An aerial photograph of a coastal town, likely in New Jersey, with a large body of water in the foreground and a clear blue sky. The town is densely packed with buildings and is situated along the water's edge. The water is a deep blue, and the sky is a lighter blue. The overall scene is bright and clear.

Application of Microbial Source Tracking

NJ Water Monitoring Coordinating Council
January 31, 2007

New Jersey Department of Environmental
Protection

Water Monitoring & Standards

Bureau of Marine Water Monitoring

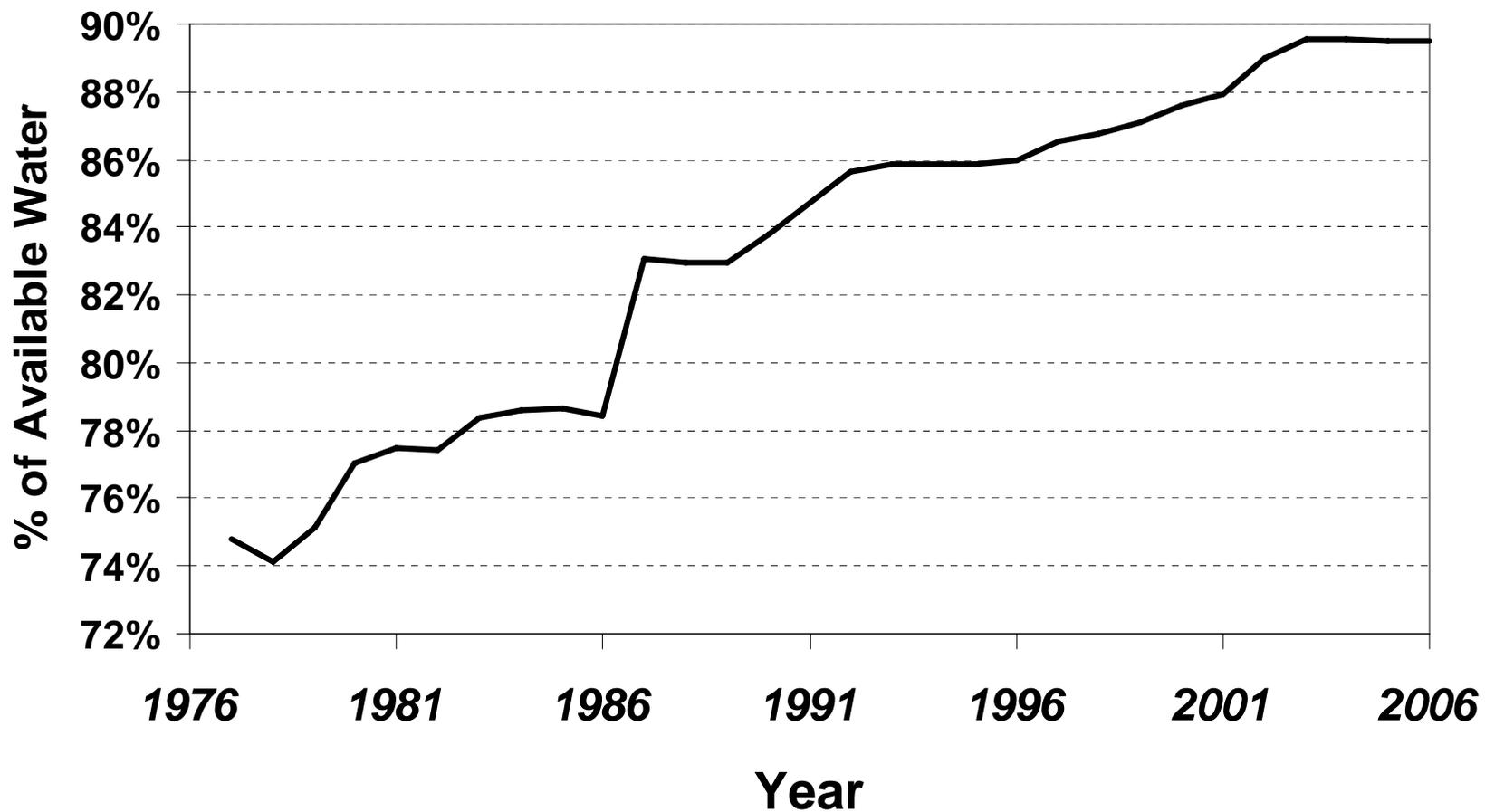
Presented by: Bob Connell, Chief

Monitoring for Public Health Seafood Safety

- Required by NJ Statute (NJSA 58:24).
- Required by US Food and Drug Admin. for interstate sale of NJ shellfish (worth ~\$500 million/year to the NJ economy).
- Supporting data for NJ's Integrated Report to identify impaired waters.
- 2,500 locations, 15,000 samples/year for coliform bacteria



New Jersey Harvestable Shellfish Waters



General Process for NPS Source Tracking

1. Identify use impairments related to water quality and NPS pollution using existing monitoring data
2. Trace water quality problem back to its source
3. Correct the problem at its source and monitor effectiveness using evaluation monitoring to measure pollution control
4. Using the monitoring systems described in 1,2 and 3 above, trace the water quality improvement back to the removal of the use impairment.

NJDEP, 1997. Monitoring Strategy For Nonpoint Source Pollution In New Jersey's Coastal Zone



new jersey **njdep**
department of environmental protection
water monitoring & standards

Source Tracking Tools

- Shoreline Survey - a critical first step
- Existing Data
- Collection of New Data
 - Traditional indicators (coliform bacteria, E. coli)
 - New indicators
 - Coliphage (viral indicator)
 - Multiple Antibiotic Resistance (MAR)
 - Optical Brighteners (currently evaluating – promising)

Coliphage - Viral Indicator

- Viruses that infect bacterial cells
- Similar in size, shape and morphology to HEV including; HAV and Norwalk therefore: good viral pathogen indicator
- More resistant to chlorination than the conventional indicators
- Good wastewater effluent indicator

Genotyping of Coliphage

- Group I - Animal
- Group II - Human
- Group III - Human
- Group IV - Animal

Multiple Antibiotic Resistance (MAR)

- Identifies *E. coli* that are resistant to antibiotics used to treat bacterial infections in humans. *E. coli* that is resistant to multiple medicinal antibiotics are typically of human origin
- Can also allow differentiation between domestic animals versus wild animals.
- Methods employed are those developed by NOAA Center for Coastal Environmental Health & Biomolecular Research.

Completed and Ongoing Nonpoint Source Tracking Projects

Water Monitoring & Standards

In each of these locations,
significant pollution sources that
were impacting these waters
were identified.





Impairment: Waters Closed to
Shellfish Harvest

Non-Stormwater Related

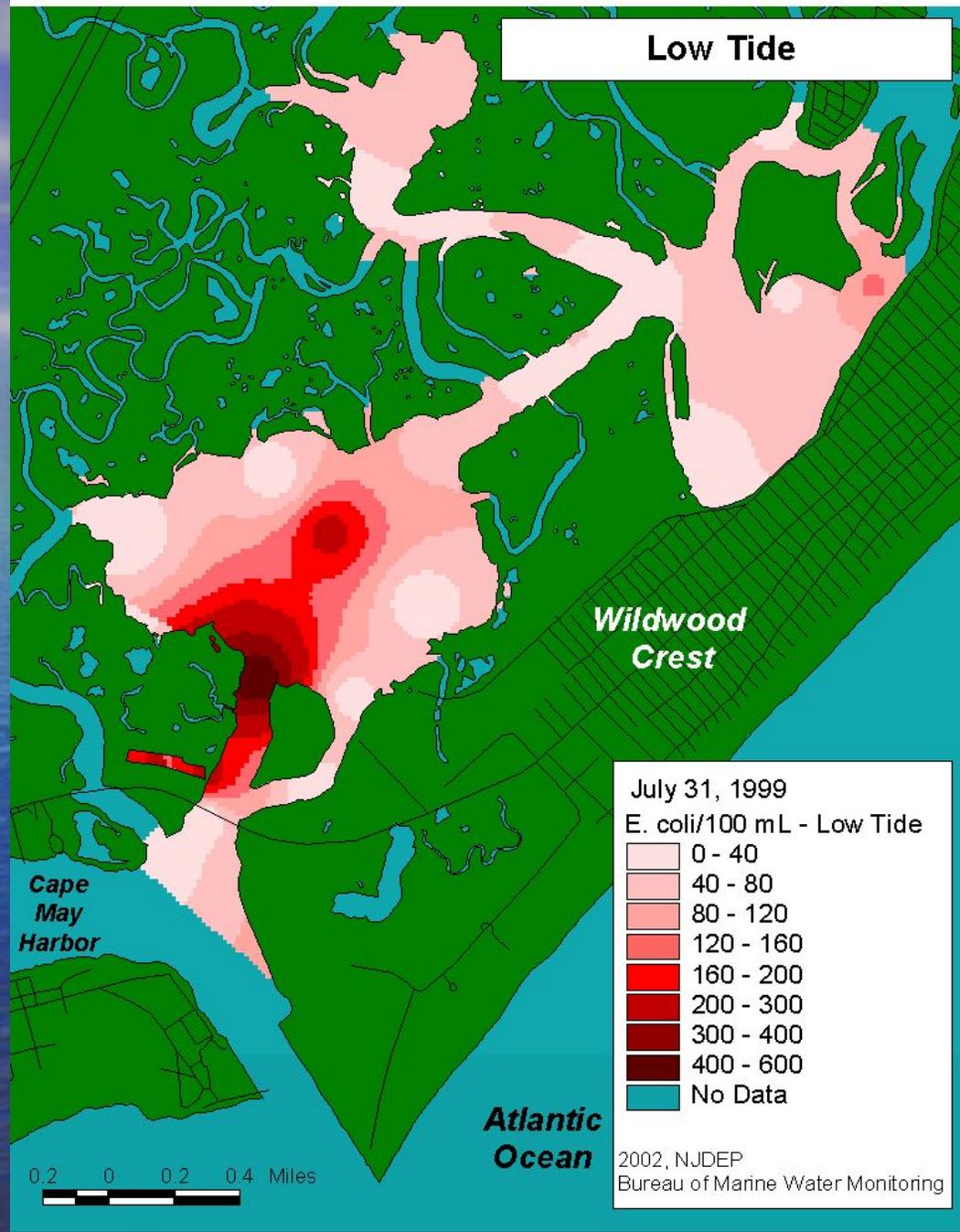
Cape May, NJ

Cape May County - Jarvis Sound & Sunset Lake

Waters have had elevated bacterial levels in all seasons for many years with no plausible explanation.



Low Tide

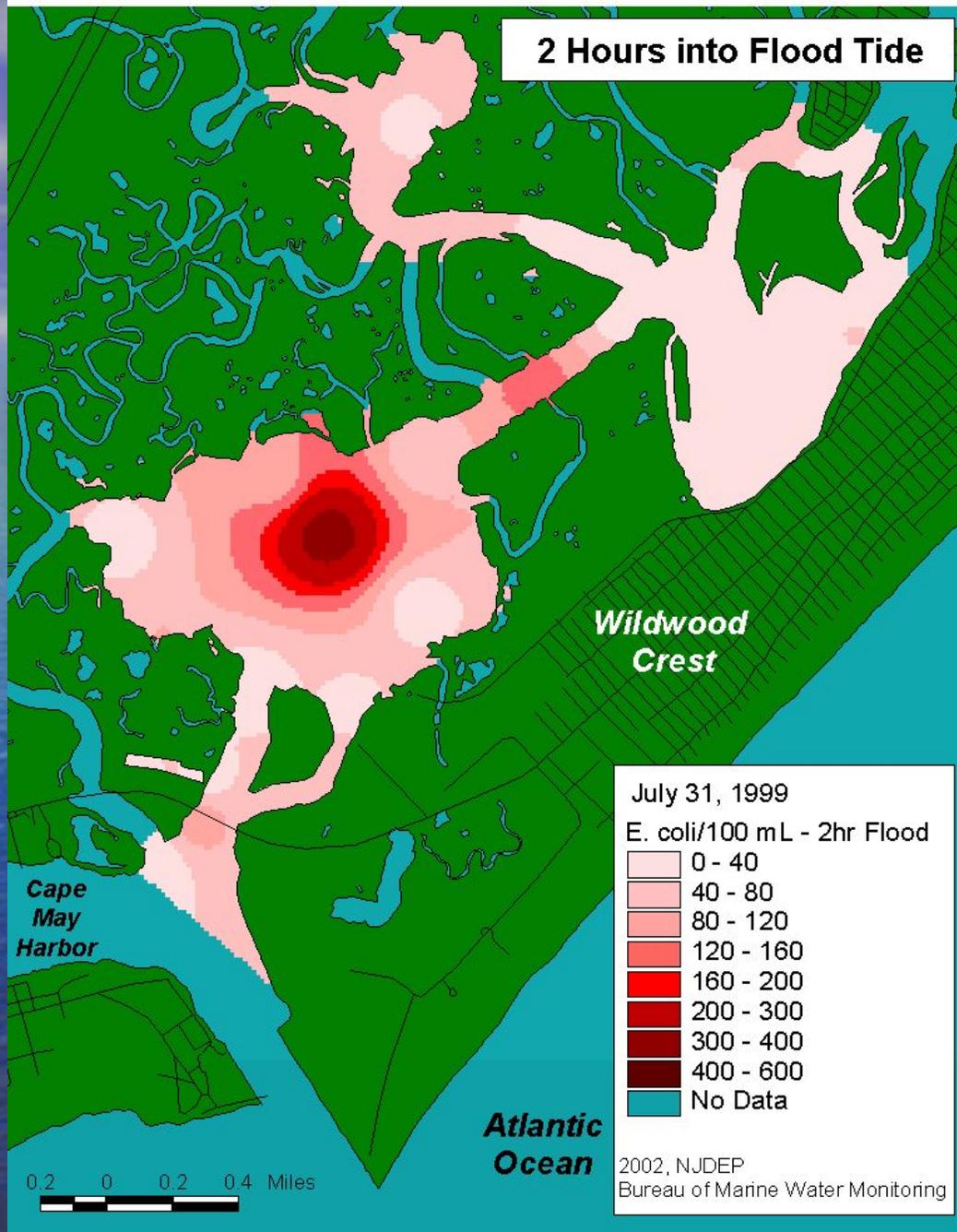


July 31, 1999
E. coli/100 mL - Low Tide

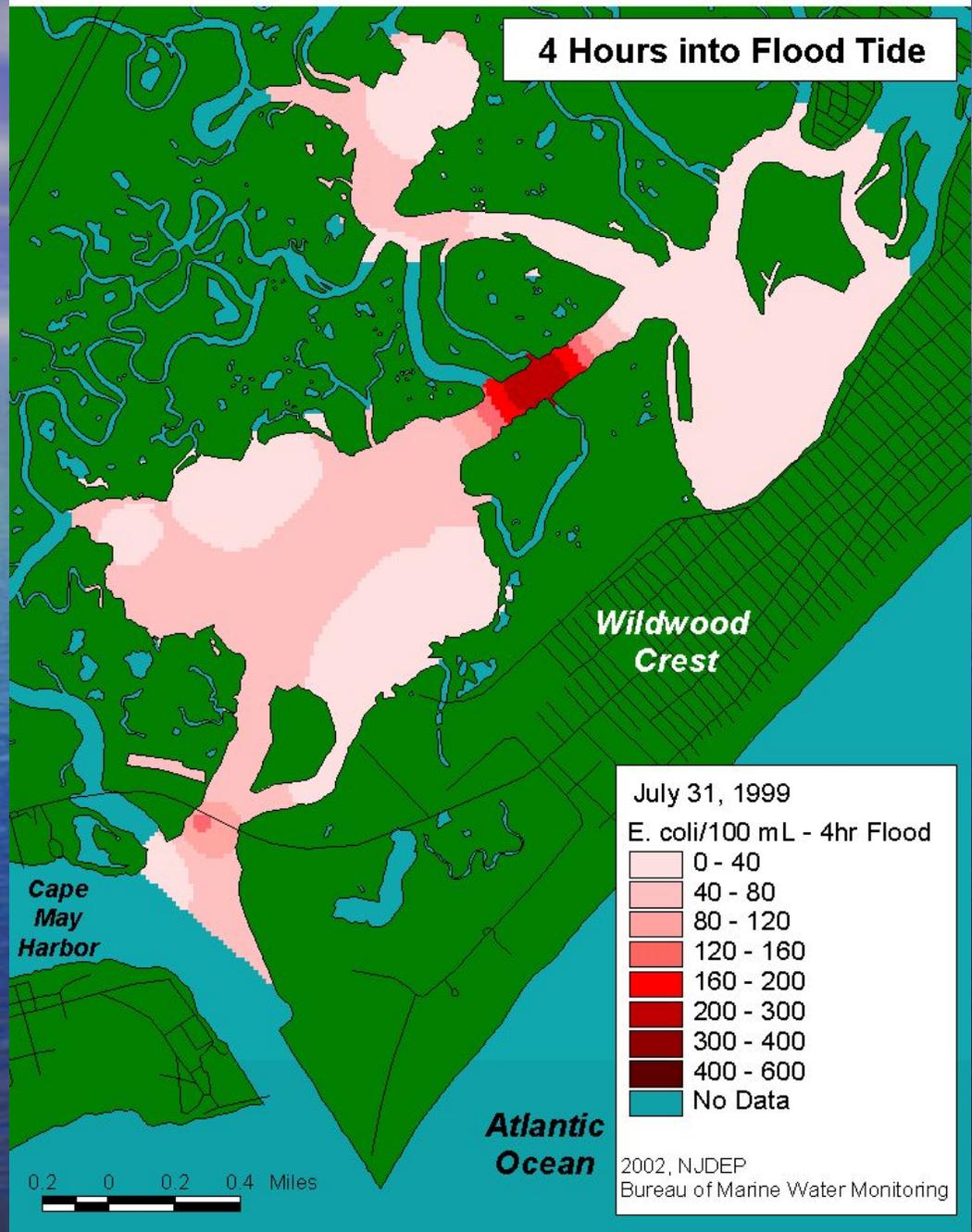
0 - 40
40 - 80
80 - 120
120 - 160
160 - 200
200 - 300
300 - 400
400 - 600
No Data

