

# GEOLOGY, HURRICANE AND STORM HISTORY OF STATEN ISLAND, NY

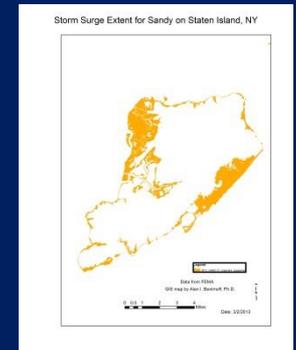
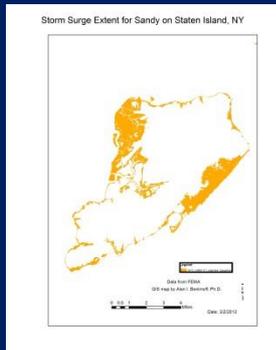
Alan I. Benimoff, Ph.D.

Department of Engineering Science and Physics

Center For Environmental Science

College of Staten Island/CUNY

Staten Island, NY 10314



# Staten Island Was Tragic Epicenter of Storm's Casualties

By JAMES BARRON, JOSEPH GOLDSTEIN and KIRK SEMPLE

Published: November 1, 2012

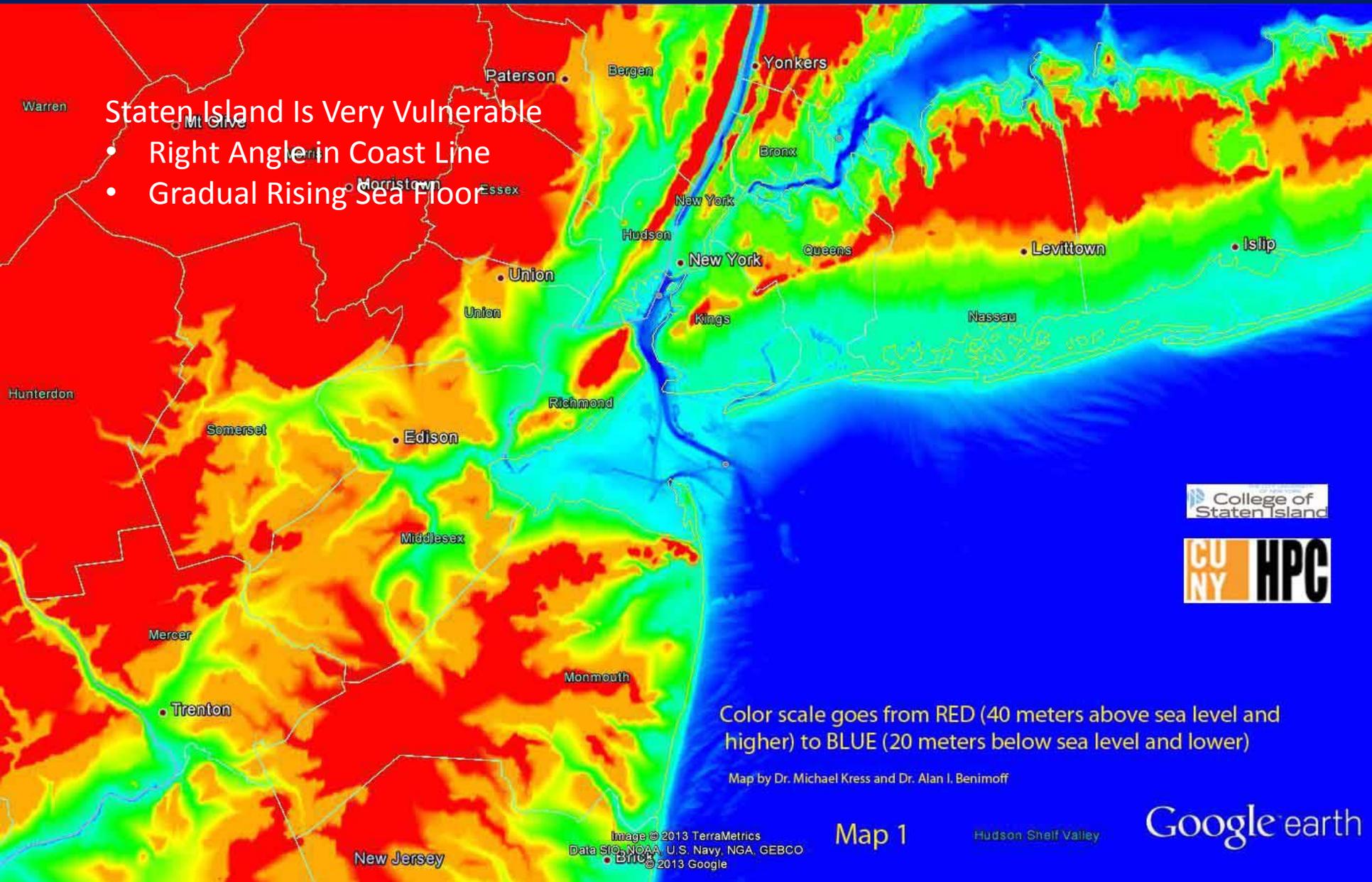
The soggy marshes and still-damp ruins of homes on Staten Island

That the borough was the scene for so much loss of life had a lot to do with the storm's path and the island's own evolution, and what happened was not entirely a surprise to Staten Islanders like Dr. William J. Fritz, the interim president of the [CUNY College of Staten Island](#), and Dr. Alan I. Benimoff, a geology lecturer there.

Dr. Benimoff said Staten Island was in the wrong place at the wrong time for a storm that scored a perpendicular hit on the New Jersey coast. "That put Staten Island in the bull's eye" for the surge, he said. "The water didn't have anywhere else to go."

## Staten Island Is Very Vulnerable

- Right Angle in Coast Line
- Gradual Rising Sea Floor



# GEOLOGIC MAP OF STATEN ISLAND NY



0 0.75 1.5 3 4.5 6 Miles

Data from USGS

GIS MAP By Alan I. Benimoff, Ph.D.

Date: 3/2/2013

Time: 12:55:34 PM

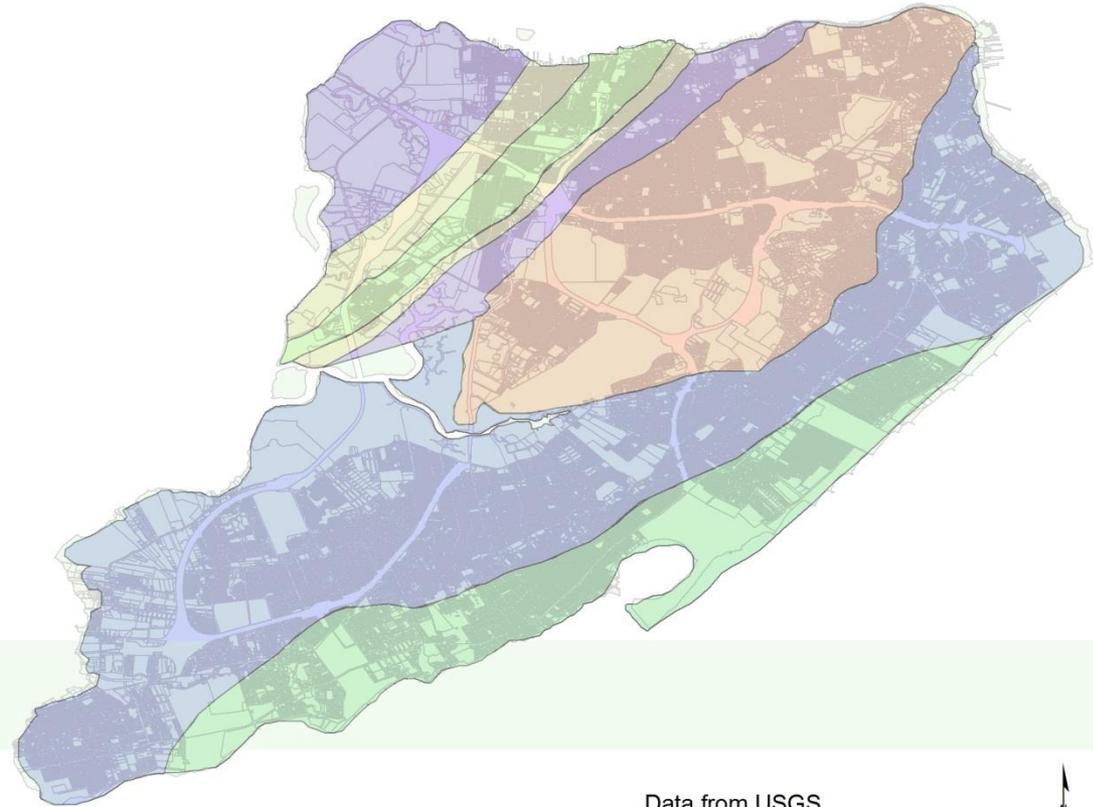


# GEOLOGIC MAP OF STATEN ISLAND NY

## Legend

- Cretaceous
- Magothy fm.
- Palisades Diabase
- Stockton fm.
- Passaic fm.
- Lokatong fm.
- SI SERPENTINITE

## Bedrock Geology of Staten Island



0 0.75 1.5 3 4.5 6 Miles

Data from USGS

GIS MAP By Alan I. Benimoff, Ph.D.

Date: 3/2/2013

Time: 1:03:51 PM



# GEOLOGIC MAP OF STATEN ISLAND NY

## Legend

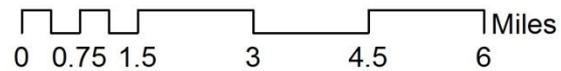
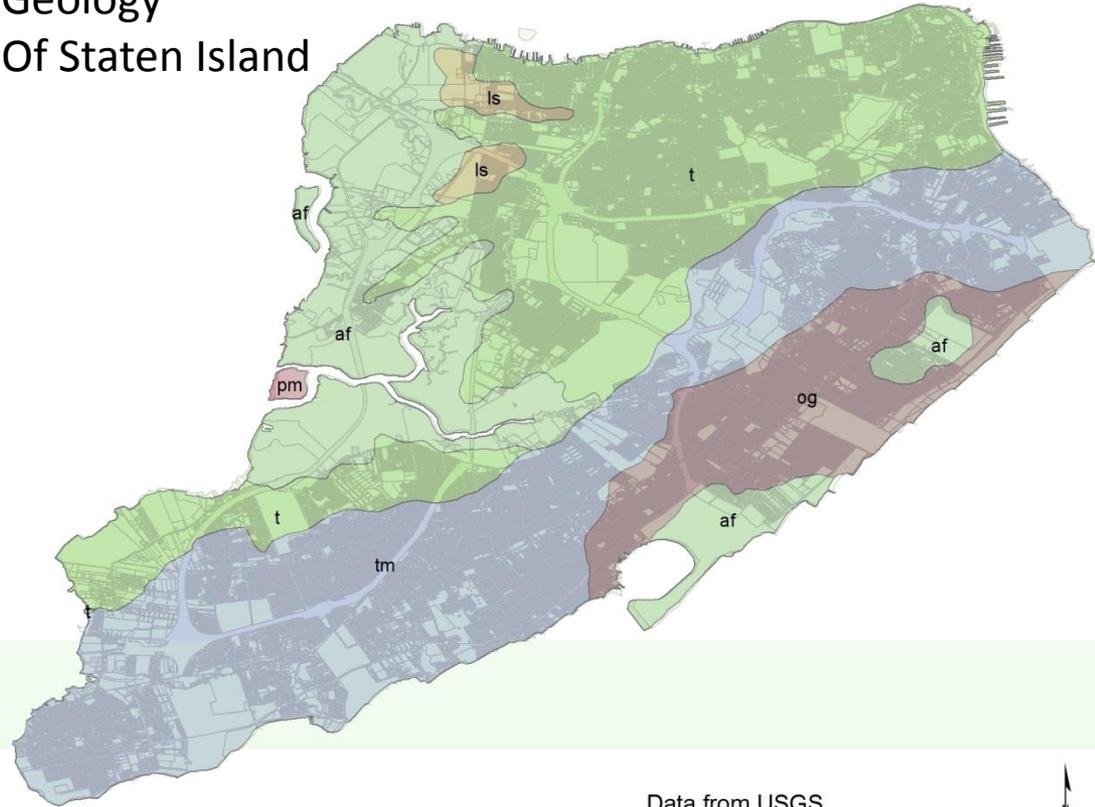
### LHUD\_S

 <all other values>

### MATERIAL

-  af
-  al
-  alf
-  b
-  bi
-  h2o
-  k
-  km
-  ld
-  ls
-  lsc
-  og
-  pm
-  r
-  t
-  tm

## Surficial Geology Of Staten Island



Data from USGS

GIS MAP By Alan I. Benimoff, Ph.D.

Date: 3/2/2013

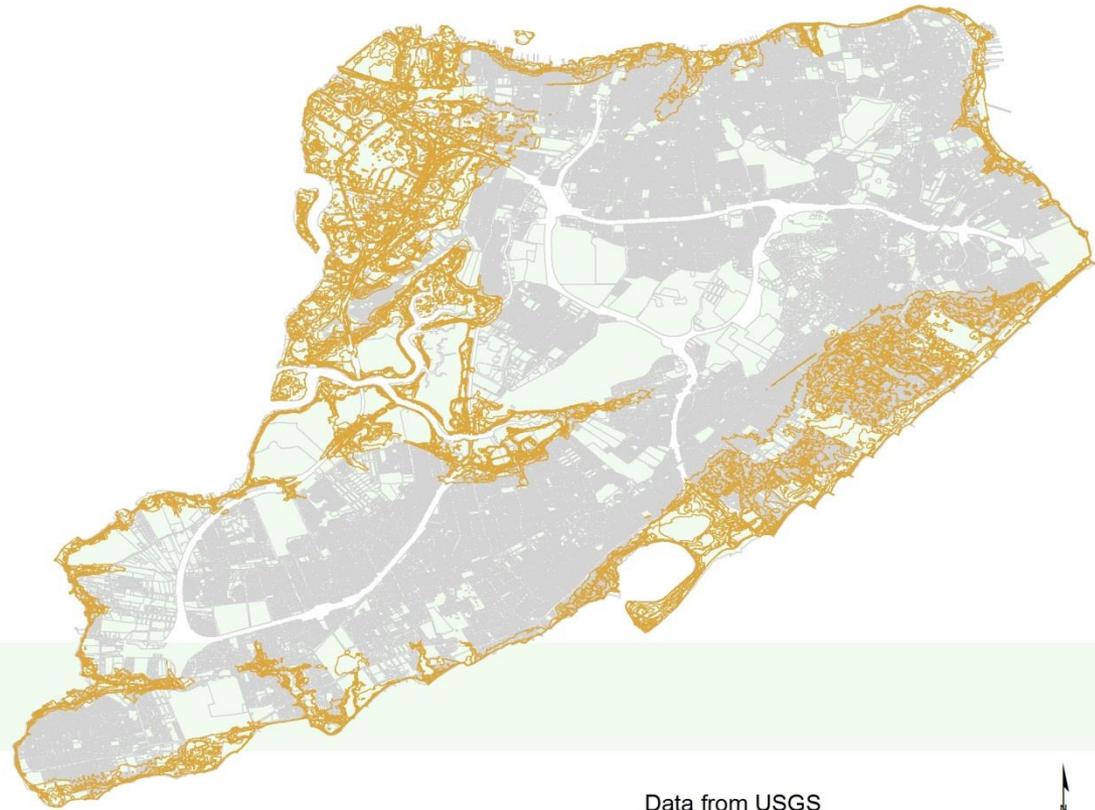
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# GEOLOGIC MAP OF STATEN ISLAND NY

## Legend

- 20 ft contour line
- 14 ft contour line
- 12 ft contour line
- 10 ft contour line
- 8 ft contour line
- 6 ft contour line
- 4 ft contour line
- 2 ft contour line



0 0.75 1.5 3 4.5 6 Miles

Data from USGS

GIS MAP By Alan I. Benimoff, Ph.D.

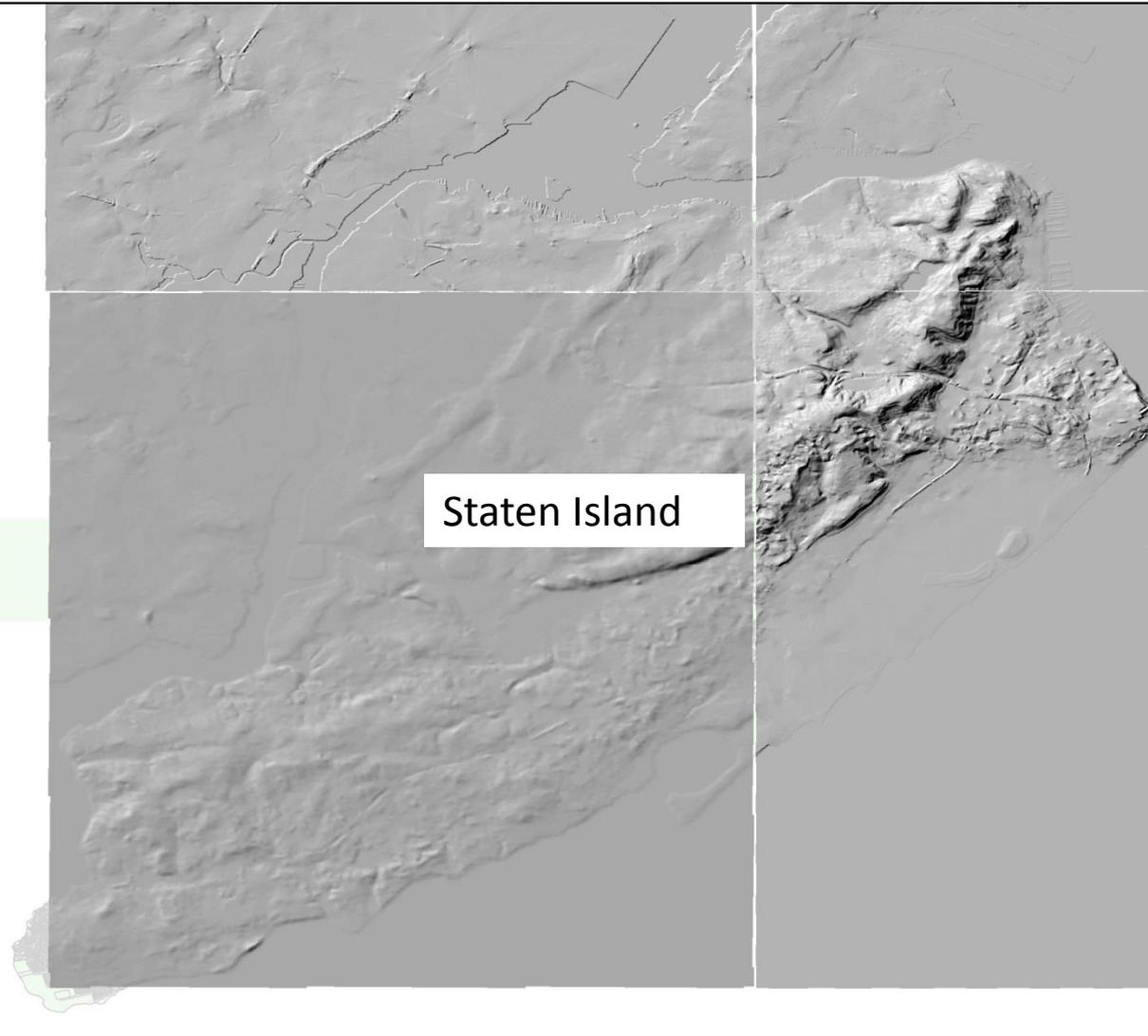
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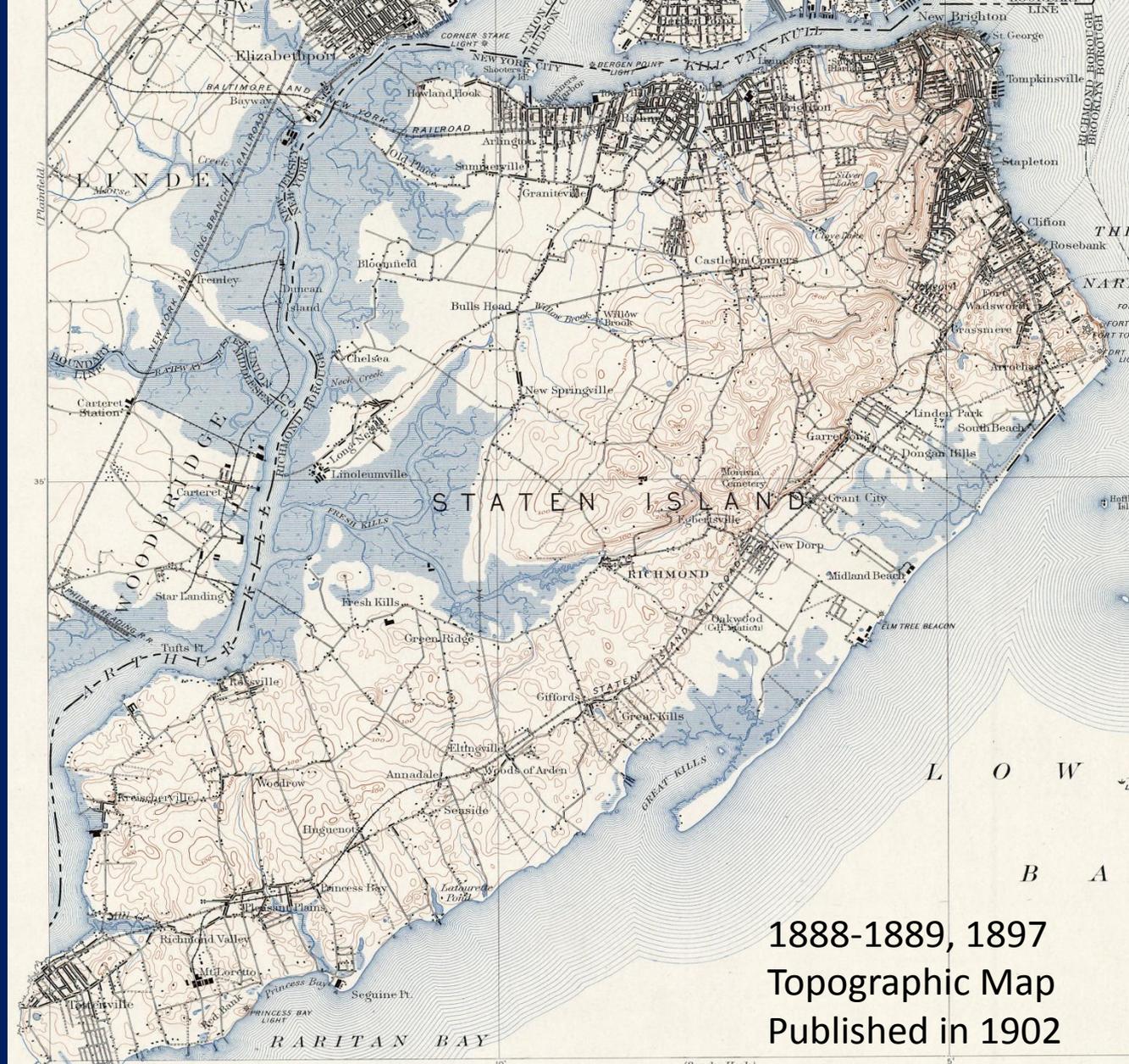
# Hillshade MAP OF STATEN ISLAND NY

This is a  
GIS map  
made from  
Digital  
Elevation  
Models.



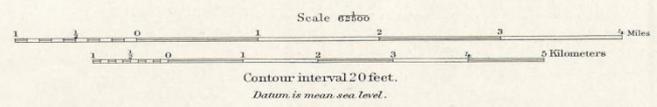
Data from USGS and FEMA GIS MAP By Alan I. Benimoff, Ph.D.  
Date: 3/2/2013  
Time: 3:20:39 PM





1888-1889, 1897  
 Topographic Map  
 Published in 1902

H.M. Wilson, Geographer in charge.  
 Triangulation by U.S. Coast and Geodetic Survey.  
 Topography by U.S. Coast and Geodetic Survey.  
 S.H. Bodfish, Frank Sutton, J.W. Thom, and J.H. Wheat.  
 Surveyed in 1888-89 and 1897 in cooperation with the State of New York;  
 Campbell W. Adams, State Engineer and Surveyor.



# SLOSH – Sea Lake and Overland Surges From Hurricanes

Hurricane storm surge zones are based on NOAA Sea, Lake and Overland Surge from Hurricanes (SLOSH) model projections of vertical surge heights associated with Saffir - Simpson scale category 1 - 4 storms.

Surge heights are associated with terrain elevation to delineate inundation zones for hurricane category 1 - 4 storms.

Multiple storm landfall locations have been factored to produce a worst case flooding for any given area. Northwest direction storms which landfall at high tide are used as these storms produce the highest surge in this region.

## **Tropical Storm**

Winds 39-73 mph

### **Category 1 Hurricane — winds 74-95 mph (64-82 kt)**

No real damage to buildings. Damage to unanchored mobile homes. Some damage to poorly constructed signs. Also, some coastal flooding and minor pier damage.

- Examples: Irene 1999 and Allison 1995

### **Category 2 Hurricane — winds 96-110 mph (83-95 kt)**

Some damage to building roofs, doors and windows. Considerable damage to mobile homes. Flooding damages piers and small craft in unprotected moorings may break their moorings. Some trees blown down.

- Examples: Bonnie 1998, Georges(FL & LA) 1998 and Gloria 1985

### **Category 3 Hurricane — winds 111-130 mph (96-113 kt)**

Some structural damage to small residences and utility buildings. Large trees blown down. Mobile homes and poorly built signs destroyed. Flooding near the coast destroys smaller structures with larger structures damaged by floating debris. Terrain may be flooded well inland.

- Examples: Keith 2000, Fran 1996, Opal 1995, Alicia 1983 and Betsy 1965

### **Category 4 Hurricane — winds 131-155 mph (114-135 kt)**

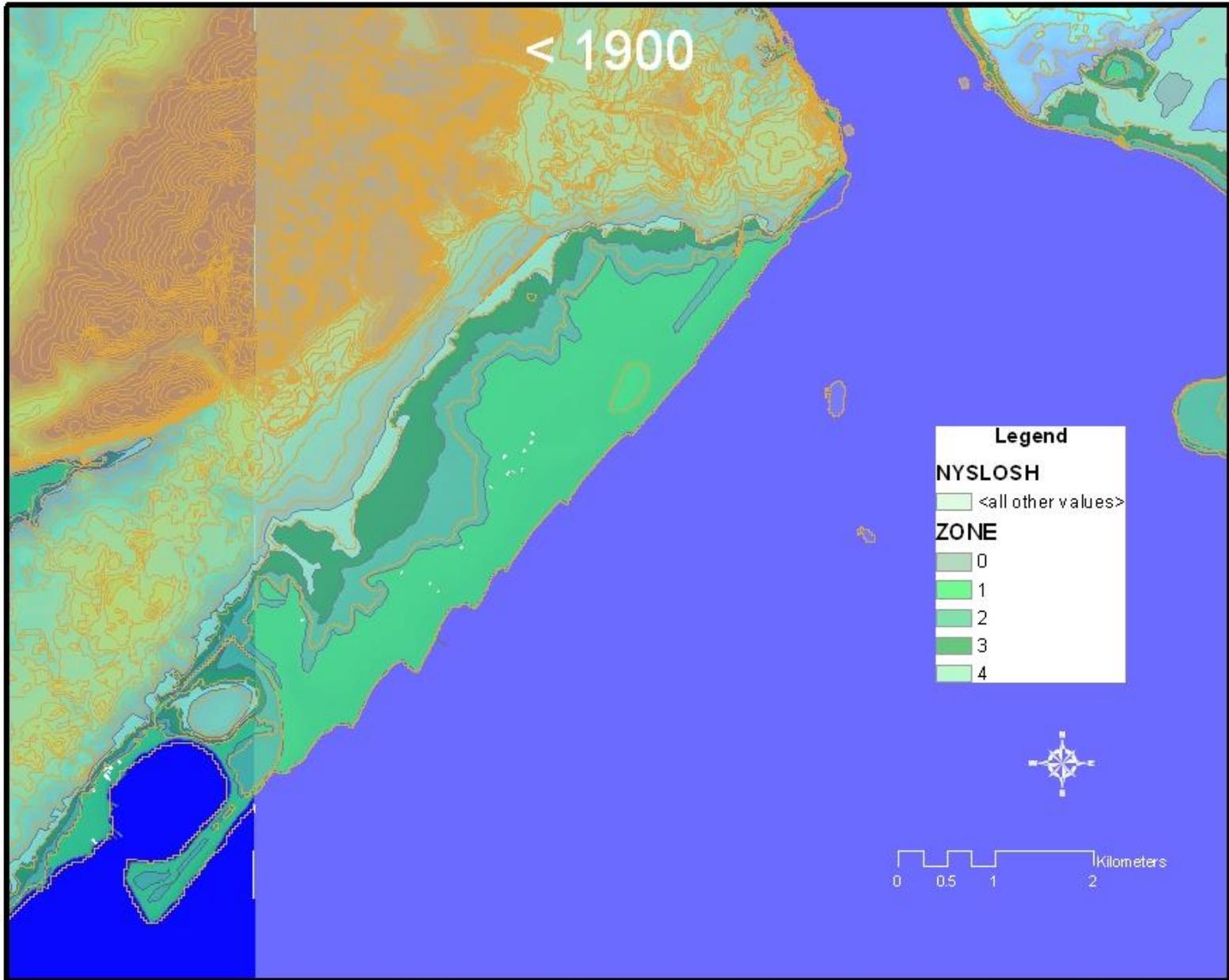
More extensive curtainwall failures with some complete roof structure failure on small residences. Major erosion of beach areas. Terrain may be flooded well inland.

- Examples: Hugo 1989 and Donna 1960

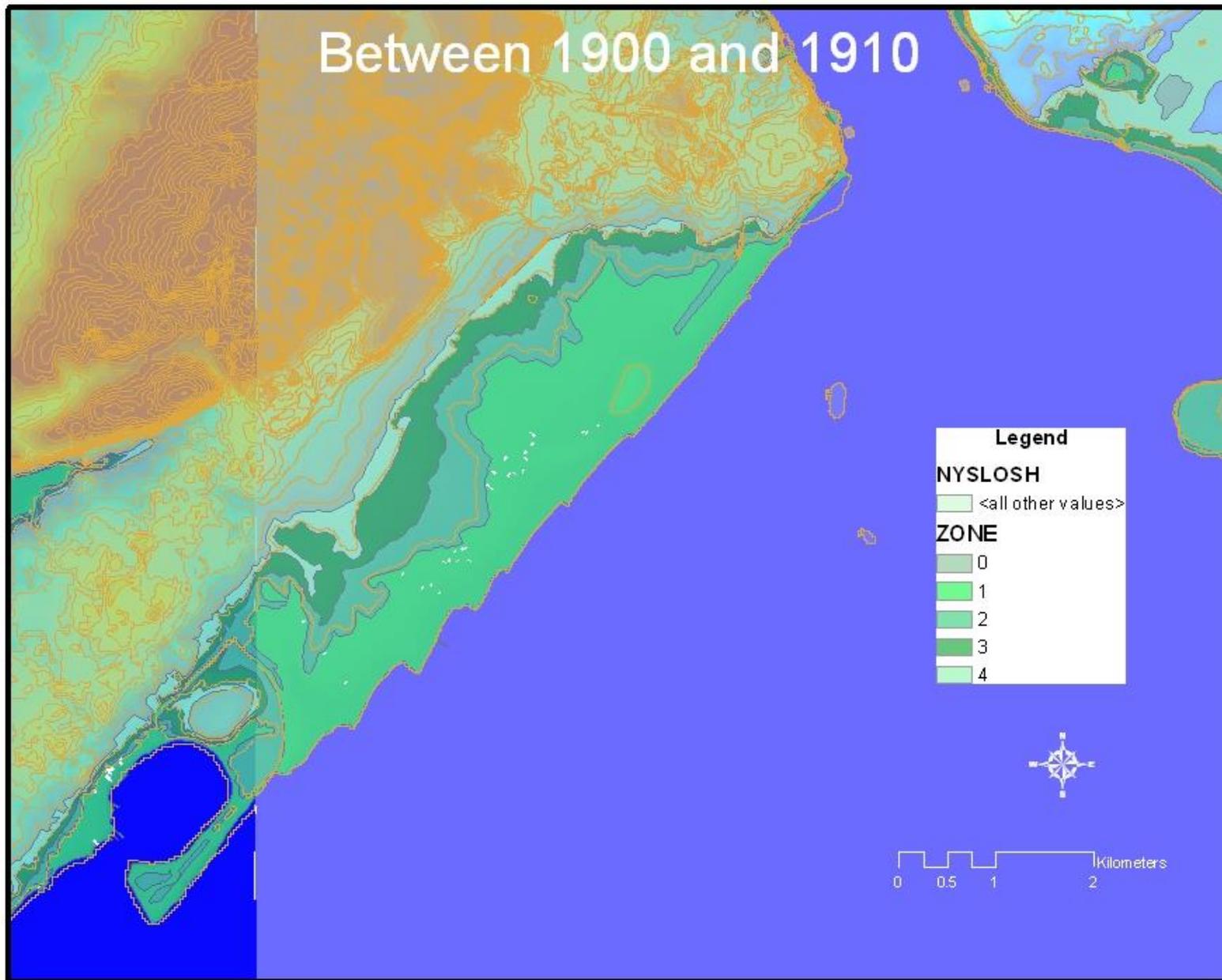
### **Category 5 Hurricane — winds 156 mph and up (135+ kt)**

Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Flooding causes major damage to lower floors of all structures near the shoreline. Massive evacuation of residential areas may be required.

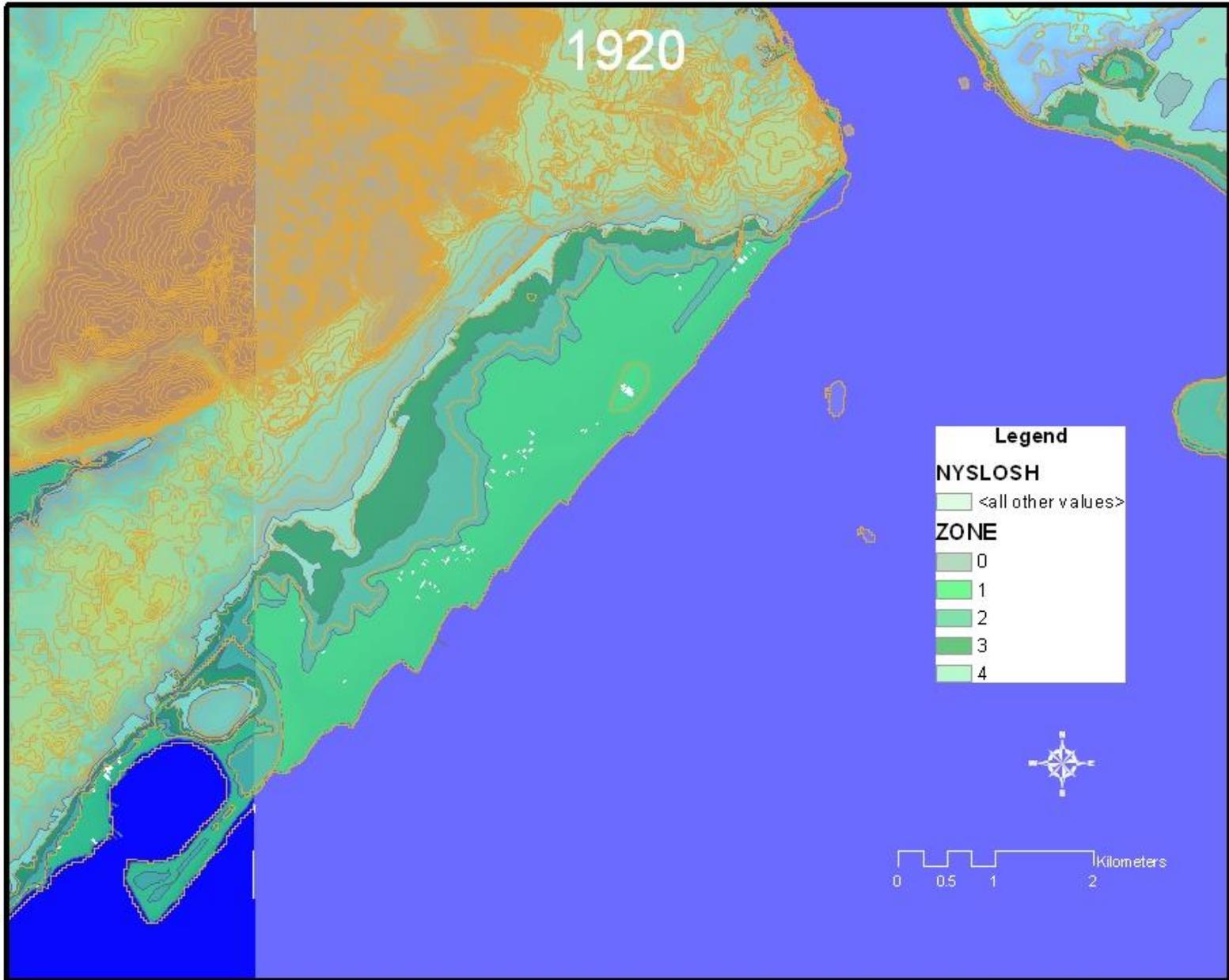
- Examples: Andrew(FL) 1992, Camille 1969 and Labor Day 1935



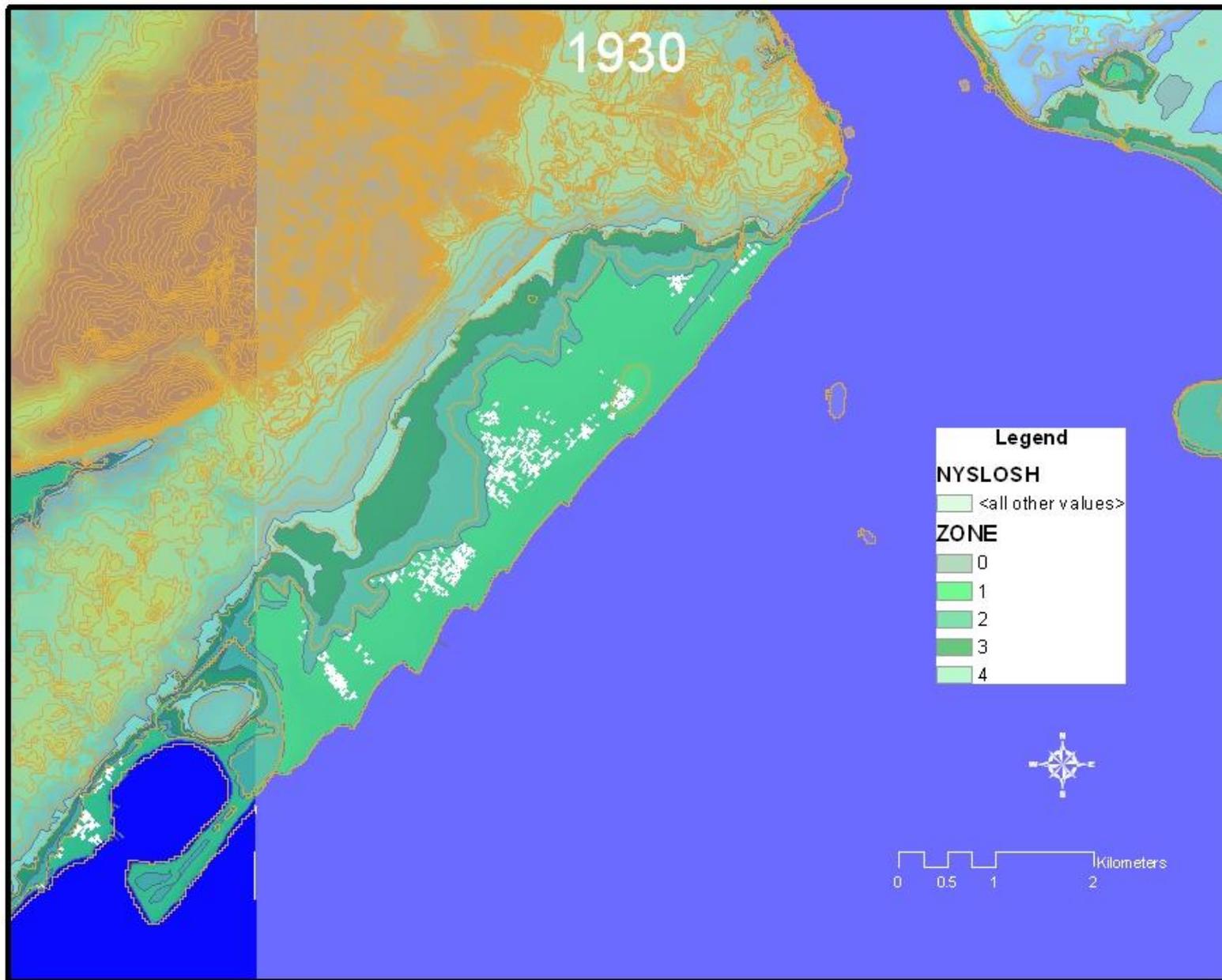
GIS Map By Alan I. Benimoff, Ph.D.



