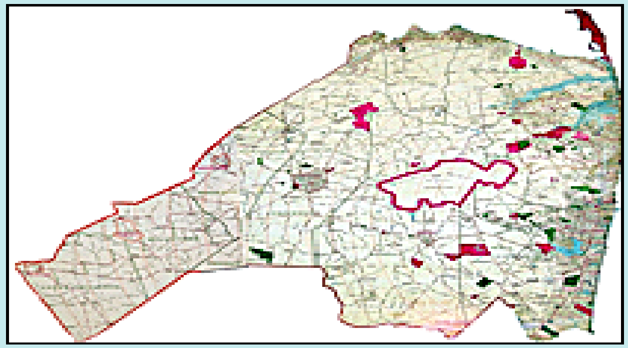
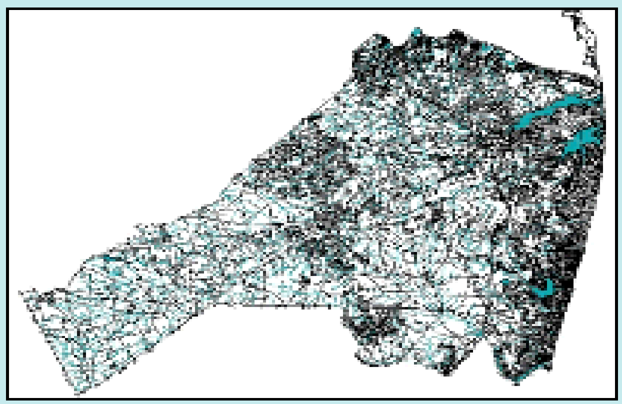
LOW IMPACT DEVELOPMENT:

Restoring Surface Water and Sediments Impaired by Eroding Runoff from Impervious Surfaces



Monmouth County Roads in 1950



Monmouth County Roads in 1997

- William Simmons, Environmental Health Coordinator, Monmouth County Health Department
- 05/16/05

Presented at NJ Water Monitoring Coordinating Council Meeting - May 25, 2005

COMPARISON OF 1 ACRE OF PARKING LOT VERSUS 1 ACRE OF MEADOW IN GOOD CONDITION

Hydrologic or Water Quality Parameter	**Parking Lot**	**Meadow**
Curve number (CN)	98	58
Runoff coefficient	0.95	0.06
Time of concentration (minutes)	4.8	14.4
Peak discharge rate, 2–yr, 24–h storm (cu. ft/s)	4.3	0.4
Peak discharge rate, 100–yr storm (cu. ft/s)	12.6	3.1
Runoff volume from 1–inch storm (cu. ft)	**3450**	**218**
Runoff velocity @ 2–yr Storm (ft/s)	8	1.8
Annual phosphorus load (lbs/ac/yr).	2	0.10
Annual nitrogen load (lbs/ac/yr).	15.4	0.8
Annual zinc load (lbs/ac/yr)	0.30	ND
Key Assumptions: Parking Lot: 100% impervious, 3% slope, 200 ft flow length, Type 2 Storm, 2–yr, 24–h storm = 3.1 in, 100–yr storm = 8.9 in., hydraulic radius = 0.3, concrete channel, suburban Washington 'C' values Meadow: 1% impervious, 3% slope, 200 ft flow length, good vegetative condition, B soils, earthen channel.		

16 X

Data from 44 small catchment areas in the US, from EPA’s Nationwide Urban Runoff Program. Schueler, 1987.

LOW IMPACT DEVELOPMENT(LID)

LID is the reduction of stormwater volume through 1)infiltration and 2)reducing and disconnecting impervious surfaces.

In 2004, “Non Structural Strategies” were mandated in NJAC 7:8- 5.2 and 5.3.

Municipalities must adopt a MSWMP as an element of their Master Plan by April 1 of 2005. Within 12 months they must adopt controlling stormwater ordinances. They then must submit both the MSWMP and the ordinances to the MCPB STAC for review. See matrix on the NJDEP website: www.njstormwater.org/tier_A/pdf/tier_a_matrix.pdf . (Source:Turner Shell of MCPB)

Retention, Infiltration and Detention Basins in Monmouth County

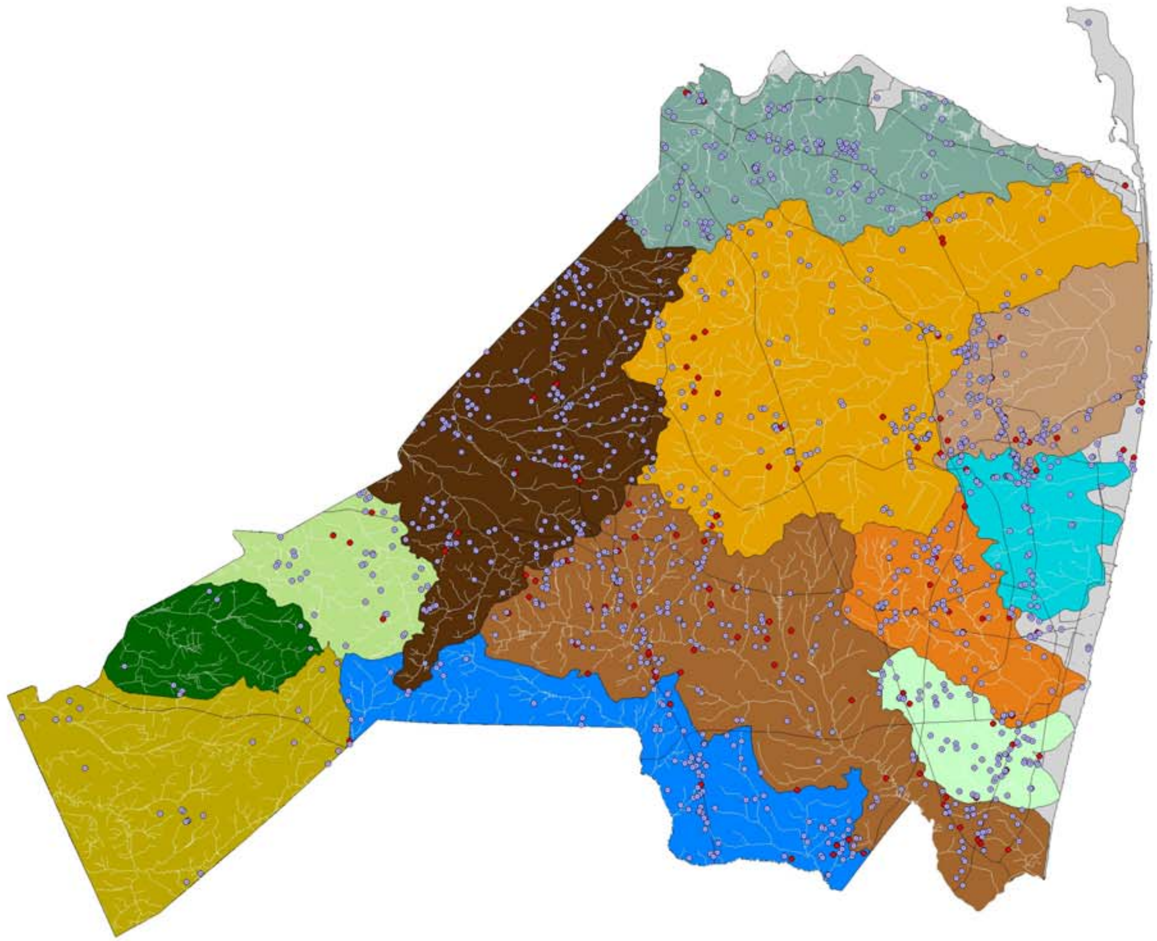
GPS & GIS Data Provided by the Freehold Soil Conservation District

- Basins Outlet Structures: 1296
- Proposed Sites: 128
- Total Basin Count: 1424
- Streams

Major Watersheds

- Assunpink Creek/Lower Delaware (9)
- Lower Delaware (27)
- Manasquan River (266)
- Bayshore/Raritan (145)
- Metedeconk River (112)
- Millstone River-Rocky Brook/Raritan (40)
- Navesink River (185)
- Shark River (108)
- Shrewsbury River (128)
- Raritan River (225)
- Atlantic Ocean (69)
- Wreck Pond Brook (76)

Numbers in parentheses indicate total existing and proposed basins in each watershed. Note that 34 basins outlet structures and proposed basin sites do not fall into a delineated watershed area.



5 0 5 10 15 20 Miles

This map was created by the Monmouth County Health Department

This map was developed in part using NJDEP digital data in conjunction with the MCHD's work.
This map was developed to recognize public and environmental health trends.
Site specific conditions should be field verified.
HUC 14 data from Department of Environmental Protection.

Table 2-1: Impacts from Increases in Impervious Surfaces

Increased Imperviousness Leads to:	Flooding	Habitat Loss*	Erosion	Channel Widening	Streambed Alteration
* Increased Volume	●	●	●	●	●
Increased Peak Flow	●	●	●	●	●
Increased Peak Flow Duration	●	●	●	●	●
Increased Stream Temperature		●			
Decreased Base Flow		●			
* Changes in Sediment Loadings	●	●	●	●	●

* e.g., inadequate substrate, loss of riparian areas, etc.

Source: *Urbanization of Streams: Studies of Hydrologic Impacts*, EPA 841-R-97-009, 1997

NRDC - www.main.nc.us/riverlink/content/02chap/chap02.htm#2.2

Bergerville Road, Howell, across from Point of Woods (03-30-01)

The Manasquan River rose about 7 feet during an intense one-year storm (2.9”) in 2001.

Two year storms, also called *bankfull* storms, are often used in designing structures because this storm significantly changes stream channels. The 2 year storm in MC is 3.4”. What happened?

In urbanized areas, the probability that a two-year, channel forming (bankfull) storm will occur can increase up to 500%: from 1 every 2 years, to 5 every 2 years. Detention basins and dams are sized according to storm frequency. There is a disproportionate volumetric increase in an urbanized stream channel during these predicted storm frequencies due to impervious surface. Just using predicted storm frequency may be underestimating the design of detention basins and dams in urbanized streams.

Manasquan River, Bergerville Rd. By Guardrail

March 2004 - Tree leaning.

November 2004 – Treefall.

Photos by Steve Taylor MRWA

DEP Fish & Game policy: treefalls are always good for fish and macroinvertebrate habitat and should never be removed.