2002, NJDEP
Bureau of Marine Water Monitoring

2 Hours into Flood Tide



4 Hours into Flood Tide

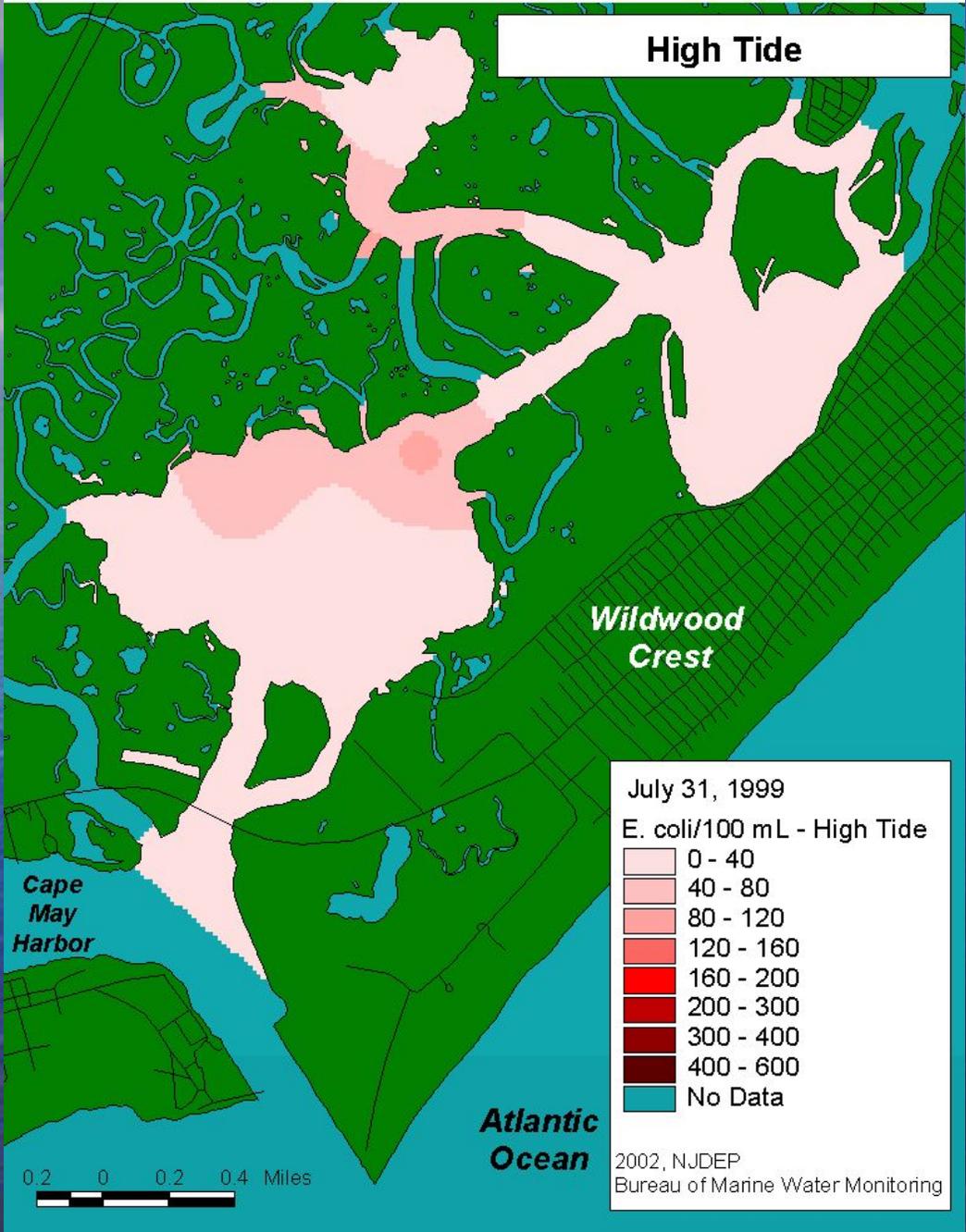


July 31, 1999
E. coli/100 mL - 4hr Flood

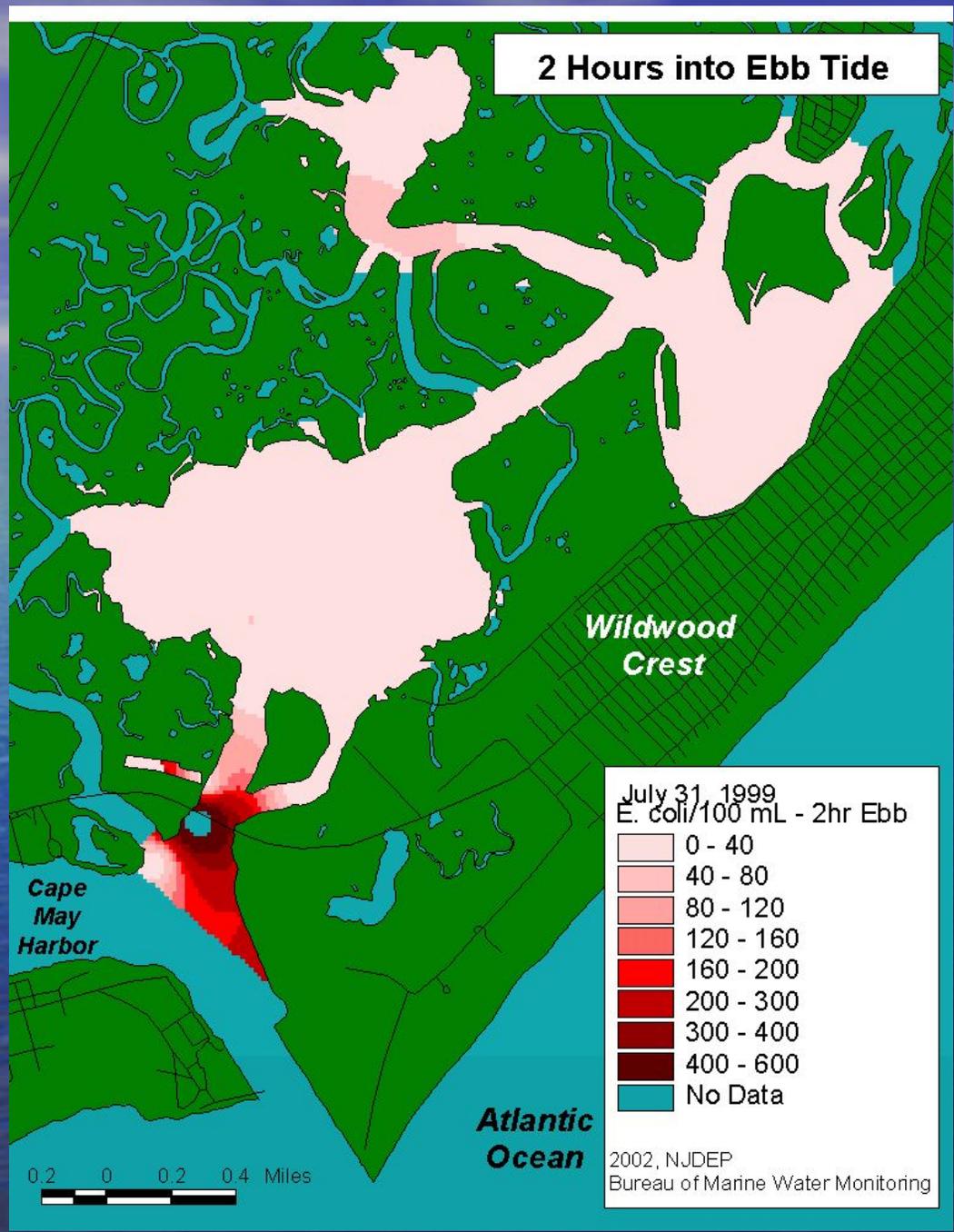
0 - 40
40 - 80
80 - 120
120 - 160
160 - 200
200 - 300
300 - 400
400 - 600
No Data