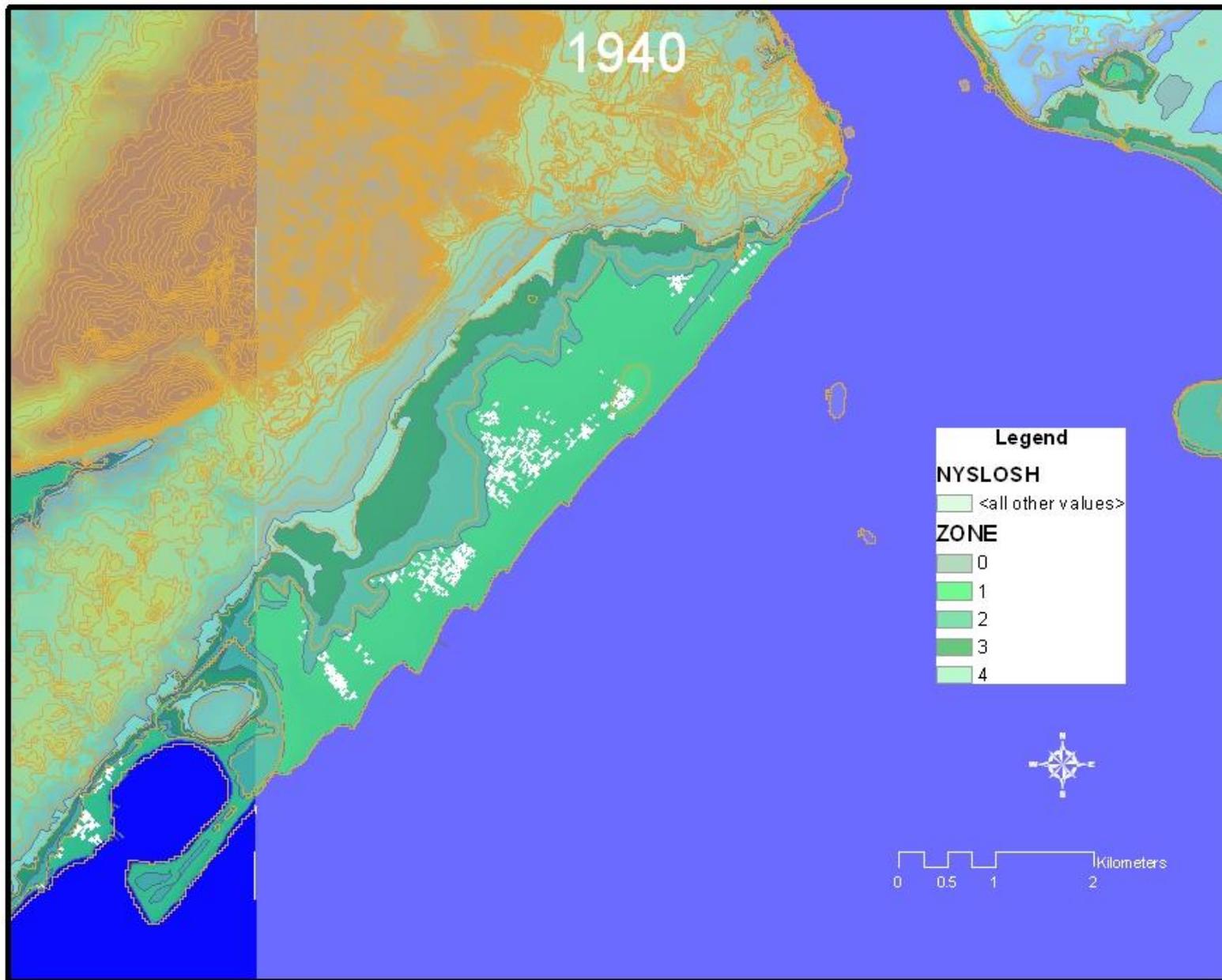
GIS Map By Alan I. Benimoff, Ph.D.



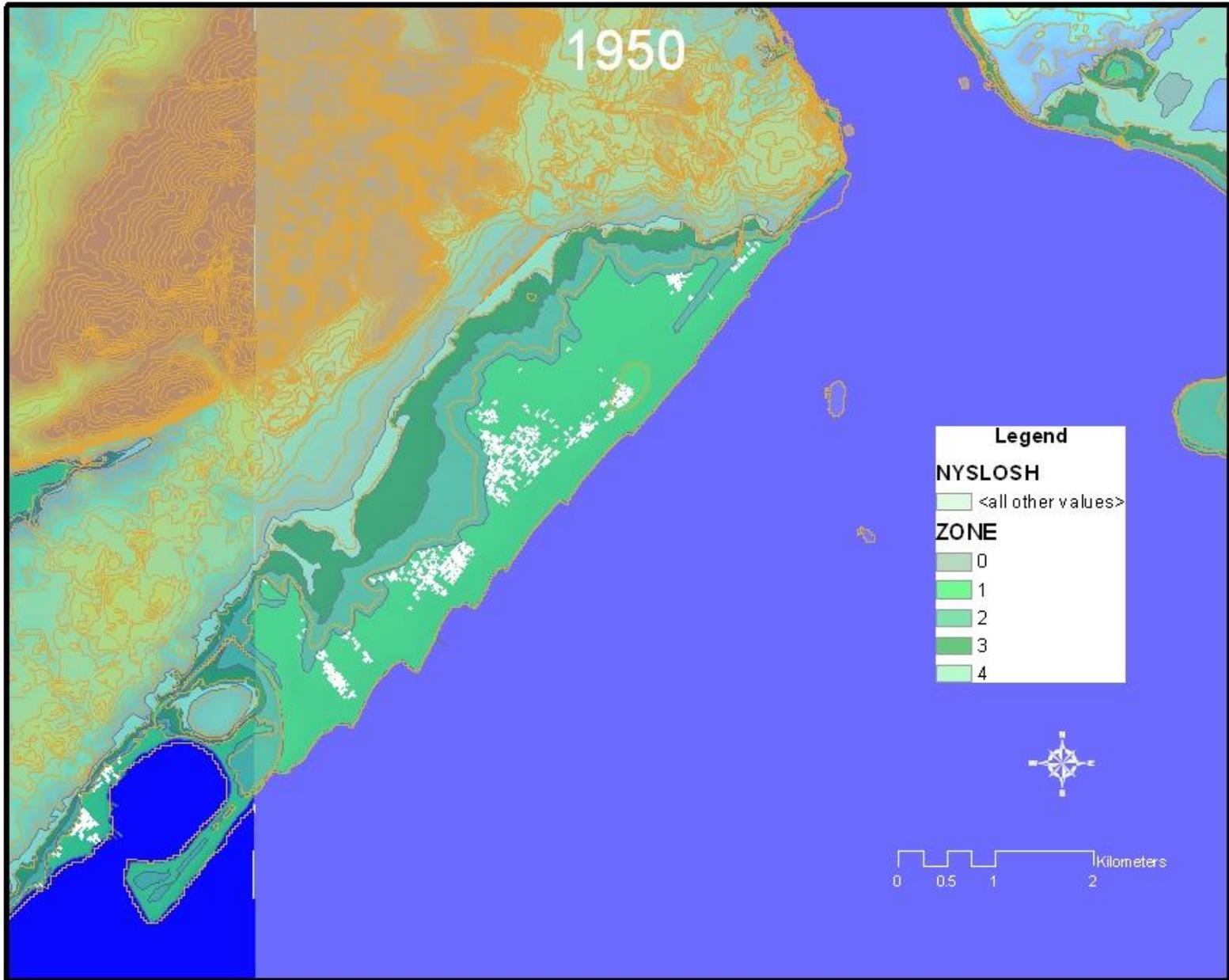
GIS Map By Alan I. Benimoff, Ph.D.



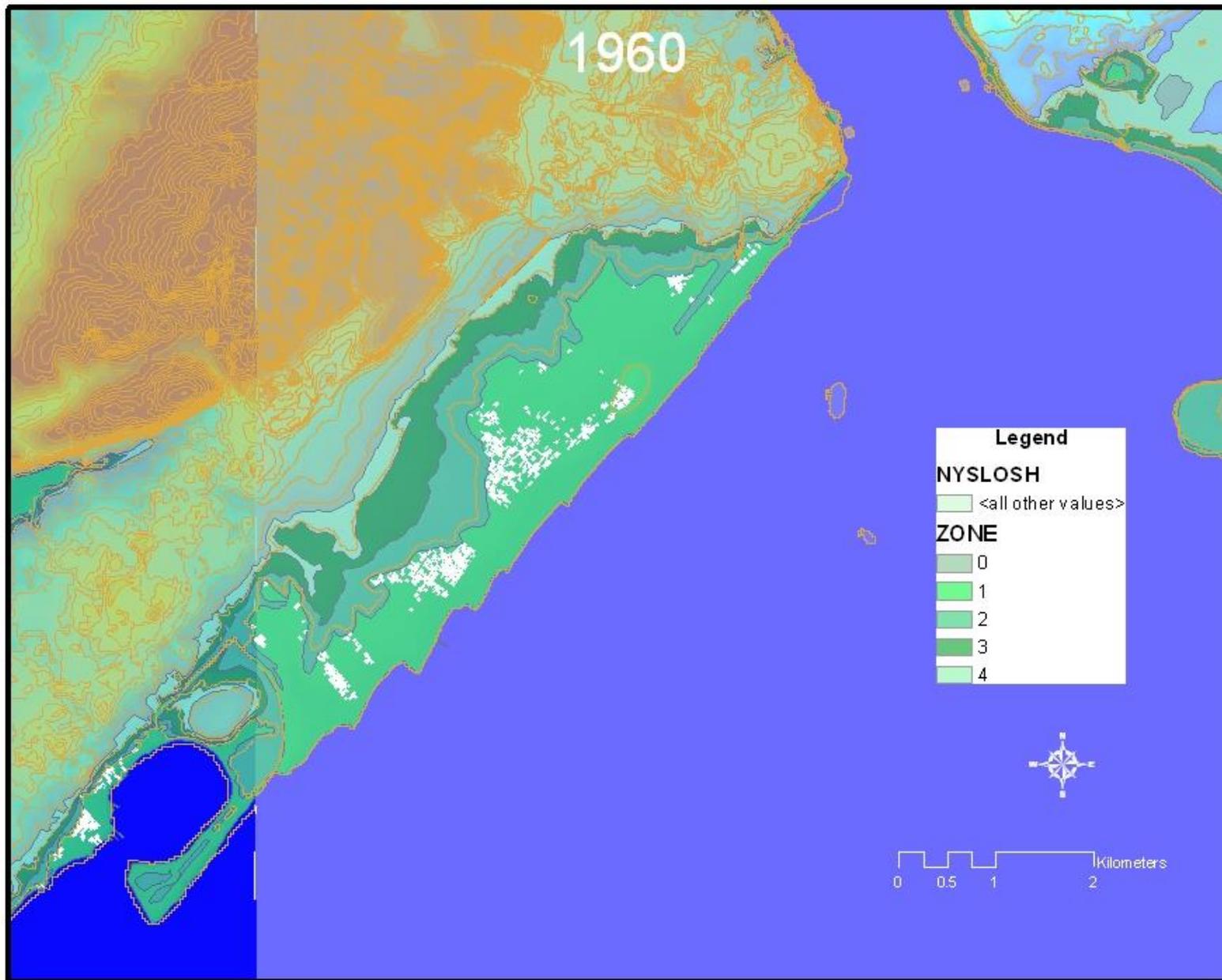
GIS Map By Alan I. Benimoff, Ph.D.



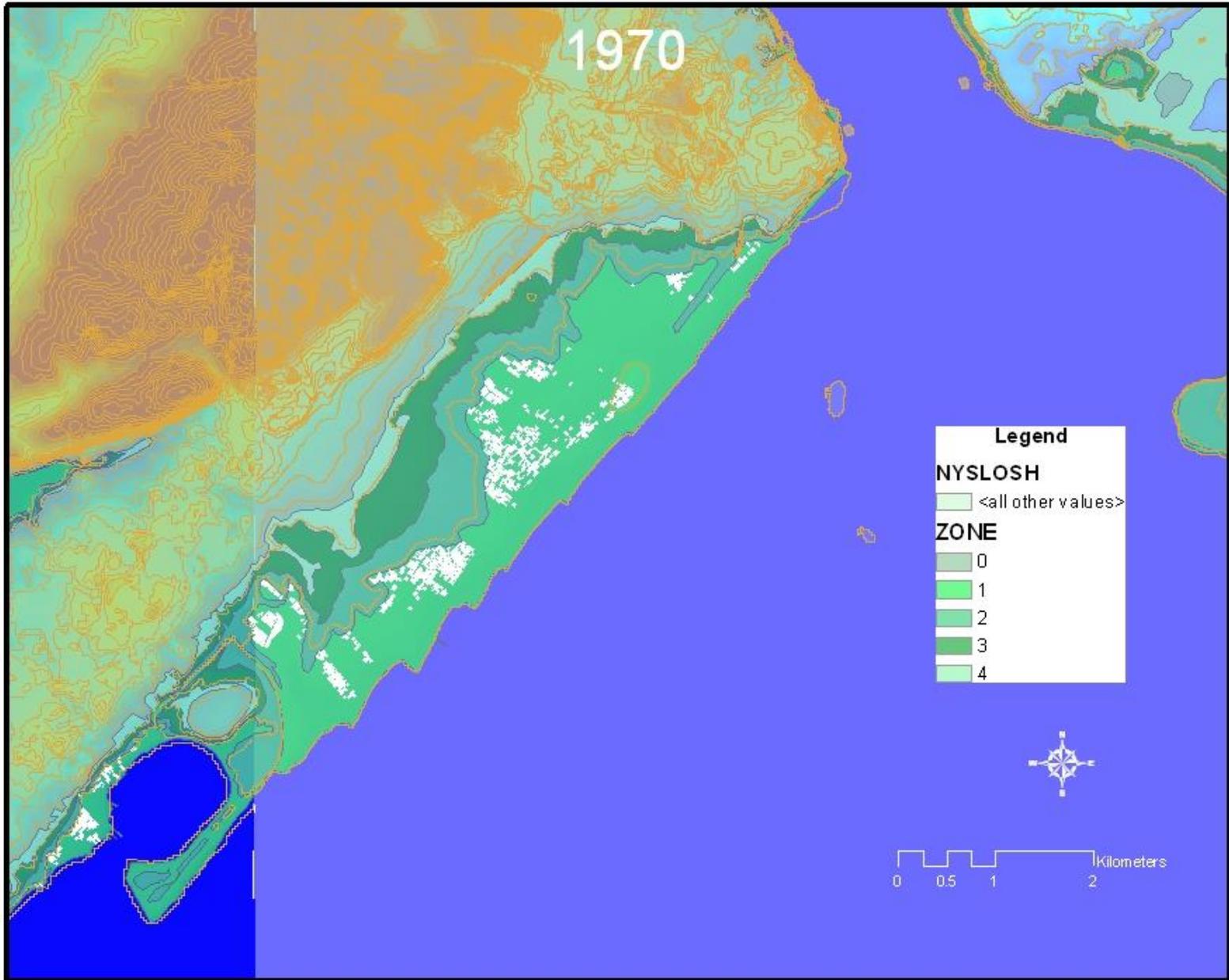
GIS Map By Alan I. Benimoff, Ph.D.



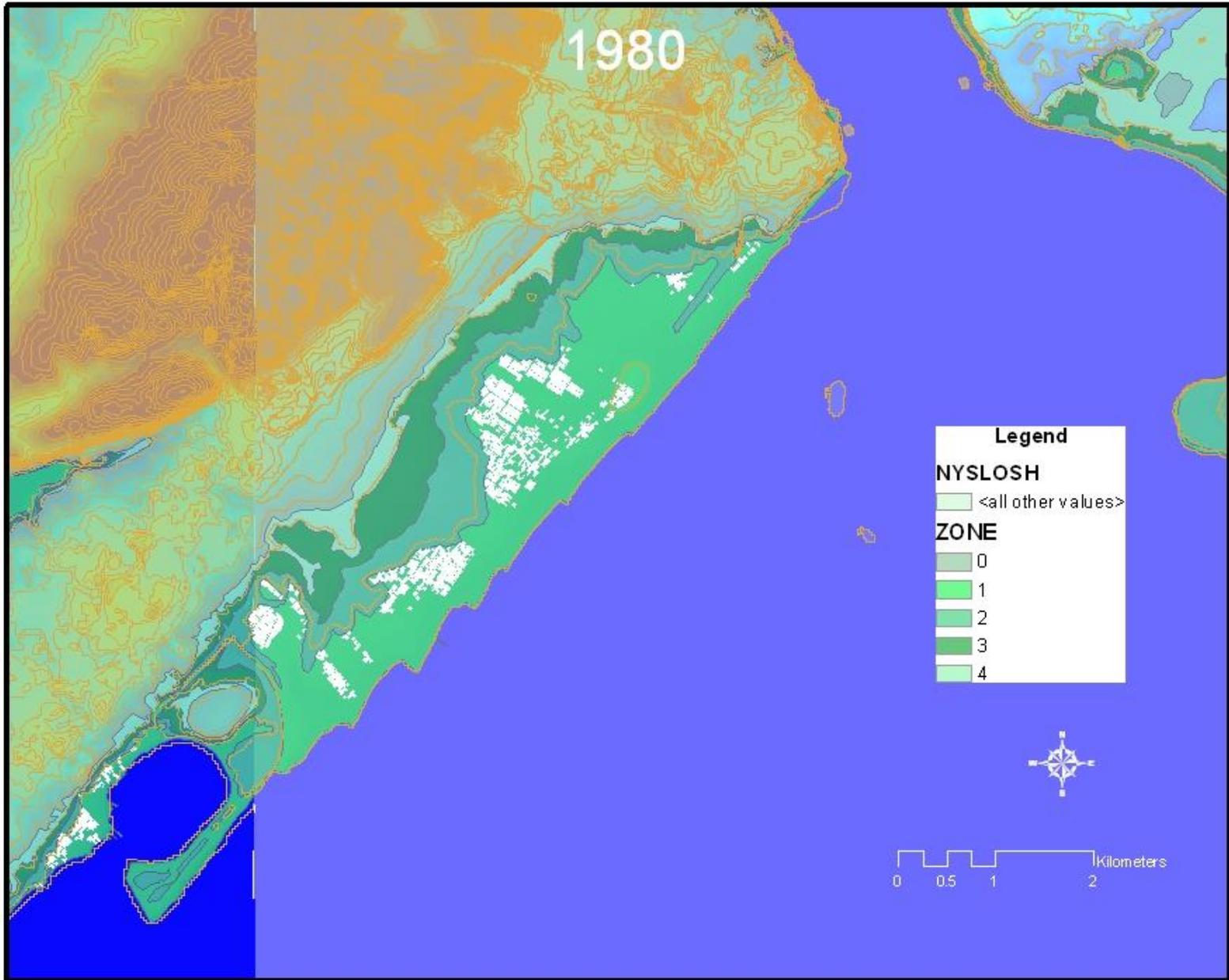
GIS Map By Alan I. Benimoff, Ph.D.



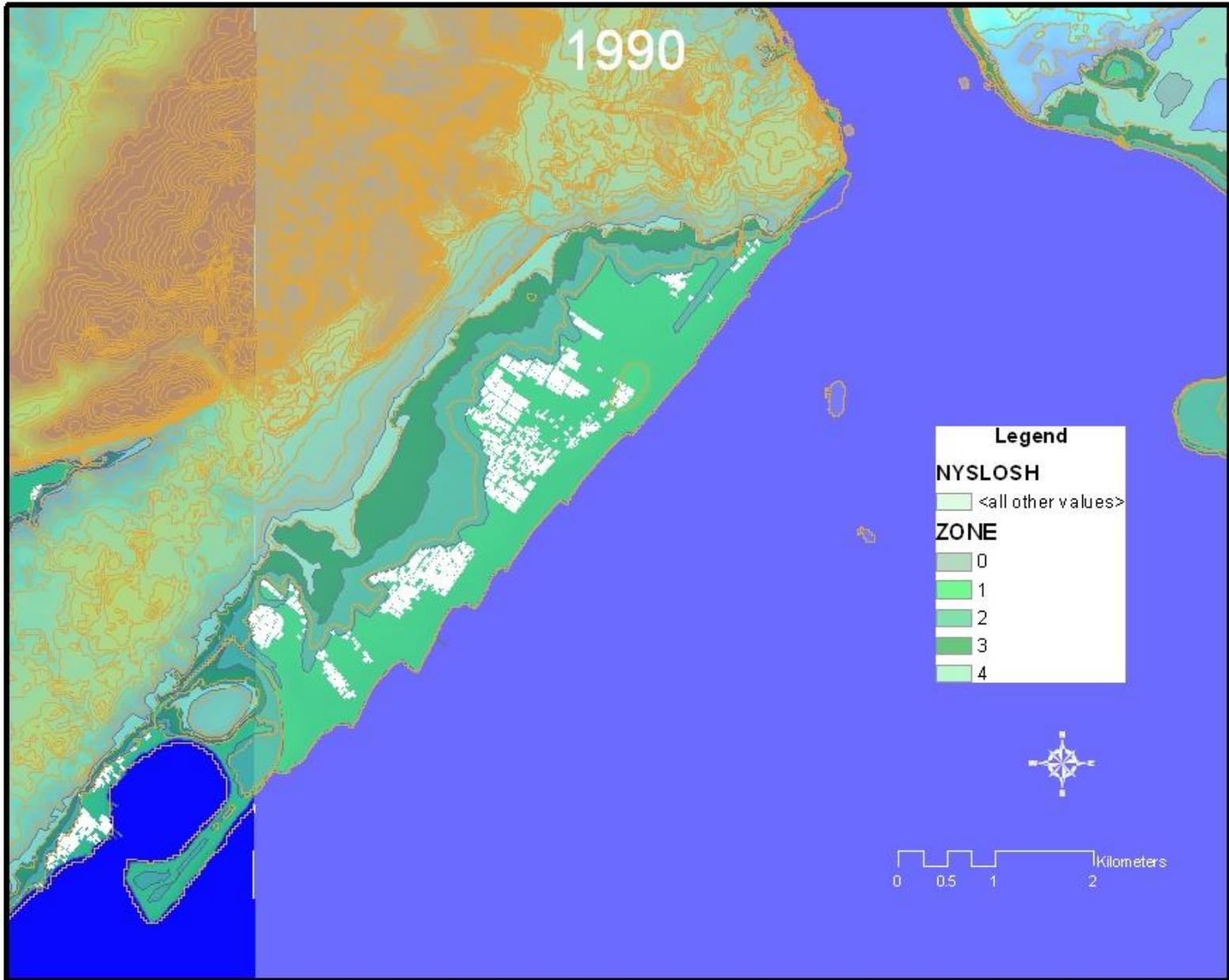
GIS Map By Alan I. Benimoff, Ph.D.



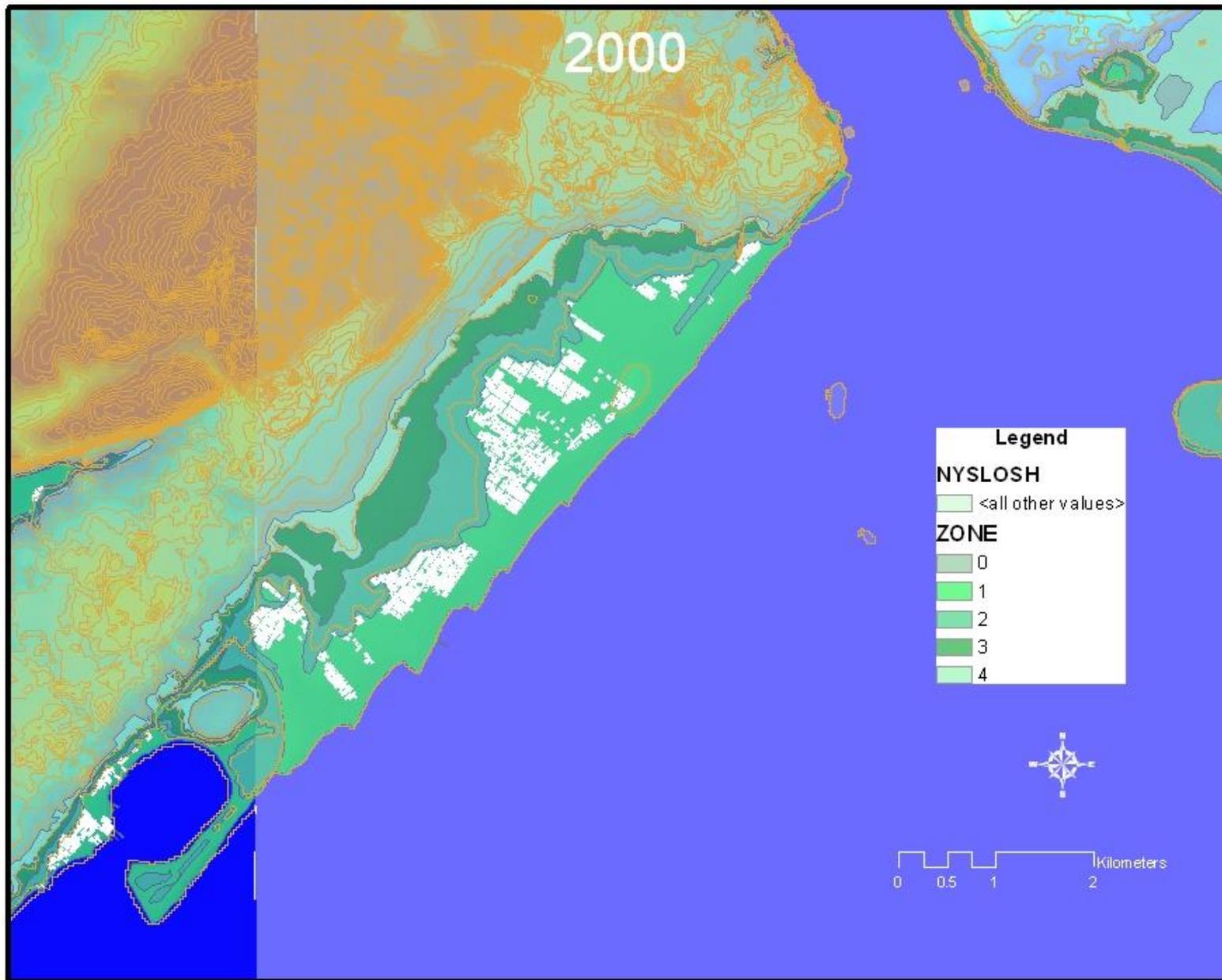
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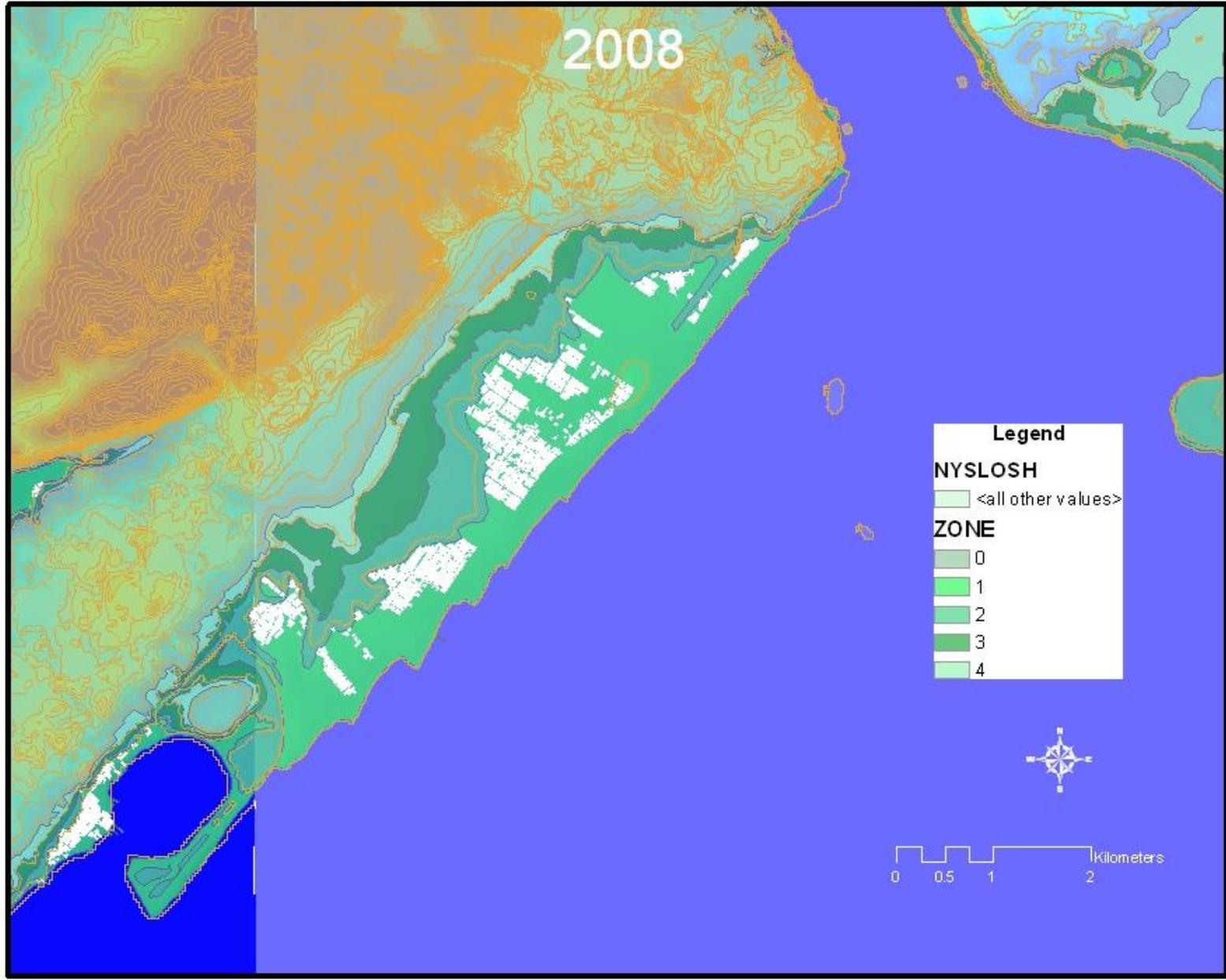
GIS Map By Alan I. Benimoff, Ph.D.



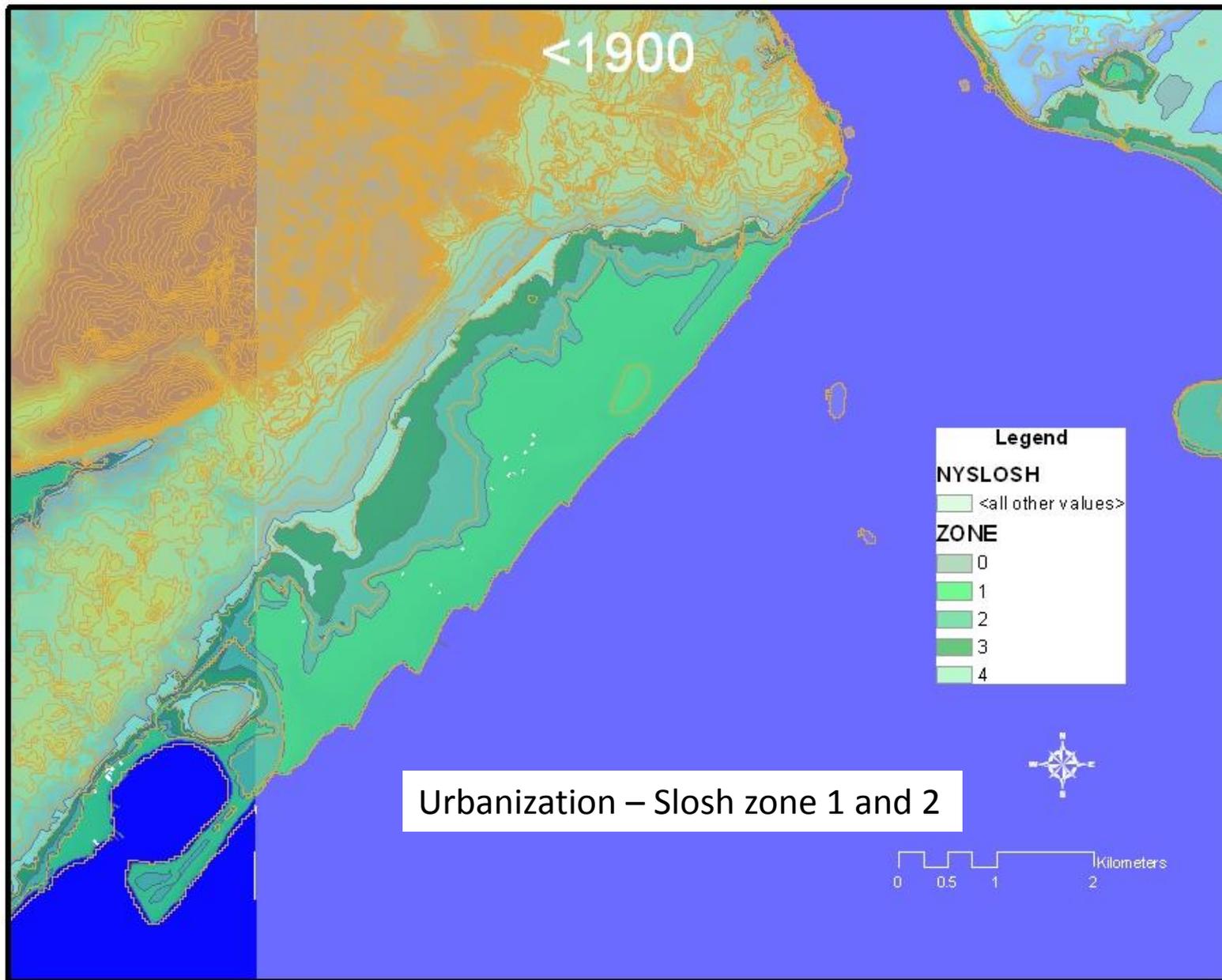
GIS Map By Alan I. Benimoff, Ph.D.