B
F

Manasquan River, W. Farms Rd.,Howell
Photo courtesy Steve Taylor, Manasquan River Watershed Association

BIG BROOK, MARLBORO

MCLEES CREEK, MIDDLETOWN

B
F

B
F

Poricy Brook, Middletown (Spring 2003)

B
F

Tributary of Willow Brook, Rt. 520 Homldel

B
F

Glauconitic Streams in Equilibrium

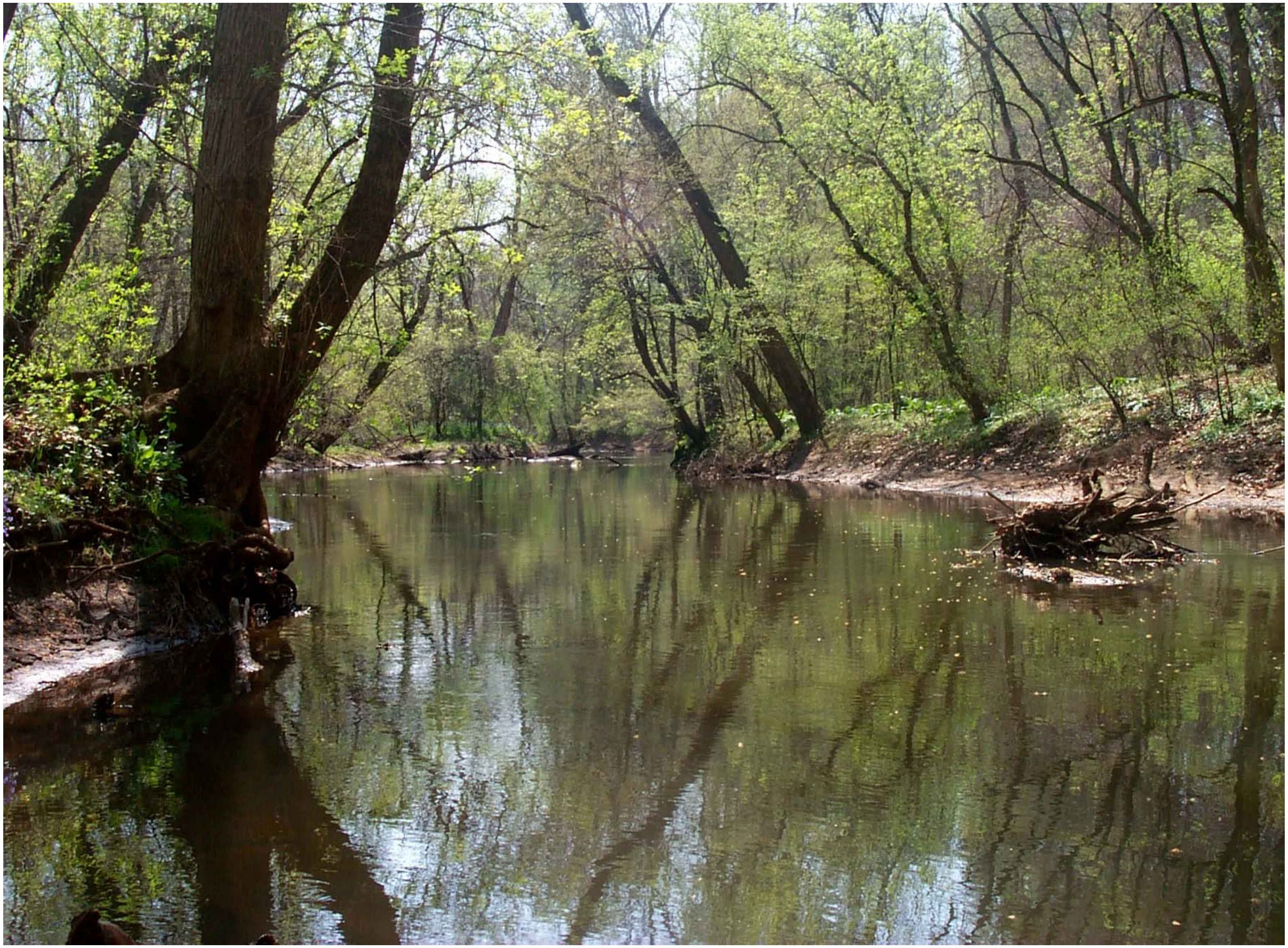
B
F

Manalapan Brook (Fall 2002)

B
F

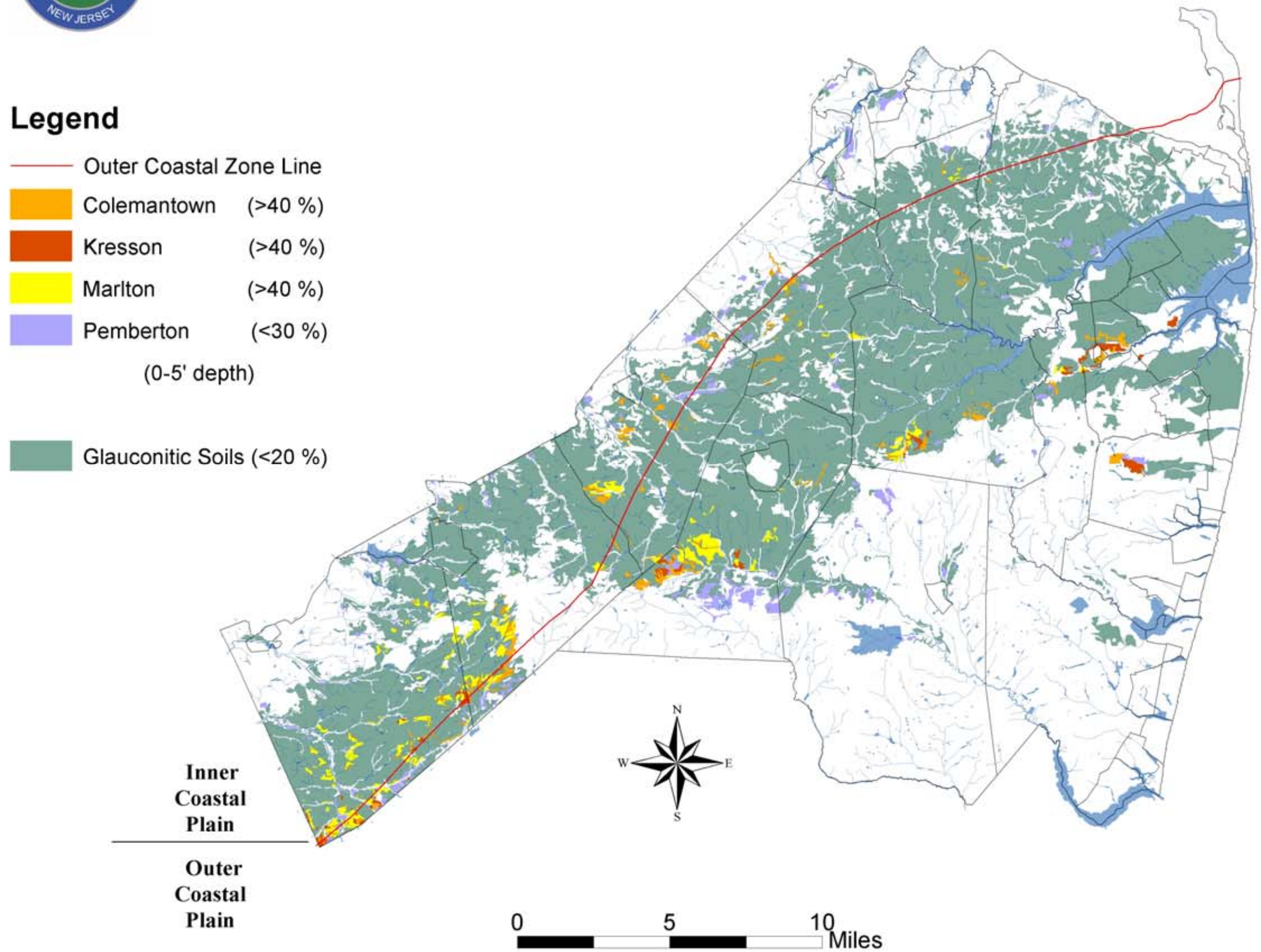
Manasquan Trib., Lone Pine Landfill (Fall 2001)

CROSSWICKS CREEK, UPPER FREEHOLD



BF

Glauconitic Soils In Monmouth County



Mike Stephens, November 2003
Proj: f:\vol1\gis\office2003\random\glauc.mxd
Img: f:\vol1\gis\map images\glauc.jpg

Matawan Creek, Marlboro (10-09-03)

B
F

GLAUCONITE was originally fecal pellets mixed in the sediments of the ancient seas, at depths of 10 to 400 fathoms (60-2400'), that covered Monmouth County.

Because of its high cation exchange capacity, it has been used both as a **soil conditioner** to concentrate nutrients in sandy farm soils and in **water conditioning** to remove heavy metals from the drinking water.

It is a sand sized aggregrate that is easily disturbed; **during streambank erosion it will break apart into its clay-sized components** which stay suspended in the water column longer and prolong the turbidity in the stream.

B
F

B
F

WETLAND AVAILABILITY IN SAND VS. GLAUCONITE

Rosgen "C" - can overflow into wetlands during the 2-year, channel forming storm

Rosgen "F" -downcutting has eliminated wetlands availability for overflow

(Bently Brook, Millstone, sites 800 feet apart)

The Manasquan River Rosgen Report (2002) is on the website of Watershed Management Area 12:

www.visitmonmouth.com/area12/TCTMDL/Reports/Manasquan%20Rosgen%20Report/Manasquan%20Rosgen%20Report.htm

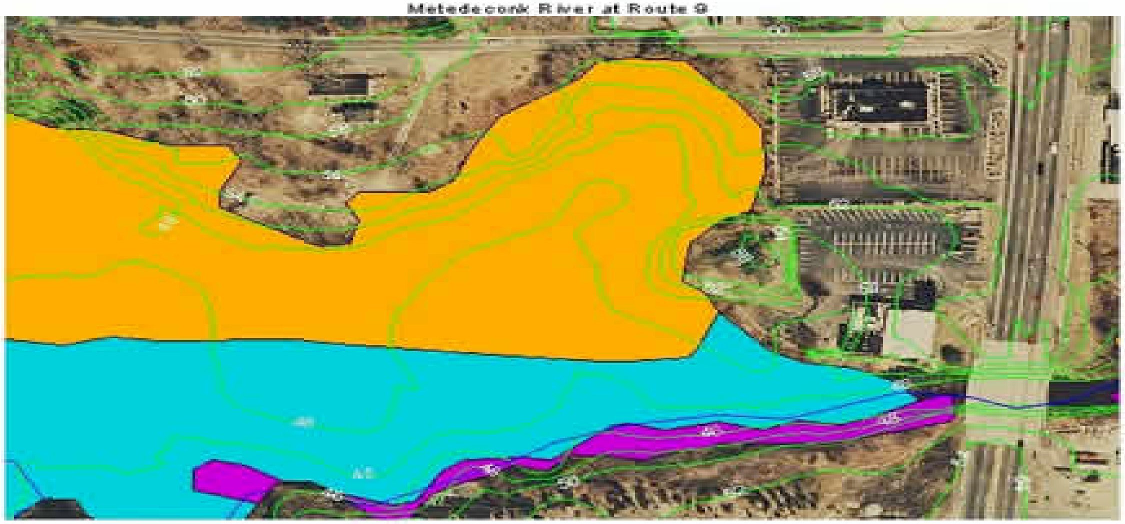
Monmouth County Health Department

Manasquan and Metedeconk Watersheds

A closer view of wetlands, topography and functional availability for stormwater retention at sections of the Manasquan and Metedeconk Rivers