2002, NJDEP
Bureau of Marine Water Monitoring

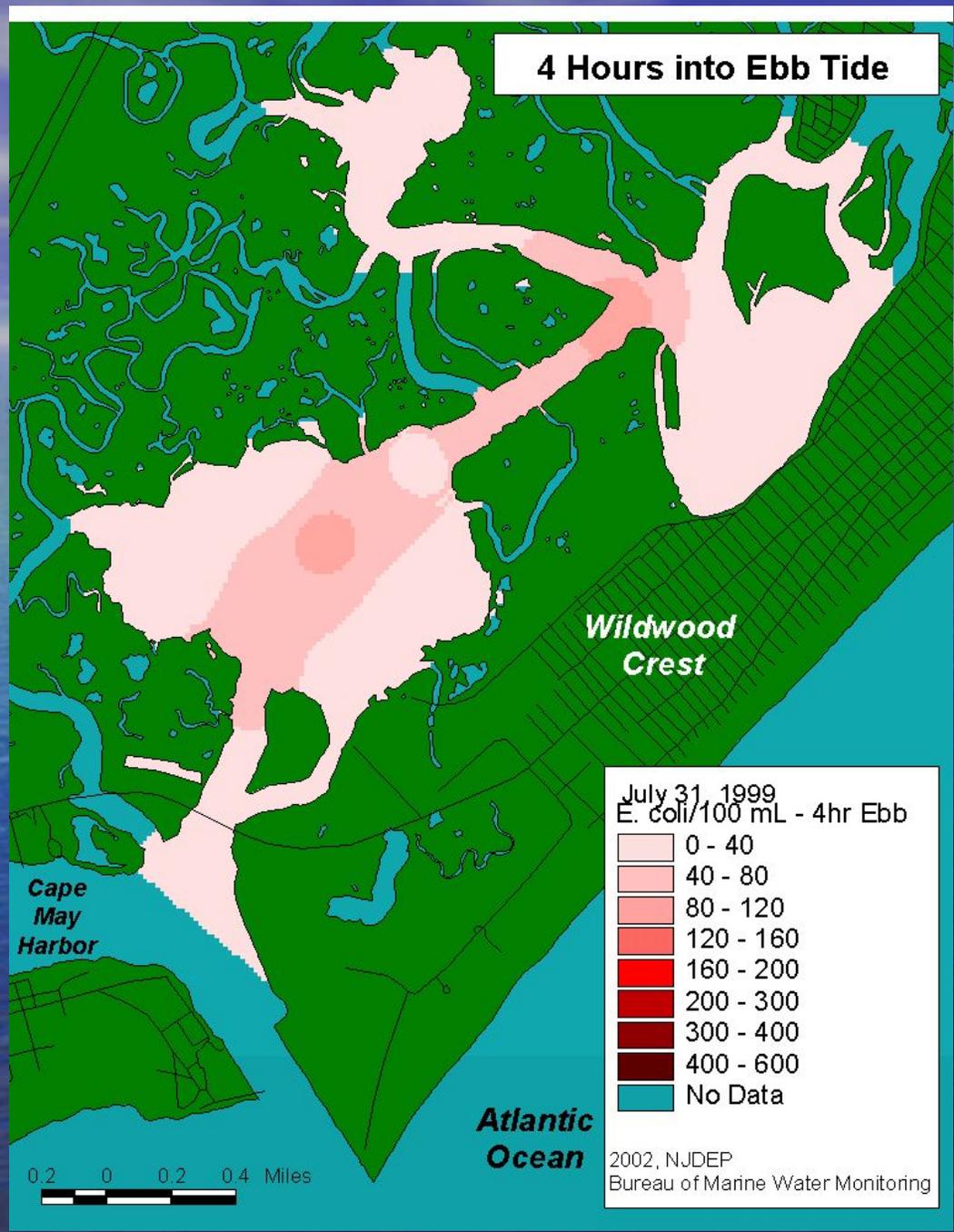
High Tide

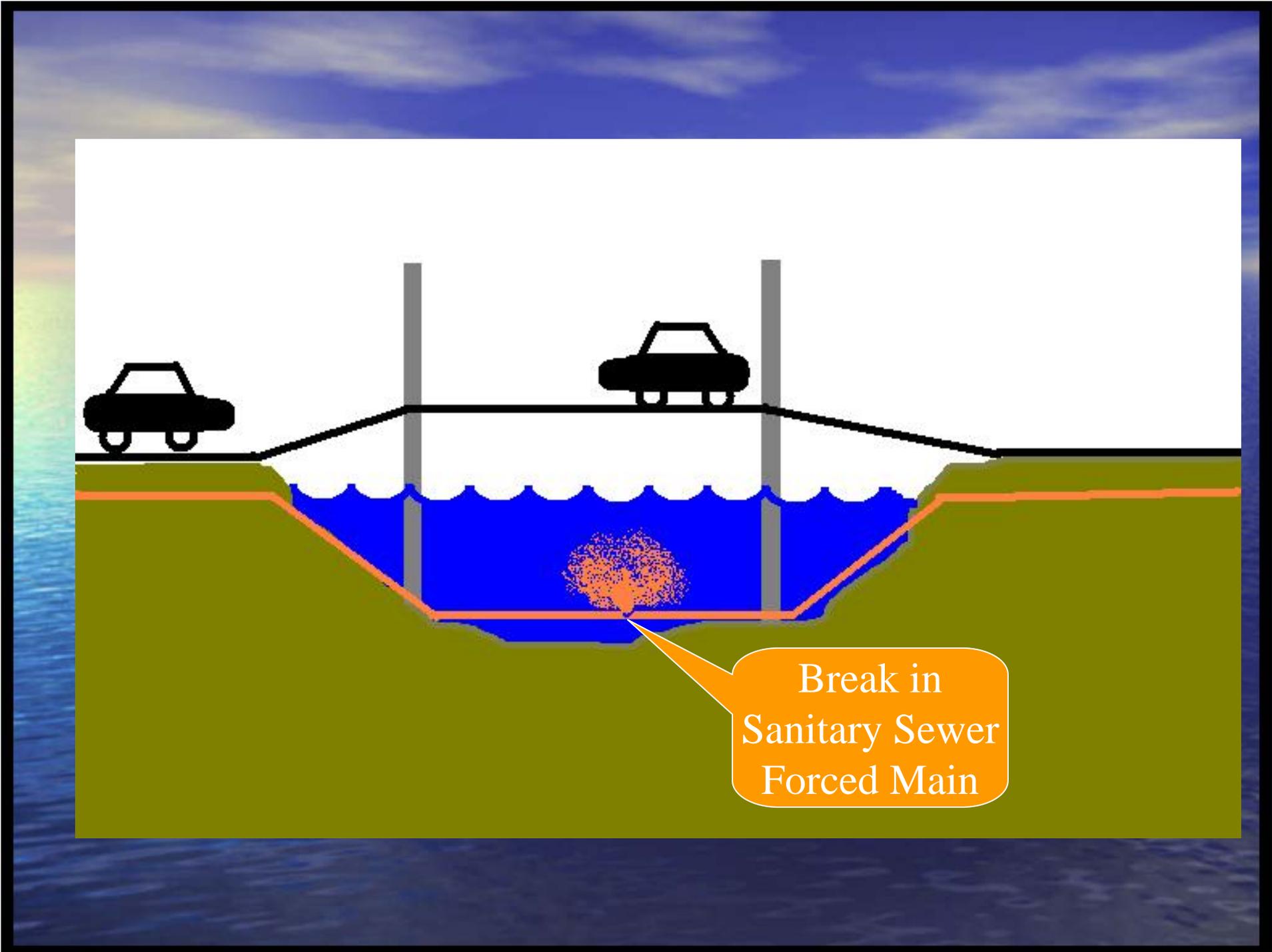


2 Hours into Ebb Tide



4 Hours into Ebb Tide

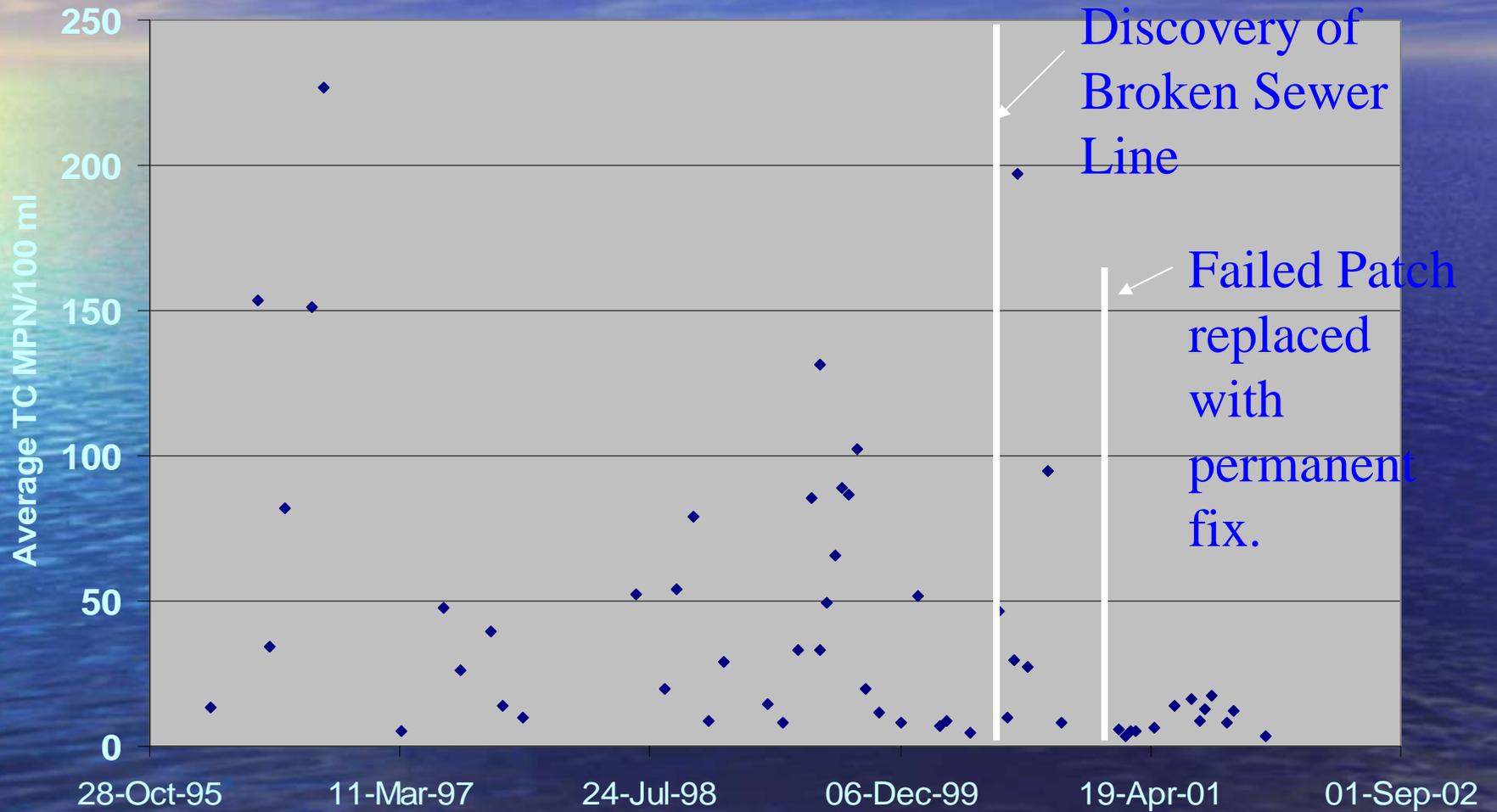




Break in
Sanitary Sewer
Forced Main

NSSP Area SE-7

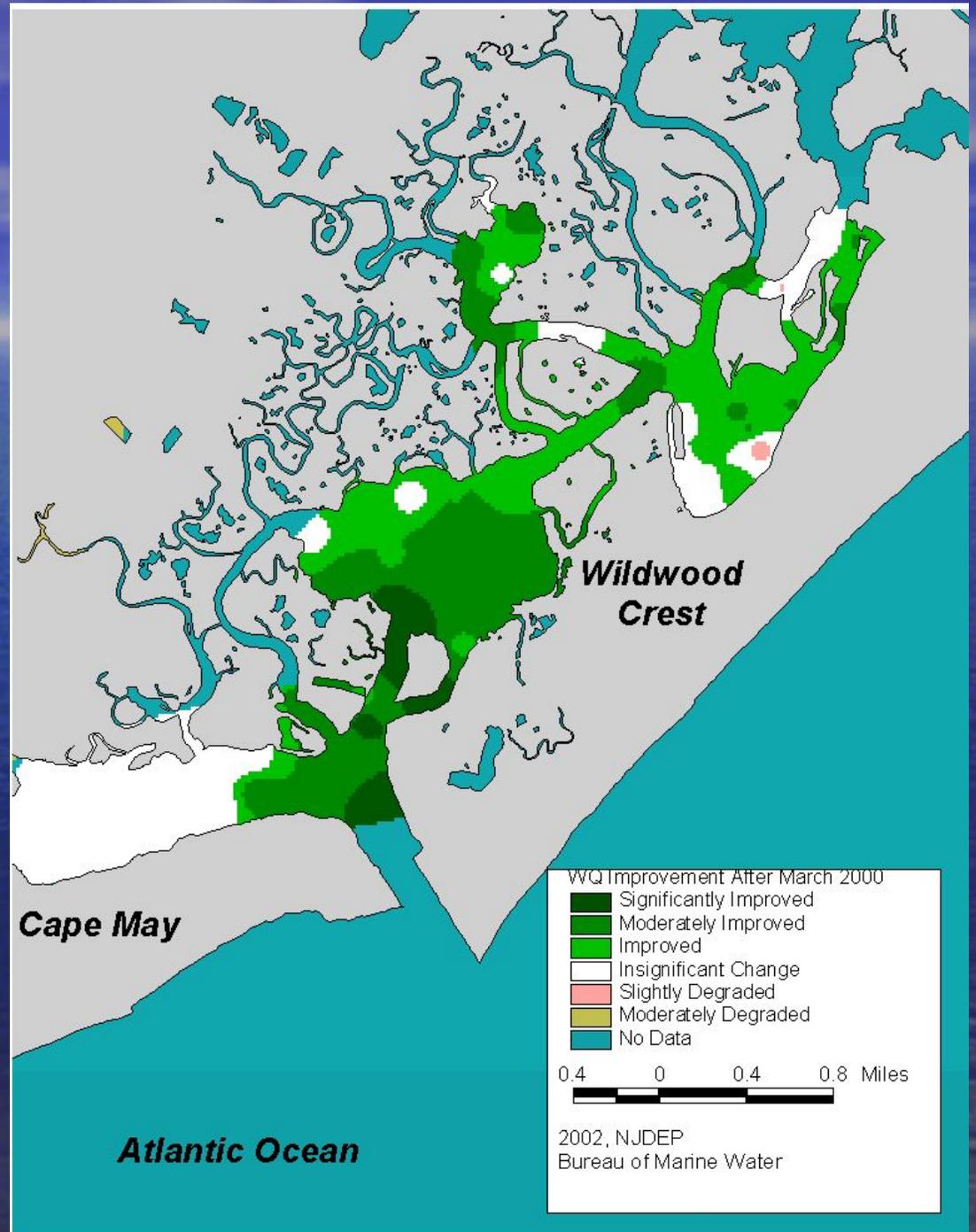
Average Total Coliform Levels by Date



Effectiveness Monitoring

Water Quality
Improvement following
Sewer Line Repair

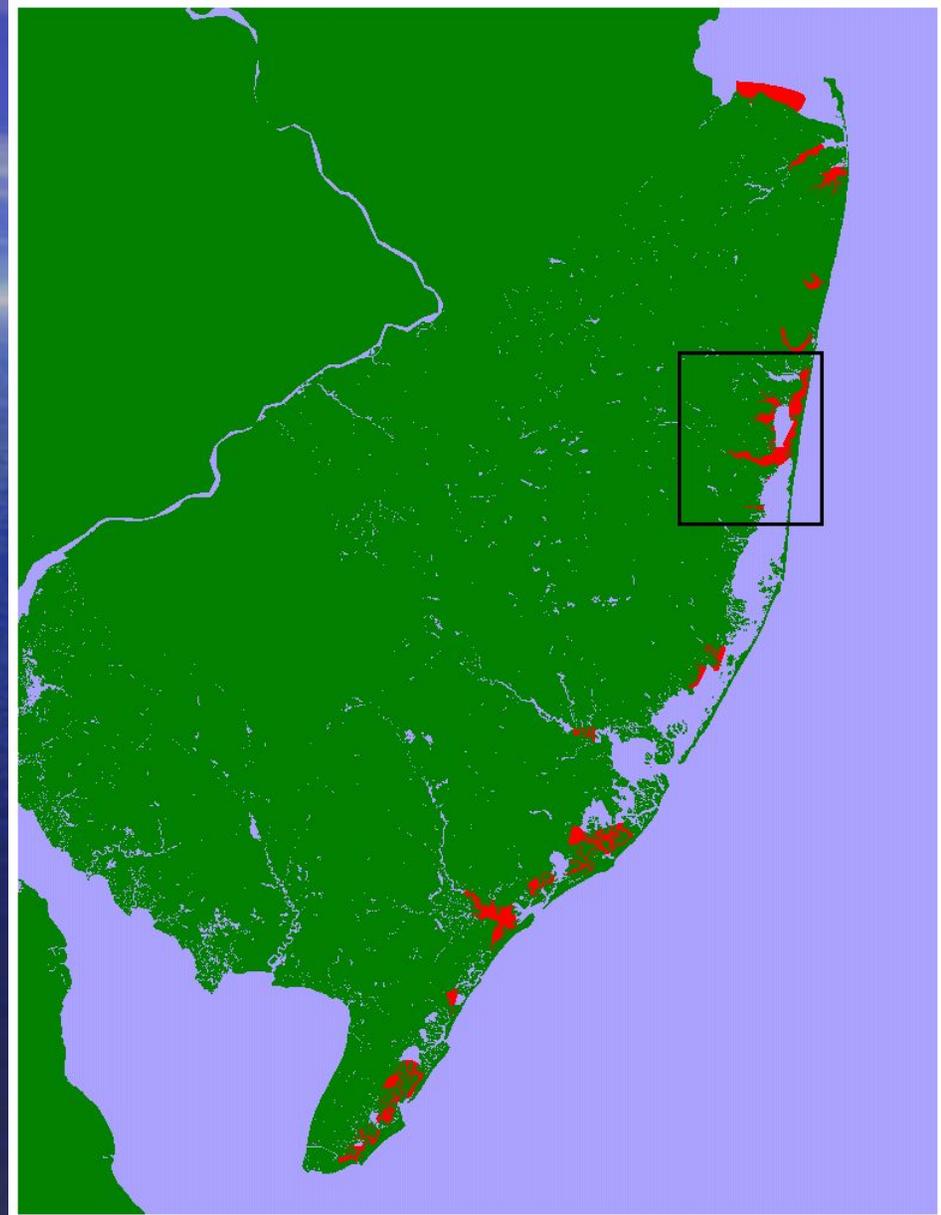
As a result of this work,
349 acres of shellfish
waters became
harvestable by
recreational and
commercial baymen in
2004.



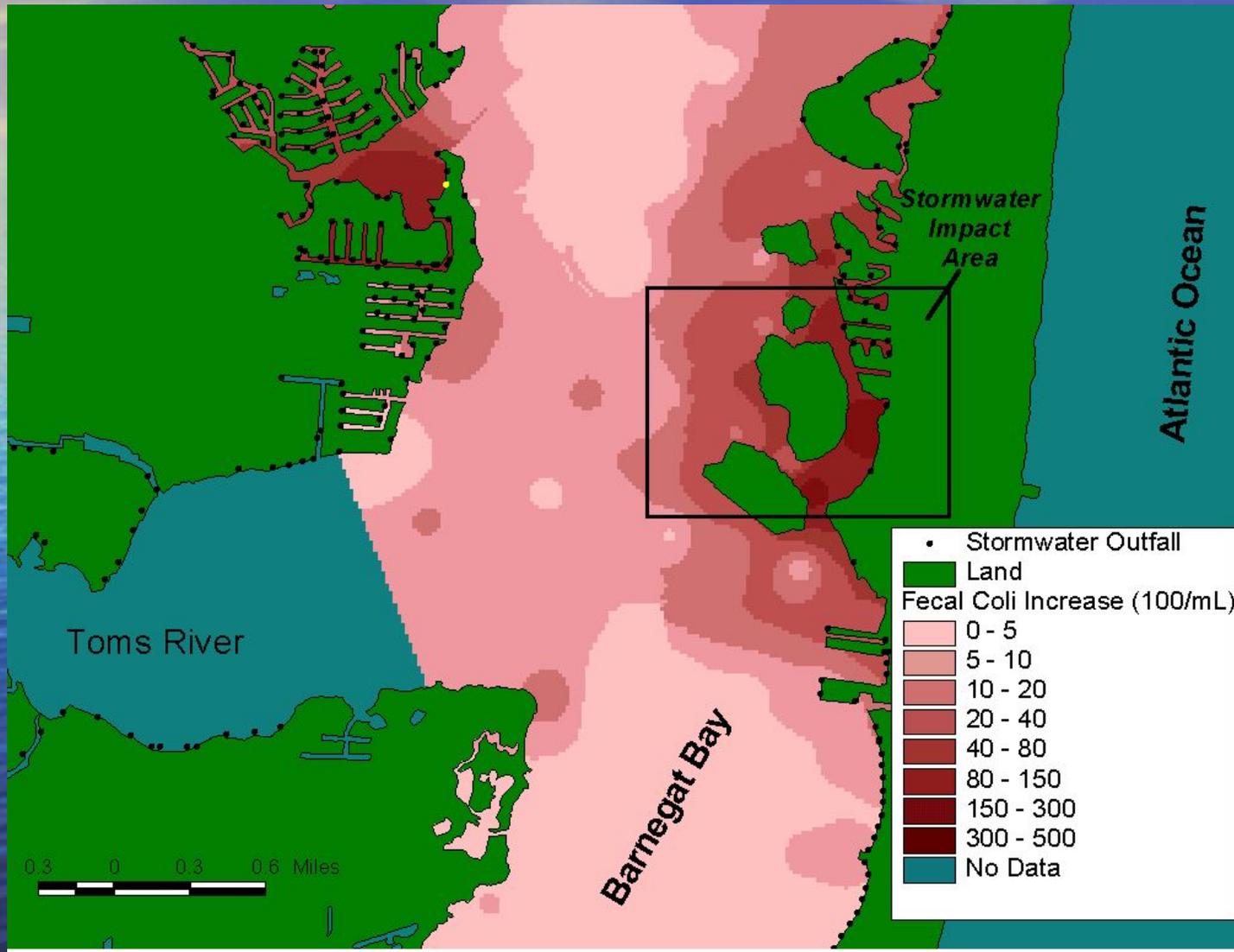
Impairment: Closed Shellfish Waters & Bathing Beach Impacts

Areas shaded red - coastal
water quality degraded
following storm events.

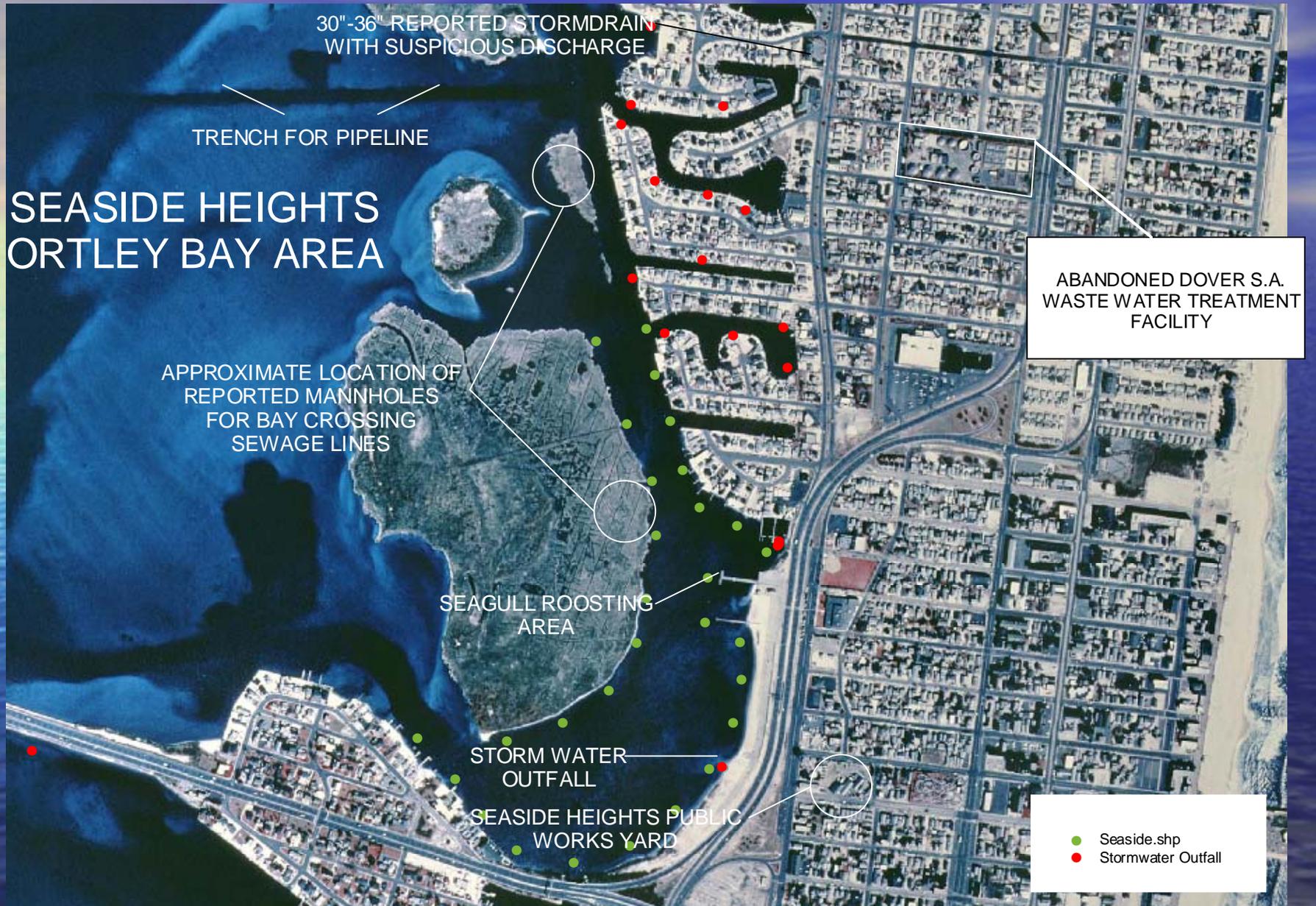
Evaluation based on
10 years of data from routine
monitoring (National
Shellfish Sanitation
Program).