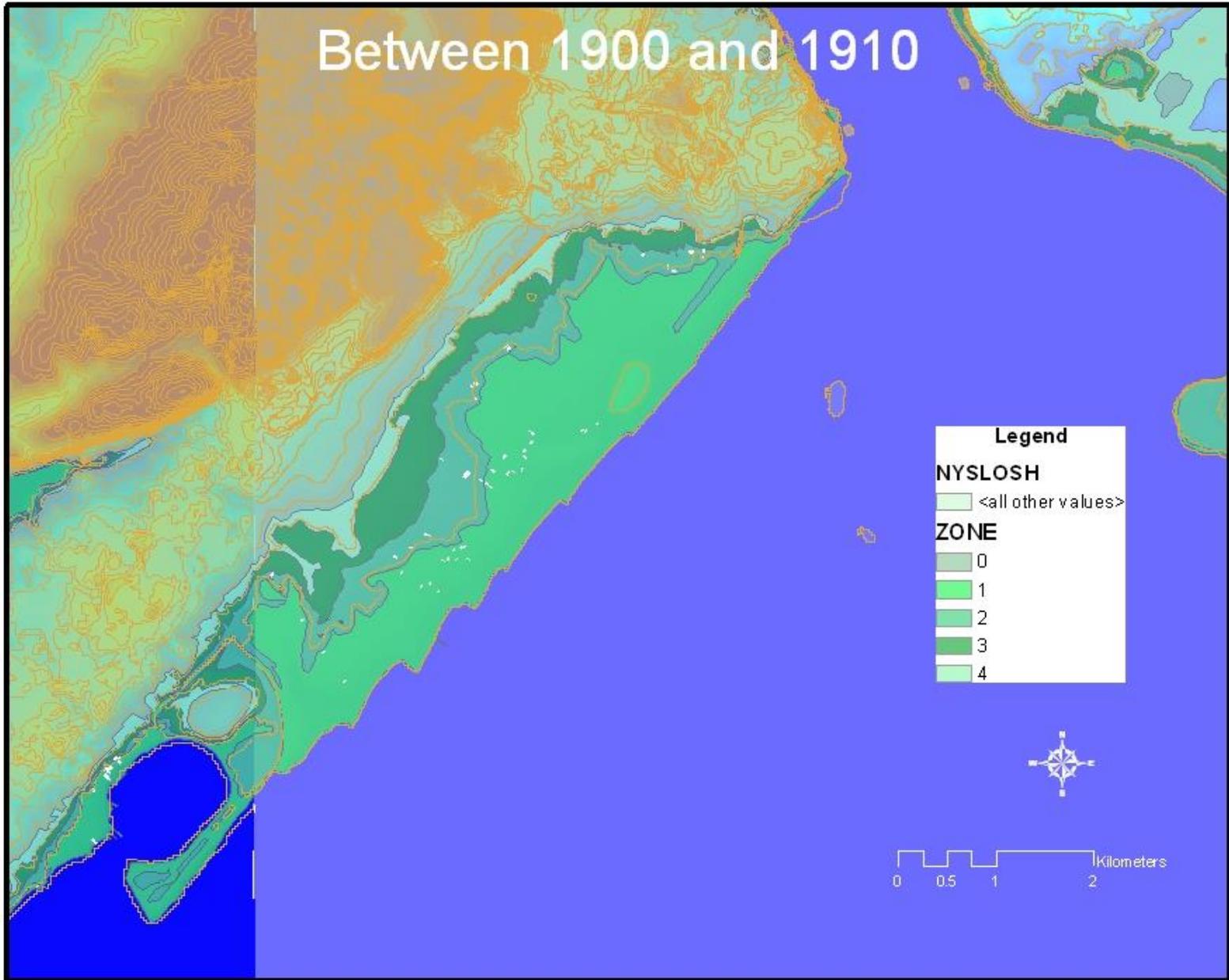


2008

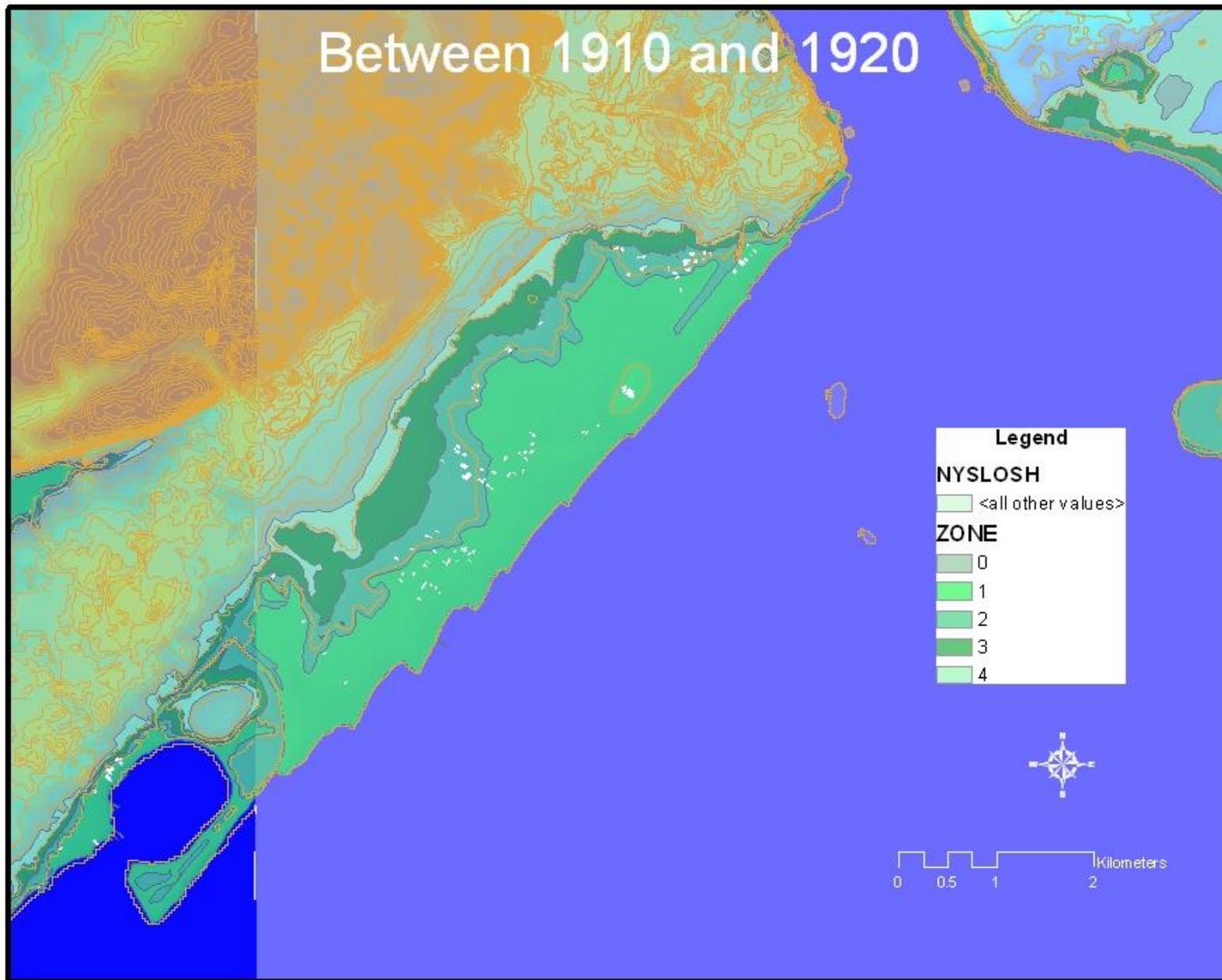


0 0.5 1 2 Kilometers

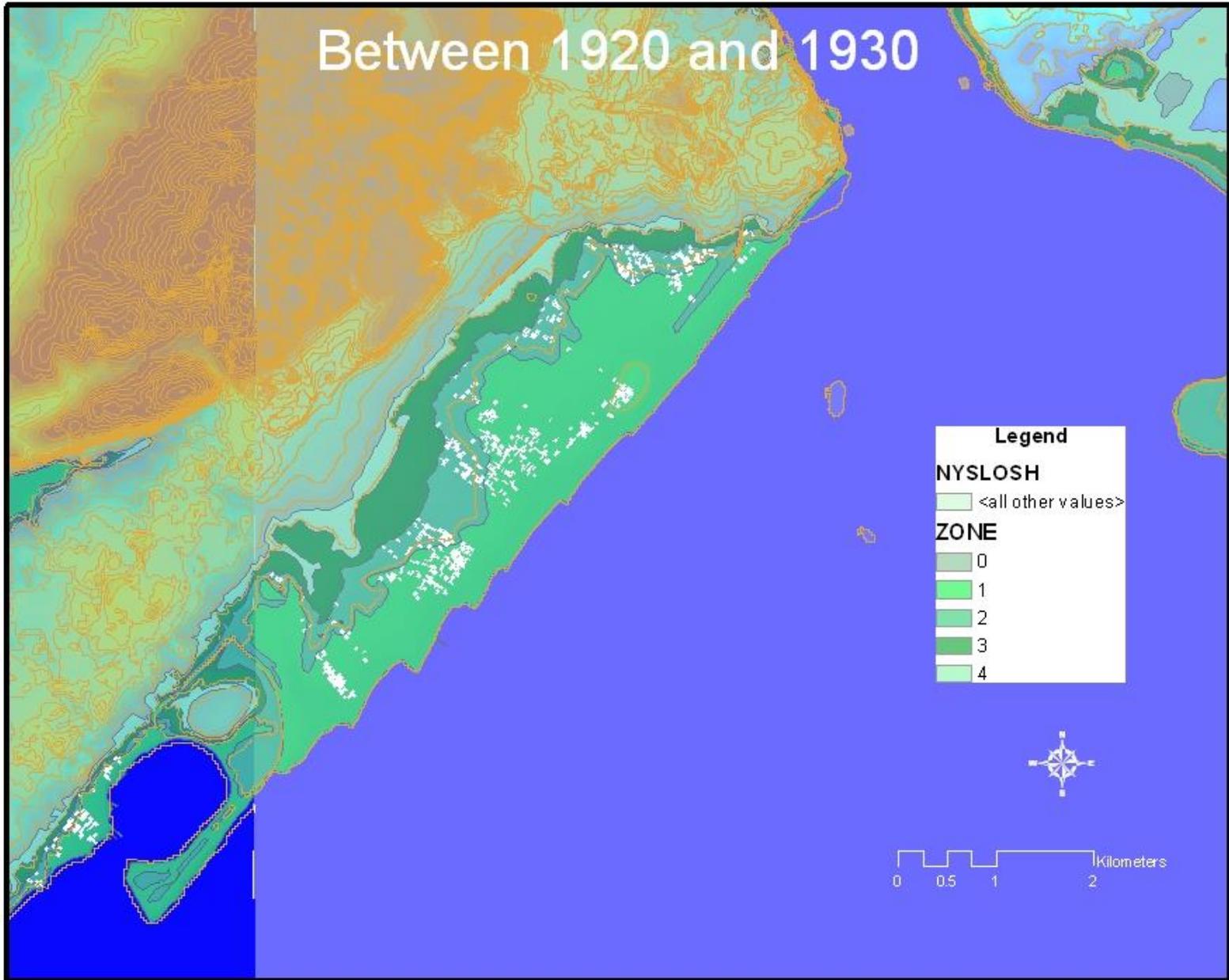




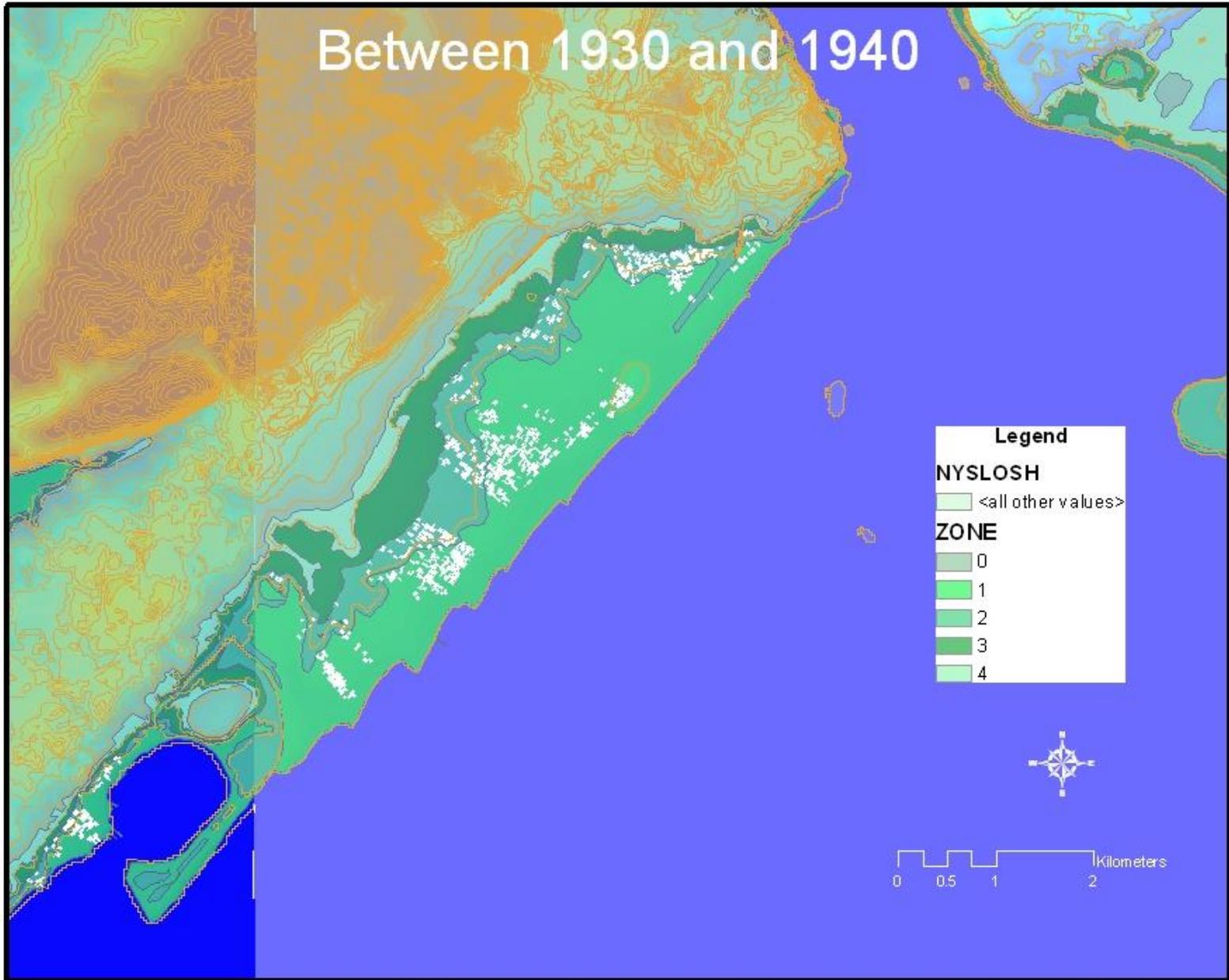
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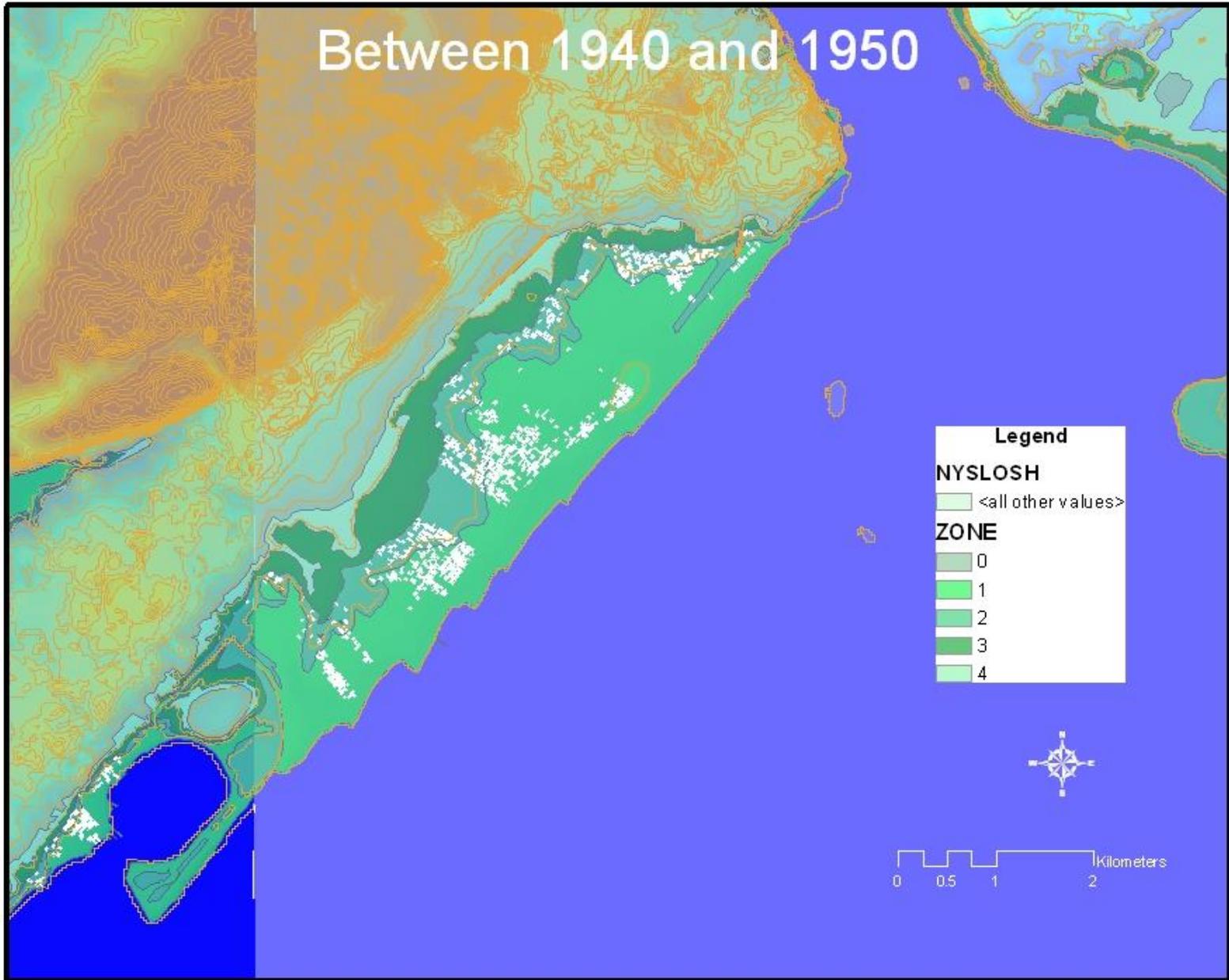
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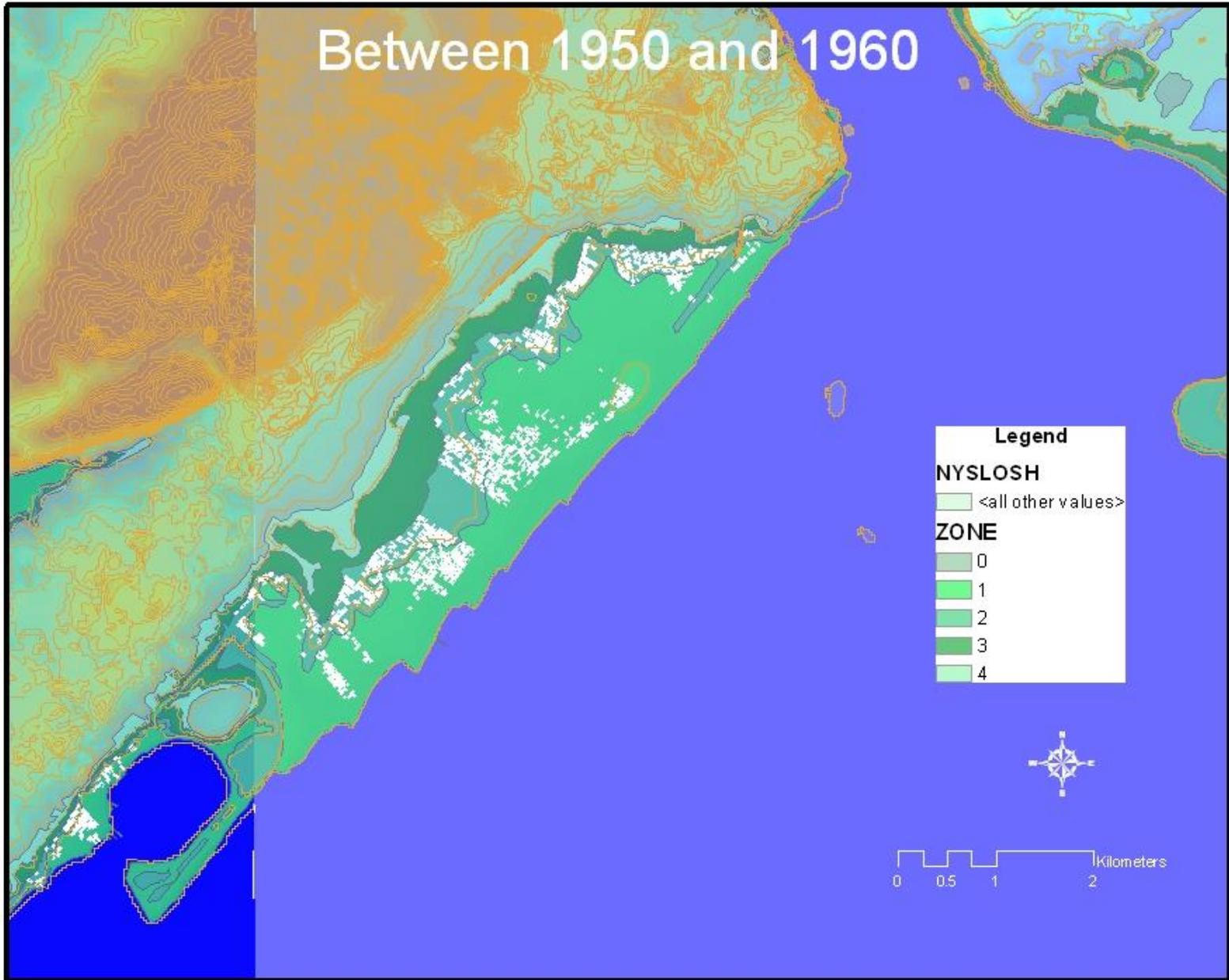
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# New Yorker Magazine

*Sandy and the future.*

BY IAN FRAZIER

When the storm hit, on October 29th, all the Staten Island ferries on the water were on the Staten Island side. One ferry was in drydock; the seven others had been tied to piers near the St. George ferry terminal. At about five-fifteen in the afternoon, the hawsers began to snap as the surge lifted the boats above the piers. Soon the piers could not

down the shore, old dock pilings thirty feet long with two-foot-long rusted iron spikes that showed the marks of a blacksmith's hammer were floating in and smashing the lower windows and doors of a luxury apartment complex called Bay Street Landing. A few hundred yards beyond the apartments, a hundred-and-eighty-four-foot-long tanker ship, the

tongue, the Verrazano-Narrows Bridge gives the island its only highway connection to the rest of New York City—and not an ideal one, because the bridge deposits incoming traffic on the Belt Parkway or the Gowanus Expressway in distant Bay Ridge, Brooklyn. The front part of the boat, where the facings would be, faces southeastward, toward the Atlantic Ocean. Flooding did a lot of damage to the island north of the Verrazano Bridge, but south of it, on the island's ocean side, was where all but one of the fatalities



*Standing in a soggy no man's forest near a beach, I saw the landscape of the hot new world to come.*

be seen, and the boats' crews, at full strength, maneuvered them back and forth with the engines so they wouldn't go aground or crash into pieces of debris or each other. Fully lit, the seven ferry

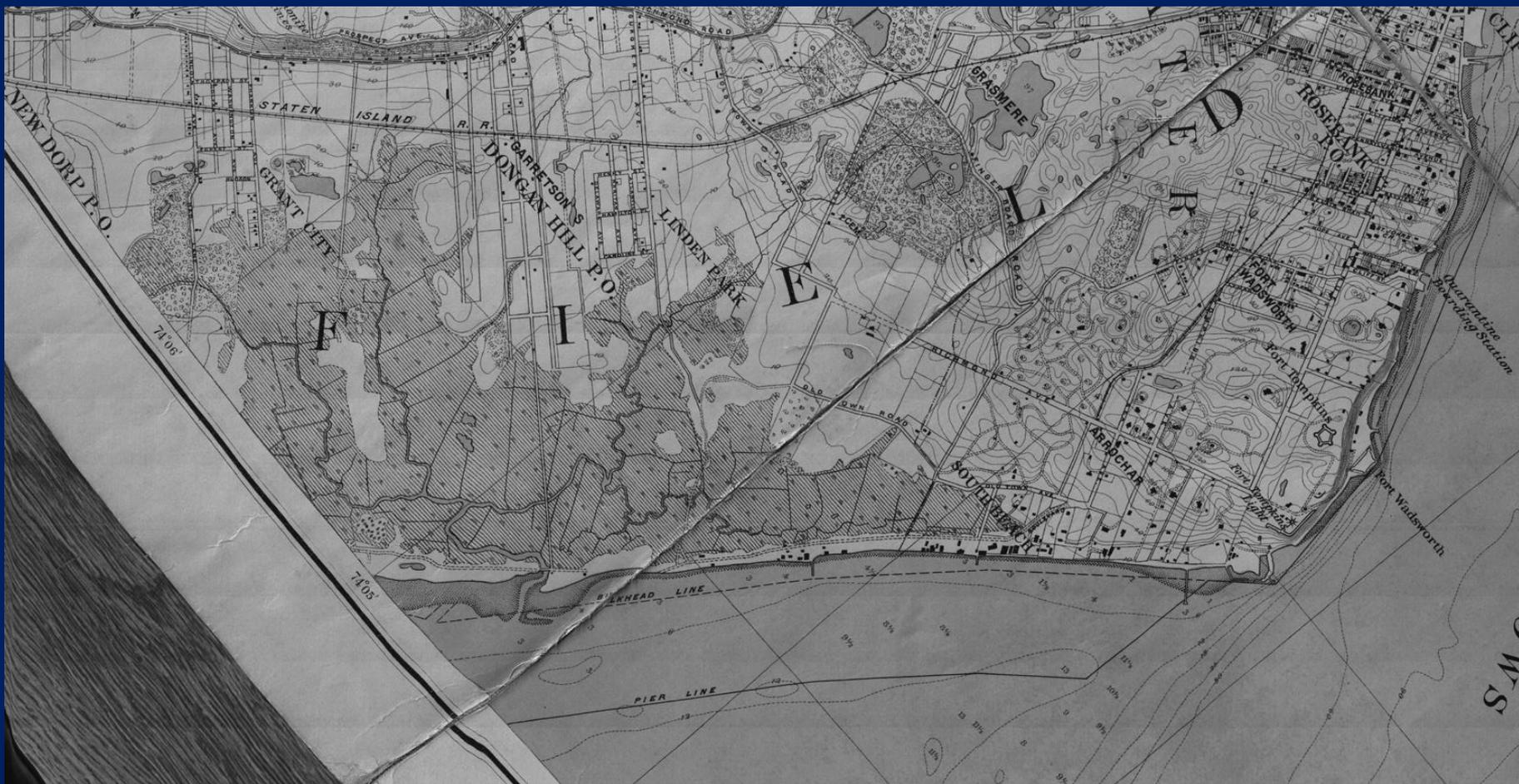
John B. Caddell, washed up on a small stretch of undeveloped shoreline and stayed there.

Staten Island has the shape of an ankle boot. The sole runs along a chan-

occurred. The storm killed twenty-three on Staten Island, the highest number of storm-related deaths in any borough. Twenty of them drowned.

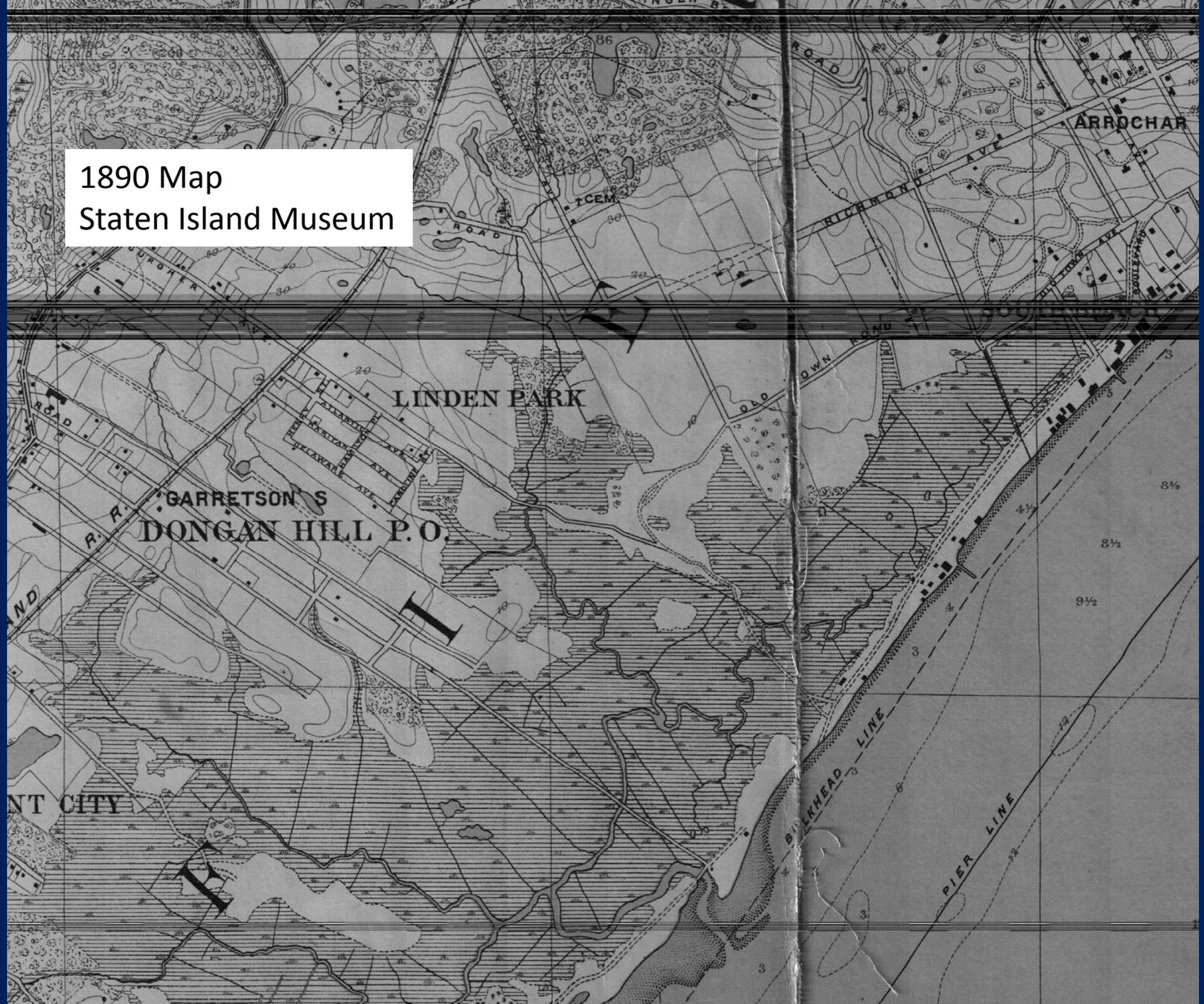
“After Hurricane Irene, Dr. Fritz began a study of what would happen to Staten Island in bigger hurricanes.”

“With Dr. Alan Benimoff, a C.S.I. professor of geology, who had been examining the changes since 1898 in housing density along Staten Island’s Atlantic shore”



1890 Map  
Staten Island Museum

1890 Map  
Staten Island Museum





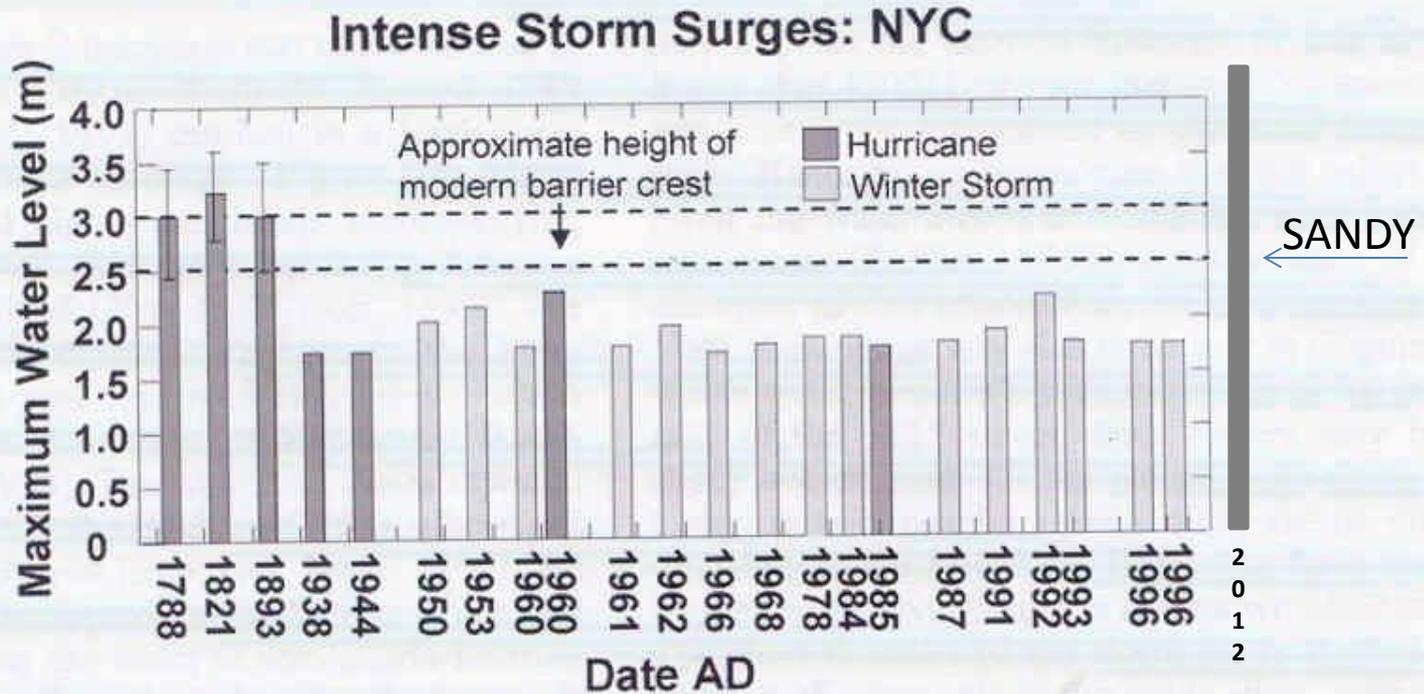
1890 Map  
Staten Island Museum

1890 Map  
Staten Island Museum

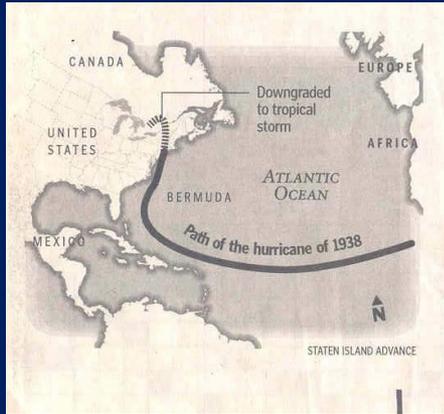


# Hurricane History

- 1635, 1638, 1720, 1781, 1811, 1815, 1861, 1888, 1889, 1893, 1896, 1897, 1901, 1903, 1914, 1920, 1927, 1932, 1935, 1938, 1944, 1953, 1954, 1955, 1960 and 1962.



**Figure 5.** Storm surge heights relative to modern mean sea level which accompanied the 1788, 1821, and 1893 hurricanes inferred from historic archives and the most extreme flooding events of the 20th century recorded by the Battery Park (New York City) tide gauge from 1920 to present. The average height of the modern [2002] barrier crest (2.5–3.0 m) is indicated with dashed lines.



Images from Staten Island Advance





Bungalows near the ocean were no match for the powerful winds of the 1938 hurricane.

The protective fence was blown against the side of the former Richmond County Yacht Club during the hurricane of 1938.



Two boats were tossed out of the harbor and onto a roadway by the storm surge.



Waves crash into a railroad yard in St. George during Hurricane Donna on Sept. 12, 1960.

almost all of the land between



ADVANCE FILE PHOTO

The storm surge from Hurricane Donna tossed this boat onto a bulkhead at Great Kills Harbor.

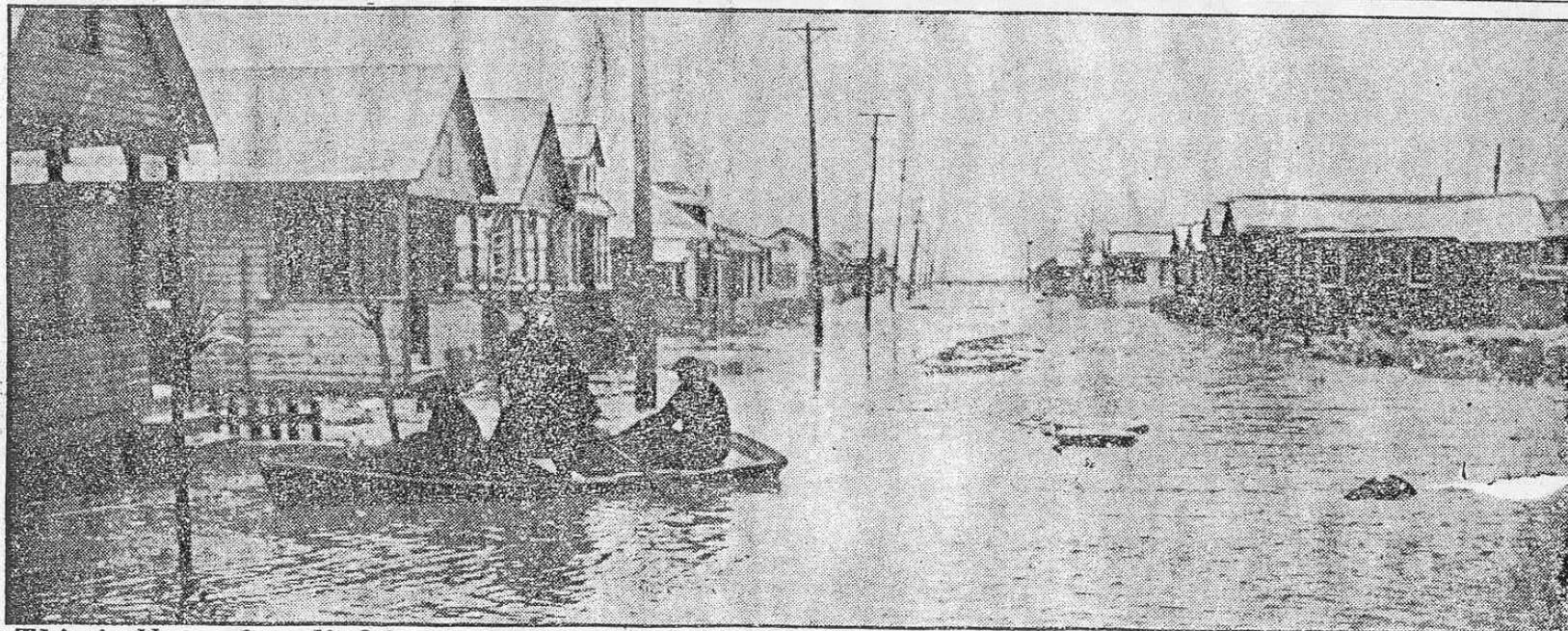
# Extratropical Storm of 1927

From Staten Island Museum Archives

STATEN ISLAND ADVANCE

STATEN ISLAND, N. Y., MONDAY, FEBRUARY 21, 1927

# LATEST PHOTOS OF RUINS WREAKED BY FURIOUS OCEAN TIDE WAVE



**This is Not a Canal!**—Only a flood street in Midland Beach, Staten Island. A dozen streets in this section were yesterday flooded to a depth of several feet. Telephone and telegraph services were crippled. Policemen and firemen in boats rowed along the flooded streets to save whatever floating household goods came their way.

Flooded tide  
February 20

# TIDAL WAVE BIGGEST IN LAST 125 YEARS

## Commissioner Cole Cites Record in An- cient Mill.

That the tidal wave which swept a large portion of Staten Island on Sunday was greater than any in more than a hundred years, is the claim of Commissioner Charles P. Cole, superintendent of the bureau of sewers under Borough President John A. Lynch.

In making this statement, Commissioner Cole recalls the record of high tides kept in the old mill which stood until 1907 at the foot of Richmond Valley road, Richmond Valley, which was built about 1802 by a brother of his great grandfather, Israel Dissosway. On a large oak post in the ancient mill, Commissioner Cole says, a record of high tides together with the date that the point was reached,

was cut into the timber and for many years a tide in the fall of 1876 stood as the peak mark on the post.

Among the old families on the Island, this tide of 51 years ago was frequently mentioned, Commissioner Cole relates, as the greatest that had ever visited the Island and many stories were told of incidents at the time. However, in the late 90's, he says, the record of the earlier storm was exceeded on the ancient guage and pointed out to all visitors to the mill as the highest point ever reached by the water here. Other records show that the tide last Sunday exceeded the highest peak of the one about thirty years ago.

Commissioner Cole places the date of the construction of the old mill through records kept by his early ancestor of the amount of pounds and shillings spent for liquor served as refreshments to the neighbors who assisted in the raising of the building.

*Advance Feb 23 '27*

*Feb 20*

*Feb 28 1927*

*Storm of Aug 24-1893 (See notes)*

*Also P.M. Nat. Sci. Assoc. Sept 1893*

From Staten Island Museum Archives

March 5, 1931

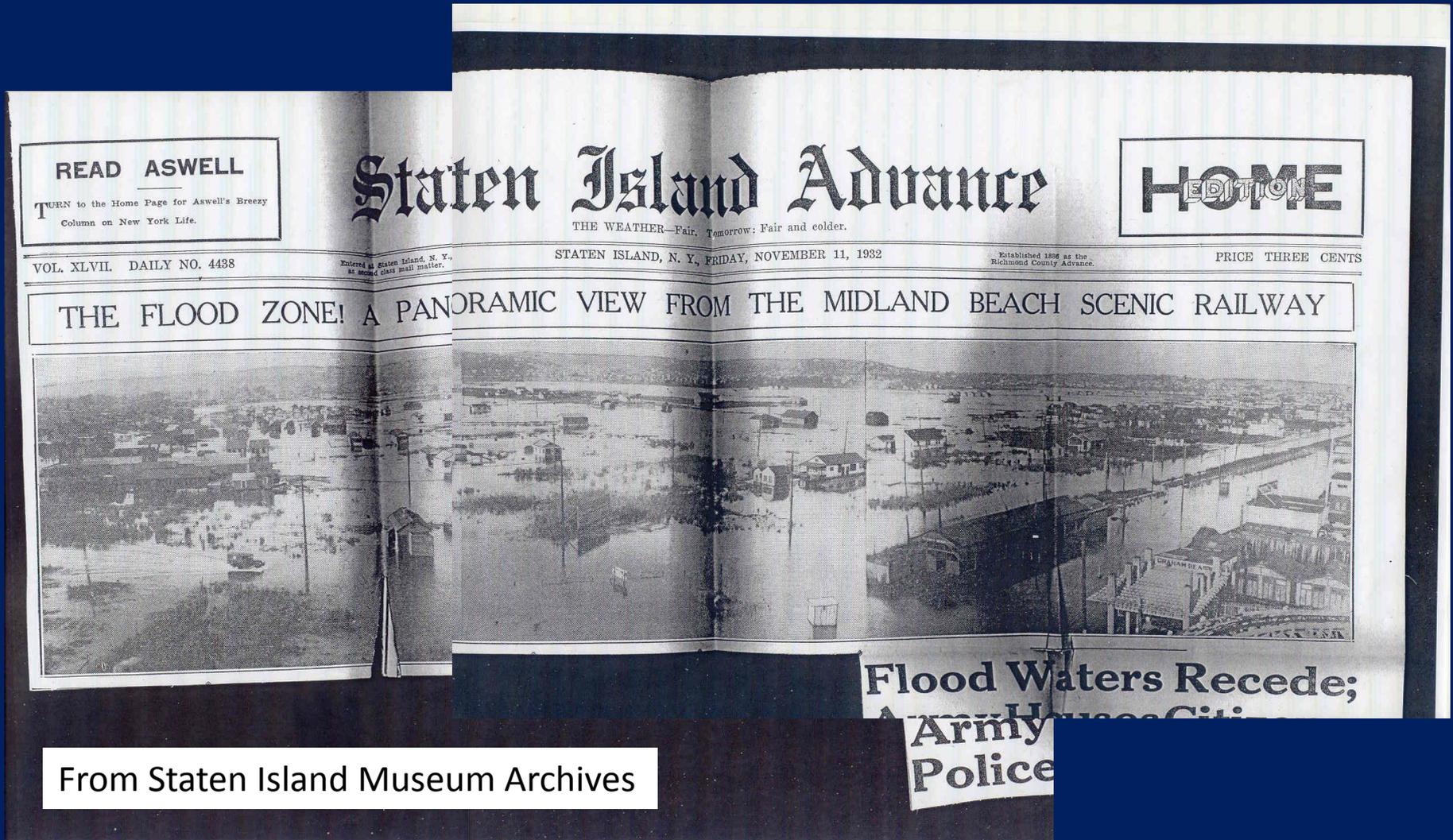
## OAKWOOD IS AWASH

*S. I. Advance March 6, 1931*

**H**IGH tides swept over Oakwood beach Wednesday night and flooded the lowlands upon which the bungalow colony stands. Here is how Oliver street looked yesterday, after the tide had begun to recede. A lake covering nearly a square mile was formed at the foot of Guyon avenue.



# Extratropical Storm of 1932



STATEN ISLAND, N. Y., FRIDAY, NOVEMBER 11, 1932

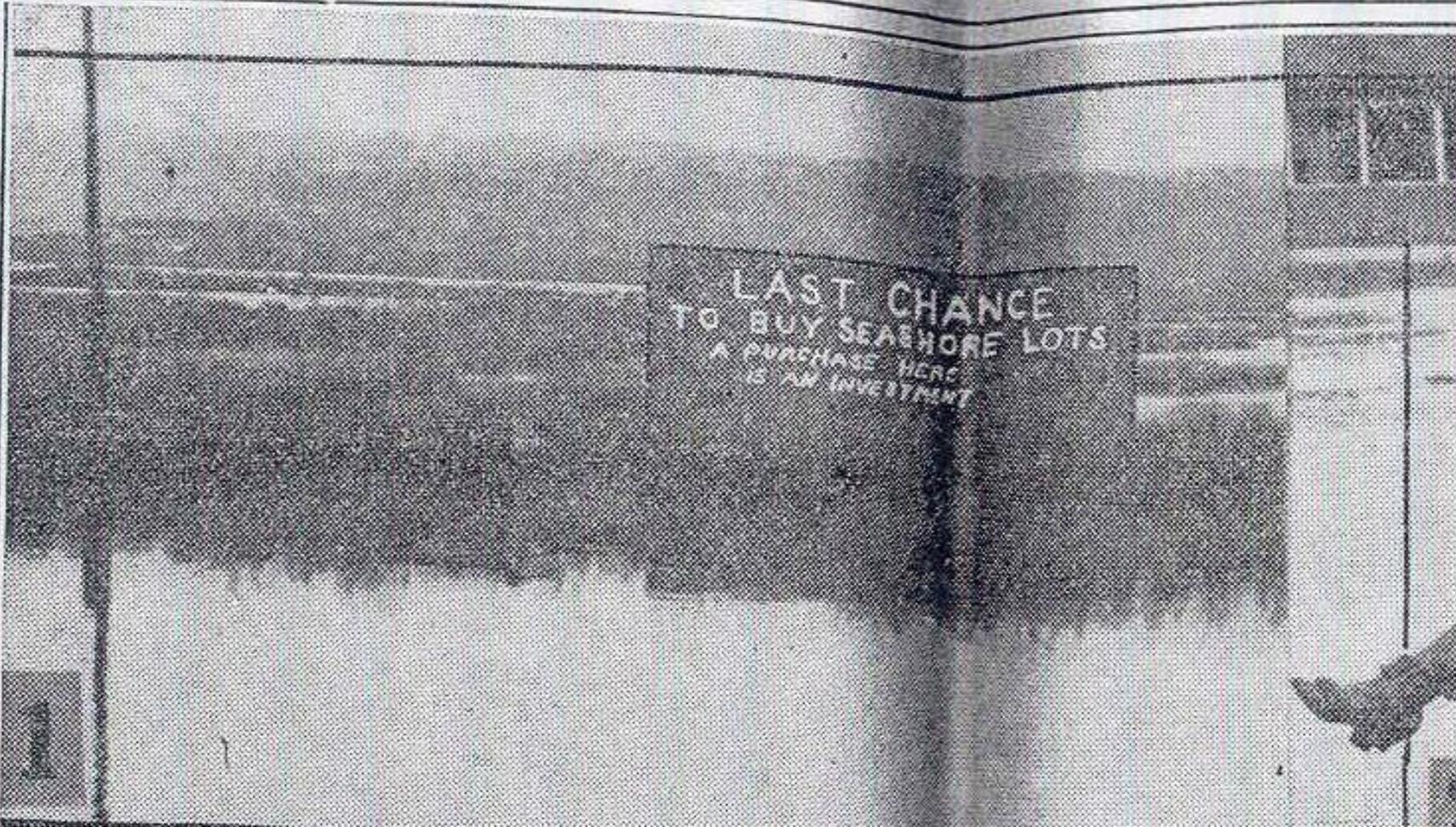
STATEN ISLAND ADVANCE

# STORY OF STORM AND FLOOD, OF RESCUES AND RELIEF



From Staten Island Museum Archives

# PICTURES TELL THE STO



LAST CHANCE  
TO BUY SEASHORE LOTS  
A PURCHASE HERE  
IS AN INVESTMENT

# OF STORM AND FLOOD, OF RESCUES AND RELIEF

## OAKWOOD BEACH ASKS BULKHEAD

Prompt construction of a bulkhead to protect Oakwood Heights Beach which suffered heavily in Wednesday's storm was demanded by the Democratic Club of Oakwood Heights in a resolution passed at a meeting last night. The bulkhead has been promised and money has been set aside for the purpose, John Cummings, president, told members at the session which was held at the headquarters, Guyon avenue.

Another resolution urged the redistricting of Oakwood Heights. At the last elections residents were

compelled to go to Great Kills, Eggenville or New Dorp to vote, according to the section of Oakwood they lived in. The resolution would provide for one election district for the entire town.

Agitation to have school buses continue to the beach instead of making a last stop at Mill road and Guyon avenue, a half-mile from the beach, has been started by the club.

The group will entertain at a dance Saturday night, Nov. 26, at the Hofbauhaus, Stapleton.

black cat . . .

many styles for you to choose

of the perforations see to that

things and supporting rows of

will, a Cabana won't stretch out

like perforations through the

yields on their feet due to the cleverly

yield to without regret. For this smart shoe, in turn,

● Our Cabanas are the sort of temptation all women



Why the CABANA  
yields without  
stretching!



From Staten Island Museum Archives

THE WEATHER

Cloudy with Probable Snow Flurries  
To-night; Tuesday, Fair. Not Much  
Change in Temperature.

# Staten Island

VOL. XLII. DAILY NO. 2673

Entered at Staten Island, N. Y.,  
as second class mail matter.

STATEN ISLAND, N. Y.

# OCEAN SP

## 1 Reported Dead, Many Homeless!

South Shore Colonies Under  
Water As Tidal Wave  
Sweeps Island

### BUNGALOWS WRECKED

Destruction Is Spread From  
South Beach To Prince  
Bay

In spite of early reports that one  
or more men of the crew of the  
barge Ambrose II, which was  
wrecked on the shore at Dorp  
Beach, may have lost their  
lives, police of the New Dorp  
precinct said early this morning that  
no trace had been found of any  
members of the crew.

During the night close watch was  
kept along the Island coast for  
wrecks or vessels which may be in  
distress, but no reports of the kind  
have been received up to the time of  
going to press. The barge which  
has been totally wrecked was washed  
high up on the shore by the force  
of the waves, and debris is scattered  
about for a considerable distance.

