Evaluating the Costs and Benefits of Floodplain Protection in the Town of Waterbury, Vermont

Presented by

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Acknowledgements

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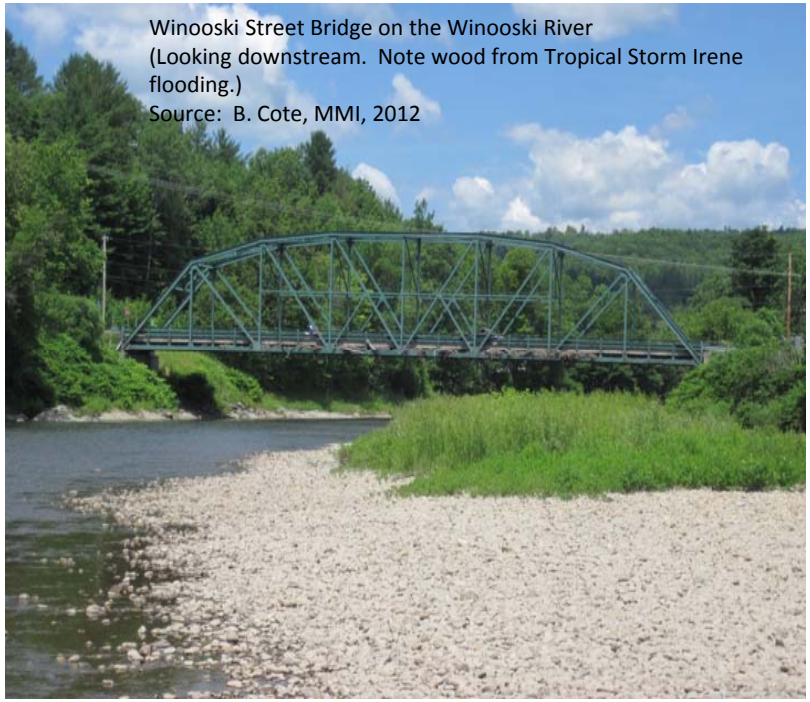
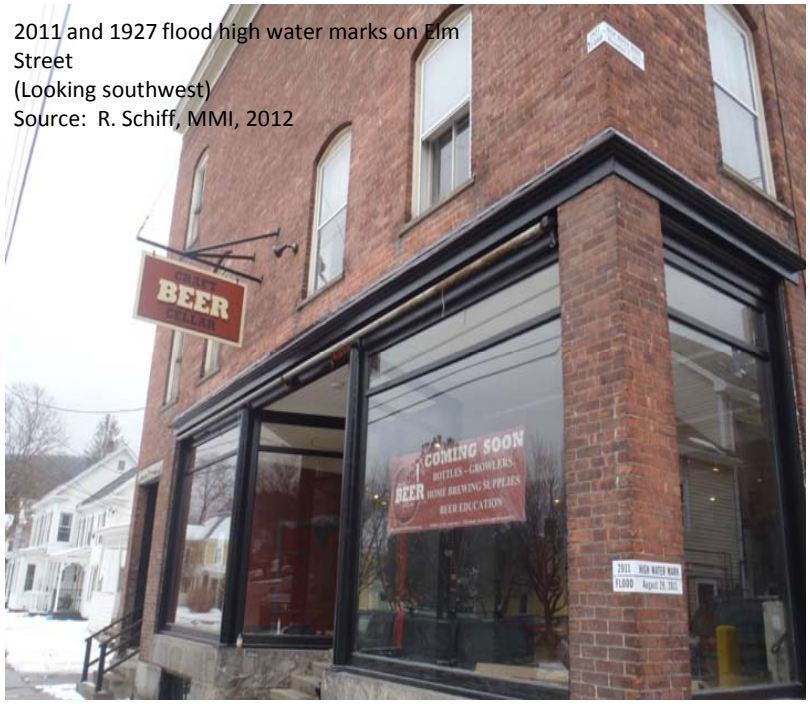
Town and Village of Waterbury, Vermont

VT Agency of Natural Resources



Winooski Street Bridge on the Winooski River
(Looking downstream. Note wood from Tropical Storm Irene flooding.)
Source: B. Cote, MMI, 2012

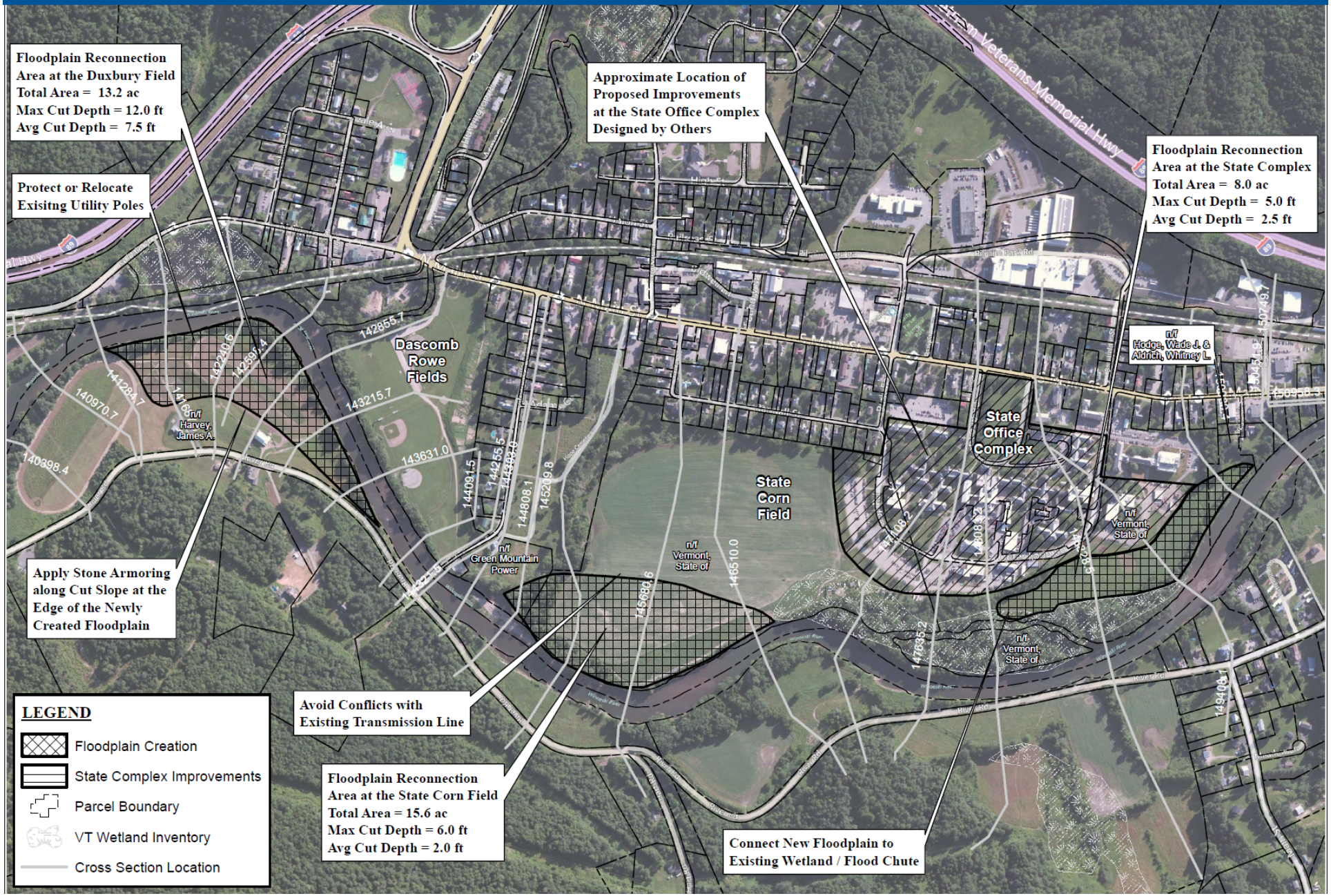
2011 flooding during Tropical Storm Irene
(Looking southeast along Main Street.)
Source: V. Starinskas, Rutland Herald



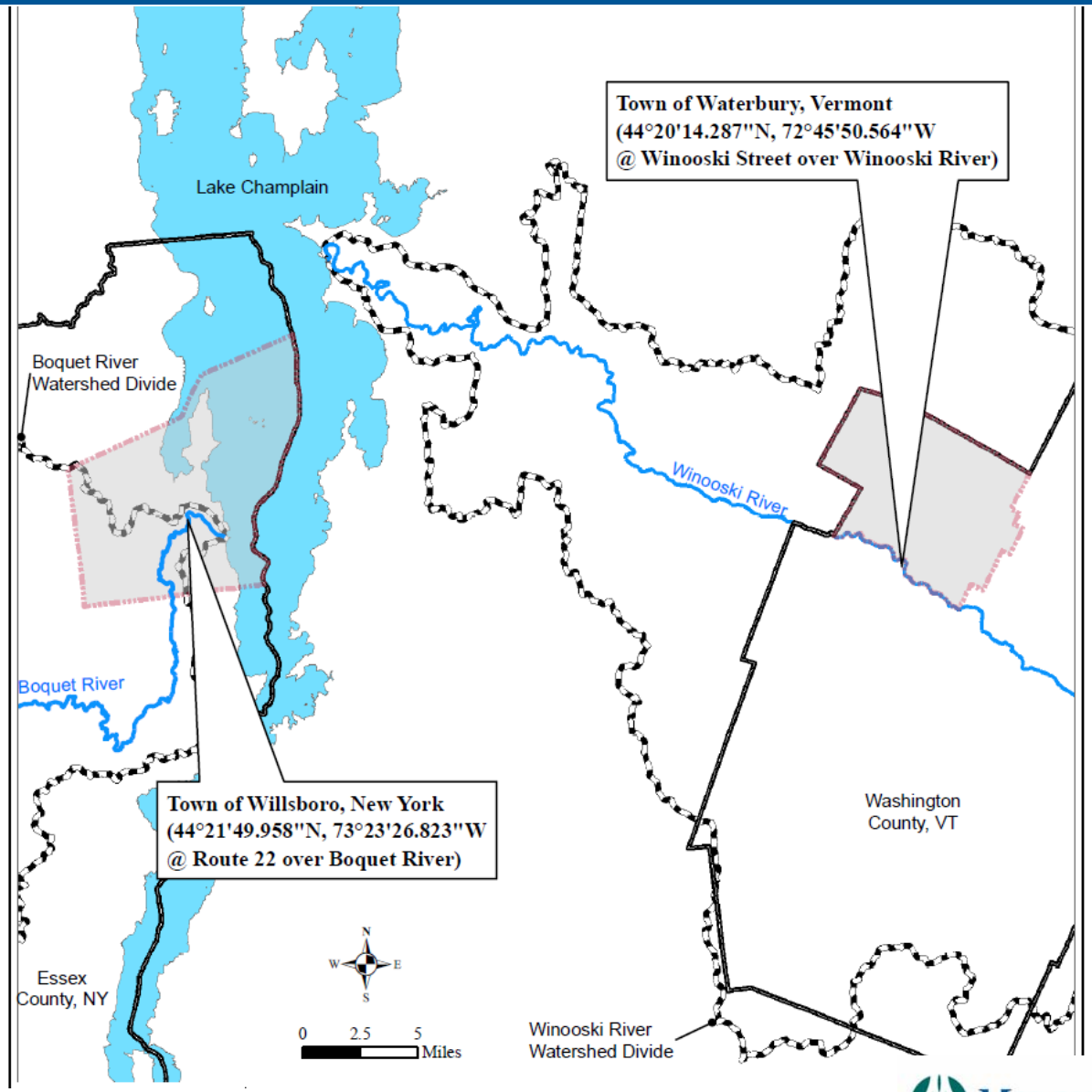
2011 and 1927 flood high water marks on Elm Street
(Looking southwest)
Source: R. Schiff, MMI, 2012