Evaluation of Existing Data 10 Years of Fecal Coliform Data



Shoreline Survey - A Critical Step in Source Tracking



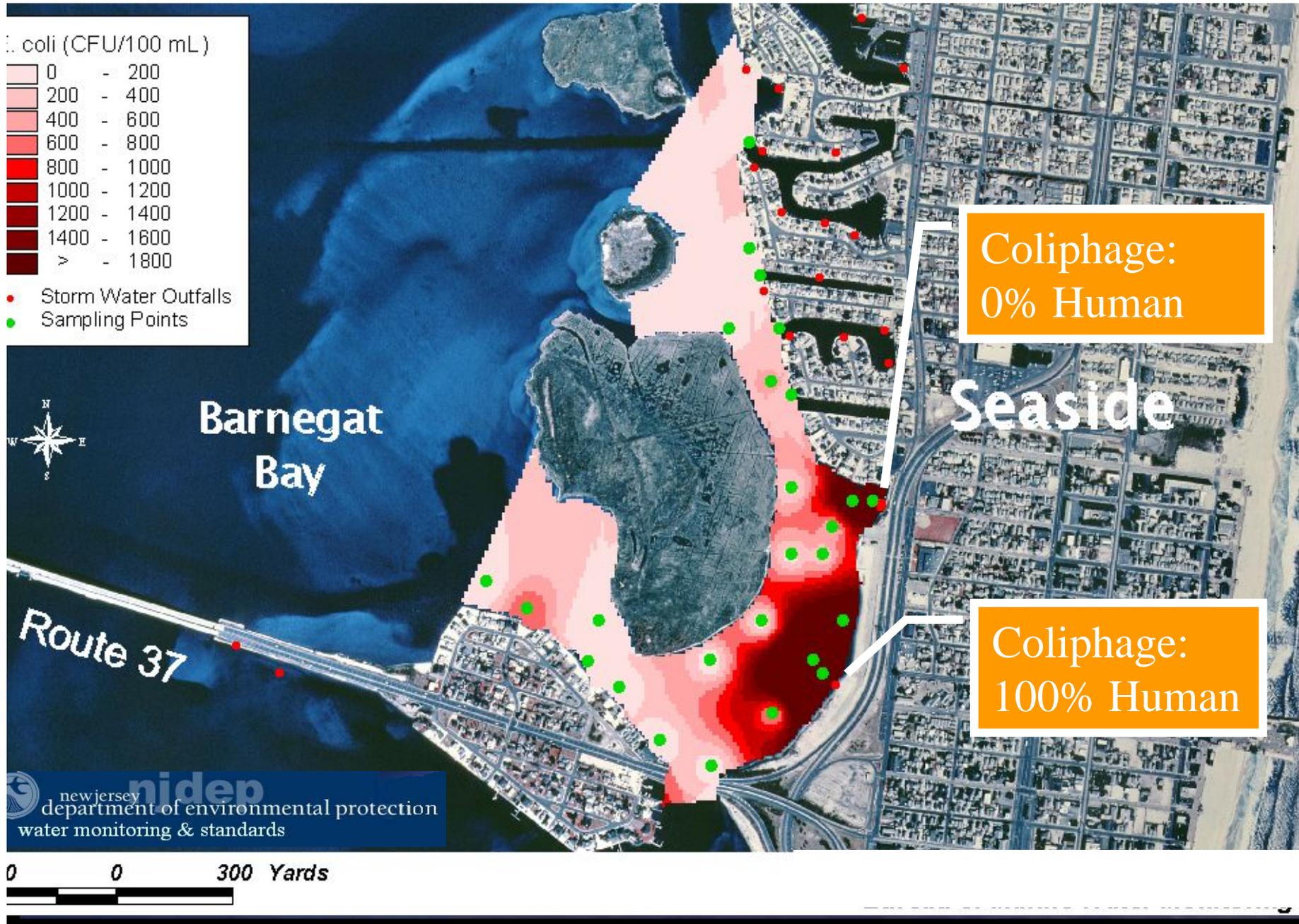
Intensive Storm Event Monitoring

Prior to Rainfall



Seaside Storm Water Project

1 Hour After Storm Event Began

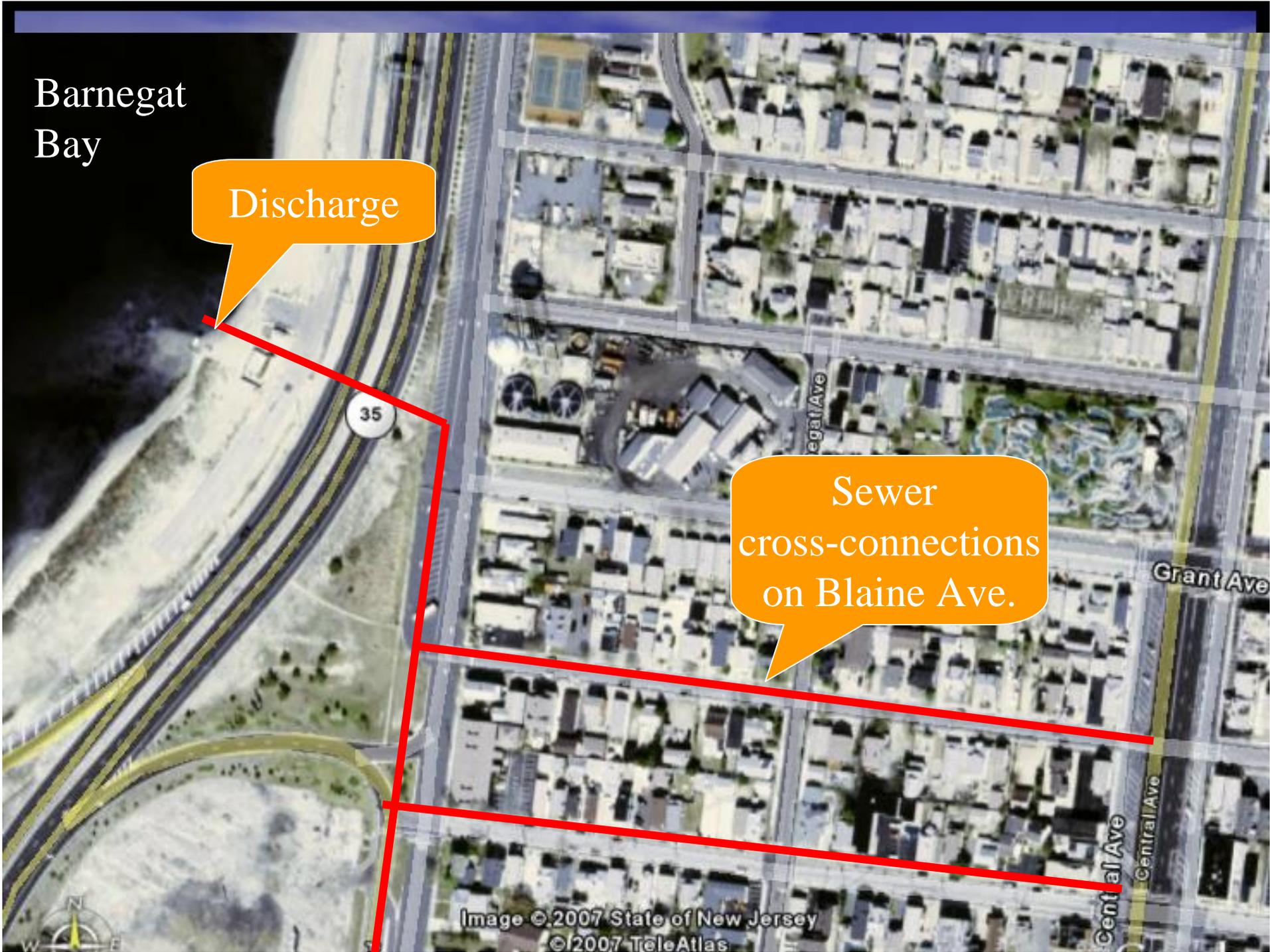


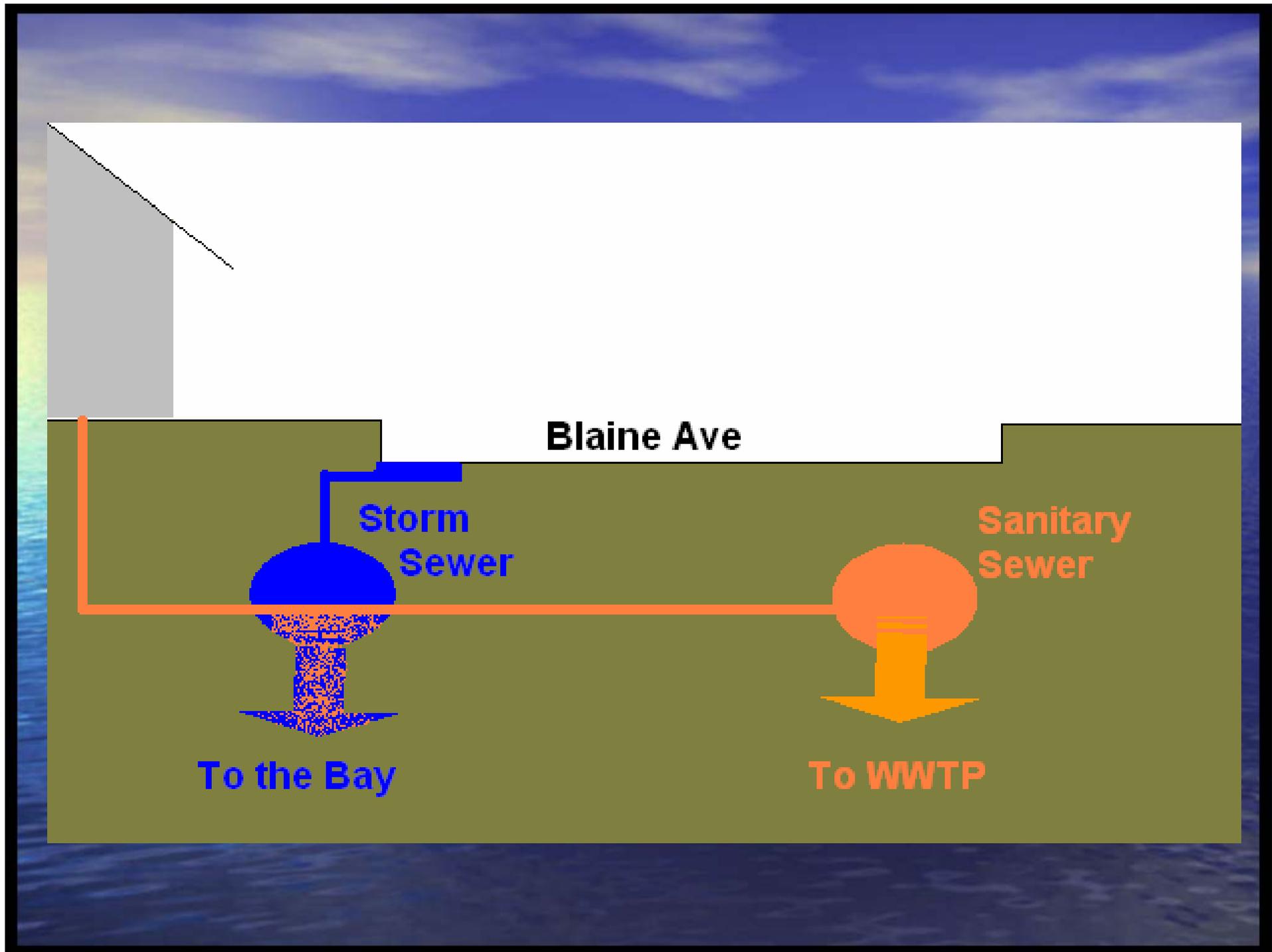


Barnegat Bay

Discharge

Sewer cross-connections on Blaine Ave.



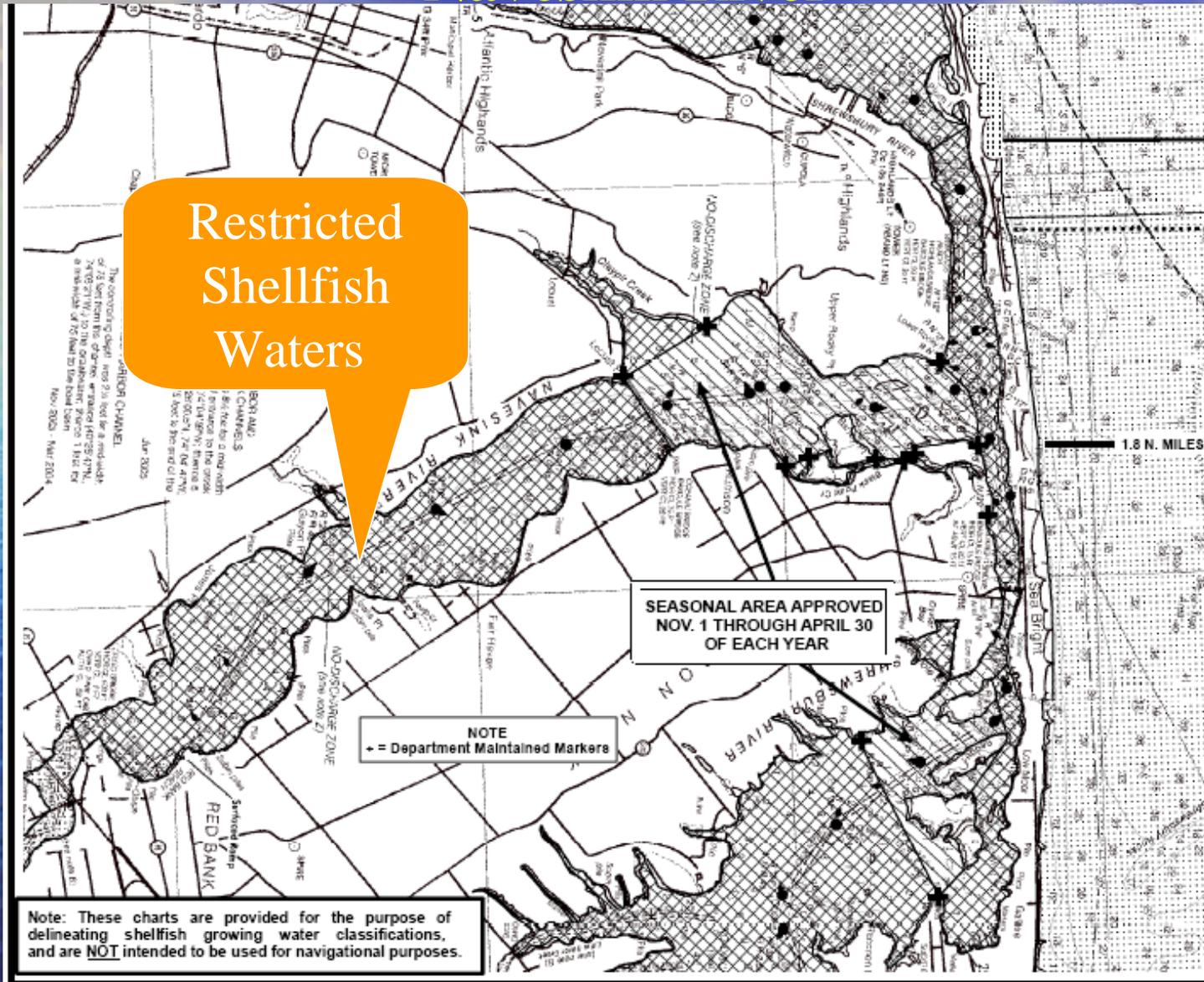




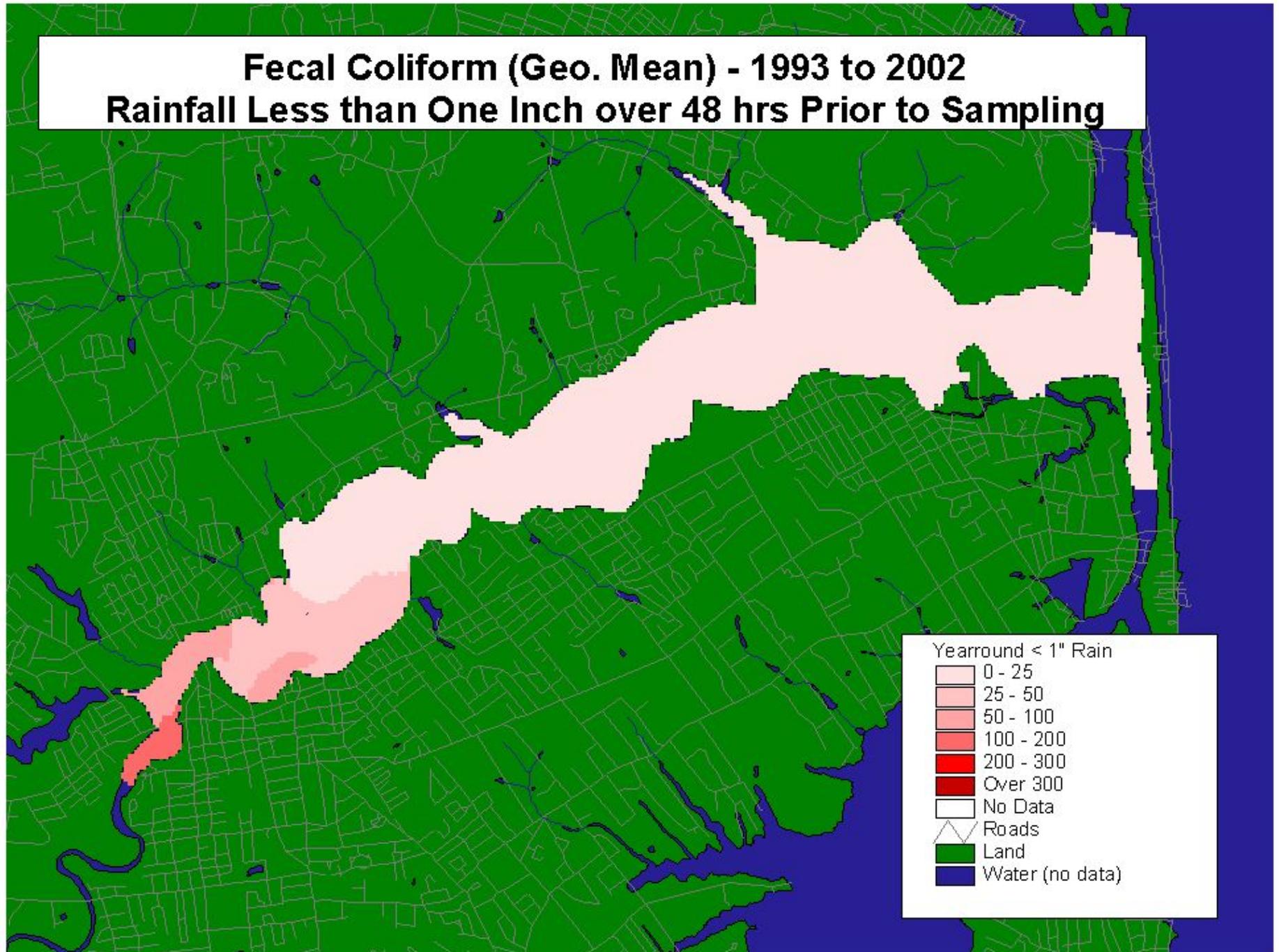
Upper Navesink River

Impairment: Closure of Shellfish Beds

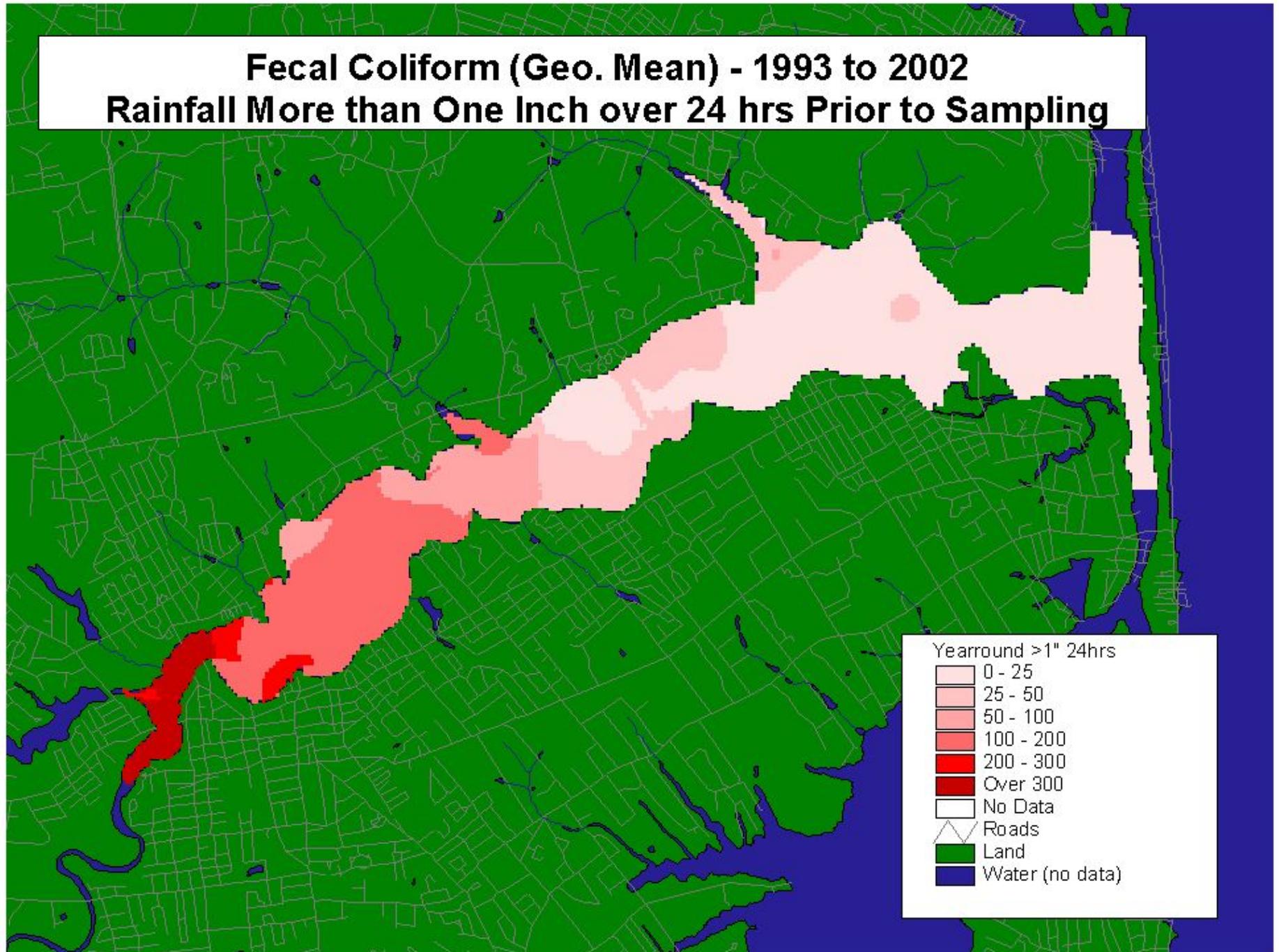
Impairment: Waters Closed to Shellfish Harvest Navesink River



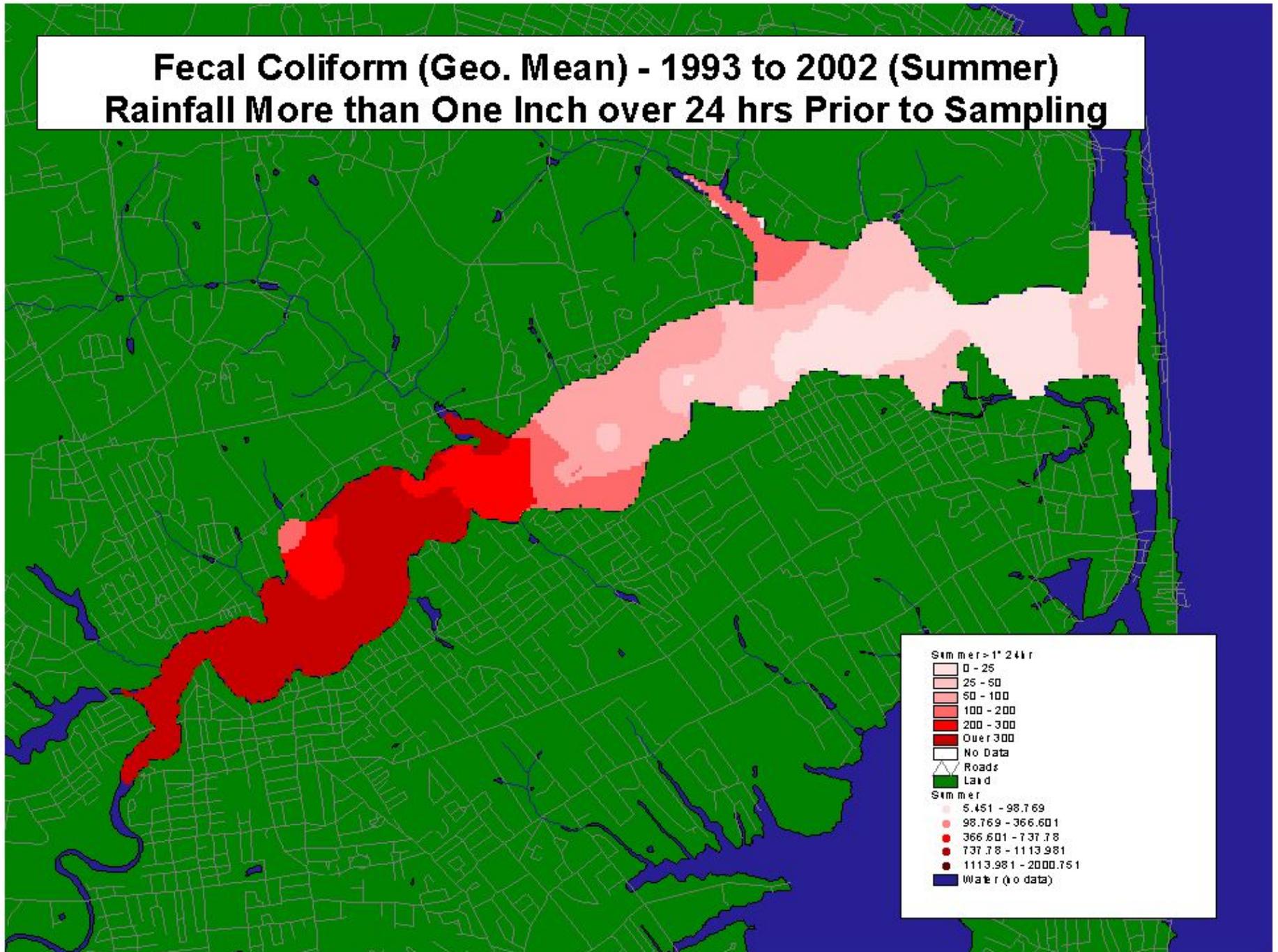
Fecal Coliform (Geo. Mean) - 1993 to 2002
Rainfall Less than One Inch over 48 hrs Prior to Sampling