A flood such as had never been experienced within the memory of the  
oldest citizens spread among the various  
communities on the South Shore  
over an ocean front of more than  
twelve miles Sunday morning when  
a tidal wave swept over the low lying  
land and reached points in several  
places more than a mile inland.  
The destruction was greatest at Midland  
Beach, Oakwood Beach and  
Great Kills, while other shore front  
communities suffered considerably.  
The flood came without warning  
and spread terror in the hearts of

## Transit Crippled On Weekend, Is Resumed Today

Municipal Trolleys Paralyzed;  
Buses Save Situation  
For Commuters

Transportation was crippled but not  
conquered by the fury of the storm  
that broke over the Island Saturday.  
By gigantic effort the great part of the  
storm damage was repaired and service  
restored on nearly all the lines that  
were forced to suspend operation  
Saturday.

This morning the thousands of  
workers who make up the morning  
peak of traffic were moved safely and  
but a few minutes behind regular  
schedule to their destination. All day  
Saturday and Saturday night hundreds  
of men and trackmen fought  
the storm and yesterday and last night  
by incessant labor restored service  
where it had collapsed.

Service Crippled Saturday  
Late Saturday, service on the North  
Shore by trolley and train was completely  
paralyzed while the Municipal  
trolleys, always the first to feel the  
effect of storm had suspended operation  
on all its lines. The buses by  
changing their routings on many lines,  
were able to avoid blocked streets and  
nearly maintained schedule throughout  
the storm.

The Staten Island Rapid Transit and  
the Richmond Light and Railroad  
service were particularly hard hit  
along the North Shore where wires  
of the telephone company, freighted  
with ice, went down over the tracks.  
All of this damage was west of Mariners  
Harbor at grade crossings and  
along Richmond terrace.

Power Shut Off  
In many places on Richmond terrace  
the telephone wires were laying  
across the trolley wire and it was  
necessary to shut off power beyond  
Union avenue until 7 a. m., yesterday  
morning when they were cleared. The  
Rapid Transit lines were similarly  
troubled at grade crossings where the  
wires, though not laying on the third  
rail, nevertheless cross the right of  
way and blocked and isolated trains.  
This service likewise was quickly  
restored.  
The Municipal trolleys, were completely  
crippled Saturday and many of the  
lines are still out of commission.

## A NARROW ESCAPE



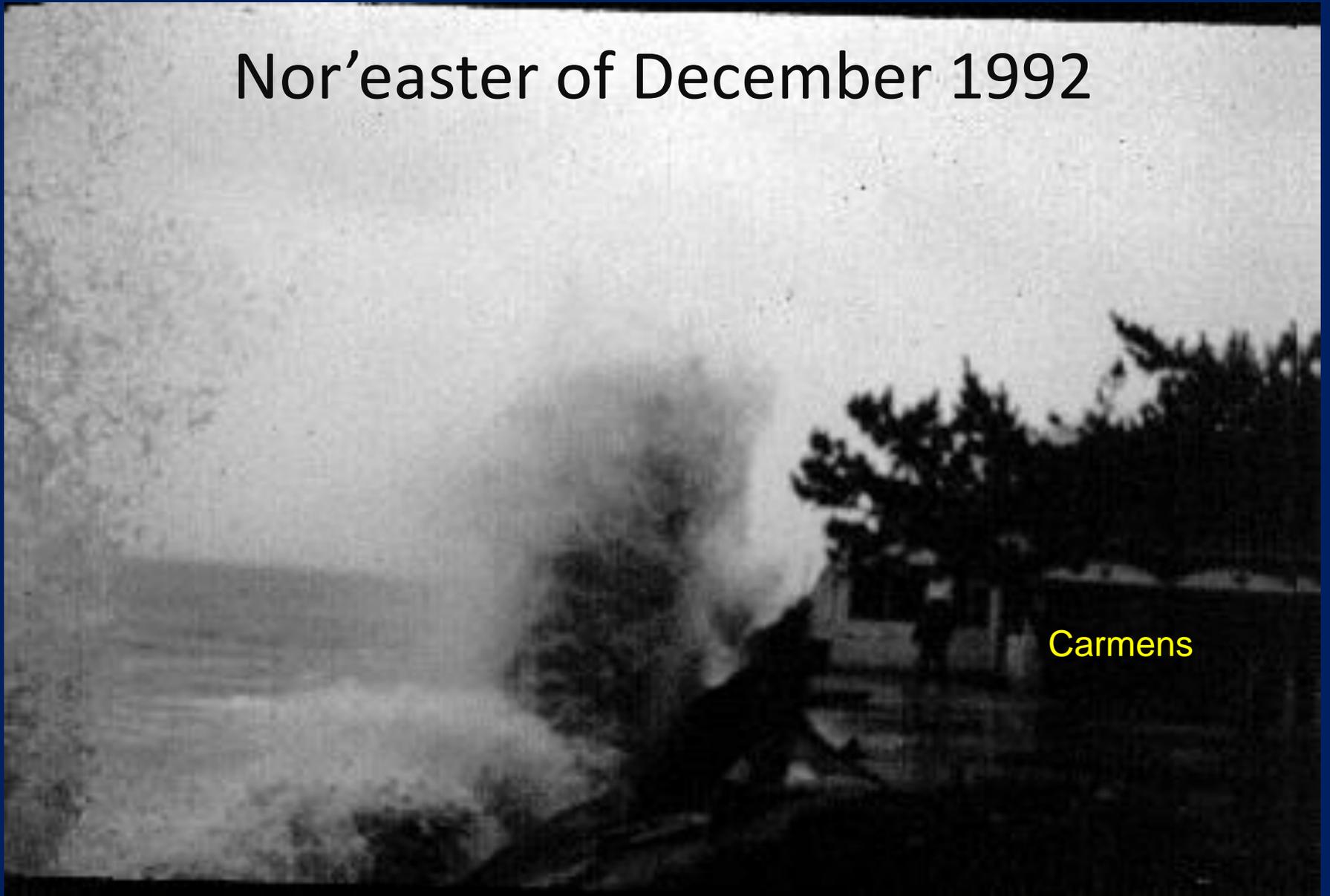
Only the icicles hanging down from the roof  
in this picture of the bitter cold endured by  
Laight and her baby as they are being placed

## A WEEK-END OF HUMOR SNUBS S

With the South Shore marooned by  
a raging flood and the inland area by  
the sleet and wind which crippled  
transportation Staten Island's week-  
end of woe was yet relieved by an  
optimism and humor that was a welcome  
mitigation of the tragic note  
effect ran a leg  
was leaning over  
section of the b  
ocean, as if to  
any moment, N  
invitation, altho  
was accepted by

Nor'easter of December 1992

# Nor'easter of December 1992



Carmens

NEWS

CLIMATE FROM PAGE A 1

# Mayor sounds alarm on climate change

danger right now.”  
 Last summer, WildMetro joined representatives from local environmental and civic groups in asking the city to place a moratorium on building along the Island’s coast and in wetland areas until a comprehensive, protective plan for those areas could be devised.  
 Burg said yesterday that the city had not responded to the request for a moratorium.

**A DILEMMA**

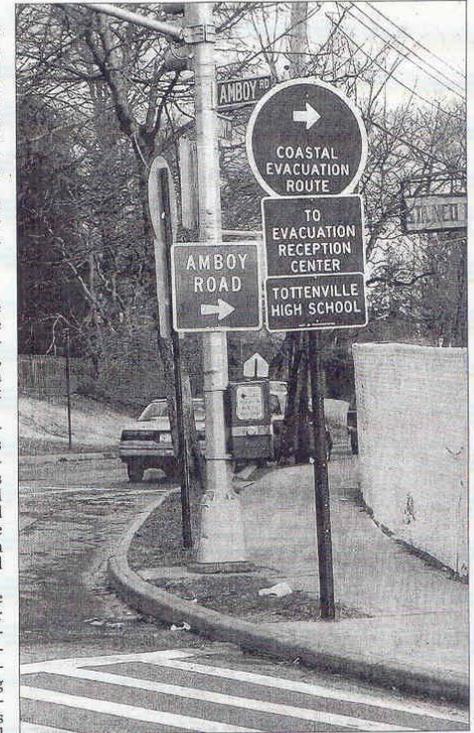
“On the one hand, we don’t want to have damage from flooding,” he said yesterday. “On the other hand, we keep building things in dangerous places. You can’t have it both ways.”

The report Bloomberg released yesterday predicts that heat waves, short periods of intense rain, droughts and coastal flooding will all become more frequent and more intense in the city. The study was conducted by a panel of scientists convened by the mayor.

Bloomberg released the findings at a wastewater treatment plant on the Rockaway peninsula where workers were preparing for climate change by raising equipment such as pump motors and circuit breakers below sea level.

predictions are the changes projected by scientists who have studied the effects of deforestation and burning of fossil fuels.

Dr. Alan Benimoff, a professor with the Department of Engineering, Science and Physics at the College of Staten Island, said the South Shore of Staten Island could be impacted by a storm surge of as much as 20 feet if a strong hurricane hits our



STATEN ISLAND ADVANCE FILE PHOTO

The New York City report predicts that sea levels will rise by 12 to 23 inches and possibly more by the end of the century, meaning more local flooding.

Dr. Alan Benimoff, a professor with the Department of Engineering, Science and Physics at the College of Staten Island, said the South Shore of Staten Island could be affected by a storm surge of as much as 20 feet if a strong hurricane hits our shores.

## Mayor sounds the alarm on climate change

Bloomberg report warns of more days of intense heat, frequent storms and rising seas

By KAREN O'SHEA  
 STATEN ISLAND ADVANCE

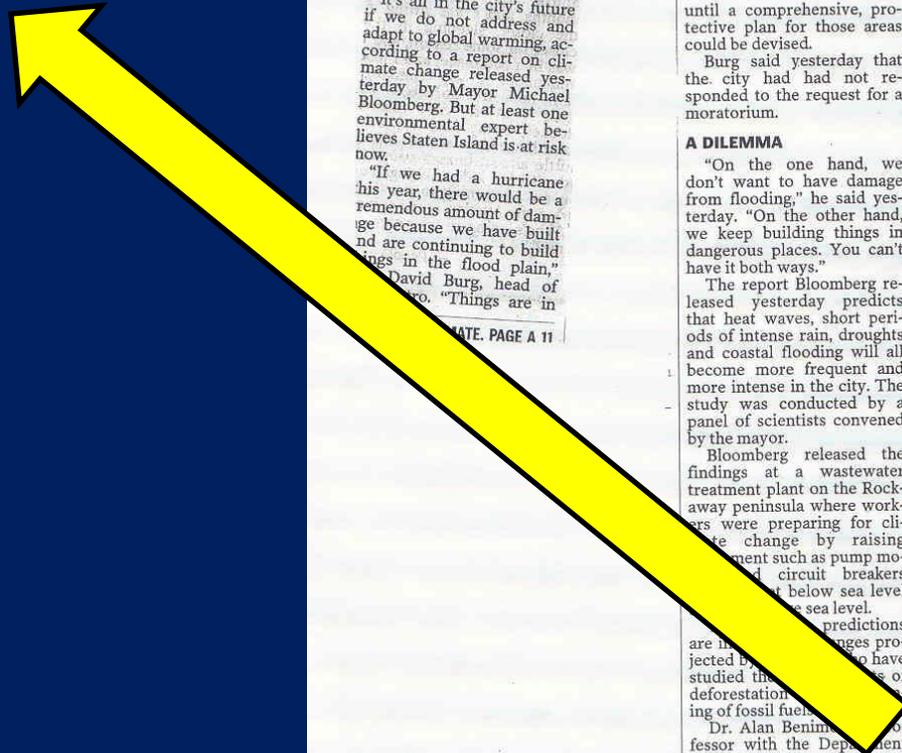
It's a chilling snapshot: Stifling heat, driving rains and water levels rising by two feet or more.

It's all in the city's future if we do not address and adapt to global warming, according to a report on climate change released yesterday by Mayor Michael Bloomberg. But at least one environmental expert believes Staten Island is at risk now.

"If we had a hurricane this year, there would be a tremendous amount of damage because we have built and are continuing to build things in the flood plain," said David Burg, head of WildMetro. "Things are in

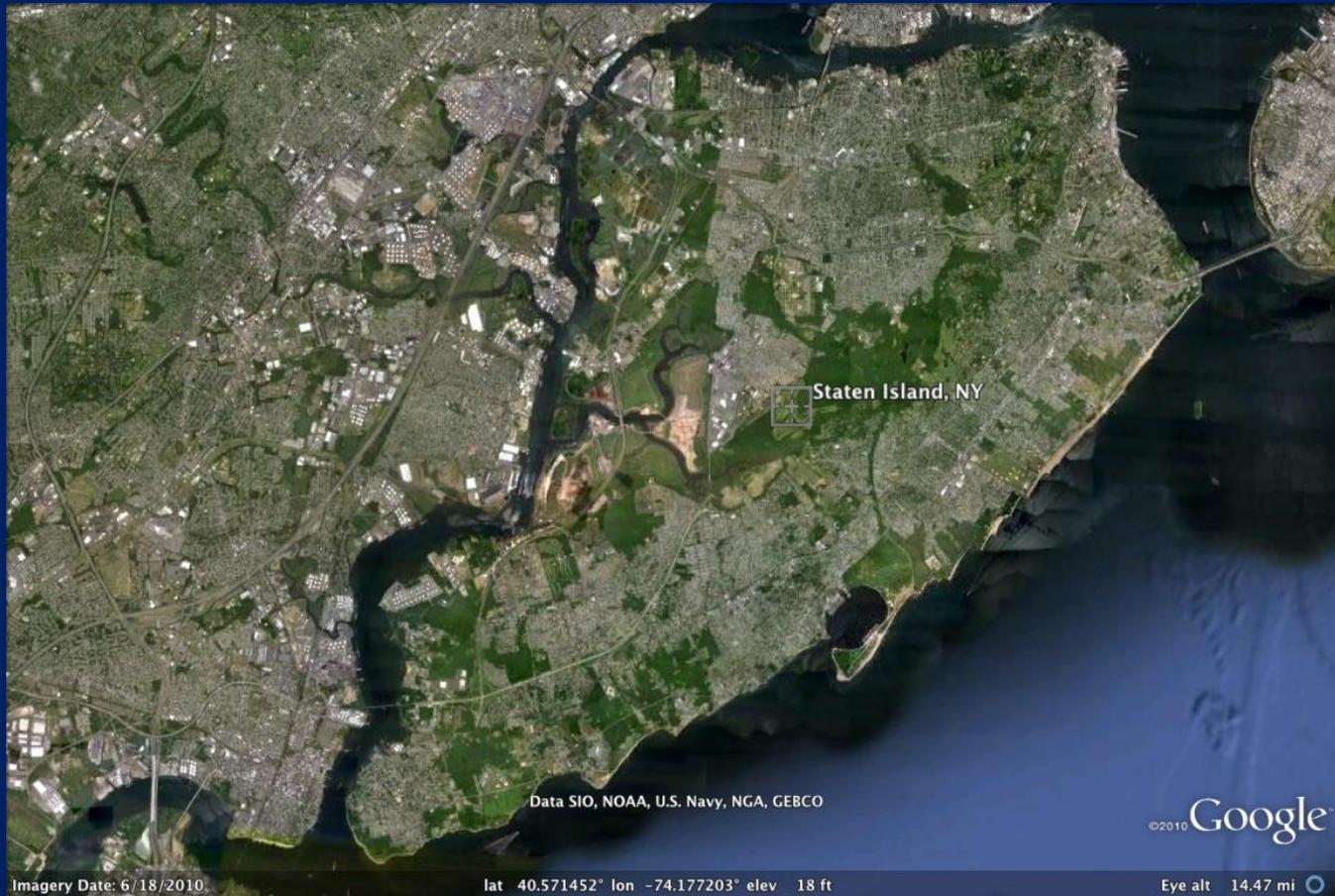
CLIMATE. PAGE A 11

Dr. Alan Benimoff, a professor with the Department of Engineering, Science and Physics at the College of Staten Island, said the South Shore of Staten Island could be affected by a storm surge of as much as 20 feet if a strong hurricane hits our shores.

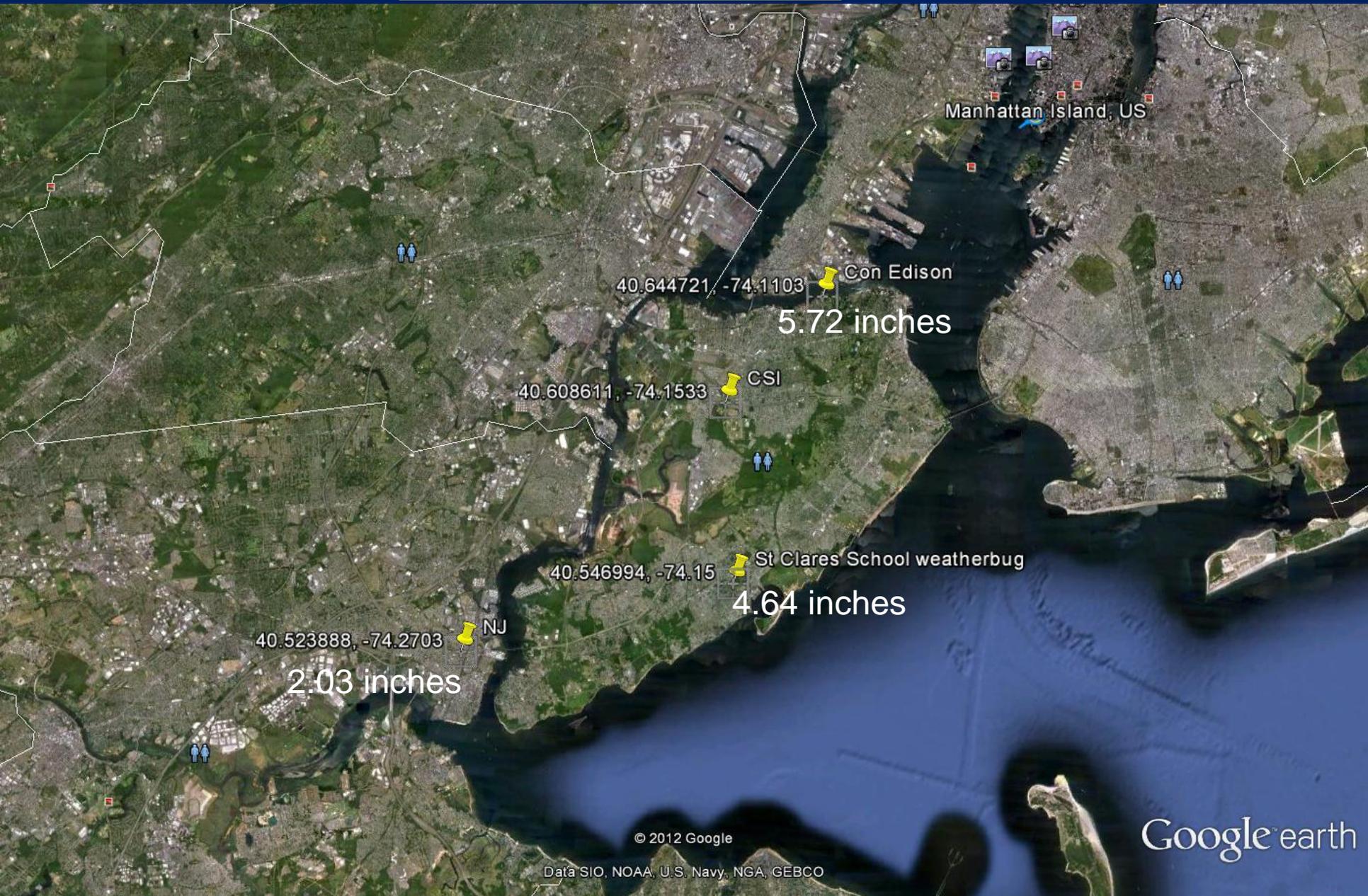


# HURRICANE IRENE

## August 28, 2011



# TOTAL RAINFALL - IRENE



© 2012 Google

Data SIO, NOAA, U.S. Navy, NGA, GEBCO

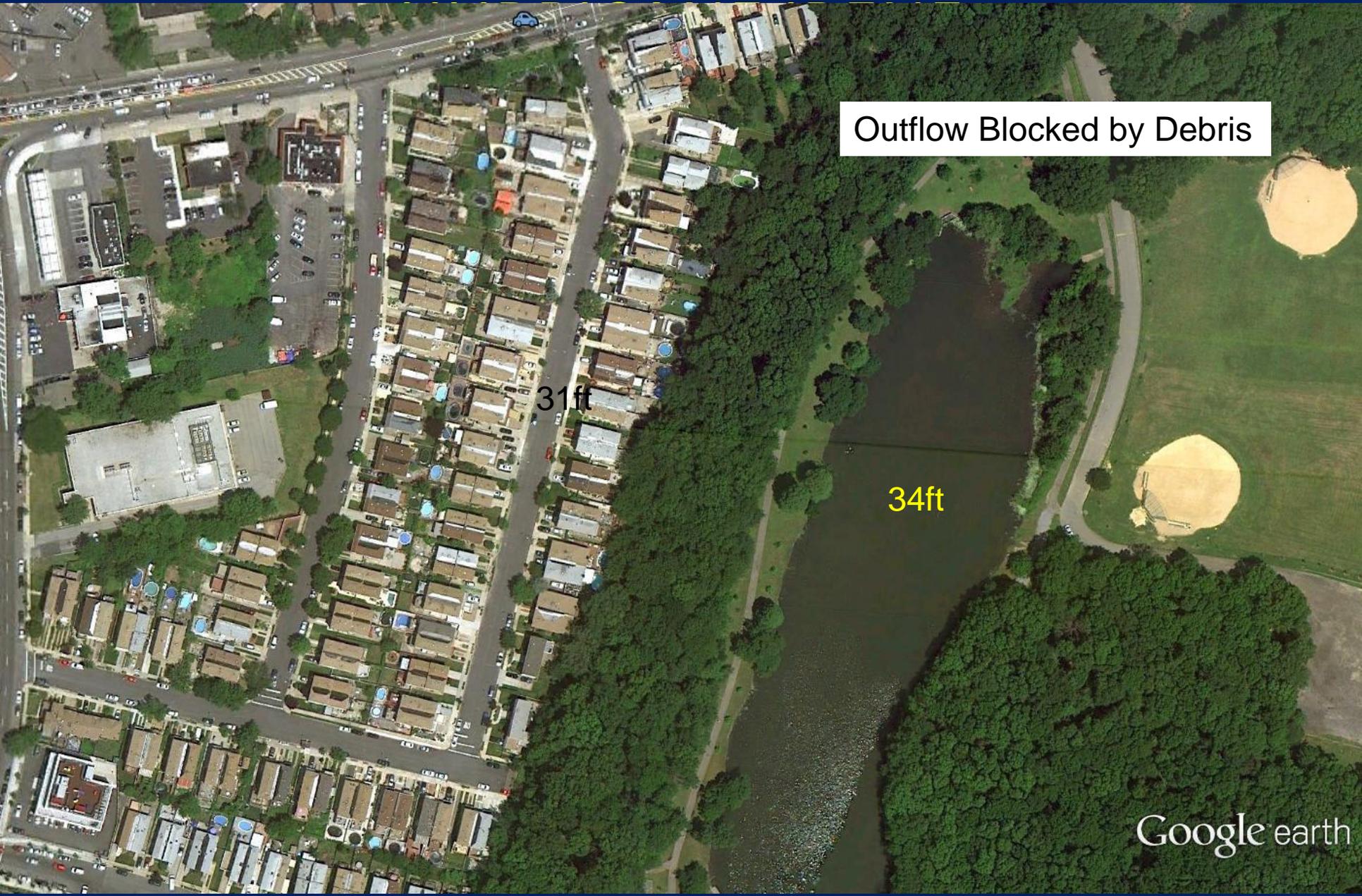
Google earth

Outflow Blocked by Debris

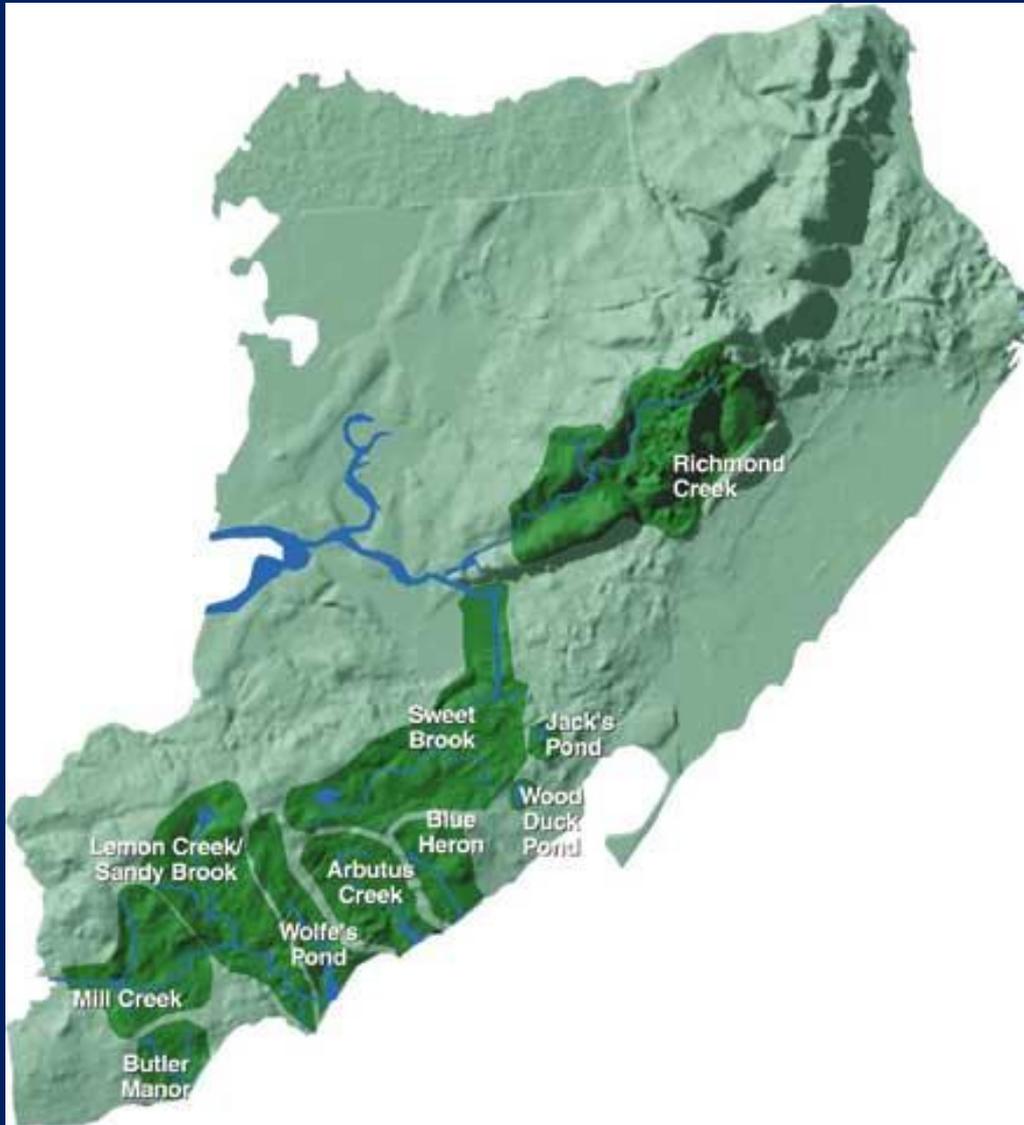
31ft

34ft

Google earth



# STATEN ISLAND BLUEBELT



NYC DEP IS USING  
EXISTING STREAMS  
TO MANAGE  
STORM WATER









From South Shore Beach Areas



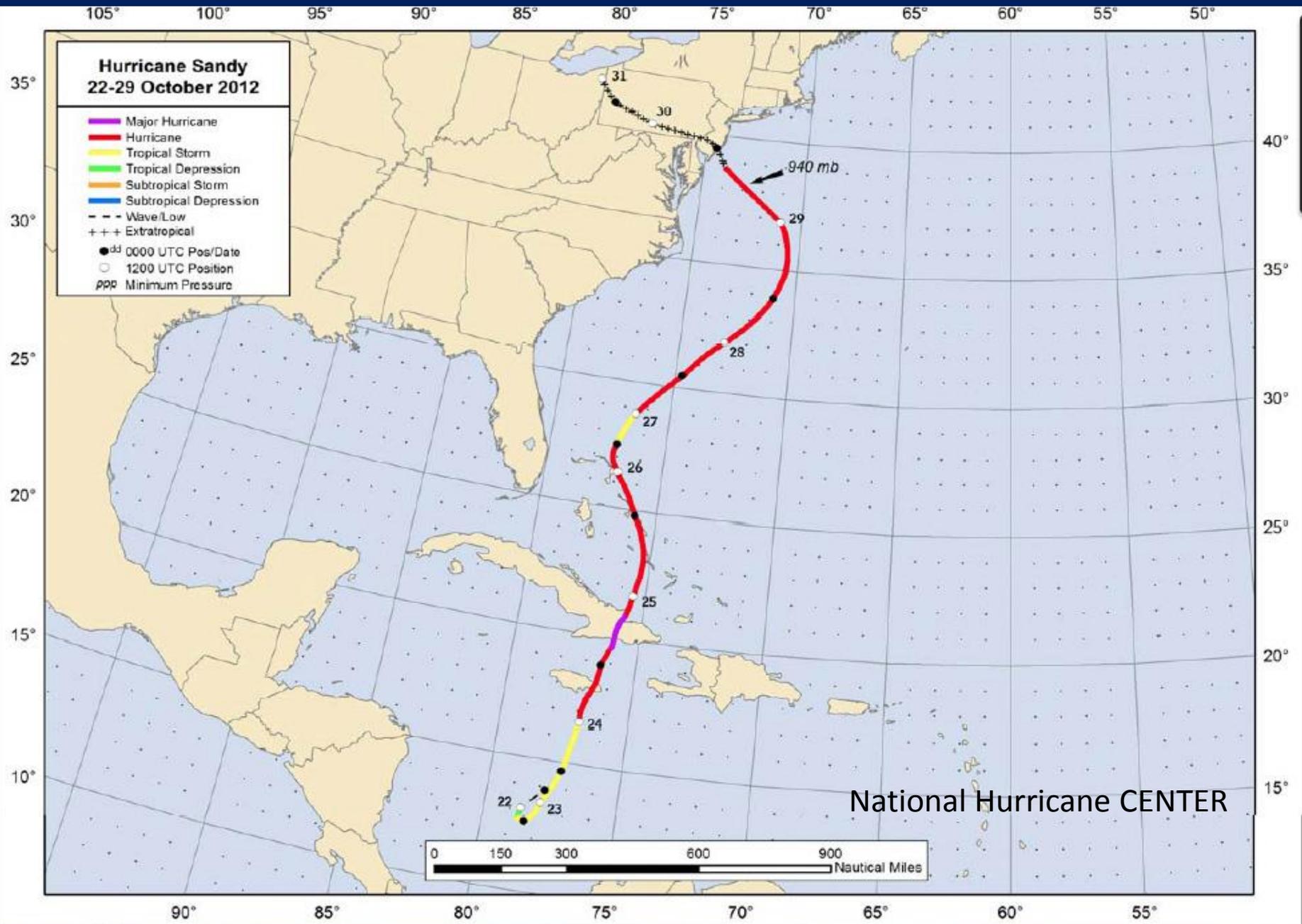
St Andrews

To Richmond Creek



# SANDY





October 30, 2012 0630

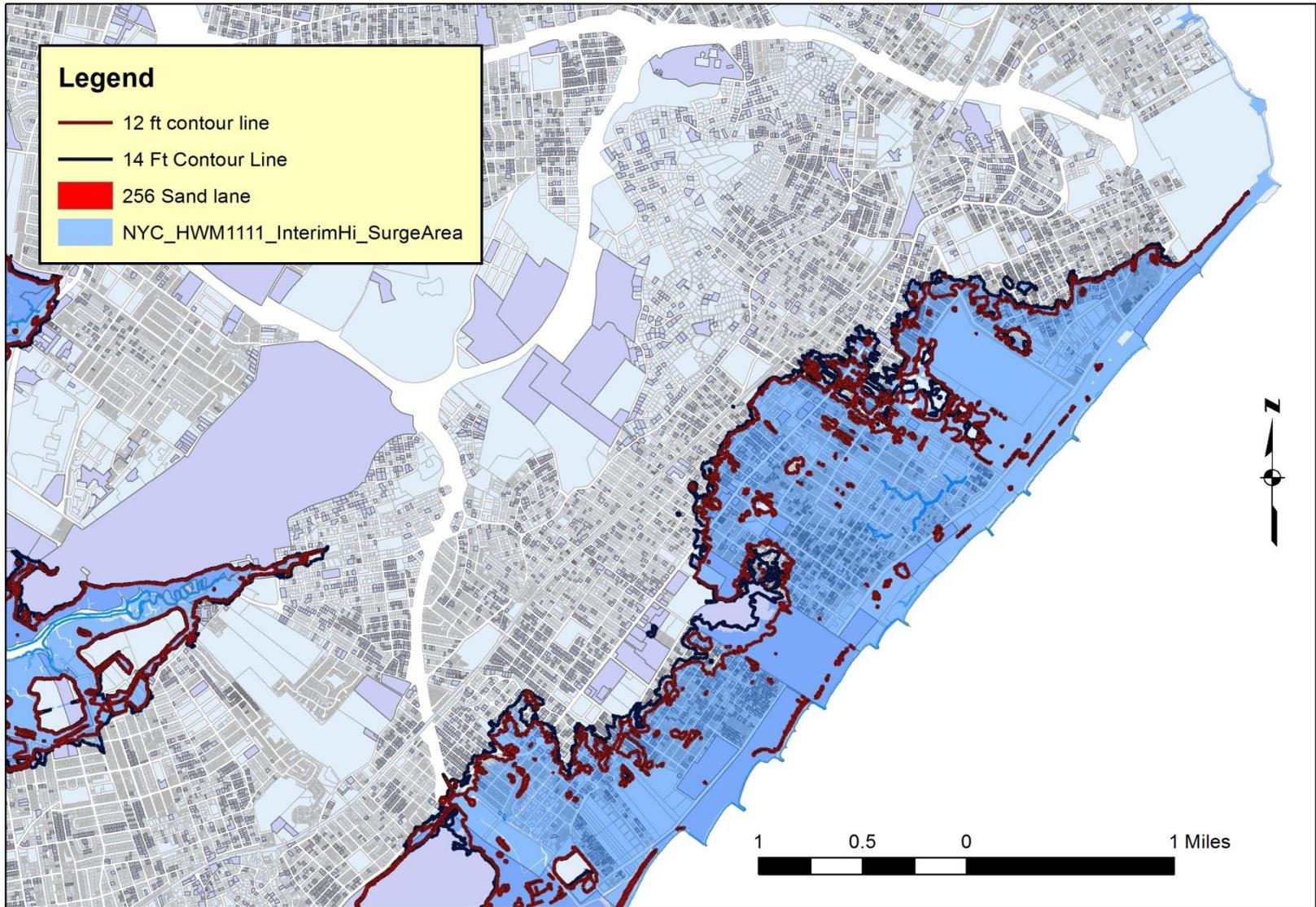




GIS Map By Alan I. Benimoff, Ph.D.



GIS Map By Alan I. Benimoff, Ph.D.

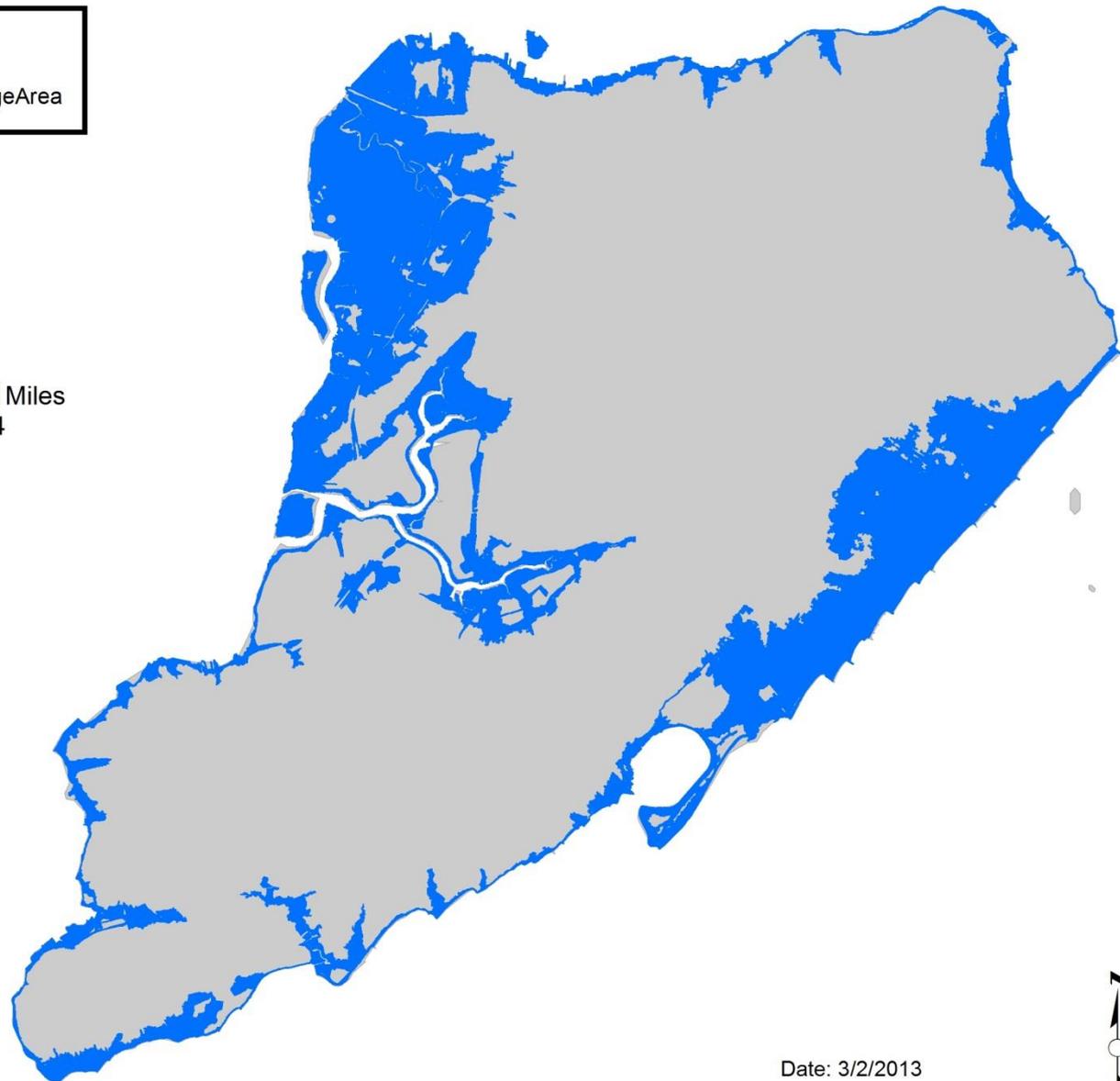


GIS Map By Alan I. Benimoff, Ph.D.

### Legend

 NYC\_HWM1111\_InterimHi\_SurgeArea

0 2 4 Miles



Date: 3/2/2013

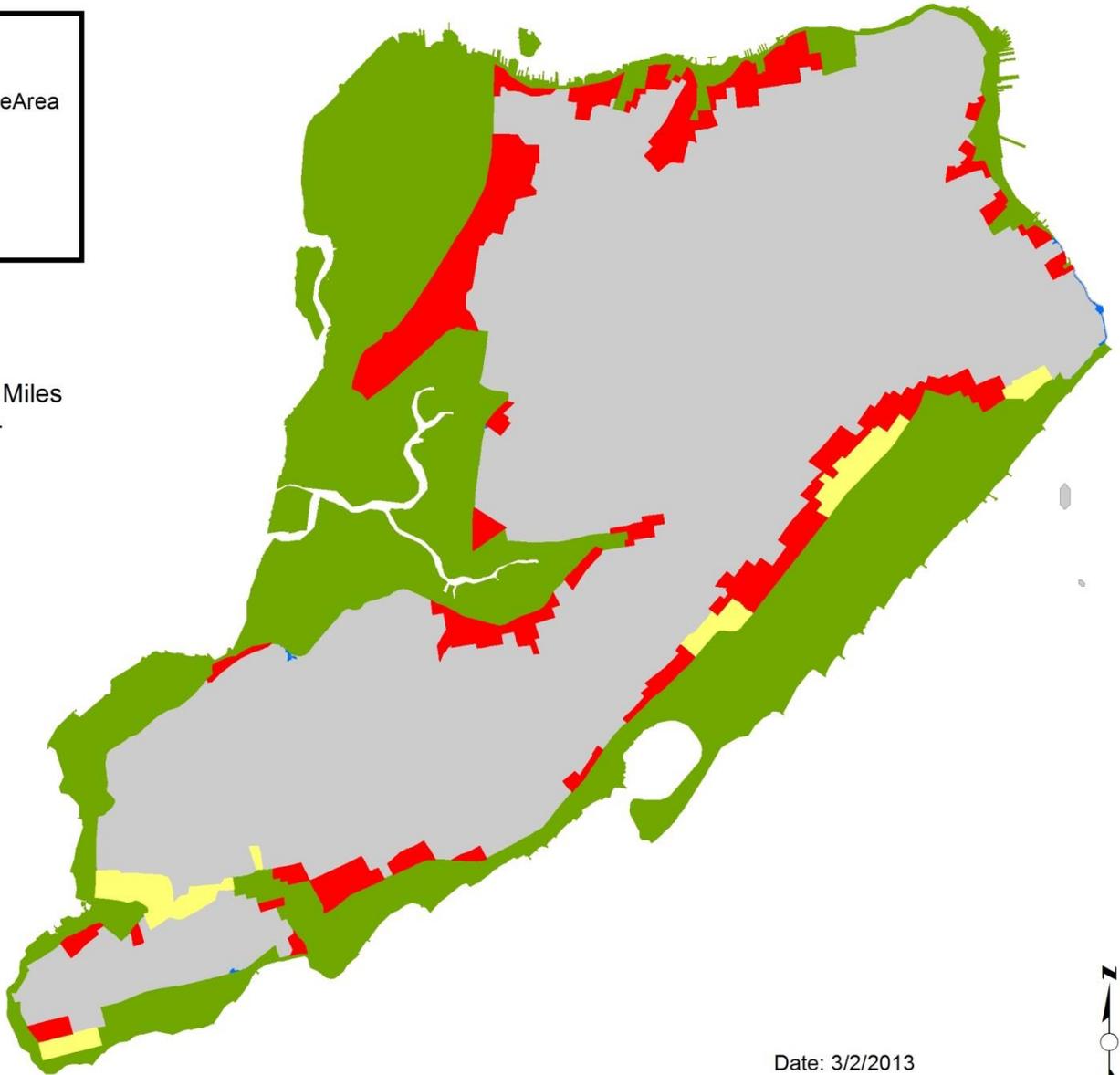
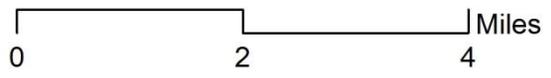
Time: 10:50:43 AM

Draft GIS map by Alan I. Benimoff, Ph.D.



