

# A Salt Marsh Advancement Zone Assessment of Greenwich, Connecticut



*Front cover image: Open space and unprotected parcels critical to the conservation of marsh advancement corridors in Greenwich; from the accompanying Comprehensive Map Book of Greenwich, Connecticut.*



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### ACKNOWLEDGEMENTS:

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## Introduction

In 2006, The Nature Conservancy established the Coastal Resilience Program ([www.coastalresilience.org](http://www.coastalresilience.org)) that provides tools and a solution framework to reduce the ecological and socio-economic risk of hazards and comprehensively improve community resilience. The Program focuses on helping decision-makers explore locally relevant, downscaled, flooding scenarios from sea-level rise and/or storm surge, analyze the potential ecological, social and economic impacts of each scenario at a local, regional, and state scale, and facilitate solutions to address these issues. Since 2006, The Nature Conservancy has assisted many coastal and inland communities in Connecticut by providing this critical information and a comprehensive, community-based process that improves overall resilience and sustainability.

There is a universal recognition by coastal and inland communities in Connecticut and elsewhere that natural infrastructure – wetlands and forests - is a cost effective, long-term part of the solution to help protect people, infrastructure and natural systems from extreme weather and climatic change. Fortunately, our state has a remarkable diversity and abundance of natural resources that provide habitat for wildlife and fisheries, enhance the aesthetics and quality of life for residents, and, of course, defend the shoreline and rivers against storm surge, inland flooding, and sea level rise. The presence of natural resources across the state – in particular salt marsh, beaches/dunes, forested headwaters, and river floodplains – is the result of previous recognition and commitment to long-term conservation and the requisite balance with socio-economic growth. In order to maintain these natural resources it will require 1) routine and on-going management activities as well as the restoration of degraded areas, 2) forward-looking planning to accommodate changes in habitat composition and location due to climatic change and 3) enforcement, modification and/or development of new land use policies and growth strategies. Opportunities also exist to account for and integrate the services or co-benefits provided by natural infrastructure via new development, redevelopment, or realignment activities. Economically important services/co-benefits from natural infrastructure include wave attenuation, improved water storage and filtering of pollutants from surface runoff, erosion control, and improved aesthetics and desirable public amenities. Taken in total, the immediate and longer-term management of natural infrastructure by the state, towns, private property owners, non-profit organizations, and others will help to reduce hazard risk and improve resilience across Connecticut.

While longer-term changes in temperature and precipitation patterns will alter the species composition and type of habitats in a given location, the more immediate implication is the upslope advancement of habitats such as salt marsh in response to continued sea level rise. Sea level rise and the impacts of flooding have and will continue to alter the presence and abundance of natural resources in Connecticut. One of the most noticeable changes is occurring at the shoreline's edge where salt marsh is in the process of advancing upslope into areas now considered uplands. In order to clearly identify where this will occur along Greenwich's shoreline, The Nature Conservancy presents the following report to assist with future planning for natural resources in the context of overall risk reduction and resiliency improvement for the community. Ultimately, it is our hope that this report will serve to inform the community about

future marsh advancement locations, current land use of those locations and which parcels are critical to ensure the persistence of natural resources in Greenwich longer term.

The Salt Marsh Advancement Model used in this analysis was co-developed by The Nature Conservancy and the University of Connecticut's Department of Natural Resources Management and Engineering. A full discussion of the Model and underlying methodology is beyond the scope of this report, but a few important details are needed to put the following analysis into context and define how to use the results for planning and implementation.

### **Suitable vs. Unsuitable Advancement**

In the following figures and tables suitable advancement areas are abbreviated as “Yes” and unsuitable areas are abbreviated as “No”. Suitable areas are classified based on the current land cover type - “forest” or “agrigrass” - and as such are expected to convert to salt marsh as hydrologic conditions change due to sea level rise, in the absence of further land use conversion. Land cover types classified as “urban” (i.e. roads, buildings, runways, parking lots, etc...) are considered to be unsuitable for salt marsh advancement at this time. Though much of our analysis is grouped by parcel ID and associated characteristics, these classifications – suitable and unsuitable – exist independent of the parcel boundaries. In other words, a given residential parcel can have both suitable (lawn) and unsuitable (building footprint) advancement areas.

### **Marsh Advancement vs. Wetland Extent**

There is a key distinction in this report between the current wetland extent in a municipality and the marsh advancement areas analyzed herein. Marsh advancement areas include only the future projected wetland extent clipped to current upland land cover. Therefore, no assumption should be made about net gain or loss of current wetland extent based on this advancement area analysis. Another key consideration is that in some cases the identified advancement area will include land that converts to wetlands and subsequently to open-water over time. This further demonstrates that net change in both existing and future wetland extent should not be inferred from our analysis.

### **Planning for the Future**

The advancement and eventual establishment of coastal marshes will occur over the course of several decades and as such our analysis extends out to the 2080s. The rate of change is slow and decadal, yet inevitable. There is an abundance of existing property, infrastructure and natural infrastructure assets clustered along the Connecticut coast and communities will need to formulate growth and realignment plans well in advance of the 2080s scenario presented here. The following data analysis and associated map book (Appendix) can assist with a resilient transition through the presentation of marsh advancement areas and an accounting of the projected changes to coastal property.

## Total Marsh Advancement

The full extent of marsh advancement in Greenwich by the 2080s is projected to be 876.0 acres, with 681.0 acres (77.7%) having suitable (Yes) land cover for wetland advancement. The other 195.0 acres (22.3%) are occupied by built structures and associated infrastructure and are unsuitable for marsh advancement (No), currently.

Total Marsh Advancement by 2080s		
Marsh Adv	Acres	Percent (%)
Yes	681.0	77.7
No	195.0	22.3
Total	876.0	100.0

## Marsh Advancement in Open Space Parcels

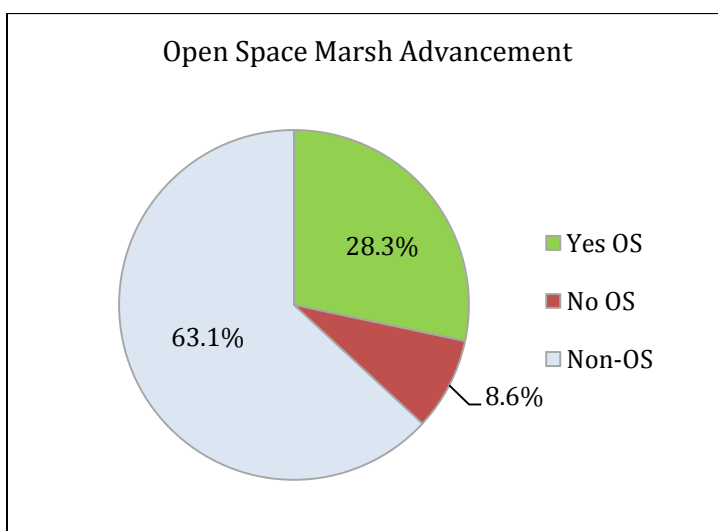
Open space (OS) properties are a critical component of long-term community resilience because they currently have little to no development and are the most likely areas to remain undeveloped through the 2080s. The recognition of the role of these parcels in future wetland extent and improved resilience in Greenwich is vital for strategic land management, economic development, and planning.

### Total Advancement in Open Space Parcels

The following three categories are considered in this section:

- Yes OS: Areas of open space suitable for marsh advancement
- No OS: Areas of open space unsuitable for marsh advancement
- Non-OS: Unprotected areas both suitable and unsuitable for marsh advancement

Greenwich's open space parcels contain 323.1 acres of total marsh advancement area with 248.1 acres (28.3% of total) having a land cover suitable for future wetlands (Yes OS). Further analysis of the 552.9 acres of unprotected parcels (Non-OS) can be found in the following "Marsh Advancement in All Parcels" section.

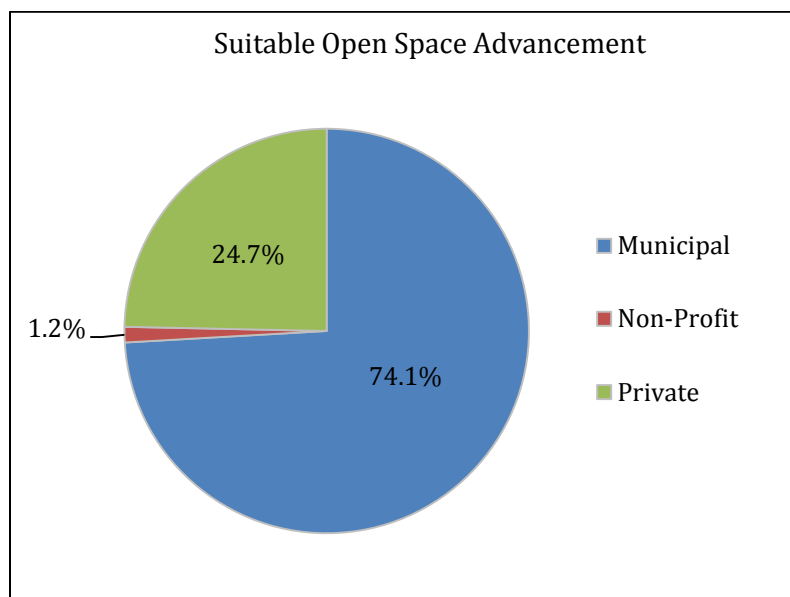


Open Space Marsh Advancement	
OS type	Acres
Yes OS	248.1
No OS	75.0
Non-OS	552.9
Total	876.0

