



The single raindrop never feels responsible for the flood.

*- Douglas Adams*

## 27 Years of Experience as a Land Use Consultant in Fairfield County



DARIEN HIGH SCHOOL '90



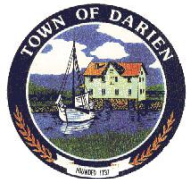
BACHELOR OF SCIENCE  
CIVIL ENGINEERING  
LEHIGH UNIVERSITY '94



SENIOR ENGINEER,  
PRESIDENT and OWNER



PROFESSIONAL ENGINEER  
LICENSED IN CT, NY, & FL



ENVIRONMENTAL  
PROTECTION COMMISSION  
2003 - 2011



PAST CHAIR, FLOOD  
MITIGATION STRATEGY  
COMMITTEE 2008 - 2011



CHAIR, SEWER COMMISSION  
2012 - CURRENT



PAST CHAIR, ADVISORY  
COMMITTEE ON  
SUSTAINABILITY 2012 - 2021





- **4 Principals, 40 Employees**
- **2 Locations – Stamford & Wilton**
- **3 Disciplines**
- **Established in 1957**

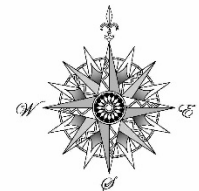
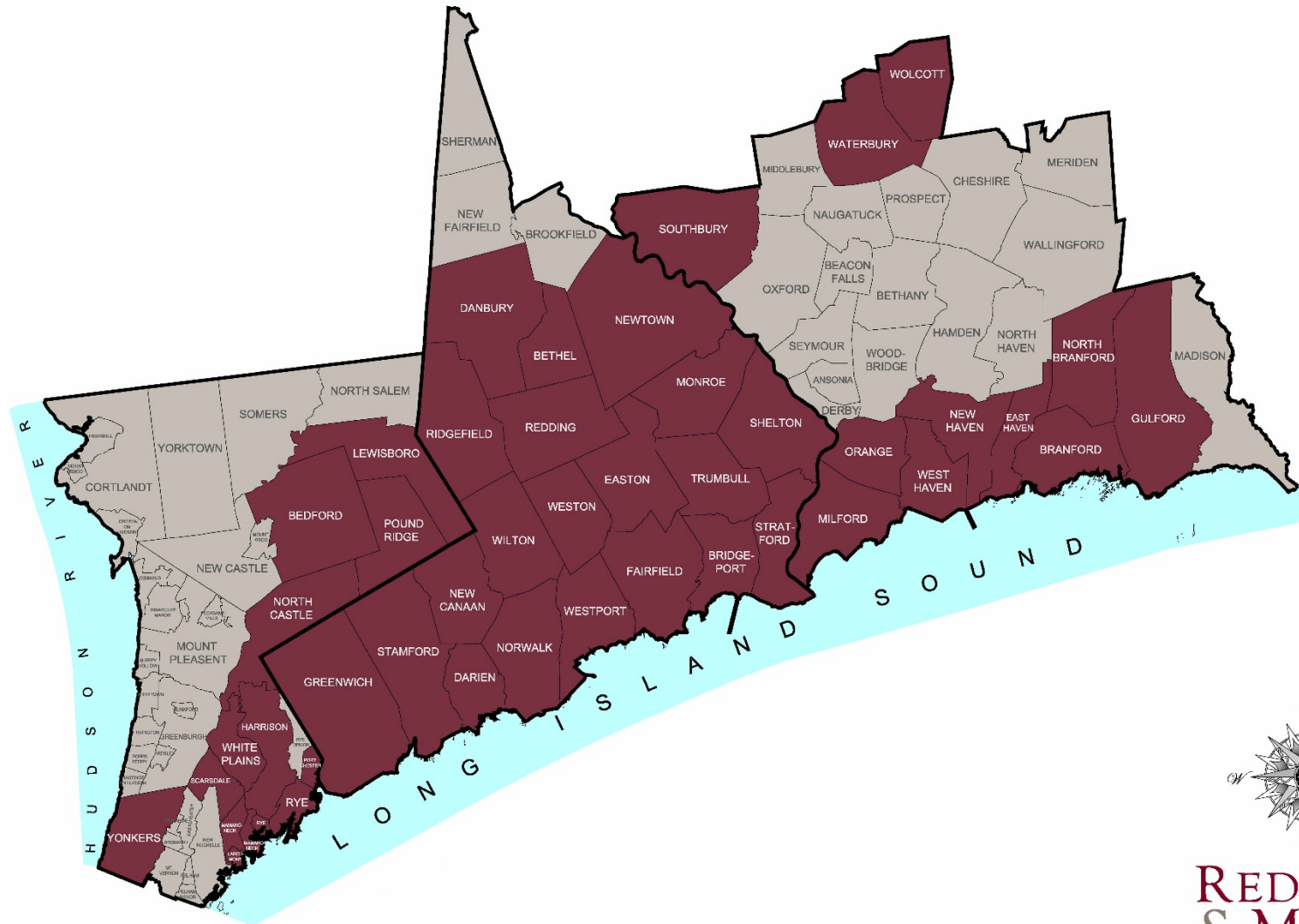


# AREA OF OPERATIONS

Enhancing Properties and Communities in Connecticut & New York

*Expanding where we provide exceptional land use services.*

2012-2017



**REDNISS  
& MEAD**

- FLOODING
- FLOOD MAPS
- COASTAL FLOODING
- RIVER FLOODING
- RAINFALL INCREASE
- REGULATIONS
- ADAPTATION AND RESILIENCY
- QUESTIONS

# Flooding

*noun*

The covering or submerging of normally dry land with a large amount of water.