Manasquan River at Bergerville Road

Metedeconk River at Route 9



Contours

Wetlands Types

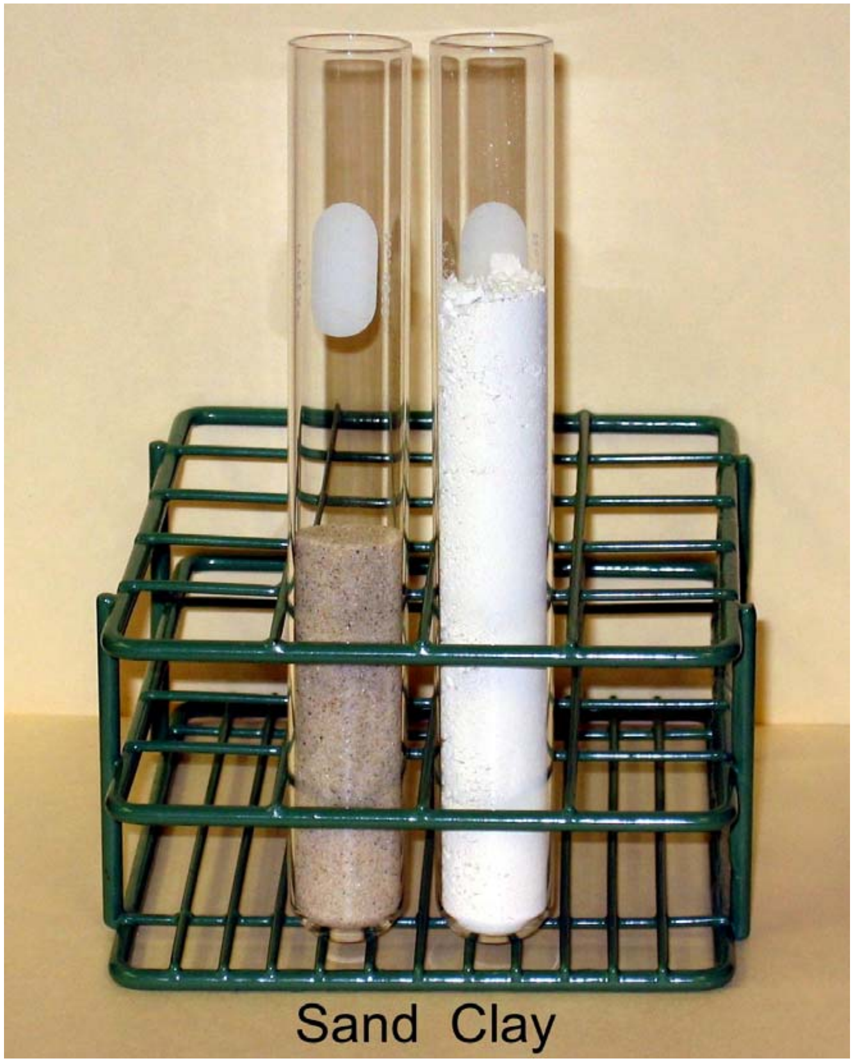
- DECIDUOUS SCRUB/SHRUB WETLANDS
- DECIDUOUS WOODED WETLANDS
- HERBACEOUS WETLANDS

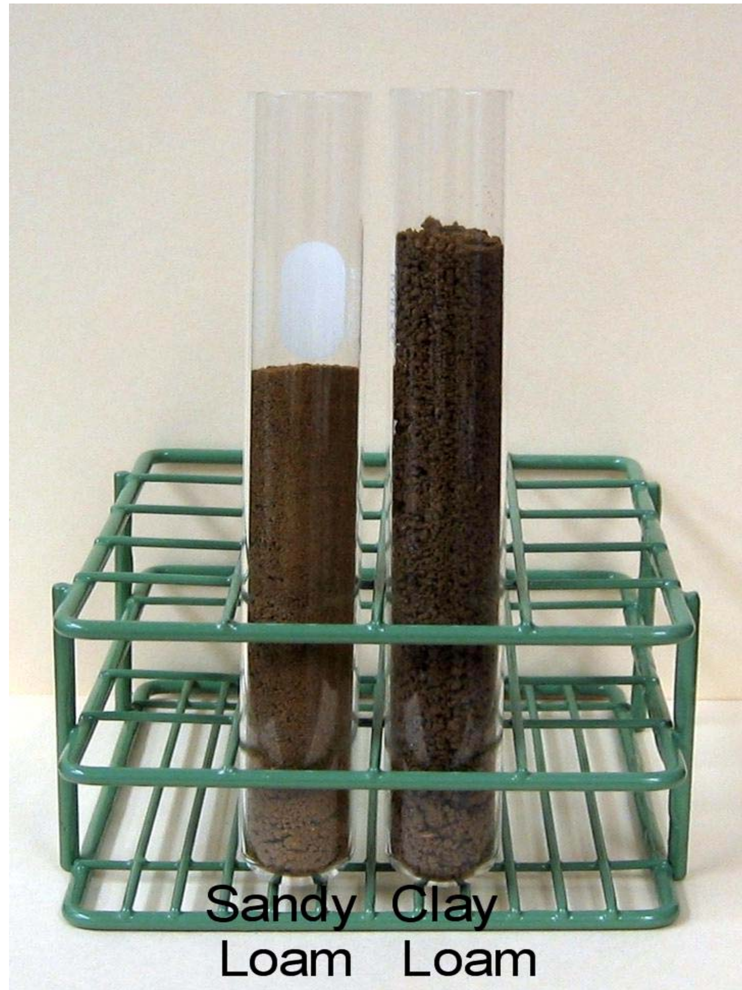
Glauconitic Soil

Compare these 2 jars of glauconitic soil to see how the colloidal fines separate from the sand when it is disturbed by water; it took 10 days for the water to clarify after shaking the jar.

Particle volume vs. weight:

25 grams of Sand, Clay, Sandy Loam, and Clay Loam



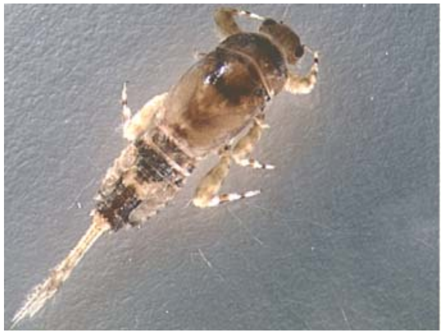
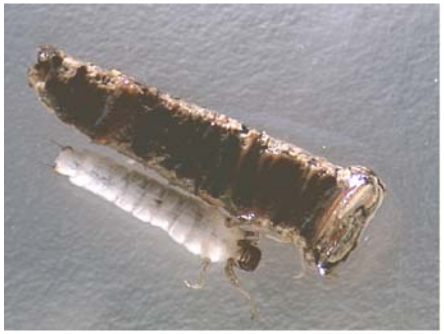


