Beach 101:
Beach Sanitary Surveys

2009 US EPA National Beaches Conference

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Beach Sanitary Surveys – Goal

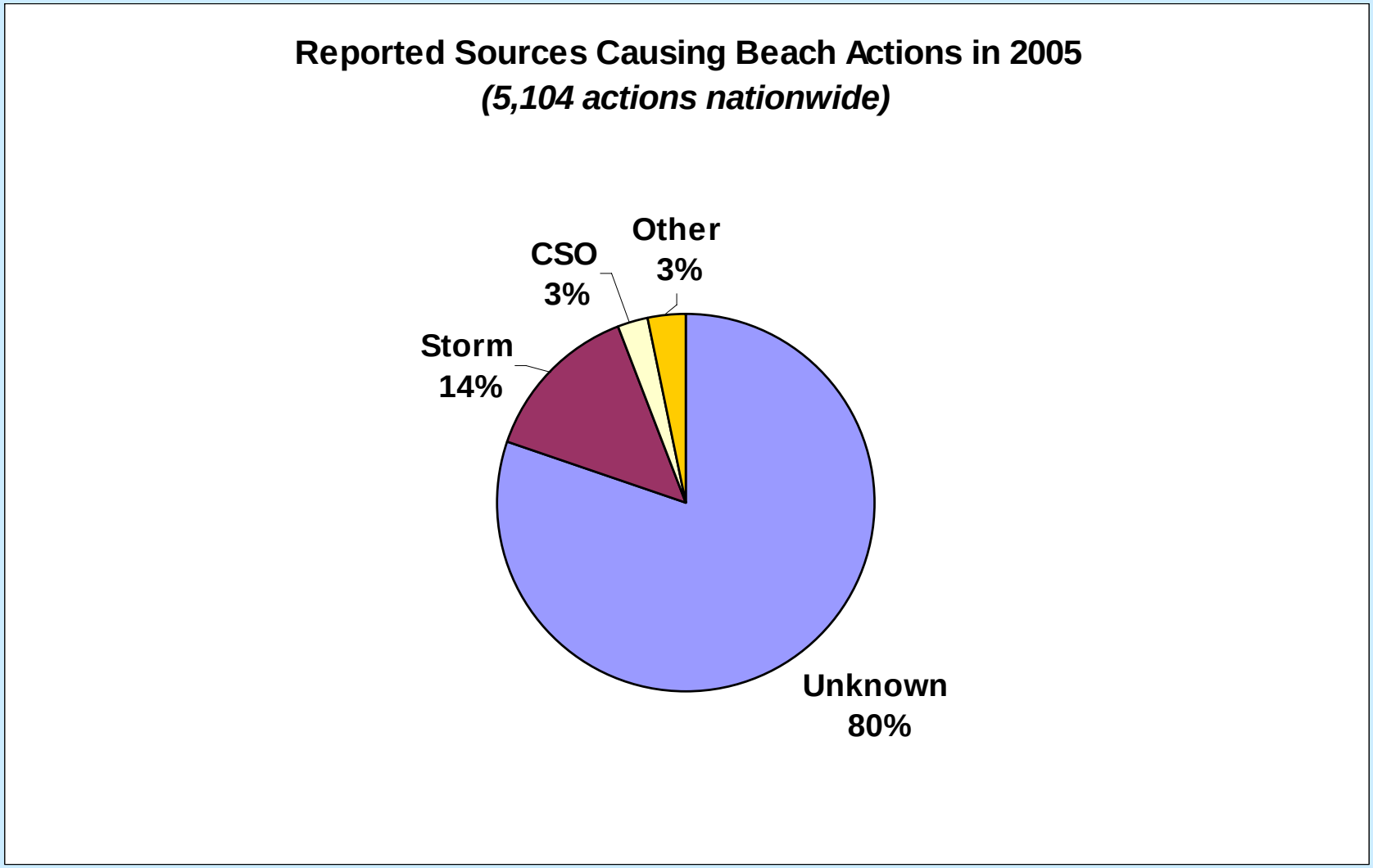
- To explore and accurately characterize beaches
- To identifying possible sources of microbial pollution entering the beach area
- To assemble a database of ambient conditions and water quality data
- To provide for targeted remediation measures

Motivation for Action

Or why would you make the effort to do a BSS?

- **Public perception/expectations**
  - **Citizens value utility as condition of residence**
- **Economic issues**
- **Social issues**
  - **Equity with regards to access**
- **Environmental protection/preservation**
  - **Coastal habitat**
  - **Fisheries and wildlife**
- **Public health**

Do we know what the sources are?



C. Kovatch, USEPA National Beaches Conference, 2006

Some sources are easy to identify

Others not so much…

Very Easily Identified…

Easily Identified/Pollution Source?

Tools Used in Sanitary Survey Project

Land Use/Source ID Data – Annual Survey

- Wastewater discharge points
- Septic systems
- Subsurface sewage disposal
- Storm water outfalls
- Rivers, creeks & streams
- Agricultural run-off
- Urban run-off
- Industrial waste
- Marinas & harbors
- Moored boats
- Land Use (local & watershed)
- Annual bather load

- Combined sewage overflows
- Caged Animal Feeding Operations (CAFOs)
- Wildlife
- Domestic animals
- Stream bank erosion
- Landfills, open dumps
- Ground water
- Bathhouse toilet facilities
- Drains & pipes
- Wetland drainage
- Hydrological assessments
- Sediment/Sand assessments

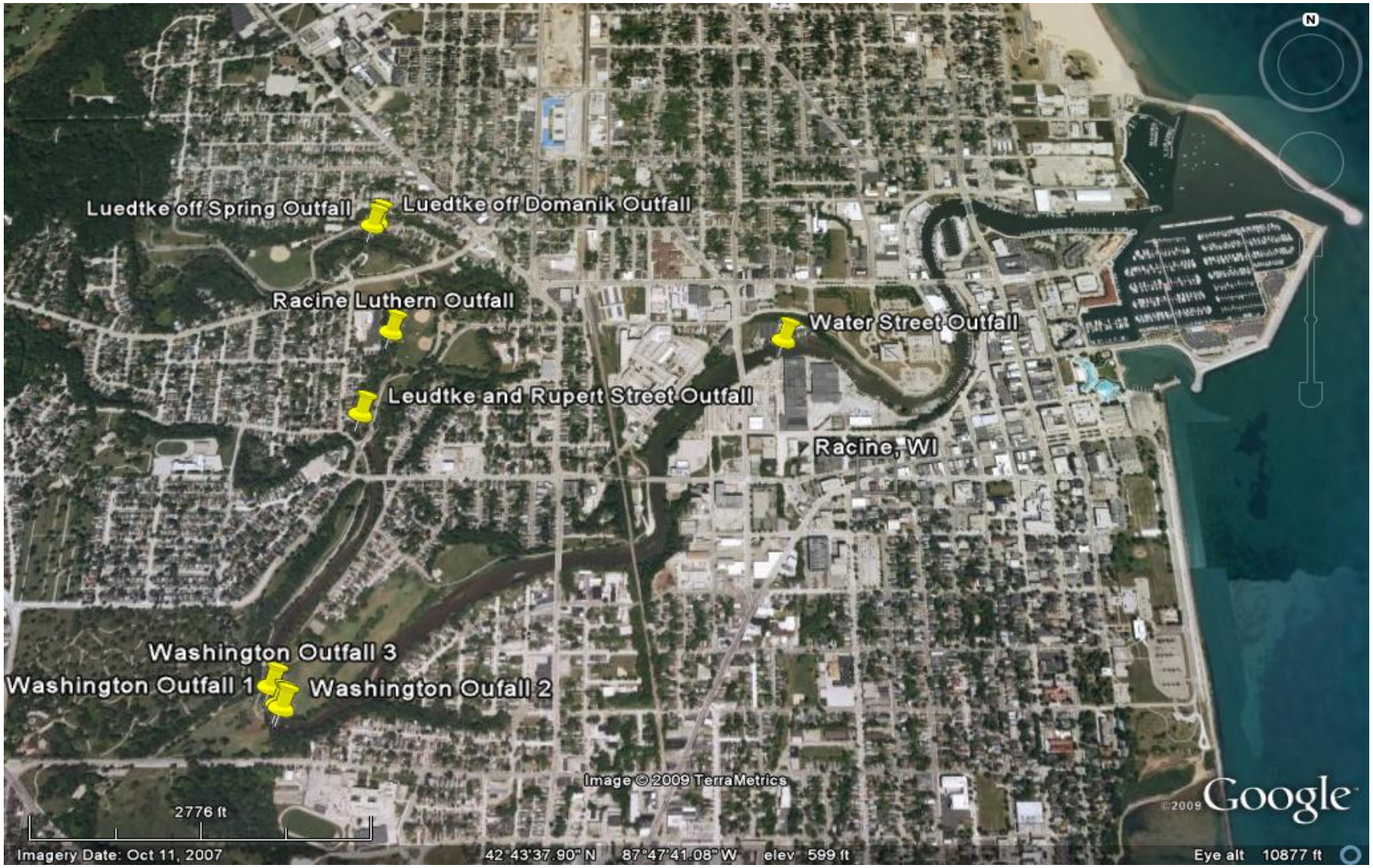
Environmental Data Collected – Routine/Daily BSS