# POST ROAD AT DARIEN TRAIN STATION





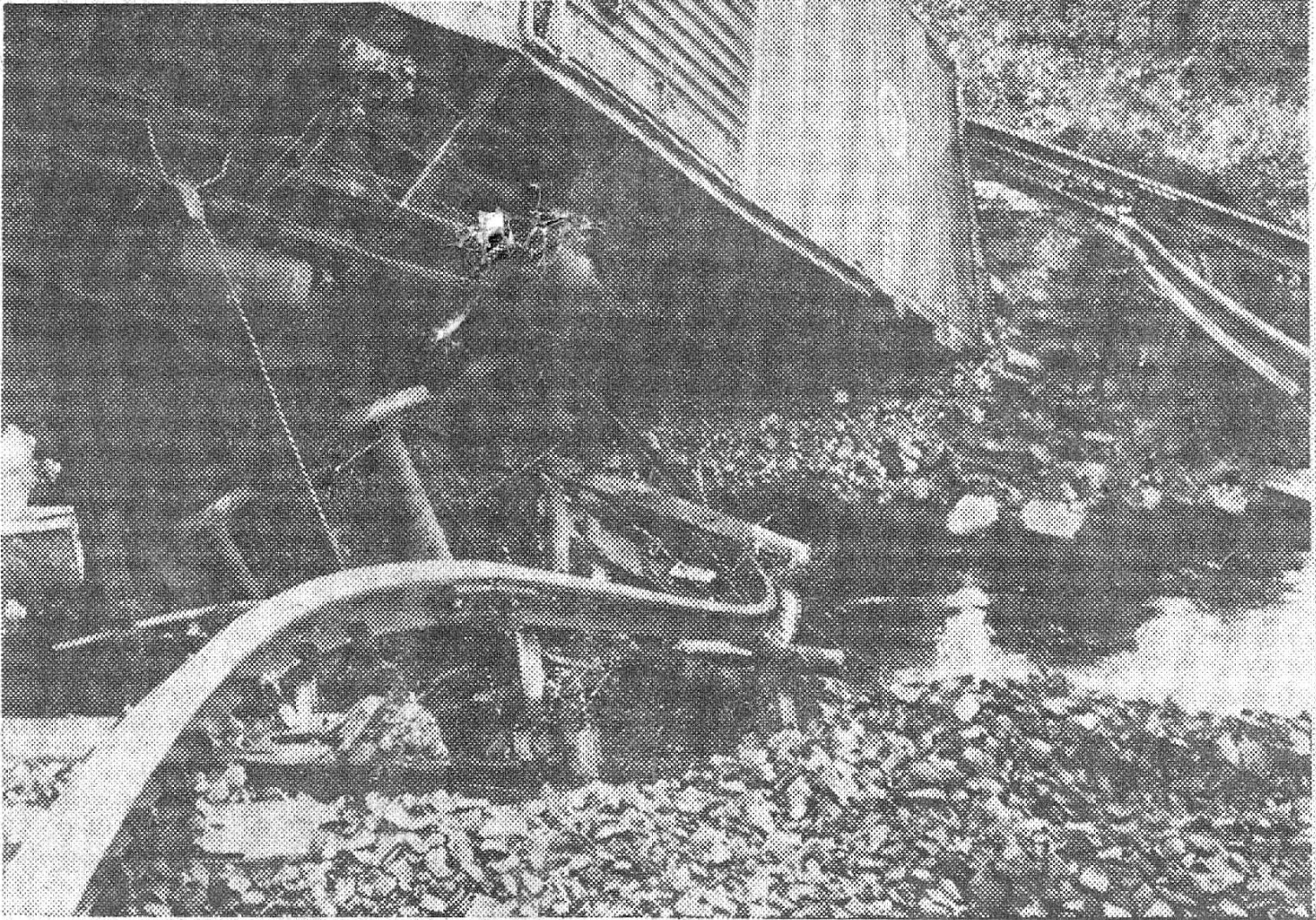


# THE SUGAR BOWL AND UNCLE'S DELI



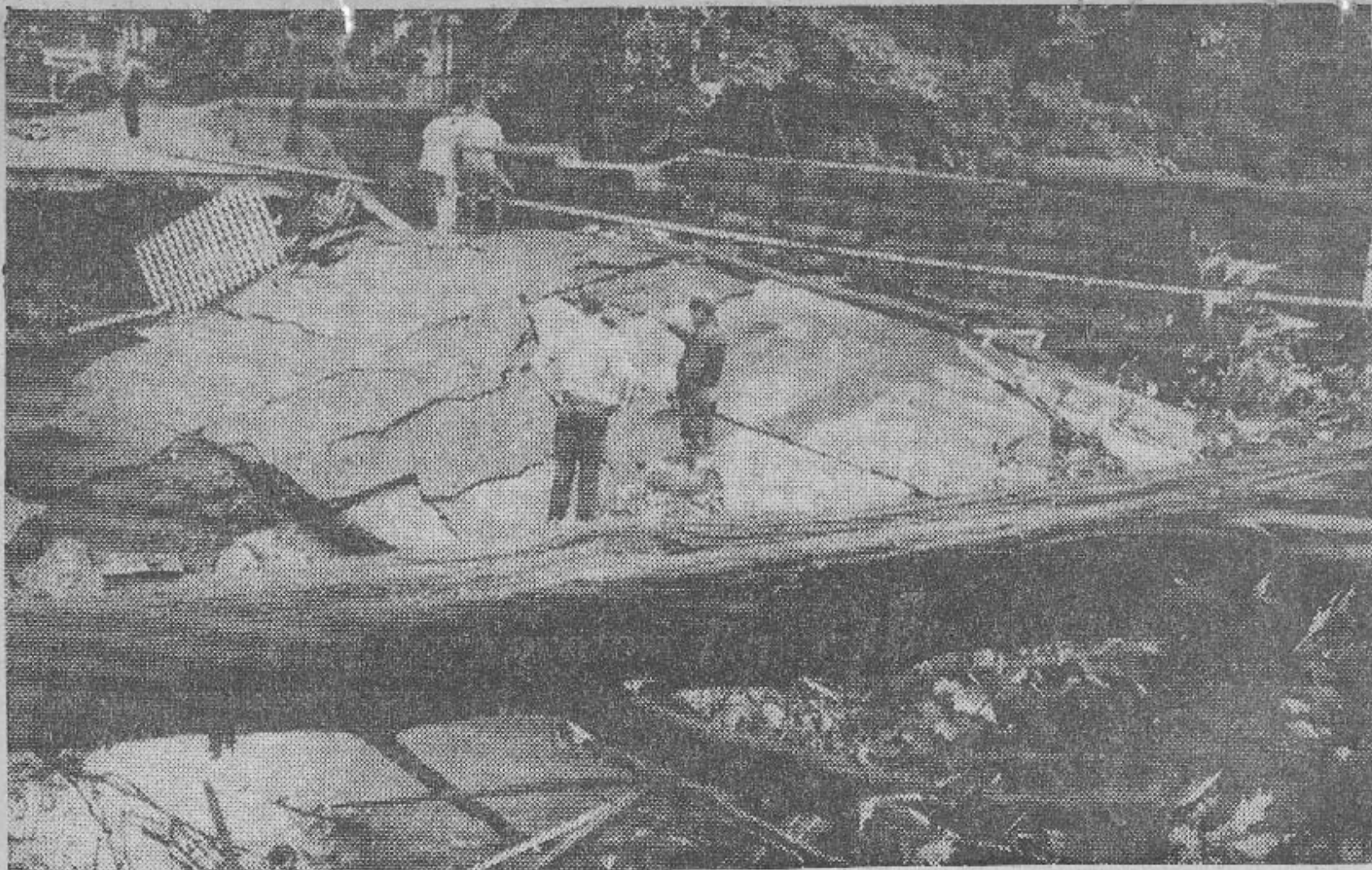


## *Aftermath Of Washout In Darien*



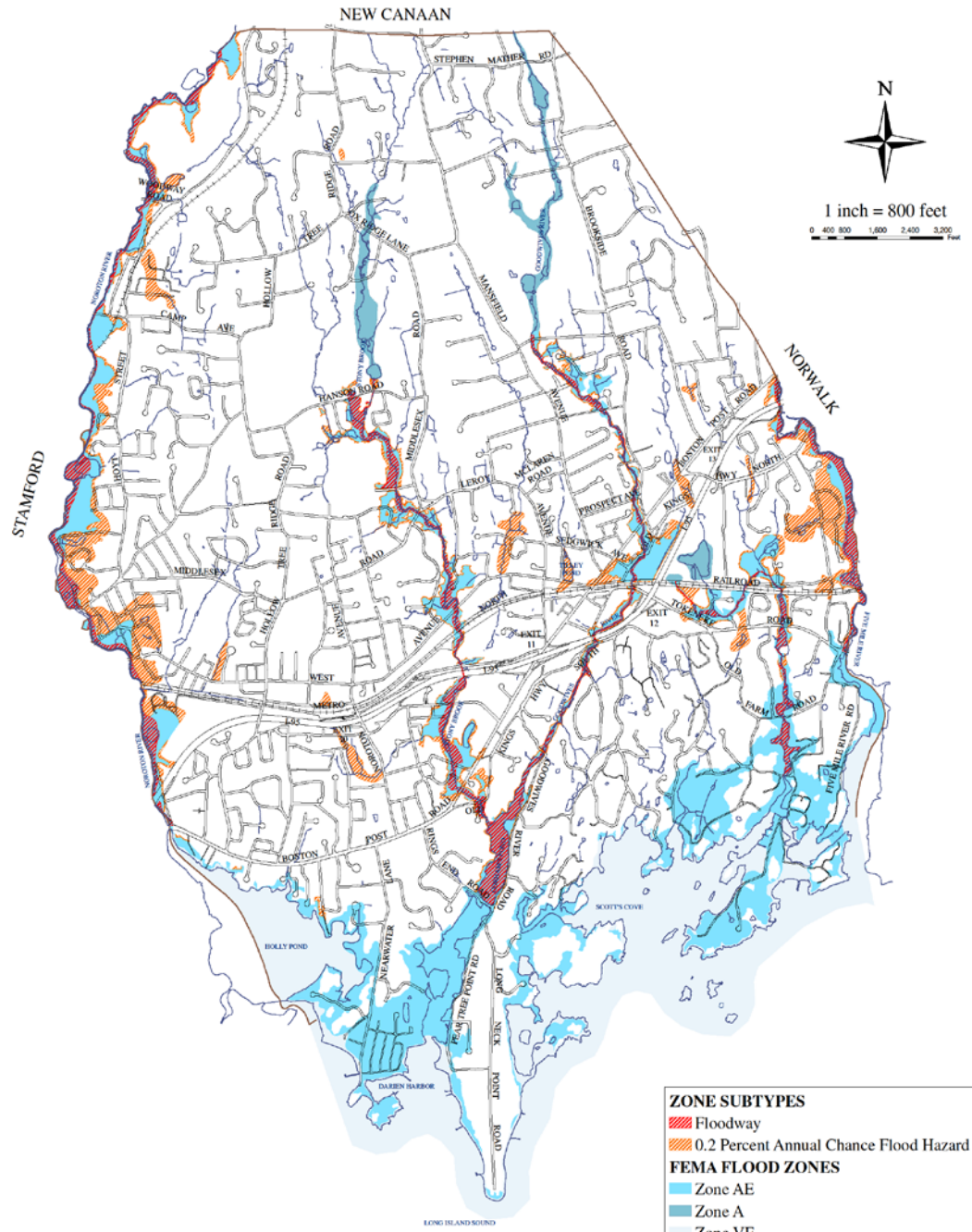
East bound tracks of the New Haven main line are shown suspended in air at the point washed out by the usually small Stonybrook s tream, where the freight train fell to pieces in Darien during the Saturday night downpour. (Stahman)

*Raging Noroton River Hits Bridge*



This is how the West Ave. bridge, at the Stamford-Darien line in Glenbrook, looked Sunday after the roadbed had been collapsed by the raging Noroton River. A fallen tree is in the foreground. (Stahman)

# FLOOD ZONES IN DARIEN



*In Darien, there are...*

**3,700 structures in a Floodplain**

**160 structures in a Floodway**

[FEMA Flood Map Service Center](#)

[Flood Factor](#)

[Darien CT mapgeo](#)

# FLOOD INSURANCE RATE MAPS

## National Flood Hazard Layer FIRMette



41°56.62'N

73°28'17.08\"W



### Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

- |                             |  |  |
|-----------------------------|--|--|
| SPECIAL FLOOD HAZARD AREAS  |  | Without Base Flood Elevation (BFE)   |
|                             |  | With BFE or Depth: Zone AE, AO, AH, VE, AR   |
|                             |  | Regulatory Floodway  |
| OTHER AREAS OF FLOOD HAZARD |  | 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile. Zone X |
|                             |  | Future Conditions 1% Annual Chance Flood Hazard. Zone X  |
|                             |  | Area with Reduced Flood Risk due to Levee. See Notes. Zone X   |
|                             |  | Area with Flood Risk due to Levee. Zone D  |
| OTHER AREAS                 |  | Area of Minimal Flood Hazard. Zone X   |
|                             |  | Effective LOMRs  |
| GENERAL STRUCTURES          |  | Area of Undetermined Flood Hazard. Zone D  |
|                             |  | Channel, Culvert, or Storm Sewer   |
|                             |  | Levee, Dike, or Floodwall  |
| OTHER FEATURES              |  | Cross Sections with 1% Annual Chance Water Surface Elevation   |
|                             |  | Coastal Transect   |
|                             |  | Base Flood Elevation Line (BFE)  |
|                             |  | Limit of Study   |
|                             |  | Jurisdiction Boundary  |
|                             |  | Coastal Transect Baseline  |
| MAP PANELS                  |  | Digital Data Available   |
|                             |  | No Digital Data Available  |
|                             |  | Unmapped   |
|                             |  | The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.                               |



This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards.