NT standard is 25 millegrams

Rapid Bioassessment

All RBA slides by E.Cosgrove, MCHD Lab

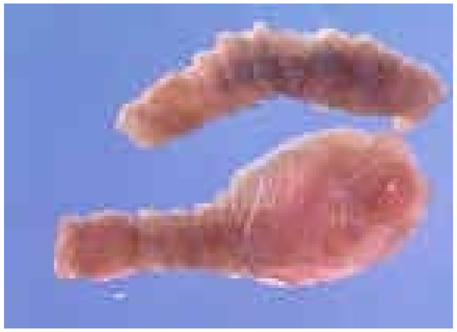
TOLERANCE VALUES


Non Impaired

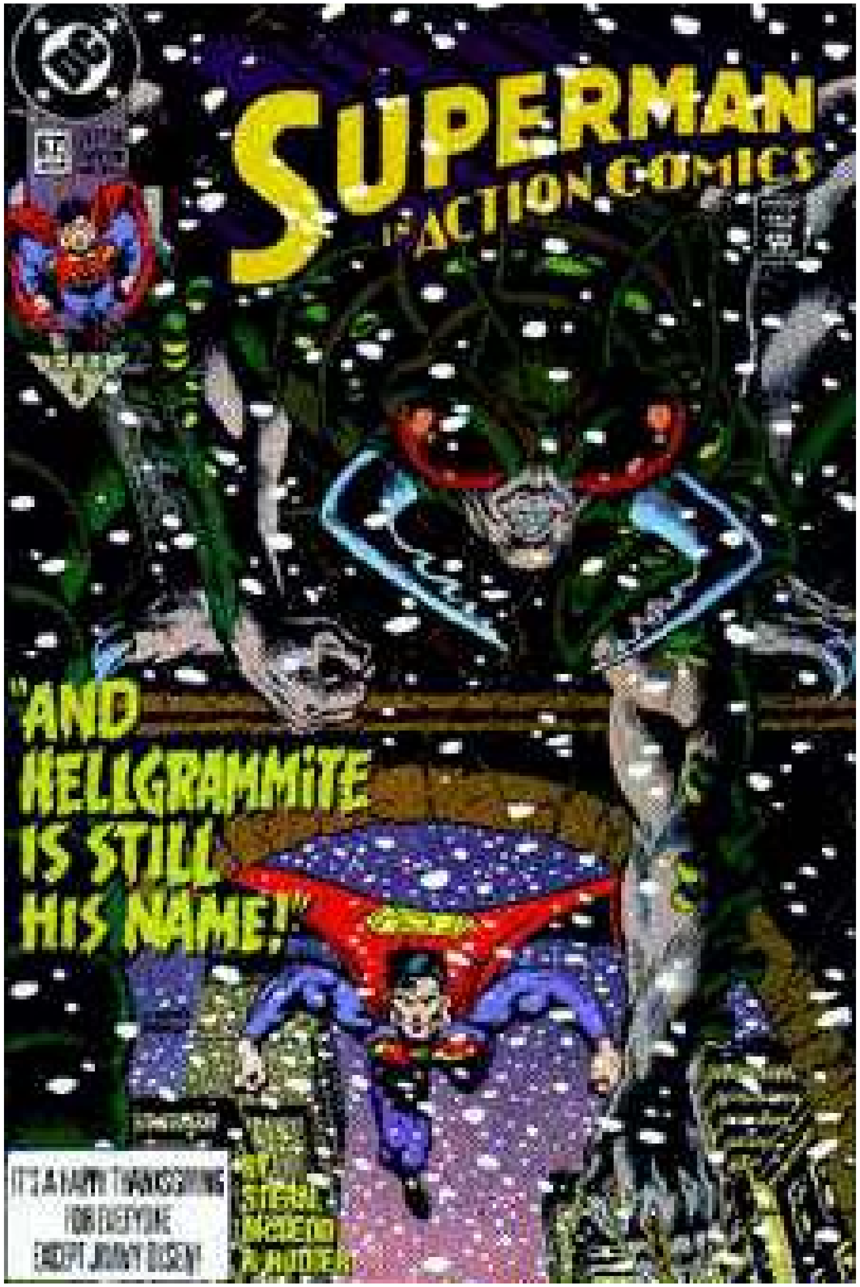


Mod. Impaired



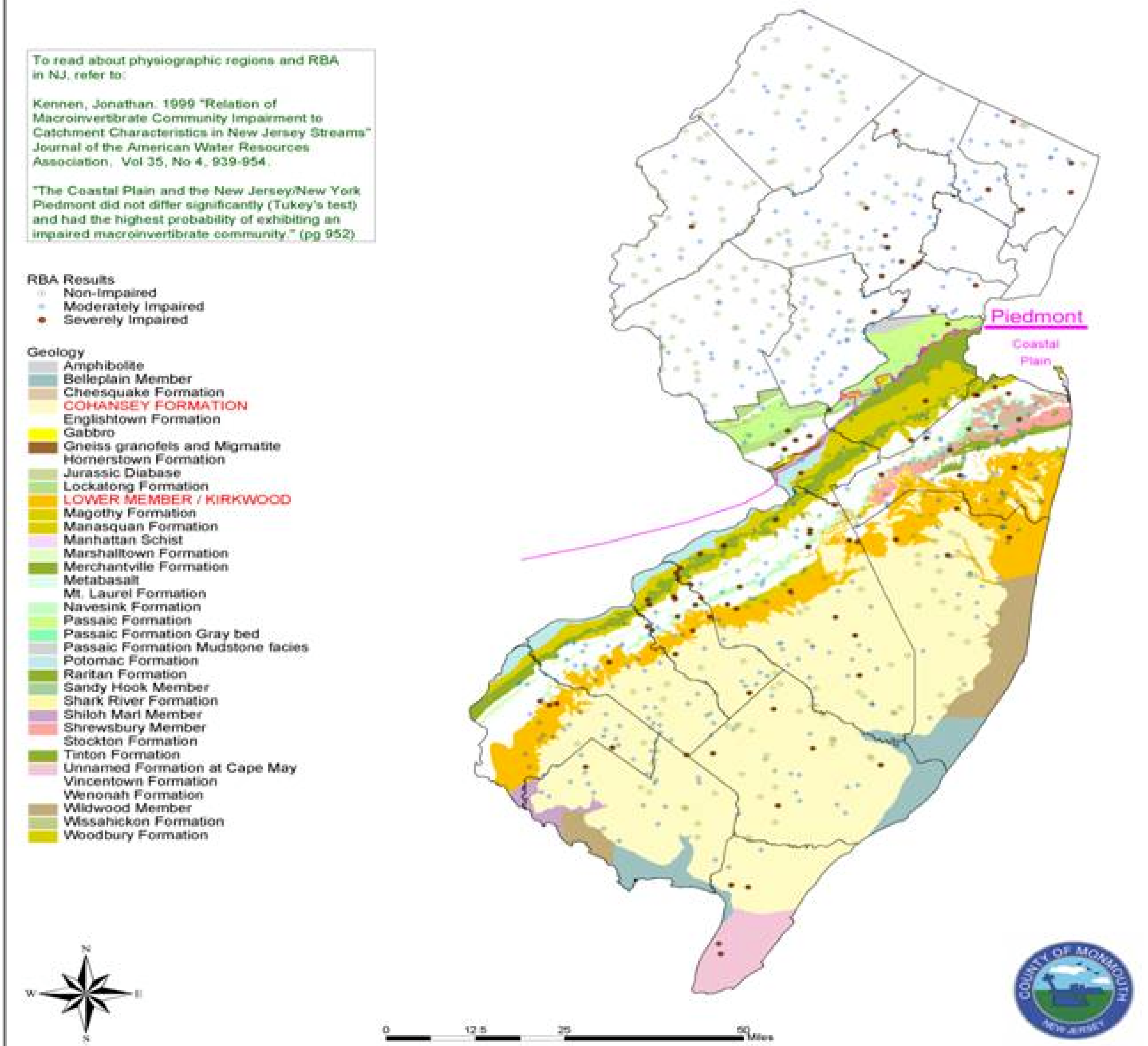
Sig. Impaired

Hellgrammite



RBA Trends Within the Coastal Plain

Severe Impairment in the Silt and Clay Formations between the Piedmont Cobble and the Kirkwood Cohansey Sands



This map was developed in part using NJDEP digital data in conjunction with the MCHDs work, but this secondary product has not been verified by the NJDEP and is not state authorized.

Data accuracy is limited by the accuracy of the scales of the original data sources. Site specific conditions should be field verified.

Ramanessin Brook, Crawford Corners Rd., Holmdel: Spring 2003 RBA

Downstream of PNC: NJIS 3

Holland Rd. Nature Trail: NJIS: 24

B
F

B
F

Effect of Two Stormwater Outfalls at Reference Site Stream

Reference stream before outfall installation

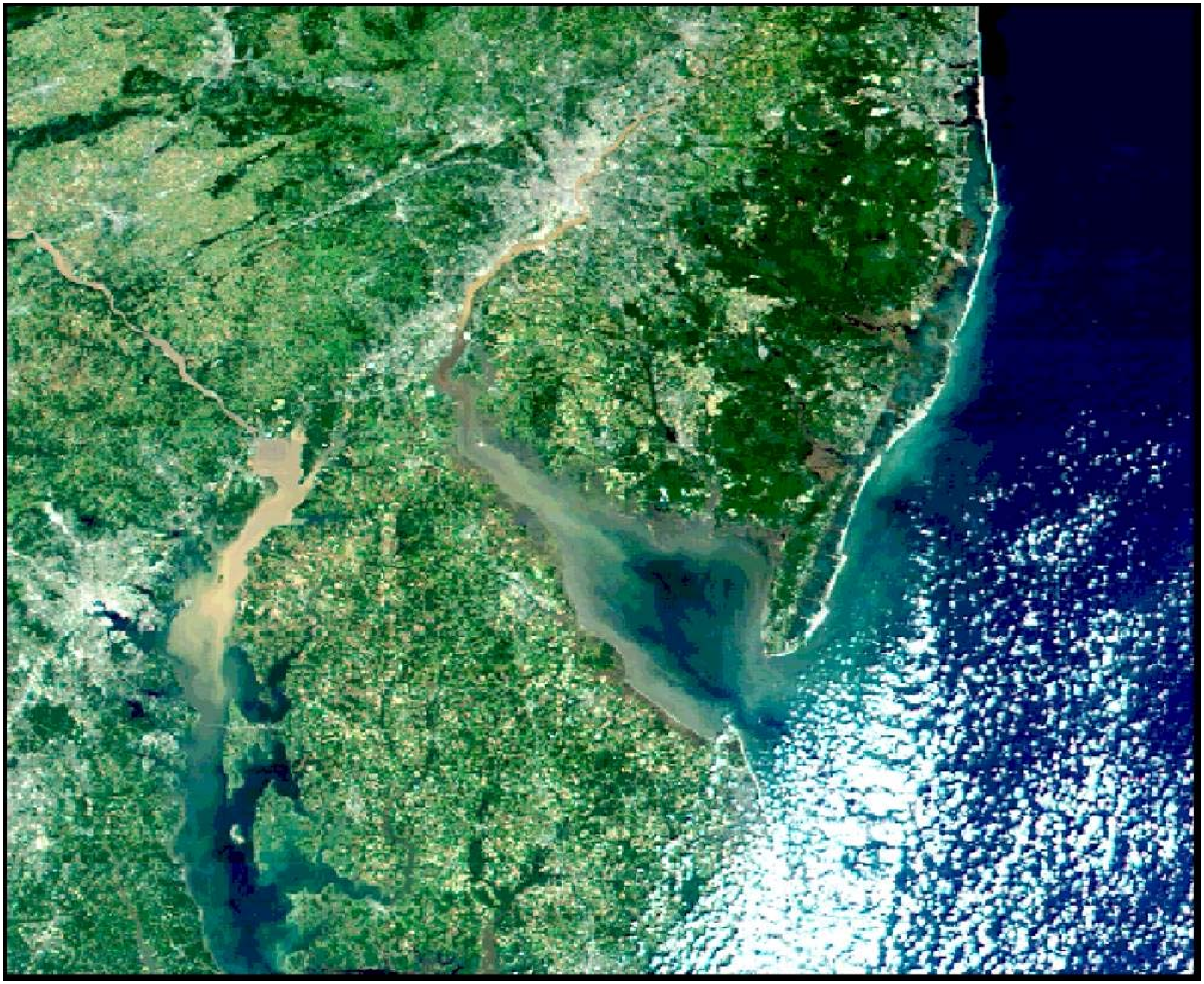
September 2002

Reference stream after outfall installation

December 2002

Cattail Creek Spring 2001 – RBA NJIS Score = 18

Cattail Creek Spring 2002 – RBA NJIS Score = 12



http://www.marine.rutgers.edu/mrs/coolresults/2004/DEP_september04.ppt

Sediment Vs. Water Column Samples

1. TMDL Site at Squankum (Rt. 195 & Rt. 524)

Fecal Coliform Counts
(Sampled 7/6/00)

	Water	**Sediment**	% Total Solids
1	210		
2		**5,000**	77.24%
3		**2,300**	80.39%
4		**13,000**	64.76%

Total **Phosphorus**
(Sampled 9/21/00)

	Water (mg/L)	Sediment (mg/kg)	% Total Solids
1			
2	0.13	**5318.00**	22.4%
3	0.30	**928.00**	70.0%
4	0.18	**2558.00**	57.1%

- Manasquan River at fishing access off Squankum – Yellowbrook Road (about 1 mile upstream of Site 1 – TMDL Site)

Fecal Coliform Counts
(Sampled 7/6/00)

	Water	Sediment	% Total Solids
Central	210	**8,000**	80.27%
East		**23,000**	72.30%
West		**5,000**	79.86 %

Total **Phosphorus**
(Sampled 9/21/00)

Water (mg/L)	**Sediment** (mg/kg)	% Total Solids
0.13	**3573.00**	65.1%
0.18	**2438.00**	42.0%
0.15	**6677.00**	34.8%

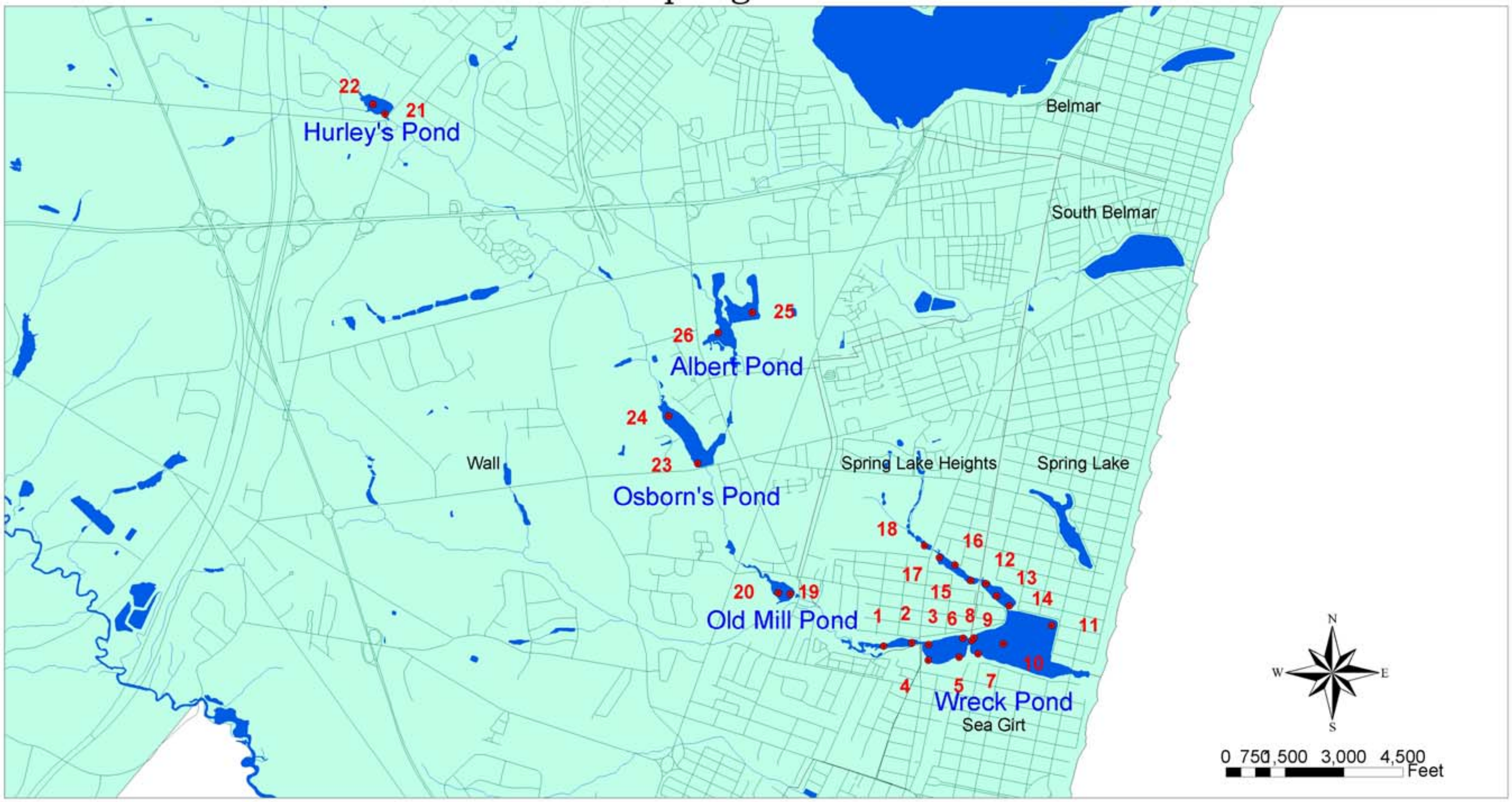
Percent total solids is the remainder of an aquatic sediment sample after the water has been evaporated. A sample that consists of silt and clay will have a lower percent total solids value than one consisting of sand and pebbles. Silt is preferentially eroded from streambanks. Fecal coliform adsorb and survive best on silt.