- **General Beach Conditions**
  - Air temperature
  - Wind speed/direction
  - Rainfall
  - Weather condition (sunny, etc.)
  - Current speed/direction
  - Wave Height
- **Water Quality**
  - FIB concentrations
  - Water temperature
  - Water color/odor
  - Turbidity (clarity)
- **Bather Load**
  - Total number of people at beach
  - Swimmers/non-swimmers
- **Potential Pollution Sources**
  - Sources of discharge
    - Rivers, outfalls, wetlands, etc.
  - Floatables
  - Amount of debris/litter
  - Amount of algae
    - Stranded on beach
    - Floating/submerged in water
  - Presence of wildlife
    - Gull counts
    - Geese, deer, other
  - Presence of domestic animals
    - Dogs, Horses

Source Determination or Microbial Source Tracking (MST) Methods

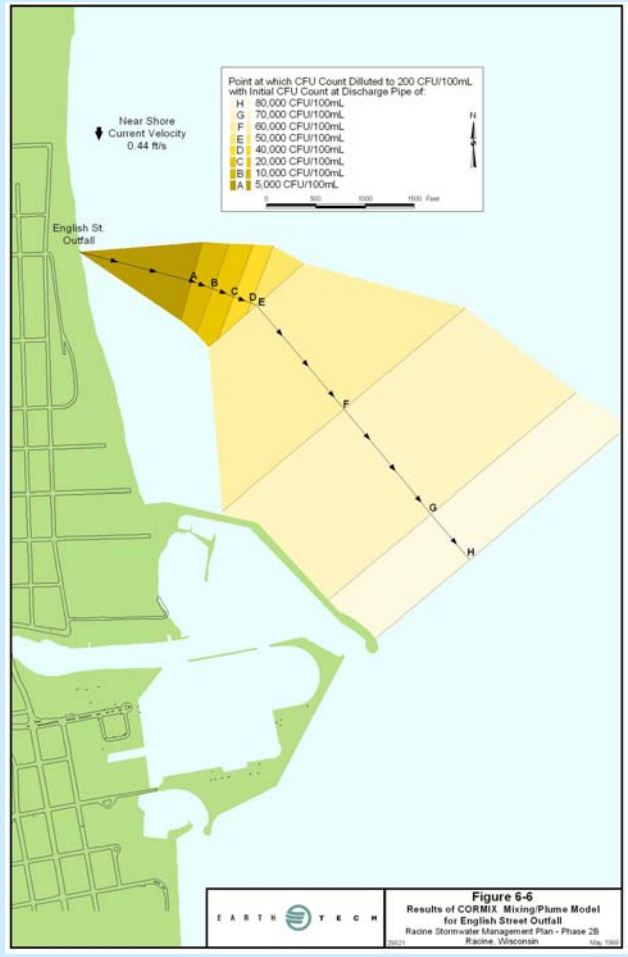
- **Sanitary Survey & Land Use Evaluations**
- **Spatial Sampling/Additional Sampling**
- **Physical Evaluations**
- **Animal/Avian/Algae Evaluations**
- **Weather Effects (Rain, temp, etc.)**
- **Genetic Evaluations**
- **New Techniques (MALDI-TOF)**

Beach CSI!


Luedtke off Spring Outfall
Luedtke off Domanik Outfall
Racine Luthern Outfall
Water Street Outfall
Leudtke and Rupert Street Outfall
Racine, WI
Washington Outfall 3
Washington Outfall 1
Washington Oufall 2
Image © 2009 TerraMetrics
2776 ft
© 2009 Google
Imagery Date: Oct 11, 2007
42°43'37.90" N 87°47'41.08" W elev 599 ft
Eye alt 10877 ft