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 10/22/2018 at 1:12:24 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Feet 1:6,000

41°4'39.50\"N

73°27'40.22\"W



# FLOOD INSURANCE RATE MAP LEGEND

## SPECIAL FLOOD HAZARD AREAS



**Without Base Flood Elevation (BFE)**

*Zone A, V, A99*

**With BFE or Depth** *Zone AE, AO, AH, VE, AR*



**Regulatory Floodway**

## OTHER AREAS OF FLOOD HAZARD



**0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile** *Zone X*



**Future Conditions 1% Annual Chance Flood Hazard** *Zone X*



**Area with Reduced Flood Risk due to Levee. See Notes.** *Zone X*



**Area with Flood Risk due to Levee** *Zone D*

# FEMA Flood Map Service Center: Search By Address

Enter an address, place, or coordinates: [?](#)




Whether you are in a high risk zone or not, you may need [flood insurance](#) because most homeowners insurance doesn't cover flood damage. If you live in an area with low or moderate flood risk, you are 5 times more likely to experience flood than a fire in your home over the next 30 years. For many, a National Flood Insurance Program's flood insurance policy could cost less than \$400 per year. Call your insurance agent today and protect what you've built.

Learn more about [steps you can take](#) to reduce the risk flood damage.

## Search Results—Products for **DARIEN, TOWN OF**

The flood map for the selected area is number **09001C0529G**, effective on **07/08/2013** [?](#)

### DYNAMIC MAP



PRINT MAP/  
FIRMette

### MAP IMAGE



DOWNLOAD  
FIRM PANEL

### Changes to this FIRM [?](#)

- 📁 Revisions (5)
  - 13-01-2598P-090005 09/09/2014 ↓DL
  - 15-01-1793P-090012 12/30/2015 ↓DL
  - 18-01-0702P-090012 08/17/2018 ↓DL
  - 18-01-1147P-090012 02/21/2019 ↓DL
  - 18-01-1237P-090005 11/13/2018 ↓DL
- 📁 Amendments (14)
- 📁 Revalidations (2)

## COASTAL FLOODING

- TIDES
- WIND
- LOW PRESSURE SURGE
- SEA LEVEL

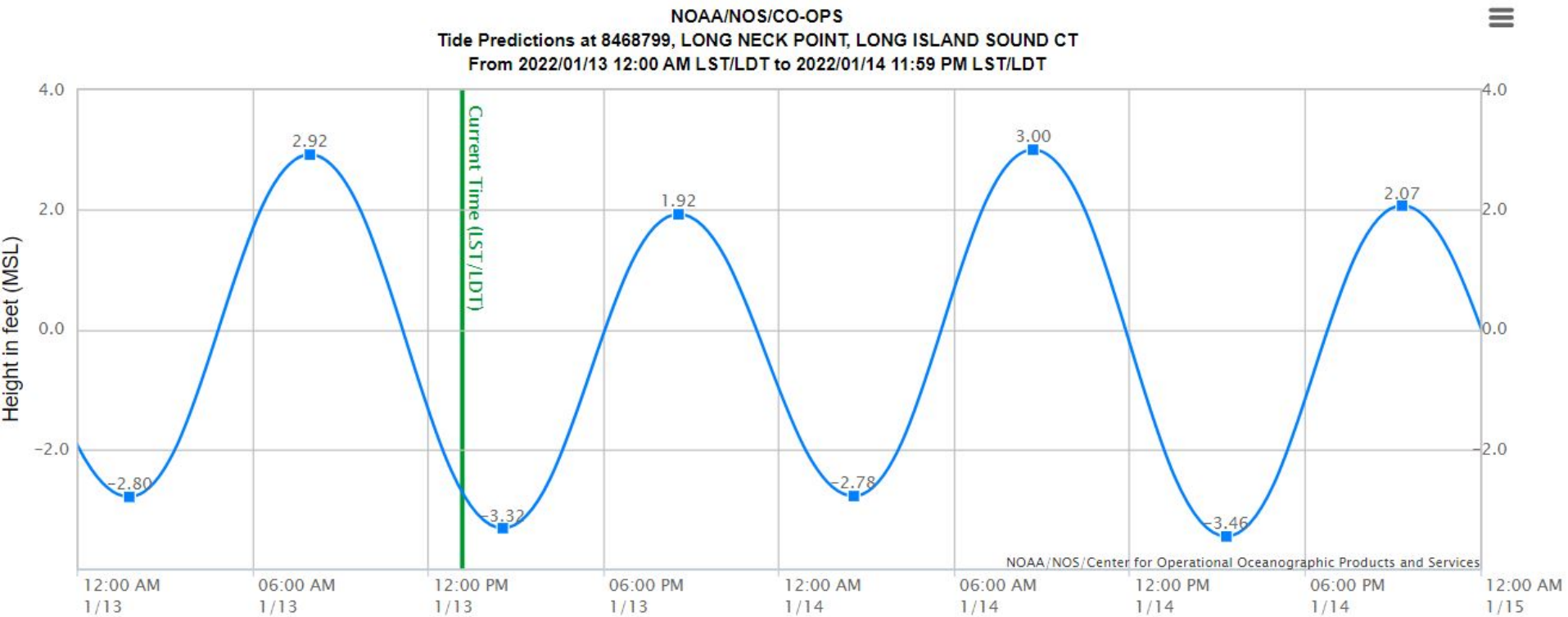


## RIVER FLOODING

- RAINFALL
- WATERSHED CHARACTERISTICS
  - SIZE
  - SLOPE
  - SOILS
  - SURFACE COVER
- RIVER CHANNEL GEOMETRY
- FLOODPLAIN CAPACITY



# TIDES, SPRING TIDES, KING TIDES

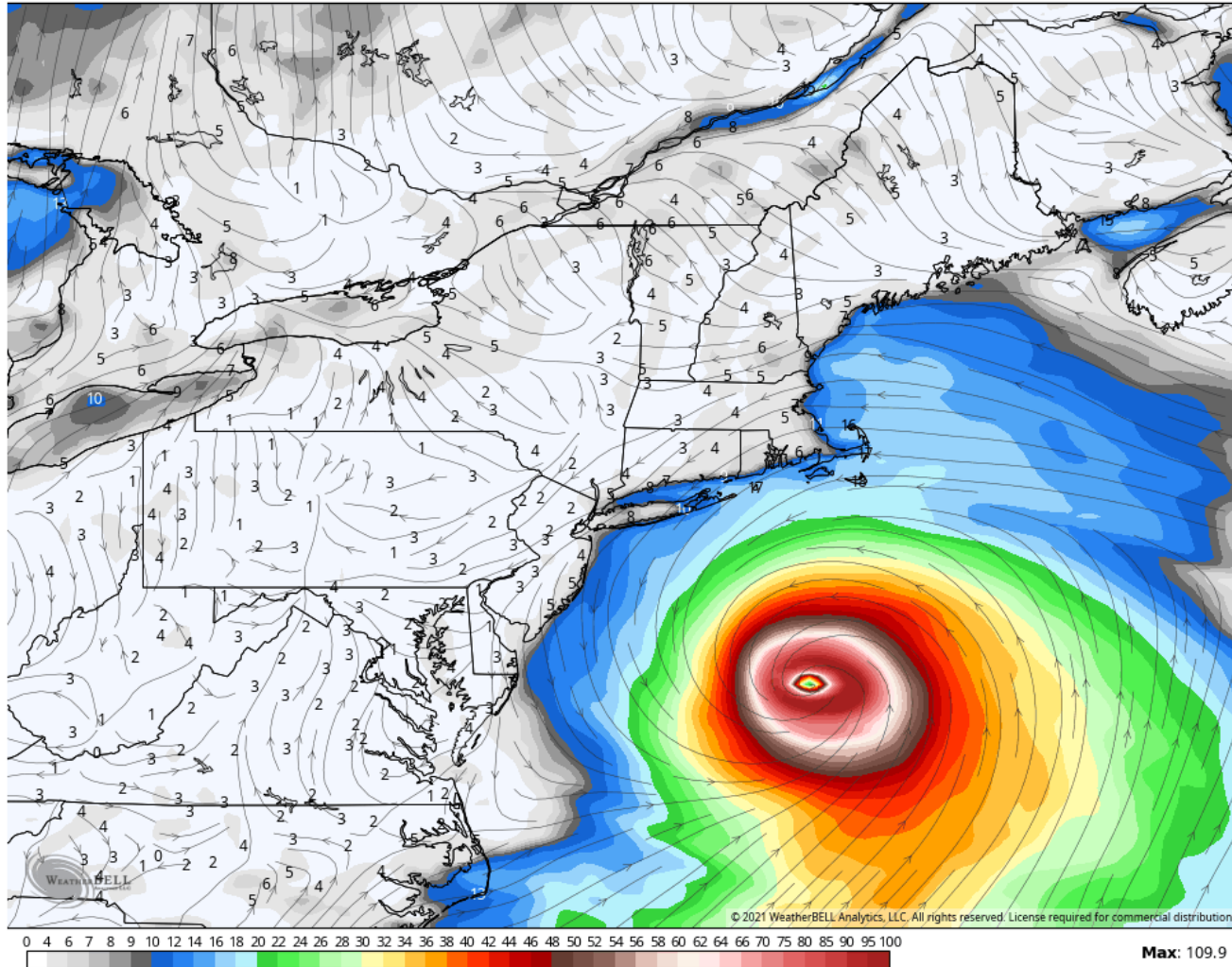


Two Spring Tides occur each month around the full and new moon. A King Tides are the highest of the Spring Tides and can be 2' higher than average high tides.