When stormwater runoff erodes streambanks, it also increases the numbers of fecal coliform in the sediment by providing greater amounts of silt in the streambed than would be present naturally. Coliform are resuspended into the water column during and after rainstorms.

Monmouth County Health Department

Wreck Pond

Fecal Coliform Colony Values
Sampling Locations



Legend

- Sample Sites
- Roads
- Streams
- Lakes
- Municipalities

Wreck Pond

1	340	17000	7	450	30000	13	220	3500
2	280	30000	8	350	5000	14	2800	1300
3	430	50000	9	140	17000	15	1700	8000
4	1060	17000	10	170	300	16	70	50000
5	100	1600000	11	70	300	17	670	500000
6	1300	2200	12	170	300	18	1600	5000

Old Mill Pond

19	670	5000
20	80	40

Hurley's Pond

21	40	11000
22	80	17000

Osborn's Pond

23	1880	1700
24	850	17000

(surface water colonies per 100mL / sediment colonies per 100grams wet weight)

This map was developed in part, using NJDEP digital data, in conjunction with the MCHDs work, but this secondary product, has not been verified by the NJDEP and is not state authorized.

This map was prepared to recognize public and environmental health trends.
Data accuracy is limited by the accuracy and scales of the original data sources.
Site specific conditions should be field verified.

Elevated coliform trends associated with rain, wind direction, and months with the warmest water temperatures have compelled provisional swimming bans at 2 beaches within 800 feet of the **Wreck Pond** outfall since 2002:

Automatically, for 24 hours after every rainfall greater than .1 inch; and for 48 hours after a 1 year storm (2.8 inches); by lifeguards during dry weather in July and August when onshore winds move the lake plume into the swimming area.

" … resuspension of the sediment and the subsequent desorption of the pathogens is a potential source of contamination to the overlying water. A study by Sherer et. al. (1992) showed that enteric bacteria can survive in sediments for several months as compared to only a few days in the overlying water." - www.epa.gov/owow/tmdl/pathogen/general.htm

COASTAL IMPACTS FROM FRESHWATER DISCHARGES

Freshwater colloidal fines, along with the adsorbed bacteria and pollutants, clump together into aggregates, self compact, sink, and accumulate in estuaries. It has been estimated that up to **80% of freshwater pollutants accumulate in estuaries.**

“Many of the fines in Monmouth County that are present in the ocean bottom outside the footprint of the barrier spit are old bay sediments (5000-6000 years).” – Jeffrey Pace, IMCS, 1/30/04. “Probably less than 5% of the sediment reaching the coastal zone in the Atlantic seaboard of the U.S. is transferred to the continental shelf or to the deep sea” – Meade (1982) in Riverine Transfer of Particulate Matter to Ocean Systems (Depetris, Pedro).

In the NY/NJ Harbor, “**95% of fine sediments contained at least 1 contaminant exceeding the Effects Range Median … compared to 16% of sandy sediments** … fine grade sediments are continually supplied to the NY/NJ Harbor from tributaries … and scavenge toxics from the water.” – Cd, Cu, Dioxin, PCBs, PAHs, and N in the NY/NJ Harbor. Boehme, S. 2000 (NYAS)

RBA CONCEPTS APPLIED TO BACTERIA

Rotifer Colony

LIMITED RESEARCH ON E. COLI PREDATORS INDICATE THEY DIEOFF FIRST WHEN STREAMS DEGRAGE

Bacteriovores are larger predatory microbes like rotifers, heterotrophic nanoflagellates, paramecia

Heavily degraded urban and agricultural streams with consistently high bacteria counts indicate " a microbial community that is out of balance".

"Low bacterial diversity confirmed by DNA work. Storm drains and sediments seem to promote regrowth of bacteria through cloning, without regard to specific host animals."

This may be because E. Coli may be consistently more adaptable (pollution tolerant) than bacteriovores.

Restoring natural conditions (health streams) will encourage greater predation of E.Coli by bacteriovores.

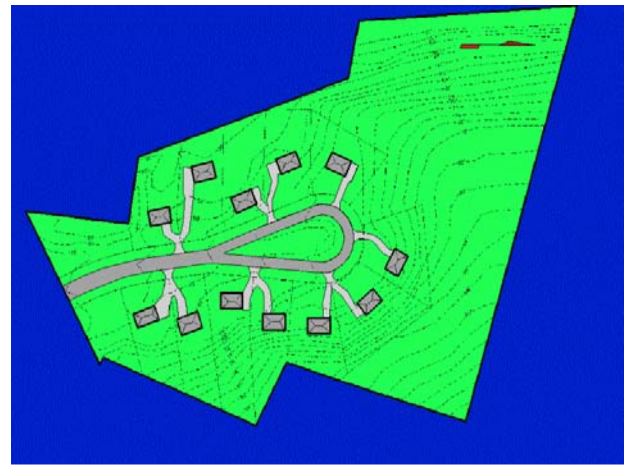
George Simmons of Virginia Tech quoted in EPA's Nonpoint Source News Notes (8/04, # 73) www.epa.gov/owow/info/NewsNotes and

"Estimating Nonpoint Fecal Coliform Sources in Northern Virginia's Four Mile Run Watershed" by Simmons, G. et. al. 2001www.novaregion.org/pdf/Bacteria_Paper.pdf

Rotifer picture from www.eeob.iastate.edu/faculty/DrewesC/htdocs

Conventional vs. LID

The smallest site disturbance area possible



PREPLAN NEW DEVELOPMENT:

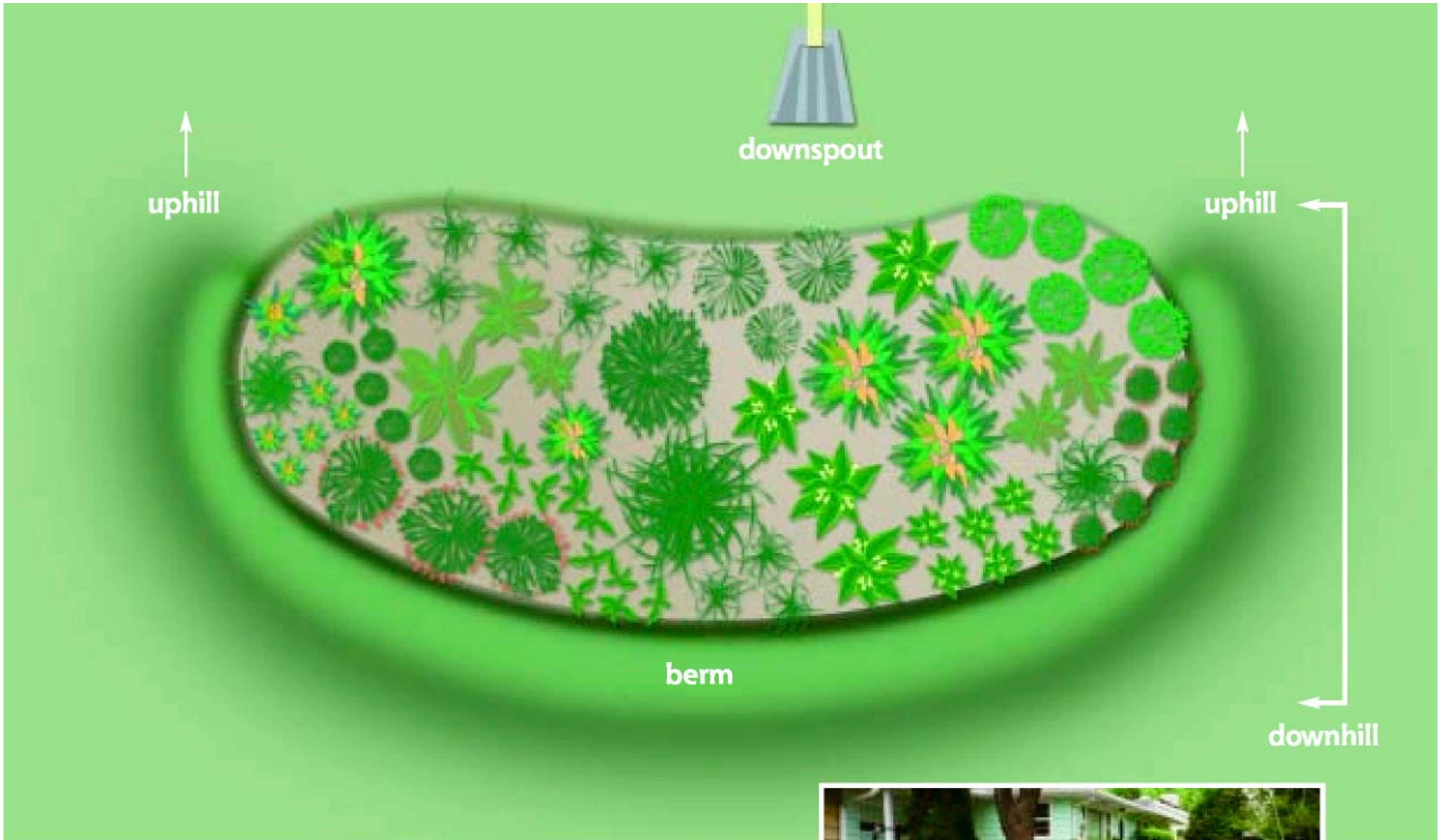
"**Use** site fingerprinting. Restrict ground disturbance to the smallest possible area.
Reduce paving.
Reduce compaction of highly permeable soils.
Minimize size of construction easements and material stockpiles.
Place stockpiles within development envelope during construction.
Avoid removal of existing trees.
Disconnect as much impervious area as possible.
Maintain existing topography and associated drainage divides to encourage dispersed flow paths.
Locate new development in areas that have lower hydrologic function, such as barren clayey soils." Build on the clay, infiltrate on the sand

To accomplish this, the RSIS needs to be revised to mandate that new conceptual plans be co-submitted to SCD at the same time they are submitted to the Municipal Engineer.

Department of Defense: LID Manual **http://www.ccb.org/docs/UFC/3_210_10.pdf**

TREES can be a significant factor in a Mitigation Plan because trees hold **20%** (deciduous) to **30%** (evergreen) of the rain before it becomes runoff.
LAWNS are compacted and act like impervious surface – www.ocscd.org/publications.shtml (Ocean County Soil Conservation District).
"**RAIN GARDENS** allow 30% more infiltration than grass" - http://clean-water.uwex.edu/pubs/raingarden/

/



http://clean-water.uwex.edu/pubs/raingarden

Reasons to Reduce the Size of Your Lawn and Practice Eco-Friendly Yard Care

- A lawn has less than 10% of the water absorption capacity of a natural woodland. This can lead to increased stormwater runoff and flooding.

- Gasoline-powered landscape equipment (mowers, trimmers, blowers, chainsaws) account for over 5% of urban air pollution.

- Residential application of pesticides is typically at a rate 20 times that of farmers per acre; this can wash into lakes and streams and cause blooms to smother aquatic life.

- Yard wastes (mostly grass clippings) comprise 20% of municipal solid waste collected. Most of this waste still ends up in landfills rather than being compost.