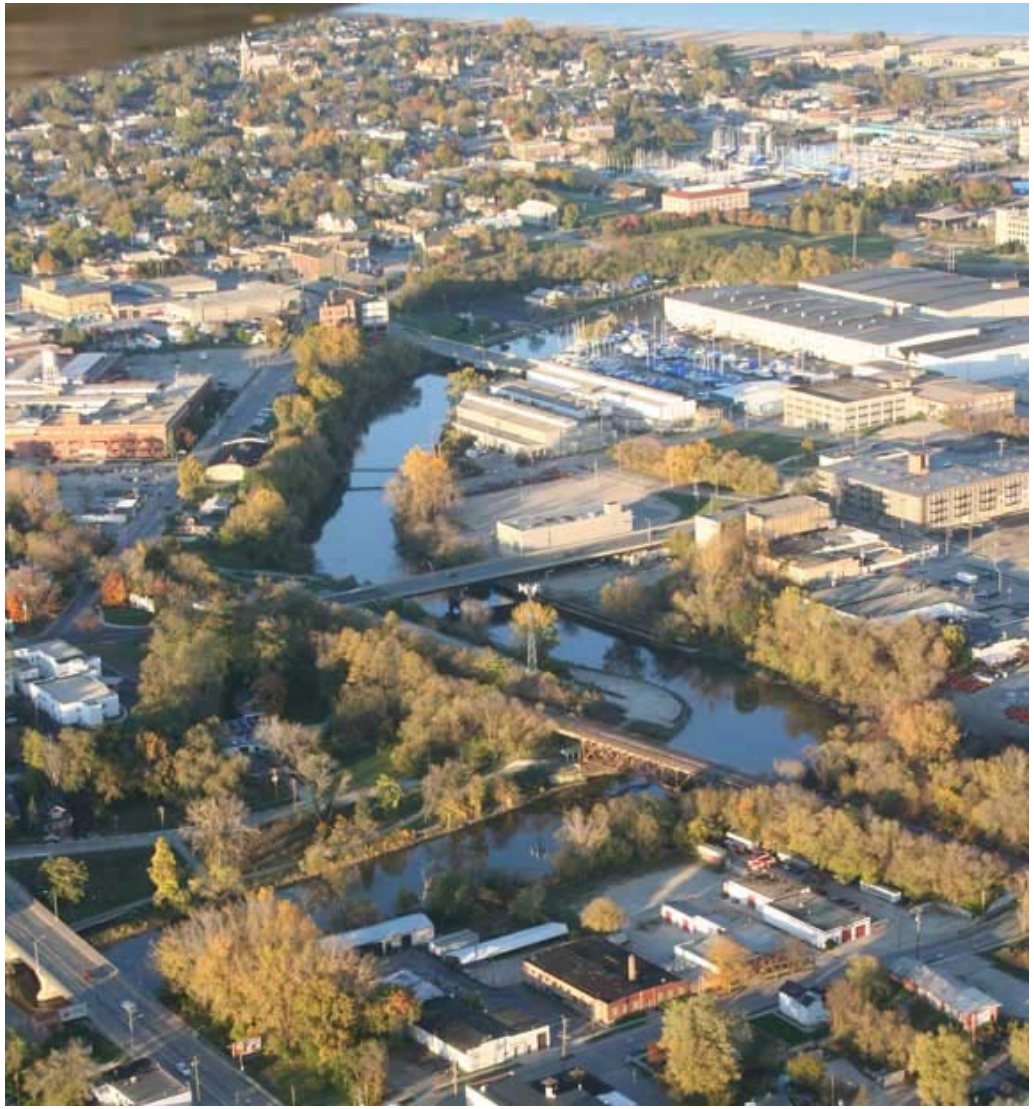
Basin Assessments

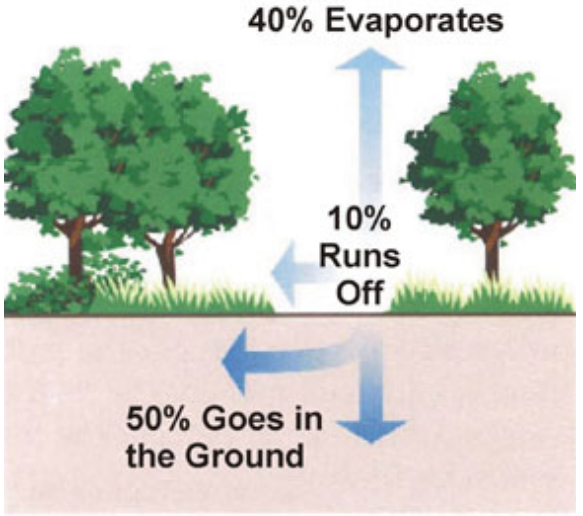
- 150 cm pipe
- Drainage area 395.5 acres (160.05 hectares)
- Land Use
  - 20-25% HD residential
  - 20-22% multi-family
  - 15-20% MD residential
  - 12-15% Commercial
  - 5-10% Industrial
  - 5-6% Open space
  - 1-2% Office, Institutional



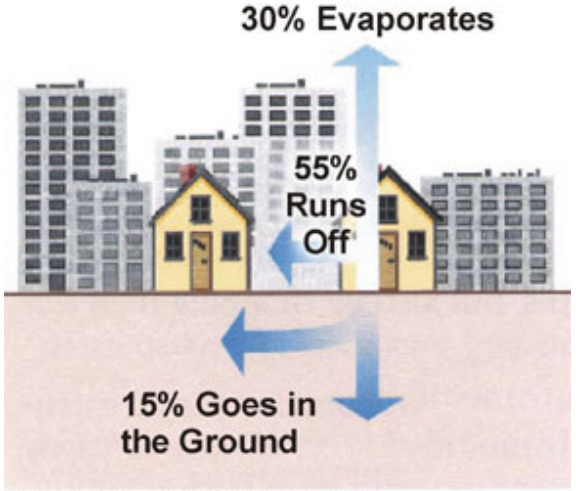
Storm water outfall, Racine, WI

What Happens When it Rains?



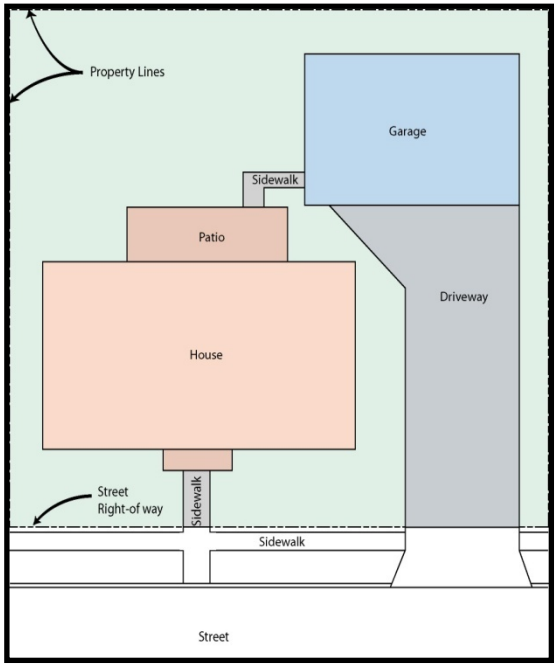


The Federal Interagency Stream Restoration Working Group



The Federal Interagency Stream Restoration Working Group

Racine Storm Water Utility

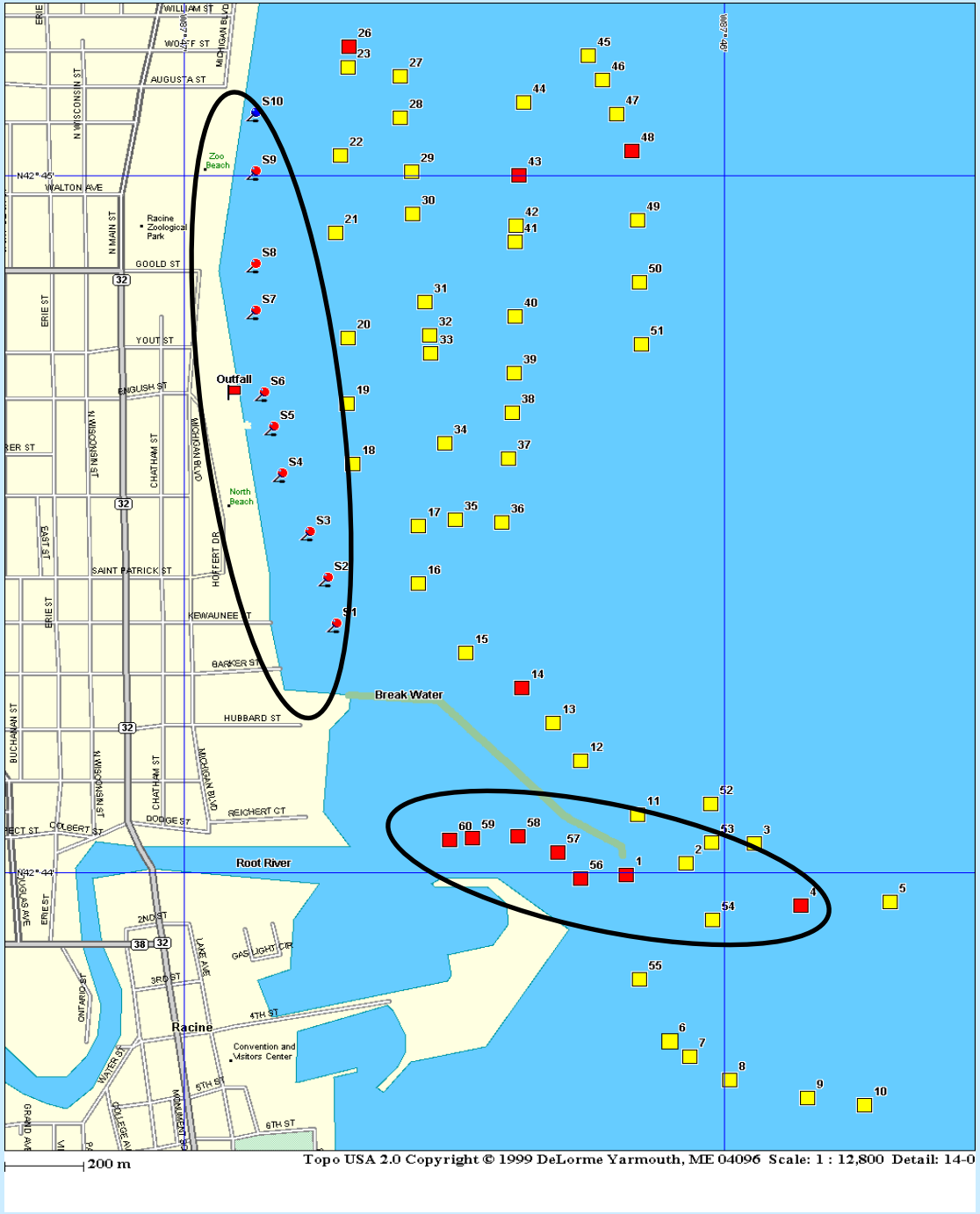


Residential Average Impervious Area = 2,844 square feet (or 1 Equivalent Residential/Runoff Unit (ERU))

Downtown Customer Example

Industrial Customer Example


Zoo Beach (Z3)
Zoo Beach (Z2)
Zoo Beach (Z1)
North Beach (N4)
North Beach (N3)
North Beach (N2)
North Beach (N1)
Main St Bridge N
Main St Bridge Middle
Main St Bridge S
HLYC/State St Bridge
Image © 2007 TerraMetrics
Image NASA
Azarian Marina 1
©2007 Google™
Pointer 42°44'17.63" N 87°46'52.02" W elev 586 ft
Streaming 100%
Eye alt 9815 ft



2004 Spatial Distribution Study

80 samples by wading or boat

Pre-rainfall, Rainfall, and Post-rainfall samples

Look for elevated levels of bacteria indicator organisms


North Beach
Root River
Wetland Outlet to Lake Michigan
Infiltration/Evaporation Basins (Wetland)
Vorceptors
NL10 Bypass Outlet
Dune #1
Dune #2
City of Racine Dept. of Public Works - 2001 (Build 2.0)

E.coli and Sand

Table 1. Beaches included in the sand evaluation study and summary of data from 2005.