## Suitable Open Space Advancement by Owner

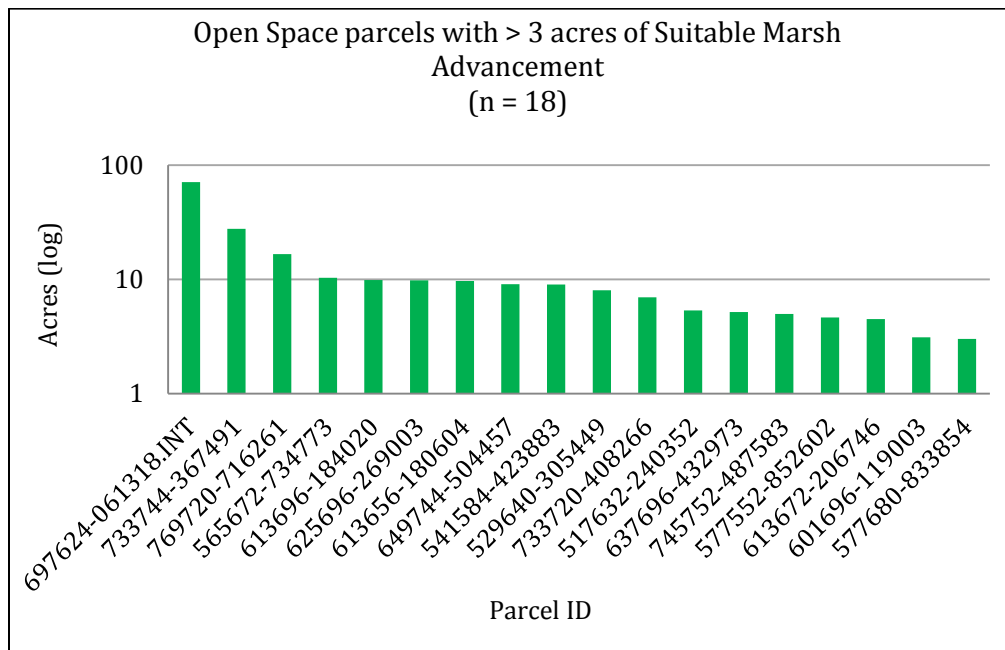
A closer look at Greenwich's protected open space properties reveals that the largest share are municipally-owned, accounting for 183.8 acres (74.1%) of suitable open space. Private owners hold the next largest portion of open space advancement area, providing 61.2 acres (24.7%) of suitable marsh advancement area. A non-profit organization owns the remaining 3.1 acres of suitable marsh advancement area.

Suitable Open Space Advancement			
Owner type	Acres	Total "yes" OS (%)	Total "yes" adv (%)
Municipal	183.8	74.1	27.0
Private	61.2	24.7	9.0
Non-Profit	3.1	1.2	0.5
Total	248.1	100.0	36.4



## Suitable Advancement by Open Space Parcel

Greenwich has 77 open space parcels that intersect the full extent of marsh advancement by the 2080s. There are 18 open space parcels that each provides more than 3 acres of suitable advancement area with a total aggregate of 219.1 acres (88.3% of total). Greenwich Point Park provides the greatest area of marsh advancement zone with 71.0 acres, followed by Binney Park with 27.7 acres, which together represents 39.8% of total suitable open space advancement.



Open Space parcels with > 3 acres Suitable Marsh Advancement				
Parcel ID	Acres	Total "yes" OS (%)	Owner	Map Book Page #
697624-061318.INT	71.0	28.6	Municipal	7
733744-367491	27.7	11.2	Municipal	7
769720-716261	16.7	6.7	Private	7
565672-734773	10.4	4.2	Municipal	6
613696-184020	9.9	4.0	Municipal	6
625696-269003	9.8	3.9	Municipal	6
613656-180604	9.7	3.9	Private	6
649744-504457	9.1	3.7	Municipal	6
541584-423883	9.0	3.6	Private	6
529640-305449	8.0	3.2	Municipal	6
733720-408266	7.0	2.8	Municipal	7
517632-240352	5.4	2.2	Municipal	6
637696-432973	5.2	2.1	Private	6
745752-487583	5.0	2.0	Municipal	7
577552-852602	4.6	1.9	Municipal	6
613672-206746	4.5	1.8	Private	6
601696-119003	3.1	1.3	Municipal	6
577680-833854	3.0	1.2	Municipal	6
Total	219.1	88.3		

## Marsh Advancement in All Parcels

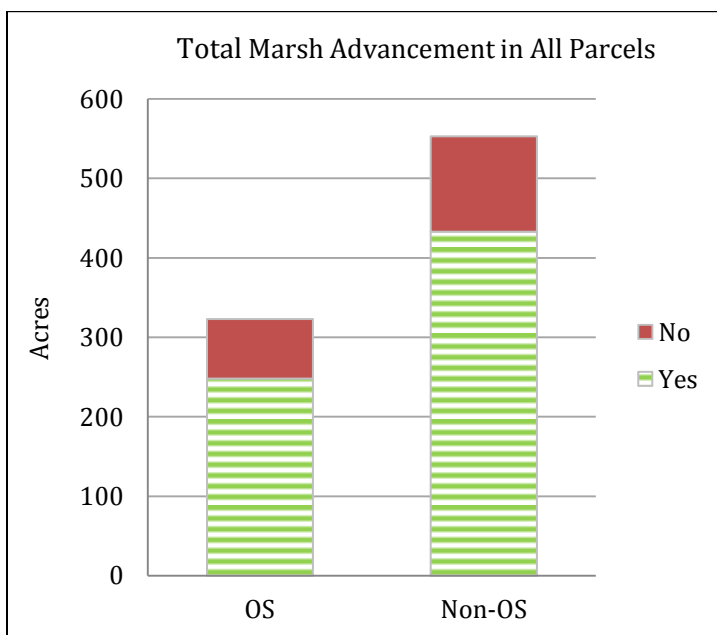
This section incorporates all parcels into the analysis of suitable marsh advancement. These results help put the open space analysis into perspective, as well as identify important unprotected parcels in Greenwich's marsh advancement landscape.

### Total Advancement in All Parcels (OS vs. Non-OS)

Greenwich's existing open space parcels are made up of municipal parks and athletic fields, private recreation areas, private and municipal open space areas, residential properties greater than 10 acres, land trust properties, properties under conservation easement, Public Act 490 properties, schools, water company land, church properties, cemeteries, and golf courses. This section provides an analysis of suitable areas for marsh advancement on these open space parcels versus all other parcels. These two types of parcels are designated as:

- 'OS' for open space parcels
- 'Non-OS' for all other parcels

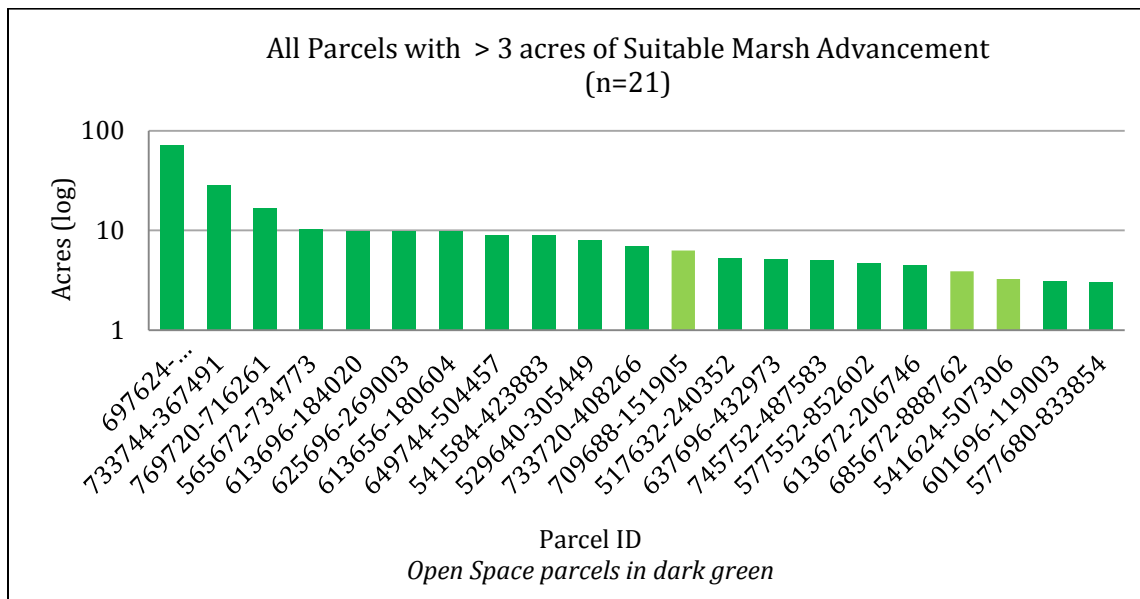
Open space parcels contain 248.1 acres of suitable marsh advancement (36.4% of total). The remaining 432.9 acres of land suitable for marsh advancement (63.6% of total) are unprotected and generally occur on residential, commercial, or industrial properties. The unprotected suitable areas will receive nearly two-fold the marsh advancement by 2080s. This information has two important implications for future planning: 1) today's unprotected properties will play a vital role in maintaining Greenwich's wetland resources in the future, and 2) a large amount of current development (120.1 acres) will be in direct conflict with rising sea levels and advancing marshes.