Randall Street Neighborhood that is prone to flooding
(Looking southeast)
Source: Google Maps Street View, 2015

Waterbury Flood Study - Floodplain Restoration



Project Location



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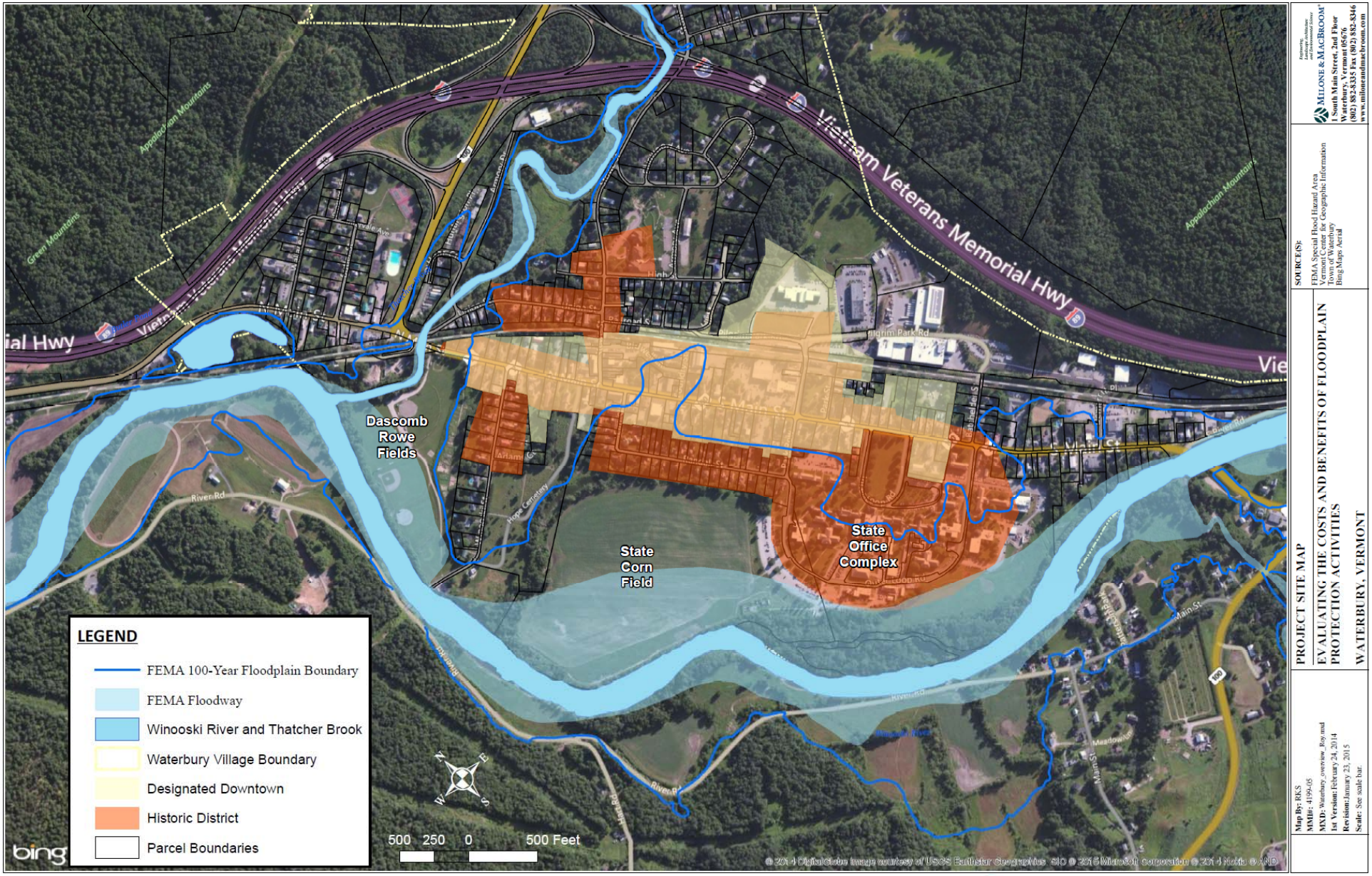
Project Location



PROJECT SITE MAP

EVALUATING THE COSTS AND BENEFITS OF FLOODPLAIN PROTECTION ACTIVITIES

WATERBURY, VERMONT

SOURCE(S):
FEMA Special Flood Hazard Area
Vermont Center for Geographic Information
Town of Waterbury
Bing Maps Aerial

MILONE & MACBROOM
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Waterbury, Vermont 05676
(802) 882-8335 Fax (802) 882-8346
www.miloneandmacbroom.com

Map By: RKS
MMIS: 4199-05
MXD: Waterbury_overview_Boy.mxd
1st Version: February 24, 2014
Revision: January 23, 2015
Scale: See scale bar.

Primary Research Question

Do the benefits of floodplain protection outweigh the costs?

Benefits

- Reduction of flood damages
- Lower recovery costs
- Increased health and safety
- Enhanced ecosystem services
- Social benefits

Costs

- Possible loss of economic opportunity
- Possible reduced tax base
- Floodplain restoration cost
- Increased building costs to flood-proof structures
- Recovery of structures remaining in the floodplain
- Demolitions

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Hypotheses

1. The benefits of floodplain protection outweigh the costs over the long term because a complete accounting includes high-value ecosystem services.

2. Floodplain protection reduces future flood damages, improves public safety, and enhances water quality because the most at-risk parcels are not developed.

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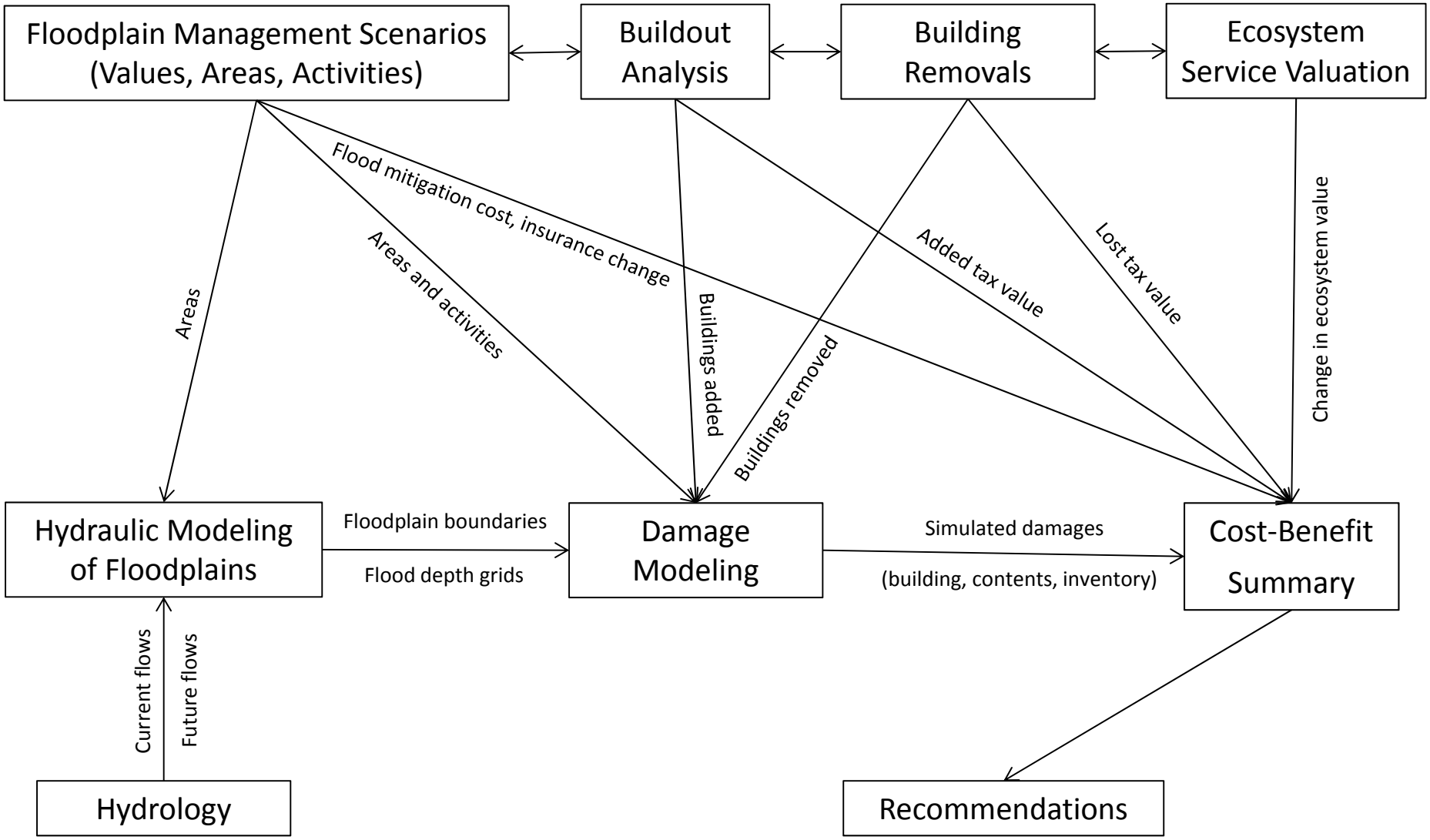
Data Flow



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Floodplain Values

We asked the community: What are your key development values?