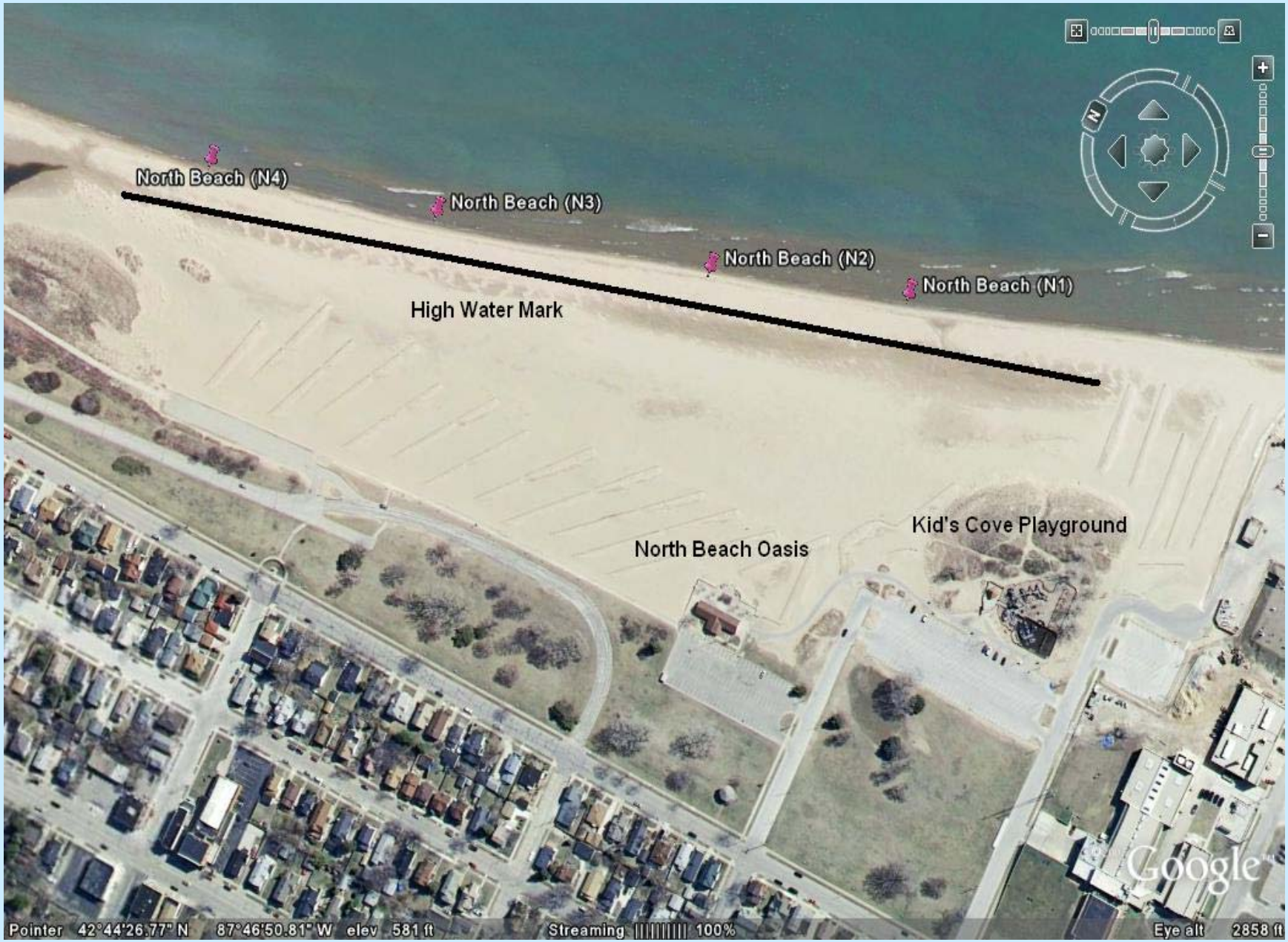
Beach	Mean Upshore Sand *E.coli* CFU/g	Mean Swash Sand *E.coli* CFU/g	Mean Submerged Sand *E.coli* CFU/g	Mean *E.coli* from water MPN/100mL
Baileys Harbor	56.6	106.5	3.5	169.8
Ephraim Beach	43.6	52.2	7.8	134.6
Fish Creek	73.7	137.9	8.7	196.9
Otumba Park	18	190.4	11.9	335.4
Sunset Park	99.4	136.7	58.1	107.3
Whitefish Dunes	216.7	91.5	2.8	259.5

Table 2. Beaches included in the sand evaulation study and summary of data from 2006.

Beach	Mean Upshore Sand *E.coli* CFU/g	Mean Swash Sand *E.coli* CFU/g	Mean Submerged Sand *E.coli* CFU/g	Mean *E.coli* from water MPN/100mL
Baileys Harbor	76.1	31.6	9.8	127.2
Ephraim Beach	13.1	29.3	0.4	38.9
Fish Creek	5.4	21.3	2.4	58.1
Otumba Park	29.7	127.2	11.5	89.4
Sunset Park	59	115.2	21	184.4
Whitefish Dunes	78.7	39.9	1.9	141.3