Total Marsh Advancement			
Parcel type	Yes	No	Total
OS	248.1	75.0	323.1
Non-OS	432.9	120.1	552.9
Total	681.0	195.0	876.0

## Suitable Advancement by All Parcels

There are 1,462 parcels in Greenwich that provide areas of suitable marsh advancement, but only 21 parcels offer suitable areas greater than 3 acres. This small subset provides 232.8 acres of marsh advancement; 34.2% of Greenwich's overall total. The specific parcels can be viewed via the corresponding Map Book pages (Appendix) indicated in the table below.



All Parcels with > 3 acres of Suitable Marsh Advancement			
Parcel ID	Acres	Total yes adv (%)	Map Book Page #
697624-061318.INT	71.0	10.4	7
733744-367491	28.1	4.1	7
769720-716261	16.6	2.4	7
565672-734773	10.4	1.5	6
613696-184020	9.9	1.4	6
625696-269003	9.8	1.4	6
613656-180604	9.8	1.4	6
649744-504457	9.1	1.3	6
541584-423883	9.0	1.3	6
529640-305449	8.0	1.2	6
733720-408266	7.0	1.0	7
709688-151905	6.3	0.9	5,7,14,26
517632-240352	5.3	0.8	6
637696-432973	5.2	0.8	6
745752-487583	5.0	0.7	7
577552-852602	4.6	0.7	6
613672-206746	4.4	0.7	6
685672-888762	3.9	0.6	5,7,14,26
541624-507306	3.3	0.5	4,6,16,28
601696-119003	3.1	0.5	6
577680-833854	3.0	0.4	6
<b>Total</b>	<b>232.8</b>	<b>34.2</b>	

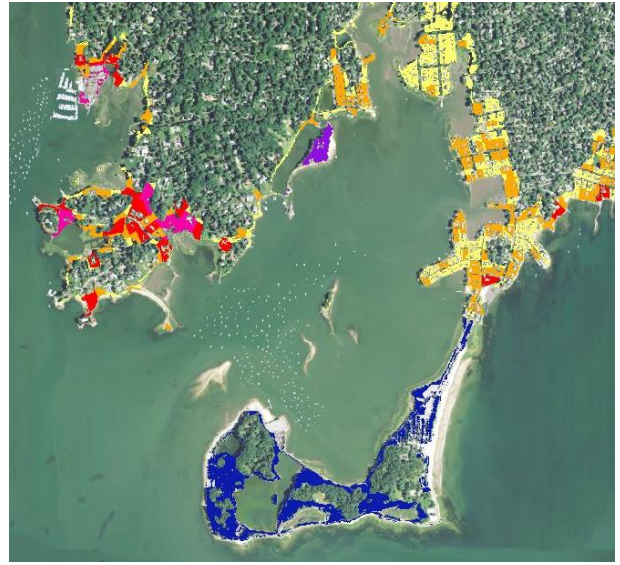


## **Appendix – Map Book**

Please consult your Salt Marsh Advancement Resource Disc for the complete dataset of suitable and unsuitable advancement per parcel.



# Comprehensive Map Book of Greenwich, Connecticut



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# Marsh Advancement by the 2080s