Social

- Maintain vibrant village
- Help establish housing and businesses
- Grow tax base
- Create flood-safe community
- Support state government presence
- Maintain historic downtown
- Create tourism hub
- Support local arts

Environmental

- Establish connections between Village and recreation / natural areas
- Highlight river setting
- Maintain open space for recreation
- Create outdoor recreation tourism economy
- Support local agriculture

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Floodplain Management Scenarios

Flows:
Q10, Q50, Q100, Irene, Q500, Q100 future

Scenarios:
Existing floodplain configuration
Proposed1 – Restore all 3 floodplain areas.
Proposed2 – Restore 2 of 3 floodplain areas.

1. **Business as usual**
   - 1A. Existing floodplain development
   - 1B. Full floodplain development to current zoning.

2. **Elevation Policy**
   - 2A. All structures in the 0.2% annual chance floodplain to be elevated two feet above the 1% annual chance flood elevation.
   - 2B. All new structures in buildout or following substantial damages in the 0.2% annual chance floodplain to be elevated two feet above the 1% annual chance flood elevation.
   - 2C. All domestic utilities in the 0.2% annual chance floodplain to be elevated to the 0.2% annual chance flood elevation.

3. **Avoidance and no fill**
   - 3A. Migrate out of the most at-risk areas (Q50) with deepest 1% annual chance flood levels.
   - 3C. Elevation of all existing structures required upon rebuild following substantial damages to one foot above the 0.2% annual chance flood level.

4. **Extreme flood risk avoidance**
   - 4A. Abandonment of majority of structures in the 1% annual chance floodplain (Q100) following substantial damages.
   - 4B. As 4A, except elevate essential buildings and select historic structures following damages selected to remain.

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Build-out Analysis

Parcels Most Vulnerable to Flooding (50-Year Floodplain)

	Existing		Buildout		
Existing Land Use	# of Parcels	Assessed Value	Potential Dwelling Units allowed by Right	Potential Commercial / Industrial Square Footage	Potential Value
Commercial/ Industrial	7	$2,559,000	31	60,072	$10,357,360
Residential	41	$7,723,700	68	0	$12,780,000
Mixed Use	2	$478,200	4	0	$852,000
Municipal/ Institutional**	2	$451,600	n/a	26,986	$3,508,180
Vacant/ Unclassified	1	$70,500	0	0	$0
TOTAL	**53**	**$11,283,000**	**103**	**87,058**	**$27,497,540**

Parcels Vulnerable to Flooding (100-Year Floodplain)

	Existing		Buildout		
Existing Land Use	# of Parcels	Assessed Value	Potential Dwelling Units allowed by Right	Potential Commercial / Industrial Square Footage	Potential Value
Commercial/ Industrial	19	$6,150,700	81	188,035	$30,818,550
Residential	89	$16,485,900	170	127,953	$43,881,890
Mixed Use	3	$860,800	17	22,879	$4,190,270
Municipal/ Institutional**	7	$2,688,500	86	1,657,436	$215,466,680
Vacant/ Unclassified	1	$70,500	0	0	$0
TOTAL	**119**	**$26,256,400**	**354**	**1,996,303**	**$294,357,390**

RANGE OF VALUES FOR ECOSYSTEM SERVICES IN THE FLOODPLAINS OF THE LAKE CHAMPLAIN BASIN

Ecosystem Service	Agriculture		Forest	
	Low Value ($/acre/year)	High Value ($/acre/year)	Low Value ($/acre/year)	High Value ($/acre/year)
Aesthetic	0	6134	5497	5497
Air Quality			195	195
Biological Control			14	14
Climate Stability	2	125	1	166
Cultural and Artistic	55	2091		
Energy and Raw Materials			48	48
Erosion Control	5	122	1	4
Flood Mitigation				
Food Production	150	150		
Genetic Resources				
Habitat and Nursery				
Medicinal Resources				
Ornamental Resources				
Pollination	46	1903		
Recreation and Tourism	67	67	14	68
Science and Education				
Soil Formation	1	166		
Spiritual and Historic				
Waste Treatment			48	465
Water Regulation	26	50		
Water Supply			3	3
TOTAL	**$ 352**	**$ 10,808**	**$ 5,823**	**$ 6,461**

EARTH ECONOMICS

50 yr timespan						
Floodplain Land Cover Class	Low Value ($/acre/year)	High Value ($/acre/year)	Carbon Storage Low	Carbon Storage High	NPV per Acre Low (4.125%)	NPV per Acre High (4.125%)
Agriculture	352	10,808	500	3,605	7,679	224,130
Forest	5,823	6,461	345	19,762	119,176	151,519
Shrubland / Grassland	9,147	9,247	170	315	186,849	189,040
Wetland	5,807	55,870	4,862	84,131	123,389	1,224,428
River	2,119	77,089	-	-	43,252	1,572,970
Village Greenspace	2,404	17,919	78	16,129	50,632	392,974
Developed Land	Not Valued	Not Valued	Not Valued	Not Valued	Not Valued	Not Valued

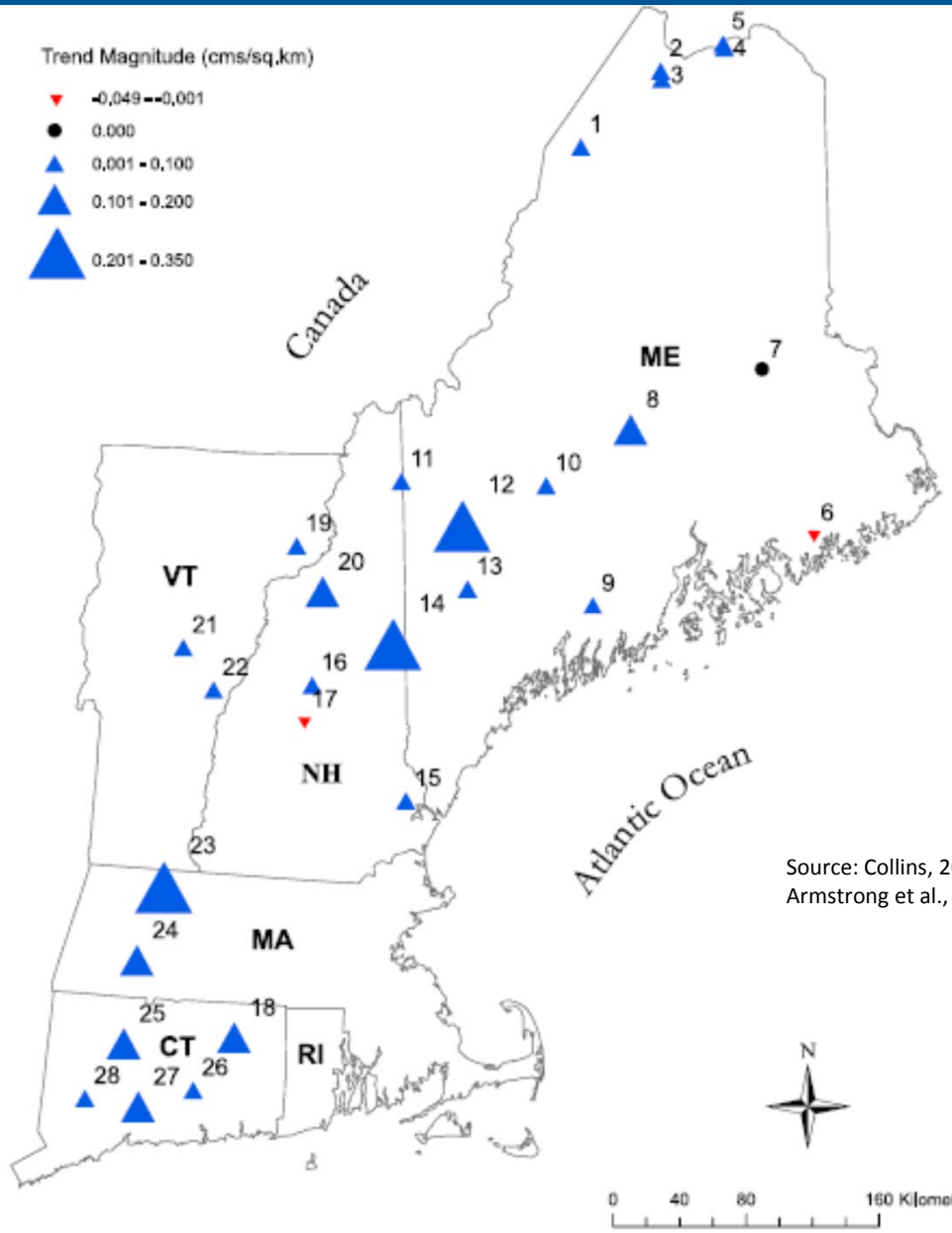
RANGE OF VALUES FOR ECOSYSTEM SERVICES IN THE FLOODPLAINS OF THE LAKE CHAMPLAIN BASIN