From the F. X. Browne, Inc. website at www.fxbrowne.com/html/workshops.htm, based on the EPA Green Communities website http://www.epa.gov/greenkit/landscap.htm

STORMWATER PLANS and EXISITING CONSTRUCTION

- Reduce flooding damage
- Minimize any increase in stormwater runoff from any **NEW** development
- Reduce soil erosion
- Assure the adequacy of existing and proposed in-stream structures
- Maintain groundwater recharge
- Prevent, to the greatest extent feasible, an increase in nonpoint source pollution;
- Maintain the stream's biological functions as well as for drainage
- Minimize pollutants in stormwater runoff from new and existing development
- Protect public safety through the proper design and operation of sw facilities.

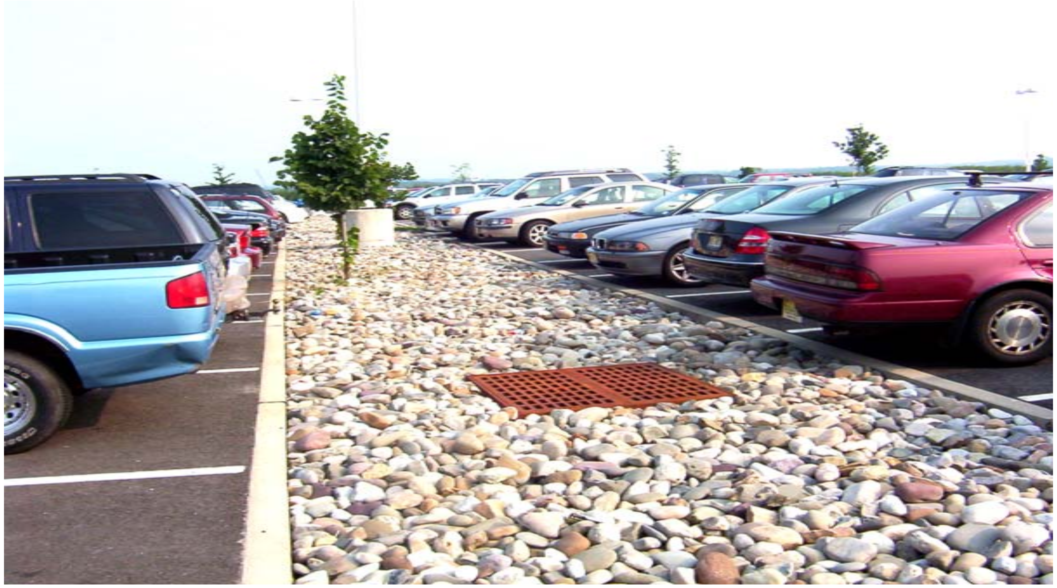
"The Mitigation Plan is the best opportunity to deal with EXISTING runoff"

- Retrofitting rain gutters and driveways as part of a Certificate of Continuing Occupancy when the house is sold.
- Rain gardens vs. grassed lawns.

Based on slides by Christopher C. Obropta, Ph.D., P.E.
Water Resources Extension Specialist with Rutgers Cooperative Extension
Assistant Professor with Department of Environmental Sciences
732-932-4917 obropta@envsci.rutgers.edu   ***http://rwqp.rutgers.edu/univ/nj/*** .

PARKING LOT

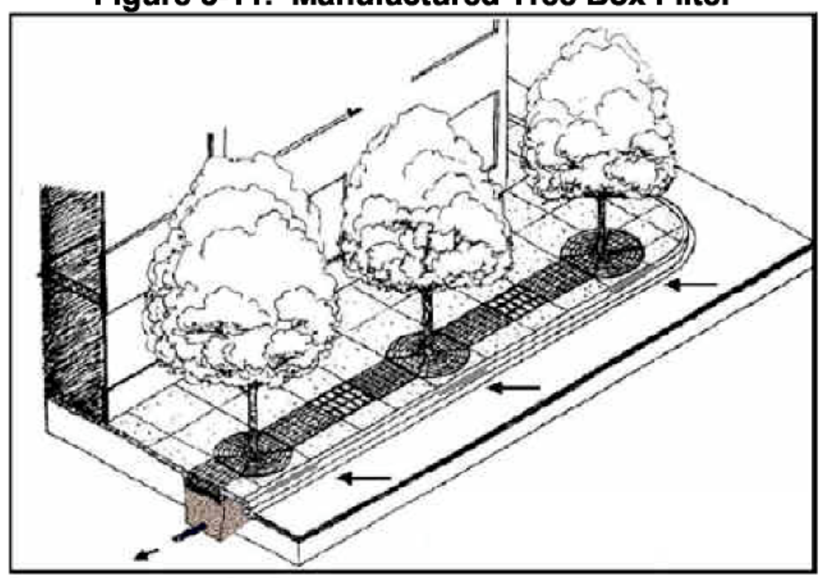
Rain Garden



The Monmouth County Belford Ferry Terminal:
A First Flush Infiltration BMP

ROOF GARDENS and
TREE BOX FILTERS

Figure 8-11. Manufactured Tree Box Filter



Source: Virginia DCR Stormwater Management Program.

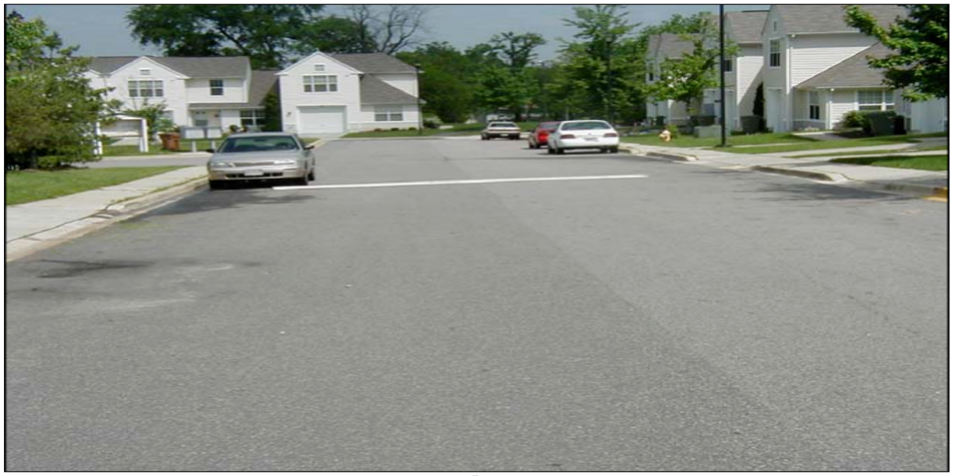
Department of Defense: LID Manual
http://www.ccb.org/docs/UFC/3_210_10.pdf

To control rates of runoff and watershed timing:

Use flatter rather than steeper grades, provided that adequate drainage for buildings and traffic is maintained
Reduce the height of slopes, to prevent runoff from gaining speed as it moves downhill
Where flow begins to accumulate, increase the length of flow paths, diverting and redirecting the flow, preferably with vegetated features
Minimize use of curb and gutter systems and piped drainage systems in favor of grassed swales
Minimize impervious area used for pavement
Disconnect impervious areas by directing runoff from buildings and pavements onto lawns or other vegetated areas, keeping flow velocities at a level that will not cause erosion
Preserve naturally vegetated areas and existing topography in places where these help slow runoff and encourage infiltration
Use weirs and check dams in swales

Department of Defense: LID Manual **http://www.ccb.org/docs/UFC/3_210_10.pdf**

Figure 10-10. Street Alterations



Before

After

CATTAIL CREEK, FREEHOLD,2001, before construction began in 2002. It was one of the last **Rosgen E** (aka NRCS Stage 5) streams in the upper Manasquan River. Note instream wetlands.

BF

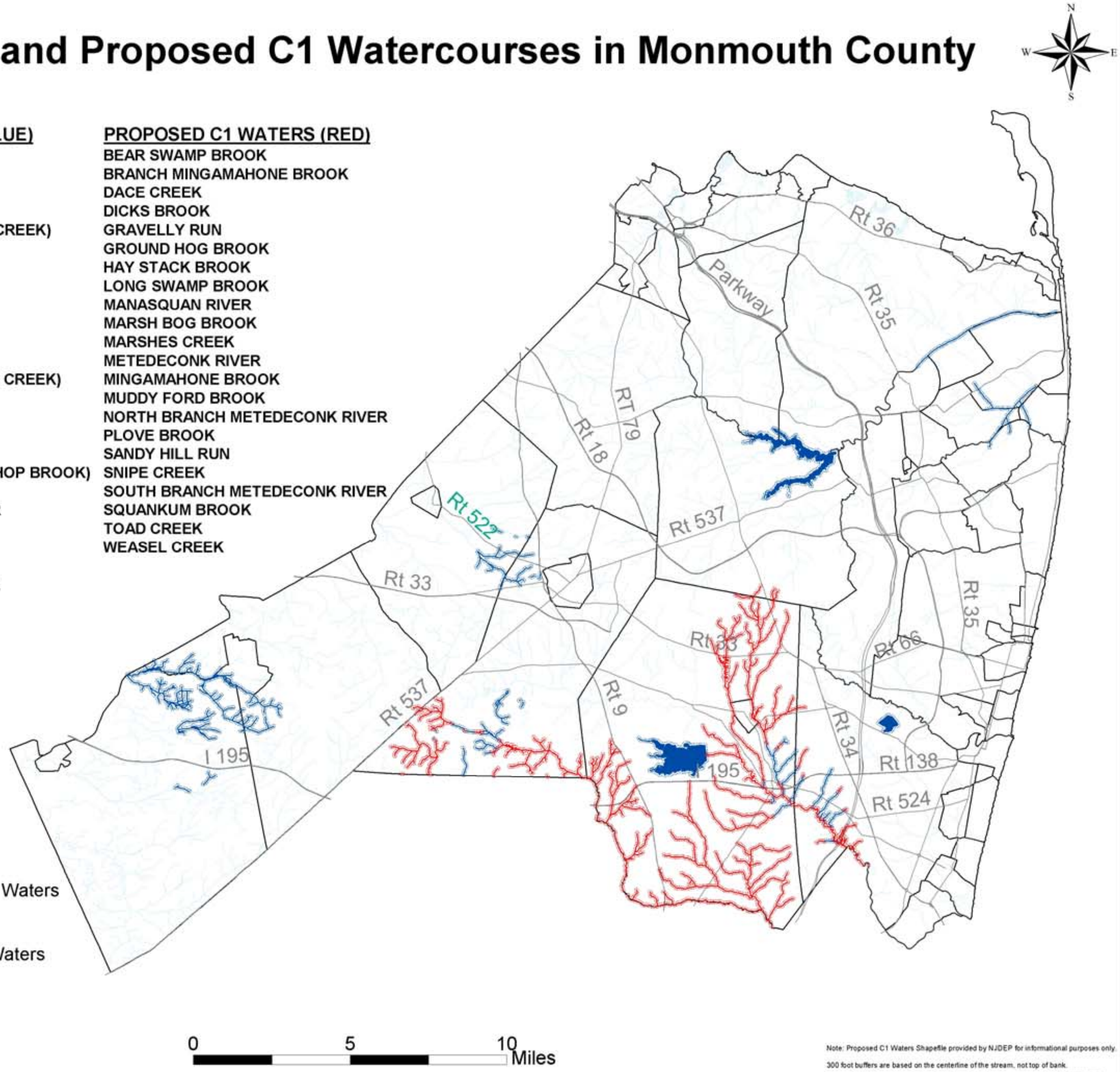
Existing and Proposed C1 Watercourses in Monmouth County

EXISTING C1 WATERS (DARK BLUE)