Fecal Coliform (Geo. Mean) - 1993 to 2002
Rainfall More than One Inch over 24 hrs Prior to Sampling



Fecal Coliform (Geo. Mean) - 1993 to 2002 (Summer) Rainfall More than One Inch over 24 hrs Prior to Sampling

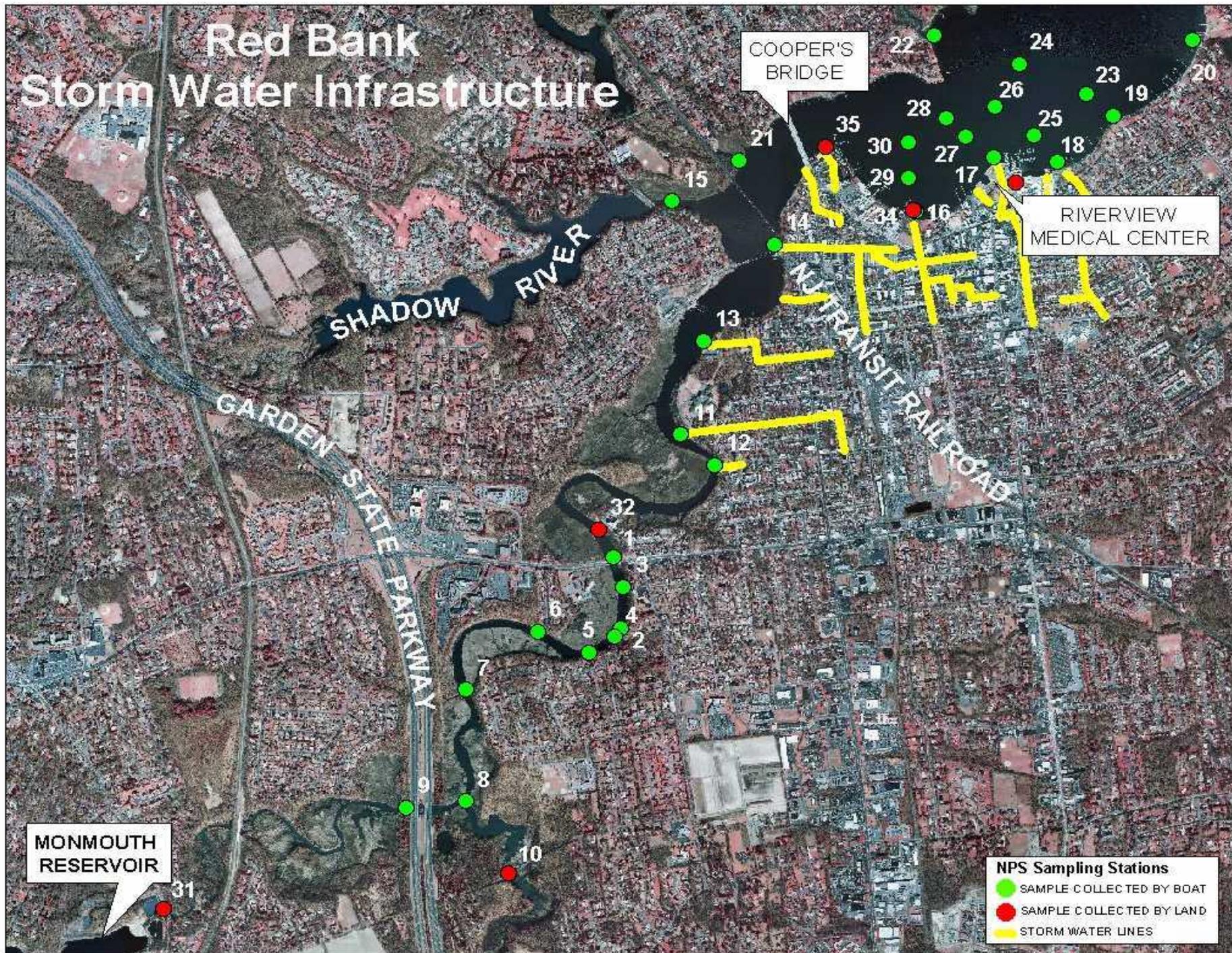


Potential Sources

- Marinas/overboard discharge
- Stormwater discharges
 - Pet waste
 - Sewer cross-connections
- Failing septic systems
- Swimming River Reservoir
- Wildlife and resuspension from marsh areas



Red Bank Storm Water Infrastructure



MONMOUTH RESERVOIR

COOPER'S BRIDGE

RIVERVIEW MEDICAL CENTER

NPS Sampling Stations
● SAMPLE COLLECTED BY BOAT
● SAMPLE COLLECTED BY LAND
— STORM WATER LINES

Fecal Coliform levels at Reservoir Spillway versus downstream portions of Swimming River.

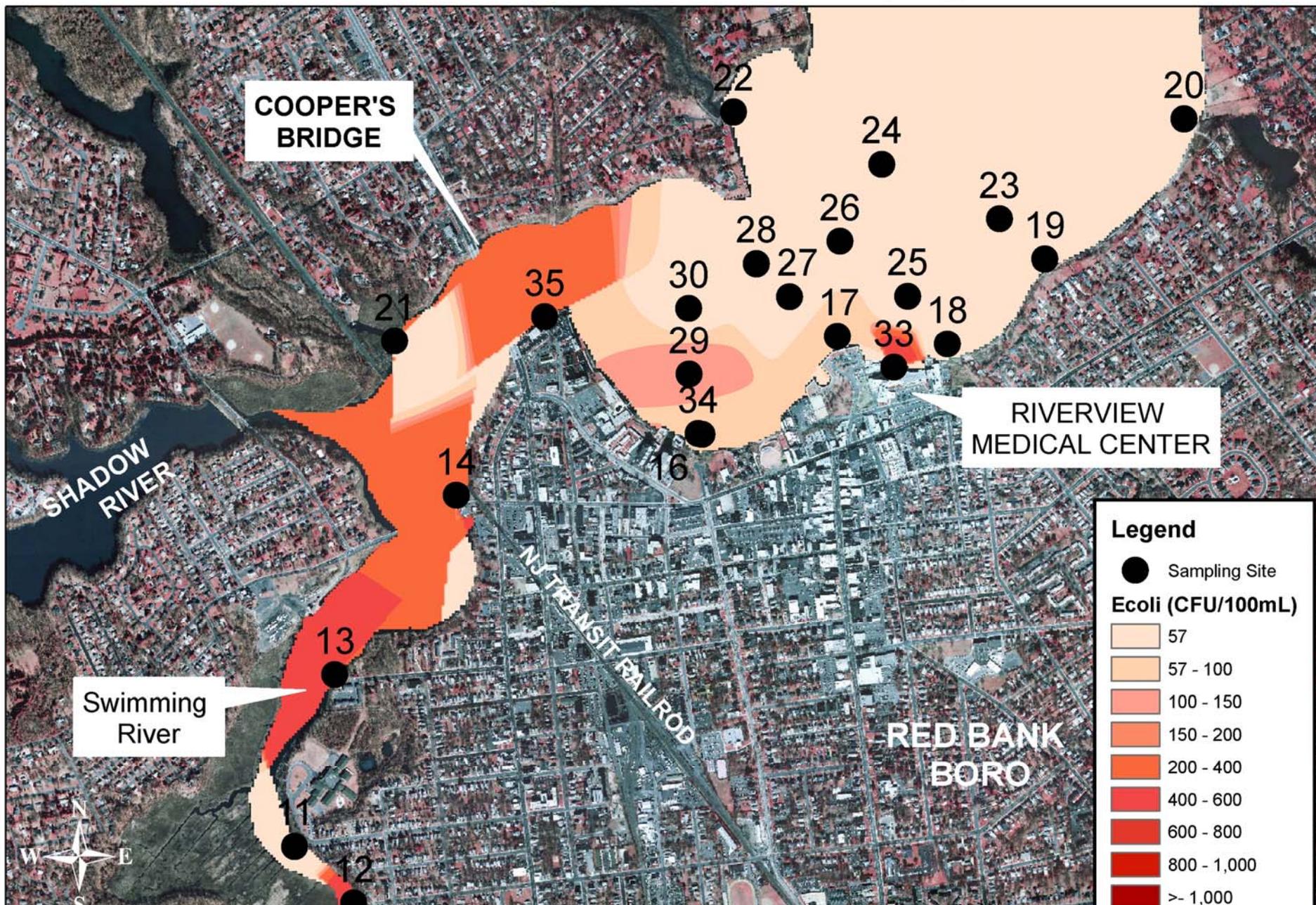
Reservoir discounted as a significant source. Based on routine fecal coliform monitoring by NJDEP/WM&S 1997 – 2000.

Reservoir spillway →



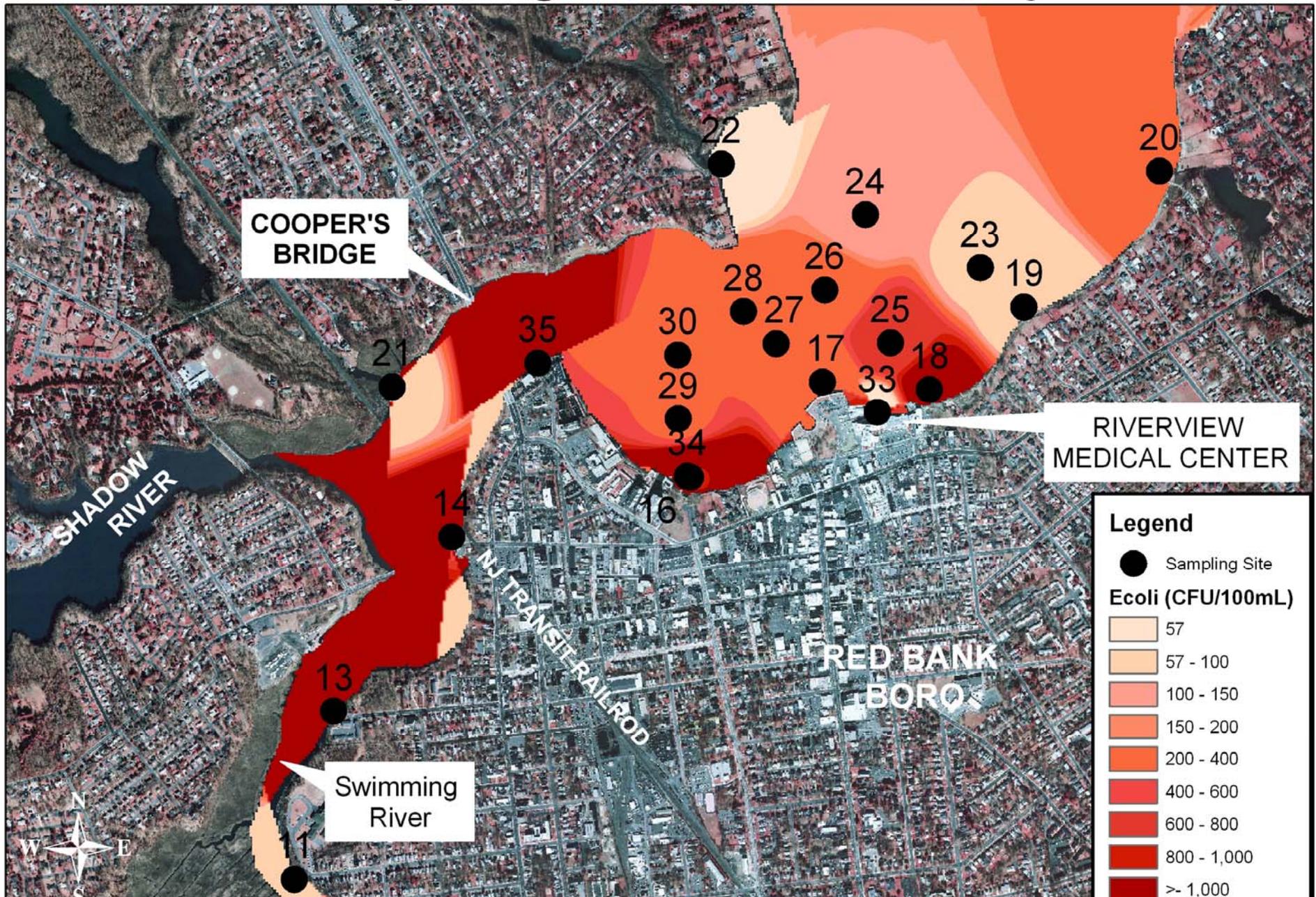
Navesink River NPS Study

Average Ecoli At Initial Sampling



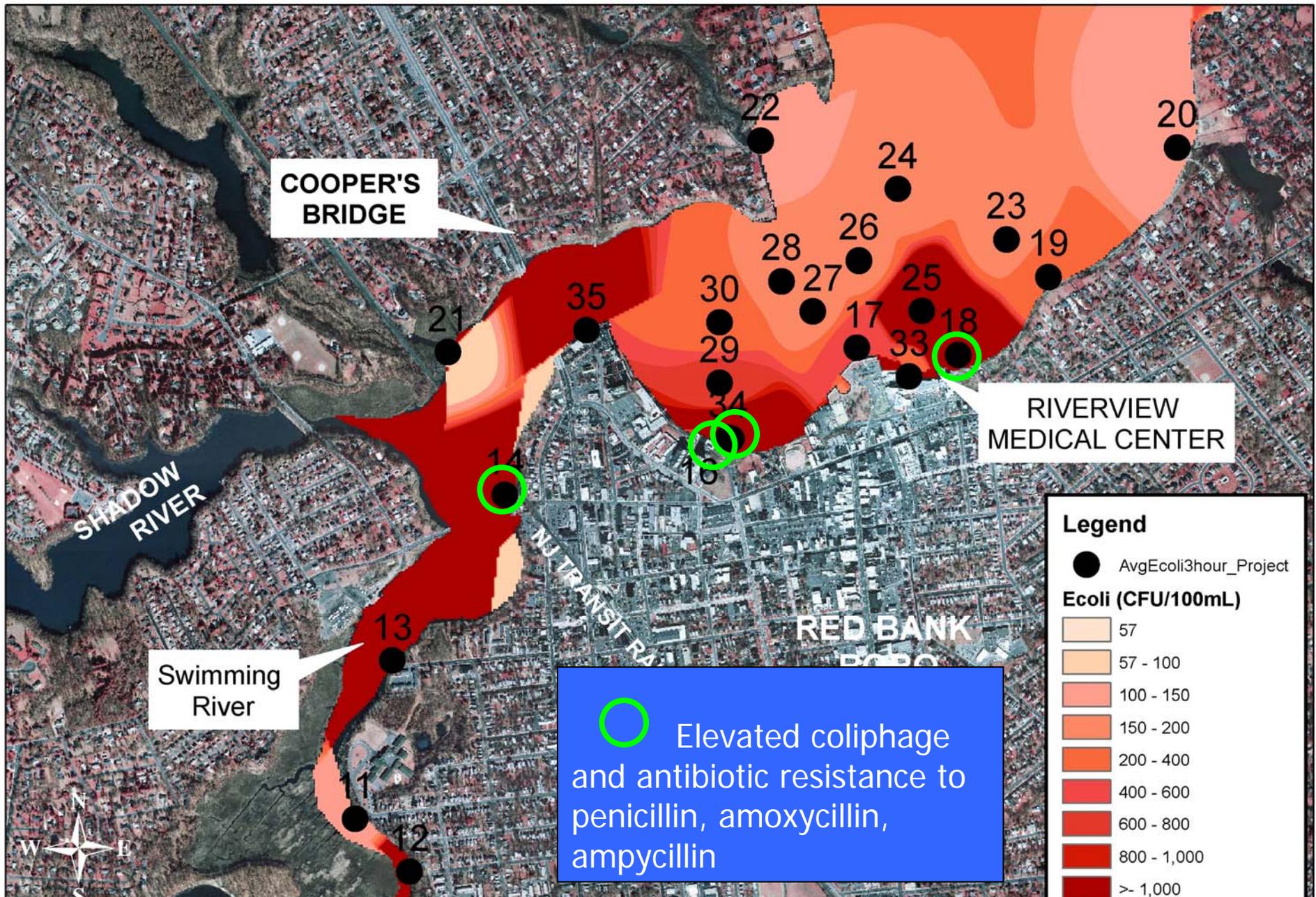
Navesink River NPS Study

Average Ecoli @ 1 Hour After Storm Event Began



Navesink River NPS Study

Average Ecoli @ 3 Hours After Storm Event Began

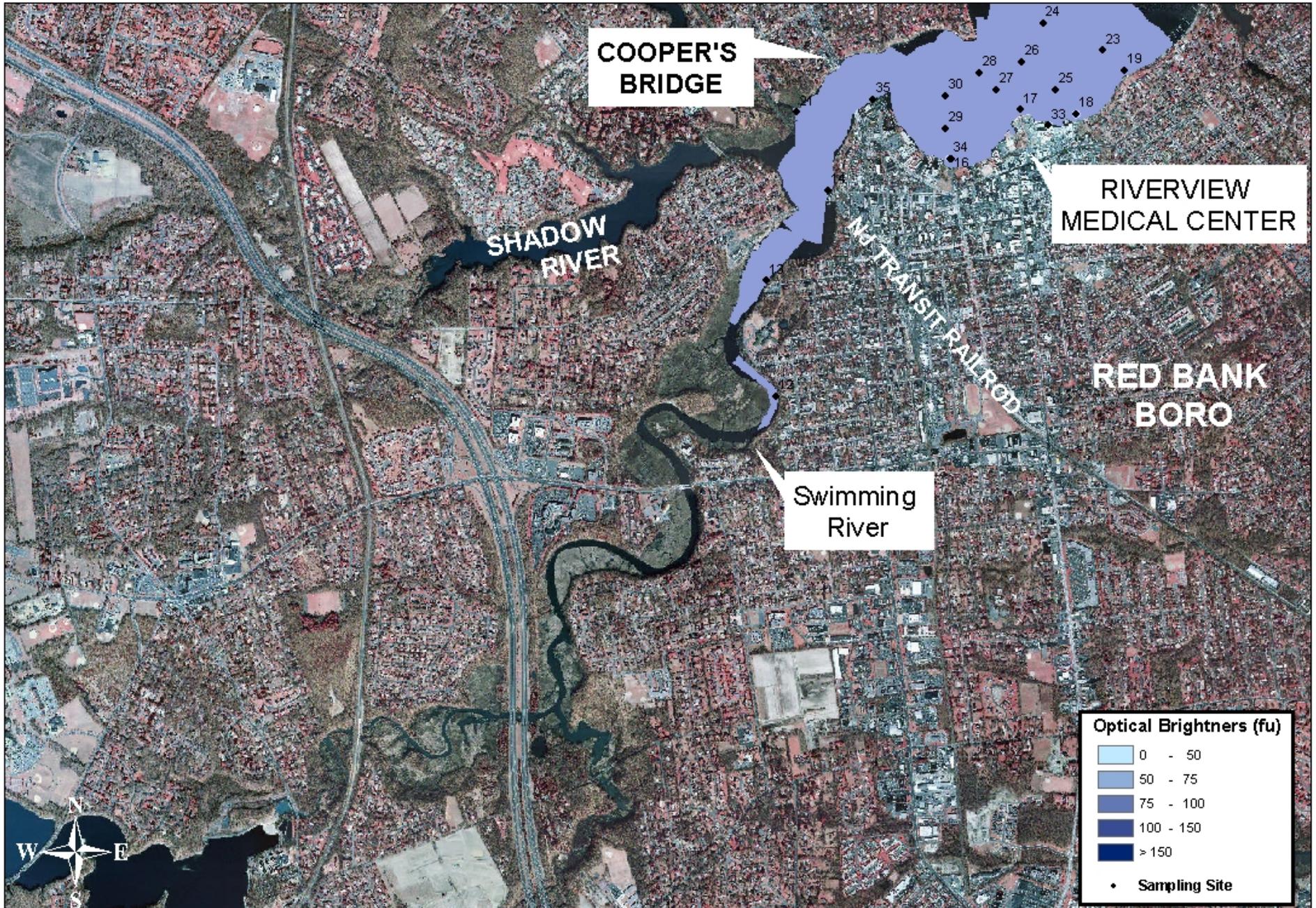


Optical Brighteners

- Fluorescent Whitening Agents (FWAs) are compounds that can be measured and studied as an indicator of human sources of pollution
- Laundry detergents contain FWAs and are discharged in substantial quantities with household wastewater
- Fluorometric Detection – Turner Fluorometer