100-Year Floodplain

Floodplain Land Cover Class	Acres	Low Value ($/acre/year)	High Value ($/acre/year)	Annual Low ($/year)	Annual High ($/year)
Agriculture	43	352	10,808	15,002.66	460,125
Forest	41	5,823	6,461	238,135	264,223
Shrubland / Grassland	80	9,147	9,247	732,250	740,275
Wetland	71	5,807	55,870	411,952	3,963,203
River	43	2,119	77,089	91,589	3,331,725
Village Greenspace	37	2,404	17,919	87,999	655,966
Developed Land	129	Not Valued	Not Valued	Not Valued	Not Valued
Total	**443**			**$ 1,576,928**	**$ 9,415,519**

EARTH ECONOMICS

Changing Regional Hydrology



Source: Collins, 2009 and Armstrong et al., 2011

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Local Hydrology – Design Flows

Design Flows – Waterbury, Vermont

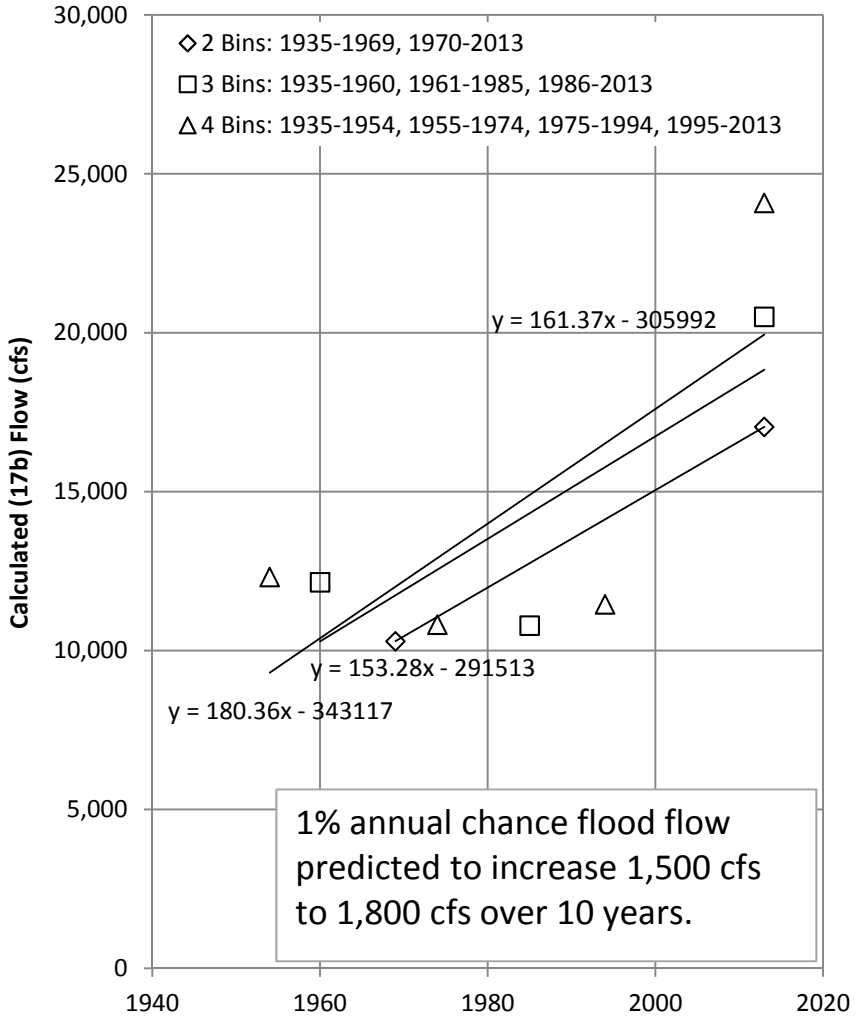
EXISTING	Waterbury	
Flood	**Existing Flow (cfs)**	**Notes**
10-year	25,800	From 2013 FEMA RAS model @ Little River.
50-year	36,800	From 2013 FEMA RAS model @ Little River.
100-year	42,400	From 2013 FEMA RAS model @ Little River.
Irene (444-year)	56,200	Superposition of flood waves from Dog, Mad, and upper Winooski Rivers. Recurrence interval interpolated from flow exceedance curve.
500-year	57,100	From 2013 FEMA RAS model @ Little River.

FUTURE	Waterbury	
Flood	**Future Flow (cfs)**	**Notes**
6-year	25,800	EX 10*
23-year	36,800	EX 50*
38-year	42,400	EX 100*
100-year	54,500	From gauge trends.
118-year	56,200	EX Irene*
128-year	57,100	EX 500*
500-year	85,500	From gauge trends.

*Modern gauge record post-1970 generates flow exceedance curve that almost contains future flow predictions seen in gauge trends. It appears a new era of larger floods is here. Transfer known existing flows to futur curve to see reduction in recurrence interval indicative of more frequent larger floods.

- Gauge trends in the watershed show increasing size of large floods.
- Gauge trends at tributaries suggest an increase in the 100-year flow by 12,100 cfs by 2065, or a **30% increase**.
- **Gauge trends show that today's 100-year flood is equivalent to the 38-year flood in 2065 – It will be 2.6 times more likely.**
- Floodplain size will be larger in the future in Waterbury, Vermont.

100-year Flood Trends
Dog River at Northfield Falls, VT
(USGS Gauge 04287000)