Town of Greenwich, CT

## Marsh Advancement - West

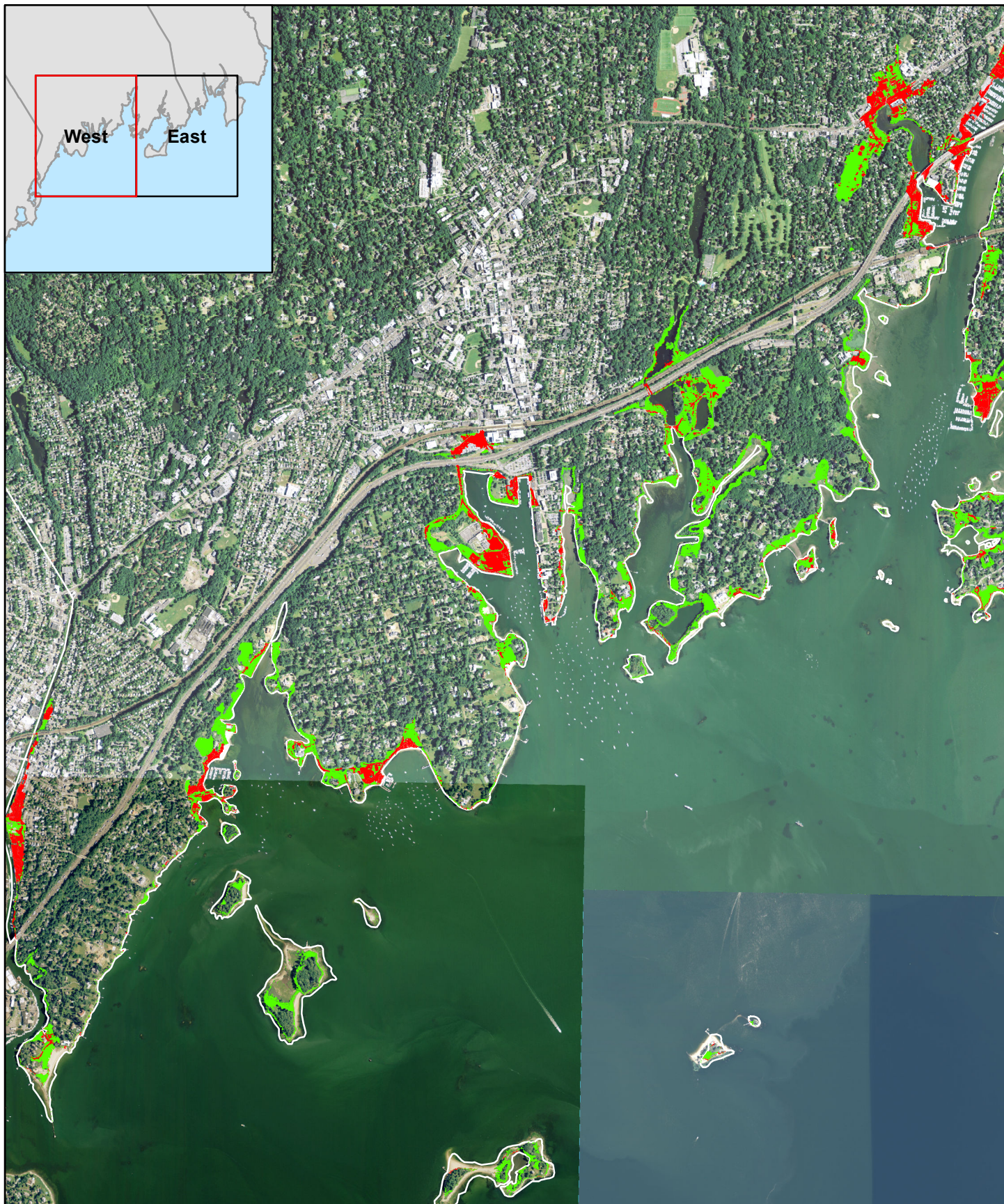
0 0.5 1  
Mile



### Marsh Advancement by 2080s

Developed Land Cover

Forest, Grass, Ag Land Cover





# Marsh Advancement by the 2080s

Town of Greenwich, CT

## Marsh Advancement - East

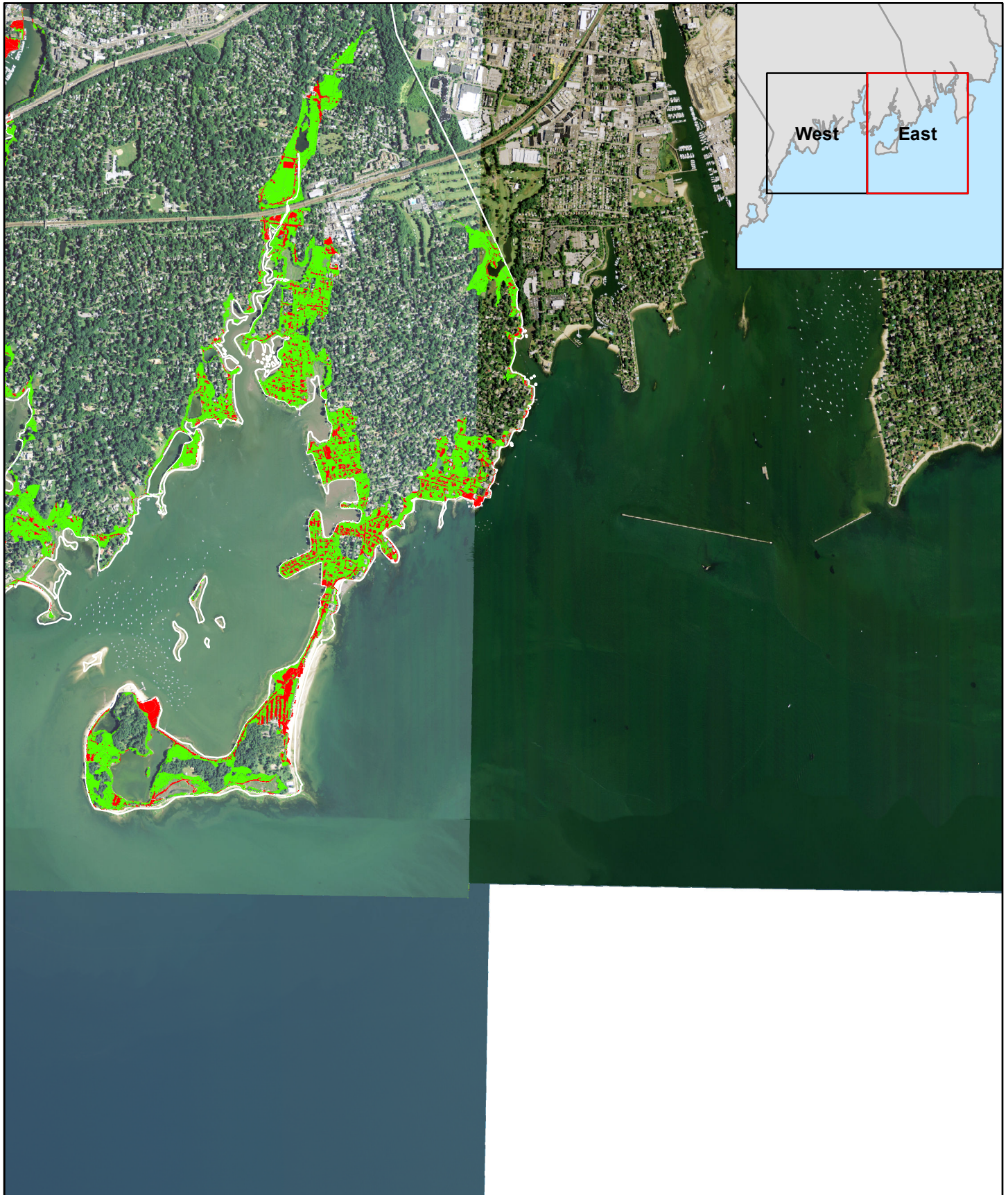
0 0.5 1 Mile



### Marsh Advancement by 2080s

Developed Land Cover

Forest, Grass, Ag Land Cover

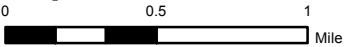




# Marsh Advancement by the 2080s

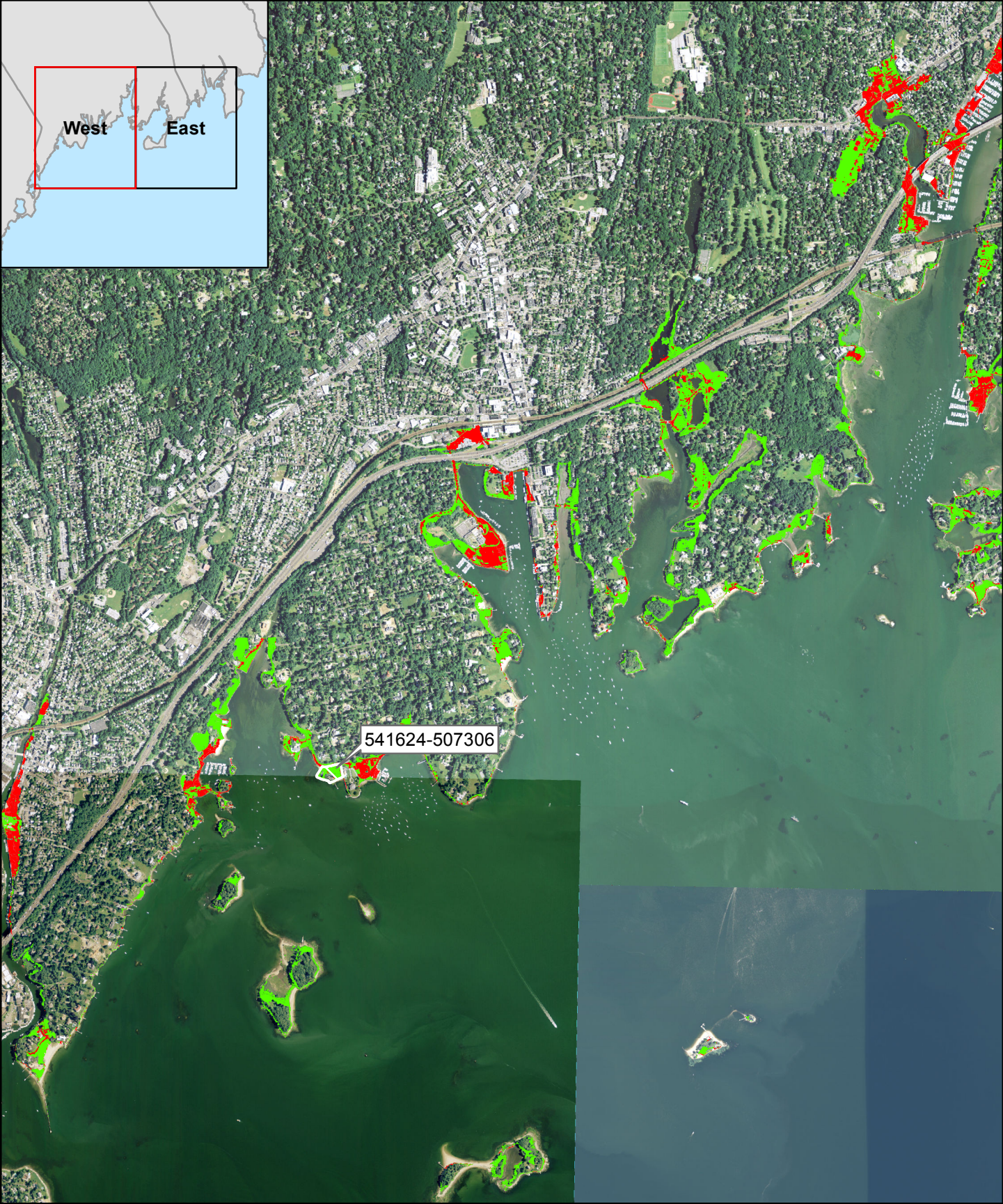
## Town of Greenwich, CT

### Unprotected Parcels - West



Parcels		Marsh Advancement by 2080s	
	Unprotected Non-OS		Developed Land Cover
			Forest, Grass, Ag Land Cover

Note: Only Non-OS parcels with > 3 acres of suitable advancement are shown.

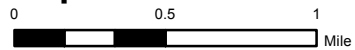




# Marsh Advancement by the 2080s

Town of Greenwich, CT

## Unprotected Parcels - East



### Parcels

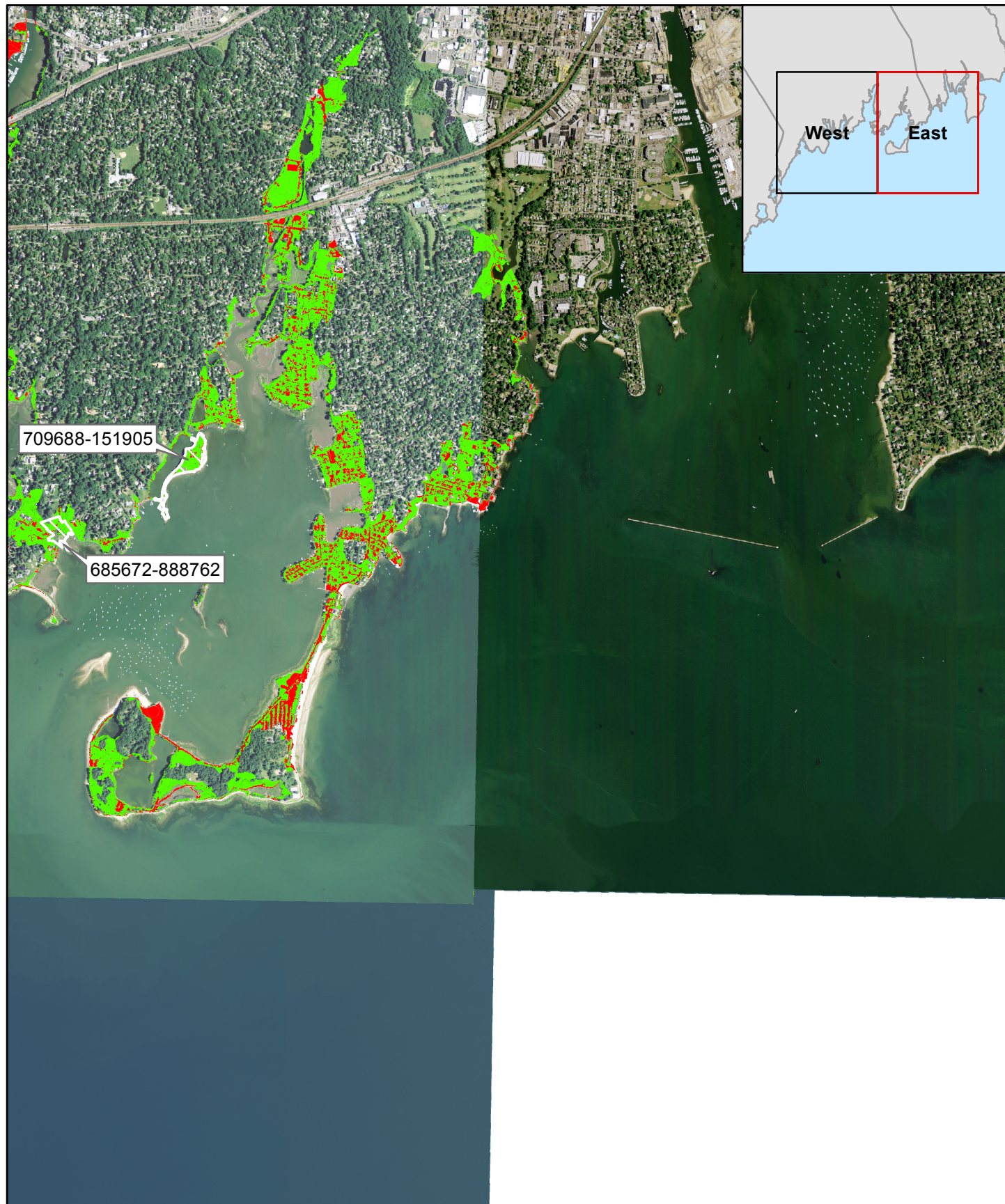
Unprotected Non-OS

### Marsh Advancement by 2080s

Developed Land Cover

Forest, Grass, Ag Land Cover

Note: Only Non-OS parcels with > 3 acres of suitable advancement are shown.