Relative Elevation Measurements

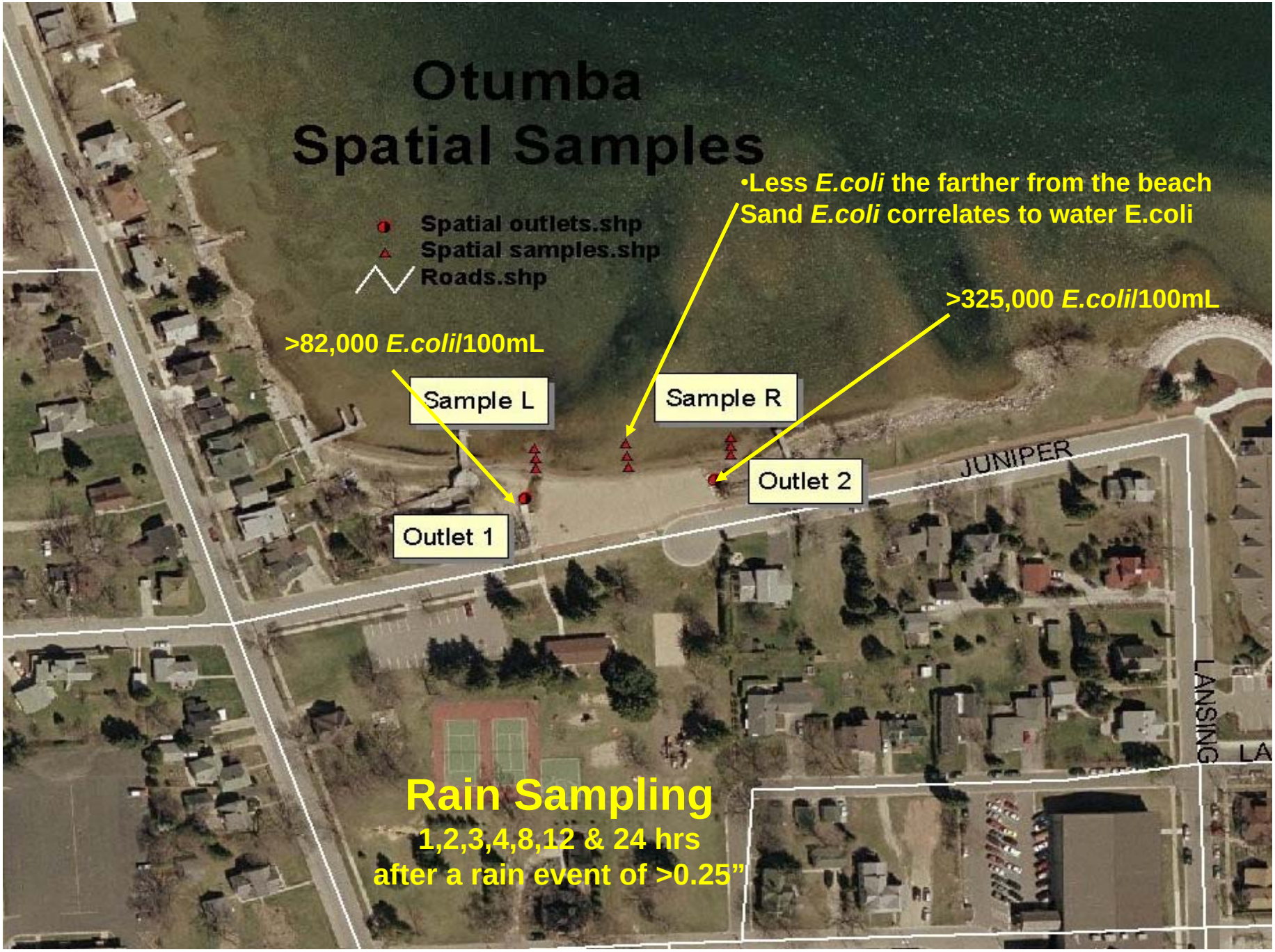
Wisconsin Coastal Management Program


North Beach (N4)
North Beach (N3)
North Beach (N2)
North Beach (N1)
High Water Mark
North Beach Oasis
Kid's Cove Playground
Google
Pointer 42°44'26.77" N 87°46'50.81" W elev 581 ft
Streaming 100%
Eye alt 2858 ft

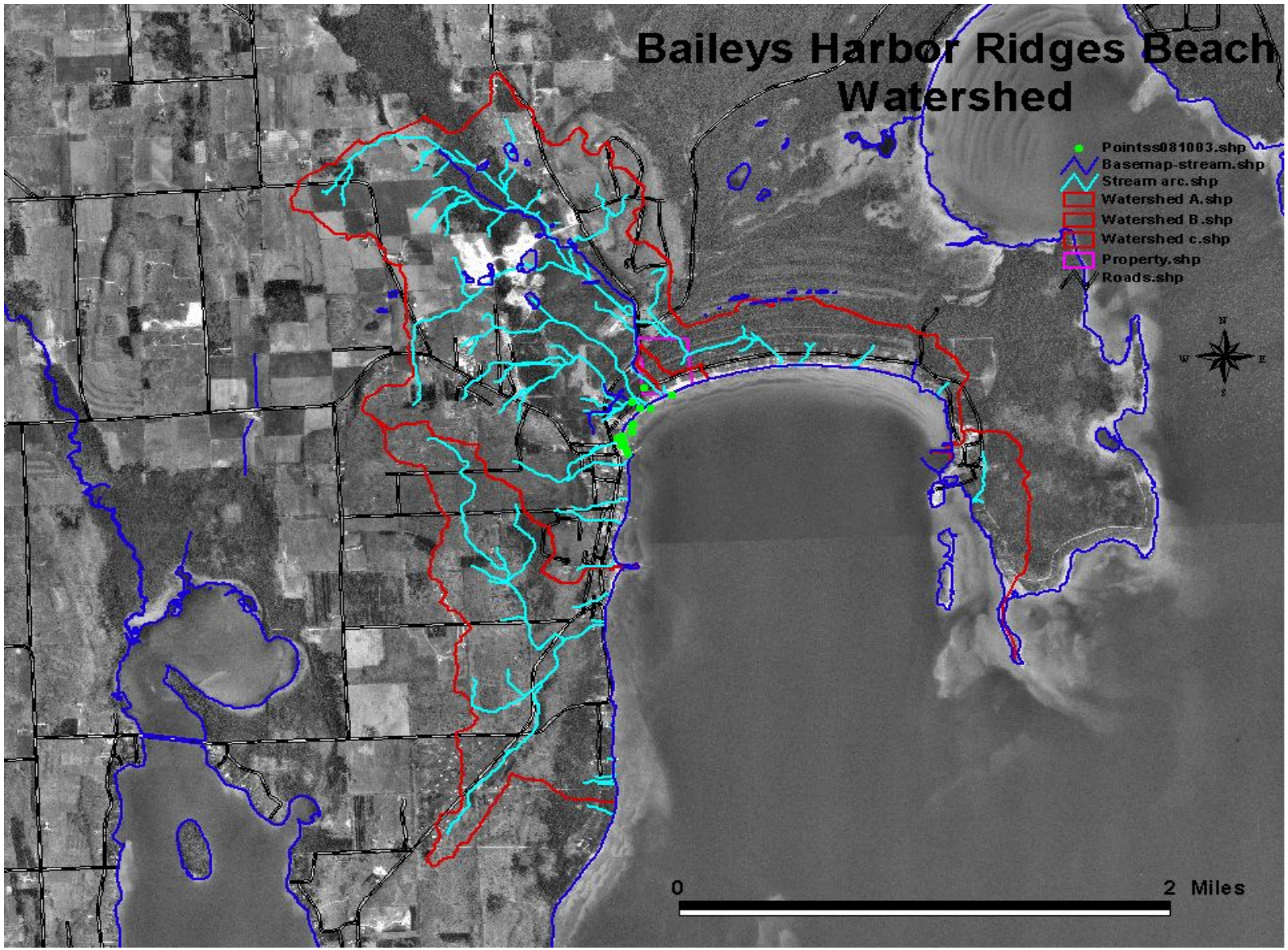
The “Yuck” Cycle

When were Bathing Water Advisories Occurring?