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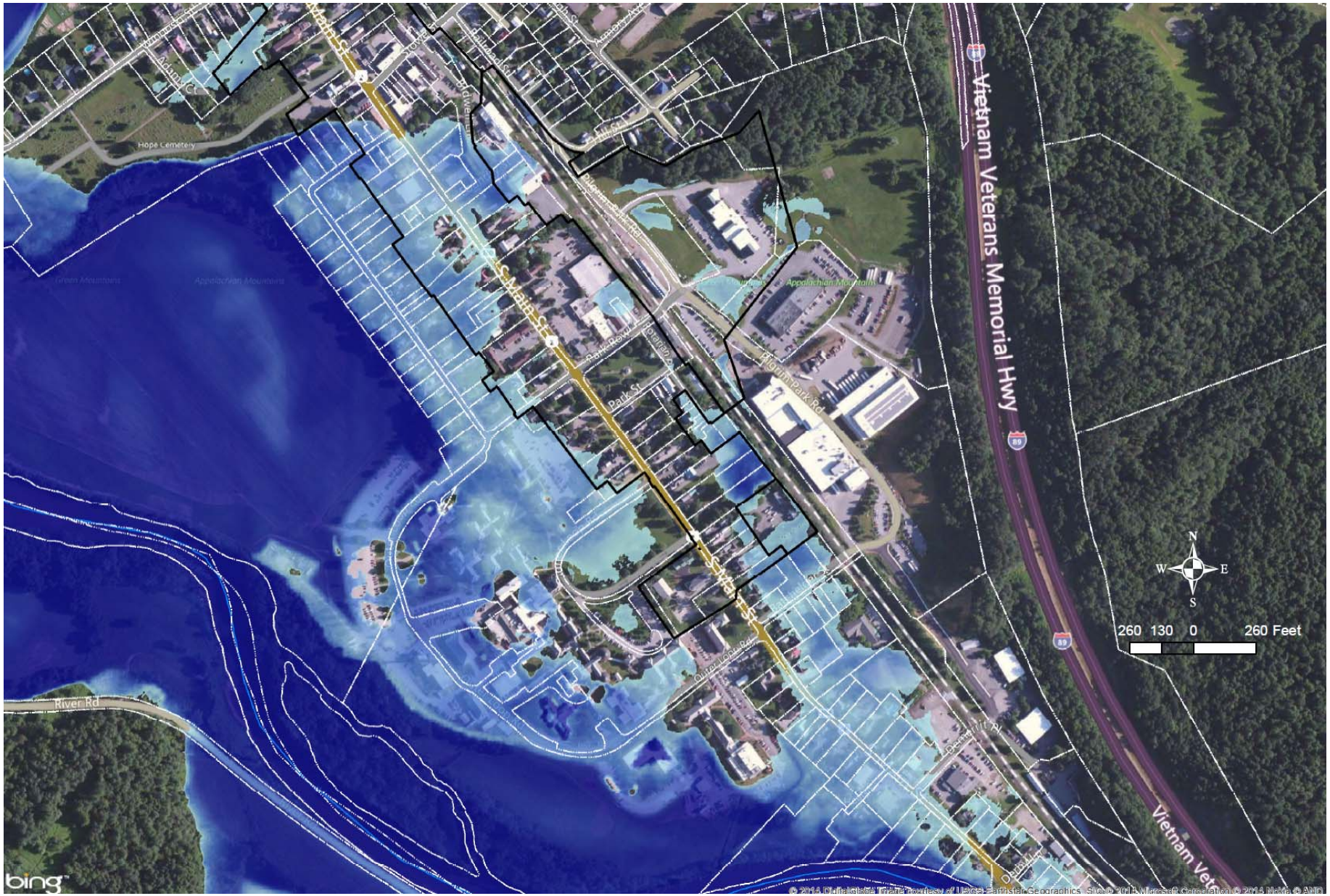
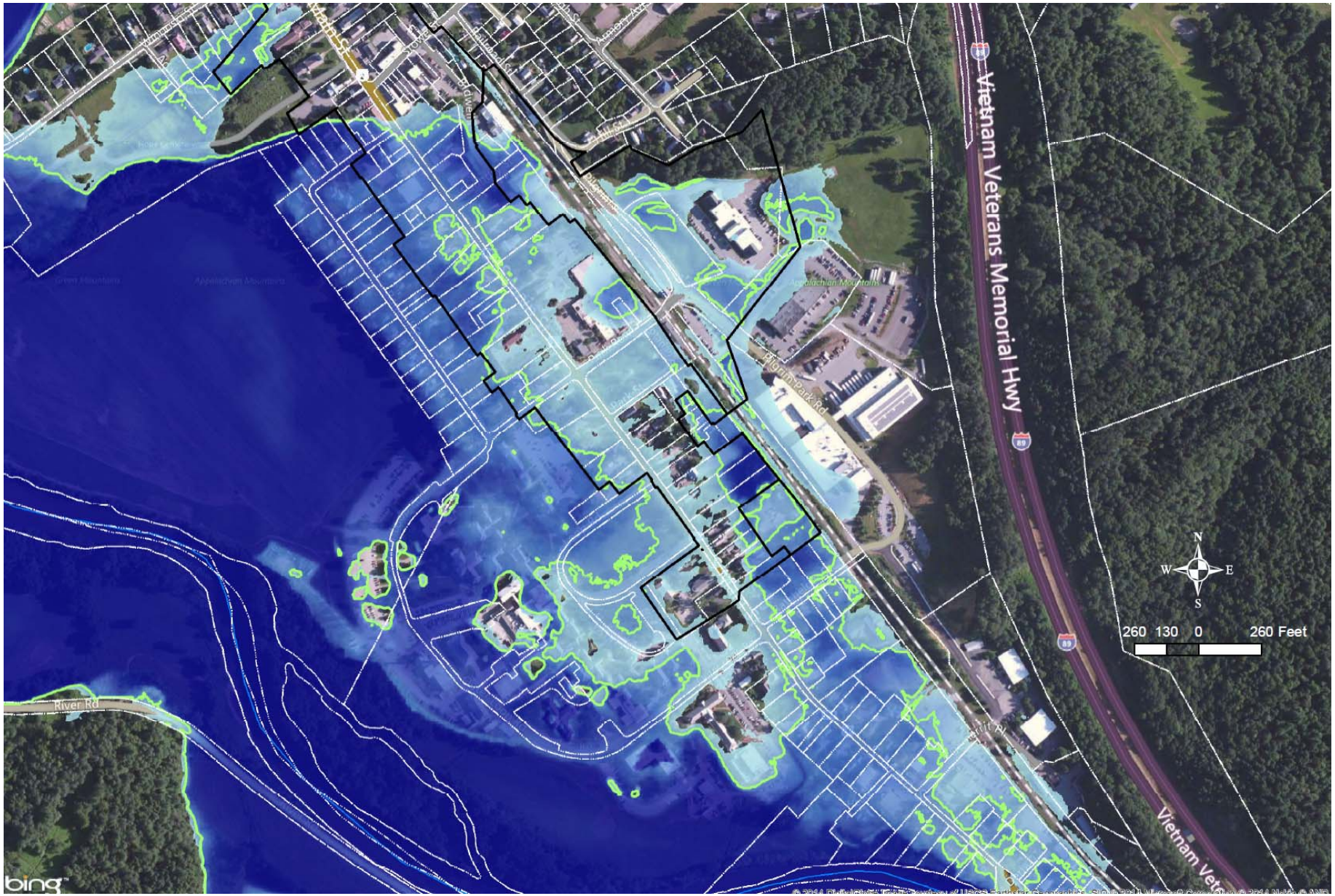
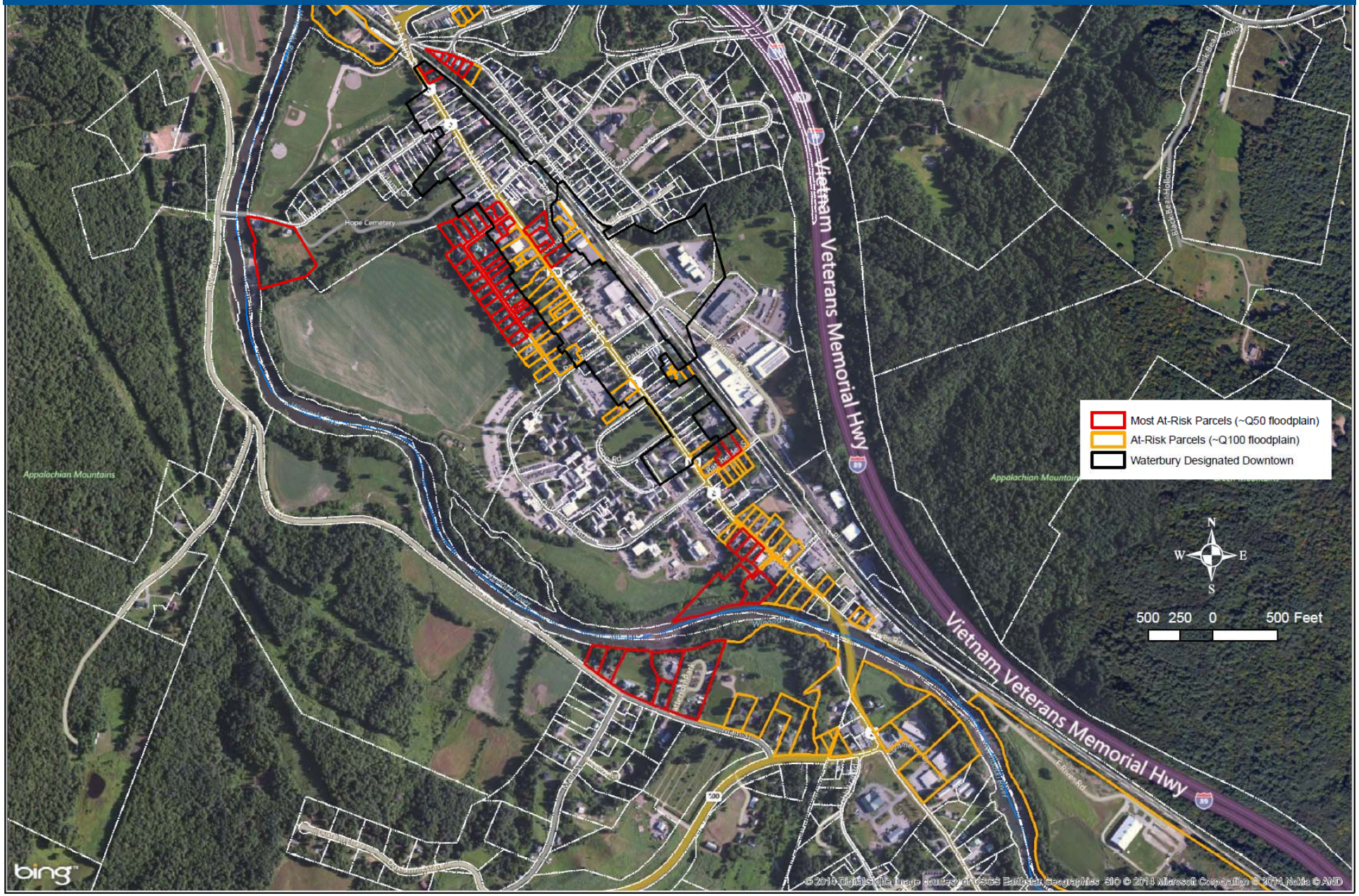
Hydraulics – Updated 100-Year Floodplain



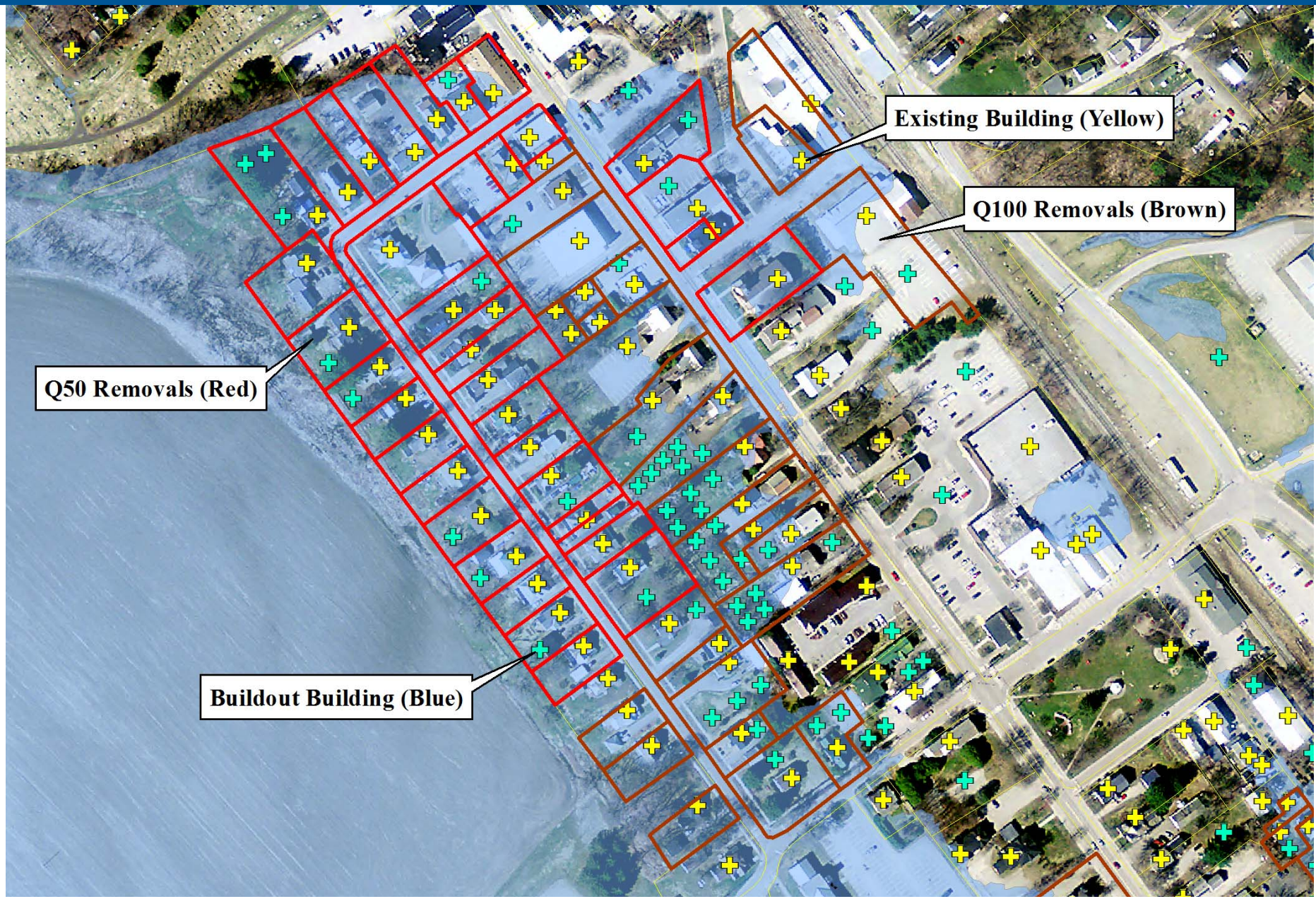
Hydraulics – Future 100-Year Floodplain



Removals Analysis



Damage Modeling – HAZUS



Damage Modeling

- Changed first floor height and foundation type for elevations
- Estimated basement building utilities at 6% of building value
- Used Q50 and Q100 removals list to “buyout” properties
- Selected elevations for Waterbury (Alt. 4B) as opposed to removals were the sewer pump station, a medical office, and selected utility elevations for Town facilities
- Town provided a $2.6 million calibration value (Irene) for building, content, and inventory damages for 49 structures (out of 256); model reported $3.48 million – relatively low difference of $4,500 per remaining structure.
- Waterbury, VT has a current annualized loss of $51,000 per year.