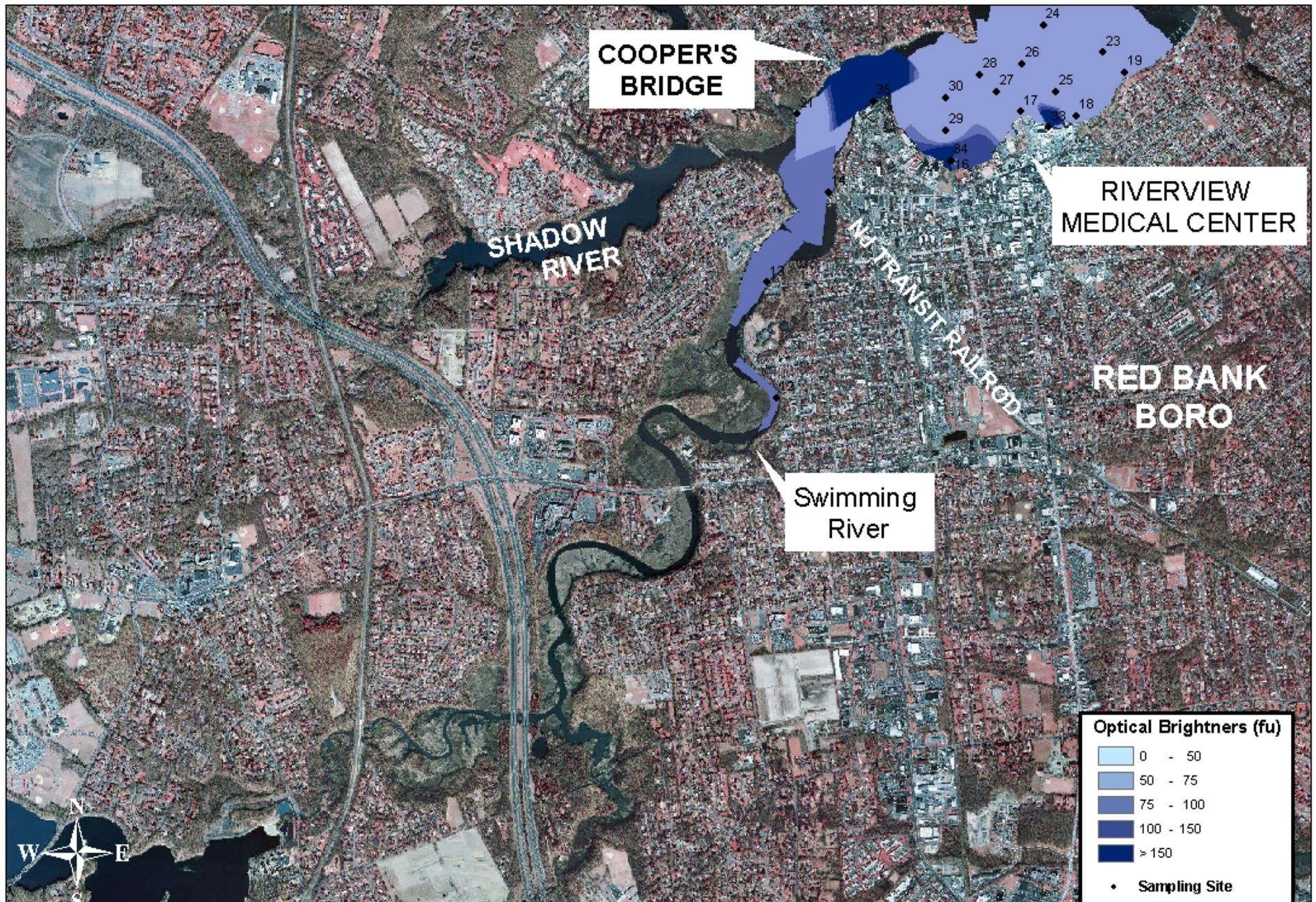
Navesink River NPS Study

Optical Brightners Average Value (Background)



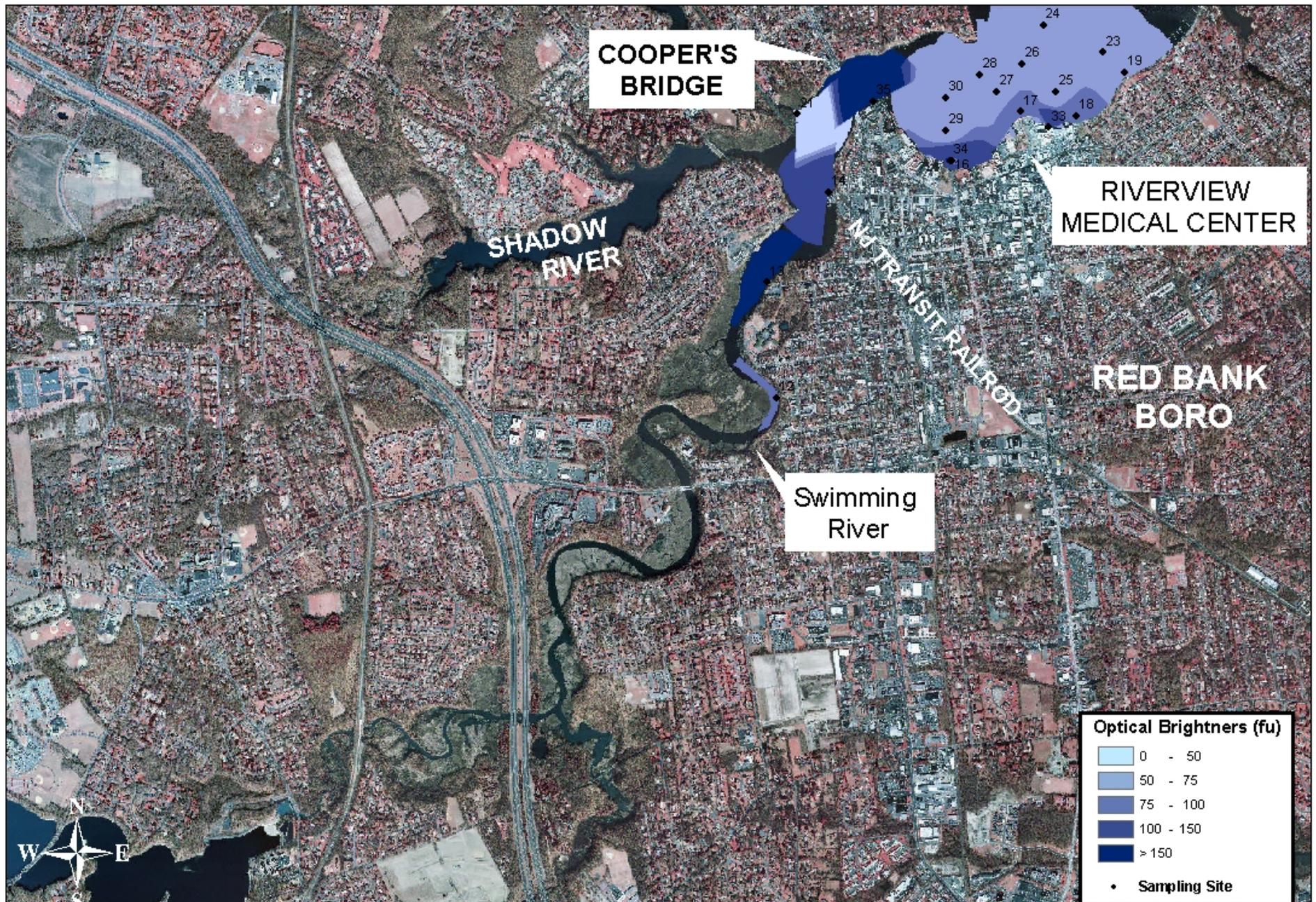
Navesink River NPS Study

Optical Brightners Average Value (1 Hour)



Navesink River NPS Study

Optical Brightners Average Value (3 Hours)



Of the Potential Sources...

- ~~Marinas/overboard discharge~~
- Stormwater discharges
 - ~~Pet waste~~
 - Sewer cross-connections – most probable source
- Failing septic systems – possible minor source
- ~~Swimming River Reservoir~~
- ~~Wildlife and resuspension from marsh areas~~



Summary

- Significant bacterial contamination loading from several Red Bank area sites
- Preliminary results for MST indicators suggest human source at several locations in the Red Bank area
- Relative contribution of bacterial loading to the Navesink River from area west of GSP is low
- Final report in April 2007

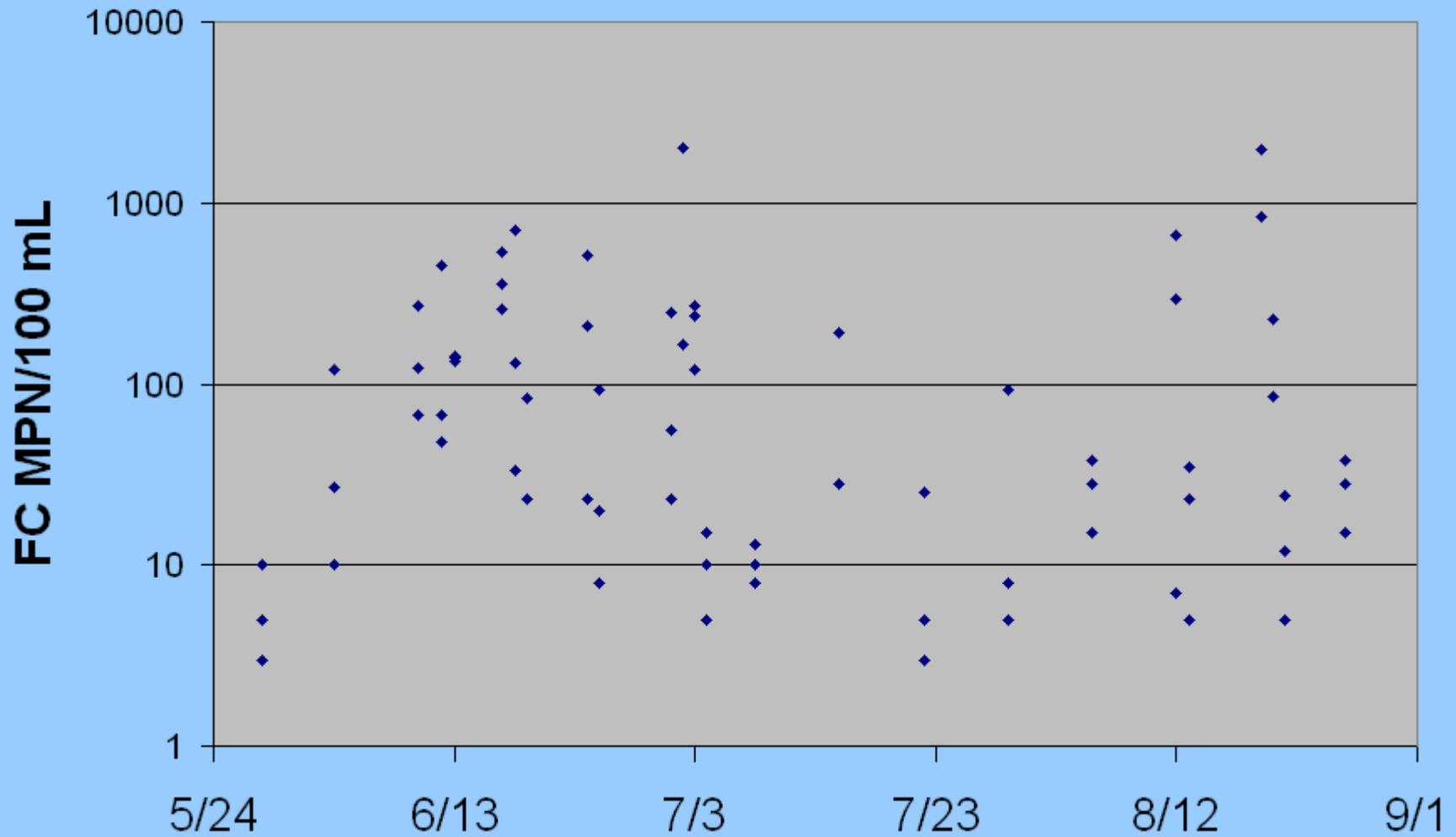


Parvin Lake Investigation

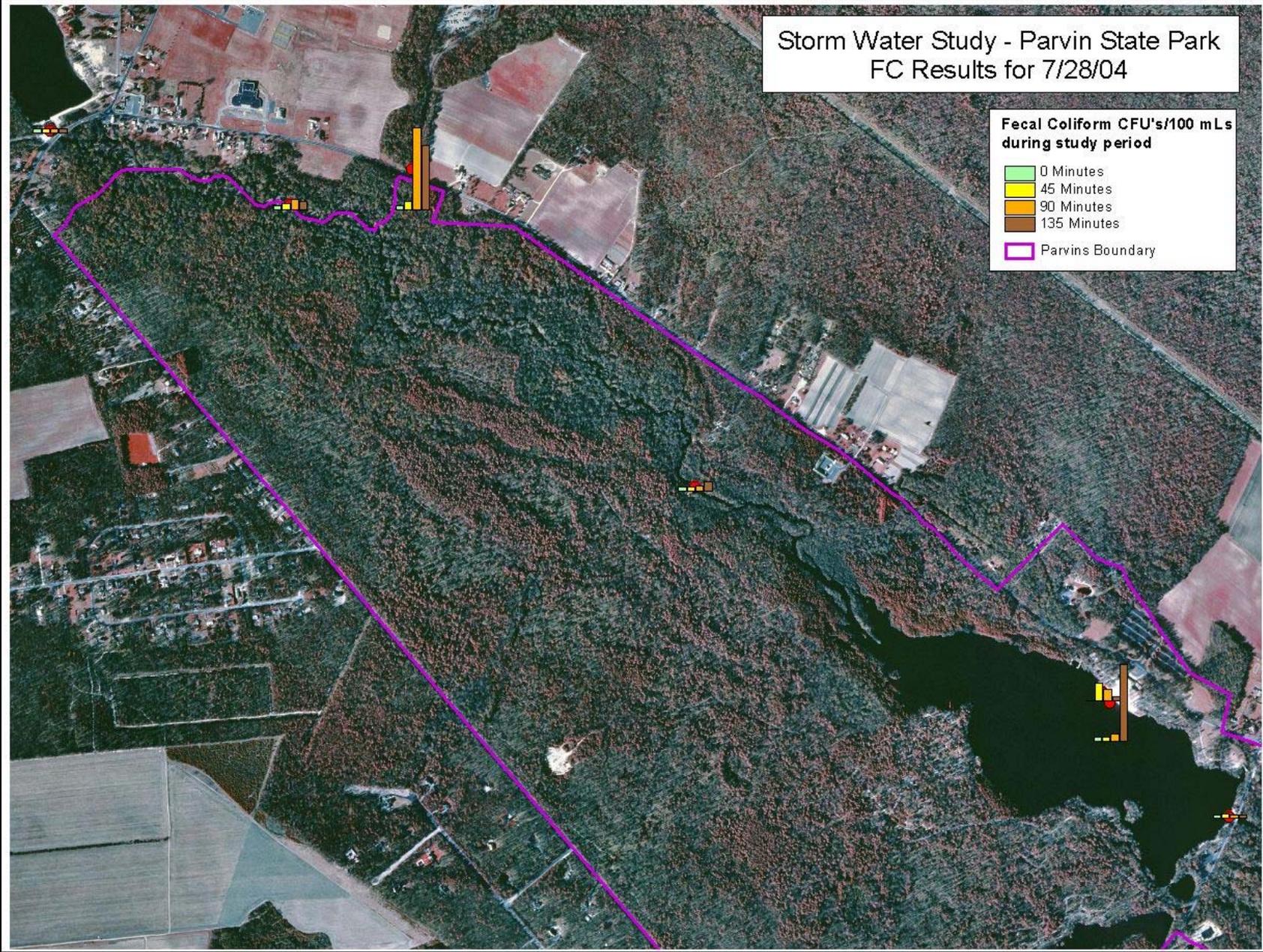
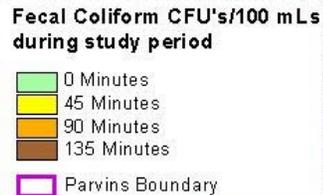
Impairment: Bathing Beach Closures

Parvin State Park - High levels after rain

Parvin Lake - 2002



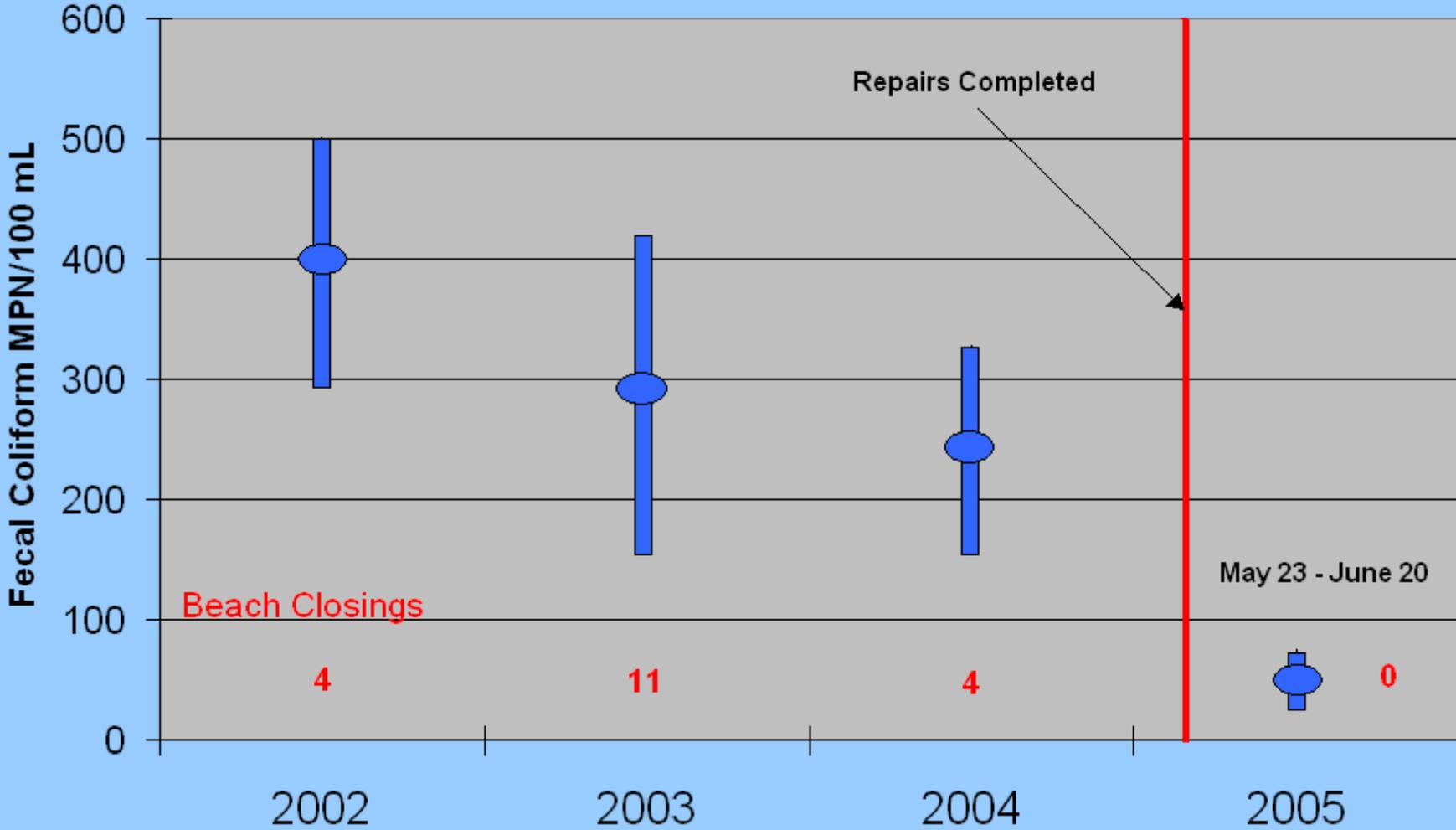
Storm Water Study - Parvin State Park FC Results for 7/28/04