**Legend**

- NYC\_HWM1111\_InterimHi\_SurgeArea
- A\_Evac\_Zones
- B\_Evac\_Zone
- C\_Evac\_Zone

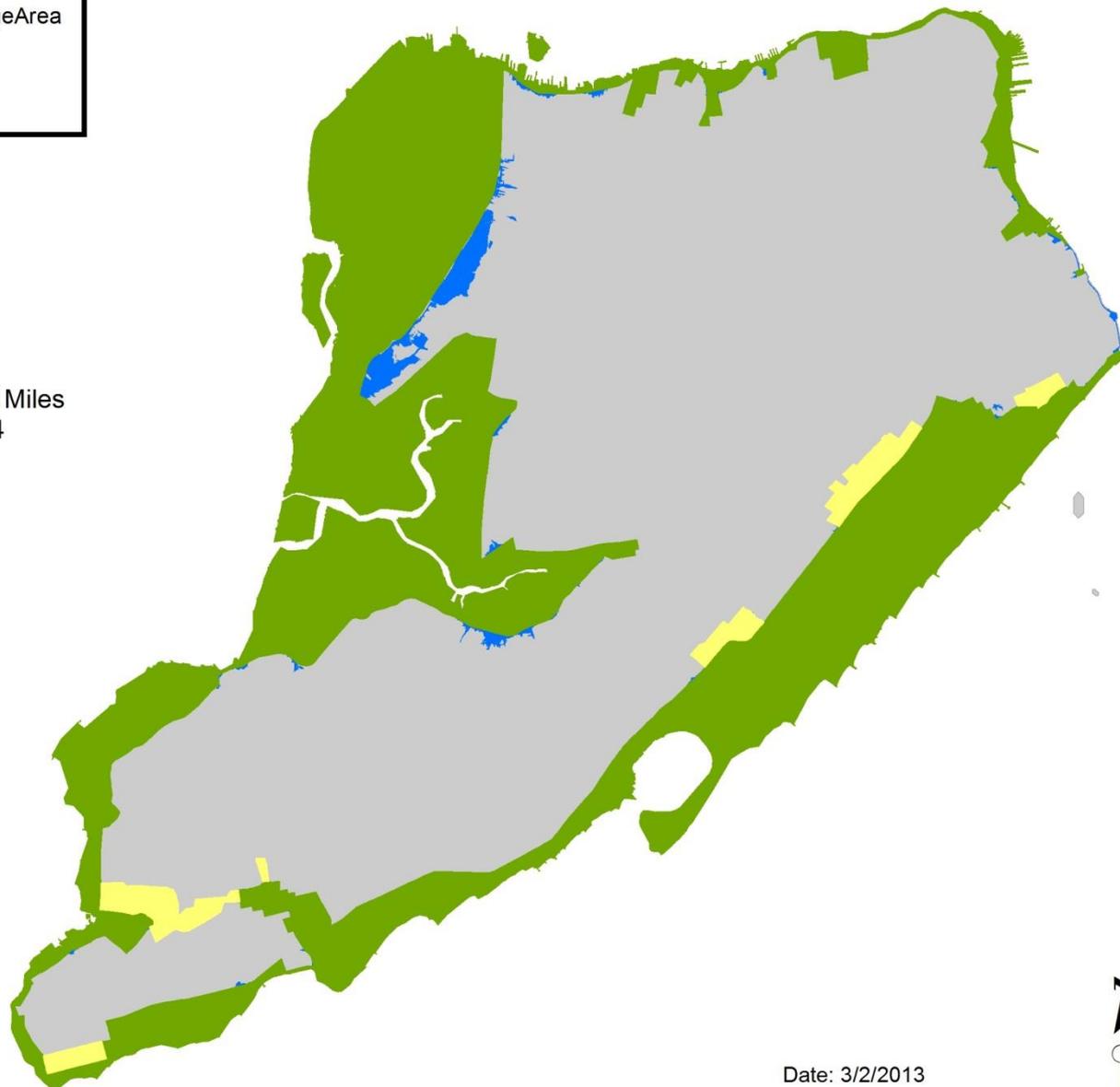


Date: 3/2/2013  
Time: 10:54:38 AM  
Draft GIS map by Alan I. Benimoff, Ph.D.

# Legend

- NYC\_HWM1111\_InterimHi\_SurgeArea
- A\_Evac\_Zones
- B\_Evac\_Zone

0 2 4 Miles



Date: 3/2/2013

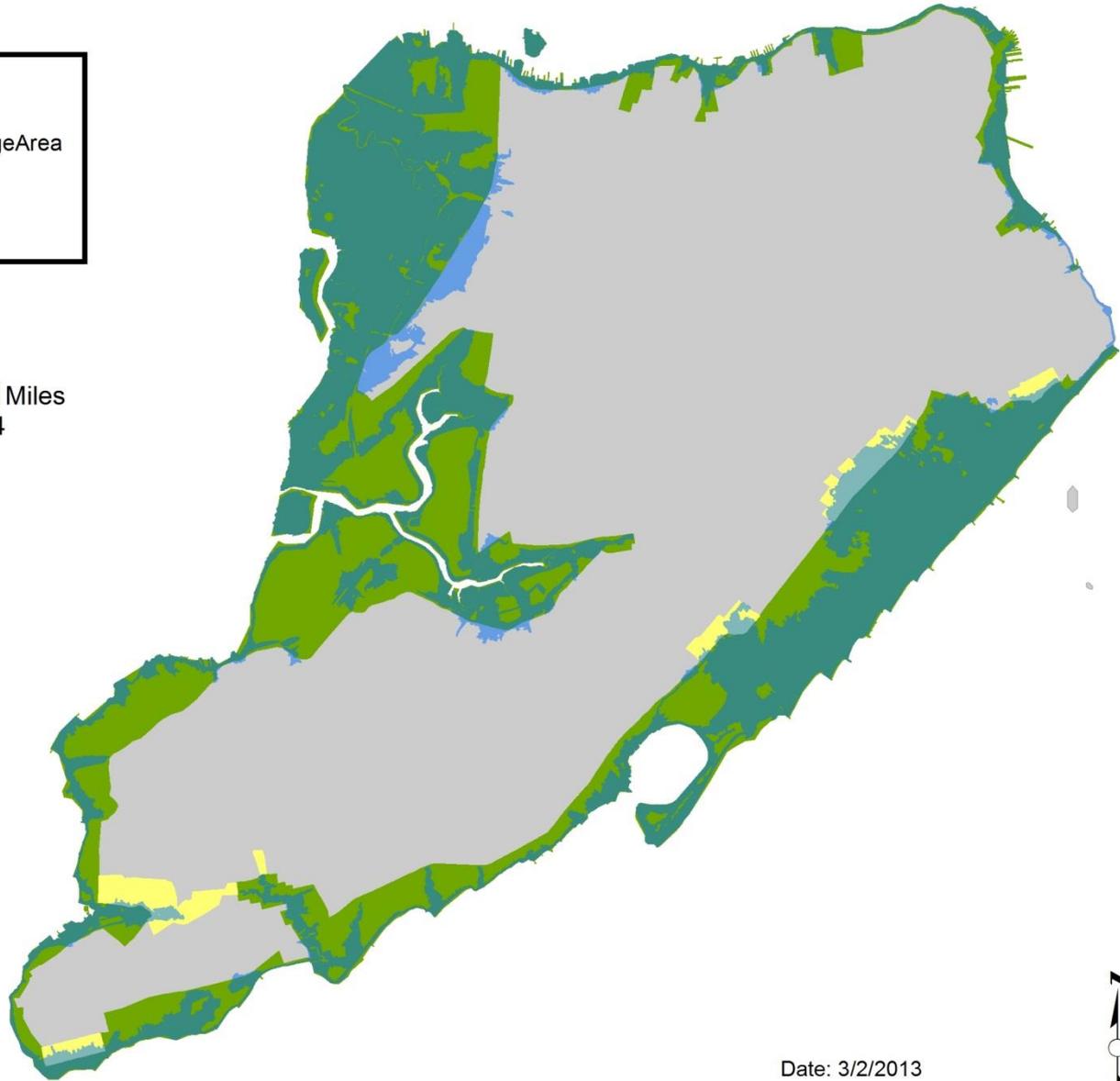
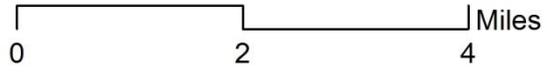
Time: 10:53:49 AM

Draft GIS map by Alan I. Benimoff, Ph.D.



**Legend**

- NYC\_HWM1111\_InterimHi\_SurgeArea
- B\_Evac\_Zone
- A\_Evac\_Zones



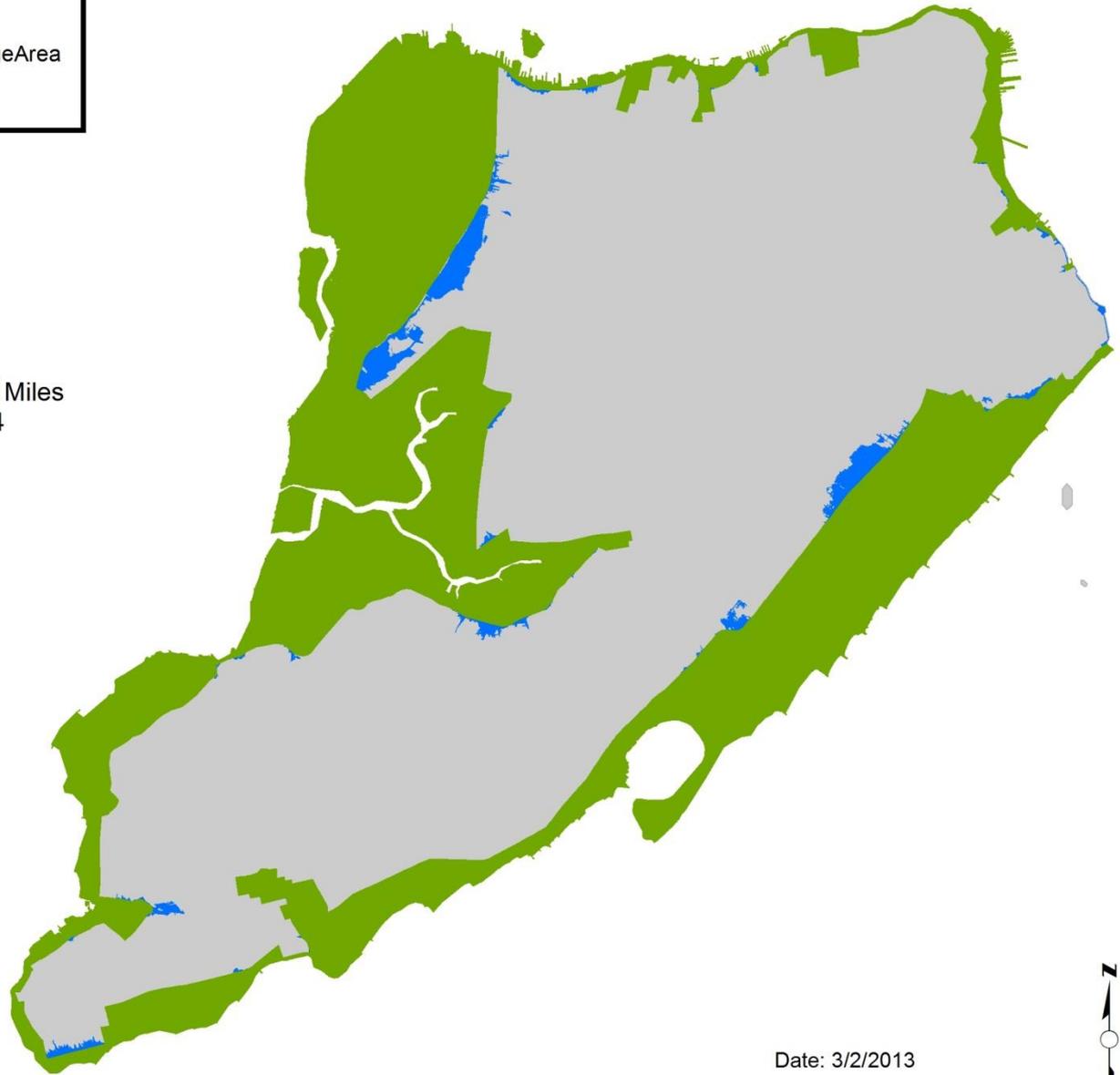
Date: 3/2/2013  
Time: 10:58:08 AM  
Draft GIS map by Alan I. Benimoff, Ph.D.



### Legend

- NYC\_HWM1111\_InterimHi\_SurgeArea
- A\_Evac\_Zones

0 2 4 Miles



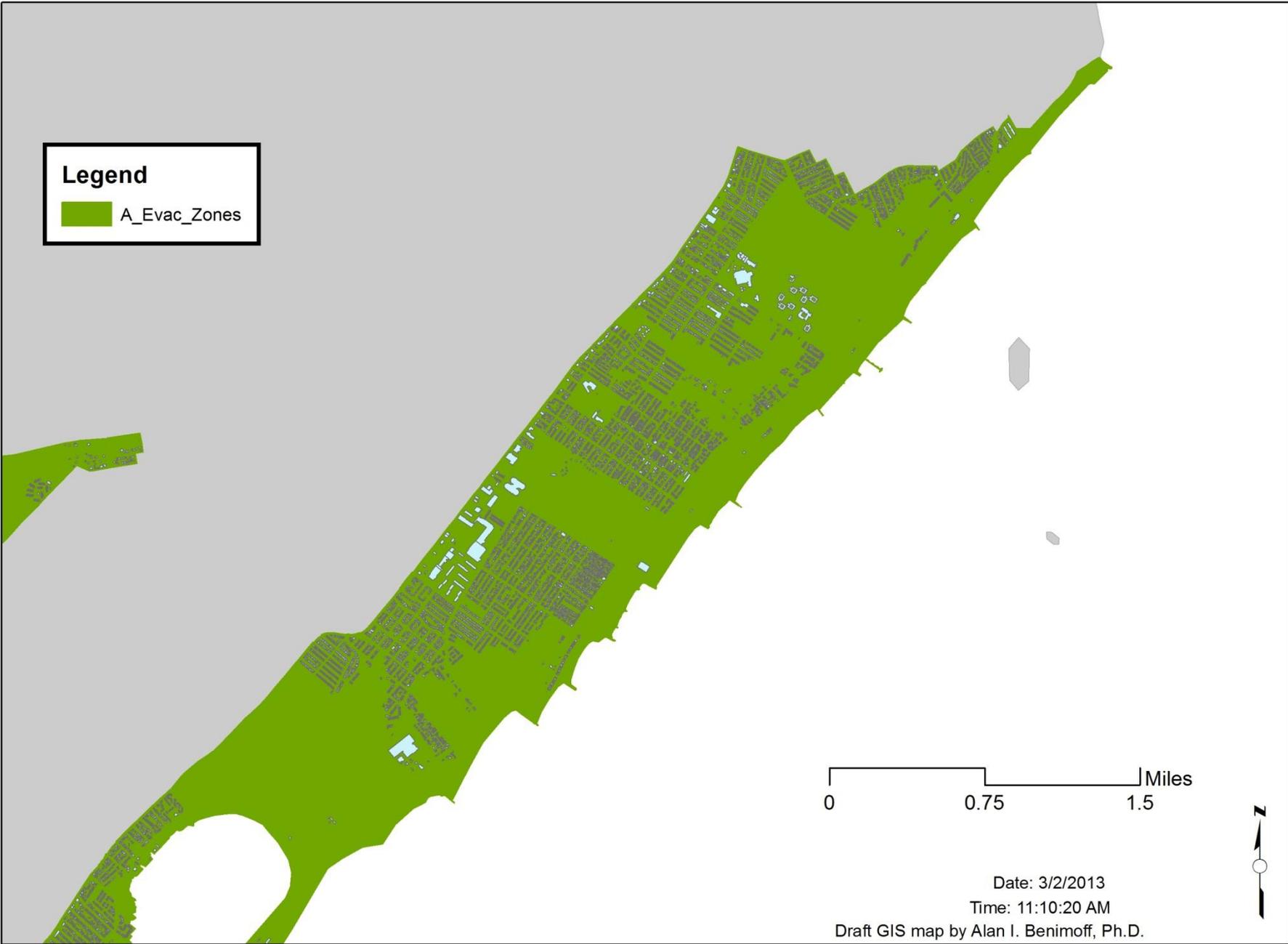
Date: 3/2/2013

Time: 10:53:28 AM

Draft GIS map by Alan I. Benimoff, Ph.D.

**Legend**

 A\_Evac\_Zones



0 0.75 1.5 Miles

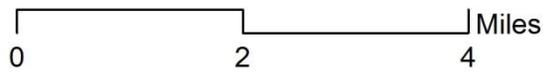
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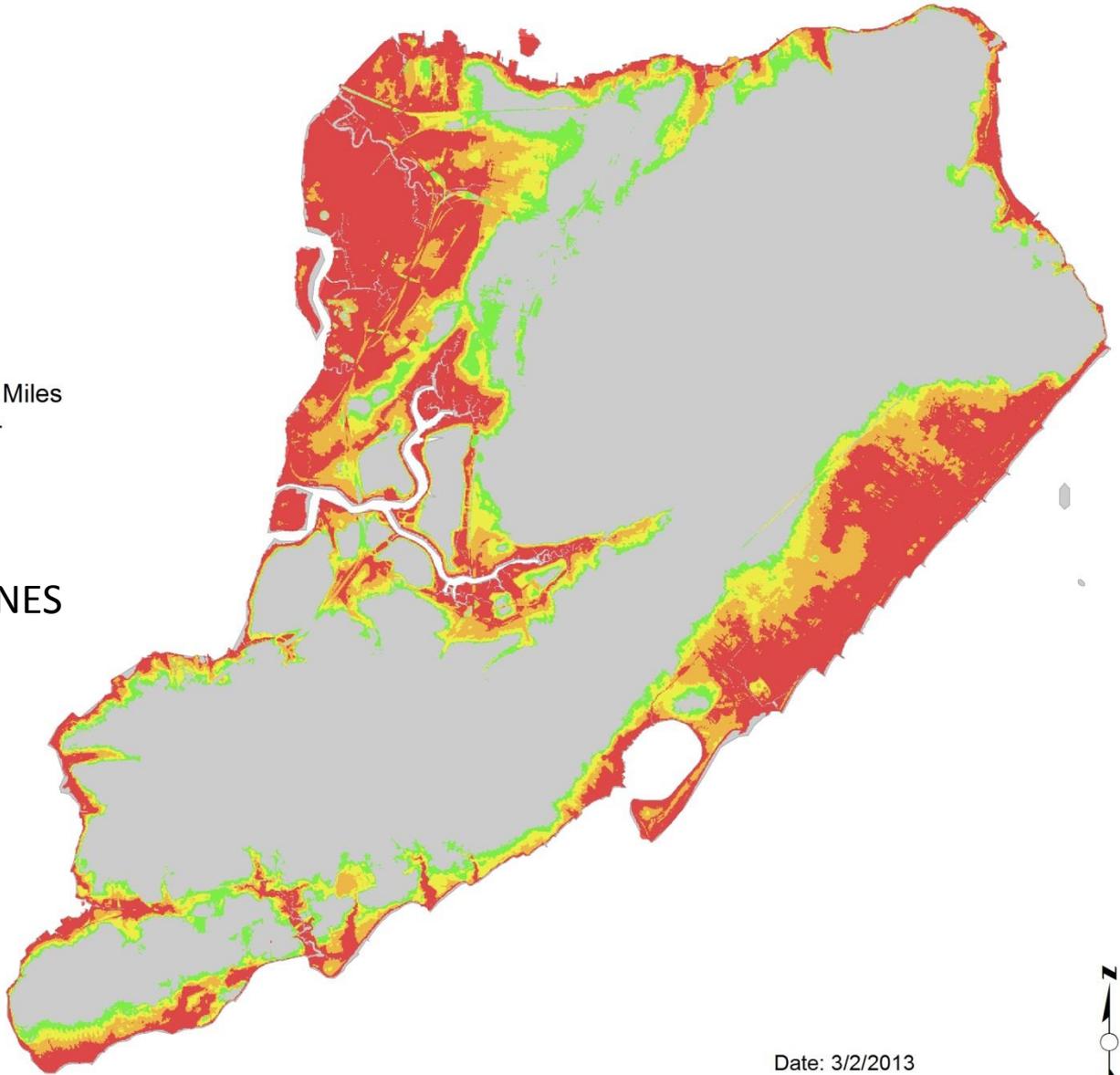
Draft GIS map by Alan I. Benimoff, Ph.D.

**Legend**

- Category 1
- Category 2
- Category 3
- Category 4



**2012 FEMA SLOSH ZONES**

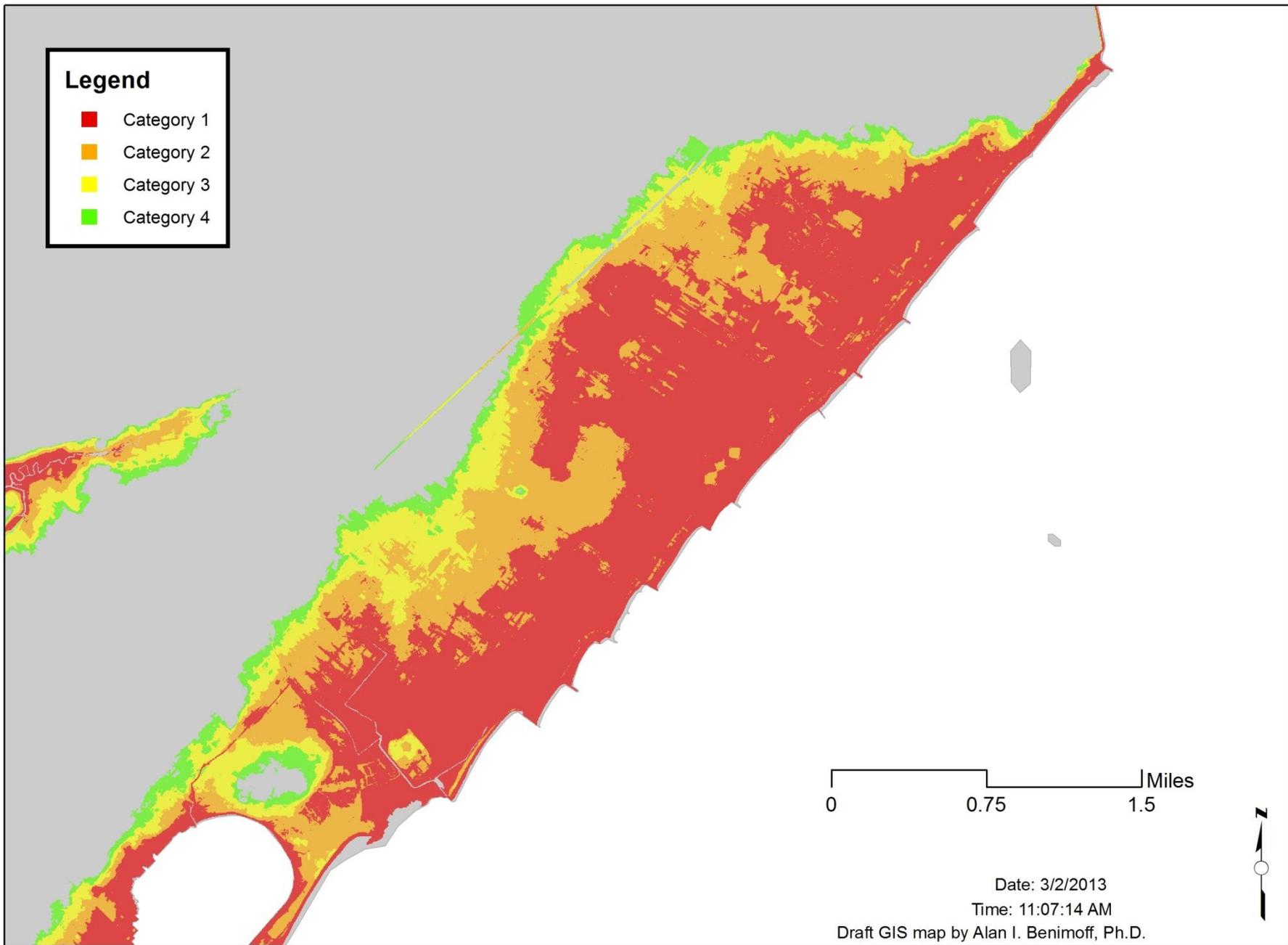


Date: 3/2/2013  
Time: 11:02:08 AM  
Draft GIS map by Alan I. Benimoff, Ph.D.



### Legend

- Category 1
- Category 2
- Category 3
- Category 4



0 0.75 1.5 Miles

Date: 3/2/2013

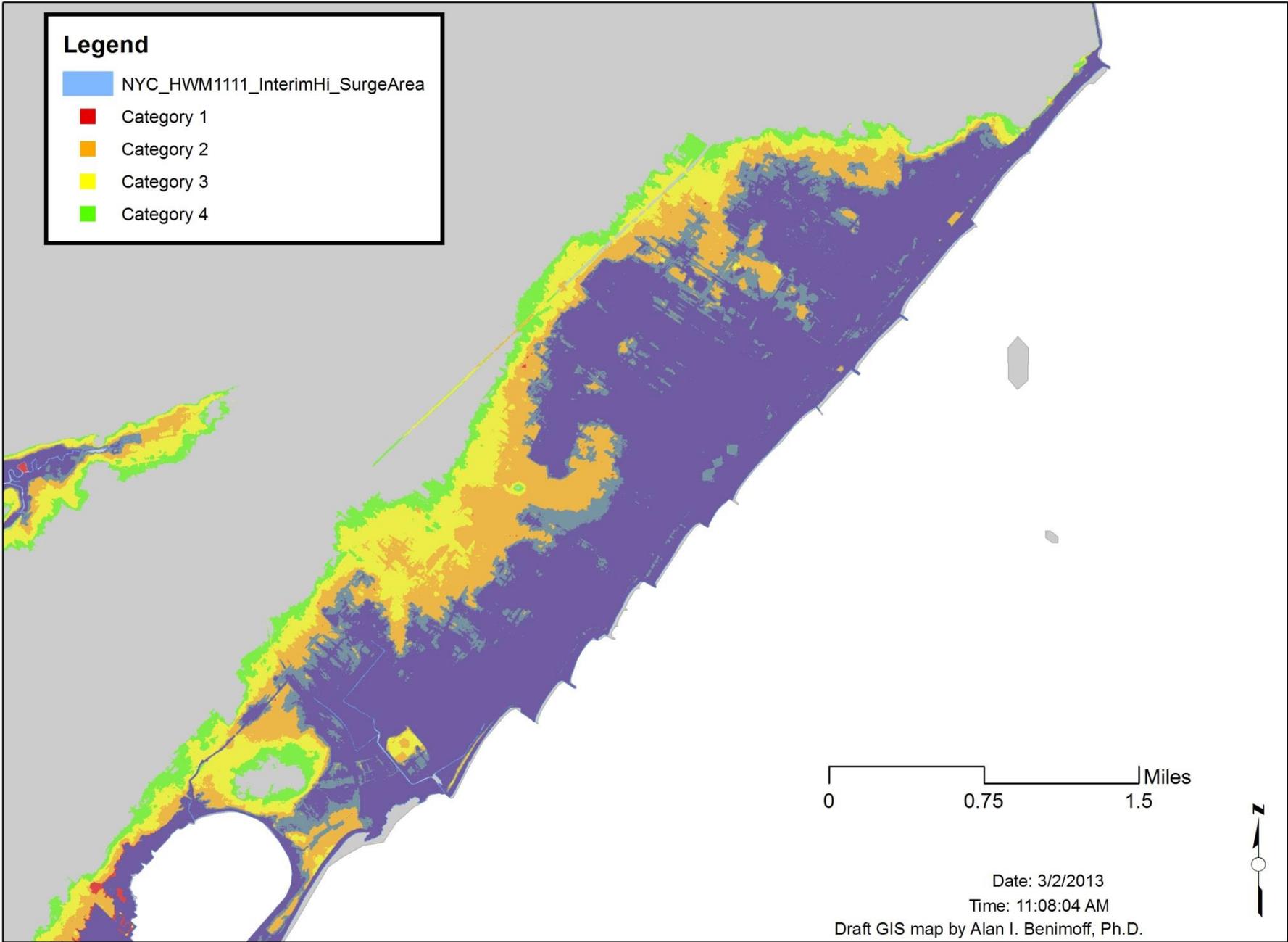
Time: 11:07:14 AM

Draft GIS map by Alan I. Benimoff, Ph.D.



# Legend

- NYC\_HWM1111\_InterimHi\_SurgeArea
- Category 1
- Category 2
- Category 3
- Category 4



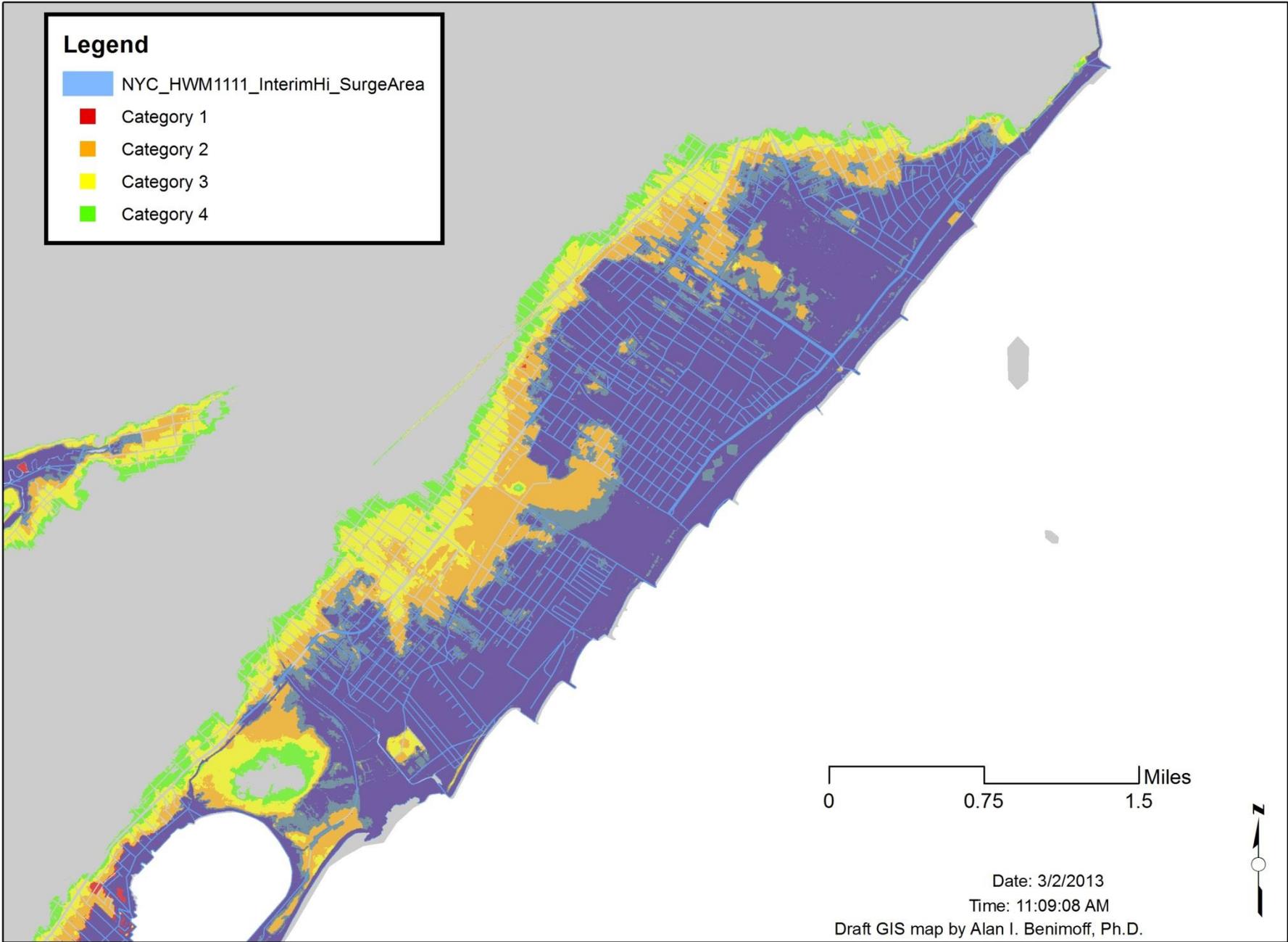
0 0.75 1.5 Miles



Date: 3/2/2013  
Time: 11:08:04 AM  
Draft GIS map by Alan I. Benimoff, Ph.D.

# Legend

- NYC\_HWM1111\_InterimHi\_SurgeArea
- Category 1
- Category 2
- Category 3
- Category 4



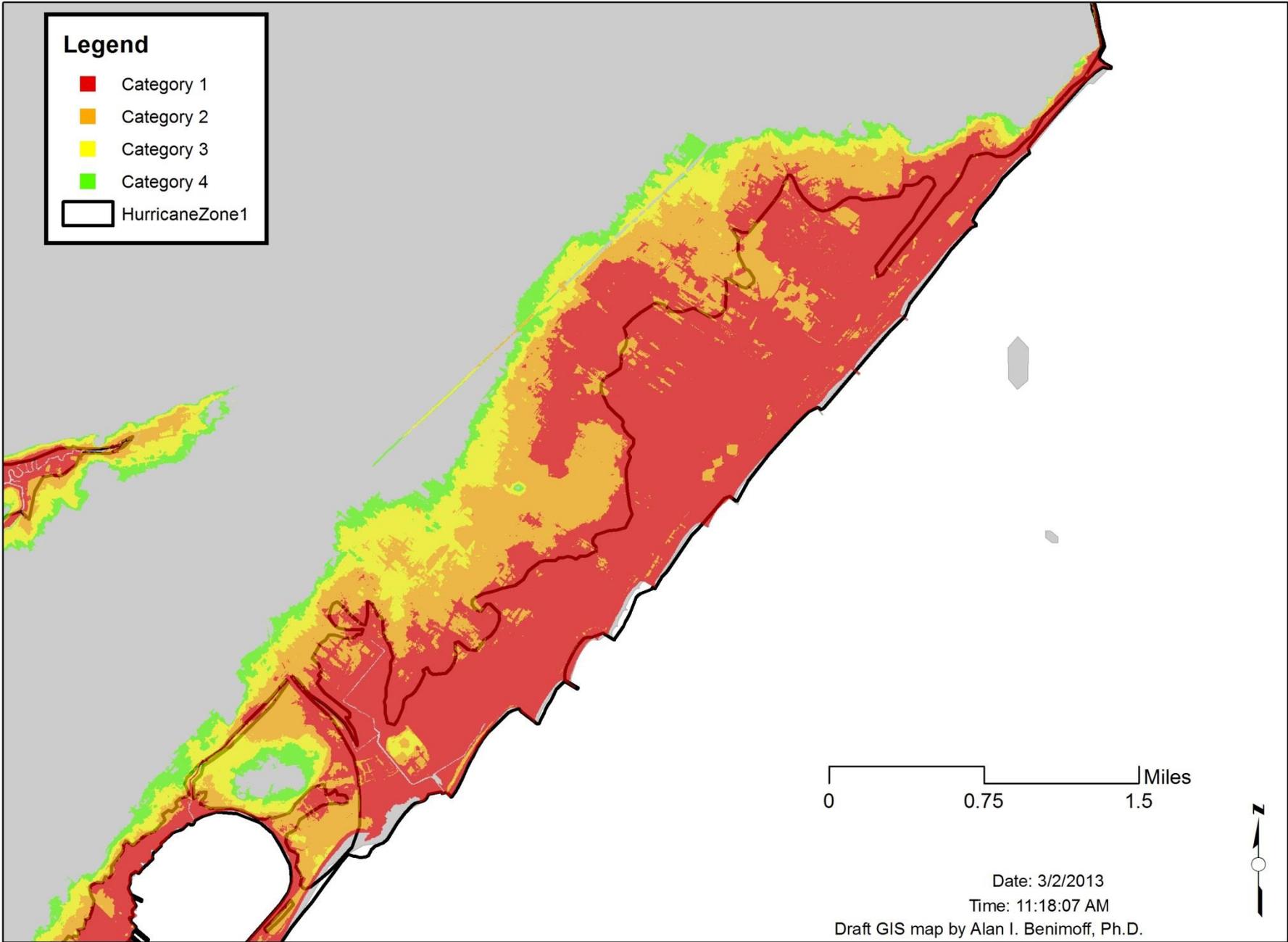
0 0.75 1.5 Miles



Date: 3/2/2013  
Time: 11:09:08 AM  
Draft GIS map by Alan I. Benimoff, Ph.D.

### Legend

- Category 1
- Category 2
- Category 3
- Category 4
- HurricaneZone1



0 0.75 1.5 Miles

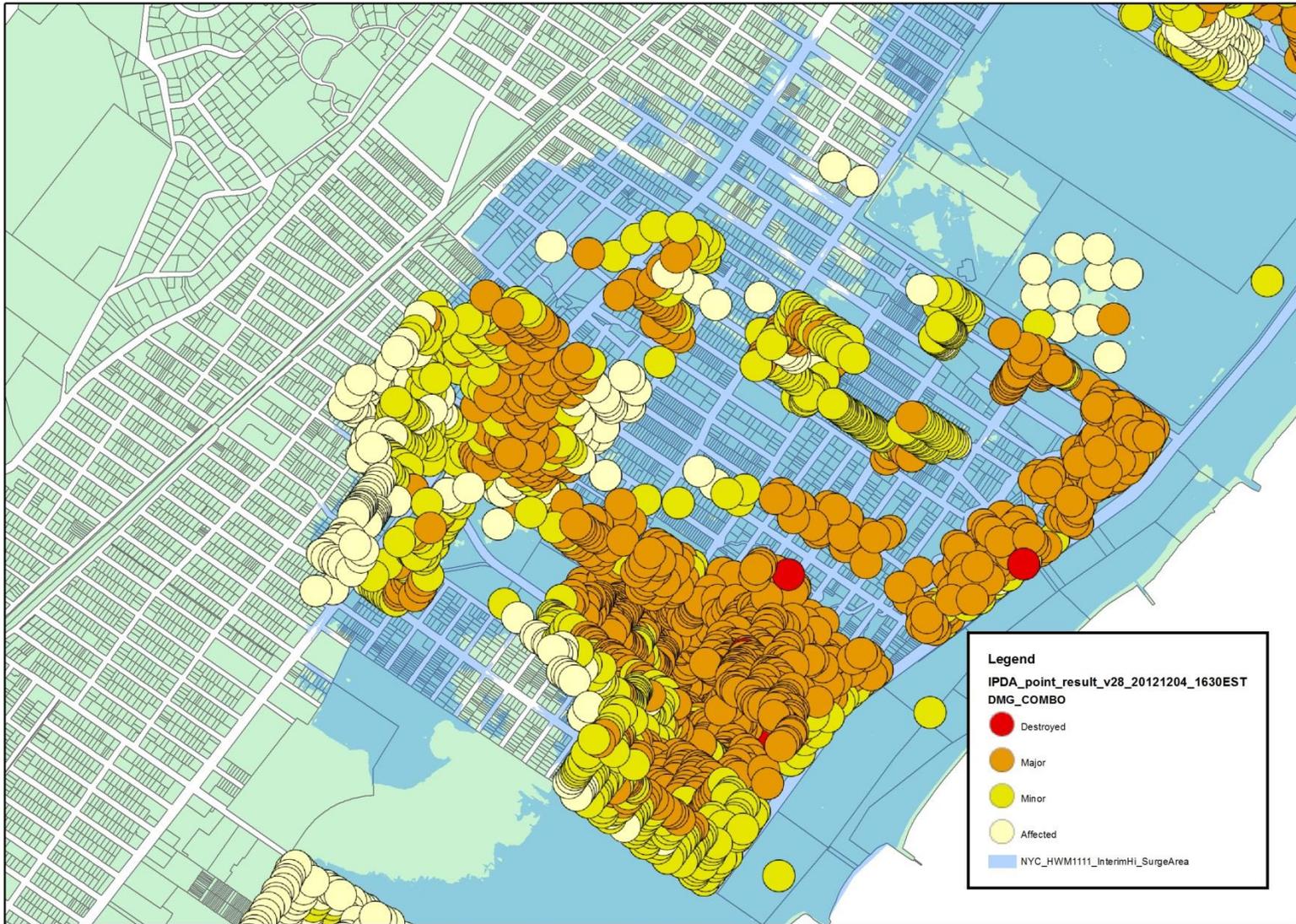
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Draft GIS map by Alan I. Benimoff, Ph.D.