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Cost – Benefit Summary

1. Changes to the value of ecosystem service with increases or decreases in naturally functioning land with buildout or building removals
2. Changes in tax revenue based on increases or decreases in building stock
3. Costs of flood mitigation activities
4. Modeled damages of buildings, contents, and inventory
5. Changes to flood insurance premiums

- Annualized net change in $2015/year and $2065/year.
- Existing and buildout with and without floodplain restoration.

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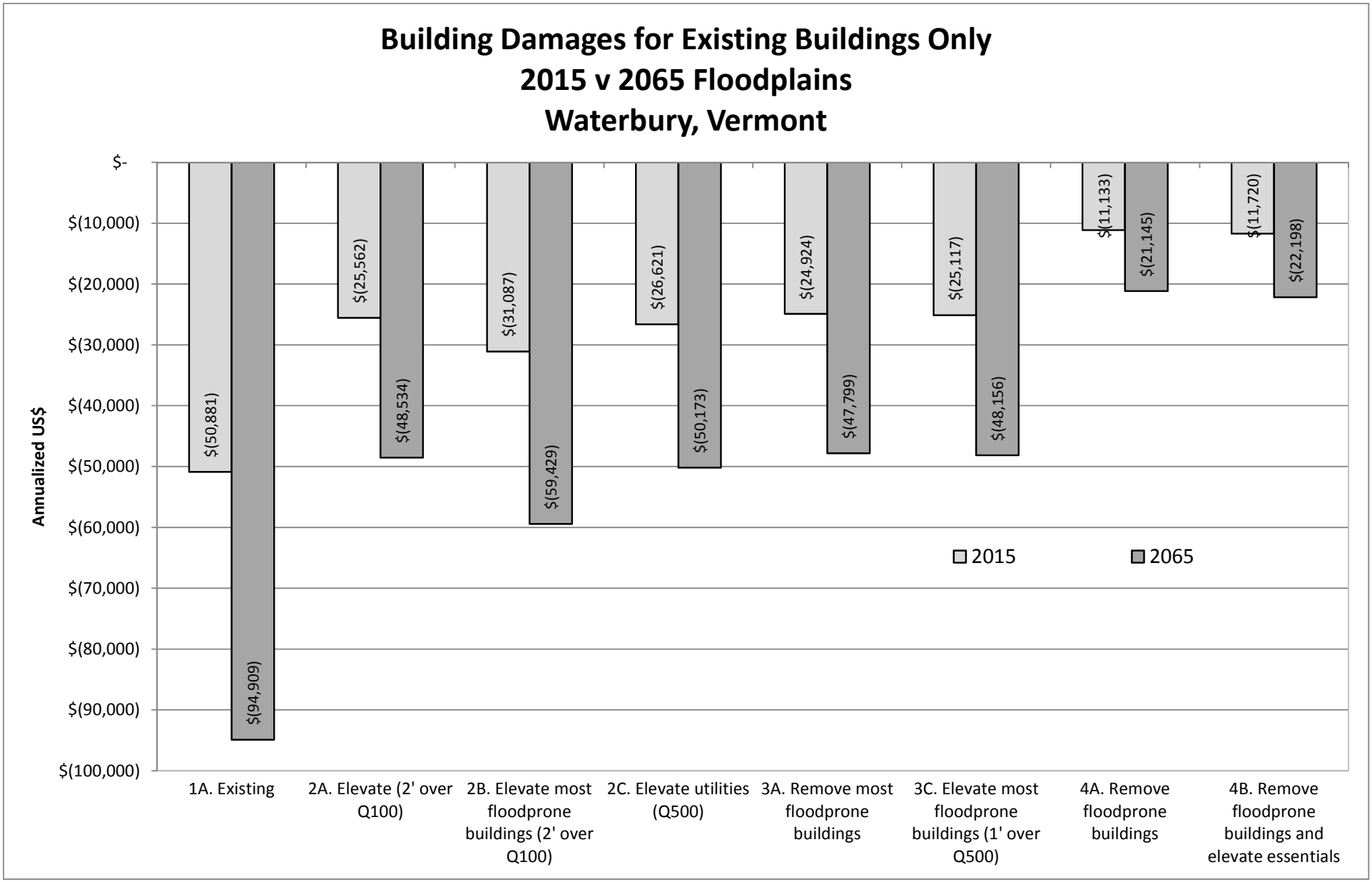
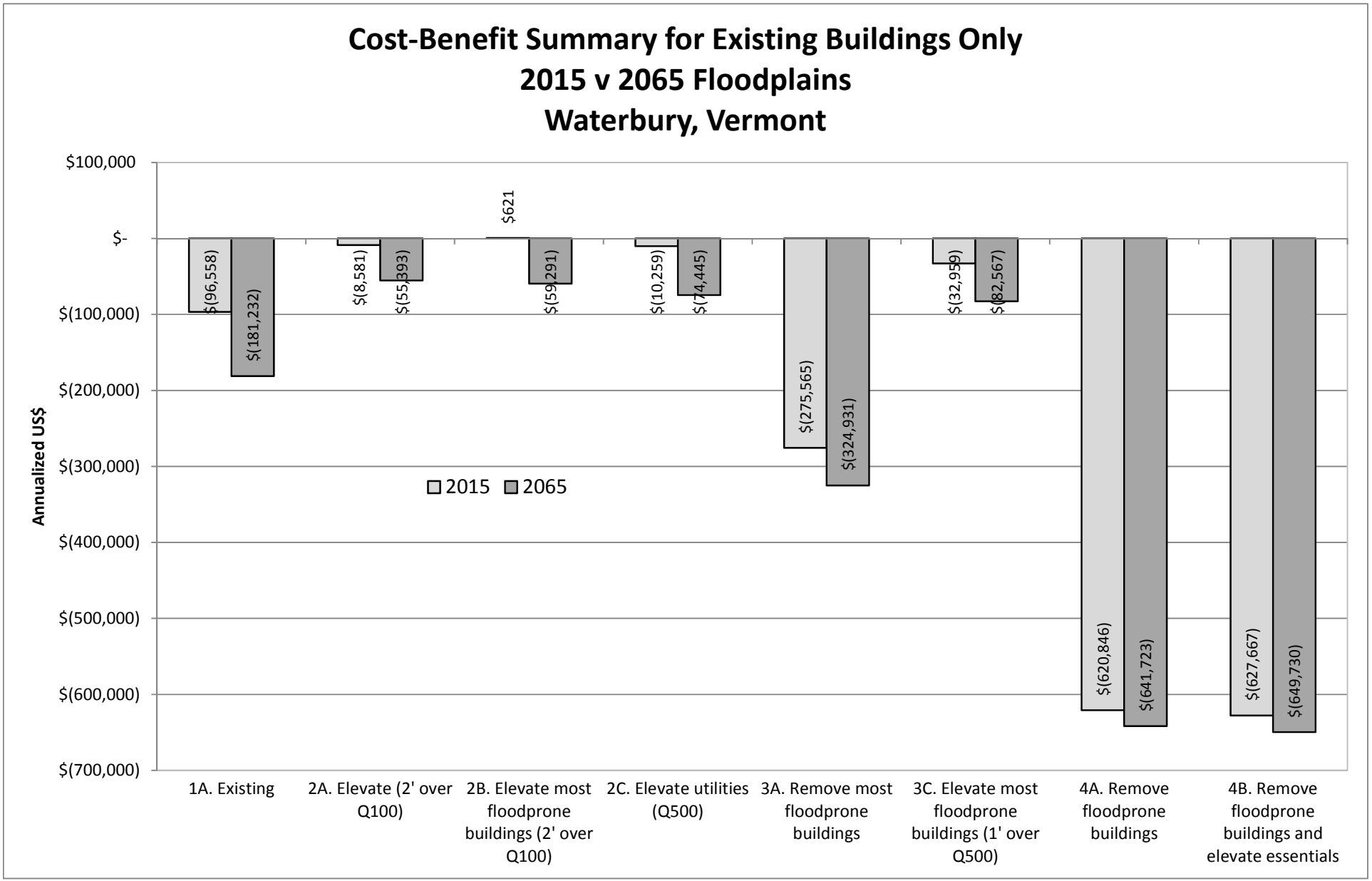
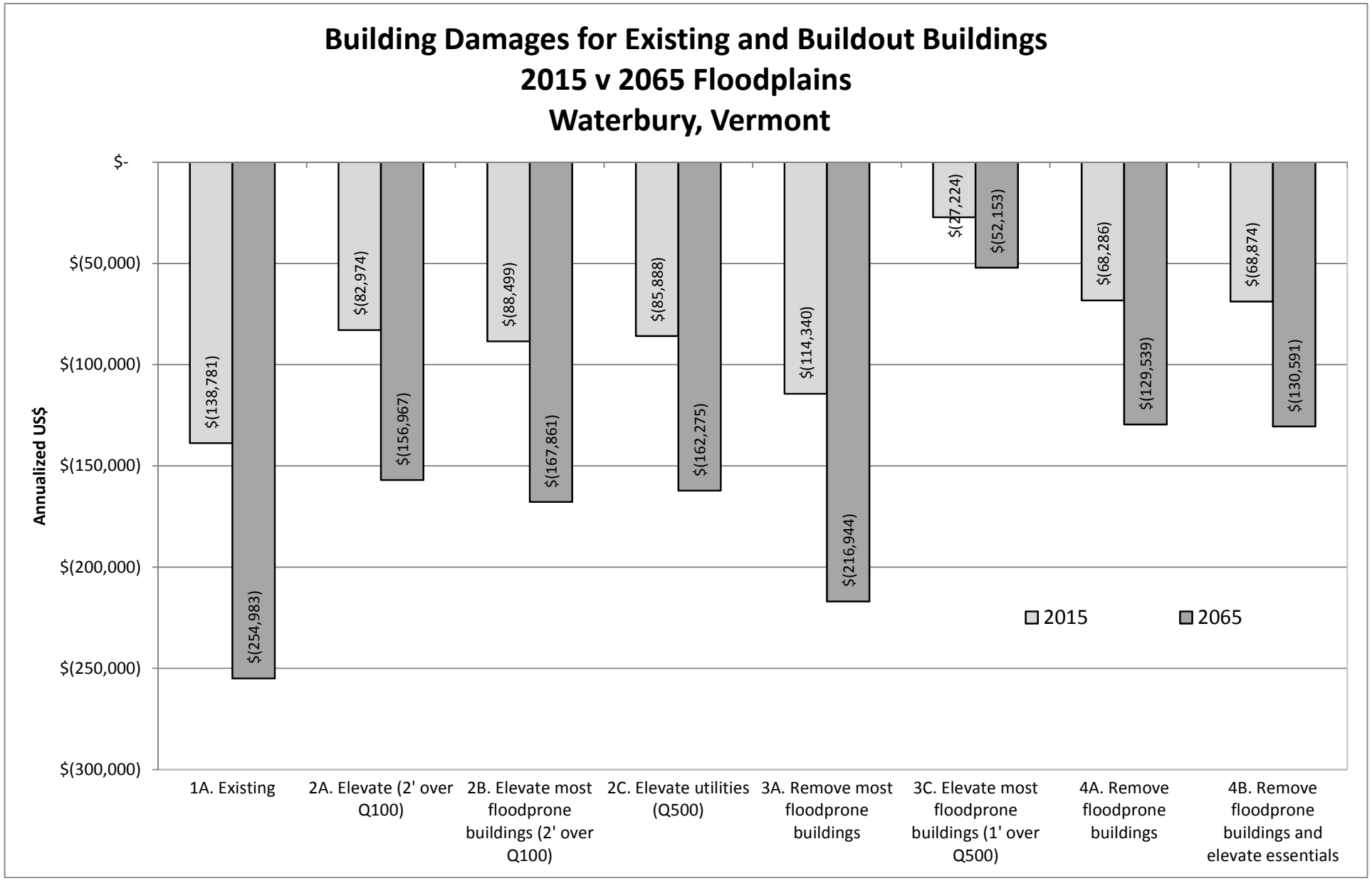
Existing Building Damages 2015 v 2065