# THE EFFECT OF CYCLONIC STORMS

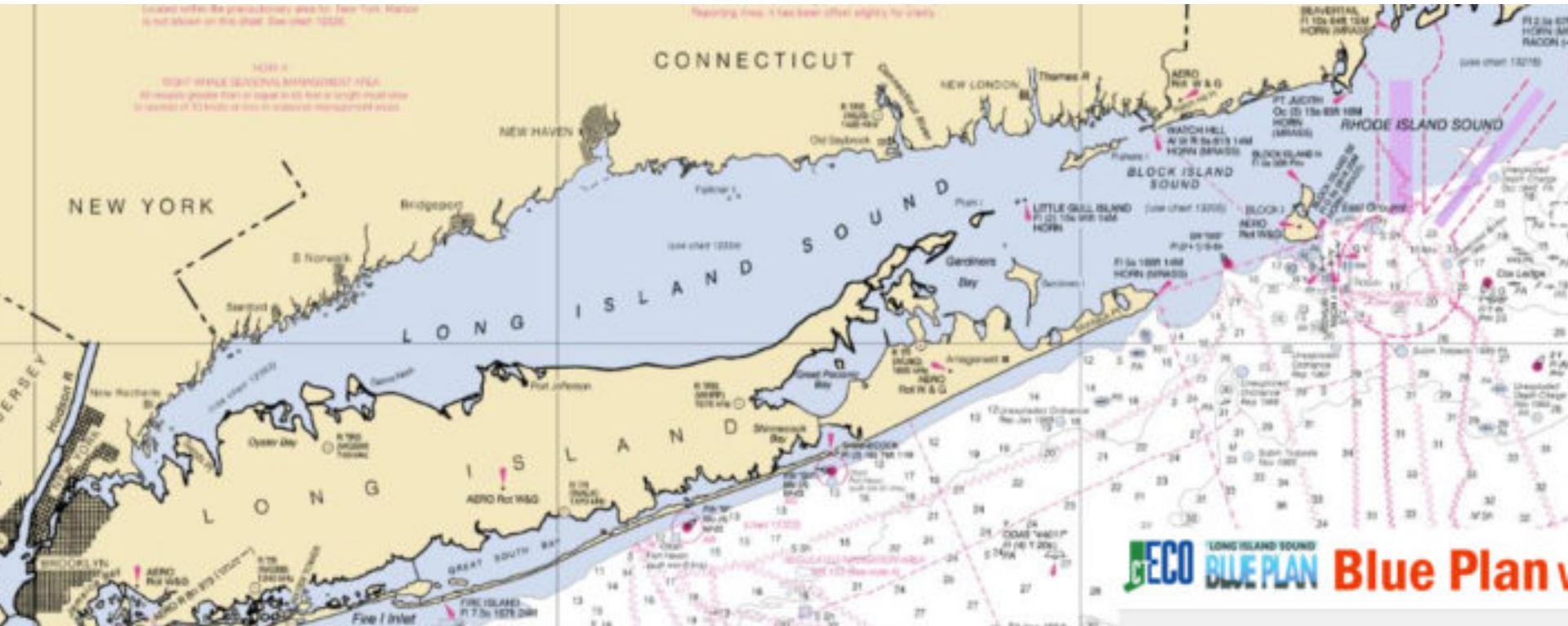
GFS 0.12° Init 06z 19 Aug 2021 • 10m Wind Speed + Streamlines (mph)

Hour: 69 • Valid: 03z Sun 22 Aug 2021



The counter-clockwise rotation of low-pressure systems pushes water from east to west in LIS.

# THE NARROWING WESTERN END OF LIS

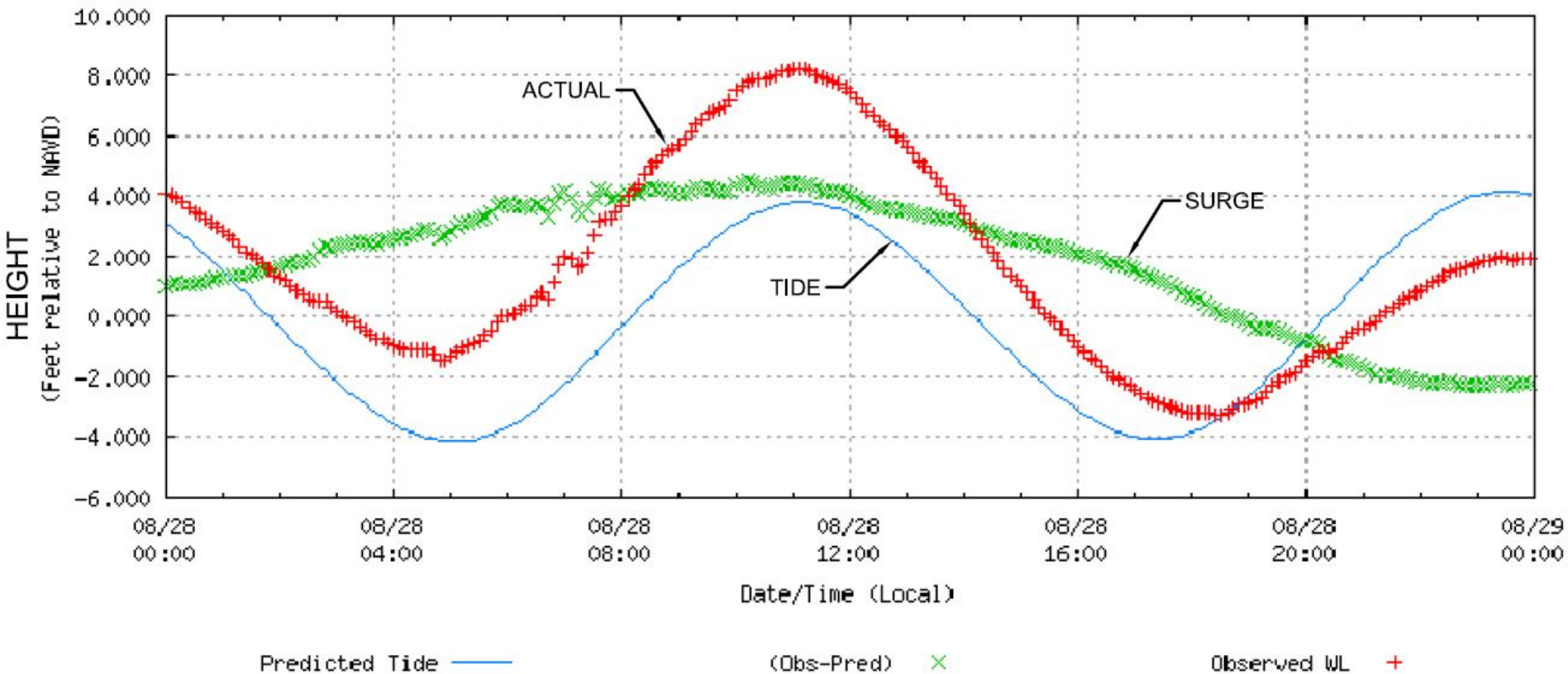


The narrowing western end of LIS can exacerbate the effect of an east to west surge of water.

During a 1% coastal storm, the backwater elevation in Old Syabrook is four feet lower than in Darien.

# HURRICANE IRENE IN 2011

NOAA/NOS/CO-OPS  
Verified Water Level vs. Predicted Plot  
8467150 Bridgeport, CT  
from 2011/08/28 - 2011/08/28

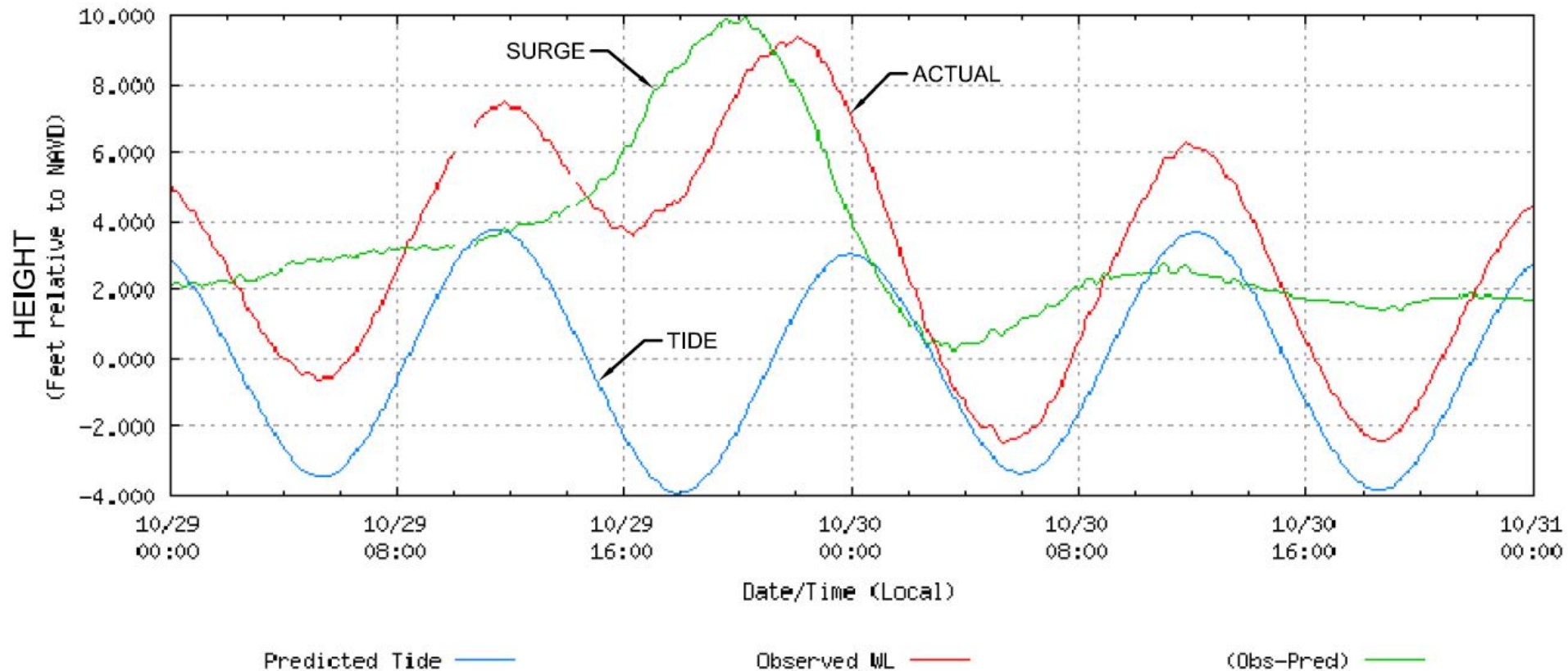


## HURRICANE IRENE (2011)

NOTE:  
SURGE PEAK COINCIDED WITH HIGH TIDE.