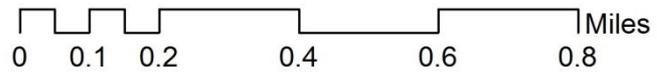


# DAMAGE - Midland Beach

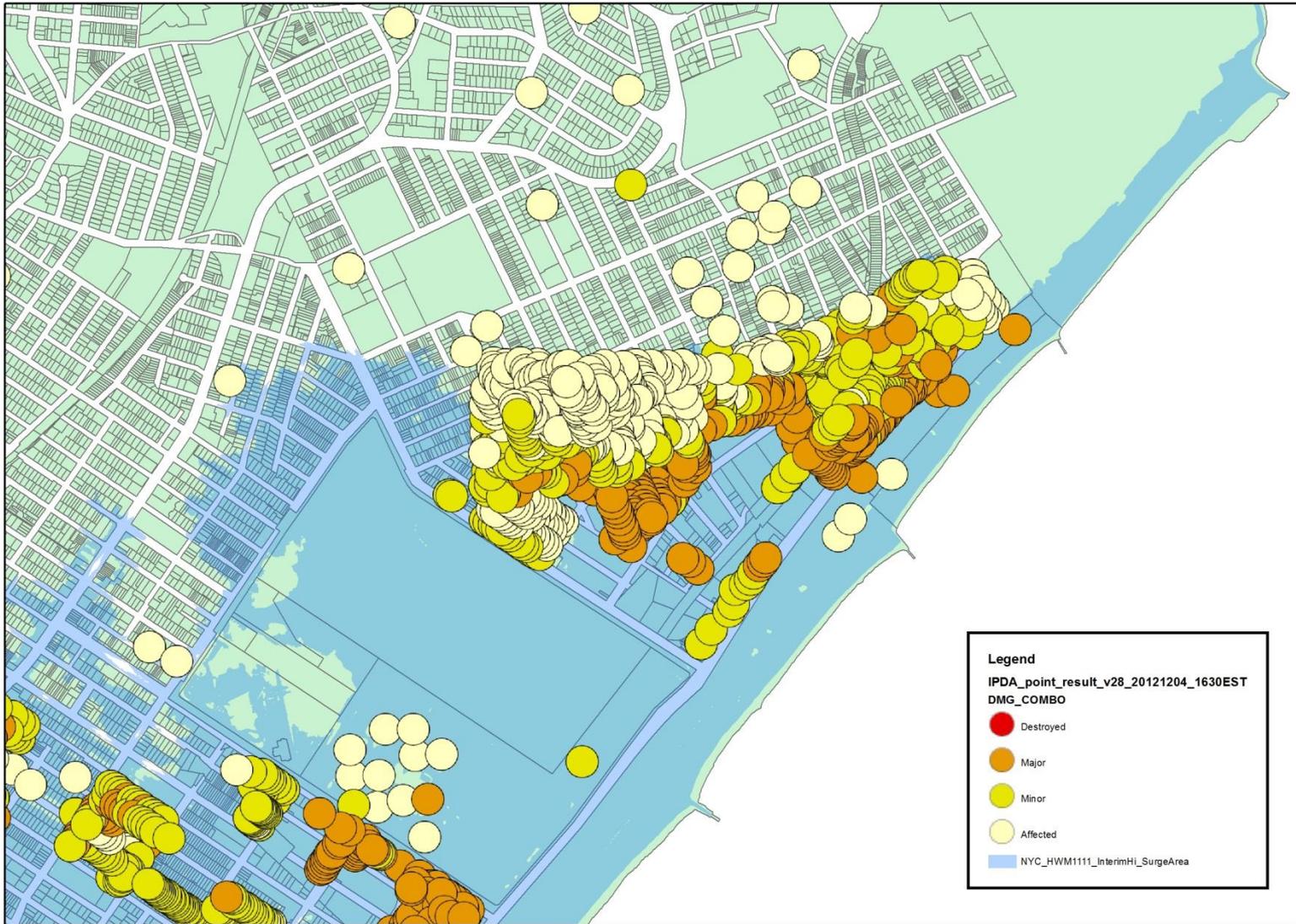


Data from FEMA  
Draft GIS map by Alan I. Benimoff, Ph.D.

Date: 2/25/2013  
Time: 6:35:09 PM

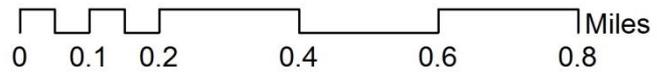


DAMAGE - South Beach

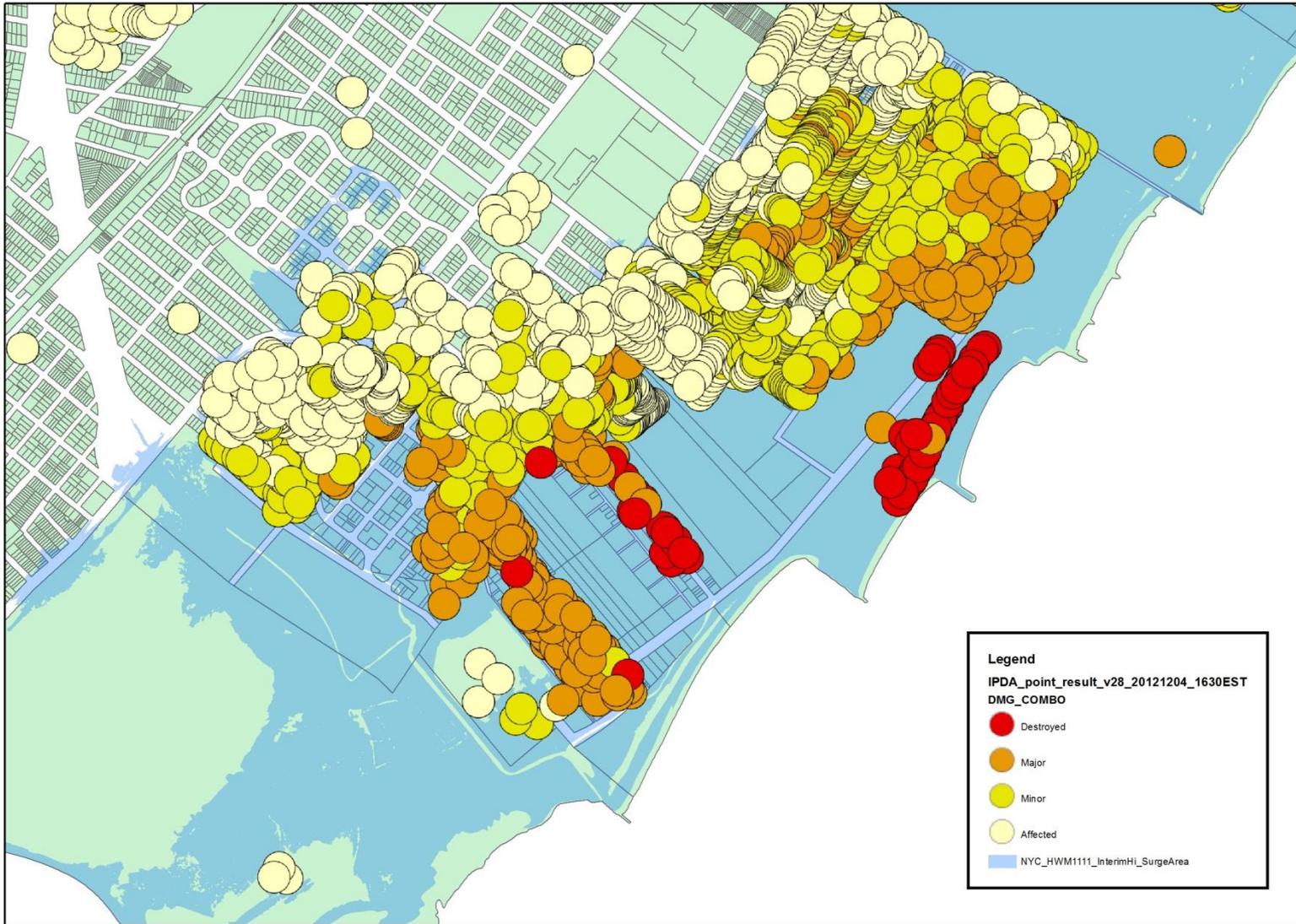


Data from FEMA  
Draft GIS map by Alan I. Benimoff, Ph.D.

Date: 2/25/2013  
Time: 6:34:14 PM



DAMAGE -Fox Beach - Oakwood Beach - New Dorp

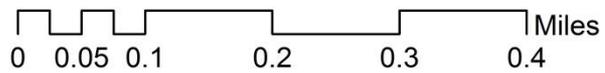


Data from FEMA  
Draft GIS map by Alan I. Benimoff, Ph.D.

Date: 2/25/2013  
Time: 6:36:40 PM

0 0.1 0.2 0.4 0.6 0.8 Miles

# SURGE EXTENT FOR SANDY - NORTH SHORE



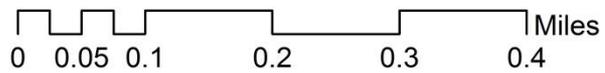
Draft GIS map by Alan I. Benimoff, Ph.D.  
Date: 3/6/2013  
Time: 4:41:11 PM

**Legend**

-  NYC\_HWM1111\_InterimHi\_SurgeArea



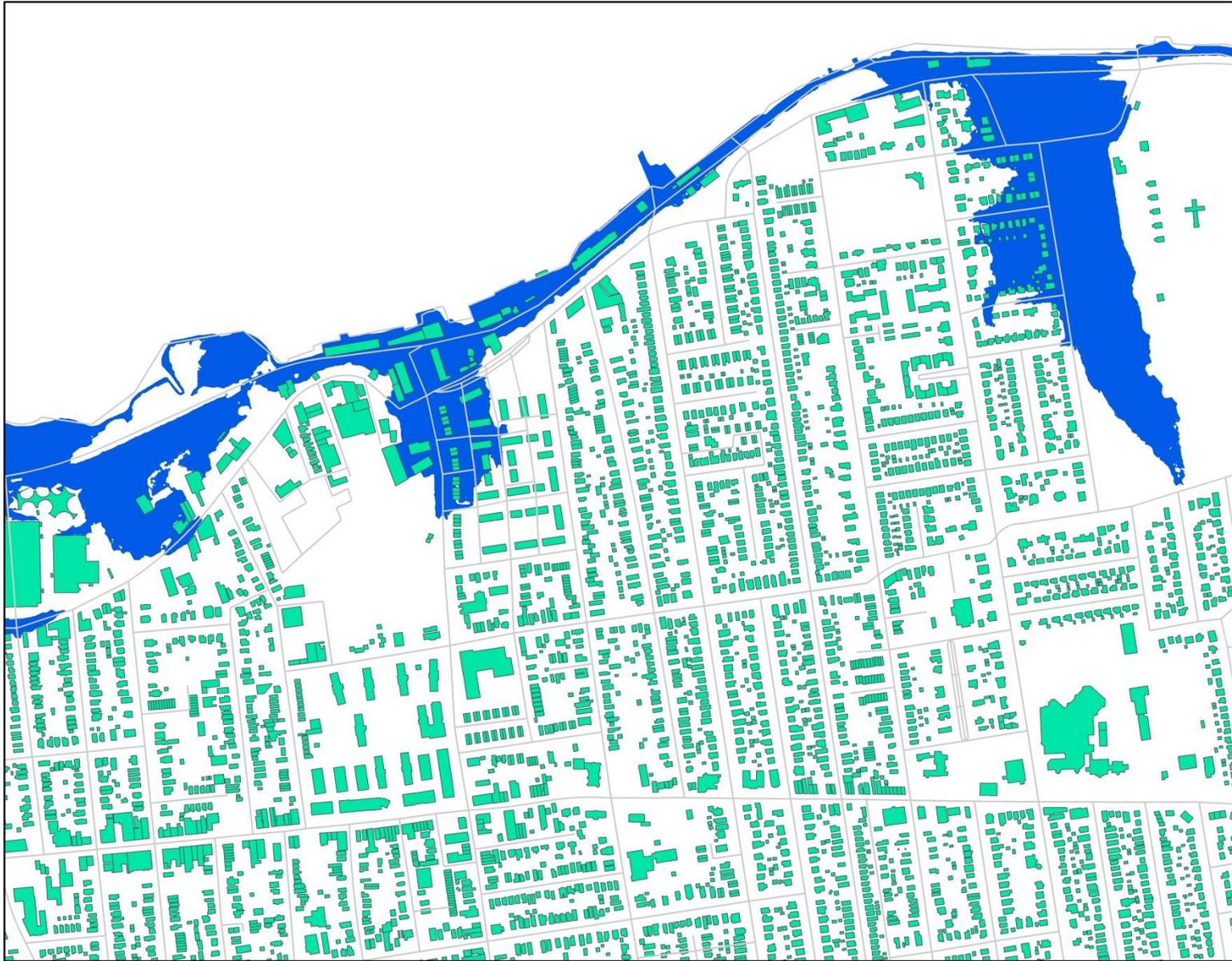
# SURGE EXTENT FOR SANDY - NORTH SHORE



Draft GIS map by Alan I. Benimoff, Ph.D.  
Date: 3/6/2013  
Time: 4:41:51 PM



# SURGE EXTENT FOR SANDY - NORTH SHORE



0 0.05 0.1 0.2 0.3 0.4 Miles

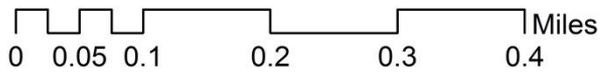
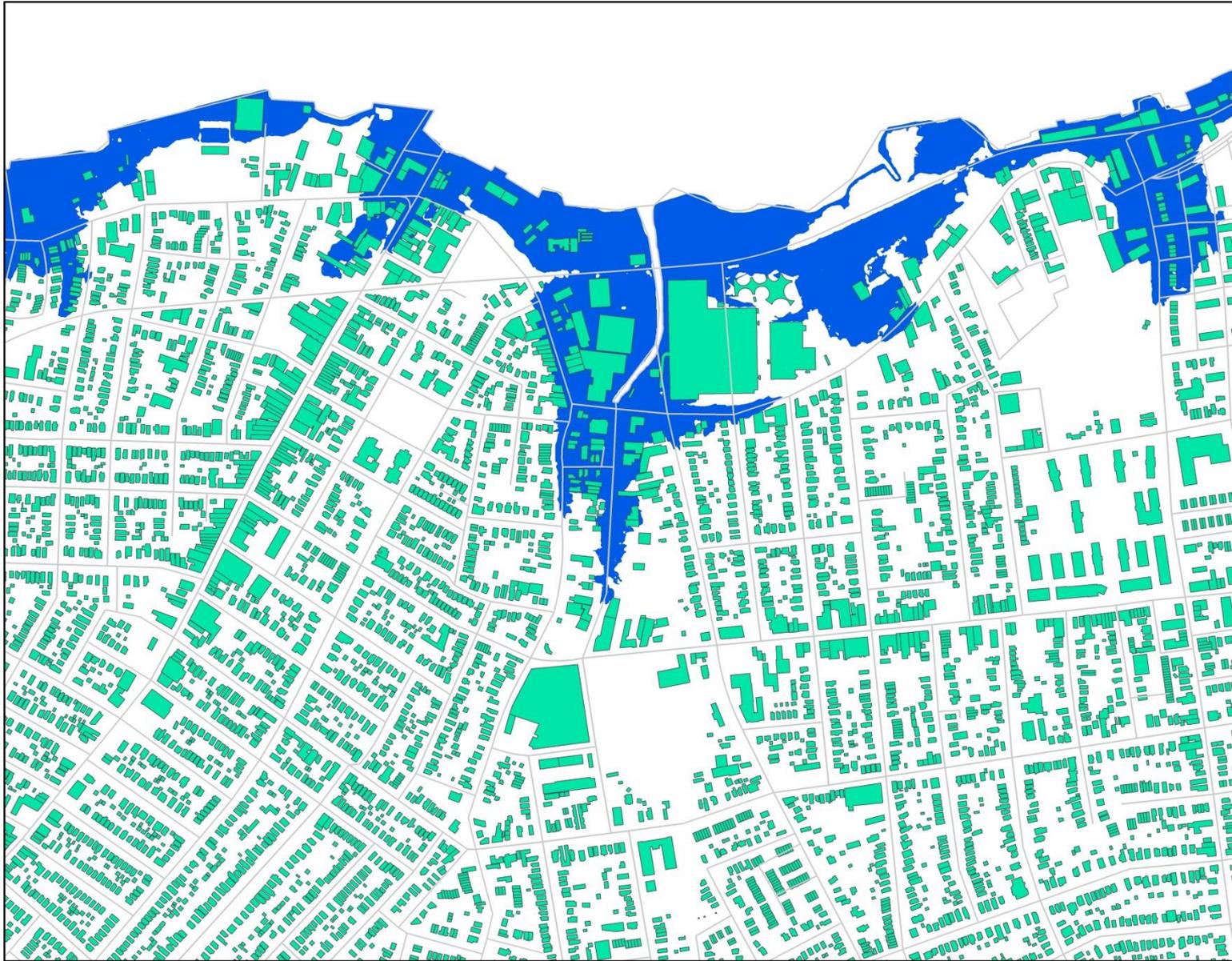
Draft GIS map by Alan I. Benimoff, Ph.D.  
Date: 3/6/2013  
Time: 4:42:29 PM

**Legend**

- NYC\_HWM1111\_InterimHi\_SurgeArea



# SURGE EXTENT FOR SANDY - NORTH SHORE



Draft GIS map by Alan I. Benimoff, Ph.D.  
Date: 3/6/2013  
Time: 4:43:10 PM

**Legend**

-  NYC\_HWM1111\_InterimHi\_SurgeArea



# Hurricane SANDY Response Imagery Viewer

National Geodetic Survey

- Layers
- Base Layers
  - Hurricane Track
    - Sandy Track
  - October 31, 2012 Fit1
    - Response Imagery
    - Processed Tiles
    - Download Zip 10-31 Fit1
  - October 31, 2012 Fit2
    - Response Imagery
    - Processed Tiles
    - Download Zip 10-31 Fit2
  - October 31, 2012 Fit3
  - November 01, 2012 Fit1
  - November 01, 2012 Fit2
  - November 01, 2012 Fit3
  - November 01, 2012 Fit4
  - November 02, 2012 Fit1
  - November 02, 2012 Fit2
  - November 02, 2012 Fit3
  - November 03, 2012 Fit1
  - November 03, 2012 Fit2
  - November 04, 2012 Fit1
  - November 04, 2012 Fit2
  - November 04, 2012 Fit3
  - November 05, 2012 Fit1
  - November 05, 2012 Fit2
  - November 06, 2012 Fit1
  - November 06, 2012 Fit2



Help Metadata Contact

Google  
Map data ©2012 Google - Terms of Use







103

30 645-3925



OCTOBER 30, 2012, Photo by A. I. Benimoff

NEW YORK  
ARB-5724  
THE EMPIRE STATE



OCTOBER 30, 2012, Photo by A. I. Benimoff



OCTOBER 30, 2012, Photo by A. I. Benimoff





OCTOBER 30, 2012, Photo by A. I. Benimoff



OCTOBER 30, 2012, Photo by A. I. Benimoff



OCTOBER 30, 2012, Photo by A. I. Benimoff





Google earth

Imagery Date: 6/18/2010 1991 lat 40.574245° lon -74.085606° elev 4 ft Eye alt 7585 ft

Graph: Min, Avg, Max Elevation: -0, 4, 8 ft  
Range Totals: Distance: 0.97 mi Elev Gain/Loss: 4.24 ft, -12.9 ft Max Slope: 2.8%, -2.6%



The New York Times

# Surveying the Destruction Caused by Hurricane Sandy

Share this on [Twitter](#) or [Facebook](#)



In the days before the arrival of Hurricane Sandy, few people in New York City anticipated the scale of destruction of the storm. The map shows the estimated height reached by floodwaters, which topped 17 feet in some parts, according to surveys and weather data collected by the Federal Emergency Management Agency.

- Click boxes to view details
- Flood zone: Approximate area inundated by the storm
- Building colors are the estimated peak water depth near building
  - 6 to 18 feet
  - 3 to 6
  - 0 to 3

By MATTHEW BLOCH, ALAN McLEAN and ARCHIE TSE; reporting contributed by Joseph Berger, Cara Buckley, Sarah Maslin Nir, Kirk Semple and Vivian Yee  
Sources: Flood areas and levels from the Federal Emergency Management Agency; Andrew A. Beveridge, [socialexplorer.com](#); building shapes from NYC Open Data



BehirScreenShot8\_2 2013-03-01 1:43:28 AM



SCREEN SHOTS



reen shot 03...2 AM.jpg



BrMain370.dmg



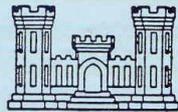
1111987297\_351453 -1.doc

AI

NEERS

STATEN ISLAND, NEW YORK  
FORT WADSWORTH TO ARTHUR KILL

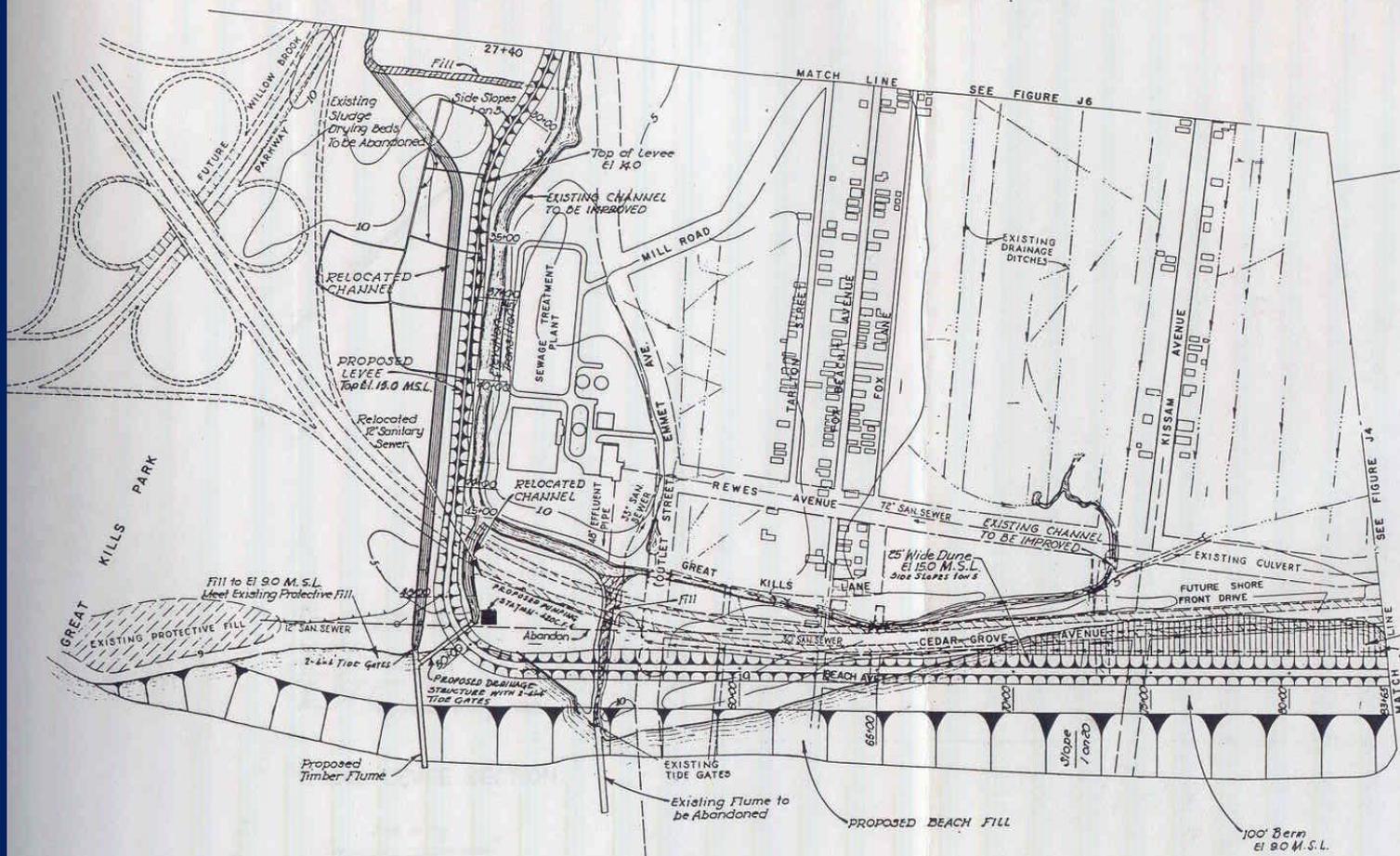
COOPERATIVE BEACH EROSION CONTROL  
AND  
INTERIM HURRICANE STUDY  
(SURVEY)



U. S. ARMY ENGINEER DISTRICT, NEW YORK  
CORPS OF ENGINEERS  
NEW YORK, N. Y. 10003

MARCH 1964



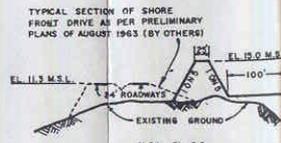


**PLAN**

Scale in Feet  
0 200 400

Drainage Structure Station 49+50  
Levee  
Beach Fill  
Top of Levee & Beach Fill  
E1 15.0 M.S.L.

**NOTE**  
Top width of Levee:  
10 feet from Station 27+40  
Varies from Station 44+00  
25 feet from Station 45+00



**DUNE AND BEACH FILL STATION (60+00)**  
HORIZ 100 0 10  
VERT 10 0 10  
SCALE IN FEET

Elevation  
Transitions  
310.000  
312.000

10  
20

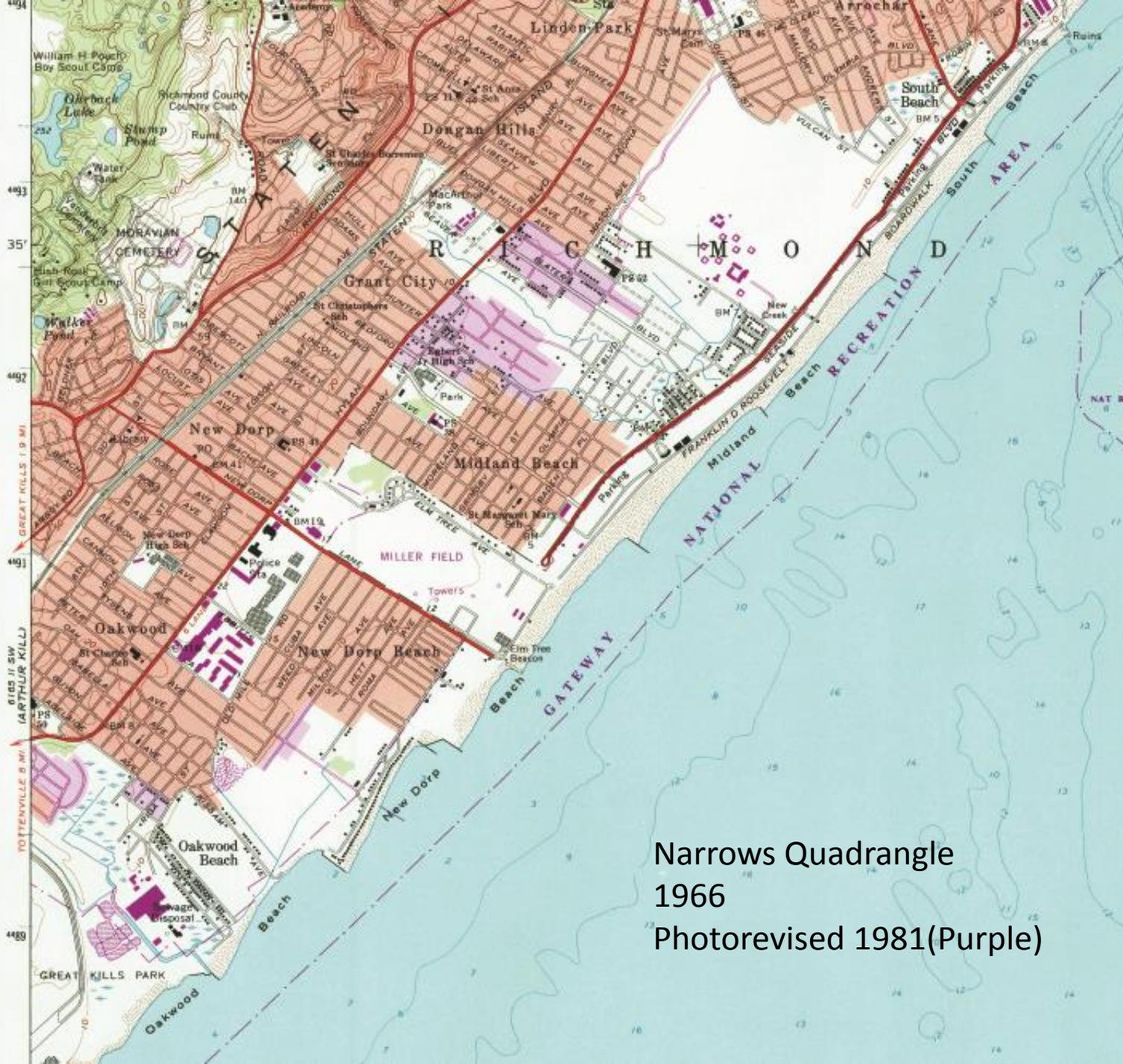




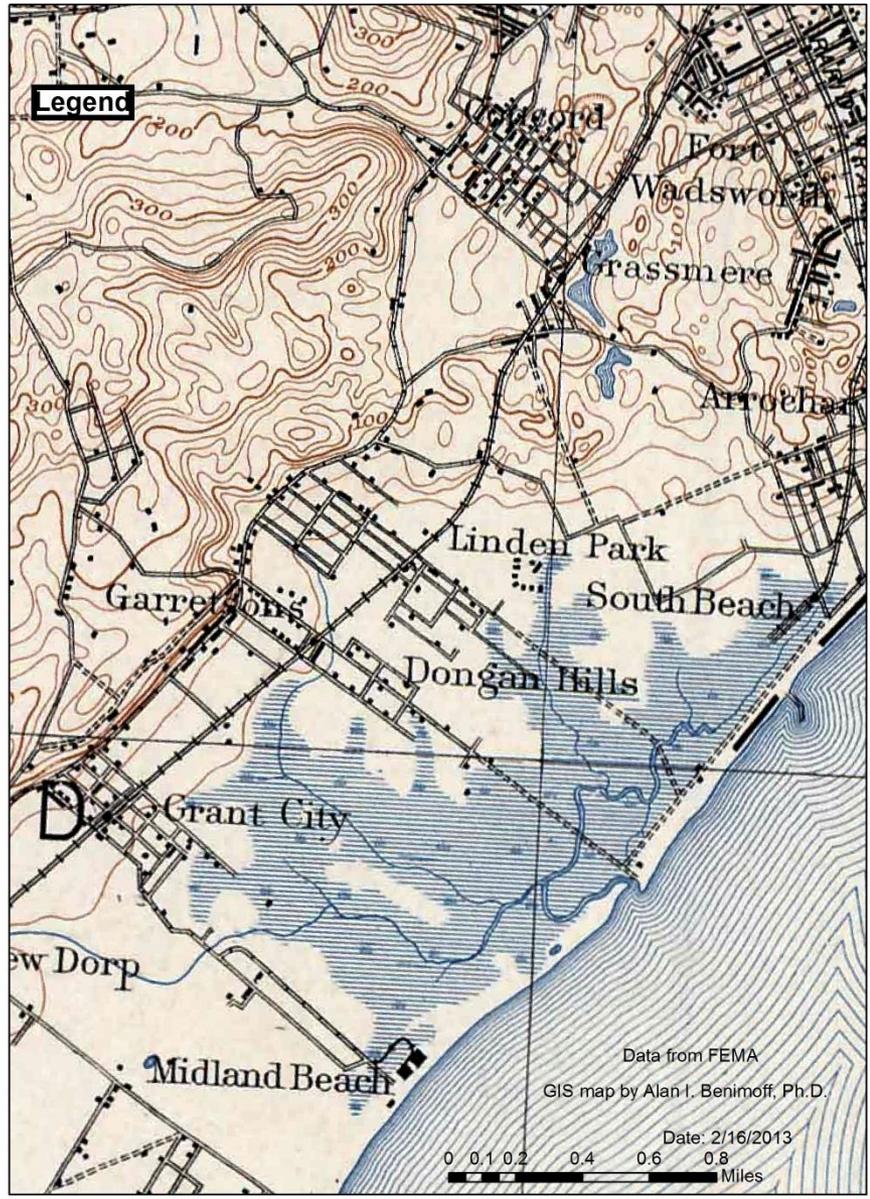
- Proposed BMP Site
- Existing Lower Bay Outfall
- Proposed Lower Bay Outfall
- Drainage Area Tributary to New Creek Bluebelt
- Proposed Drainage Plan Area Tributary to Existing Ocean Outfalls
- Existing Stream
- Parks and Open Space (City, State & Federal)
- DEP Bluebelt Property (Acquired or in the Process of Being Acquired)
- ⊖ Rail Line/Rail Station

# NYC DEP MID-ISLAND BLUEBELT NEW CREEK

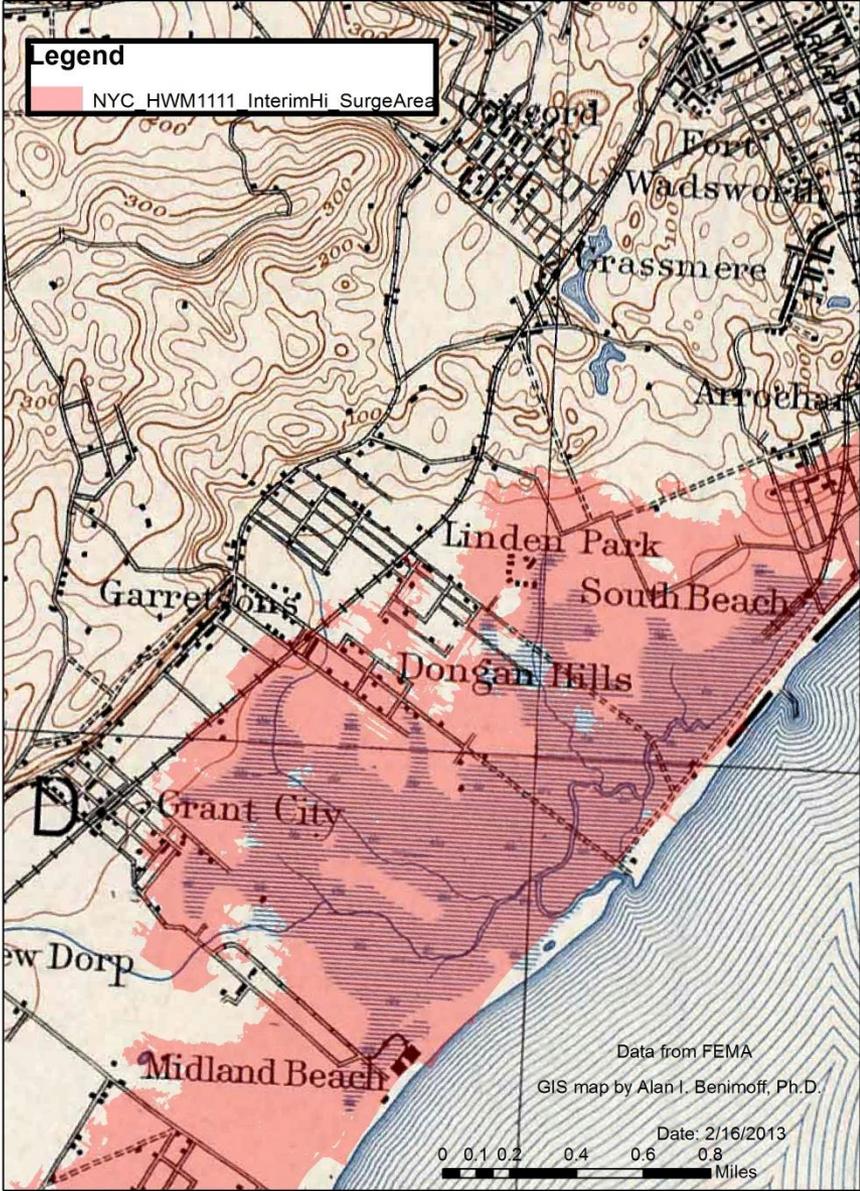
Staten Island Bluebelt Mid-Island Watersheds  
New Creek Watershed - Proposed BMP Sites  
Figure 4.1-1



Narrows Quadrangle  
1966  
Photorevised 1981(Purple)



# Storm Surge Extent for Sandy on Staten Island, NY





OCTOBER 30, 2012, Photo by A. I. Benimoff



OCTOBER 30, 2012, Photo by A. I. Benimoff





OCTOBER 30, 2012, Photo by A. I. Benimoff



OCTOBER 30, 2012, Photo by A. I. Benimoff



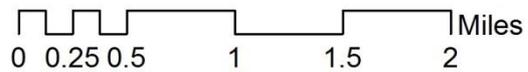
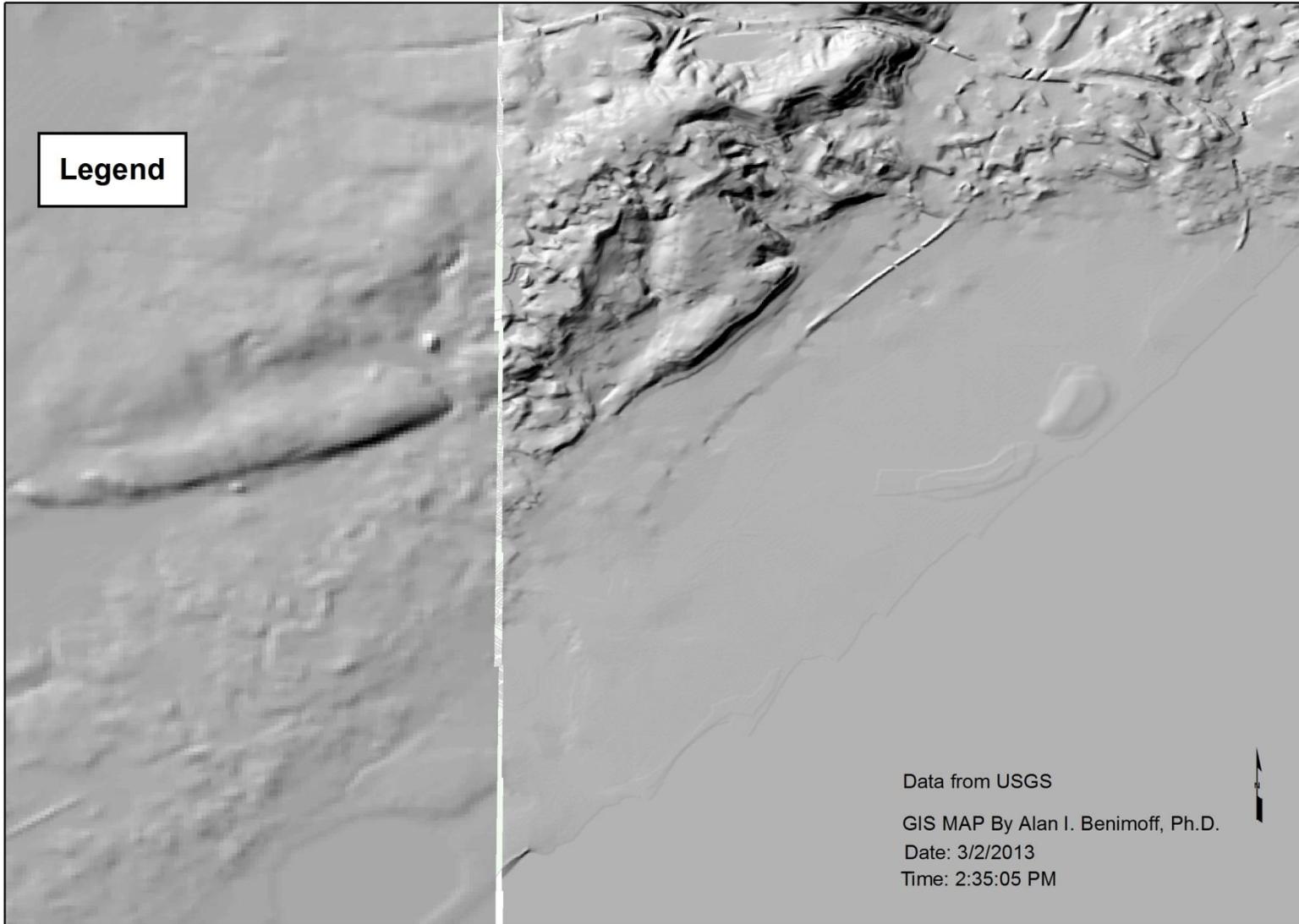
OCTOBER 30, 2012, Photo by A. I. Benimoff



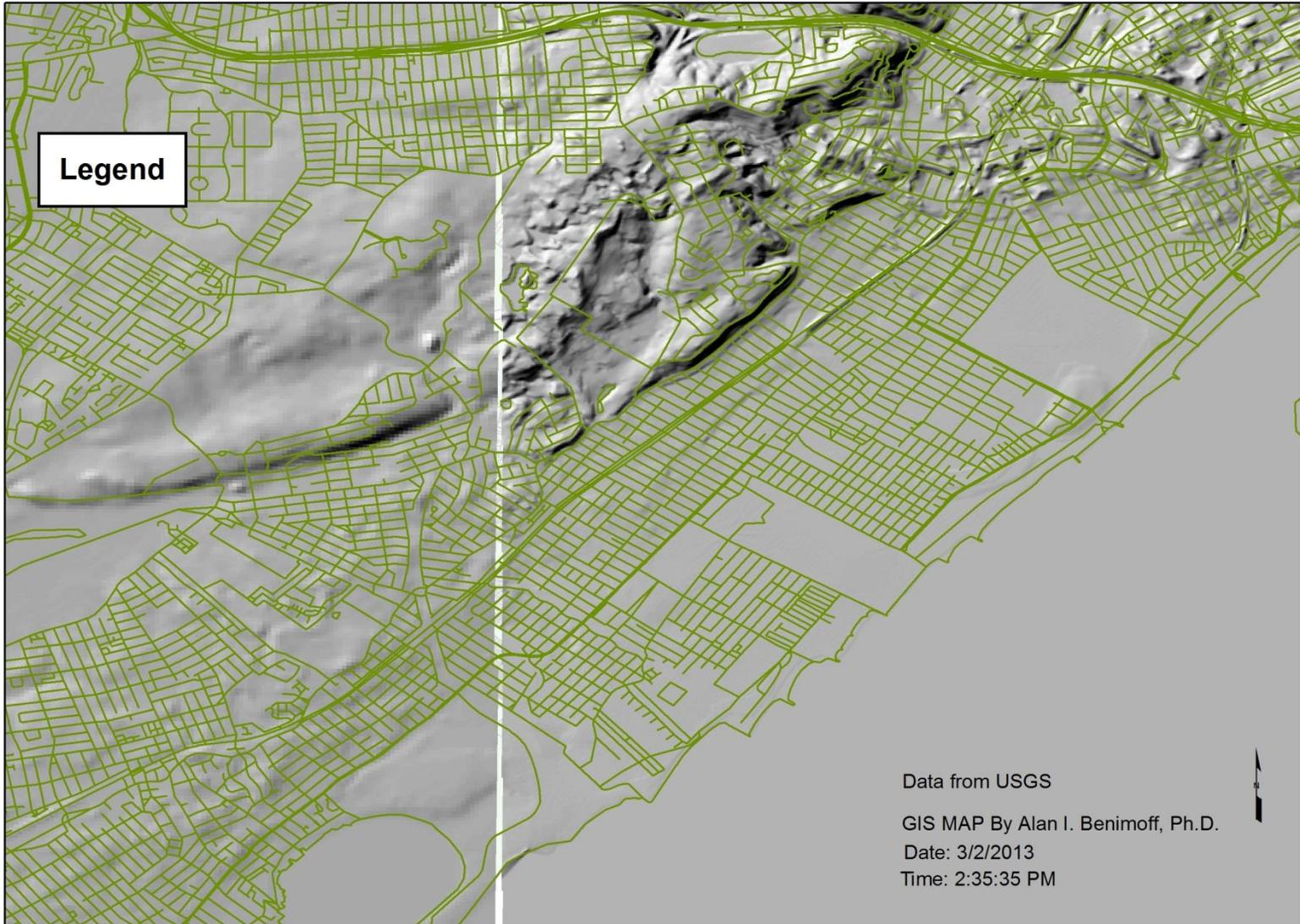
OCTOBER 30, 2012, Photo by A. I. Benimoff