- ASSUNPINK CREEK
- BEAR SWAMP BROOK
- BIG BROOK
- BLACKBERRY CREEK
- BRANCHPORT CREEK (TURTLE MILL CREEK)
- DOCTORS CREEK
- GLENDOLA RESEVOIR
- LITTLE SILVER CREEK
- LONG SWAMP BROOK
- MANASQUAN RIVER
- MANASQUAN RIVER RESEVOIR
- MARSH BOG BROOK
- MATCHAPONIX BROOK (WEAMACONK CREEK)
- MCGELLAIRDS BROOK
- METEDECONK RIVER
- MILL RUN
- MINGAMAHONE BROOK
- NAVESINK RIVER (SWIMMING RIVER, HOP BROOK)
- NEW SHARON BRANCH
- NORTH BRANCH METEDECONK RIVER
- OCEANPORT CREEK
- SHREWSBURY (PARKERS CREEK)
- SLOPE BROOK
- SOUTH BRANCH METEDECONK RIVER
- SQUANKUM BROOK
- SWIMMING RIVER RESEVOIR
- TROUT BROOK
- WEAMACONK CREEK
- WEMROCK BROOK
- WILLOW BROOK
- YELLOW BROOK

PROPOSED C1 WATERS (RED)

- BEAR SWAMP BROOK
- BRANCH MINGAMAHONE BROOK
- DACE CREEK
- DICKS BROOK
- GRAVELLY RUN
- GROUND HOG BROOK
- HAY STACK BROOK
- LONG SWAMP BROOK
- MANASQUAN RIVER
- MARSH BOG BROOK
- MARSHES CREEK
- METEDECONK RIVER
- MINGAMAHONE BROOK
- MUDDY FORD BROOK
- NORTH BRANCH METEDECONK RIVER
- PLOVE BROOK
- SANDY HILL RUN
- SNIPE CREEK
- SOUTH BRANCH METEDECONK RIVER
- SQUANKUM BROOK
- TOAD CREEK
- WEASEL CREEK



Legend

- 300ft Buffer of Proposed C1 Waters
- Proposed C1 Waters 10/03
- 300ft Buffer of Existing C1 Waters
- Existing C1 Waters
- Streams
- Major Roads
- Municipalities

Note: Proposed C1 Waters Shapefile provided by NJDEP for informational purposes only.

300 foot buffers are based on the centerline of the stream, not top of bank.

Even 300' buffers, without LID, are short circuited by storm drains

The Manasquan River has **hundreds of feet of MC Park buffer** but remains severely eroded

Tree roots by Steve Taylor MRWA

PNC ARTS CENTER

Parking lot detention basin with sheet flow to stream, with no erosion rills.

But without a reduction in runoff volume, there is still streambank erosion at the point where the runoff enters the stream. <u>Sheet flow, without LID, offers limited management</u>.

This stream-fed pond meets the NJ TSS standard for Non-Trout surface water.

PARTICAL SIZE: its biological relevance must be acknowledged to predict pollutant dynamics.

"Colloidal and the smaller suspended particles (less then about 10 micrometers) are the particles that cause turbidity. Smaller particles and colloids remain suspended in the waters because their gravitational settling is less than 0.01 cm/sec (Stumm, W. andf J.J. Morgan,1981. Aquatic Chemistry. John Wiley and Sons)

Sand	**Silt**	**Clay**
2000 - >62 microns (um)	**<62 - 4 um**	**<4 um - .24 um**

(Glauconite is found as colloidal fines in clay deposits, and cemented (clay sized) grains that appear sand-sized in sand deposits.)

"It is widely recognized that **sediments less than 63 um in size are the most important fraction for contaminant adsorption and transport**, due to their relatively large surface area and geochemical composition" (Stone and Droppo 1994 quoted in Wood and Armitage.1997. Biological Effects of Fine Sediment in the Lotic Environment. Env.Manage. V.21, N.2,pp.203-217).

******

80% Removal rates in the regulations and in storm drain treatment units do not specify <= 63 microns.

The *Total Suspended Solids (TSS)* test, that drives regulatory and engineering decision making, is an inappropriate for watersheds in the Coastal Plain because it **is weight-based. It ignores the biological/chemical relevance of particle size in aquatic systems.**

CLEAN METALS TEST

Suspended	Colloidal	Dissolved
>1 um	.001 – 1 um	<.001 um

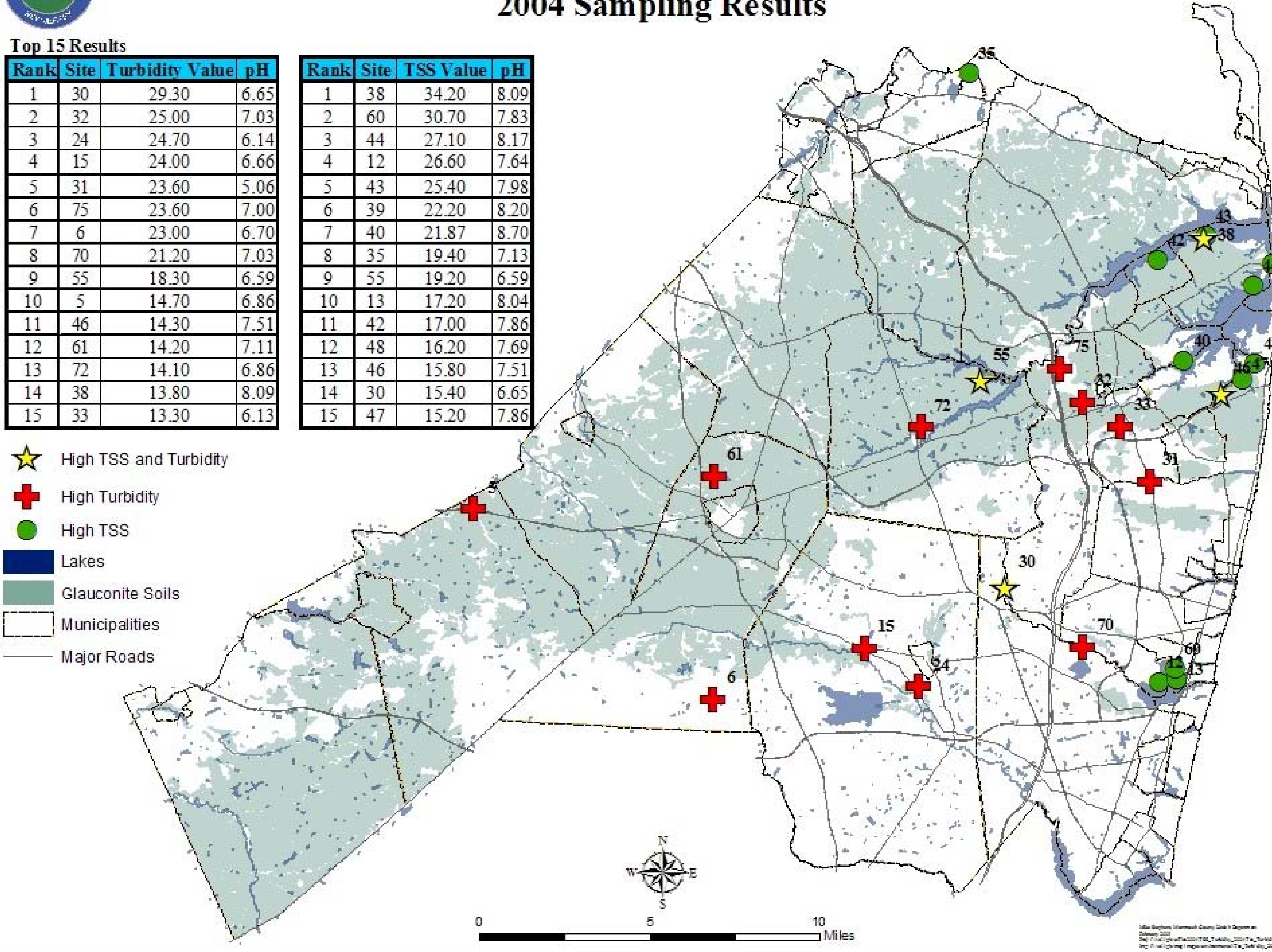
TDS /Clean Metals Filtrate: < .45 um vs. TSS: > 2.4 um

Highest TSS and Turbidity Results at Ambient Site Monitoring Locations
2004 Sampling Results

Top 15 Results

Rank	Site	Turbidity Value	pH
1	30	29.30	6.65
2	32	25.00	7.03
3	24	24.70	6.14
4	15	24.00	6.66
5	31	23.60	5.06
6	75	23.60	7.00
7	6	23.00	6.70
8	70	21.20	7.03
9	55	18.30	6.59
10	5	14.70	6.86
11	46	14.30	7.51
12	61	14.20	7.11
13	72	14.10	6.86
14	38	13.80	8.09
15	33	13.30	6.13

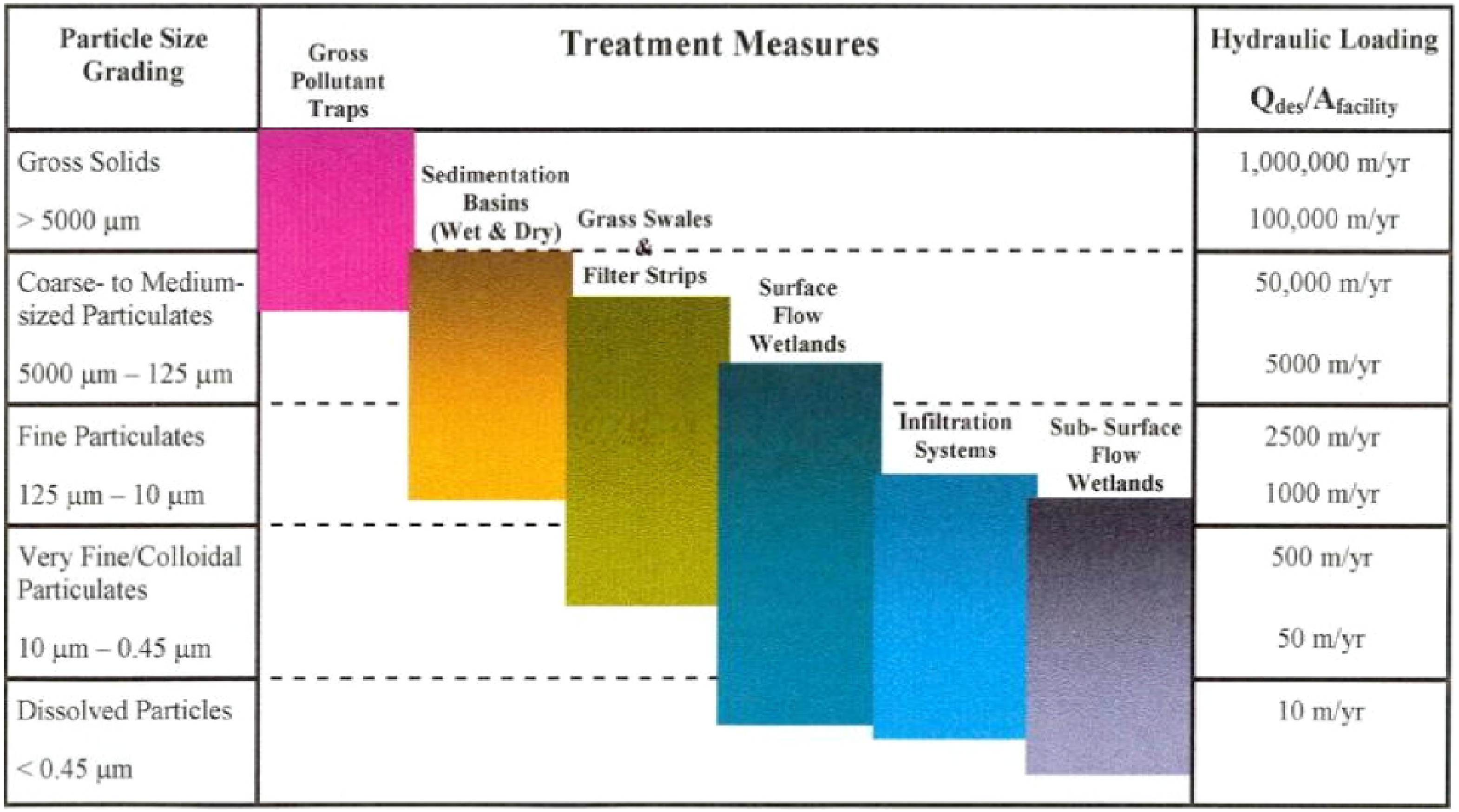
Rank	Site	TSS Value	pH
1	38	34.20	8.09
2	60	30.70	7.83
3	44	27.10	8.17
4	12	26.60	7.64
5	43	25.40	7.98
6	39	22.20	8.20
7	40	21.87	8.70
8	35	19.40	7.13
9	55	19.20	6.59
10	13	17.20	8.04
11	42	17.00	7.86
12	48	16.20	7.69
13	46	15.80	7.51
14	30	15.40	6.65
15	47	15.20	7.86