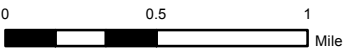




# Marsh Advancement by the 2080s

Town of Greenwich, CT

## Critical Parcels - West

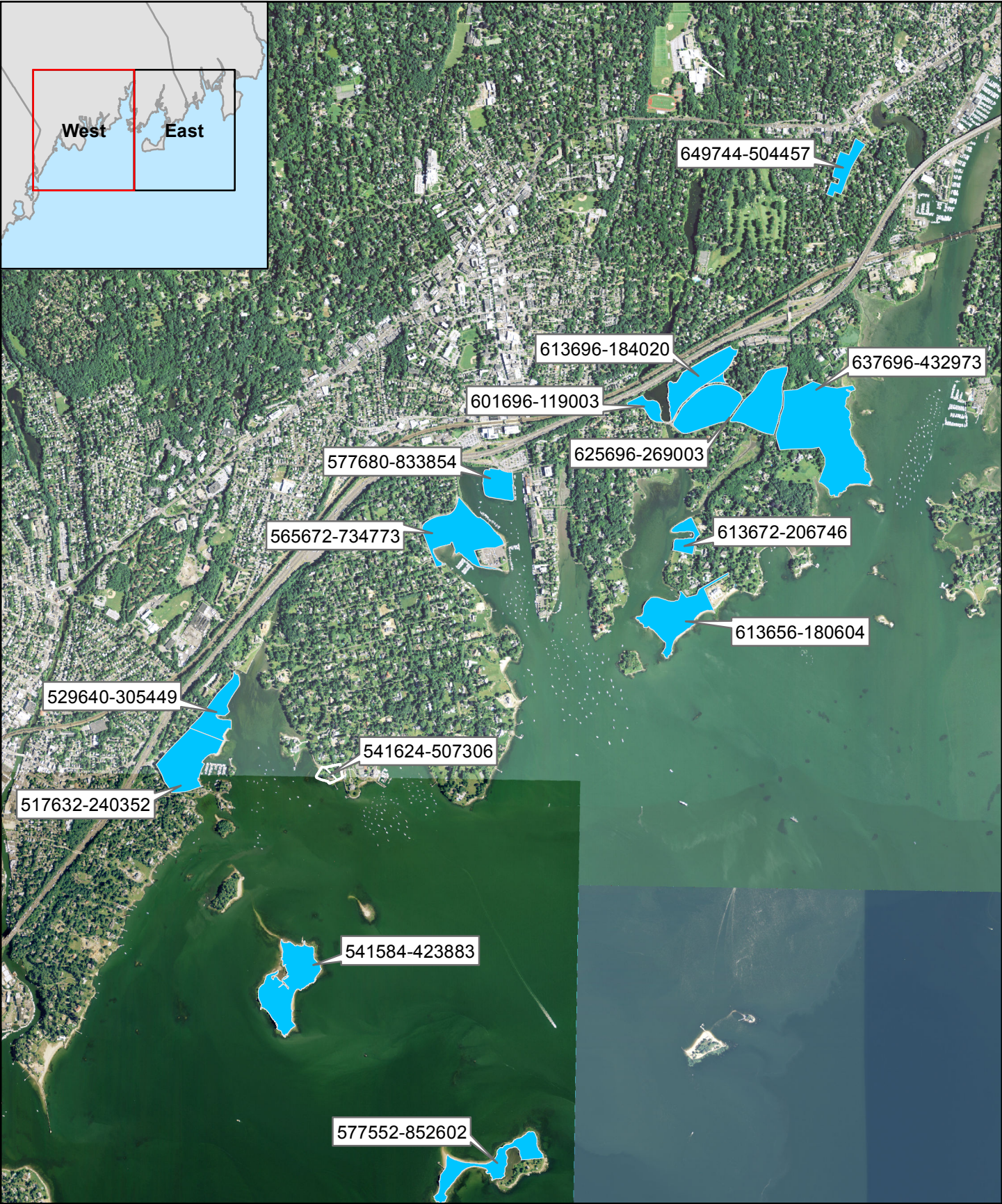


*Note: Only Non-OS parcels and OS parcels with > 3 acres of suitable advancement are shown.*

Parcels

Unprotected Non-OS

Protected OS

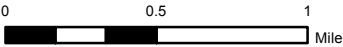




# Marsh Advancement by the 2080s


Town of Greenwich, CT


## Critical Parcels - East

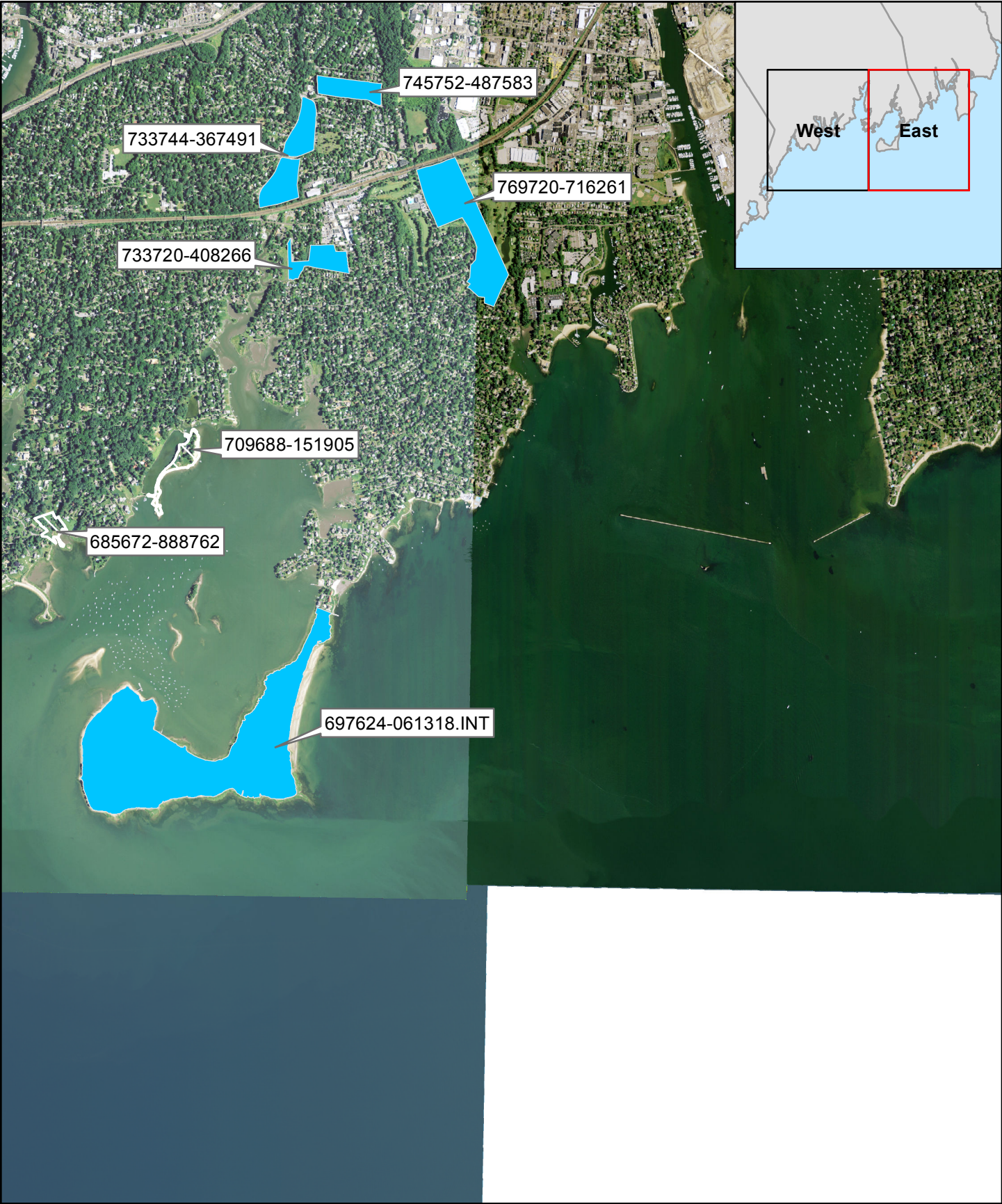


*Note: Only Non-OS parcels and OS parcels with > 3 acres of suitable advancement are shown.*