# SUPERSTORM SANDY 2012

NOAA/NOS/CO-OPS  
Preliminary Water Level (B1:2) vs. Predicted Plot  
8467150 Bridgeport, CT  
from 2012/10/29 - 2012/10/30

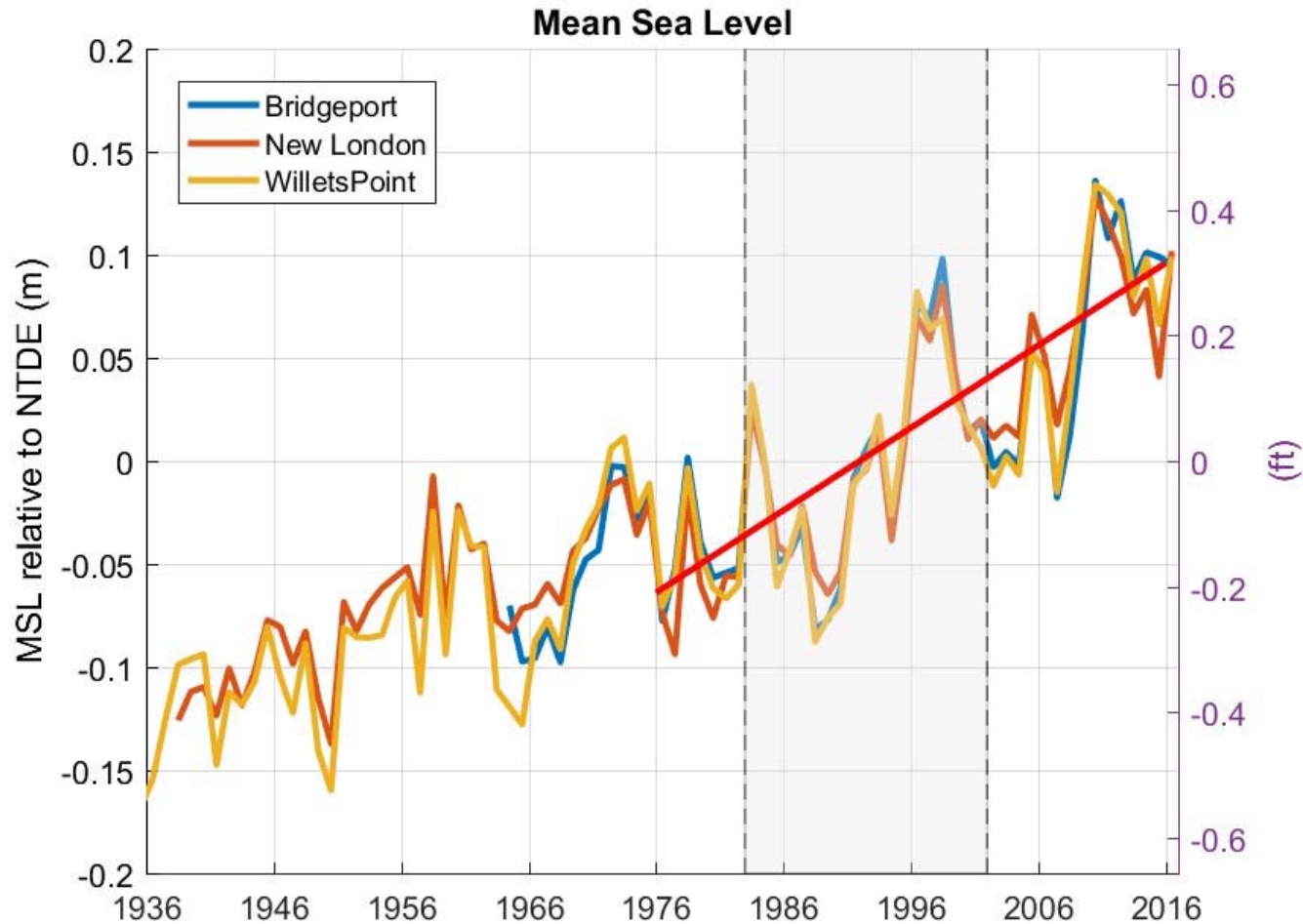


## HURRICANE SANDY (2012)

### NOTE:

SURGE PEAK OCCURRED FOUR HOURS BEFORE HIGH TIDE. HAD THEY COINCIDED, ACTUAL WATER SURFACE WOULD HAVE BEEN 3.5 TO 4 FEET HIGHER.





**CIRCA recommends planning for 20" of Sea Level Rise between 2001 and 2050**

## COASTAL FLOODING

- TIDES
- WIND
- LOW PRESSURE SURGE
- SEA LEVEL



## RIVER FLOODING

- RAINFALL
- WATERSHED CHARACTERISTICS
  - SIZE
  - SLOPE
  - SOILS
  - SURFACE COVER
- RIVER CHANNEL GEOMETRY
- FLOODPLAIN CAPACITY



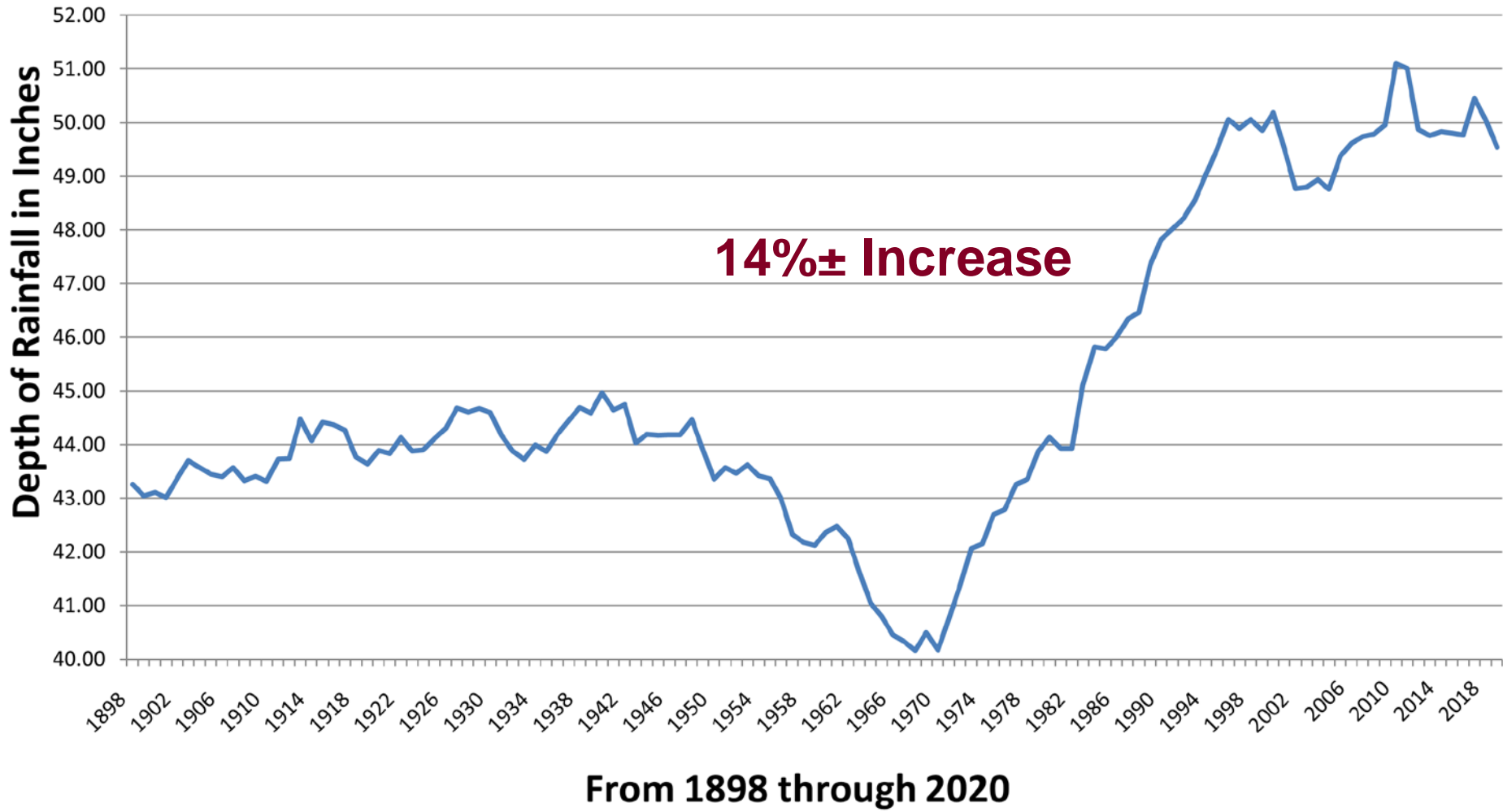
## Observed Rainfall Intensity, Duration, and Frequency Based on Darien Town Hall Rain Gauge Data

Duration	Elsa Rainfall July 9, 2021 (inches)	Average Recurrence Interval (years)	Ave. Annual Probability of Occurrence (%)	Ida Rainfall September 1, 2021 (inches)	Average Recurrence Interval (years)	Annual Probability of Occurrence (%)
15-Minute	0.56	< 1-year	100%	1.37	50-year	2%
30-Minute	1.03	2-year	50%	2.35	200-year	0.5%
1-Hour	1.89	10-year	10%	3.31	500-year	0.2%
2-Hour	2.96	25-year	4%	4.65	500-year	0.2%
3-Hour	3.37	25-year	4%	5.46	500-year	0.2%
6-Hour	4.99	50-year	2%	6.56	200-year	0.5%
12-Hour	5.1	10-year	10%	6.92	100-year	1%
24-Hour	6.66	25-year	4%	6.92	25-year	4%

The Average Recurrence Interval was estimated comparing the rain gauge data against the NOAA Atlas 14 Point Precipitation Frequency Estimates for Darien, CT (by lat. and long.)