Parvin State Park - NPS Study



Parvin Lake



“Junction” Box

Forced Sanitary Sewer Line

Bath House



© 2007 Sanborn
© 2007 Navteq
© 2007 TeleAtlas

Image © 2007 State of New Jersey

Google

Pointer 39°30'39.98" N 75°08'01.36" W elev 69 ft

Streaming ||||| 100%

Eye alt 720 ft

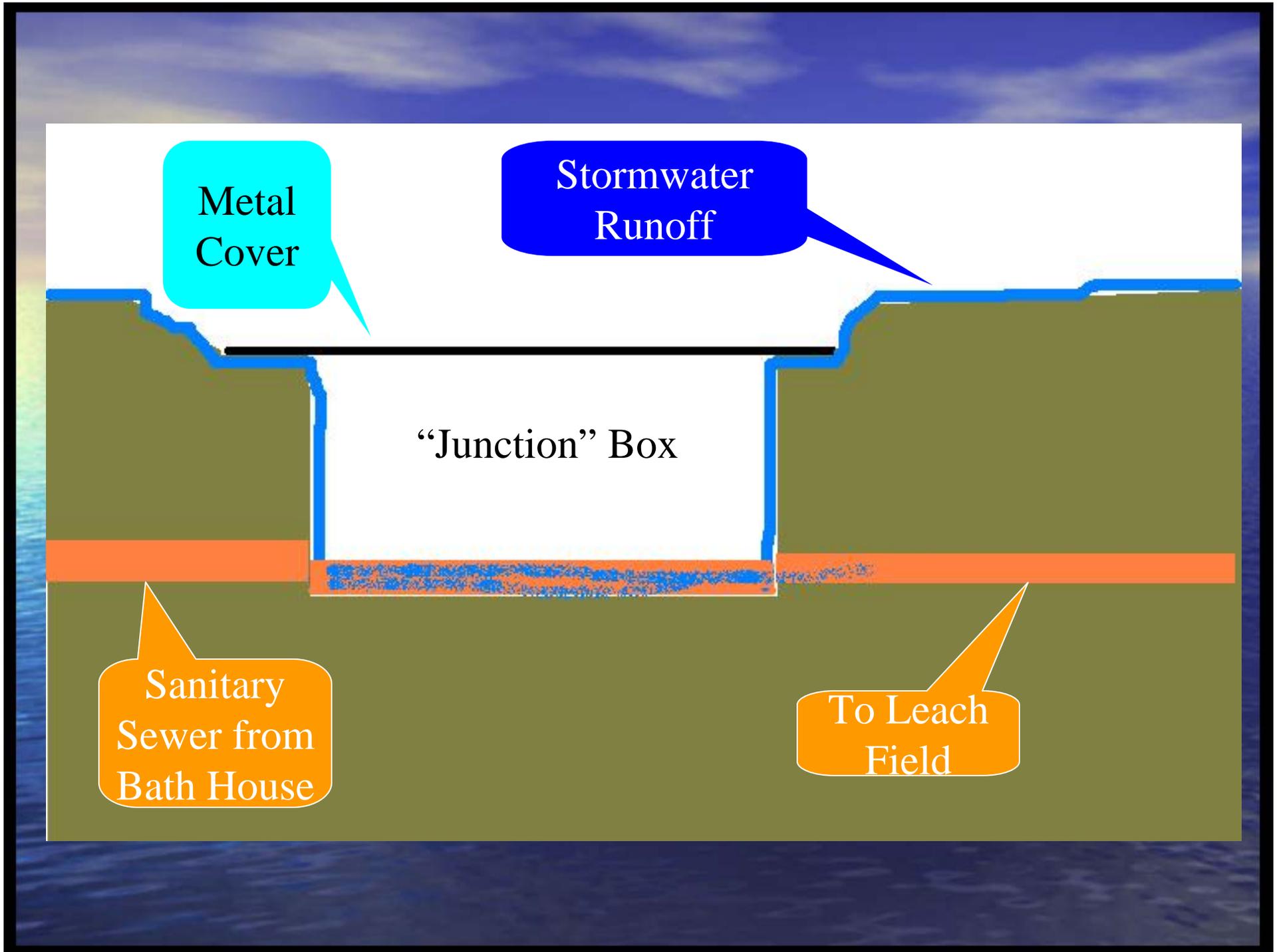
Metal
Cover

Stormwater
Runoff

“Junction” Box

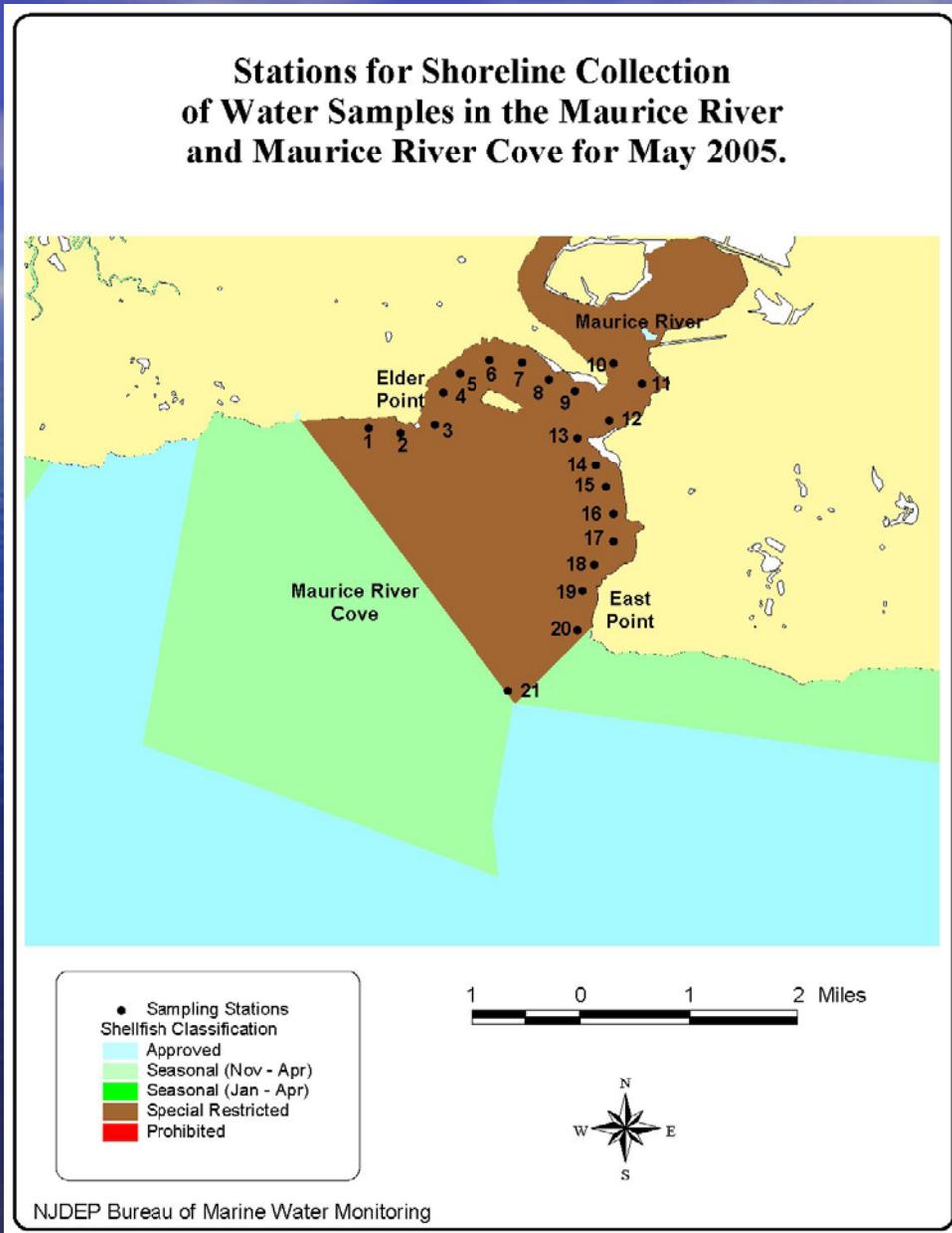
Sanitary
Sewer from
Bath House

To Leach
Field

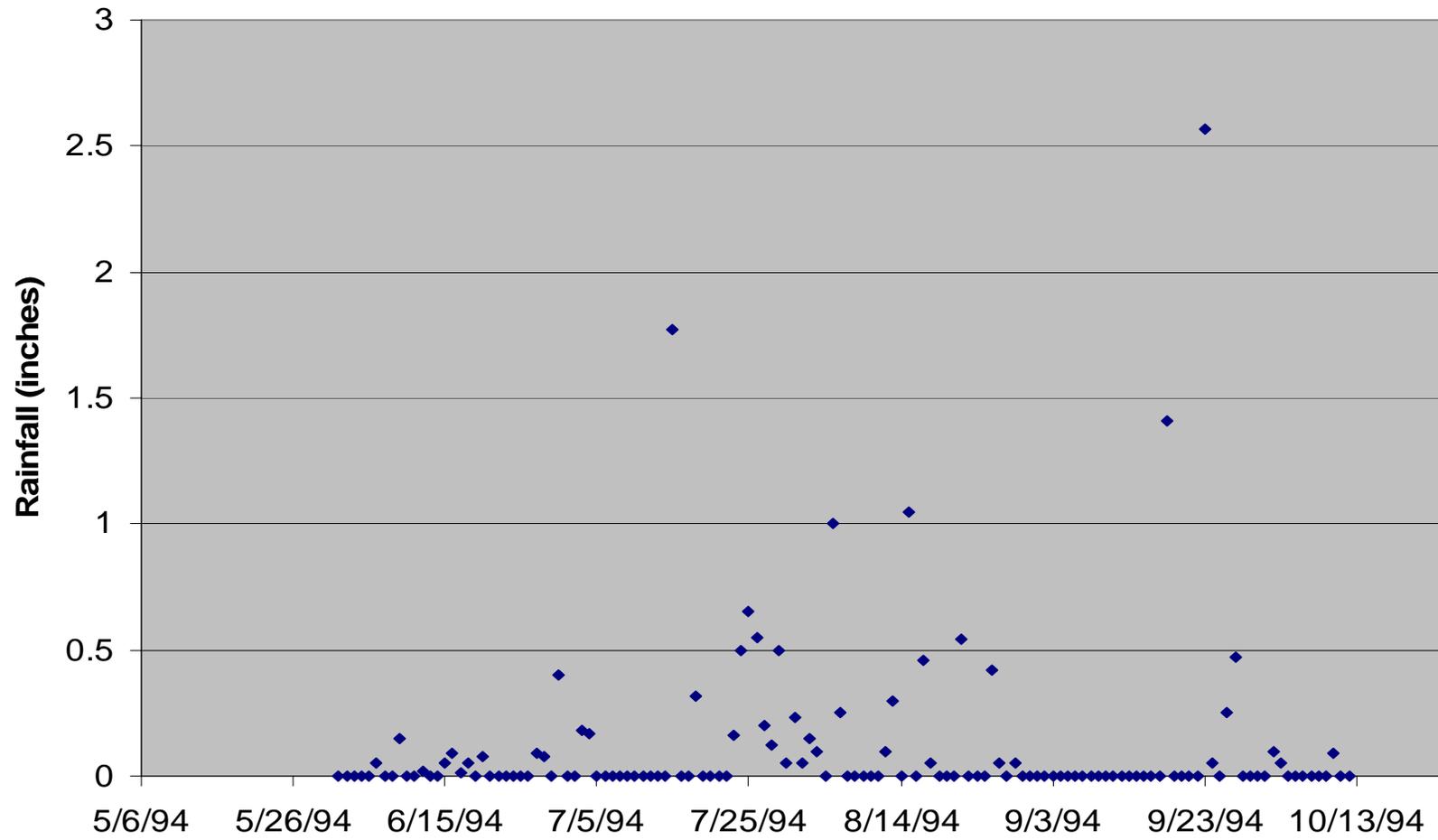


21 Stations for the Collection of Water Samples in the Maurice River and the Maurice River Cove for May 2005.

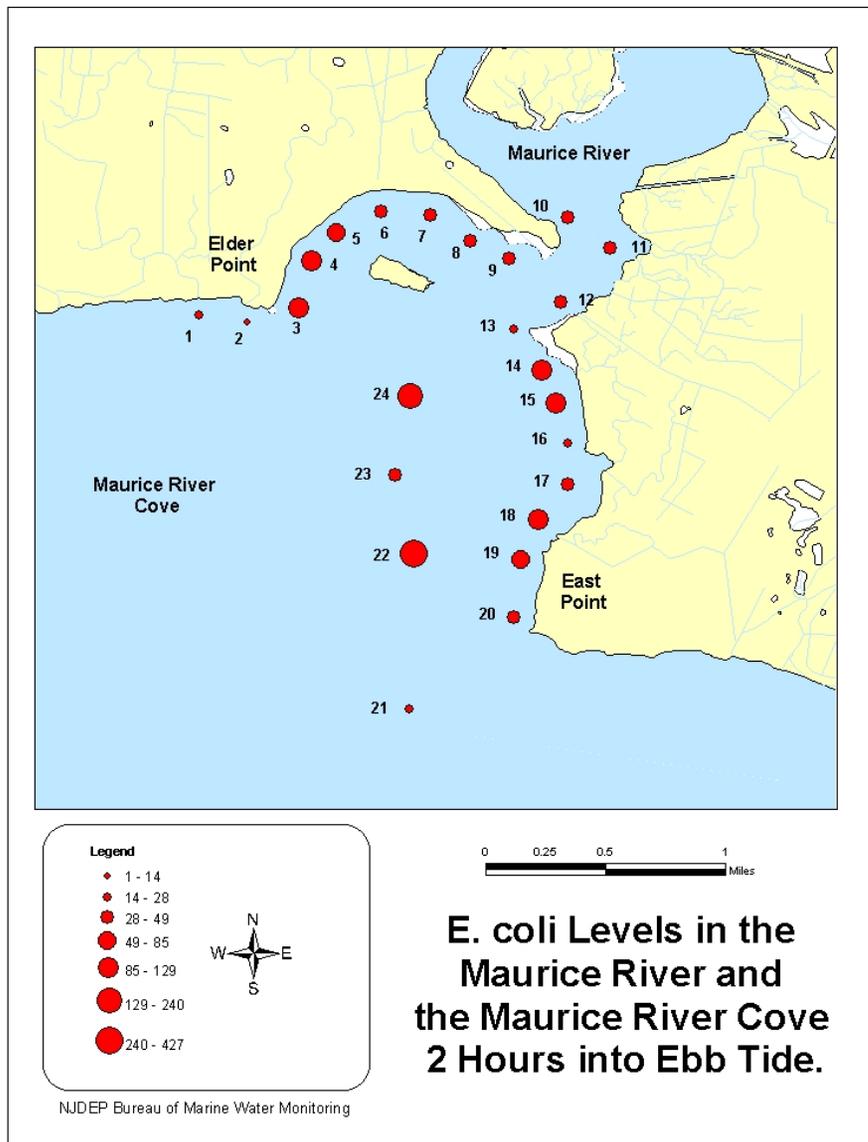
•Water Samples were collected on May 3, May 17, May 18, and May 31, 2005.



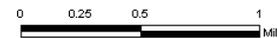
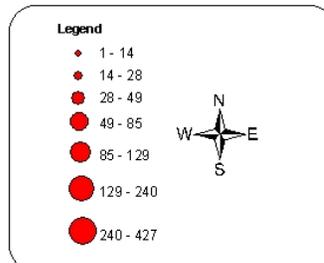
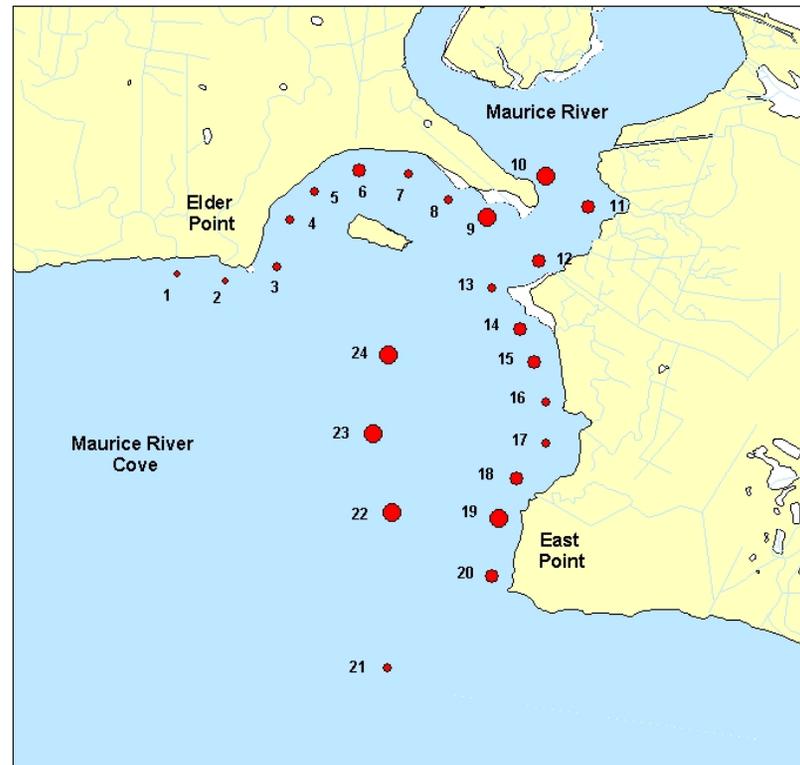
Rainfall Recorded at Belleplain, NJ



E. coli Geometric Mean for the Water Samples Collected in the Maurice River and the Maurice River Cove at these Sampling Stations at 2 Hours into the Ebb Tide on all of the Sampling Dates.