Parcels

 Unprotected Non-OS

 Protected OS



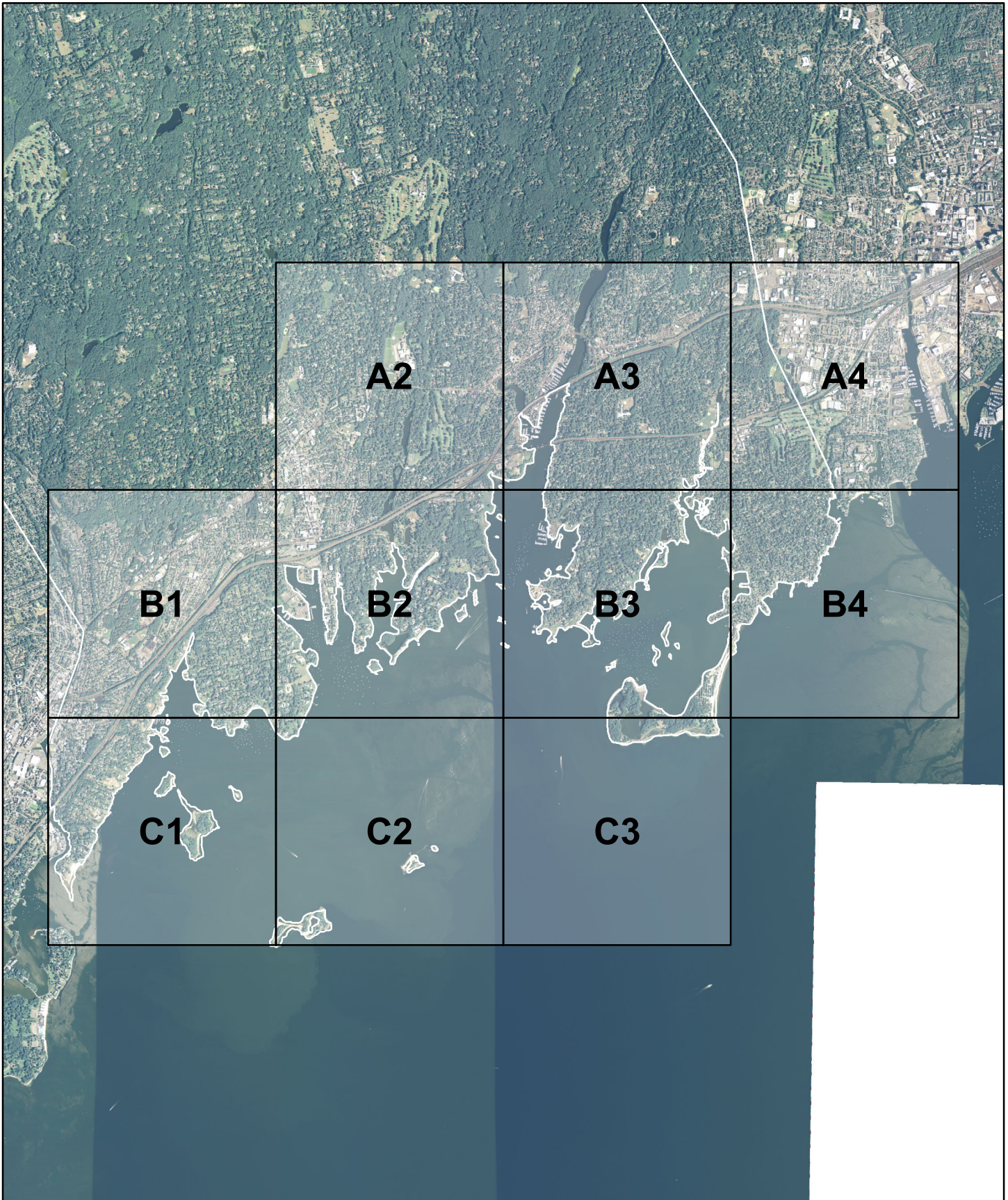
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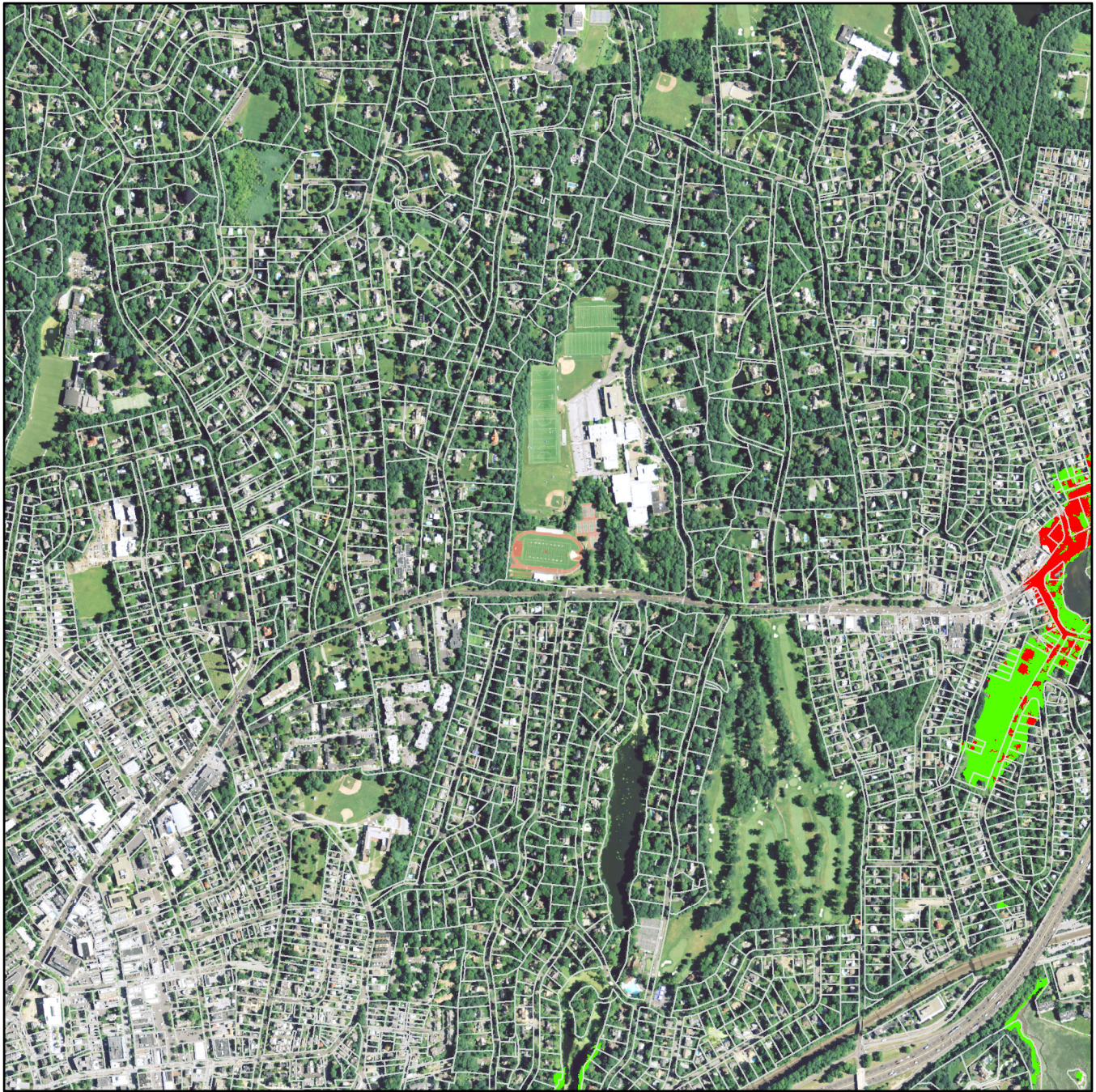
# Marsh Advancement by the 2080s

Town of Greenwich, CT

## Map Index - Unprotected Parcels







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0 500 1,000 2,000 3,000 Feet

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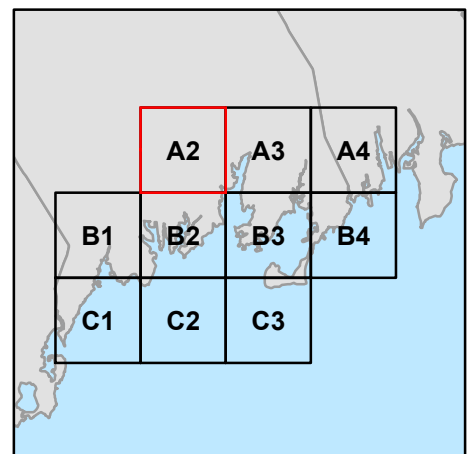
## Marsh Advancement by the 2080s