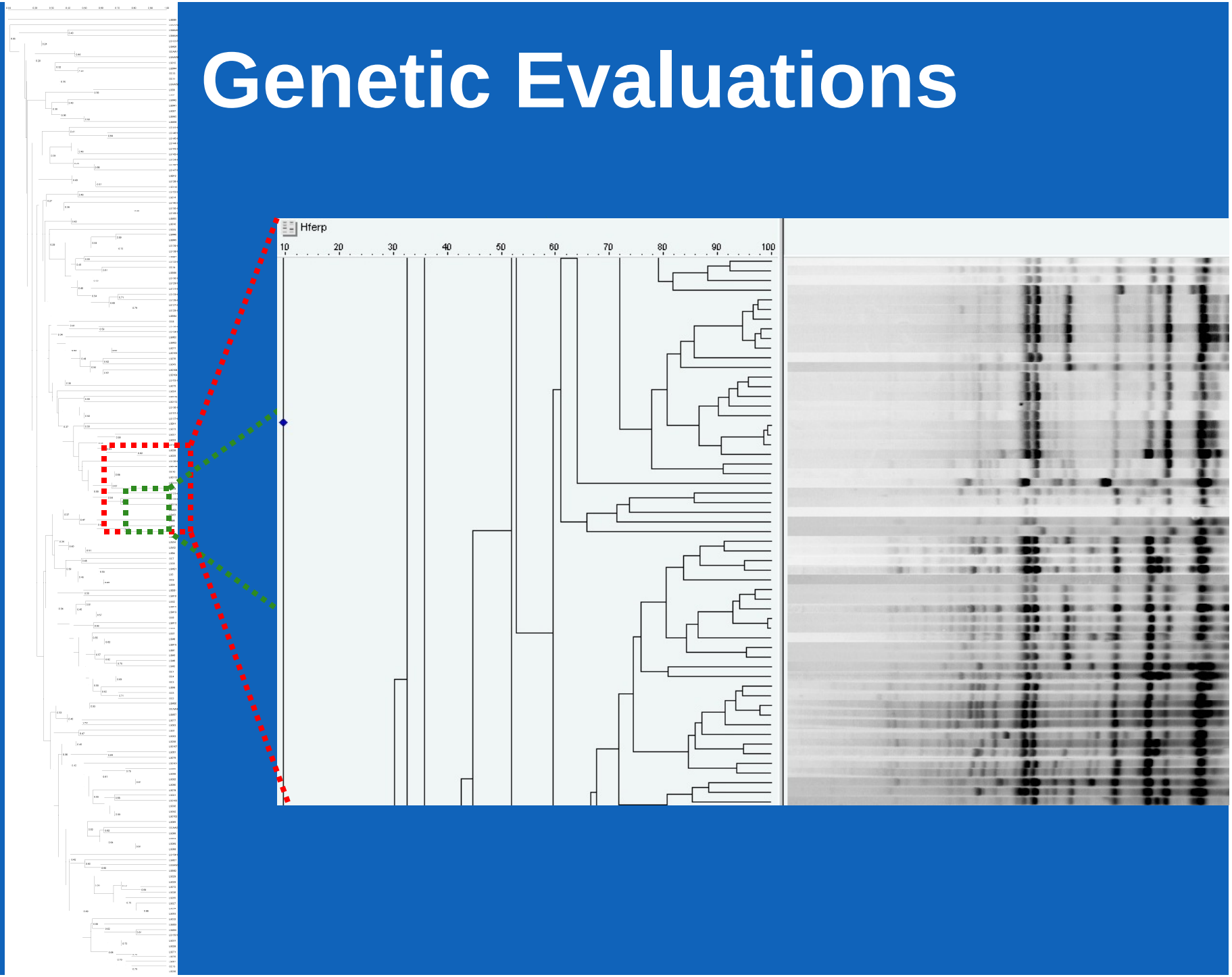
- Wind Direction
  - East winds associated with 49% of BWQF
- Wave Height
  - 85% of BWQF occurred when waves were ≥ 1.0 ft.
- Precipitation
  - Only 42% of BWQF were preceded by precipitation


Otumba
Spatial Samples
Spatial outlets.shp
Spatial samples.shp
Roads.shp
•Less *E.coli* the farther from the beach
Sand *E.coli* correlates to water E.coli
>325,000 *E.coli*/100mL
>82,000 *E.coli*/100mL
Sample L
Sample R
Outlet 2
Outlet 1
JUNIPER
LANSING
Rain Sampling
1,2,3,4,8,12 & 24 hrs
after a rain event of >0.25”

Watershed Assessments



Genetic Evaluations



Beach Sanitary Surveys:

Potential Contamination Sources

Lake Superior	Lake Michigan
Beach Sand	Beach Sand
Outfalls	Outfalls
Animal Fecal Material on Beach	Large Gull Population & Feces
Runoff through Beach Area	Potential for CSOs
Poor Beach Maintenance	Discharge from WWTPs
	Stormwater Runoff
	Cladophora/Algal Mats

Now that we have all this data…what can we do?

Make a Difference!

Best Management Practices

- **Regular Maintenance of Storm Sewers and catch basins - Significant source of *E.coli***
- **Street and Impervious Surface Cleaning**
- **Know where pipes ‘come from’ and ‘go’**
- **Beach Grooming - CORRECTLY DONE**
- **Removal of *Cladophora***
- **Storm Water Ordinances**
- **Public Signage/Public Education**
  - **Pick-up pet waste, pick-up trash, Do Not feed birds, etc.**
- **Others?**

Beach Sanitary Surveys:

Recommended Remediation Measures

Bank Stabilization with Native Plants at Zoo Beach (Racine, WI)

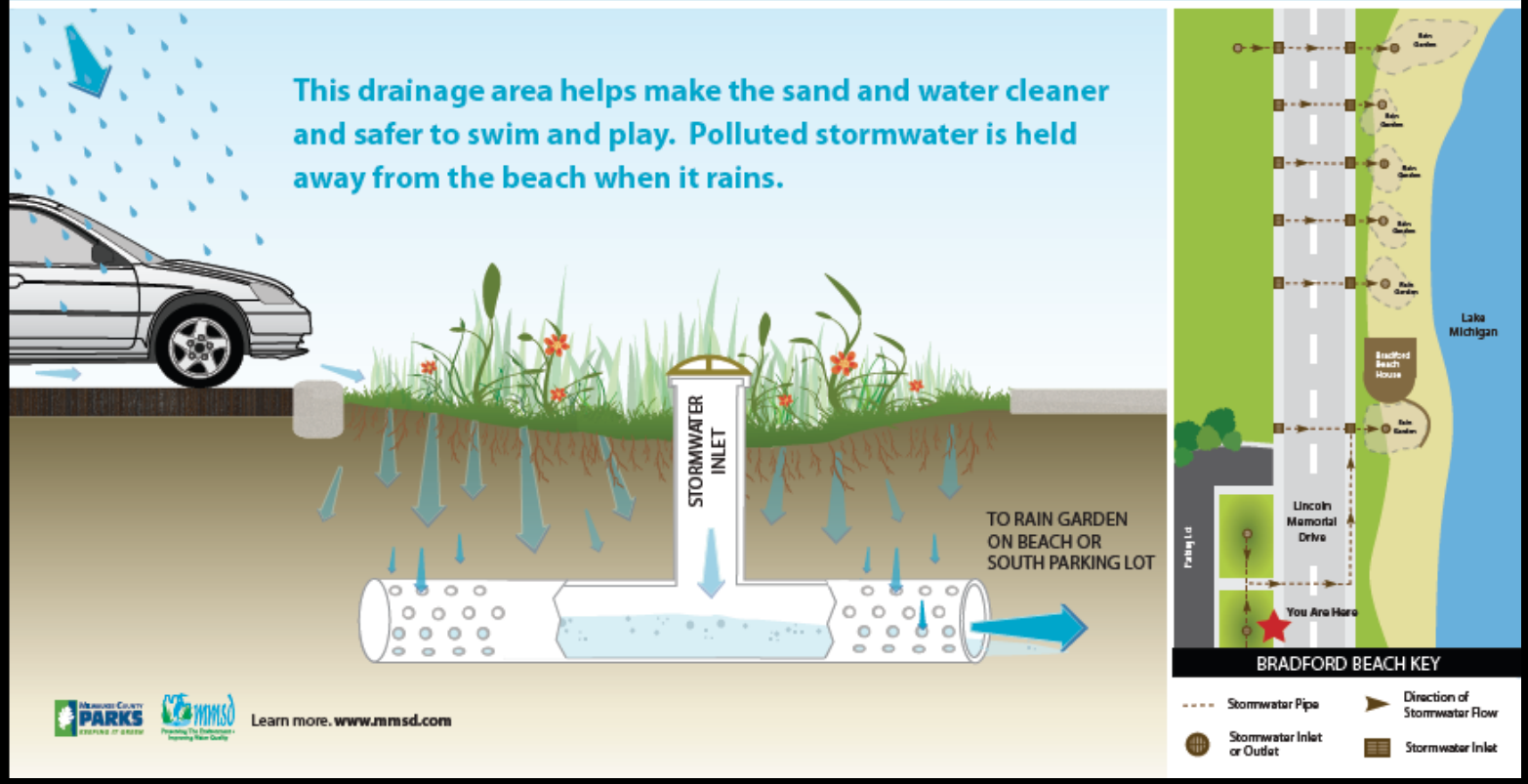
- Regular maintenance of storm water infrastructure
- Stormwater runoff controls (diverting outfalls, vegetated swales, eliminating sources of seeps)