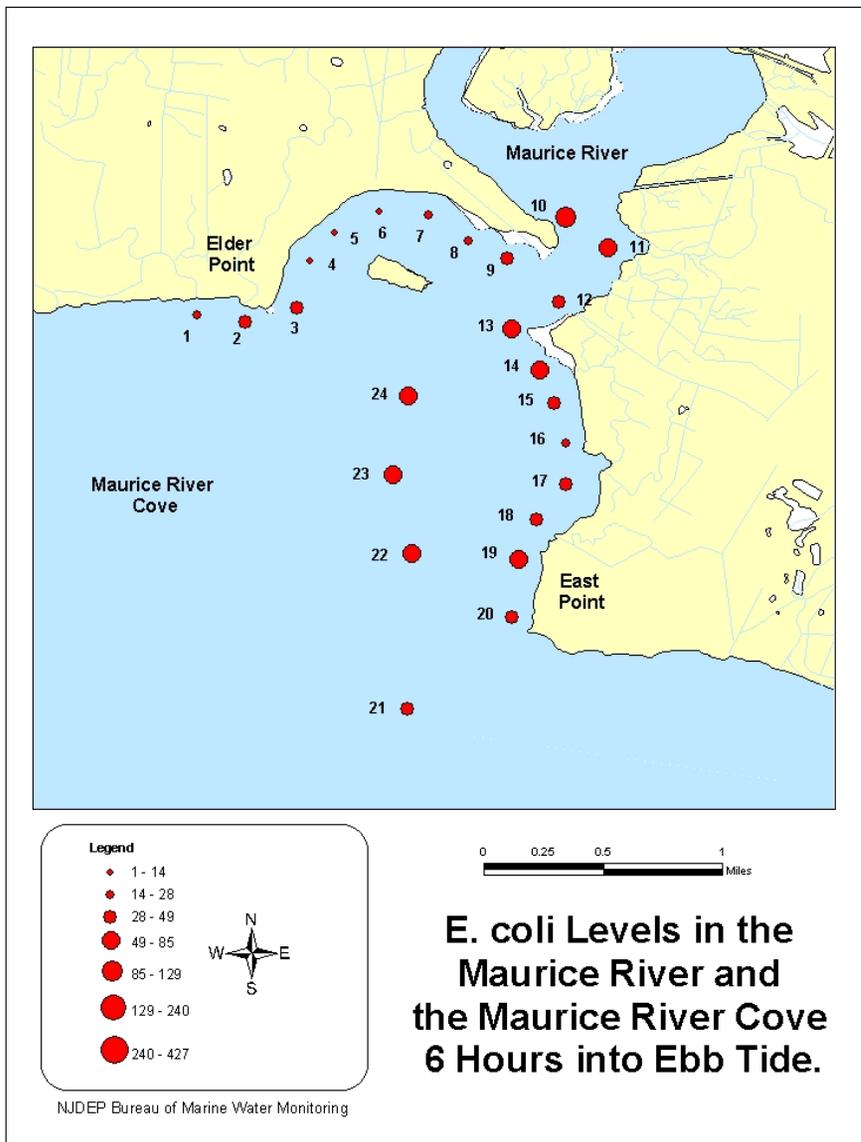


E. coli Geometric Mean for the Water Samples Collected in the Maurice River and the Maurice River Cove at these Sampling Stations at 4 Hours into the Ebb Tide on all of the Sampling Dates.

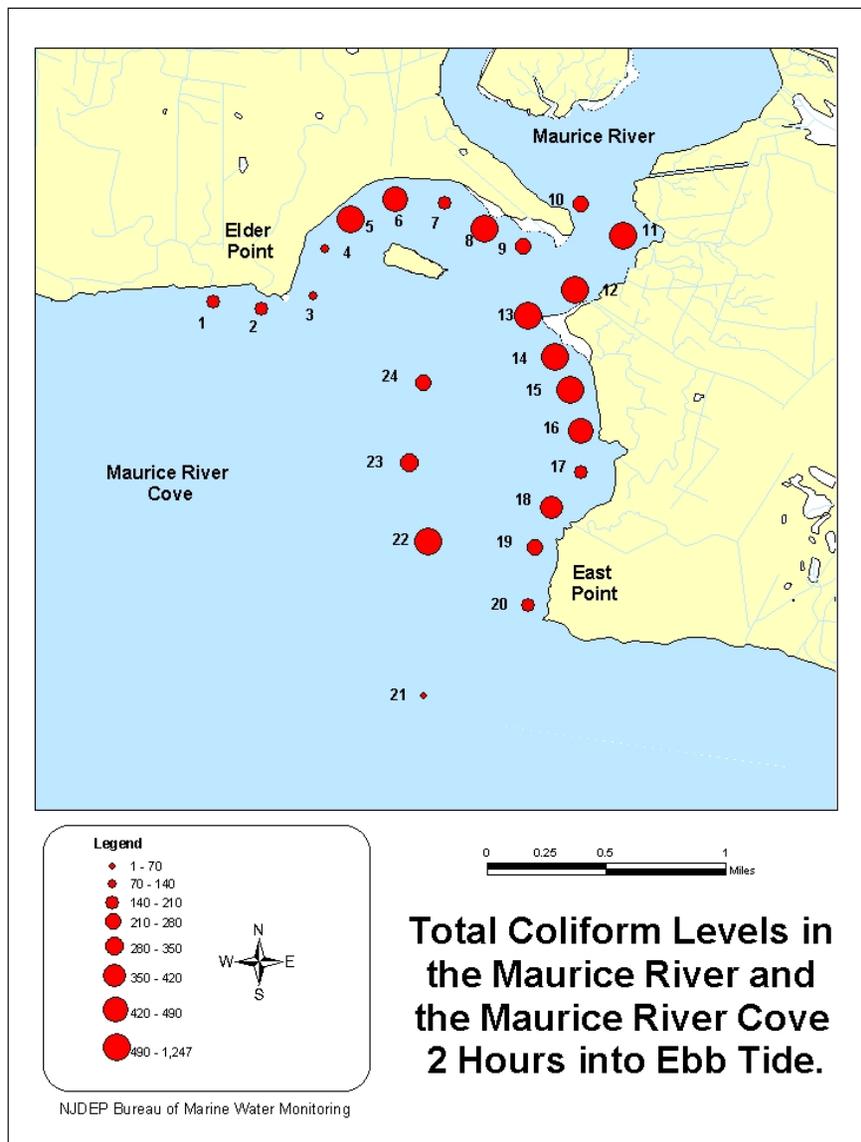


E. coli Levels in the Maurice River and the Maurice River Cove 4 Hours into Ebb Tide.

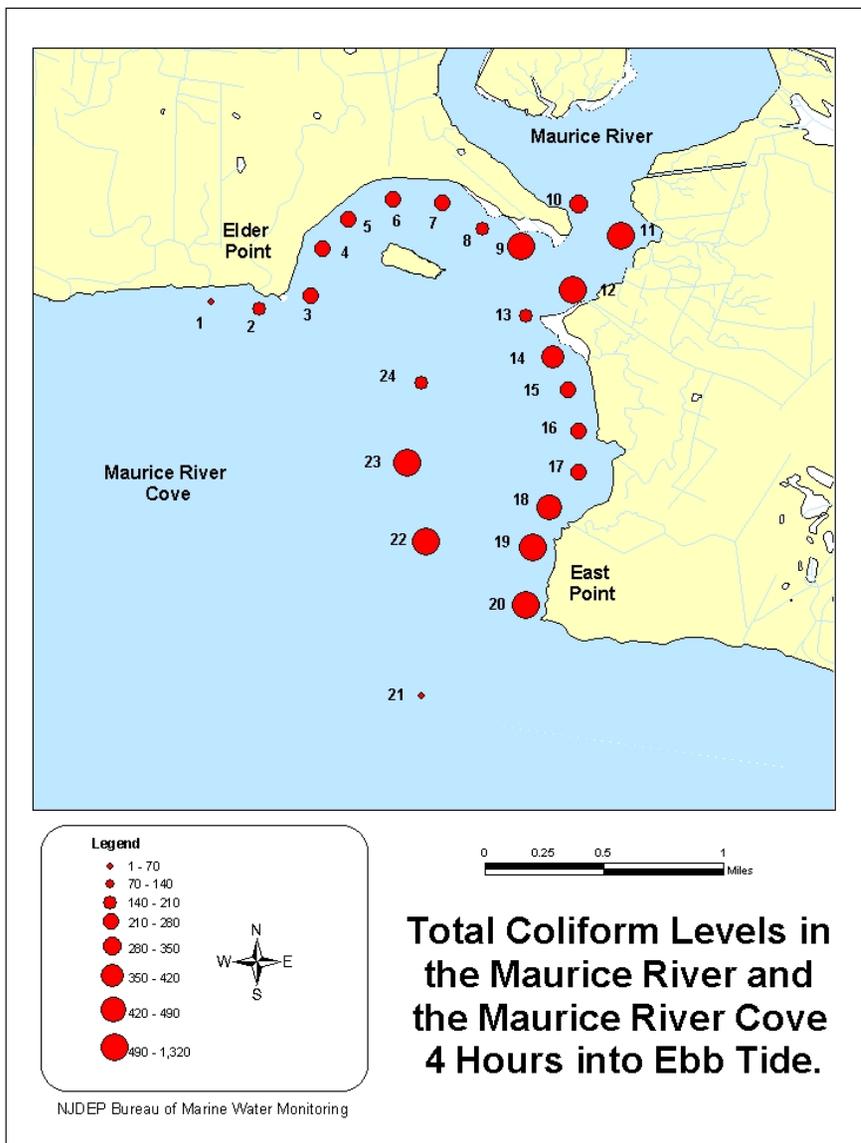
E. coli Geometric Mean for the Water Samples Collected in the Maurice River and the Maurice River Cove at these Sampling Stations at 6 Hours into the Ebb Tide on all of the Sampling Dates.



Total Coliform Geometric Mean for the Water Samples Collected in the Maurice River and the Maurice River Cove at these Sampling Stations at 2 Hours into the Ebb Tide on all of the Sampling Dates.

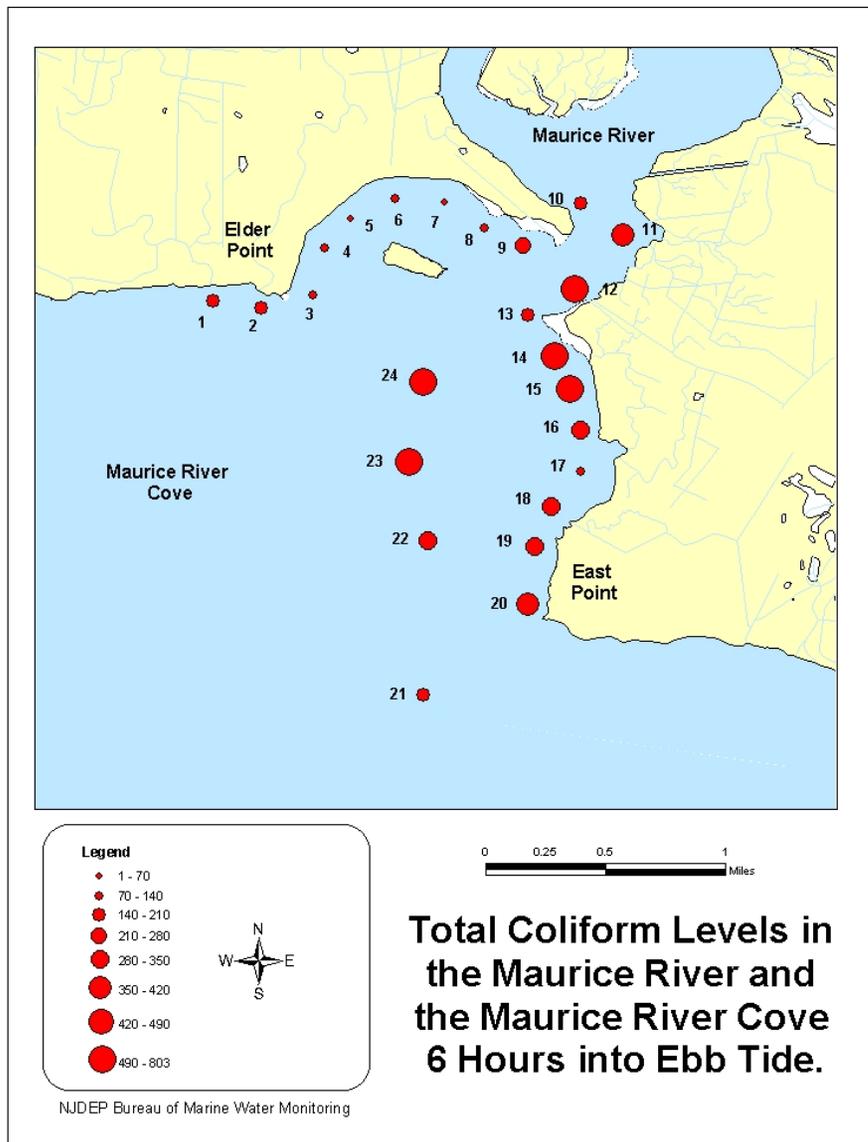


Total Coliform Geometric Mean for the Water Samples Collected in the Maurice River and the Maurice River Cove at these Sampling Stations at 4 Hours into the Ebb Tide on all of the Sampling Dates.



Total Coliform Levels in the Maurice River and the Maurice River Cove 4 Hours into Ebb Tide.

Total Coliform Geometric Mean for the Water Samples Collected in the Maurice River and the Maurice River Cove at these Sampling Stations at 6 Hours into the Ebb Tide on all of the Sampling Dates.



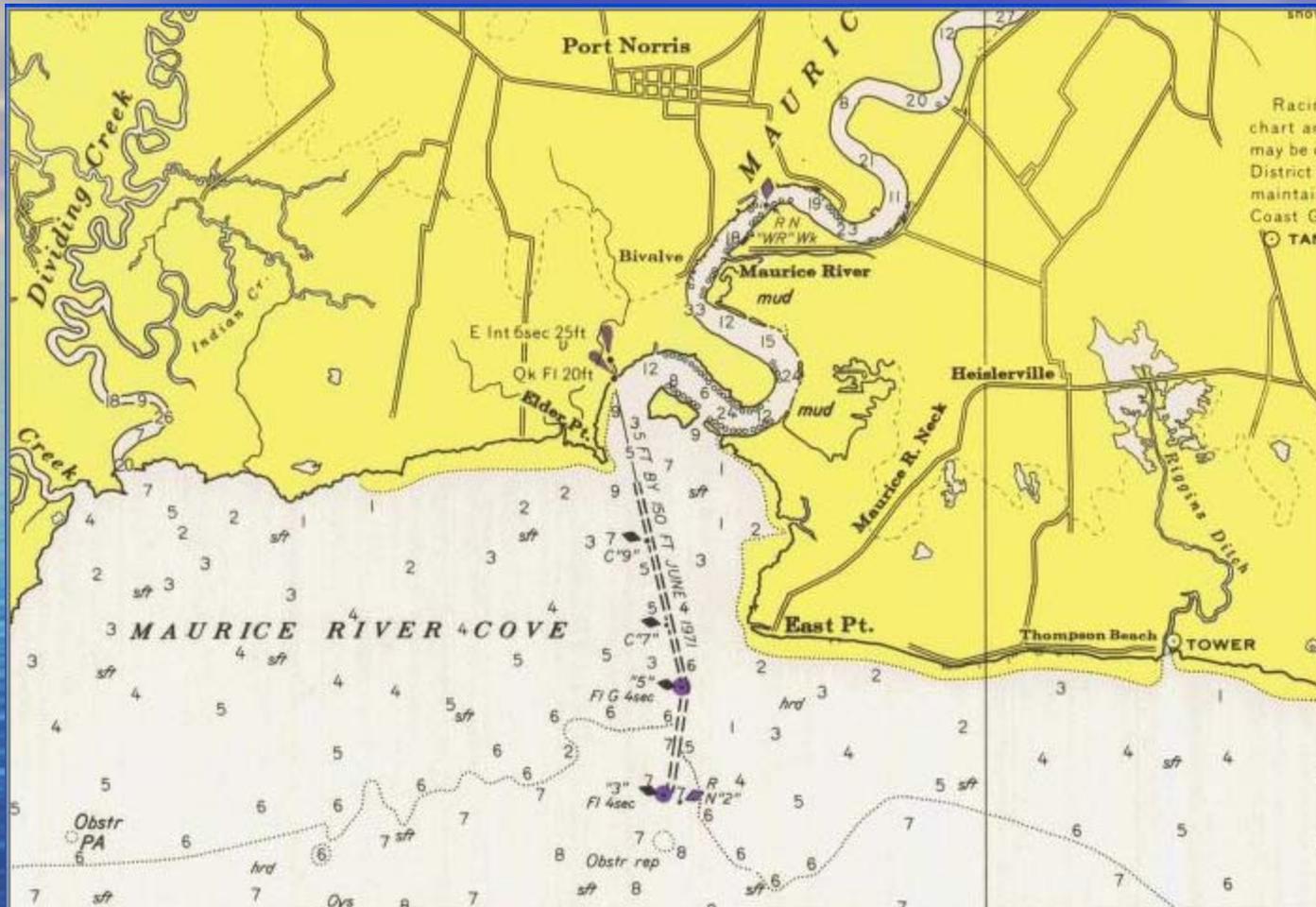


Figure . NOAA Nautical Chart - 1974.

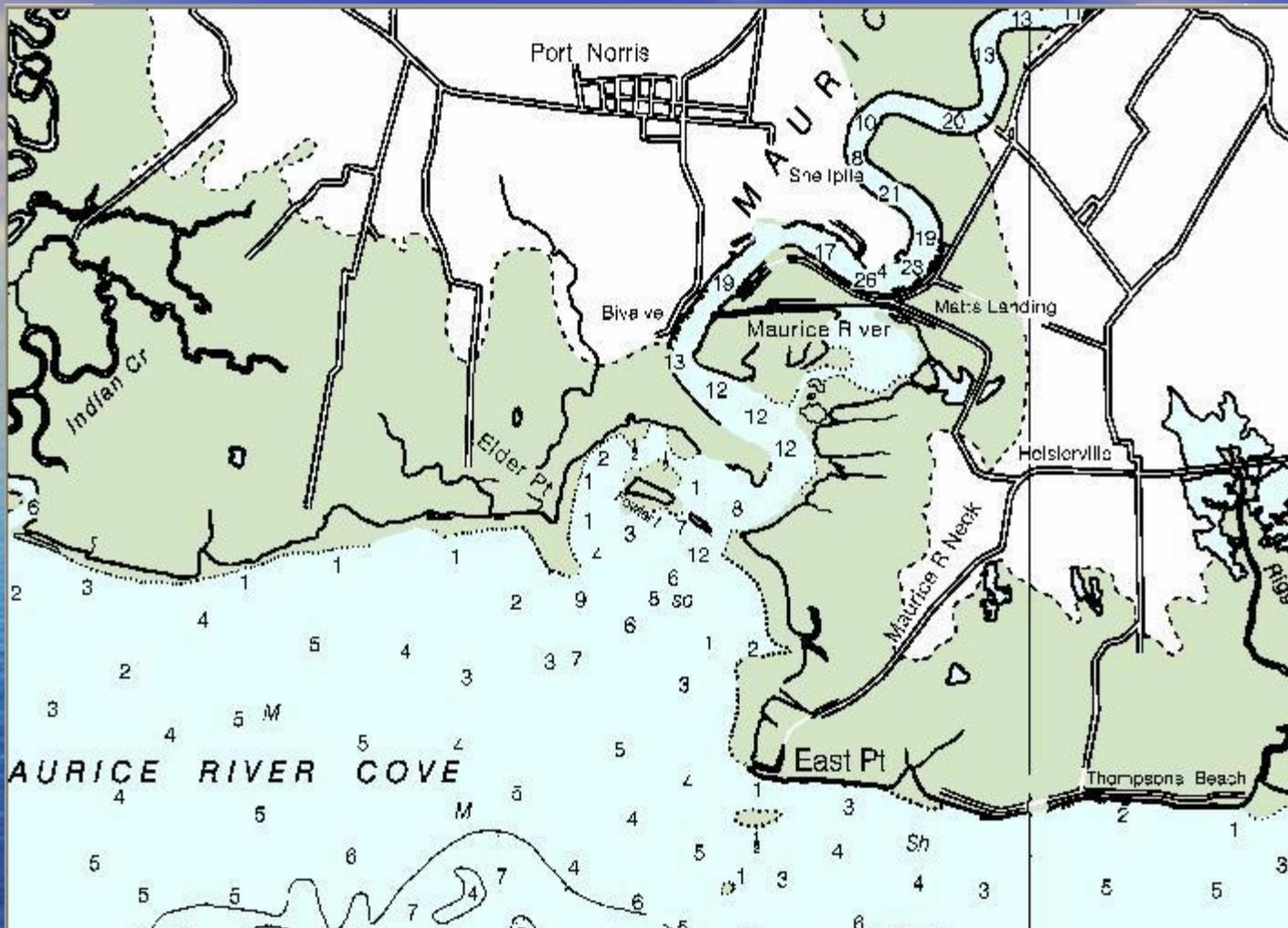


Figure . NOAA Nautical Chart - 2004.