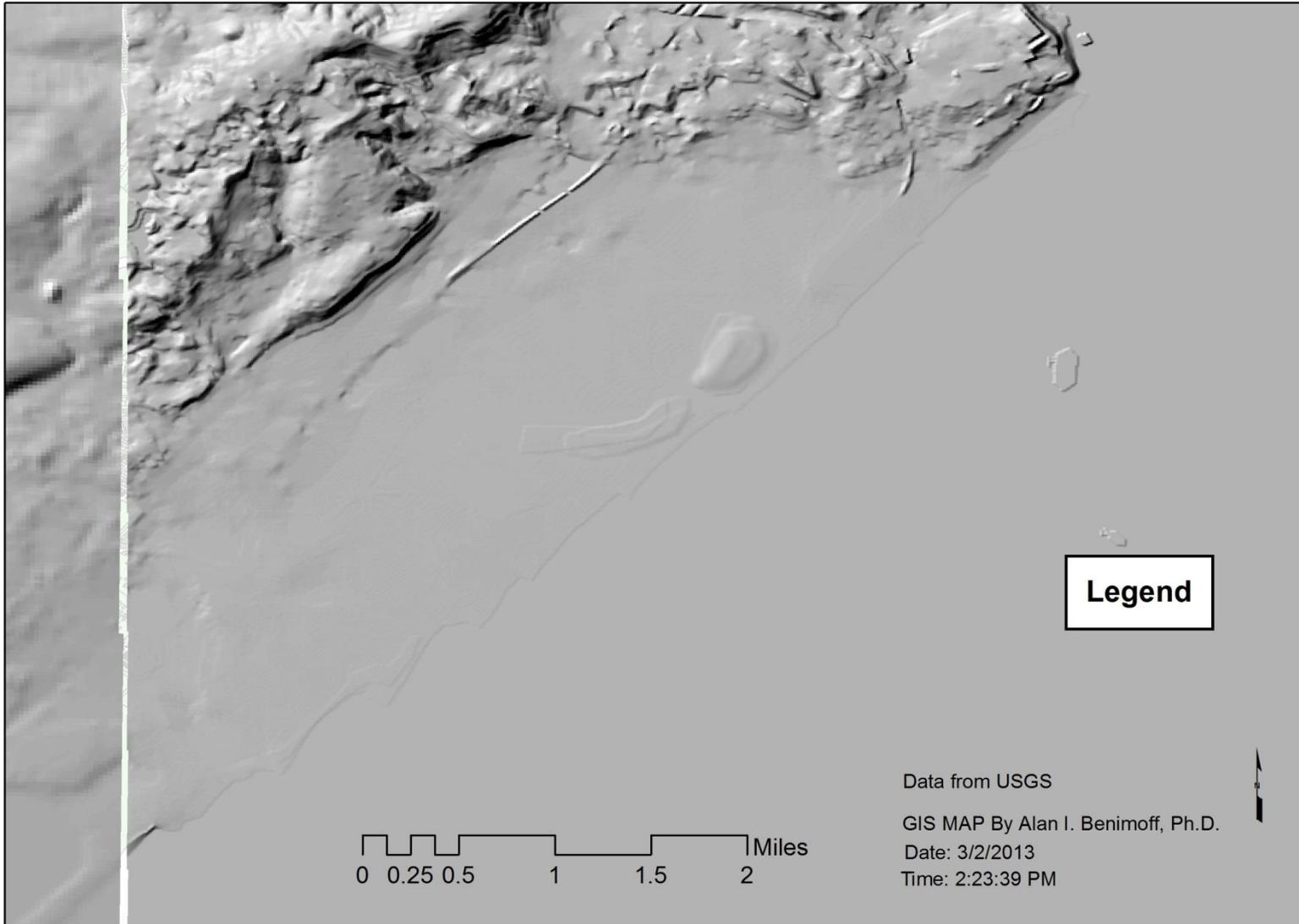
# MAP OF STATEN ISLAND NY



# MAP OF STATEN ISLAND NY



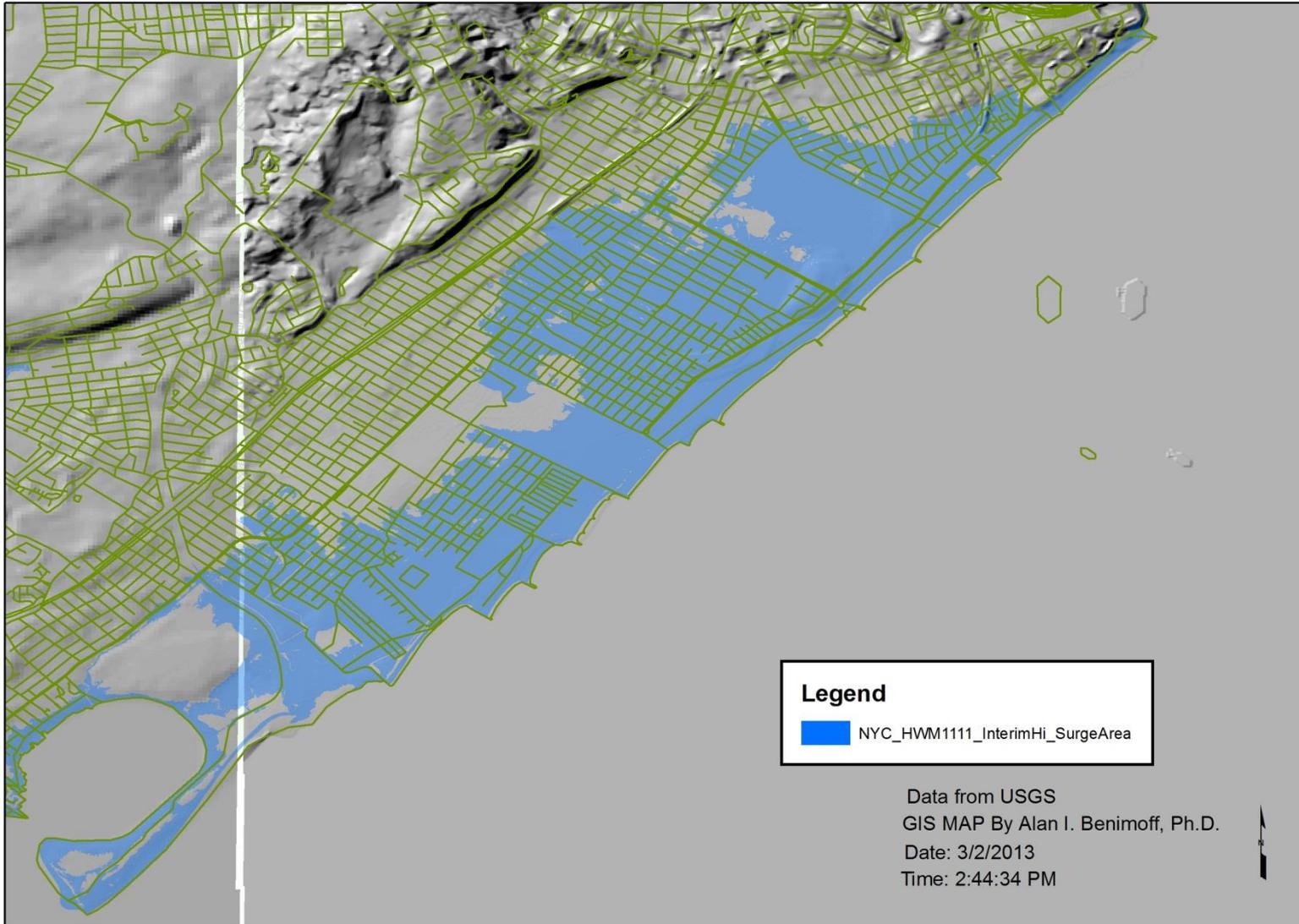
# HILLSHADE MAP OF STATEN ISLAND NY



# HILLSHADE MAP OF STATEN ISLAND NY

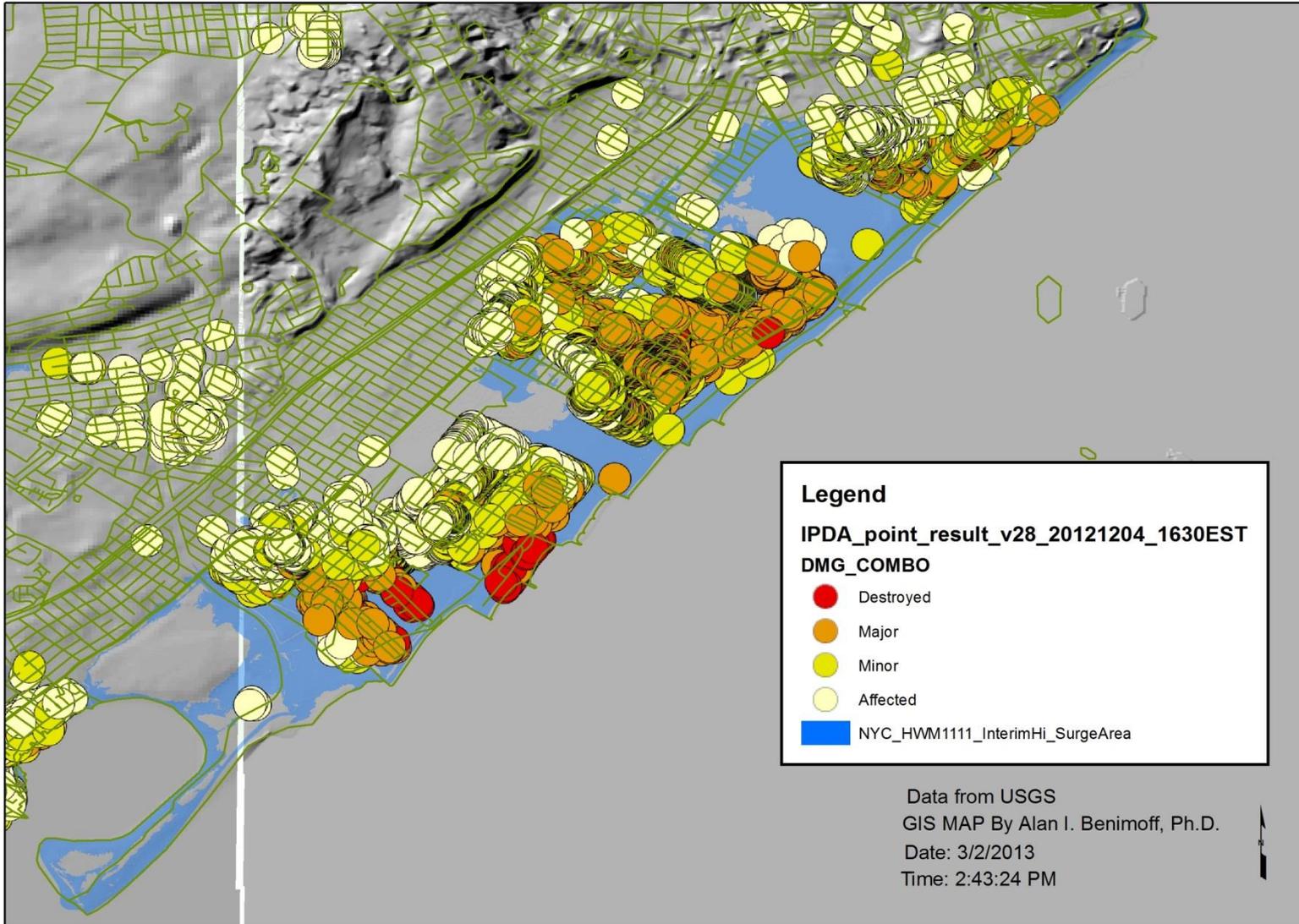


# MAP OF STATEN ISLAND NY



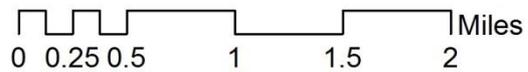
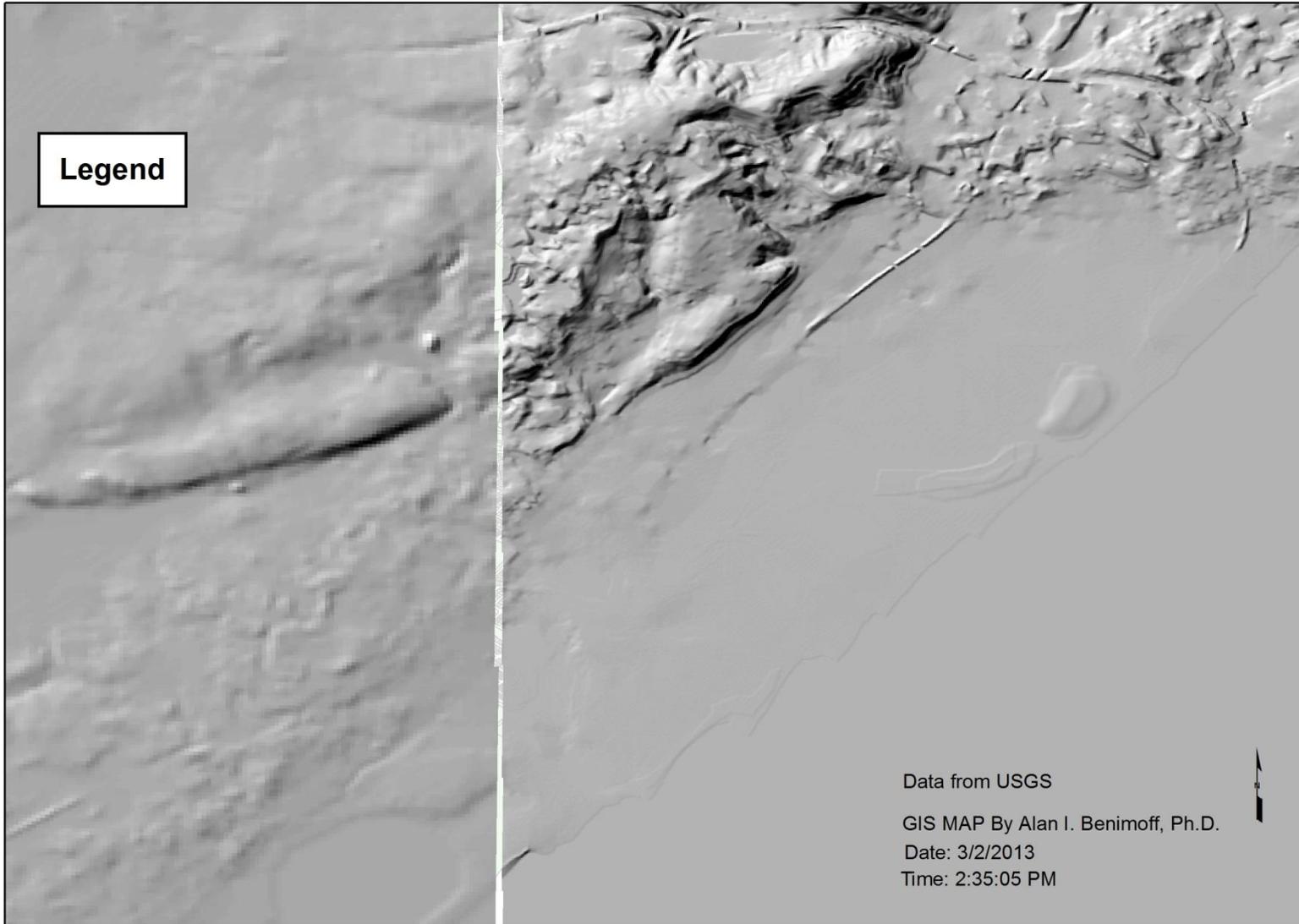
0 0.25 0.5 1 1.5 2 Miles

# MAP OF STATEN ISLAND NY

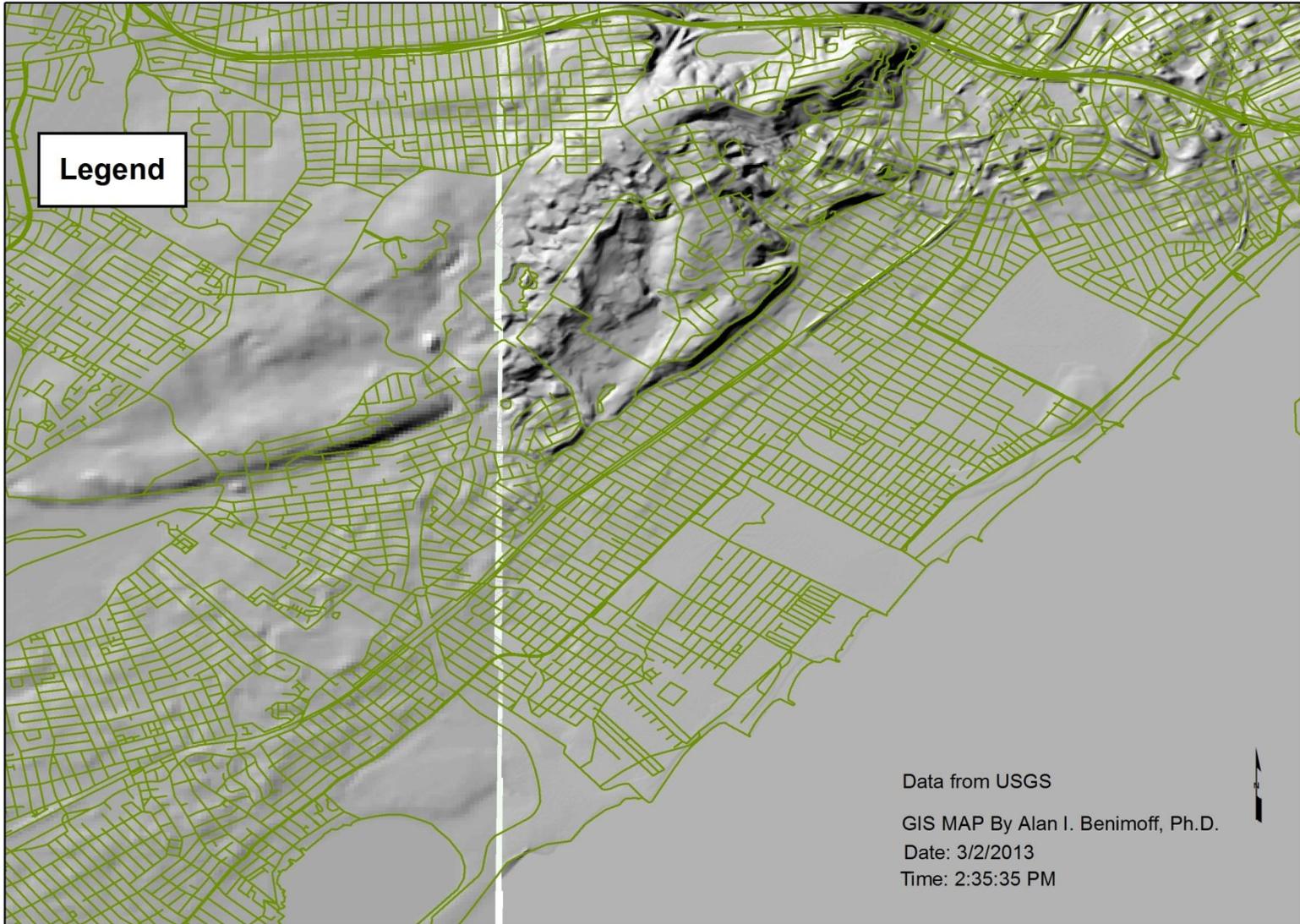


0 0.25 0.5 1 1.5 2 Miles

# MAP OF STATEN ISLAND NY

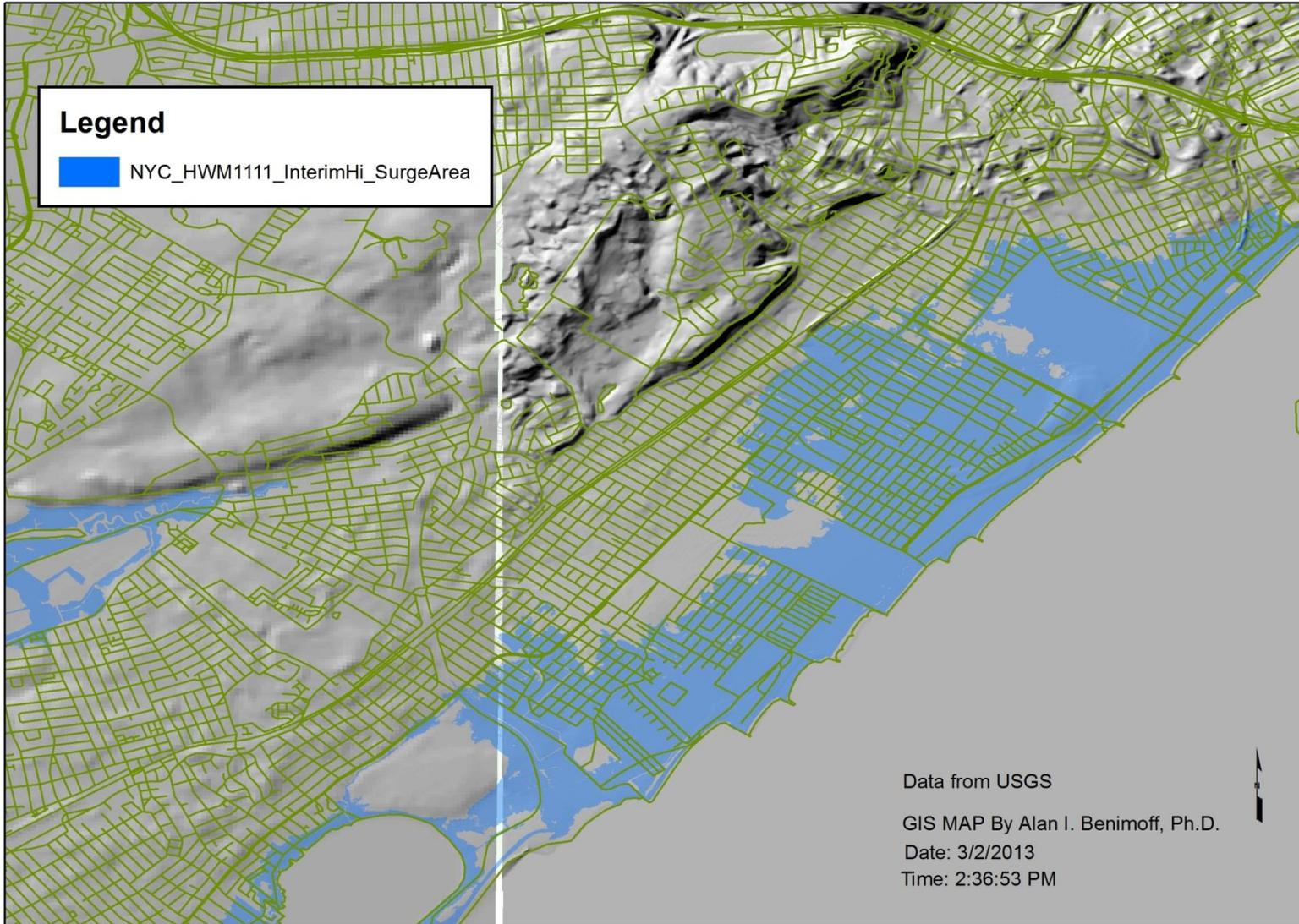


# MAP OF STATEN ISLAND NY

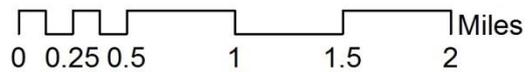
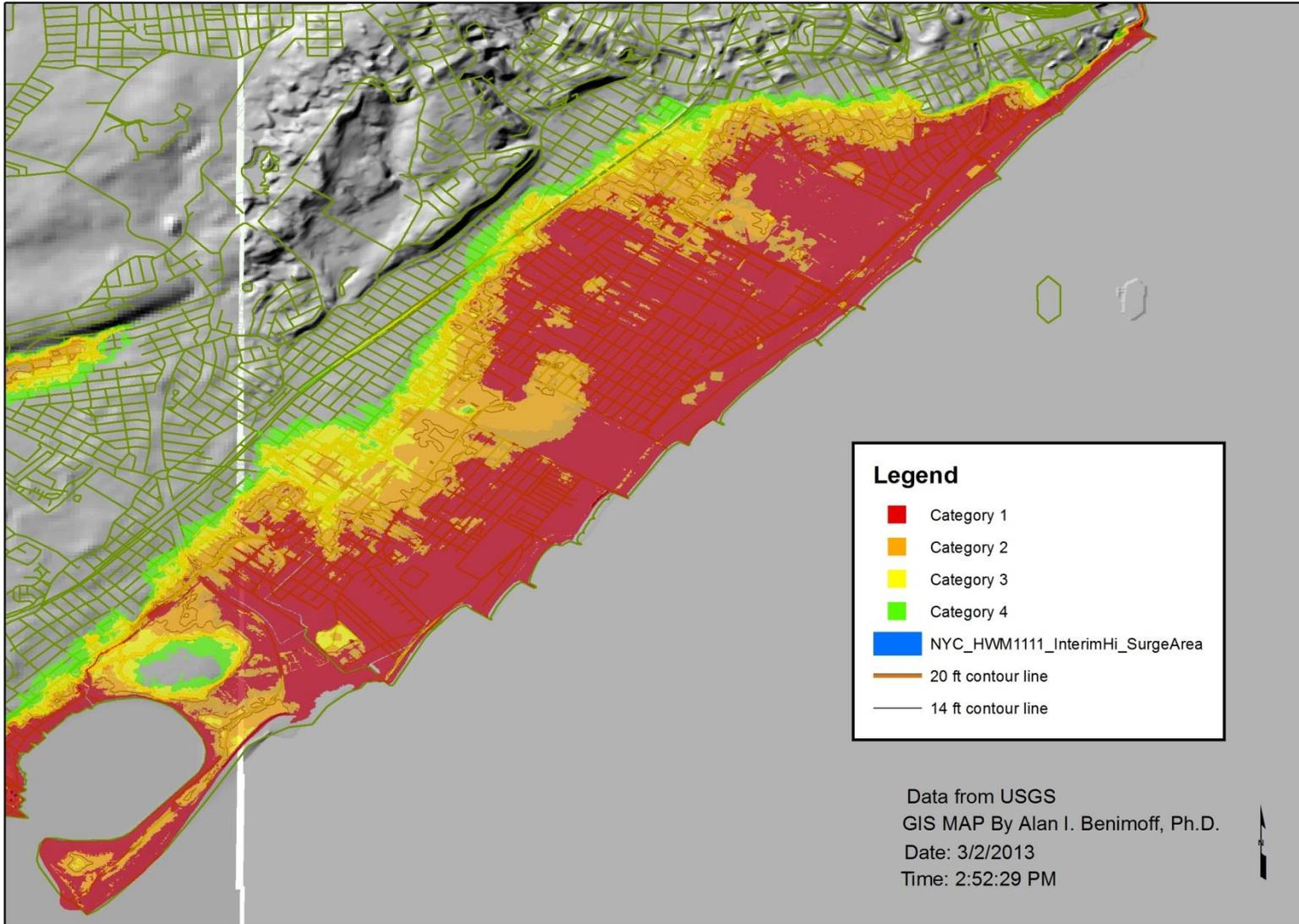


0 0.25 0.5 1 1.5 2 Miles

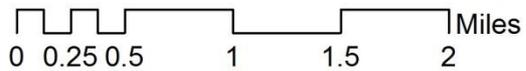
# MAP OF STATEN ISLAND NY



# MAP OF STATEN ISLAND NY

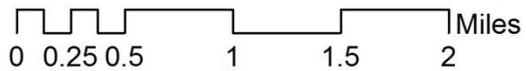


# MAP OF STATEN ISLAND NY



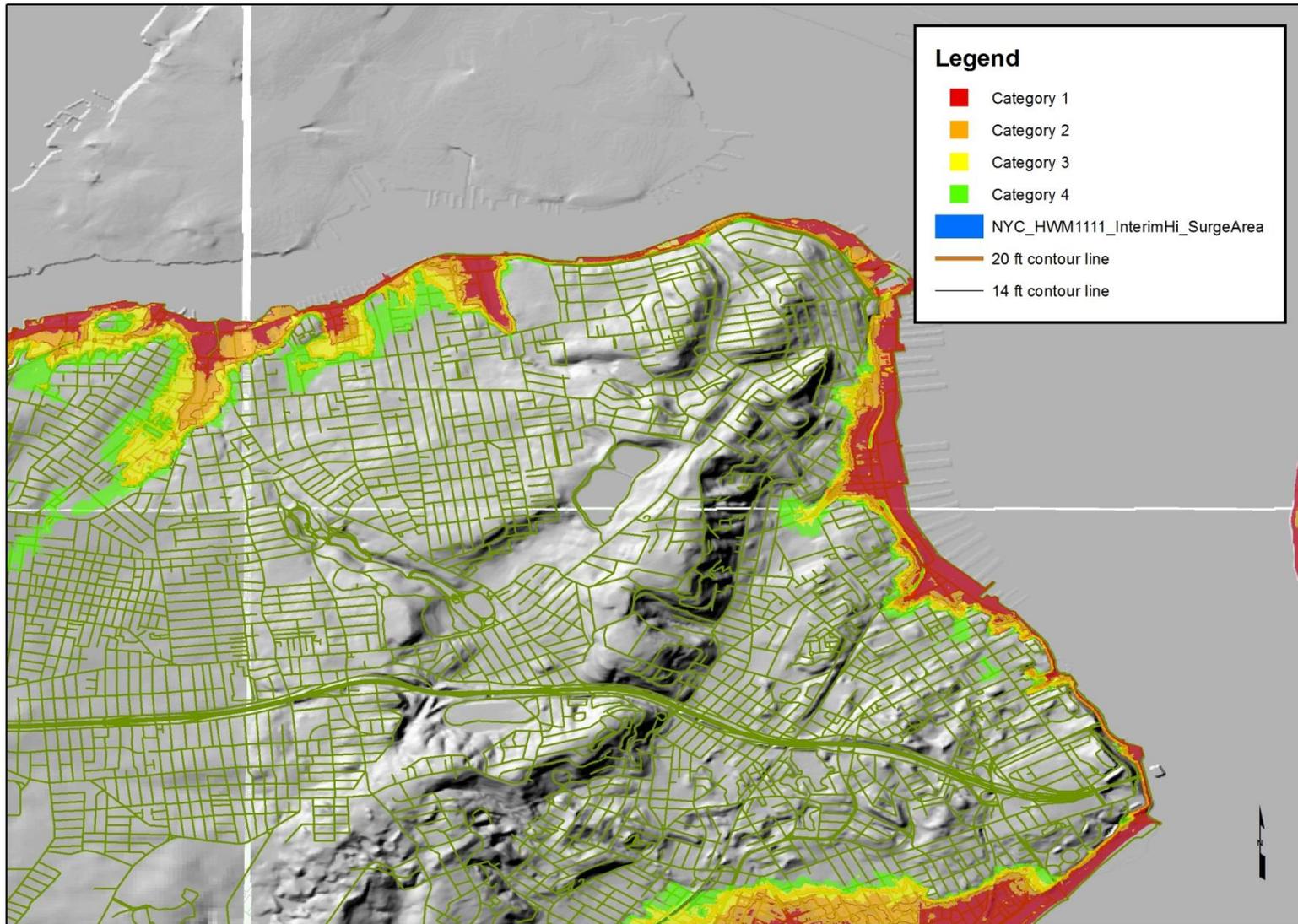
Data from USGS and FEMA GIS MAP By Alan I. Benimoff, Ph.D.  
Date: 3/2/2013  
Time: 2:56:30 PM

# MAP OF STATEN ISLAND NY



Data from USGS and FEMA GIS MAP By Alan I. Benimoff, Ph.D.  
Date: 3/2/2013  
Time: 2:56:30 PM

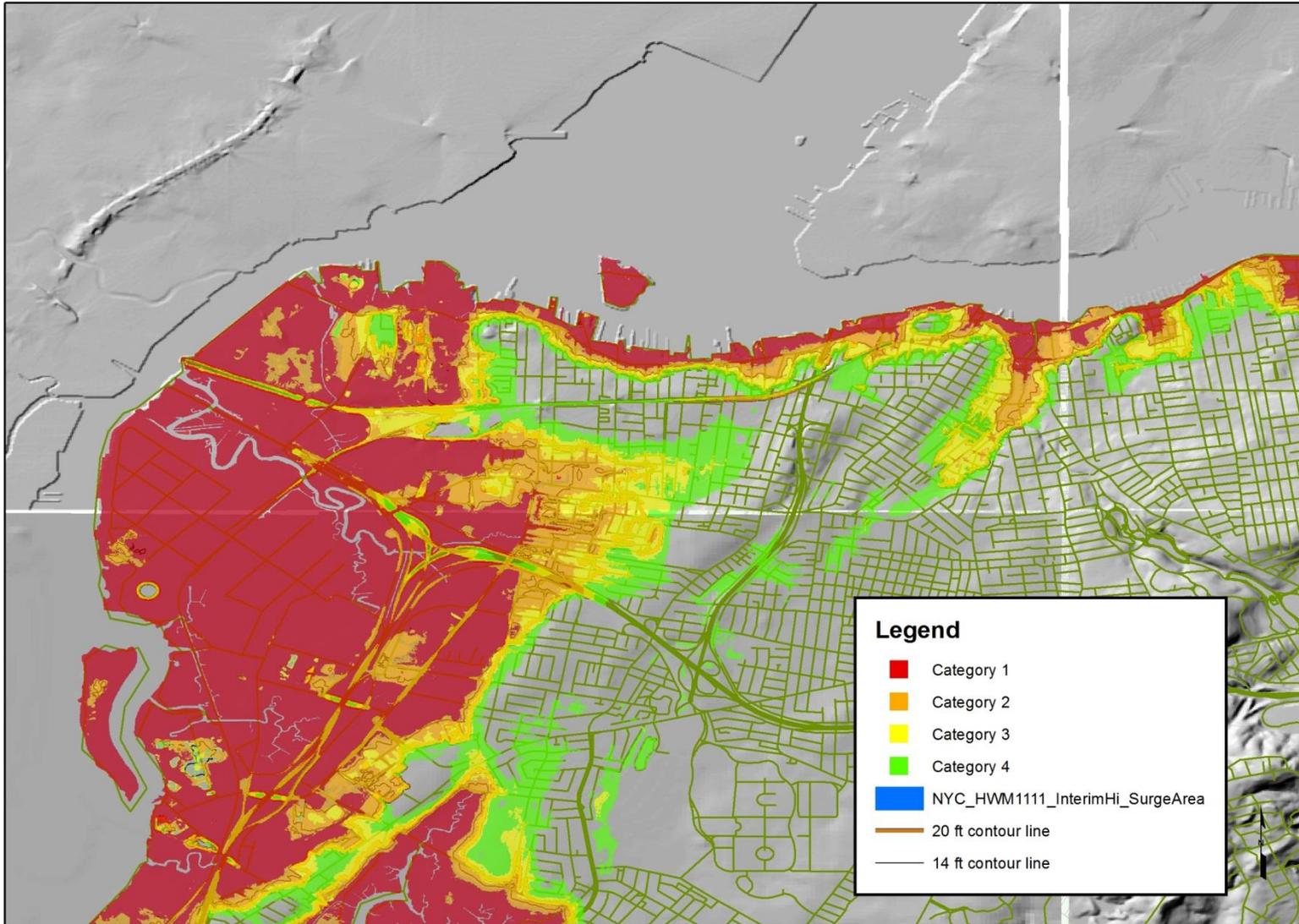
# MAP OF STATEN ISLAND NY



0 0.25 0.5 1 1.5 2 Miles

Data from USGS and FEMA GIS MAP By Alan I. Benimoff, Ph.D.  
Date: 3/2/2013  
Time: 2:55:19 PM

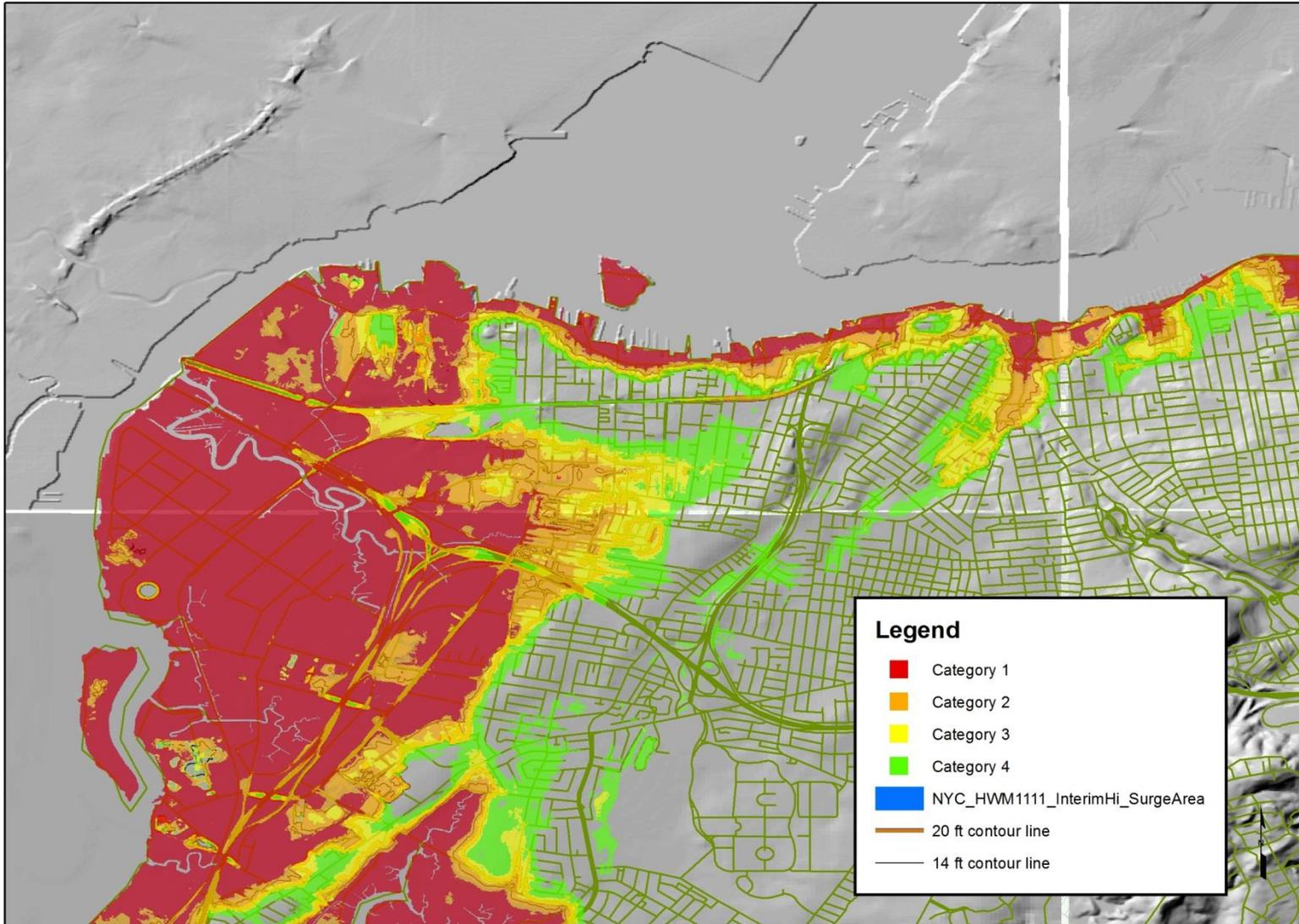
# MAP OF STATEN ISLAND NY



0 0.25 0.5 1 1.5 2 Miles

Data from USGS and FEMA GIS MAP By Alan I. Benimoff, Ph.D.  
Date: 3/2/2013  
Time: 3:00:44 PM

# MAP OF STATEN ISLAND NY



0 0.25 0.5 1 1.5 2 Miles

Data from USGS and FEMA GIS MAP By Alan I. Benimoff, Ph.D.  
Date: 3/2/2013  
Time: 3:00:44 PM

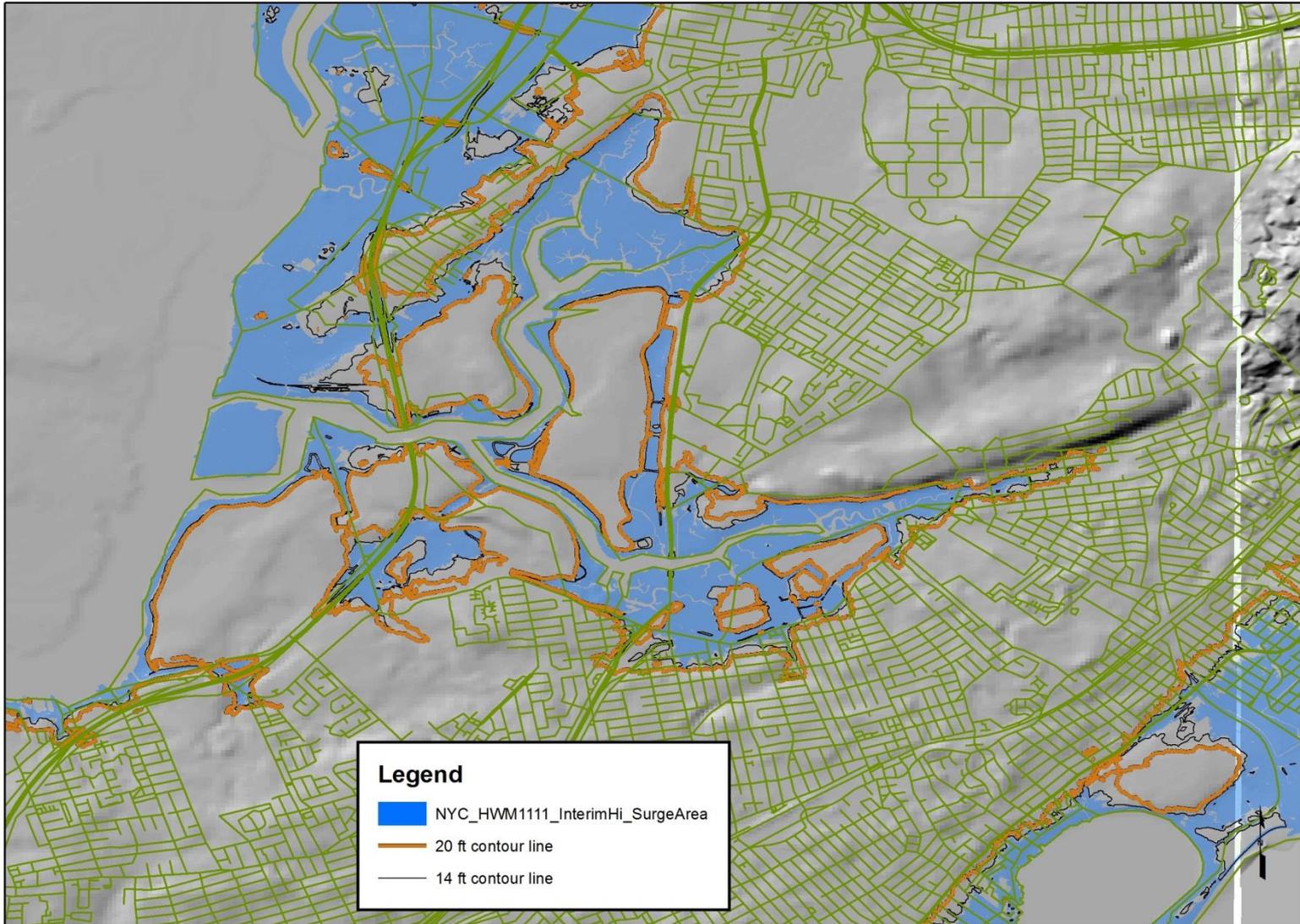
# MAP OF STATEN ISLAND NY



0 0.25 0.5 1 1.5 2 Miles

Data from USGS and FEMA GIS MAP By Alan I. Benimoff, Ph.D.  
Date: 3/2/2013  
Time: 3:01:37 PM