CAVEAT ON STORM DRAIN FILTER SYSTEMS

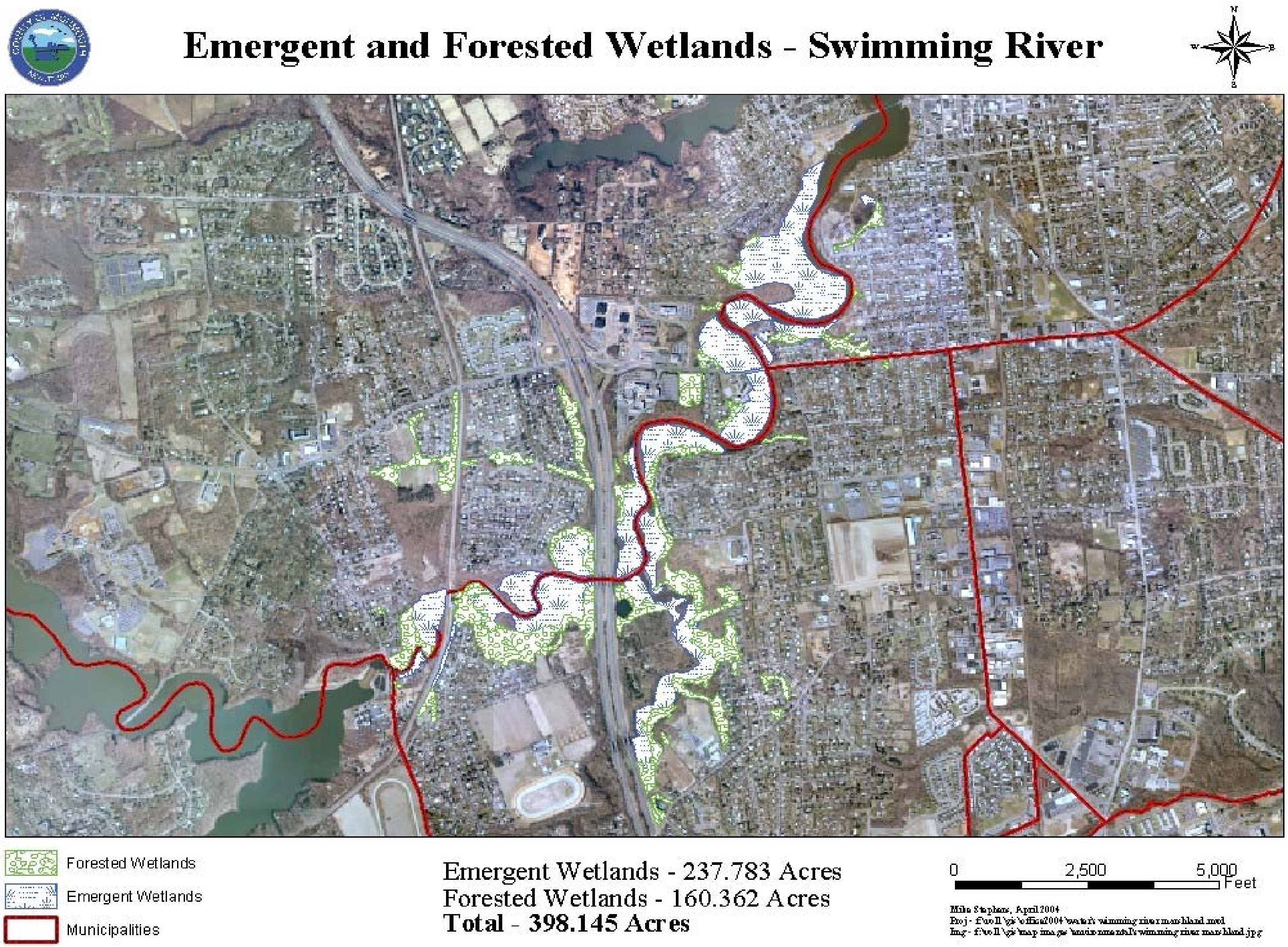
(100 microns at best, during 'bypass' 1/8" diameter)

Figure 5-1. Removal Effectiveness of Various BMPs



Source: Wong.

Department of Defense: LID Manual http://www.ccb.org/docs/UFC/3_210_10.pdf



Generation of enterococci in a salt water marsh and its impact on surf zone water quality in California : es.epa.gov/ncer_pubs/full_text/10919.pdf

Water Released From Storm-Battered Dam

July 15, 2004 5:29 pm US/Eastern

PEMBERTON TOWNSHIP, N.J. (AP) About 150 people evacuated during heavy flooding that struck Burlington County …

According to the DEP's Dam Safety Section, dam designs are still required to be based on the 100 year storm, just as they were in 1920, which is the age of the oldest dam in Monmouth County – even though there have been significant increases in impervious surface since 1920 . **"The magnitude of small floods of a 100 year interval may be doubled in size by 30% imperviousness in the watershed."** Delaware River Basin Commission, 2000. High Flow Management objectives for New Jersey Non-Coastal Waters, P.10.

LID can be part of a No Adverse Impact Floodplain Management Strategy to Protect MunicipalitiesFrom Future Lawsuits

NAIFPM "insures that the action of one property owner does not adversely impact the properties and rights of other property owners, as measured by increased flood peaks, flood stage, flood velocity, and erosion and sedimentation."

"Most local governments have simply assumed that federal floodplain management approaches", and the current National Flood Insurance Program (NFIP), "embody a satisfactory standard of care, perhaps not realizing that they actually induce additional flooding and damage."

Will a no adverse impact policy "reduce lawsuits against governments for flood losses" where new community "storm sewers will result in increased flood damage to private lands?"

As technology (**LID**) advances, "the techniques and approaches that must be applied by engineers and others to reach a level of 'reasonable conduct', as judged by practices applied in the profession, also advance" . For ex.:

10% imp. surface impacts, 16 times the runoff volume from imp surf, etc.

No Adverse Impact Floodplain Management and the Courts.2004. Kusler, J. ASFPM.
www.floods.org/NoAdverseImpact/NAI_AND_THE_COURTS.pdf

How may sediment, turbidity and pollutants confound DNA and MARS water tests that are used as the sole indicator of sewage?

HORIZONTAL GENE TRANSFER_(HGT) is the transfer of genes to unrelated species, by viral (phage) infection, through environmental DNA being taken up by the cell, or by unusual mating between unrelated species. [1]

SEDIMENT, NUTRIENTS, AND TURBIDITY AS PROMOTERS OF HGT

DNA is protected from degradation by adsorbing to detritus, humic acid, and in particular, clay and sand particles. **Half lives** in freshwater and marine water are 3 to 5 hours, with high values of 45 to 83 hours on the ocean surface, and extremely high values of 140 and 235 hours for the **marine sediment (10 days)**. [2]

Environmental DNA can be stabilized by adsorption to sand and clay particles, thereby becoming **100 to 1000 fold more resistant** to DNase. [3]

Higher **phosphate** levels (in soil) also increased the transformation frequency … may occur following the spread of manure slurries on soil … transformation … being more efficient in a silt loam than an loamy sand. [3]

POLLUTANTS AS PROMOTERS OF HGT

In routine laboratory procedures for genetic transformation, **heavy metals** … are used to greatly increase the competence of cells for transformation. [2]

Our findings indicate that mercury released from **amalgam fillings** can cause an enrichment of mercury resistance plasmids in the normal bacterial floras of primates. Many of these plasmids also carry antibiotic resistance, implicating exposure to mercury from dental amalgams in an increased incidence of multiple antibiotic resistance plasmids in the normal floras of nonmedicated subjects. [9]

Some of these transmissible elements, such as an integron or transposons, sometimes in addition to antibiotic resistant genes, … have genes for **heavy metal** resistance, such as mercury. They also have resistance genes for antiseptics like **ammonia** compounds. [10]

The **biopesticide** Paenibacillus popillae has a vancomycin resistance gene cluster homologous to the enterococcal van A vancomycin resistance gene cluster; used for more than 50 years in the US to control Japanese beetles. [11]

POLLUTANTS AS PROMOTERS OF HGT

Mutants of E. Coli selected for resistance to the disinfectant **pine oil** or to a household product containing pine oil also showed resistance to multiple antibiotics (tetracycline, ampicillin, chloramphenicol, and nalidixic acid. [12]

The fact that elevated temperature and pollutants such as **PAHs, PCBs and pesticides** cause prophage induction in natural populations suggests that such processes could in part be causing the elevated phage abundances seen in eutrophic estuaries, particularly in the summer months. [13]

BACTERIOPHAGES AS PROMOTERS (TRANSDUCTION)

A marine phage host isolate is capable of transferring an antibiotic resistant plasmid among bacterial hosts … **up to 13,000,000,000,000 transduction events per year** could occur in the Tampa Bay estuary … the presence of suspended **particulates** in the water column facilitates transduction by bringing the host and phage into close contact with each other. [7]

Turbidity: transduction frequencies were found to be enhanced as much as 100-fold in the presence of particulates. [8]

Bacteriophages themselves evolve by horizontal gene transfer and recombination; as many as 108 bacteriophages per ml. in aquatic environments, so that **one third of the total bacterial populations is subjected to a phage attack every 24 hours**. [2]

BIRDS FECES LEADING TO MISCLASSIFICATION

Waterfowl in Ohio parks had multidrug resistance to penicillin G, lincomycin, vancomycin, erythromycin, and bacitracin. [4]

Gram negative bacteria isolated from adults (**geese**) were predominantly resistant to tetracycline, erythromycin, penicillin, oxacillin, and vancomycin. [5]

Canada geese using manure lagoons at farms shed farm-animal antibiotic resistant bacteria. [6]

ANTIBIOTICS THEMSELVES AS HGT PROMOTERS (EVOLUTIONARY) AND LEADING TO MISCLASSIFICATION

The antibiotic **tetracycline** for example was found to act as an ‘aphrodisiac’ for a number of bacteria, enhancing transfer frequencies up to 100-fold” in the gut. [14]

Resistance plasmids encoding for many antibiotic resistance genes were transferred between pathogenic and non pathogenic Gram negative bacteria in several environments, including sea water. **In the presence of tetracycline concentrations that were not high enough to kill the bacteria, the rate of gene transfer between Vibrio cholerae and Aeromonas salmonicida increased 100 times.** [15]

A antimicrobial drug used as an additive in animal feed in Europe (avoparcin) caused the poultry to have, and is associated with the human prevalence of, vancomycin resistant enterococci. So a residual of an animal antibiotic (that the people ate when they ate the animal meat) gave a positive test for a human antibiotic in feces. **Can other animal antibiotics produce ‘false’ positives as a human antibiotic after ingestion, or after release to the environment?** [16]

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ANY QUESTIONS ?