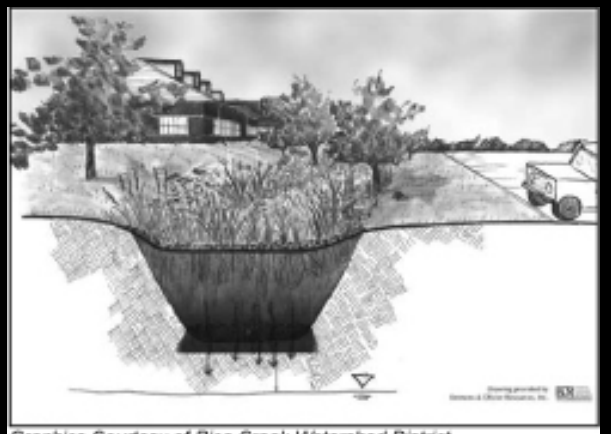
Storm Drain Televising

Important tool to identify…

- Severely cracked pipes at several points downstream
- Sanitary sewer defects
- Defects in laterals (sanitary infiltration)
- Deposits in catch basins
- Illicit discharge to storm drain system

THIS DRAINAGE AREA HELPS PROTECT LAKE MICHIGAN

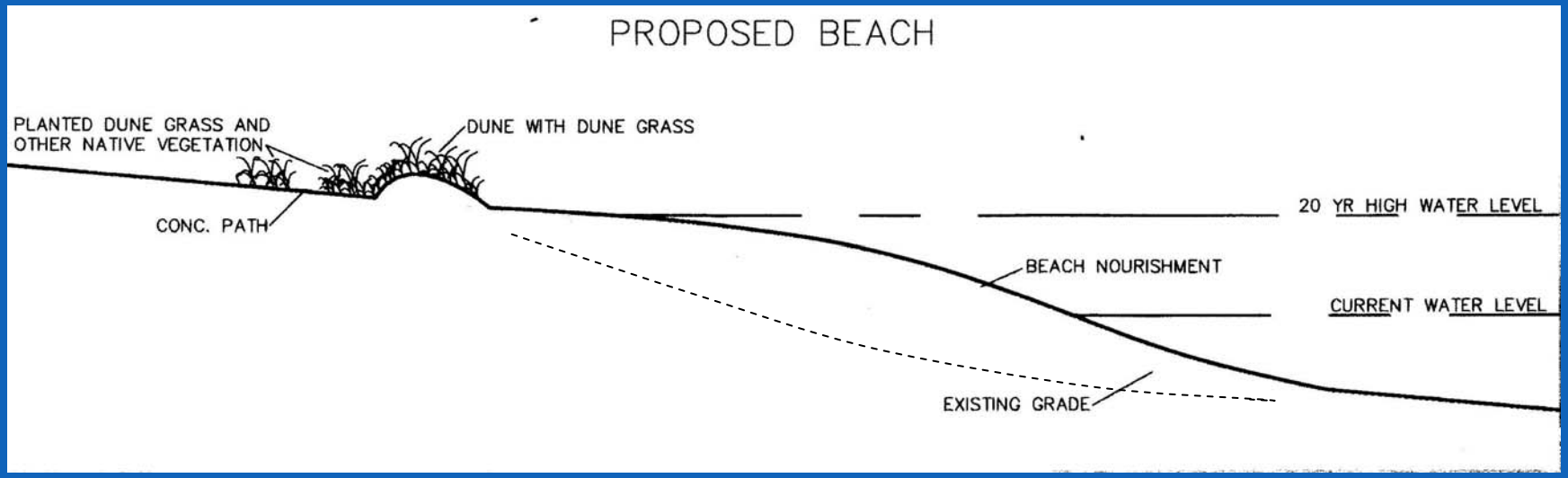




Graphics Courtesy of Rice Creek Watershed District

Beach Grooming/Beach Slope Maintenance

- ***E. coli*** **content in beach sands is influenced by the moisture content**
- **Large swales trap water and remain wetted**
- **Flat beach face allows for the encroachment of waves**
- **Deep beach grooming w/o leveling can promote drying**



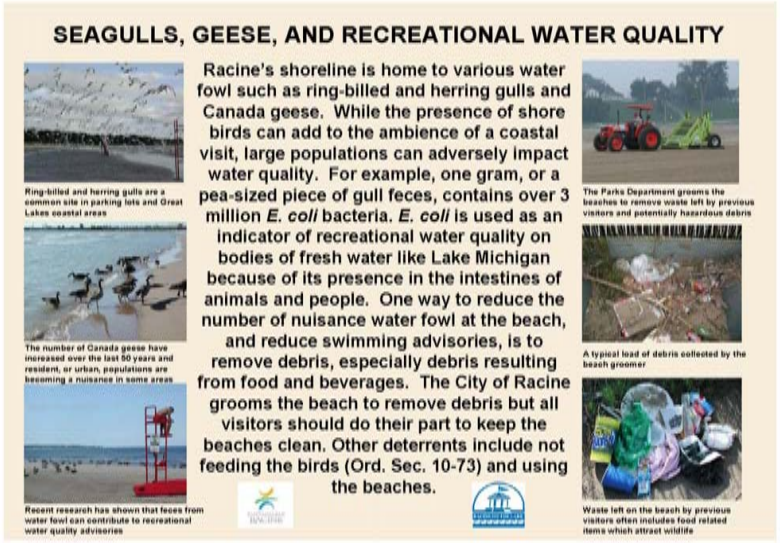
Beach Nourishment

- Improved water flow
- Decreased size of swash zone
- Improved filtration
- Increased beach area
- Aesthetic improvement

Recommended Remediation Measures

- **Removal of fecal material at beaches**
- ***Cladophora* (algae)/plant removal**
- **Gull population control**
- **Litter Management**

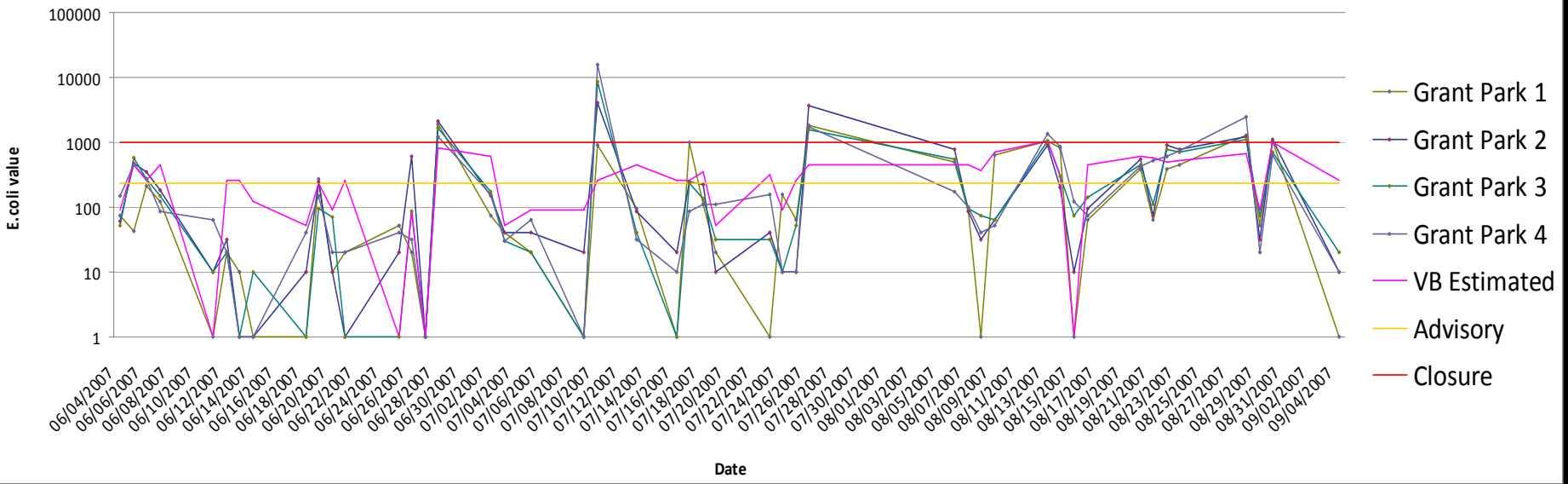
PUBLIC EDUCATION



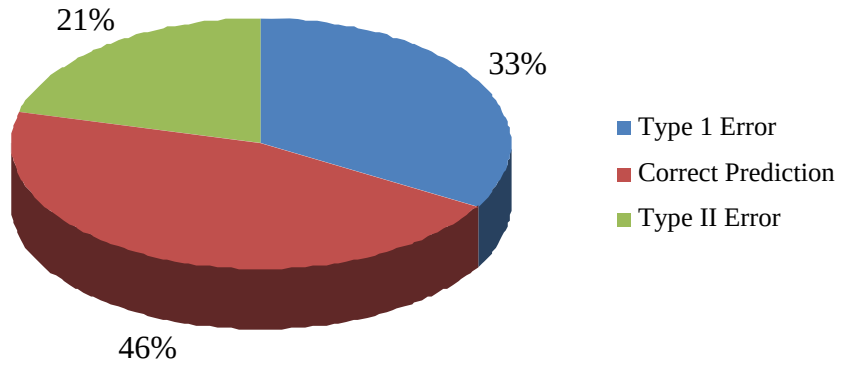
Beach Sanitary Surveys: Predictive Models