# Annual Rainfall - Central Park, NY

## 30-year moving average



# The proportion heavy rainfalls increased by 55% since 1958

Observed Change in Total Annual Precipitation  
Falling in the Heaviest 1% of Events

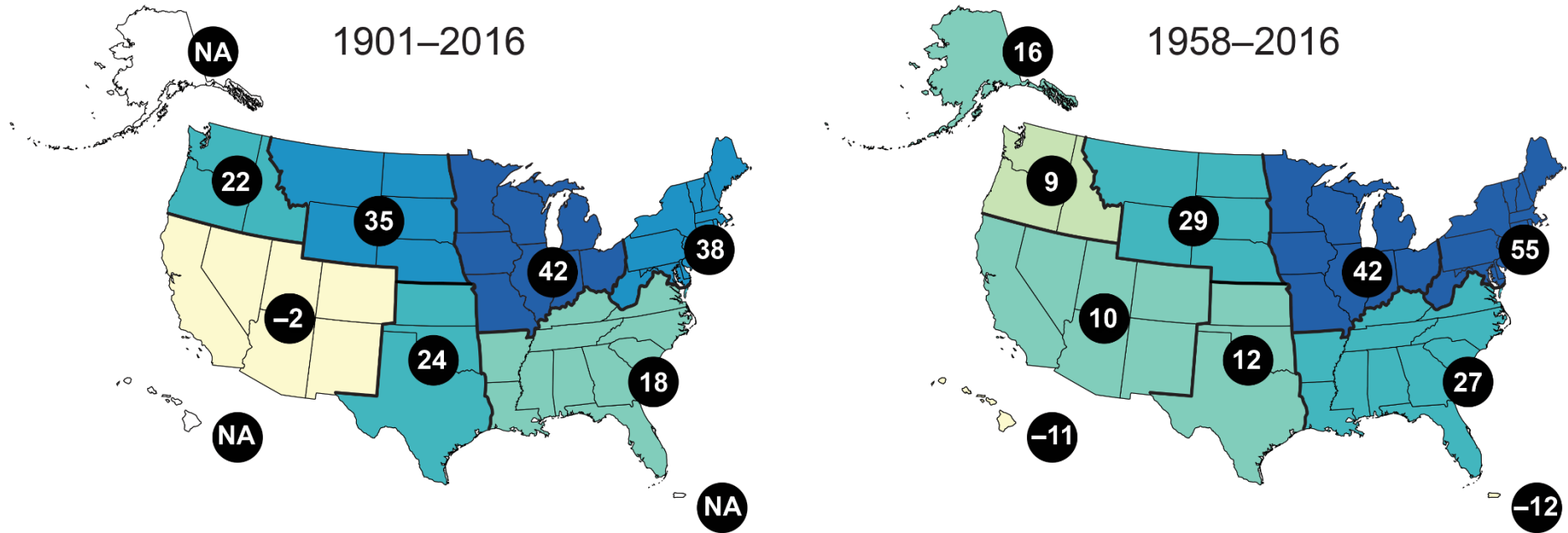


Figure 2-6 from the Fourth National Climate Assessment

**10 Wettest Years**

**80.56" 1983**

**72.81" 2011**

**67.03" 1972**

**65.11" 1989**

**61.67" 2007**

**61.21" 1975**

**60.92" 1990**

**59.90" 2006**

**59.73" 2021**

**58.56" 2003**

**10 Driest Years**

**26.09" 1965**

**32.99" 1964**

**33.72" 1910**

**33.85" 1935**

**34.28" 1963**

**35.29" 1970**

**35.37" 1895**

**35.37" 1885**

**35.58" 1954**

**35.60" 1892**

**The 10 wettest years occurred after 1971.**

**The 10 driest years occurred before 1971.**

Compiled from NWS Data.

<https://www.weather.gov/media/okx/Climate/CentralPark/wetdryyearsmonths.pdf>

# The proportion of heavy rainfalls is projected to increase

Projected Change in Total Annual Precipitation  
Falling in the Heaviest 1% of Events by Late 21st Century

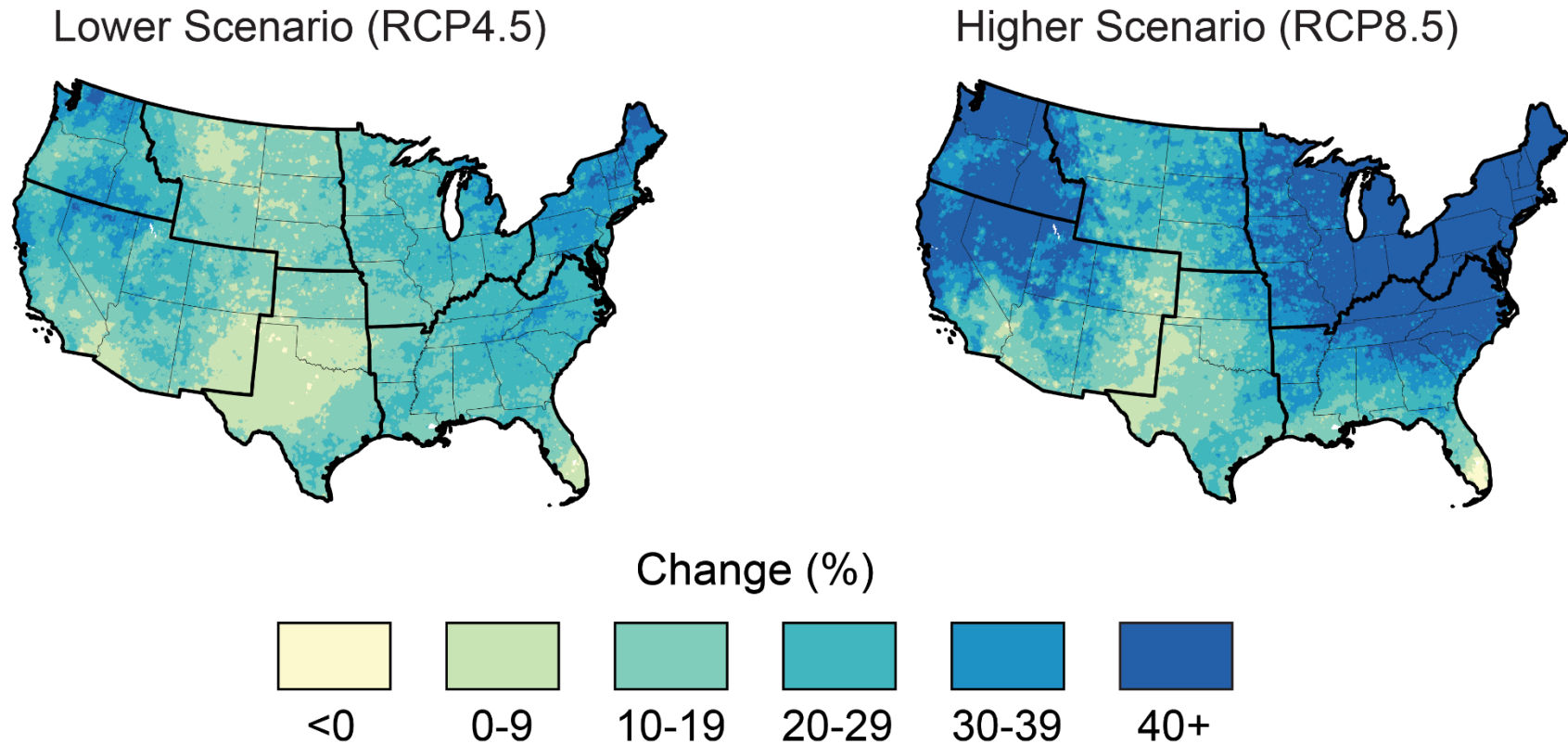


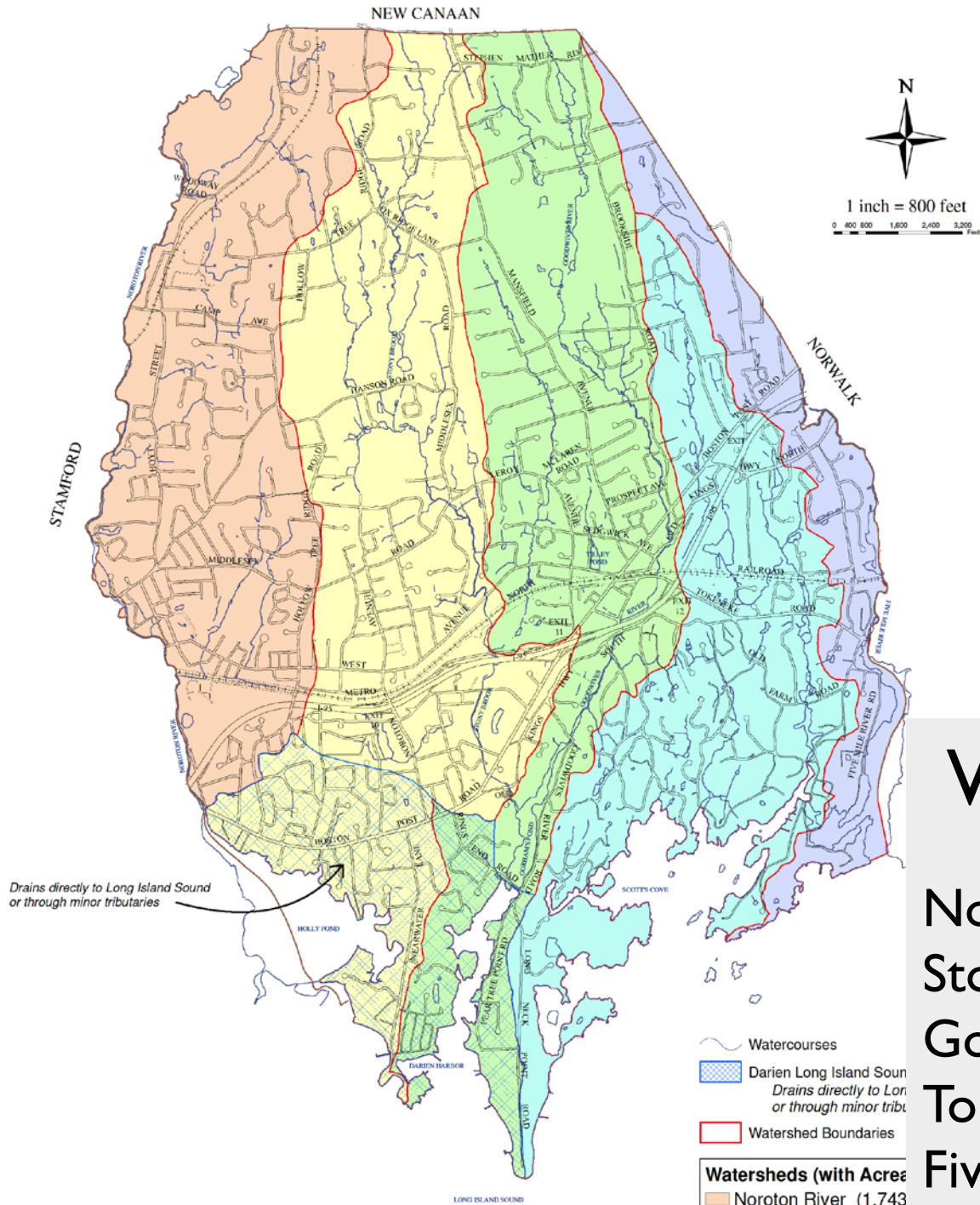
Figure 2-6 from the Fourth National Climate Assessment