Town of Greenwich, CT

Unprotected Parcels - Map A2



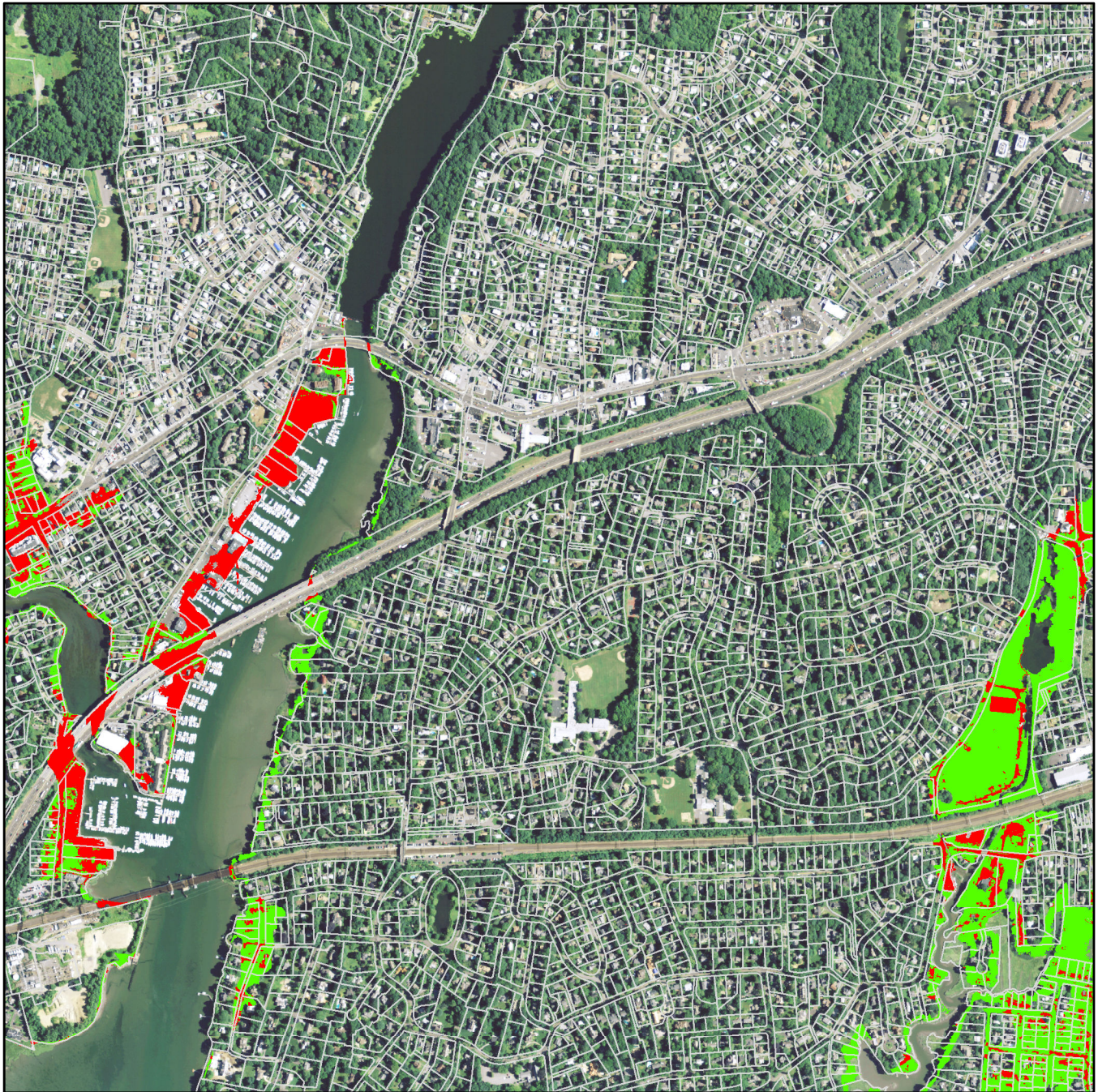
*Note: Only Non-OS parcels with > 3 acres of suitable marsh advancement are shown.*





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0 500 1,000 2,000 3,000 Feet

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## Marsh Advancement by the 2080s

Town of Greenwich, CT

Unprotected Parcels - Map A3

### Parcels

Unprotected Non-OS

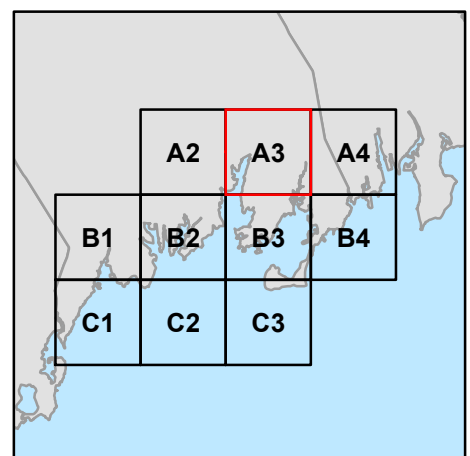
### Marsh Advancement

Developed Land Cover

Forest, Grass, Ag Land Cover

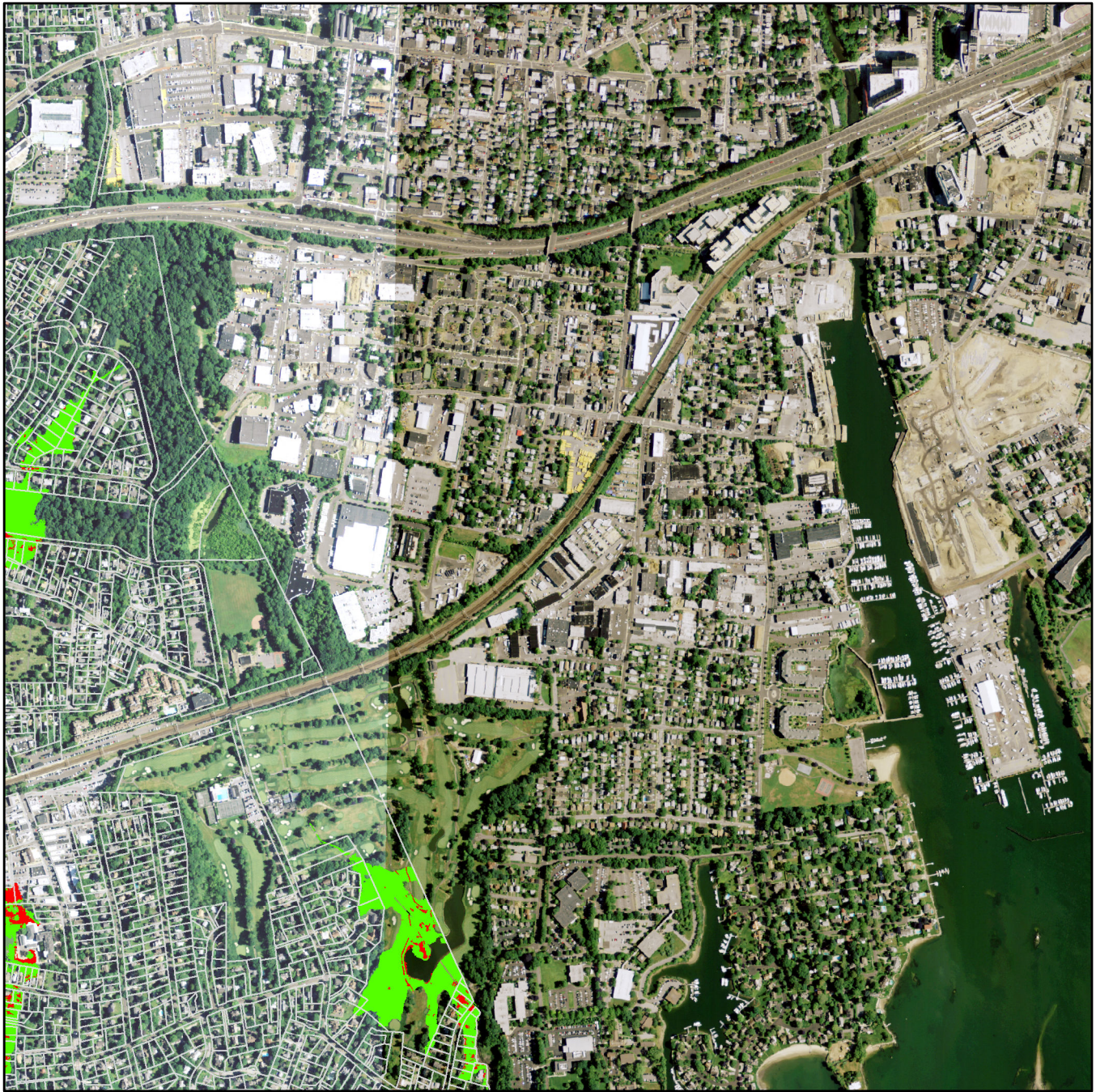


Note: Only Non-OS parcels with > 3 acres of suitable marsh advancement are shown.