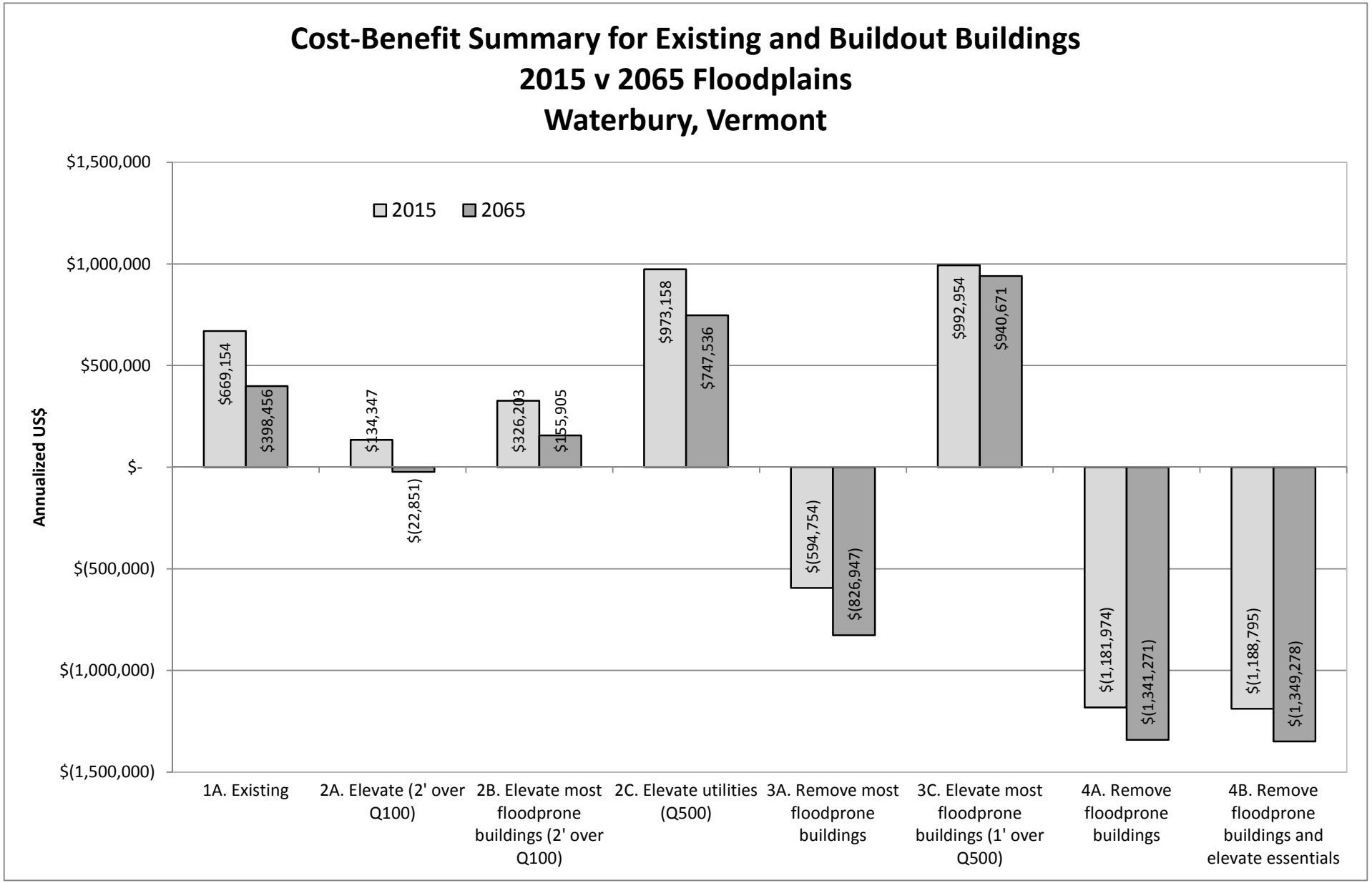
Cost-Benefit Summary 2015 v 2065



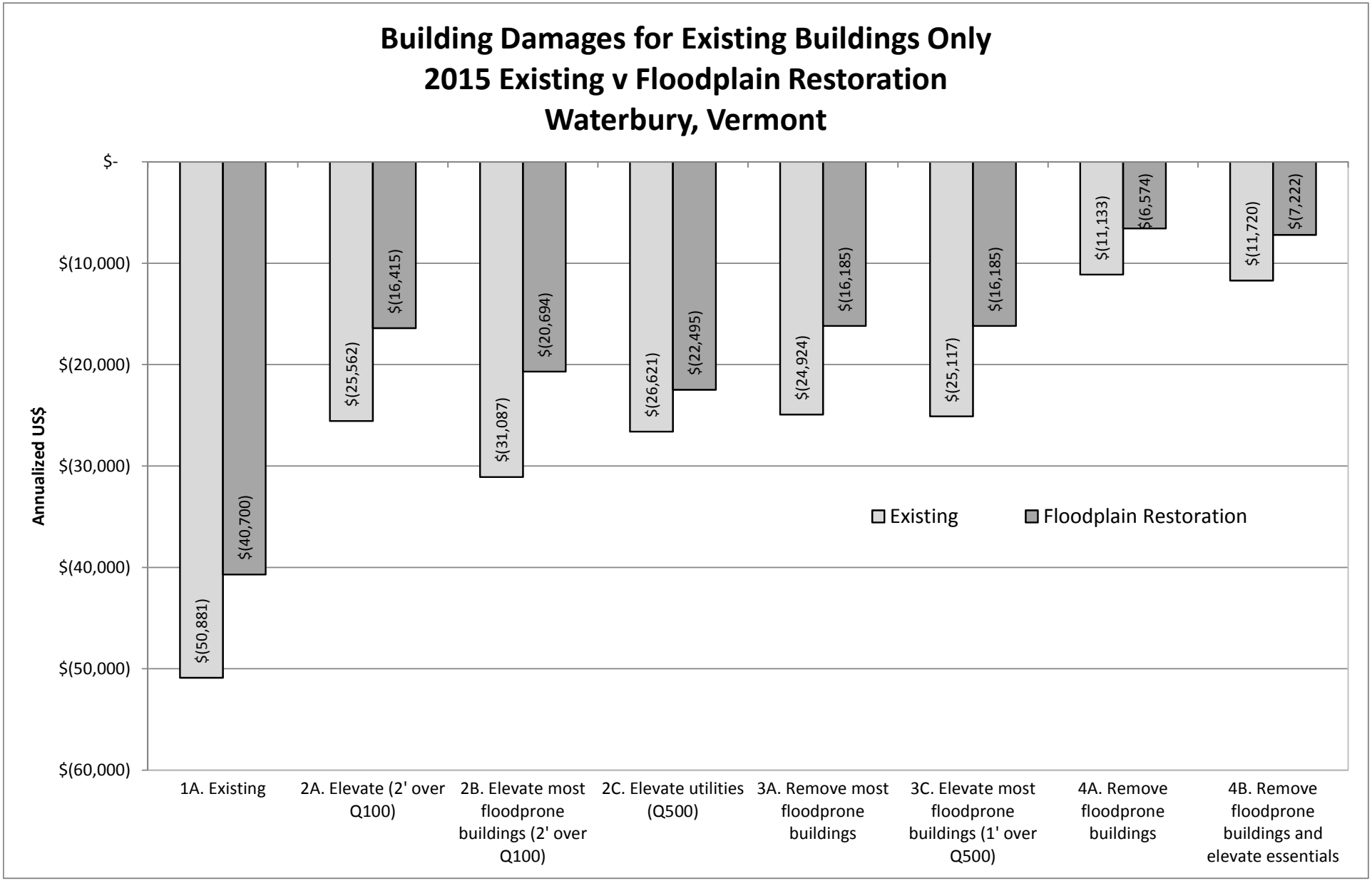
Buildout Building Damages 2015 v 2065



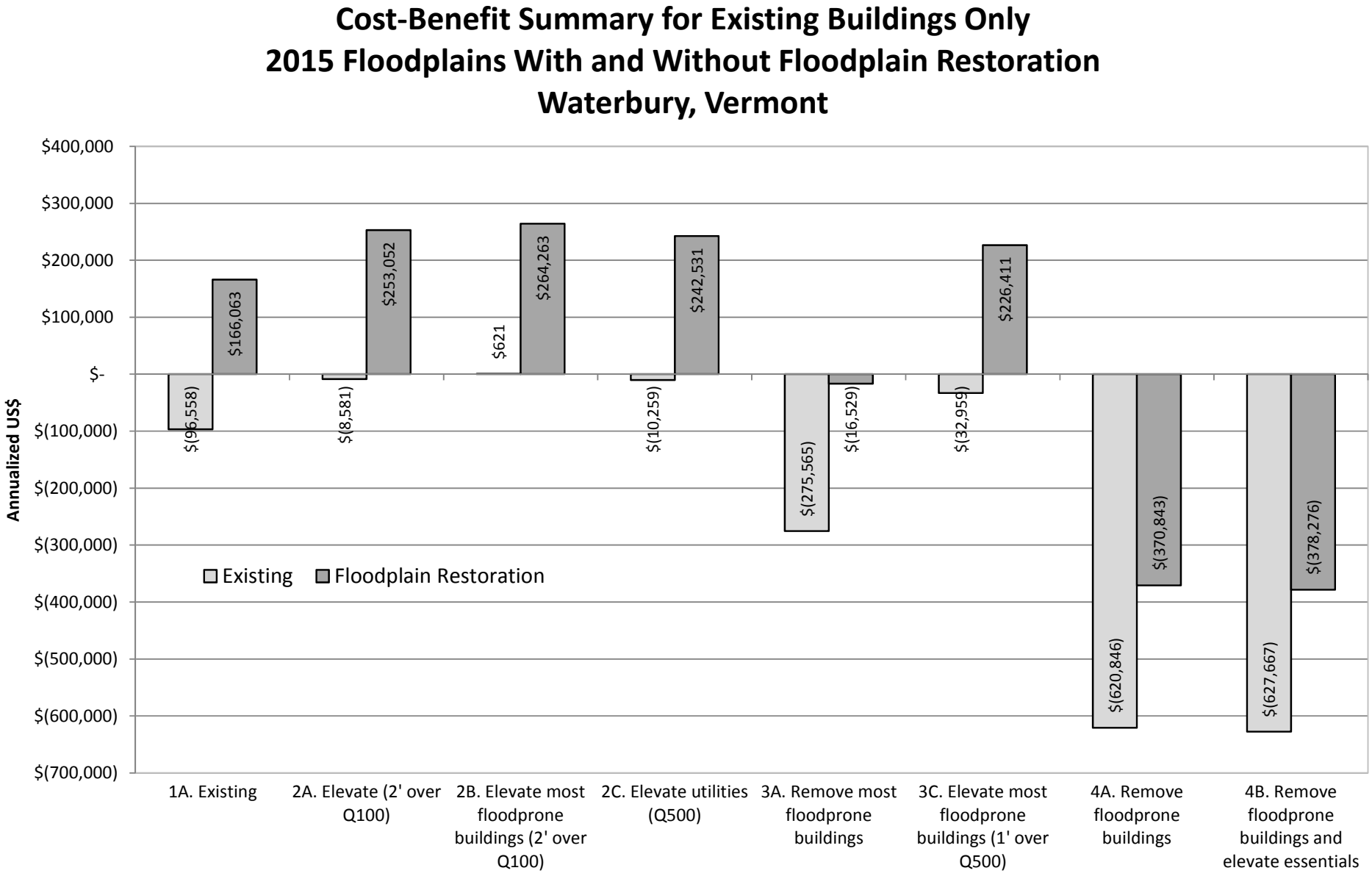
Cost-Benefit Summary 2015 v 2065



Building Damages Existing v FP Restoration



Cost-Benefit Summary Existing v FP Restoration



Floodplain Management Summary and Recommendations

- Waterbury, VT "pays" thousands of dollars in annualized damages to live in the floodplain and may pay larger amounts in the future due to the potential for increasing floods. Simulated damages increase as more buildings are placed in the floodplain.

- Building damages, loss of contents, and loss of inventory decrease as mitigation strategies get more aggressive, such as from elevating to removing select buildings in the most floodprone areas to removing buildings in a larger area across the floodplain.

- Avoidance is the best way to minimize future damages. However, the reduction of damages and increase in ecosystem function value are often outweighed by the projected maximum loss of tax revenue. For building removals to make financial sense, moving existing buildings or building new structures out of the floodplain yet in the Village and Town is needed to maintain tax revenue.