## 2 Key Message #6

### Changing U.S. Precipitation

Annual precipitation since the beginning of the last century has increased across most of the northern and eastern United States... Over the coming century, significant increases are projected in winter and spring over... the Northeast. Observed increases in the frequency and intensity of heavy precipitation events in most parts of the United States are projected to continue.





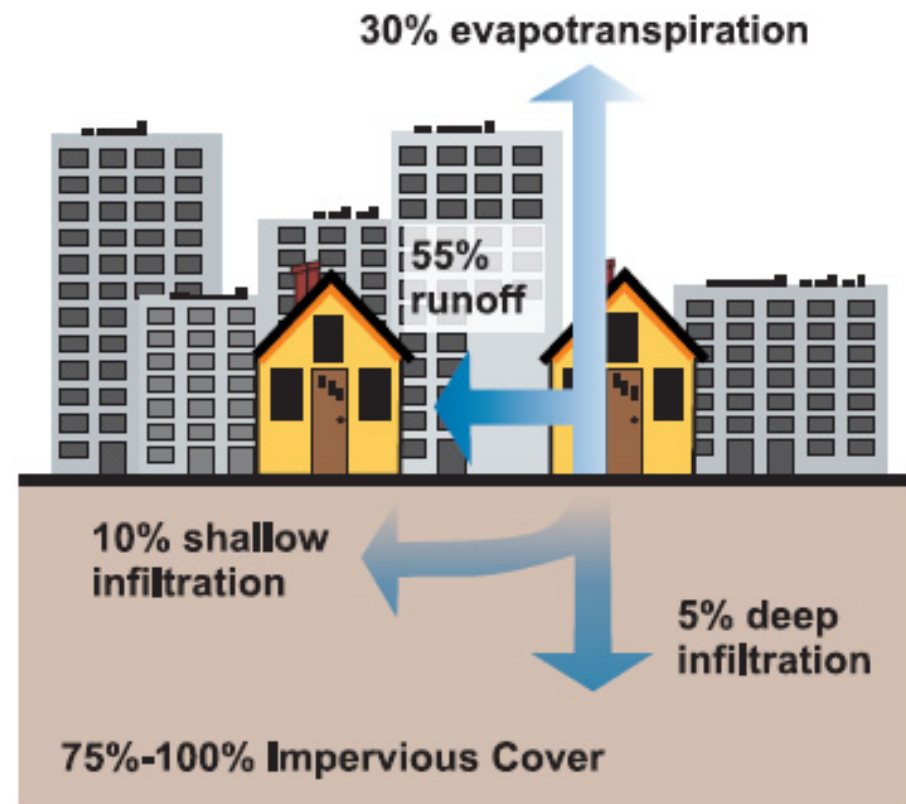
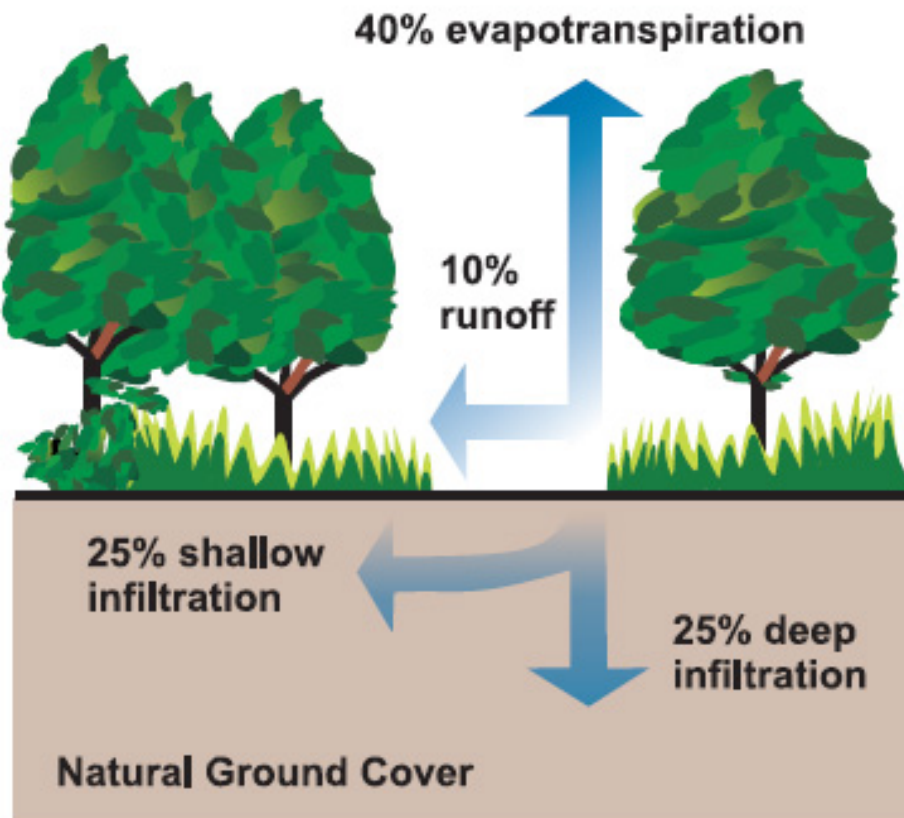
# Watershed Areas

(square miles)

Noroton River	11.0
Stony Brook	4.2
Goodwives River	2.0
Tokeneke Brook	1.2
Five Mile River	12.5

- Watercourses
  - Darien Long Island Sound  
Drains directly to Long Island Sound or through minor tributaries
  - Watershed Boundaries
- Watersheds (with Acres)**
- Noroton River (1,743)

# EFFECT OF SURFACE COVER



## Rate of Flow

(cubic feet per second and gallons per minute)

Noroton River	7,581 cfs	3,402,000 gpm
Stony Brook	2,737 cfs	1,228,000 gpm
Goodwives River	1,742 cfs	781,800 gpm

# Darien Zoning Regulations

## Section 820: Flood Damage Prevention

- Enacted in 1981
- 160 Years with no constraint or regulation on development in flood zones and floodways.
- Only the past 40 years that construction in flood zones has been regulated by PZC.
- Floors in new buildings must be one foot above the flood.
- On average, about 4 houses per year are raised or rebuilt to comply.

# Darien Zoning Regulations

## Section 880: Stormwater Management




- Adopted in 2009.
- Requires strict engineering design based on higher rainfall rates, followed by review of stormwater management by local land use boards as part of their formal applications.
- Use of “fresh meadow approach” for new construction.
- Requires mitigation so proposed runoff matches a meadow condition, not just the difference in new hardscape. One of the strictest municipal standards in CT.
- 300 properties have engineered design of on-site drainage systems in the past 12 years.