- Environmental data collected as part of a BSS can be used to begin constructing a predictive model
- Virtual Beach (USEPA model)
- Allows correlations between parameters and water quality (i.e. wave height, wind direction, rainfall, etc.)
- Data limitations prevent full use, i.e. you will likely need multiple years of data
- If funding continues, will use modeling simultaneously with sampling

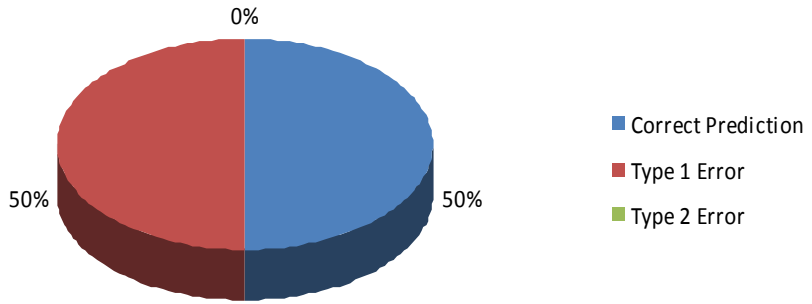
Comparison of actual E.coli values to values estimated by Virtual Beach using nearshore algae levels and clarity for analysis at Grant Park Beach



Current Method for Predicting Beach Advisory/Closure at Grant Park



Virtual Beach Predictions for Advisories and Closures at Grant Park Beach Using Nearshore Algae and Clarity for Prediction



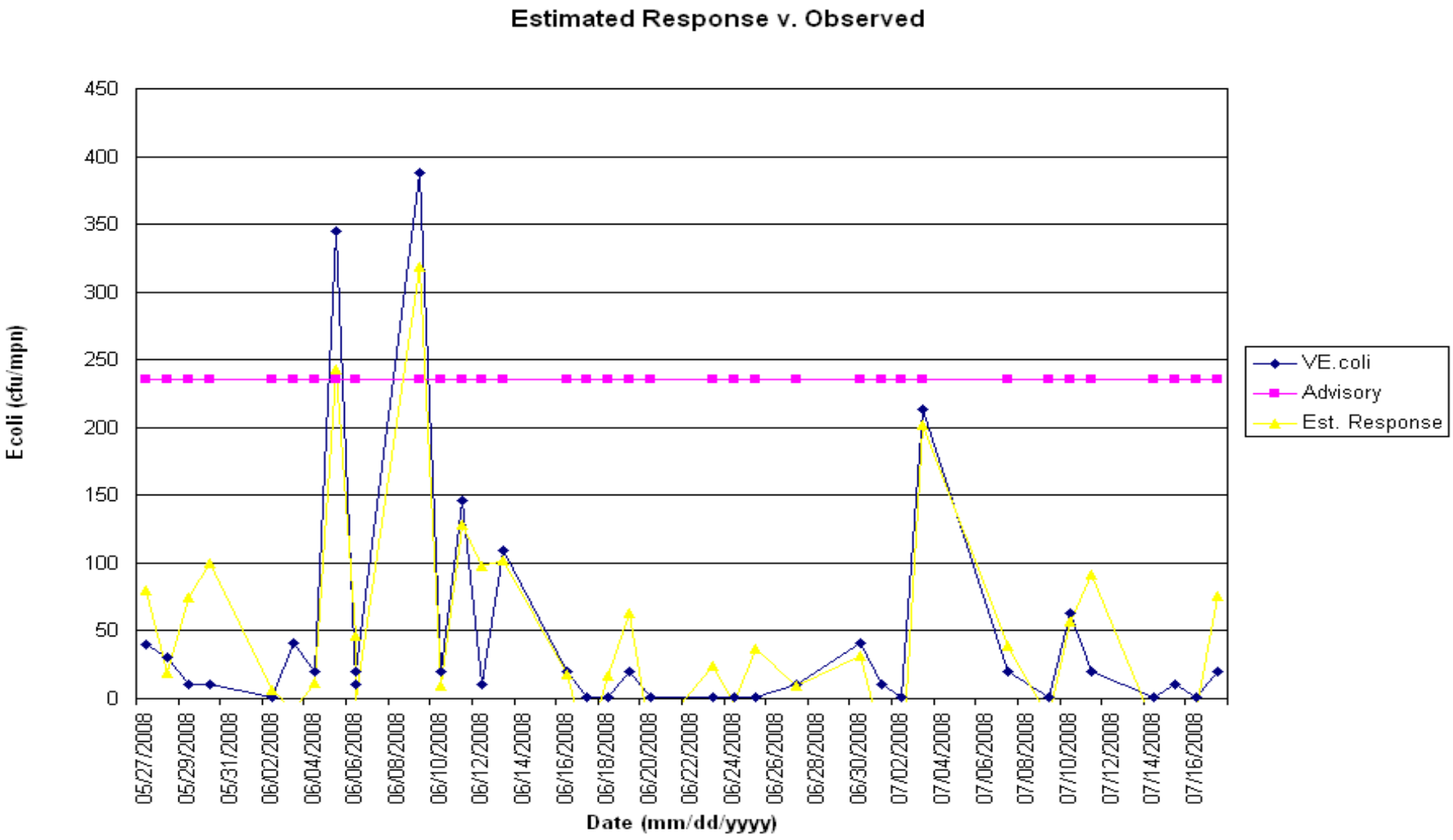


Figure 6. Estimated response against observed *E. coli* values, North Beach, Racine, WI (May through mid-July 2008).

Helpful Hints…

- BSS will provide you with the information you need to determine pollutant sources
- Don't be overwhelmed by the process
- Take a partnership approach
  - Public Works, Parks, Water/Wastewater, Health, Local Universities, Volunteers
  - One person does not necessarily have to collect all of the data
  - Some data can be collected pre- or post-beach season
- Be patient, work incrementally
  - It took Racine 5 years to ID all sources and implement remediation sources
- We're all in this together
  - People who have done this are likely willing to act as resources
  - Racine's beach sanitary surveys have been posted on their website
    - www.cityofracine.org, water quality research tab
- Some remediation measures are low/no cost
- Grant funding may be available for research/remediation
- Remediating beaches will benefit your community

Conclusions

- Collect reliable, defendable data on EACH location.
- Determine sources of *E.coli*
  - local/shore-borne
  - regional
- Utilize sustainable remediation approaches with minimal O&M costs whenever possible.
- Beach remediation/redesign will:
  - convert the beach to a more natural setting
  - increase water quality
  - protect public health
  - make each beach more aesthetically pleasing and more user friendly.

Current Initiatives

- Great Lakes Regional Collaboration
  - Coastal Health chapter recommended action
  - Beach project initiative (www.glrc.us, beaches)
    - Examples of completed BSS from 2007 pilot study
    - Guidance Document
    - Blank forms
- Great Lakes St. Lawrence Cities Initiative
  - US and Canadian Mayors
  - Recognize beaches are important to local economies
  - Encourage use of BSS to identify pollutant sources
    - Educate users on predictive modeling
  - http://www.glslcities.org/

Acknowledgements

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- City of Racine, WI
- City of South Milwaukee, WI
- Michael Evanoff, Bay City, MI
- WI DNR


THANK YOU!