- Elevating utilities across the entire floodplain to the 0.2% annual chance flood level and elevating the most floodprone structures to 1 foot above the 0.2% annual chance flood level lead to the largest benefits.

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Hypotheses / Conclusions

1. The benefits of floodplain protection outweigh the costs over the long term because a complete accounting includes high-value ecosystem services.

2. Floodplain protection reduces future flood damages, improves public safety, and enhances water quality because the most at-risk parcels are not developed.

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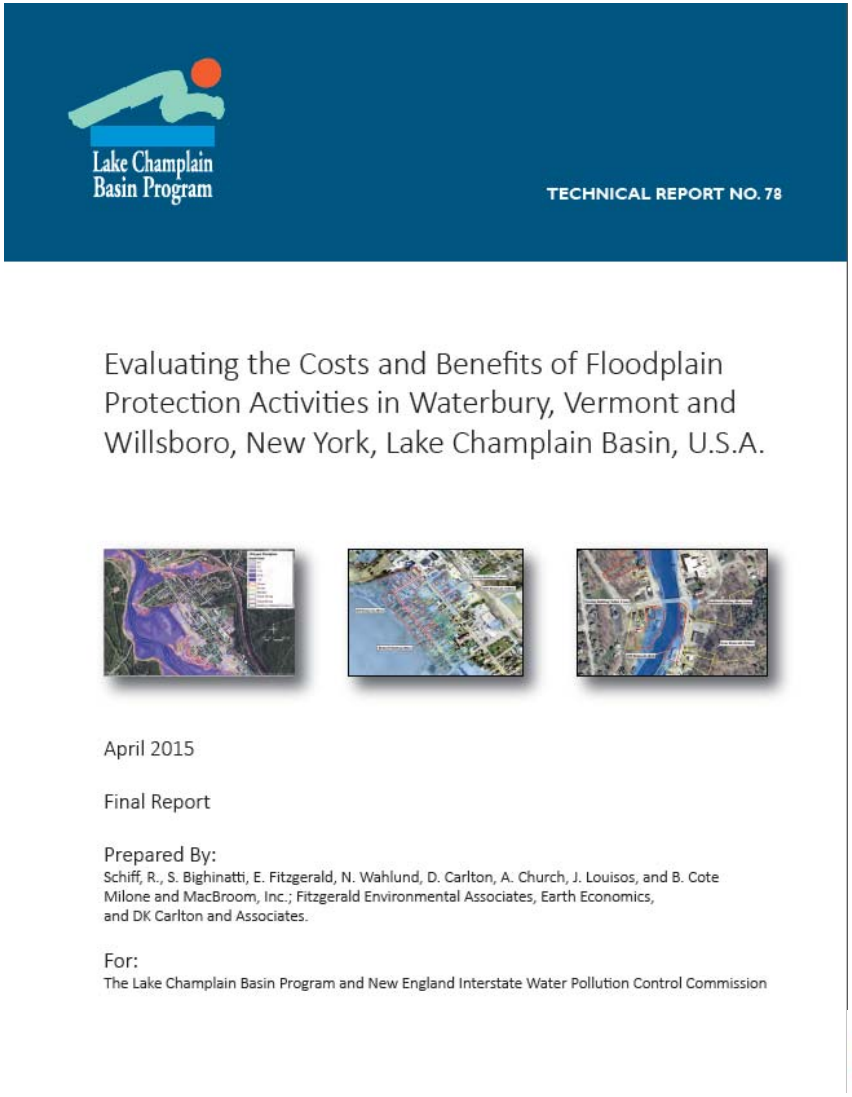
Thank You

http://www.lcbp.org/wp-content/uploads/2013/03/78_CostsBenefitsFloodplains.pdf



Lake Champlain Basin Program

TECHNICAL REPORT NO. 78

Evaluating the Costs and Benefits of Floodplain Protection Activities in Waterbury, Vermont and Willsboro, New York, Lake Champlain Basin, U.S.A.

April 2015

Final Report

Prepared By:
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and DK Carlton and Associates.

For:
The Lake Champlain Basin Program and New England Interstate Water Pollution Control Commission

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