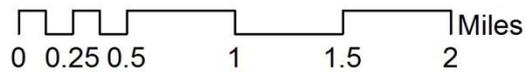
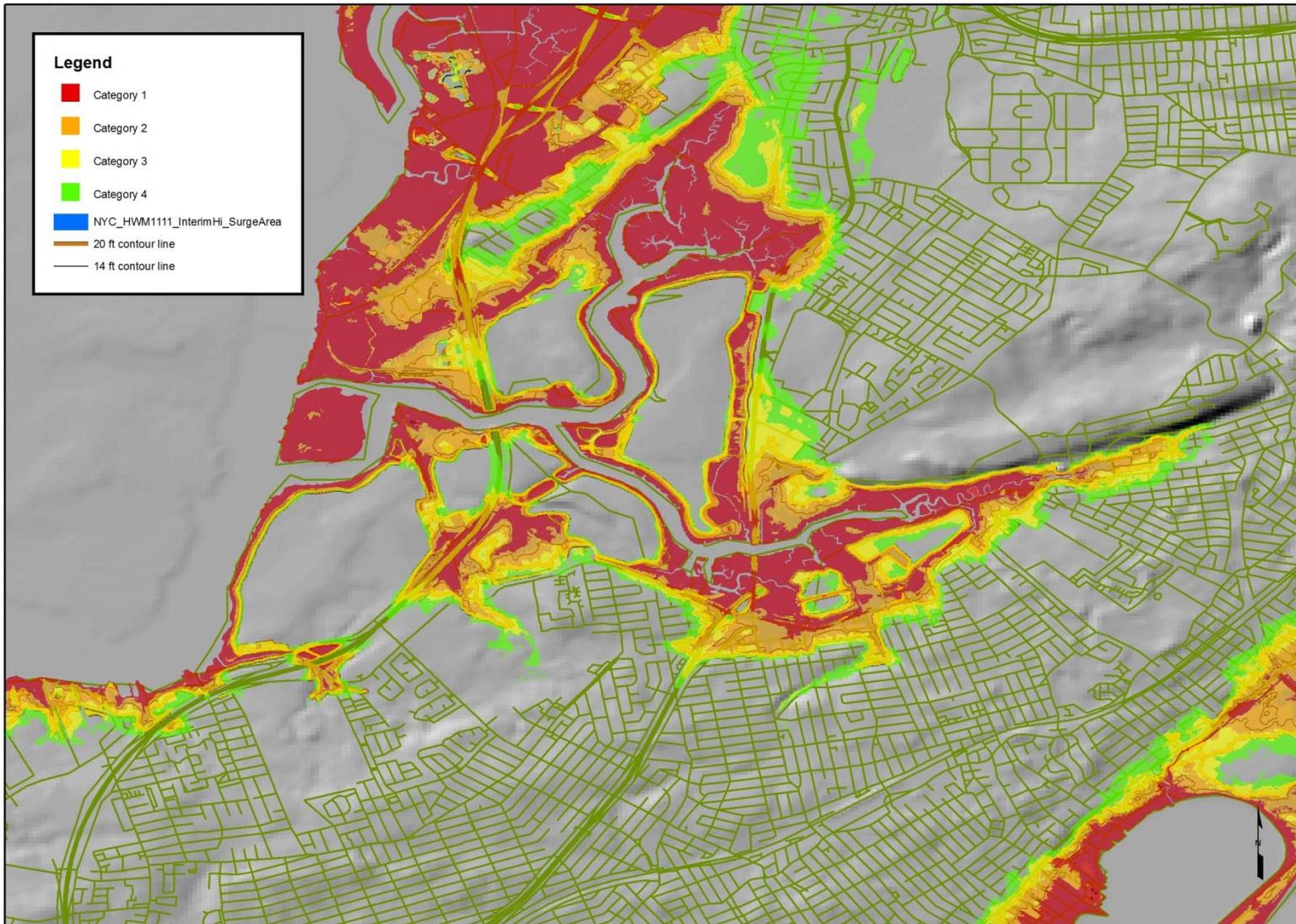
# MAP OF STATEN ISLAND NY



0 0.25 0.5 1 1.5 2 Miles

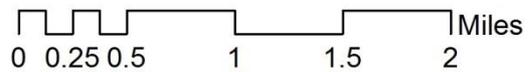
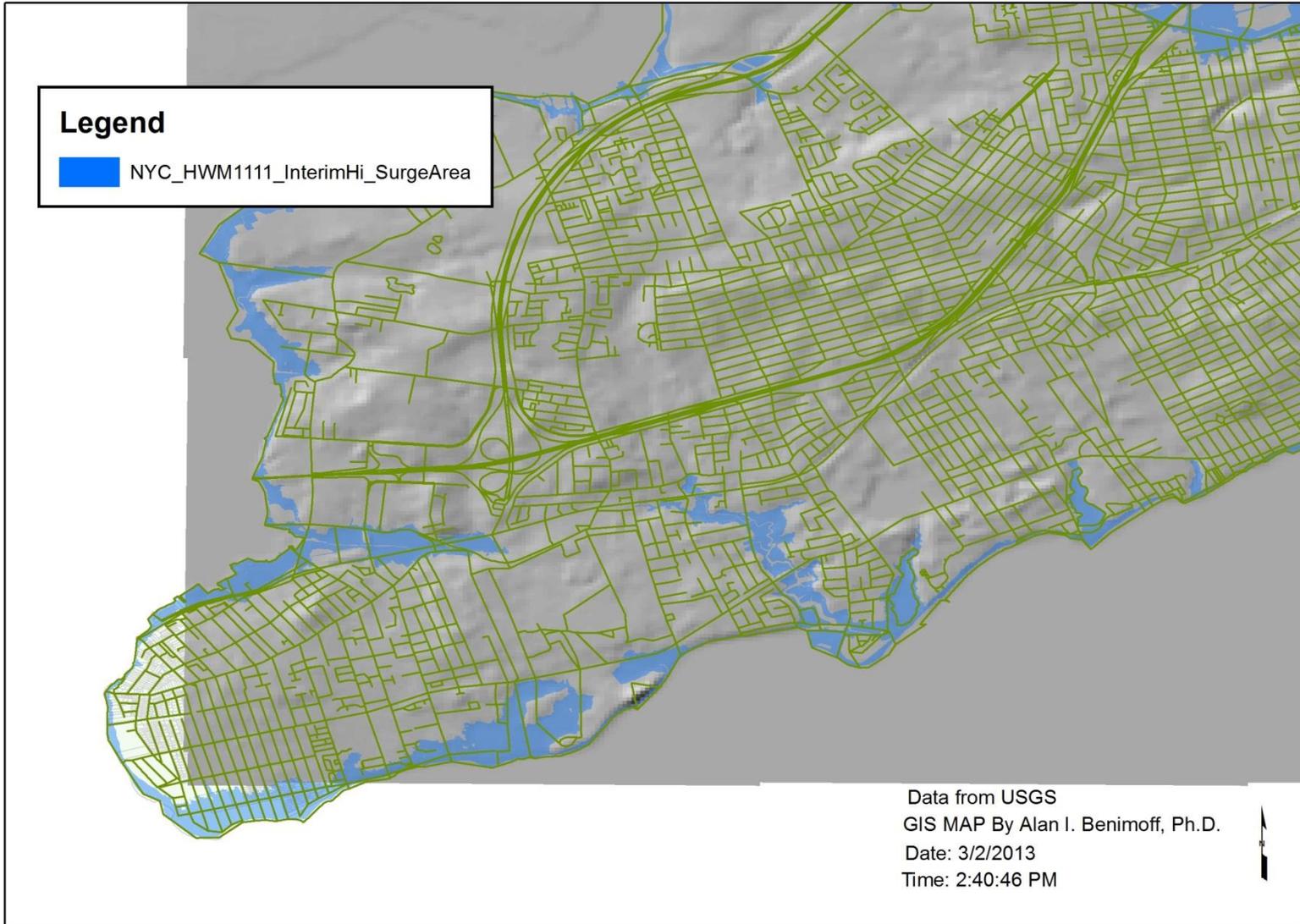
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Date: 3/2/2013  
Time: 3:04:18 PM

# MAP OF STATEN ISLAND NY

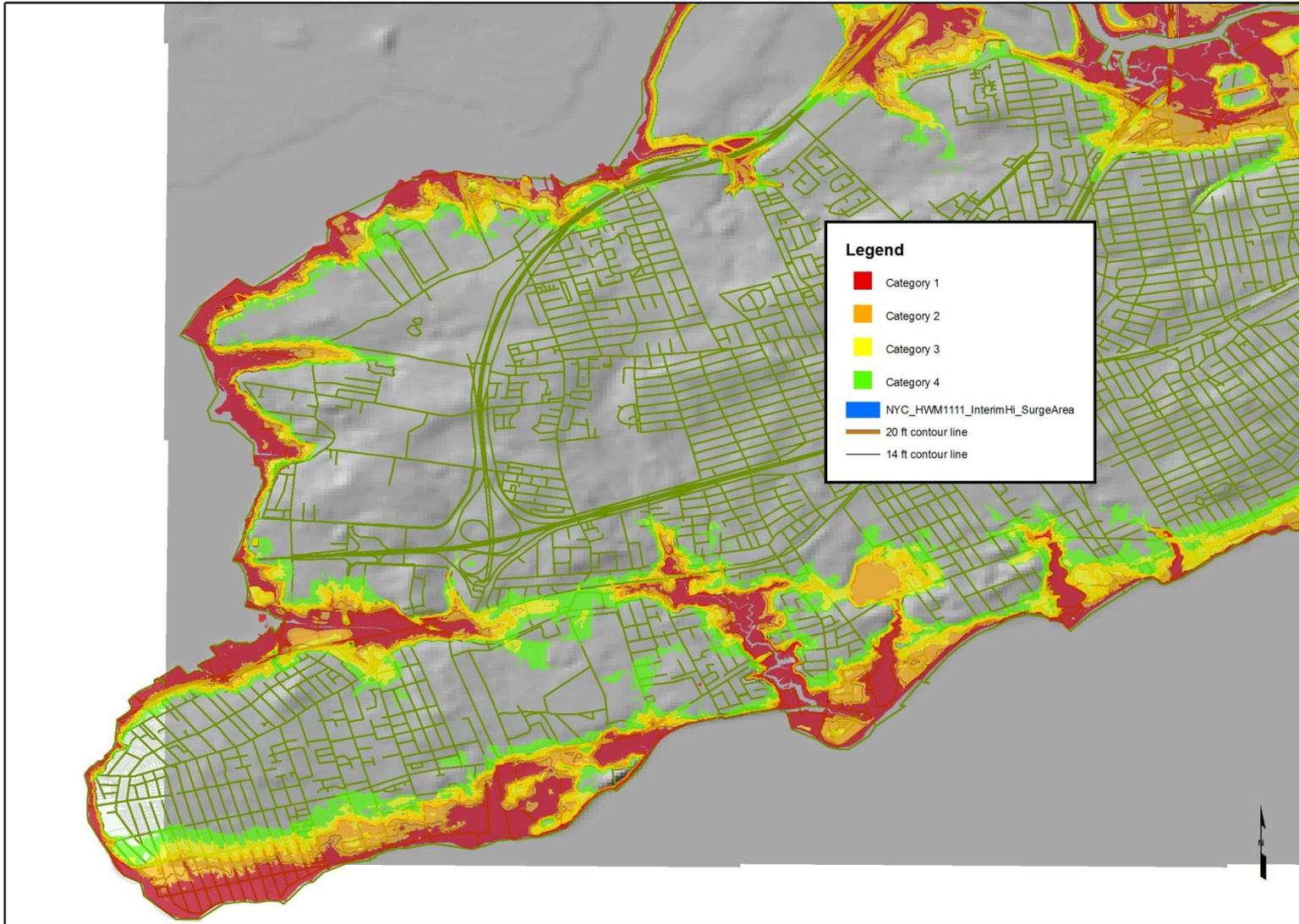


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Date: 3/2/2013  
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# MAP OF STATEN ISLAND NY



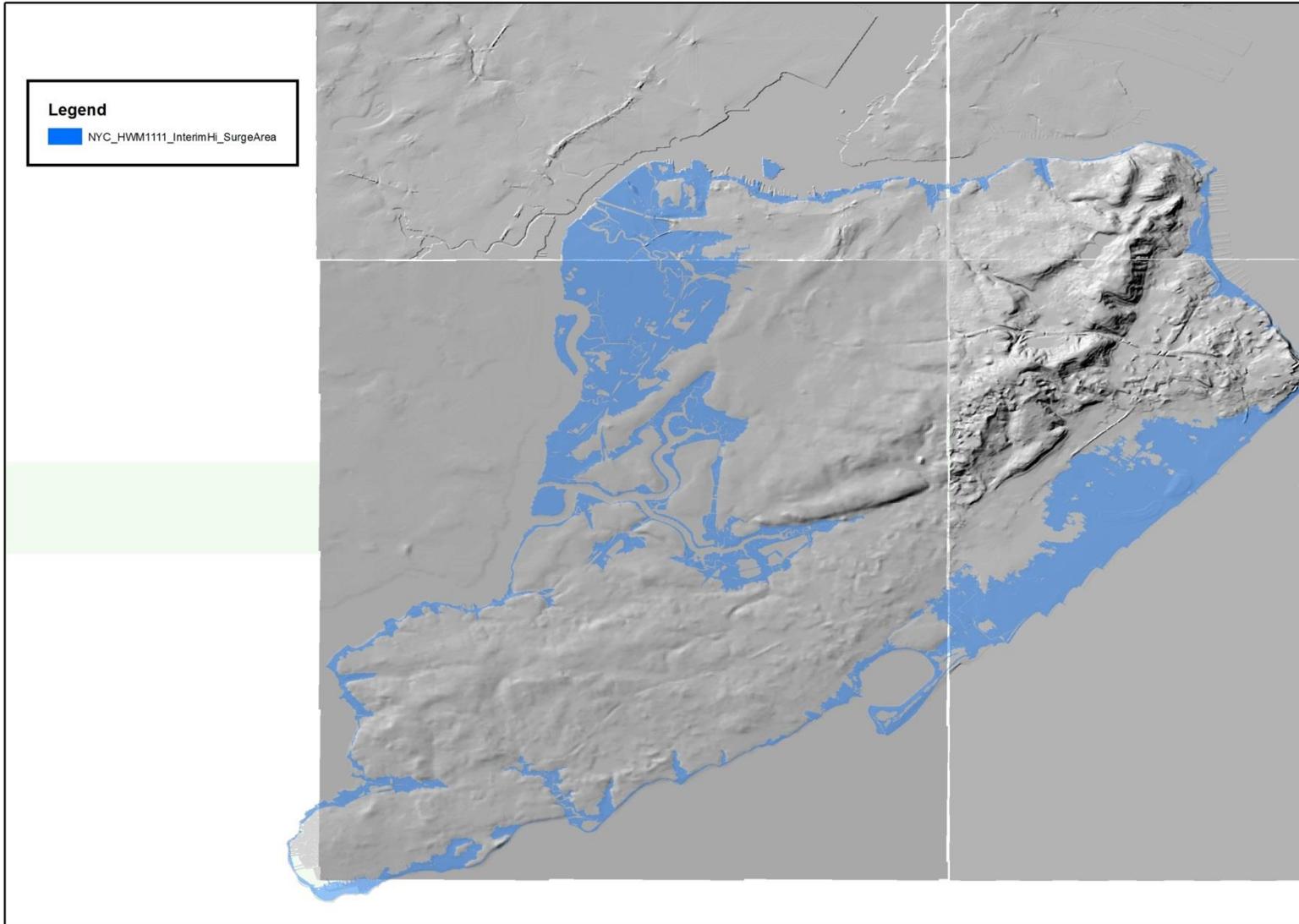
# MAP OF STATEN ISLAND NY



0 0.25 0.5 1 1.5 2 Miles

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Date: 3/2/2013  
Time: 3:09:49 PM

# MAP OF STATEN ISLAND NY



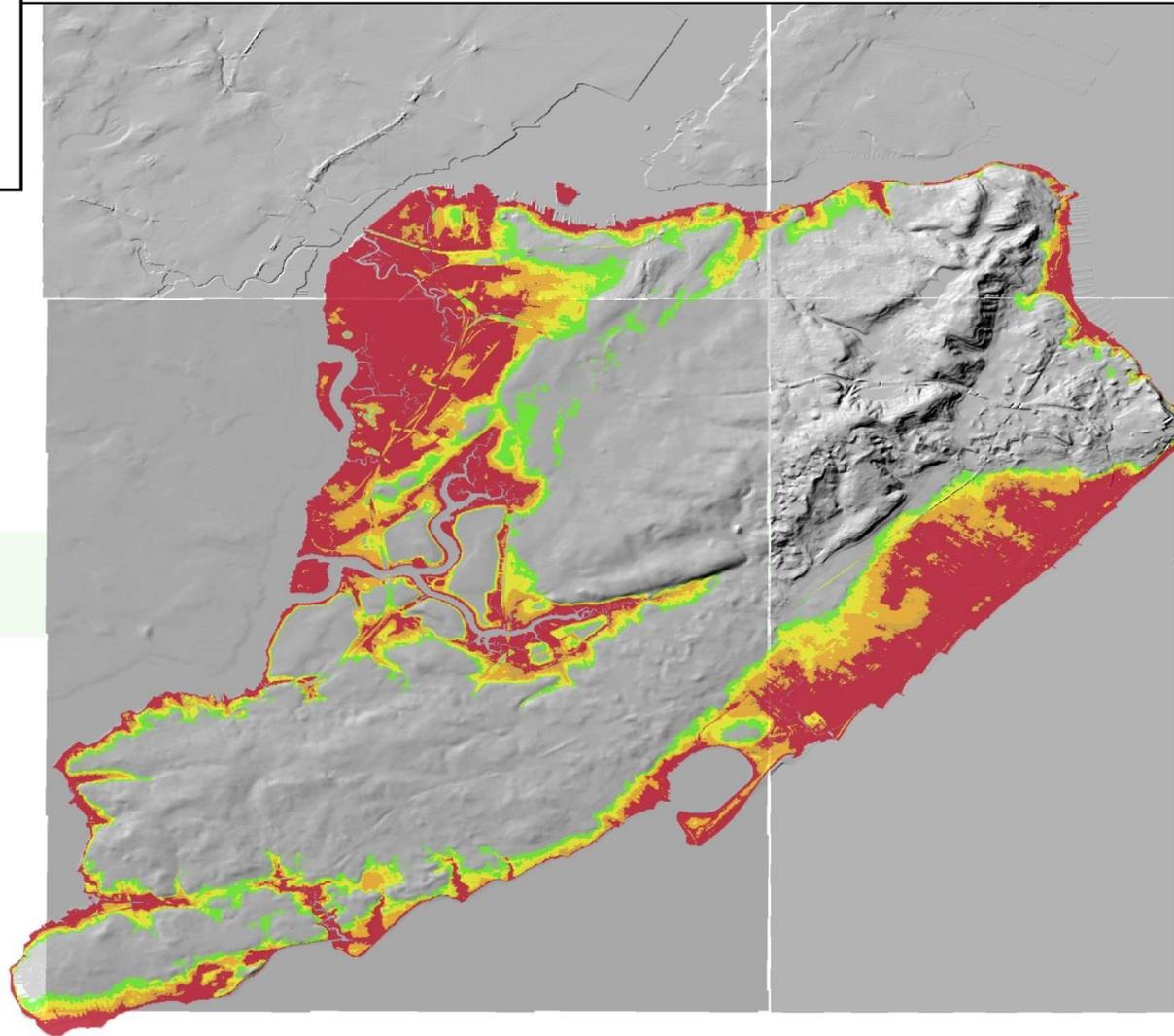
Data from USGS and FEMA GIS MAP By Alan I. Benimoff, Ph.D.  
Date: 3/2/2013  
Time: 3:22:32 PM

# MAP OF STATEN ISLAND NY

## Legend

- Category 1
- Category 2
- Category 3
- Category 4
- NYC\_HWM1111\_InterimHi\_SurgeArea

FEMA  
2012  
SLOSH



Data from USGS and FEMA GIS MAP By Alan I. Benimoff, Ph.D.  
Date: 3/2/2013  
Time: 3:23:46 PM

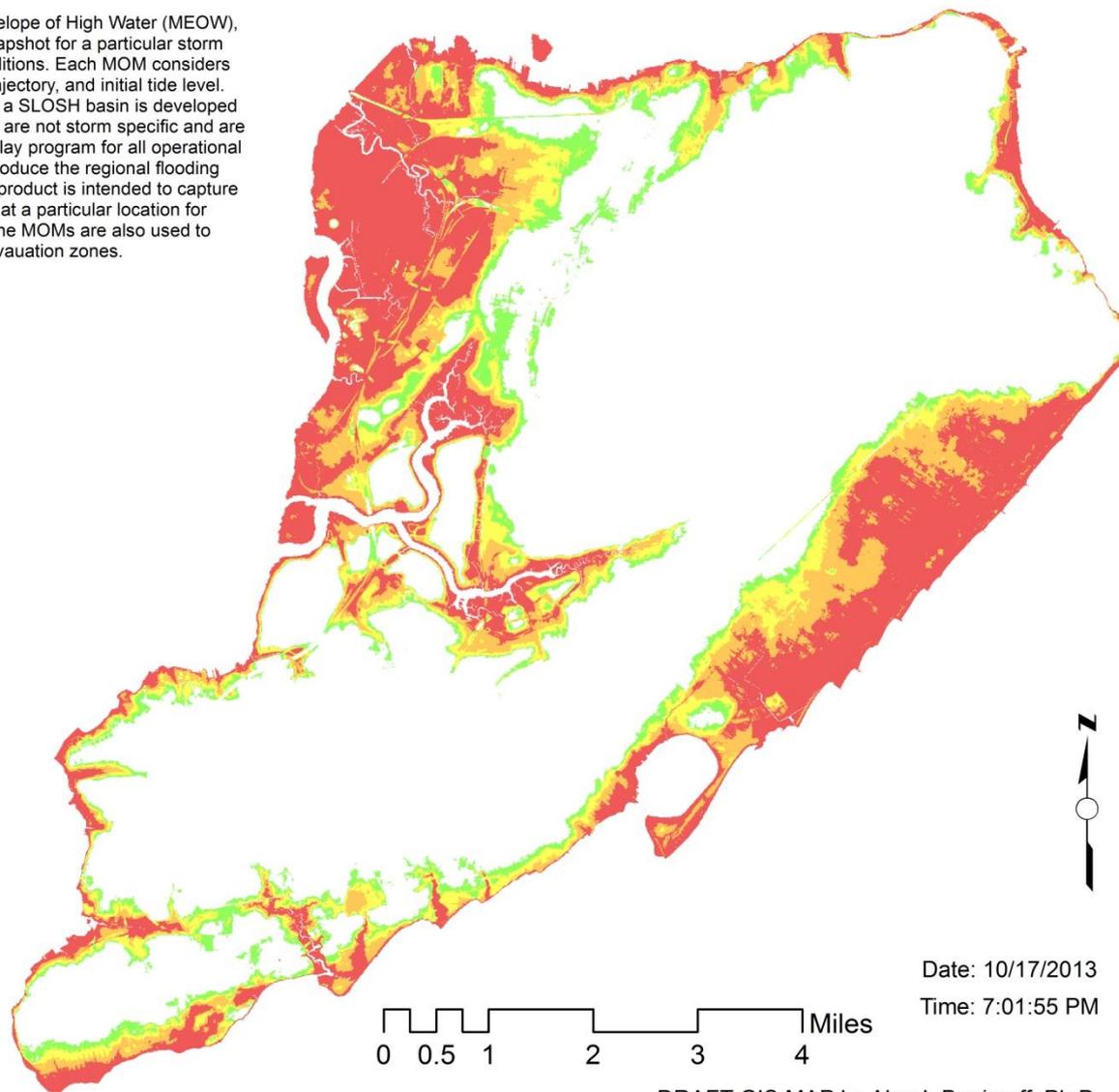


# FEMA 2012 SANDY/LIDAR Based SLOSH MOMS

The Maximum of the Maximum Envelope of High Water (MEOH), or MOM, provides a worst case snapshot for a particular storm category under "perfect" storm conditions. Each MOM considers combinations of forward speed, trajectory, and initial tide level. These products are compiled when a SLOSH basin is developed or updated. As with MEOHs, MOMs are not storm specific and are available to view in the SLOSH display program for all operational basins. No single hurricane will produce the regional flooding depicted in the MOMs. Instead, the product is intended to capture the worst case high water value at a particular location for hurricane evacuation planning. The MOMs are also used to develop the nation's evacuation zones.

## Legend

- Category 1
- Category 2
- Category 3
- Category 4

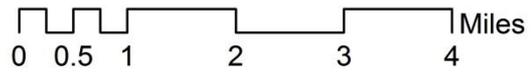
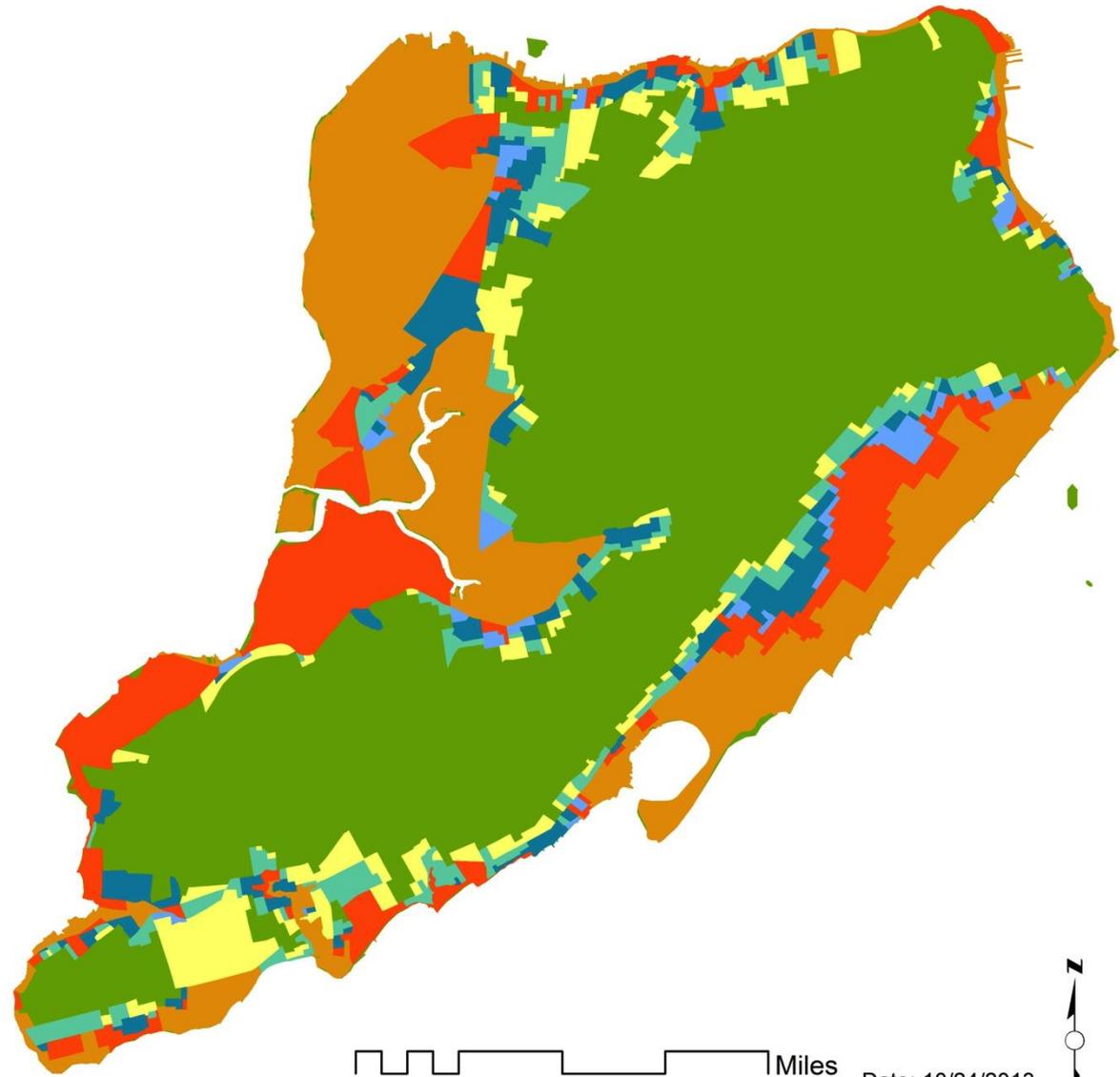


Date: 10/17/2013

Time: 7:01:55 PM

DRAFT GIS MAP by Alan I. Benimoff, Ph.D.

# STATEN ISLAND NEW EVACUATION ZONES 1-6



Date: 10/24/2013  
Time: 6:47:40 PM

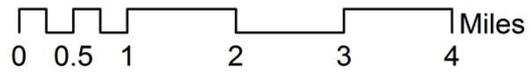
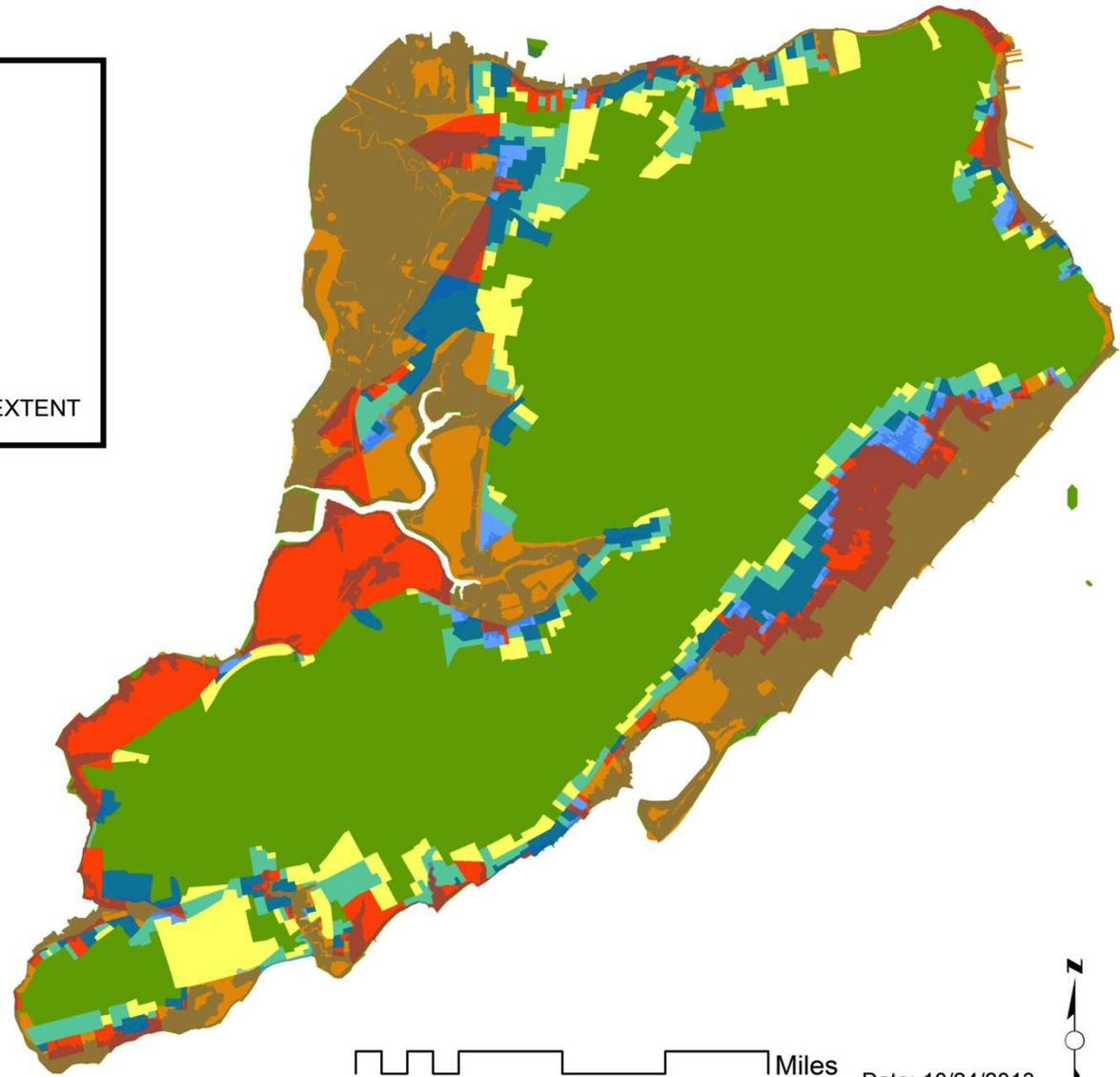


Draft GIS map by Alan I. Benimoff, Ph.D.

# STATEN ISLAND NEW EVACUATION ZONES 1-6

**Legend**

- Zone 6
- Zone 5
- Zone 4
- Zone 3
- Zone 2
- Zone 1
- SANDY SURGE EXTENT



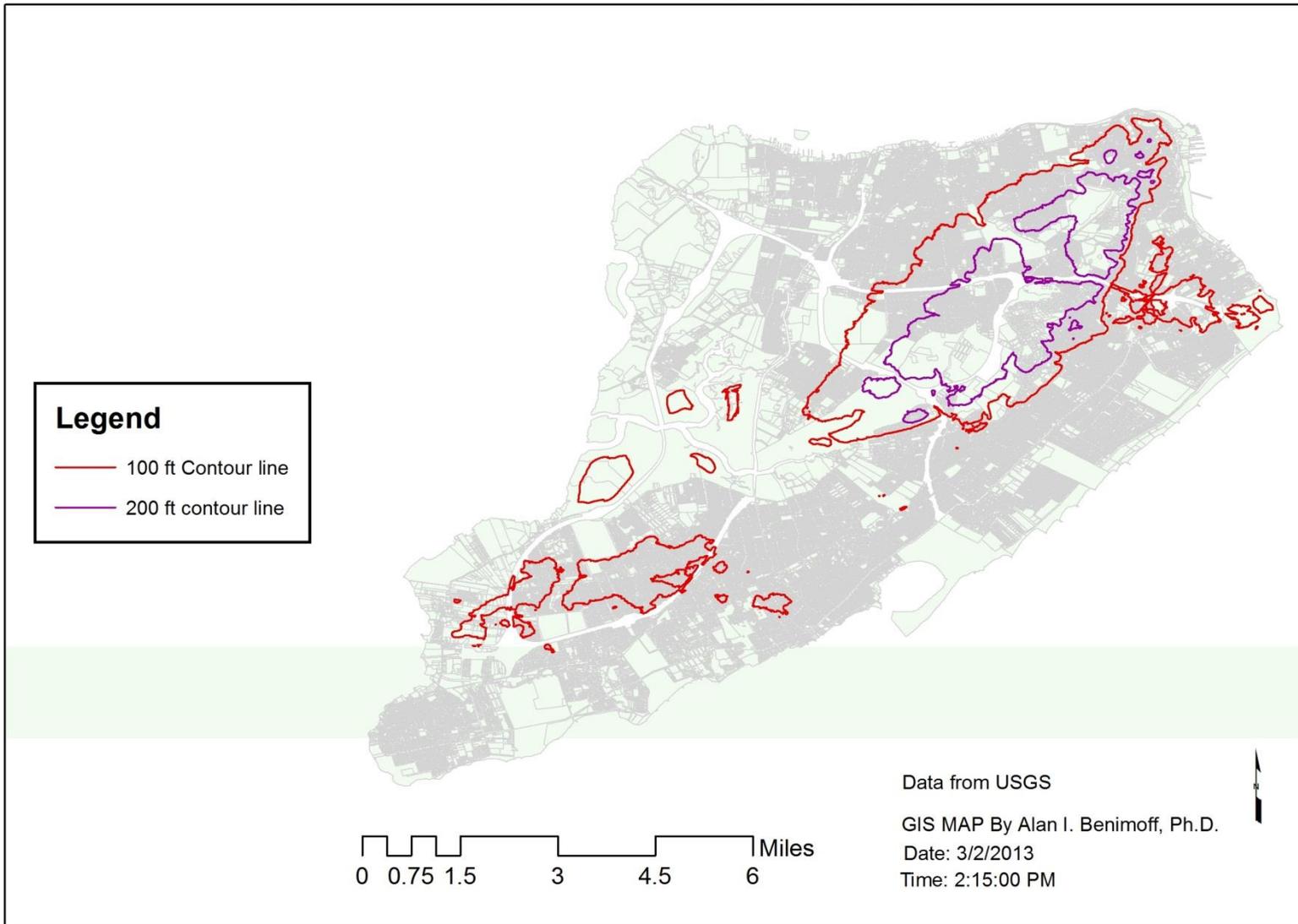
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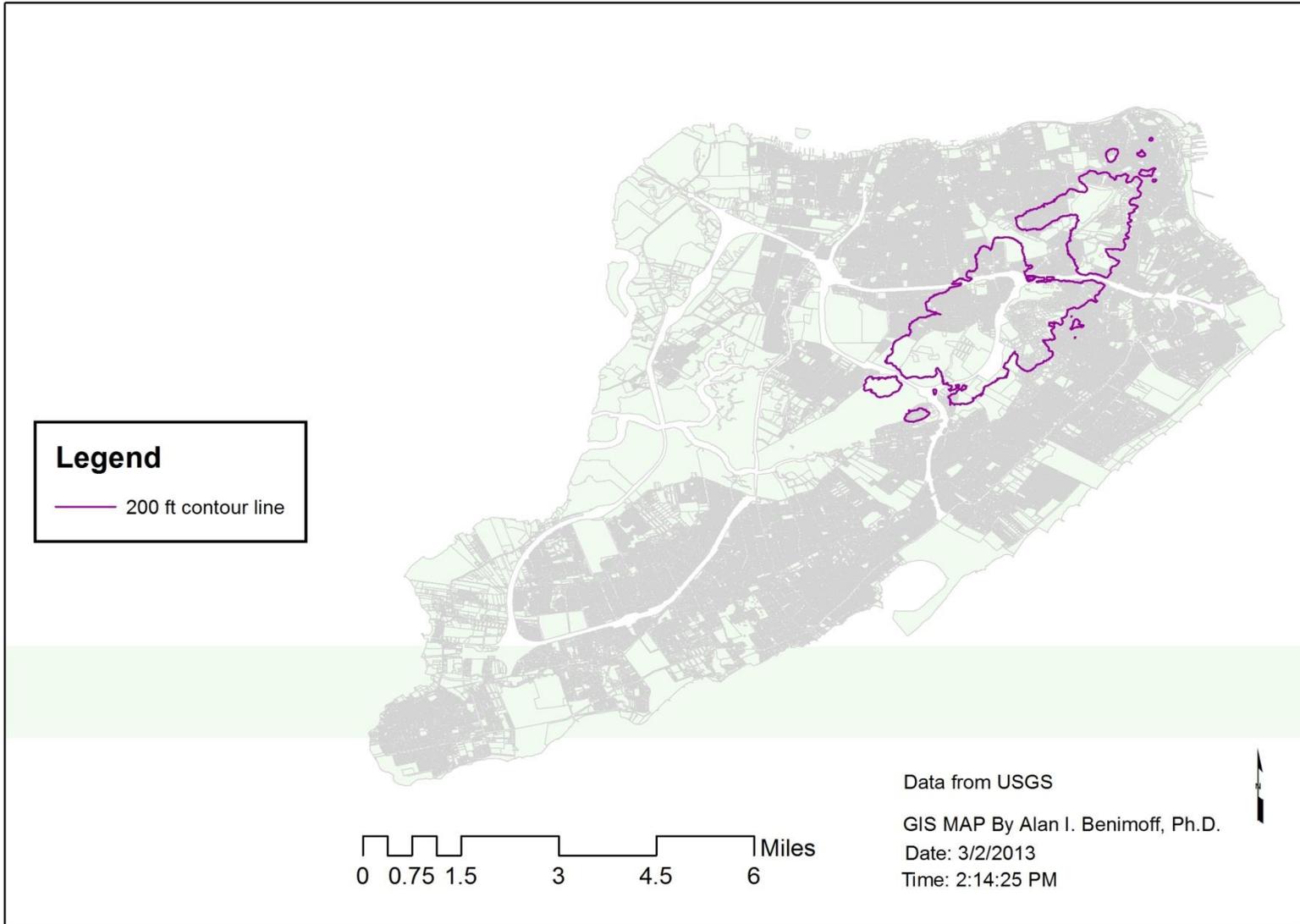
Draft GIS map by Alan I. Benimoff, Ph.D.

# Food For Thought

# GEOLOGIC MAP OF STATEN ISLAND NY



# GEOLOGIC MAP OF STATEN ISLAND NY



# Epilogue

- Next Atlantic and Gulf Hurricane Season
- June 1, 2014 – November 30, 2014
- The clock is ticking.....
- Lets have a serious conversation.....