# PERMEABLE SURFACES



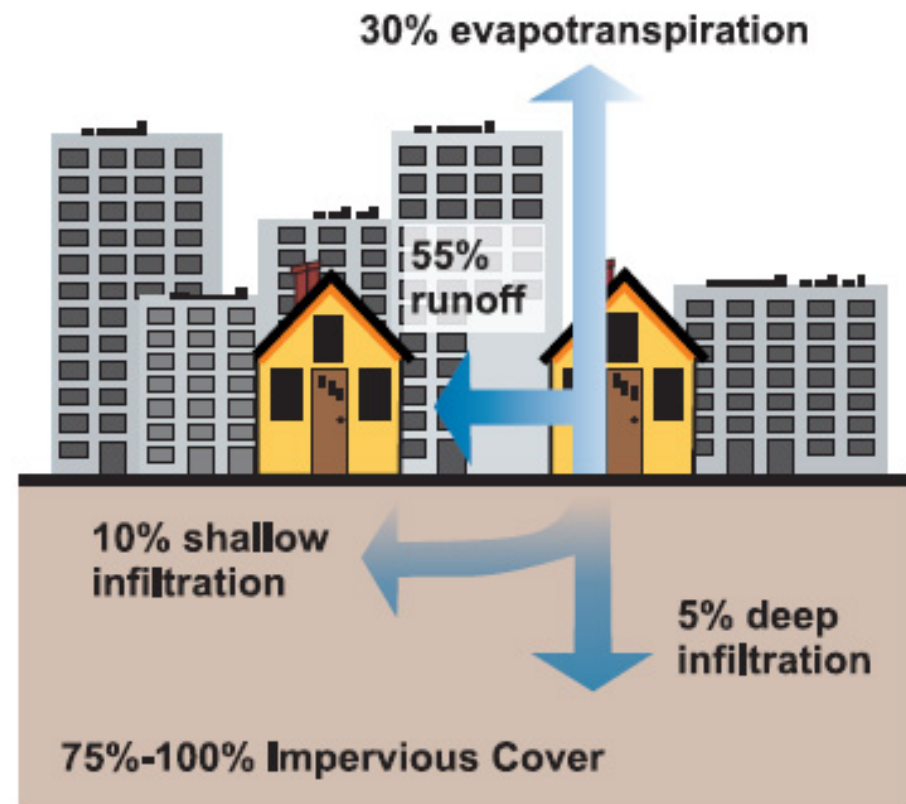
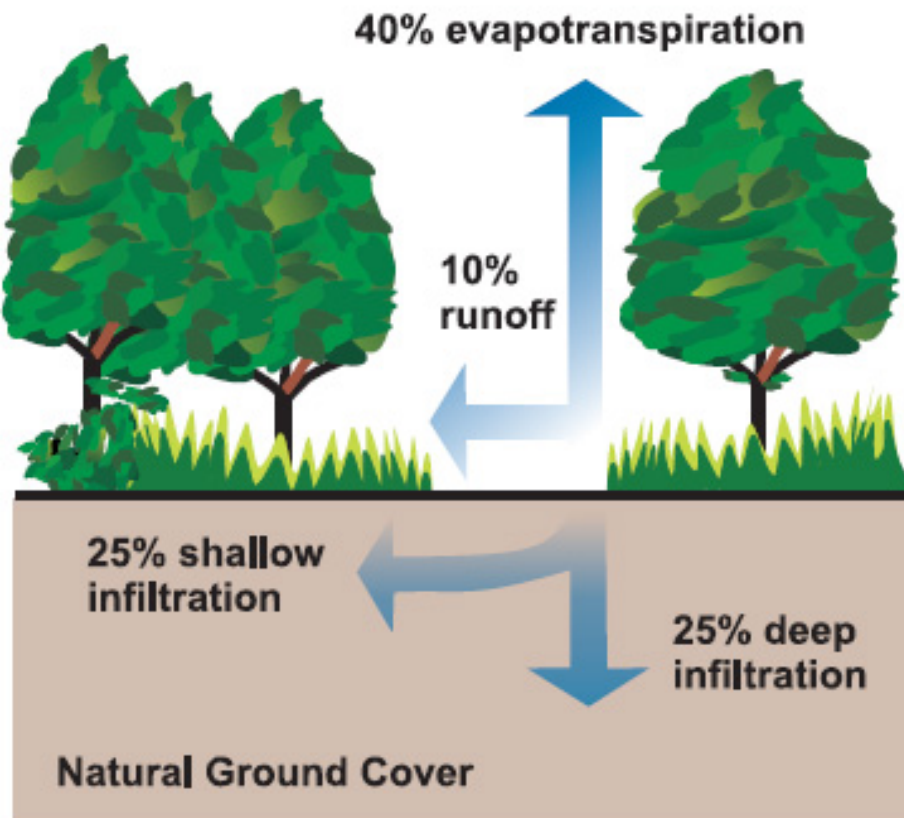
# STORMWATER INFILTRATION & STORAGE OPTIONS



EVENT	Old Data	New Data
	TP-40	Atlas-14
2yr	3.3"	3.54"
10yr	5.0"	5.39"
25yr	5.7" 	6.54"
50yr	6.4" 	7.40" 
100yr	7.2"	8.32"



# REVERSING THE EFFECT OF SURFACE COVER



# Railroad Culverts & Underpasses

Kelsey Street

Heights Road

Stony Brook

Bailey Avenue

Goodwives

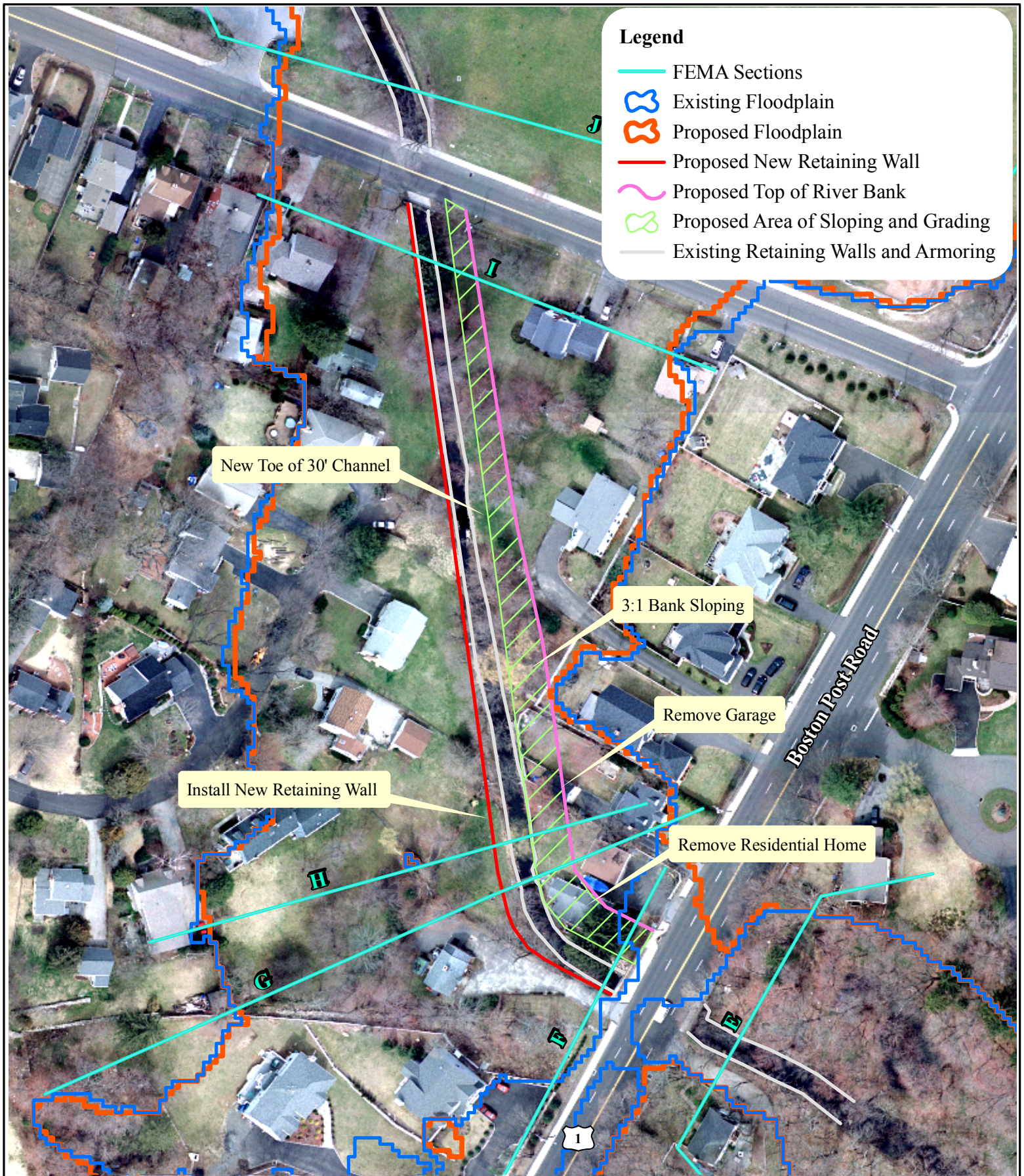
-

Leroy

Post Road

Raymond Street

# Stony Brook Examples



**Legend**

- FEMA Sections
- ⬭ Existing Floodplain
- ⬭ Proposed Floodplain
- Proposed New Retaining Wall
- ~ Proposed Top of River Bank
- ▨ Proposed Area of Sloping and Grading
- Existing Retaining Walls and Armoring

New Toe of 30' Channel

3:1 Bank Sloping

Remove Garage

Install New Retaining Wall

Remove Residential Home

Boston Post Road

1



**MILONE & MACBROOM**<sup>®</sup>

Engineering,  
Landscape Architecture  
and Environmental Science

99 Realty Drive  
Cheshire, Connecticut 06410  
(203) 271-1773 Fax: (203) 272-9733  
www.miloneandmacbroom.com

**STONY BROOK WATERSHED  
DRAINAGE EVALUATION**

MMI#: 1581-04  
MXD: H:\Fig\_5-6atler8b.mxd  
SOURCE: CT DEP



**ALTERNATIVE 8B:  
COMPOUND CHANNEL  
BETWEEN ROUTE 1 AND  
RENSHAW ROAD**

LOCATION:  
**Darien, CT**

Map By: EPB  
Date: MAY 2009  
Scale: 1"=100'

SHEET:  
**Figure 5-6**

**TABLE 5-11  
Results of Alternatives 8A and 8B**

FEMA Cross Section	Existing Conditions Station	Water Surface Elevation (feet NAVD)				
		Existing Conditions	Proposed Conditions- 30' concrete (8A)	Difference	Proposed Conditions- Compound Channel (8B)	Difference
E	1156	14.9	14.9	0.0	14.9	0.0
Boston Post Road						
F	1290	14.7	15.5	0.7	16.4	1.7
Footbridge						
G	1408	17.1	16.3	-0.8	16.8	-0.3
H	1432	17.1	16.3	-0.8	16.8	-0.3
I	1887	17.2	16.1	-1.1	16.7	-0.6
Renshaw Road						
J	2060	17.7	16.9	-0.8	17.2	-0.6
K	3008	18.2	17.6	-0.6	17.8	-0.4
L	3482	18.2	17.7	-0.6	17.9	-0.4
Hecker Avenue						

# Adaptation and Resiliency

Redevelop Resiliently

Raise or Raze in a floodplain?

After Sandy, 25 homes were elevated

25+ homes built/rebuilt to latest standards since 2013

2 properties purchased, 1 more pending

300+ zoning permits since latest stormwater reqs in 2009

Improve infrastructure

# Maintenance

Clean culverts and stream channels

Remove floatable debris from yards in floodplains

Prevent downstream pollution

80% on private property

# Why is it flooding so much?

- River flooding is a natural phenomena
- Human impacts have made it worse
  - Increased rainfall
  - Historic development in and near wetlands and floodplains
  - Minimal stormwater mitigation for much of town history
  - Suburban or urban development of entire watersheds
  - Culverts not sized to manage the intensity of recent events

**Questions?**