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## Marsh Advancement by the 2080s

Town of Greenwich, CT

Unprotected Parcels - Map A4

### Parcels

Unprotected Non-OS

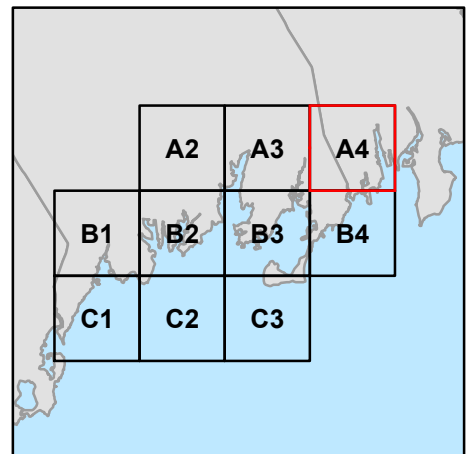
### Marsh Advancement

Developed Land Cover

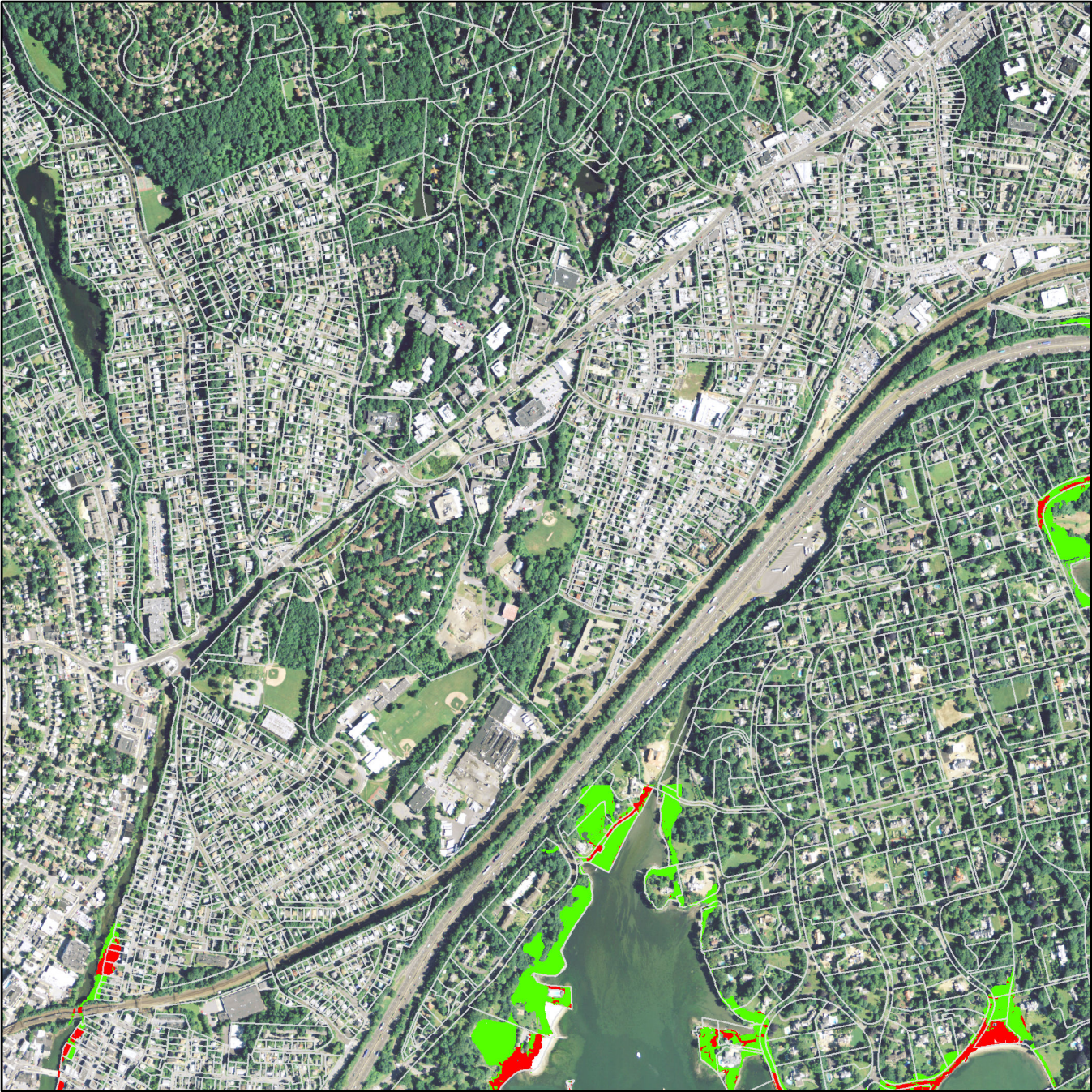
Forest, Grass, Ag Land Cover



Note: Only Non-OS parcels with > 3 acres of suitable marsh advancement are shown.







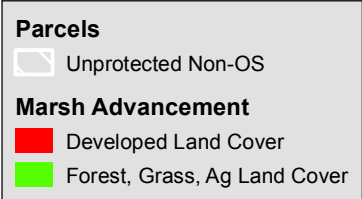
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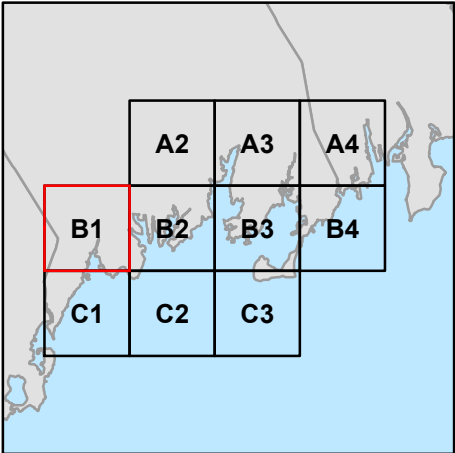
# Marsh Advancement by the 2080s

Town of Greenwich, CT

Unprotected Parcels - Map B1



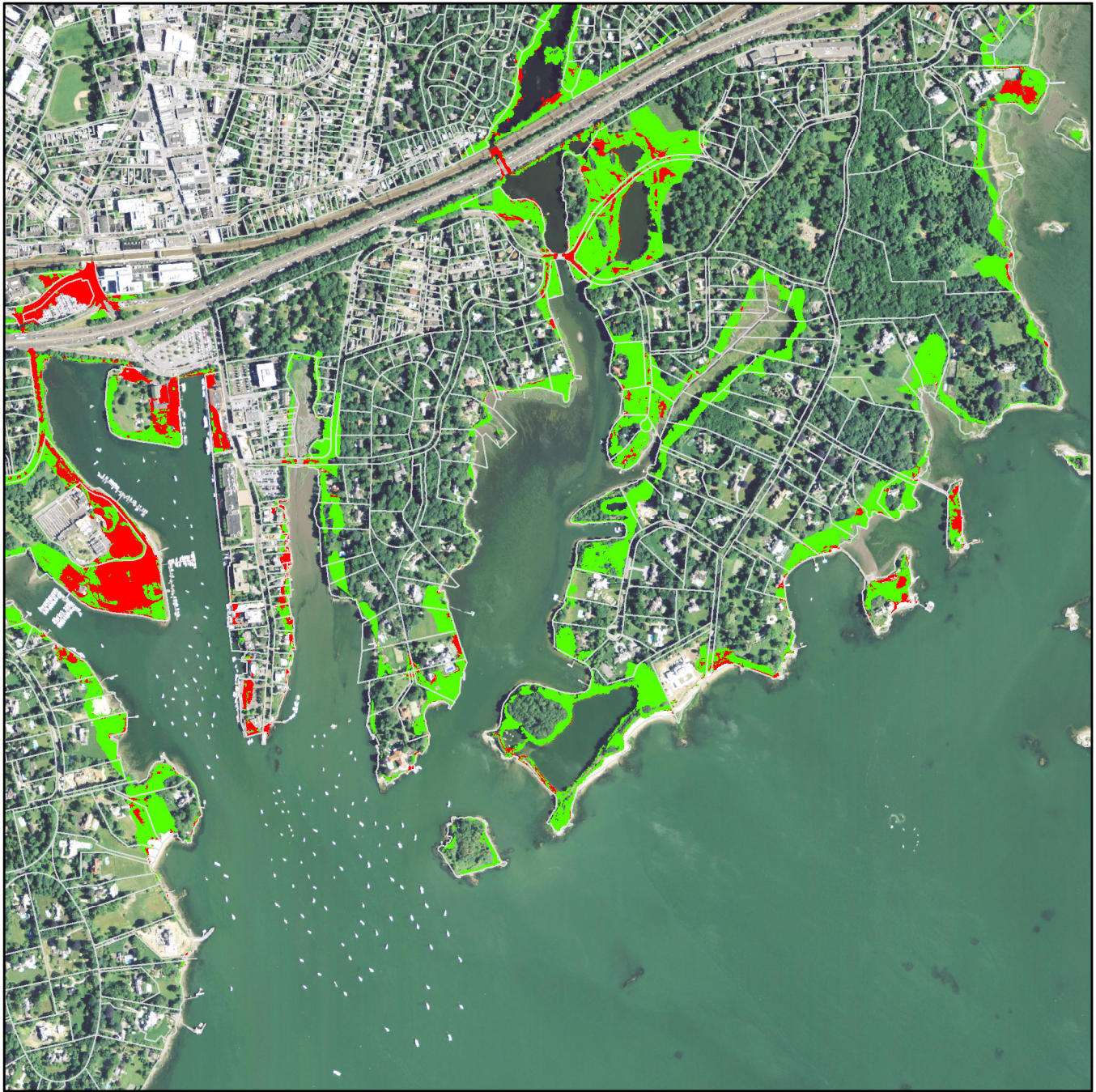
Note: Only Non-OS parcels with > 3 acres of suitable marsh advancement are shown.





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0 500 1,000 2,000 3,000 Feet

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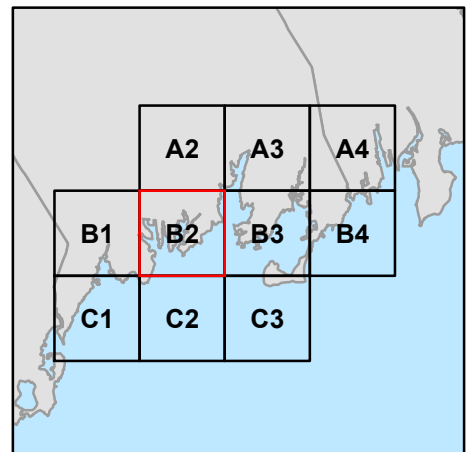
## Marsh Advancement by the 2080s

Town of Greenwich, CT

Unprotected Parcels - Map B2



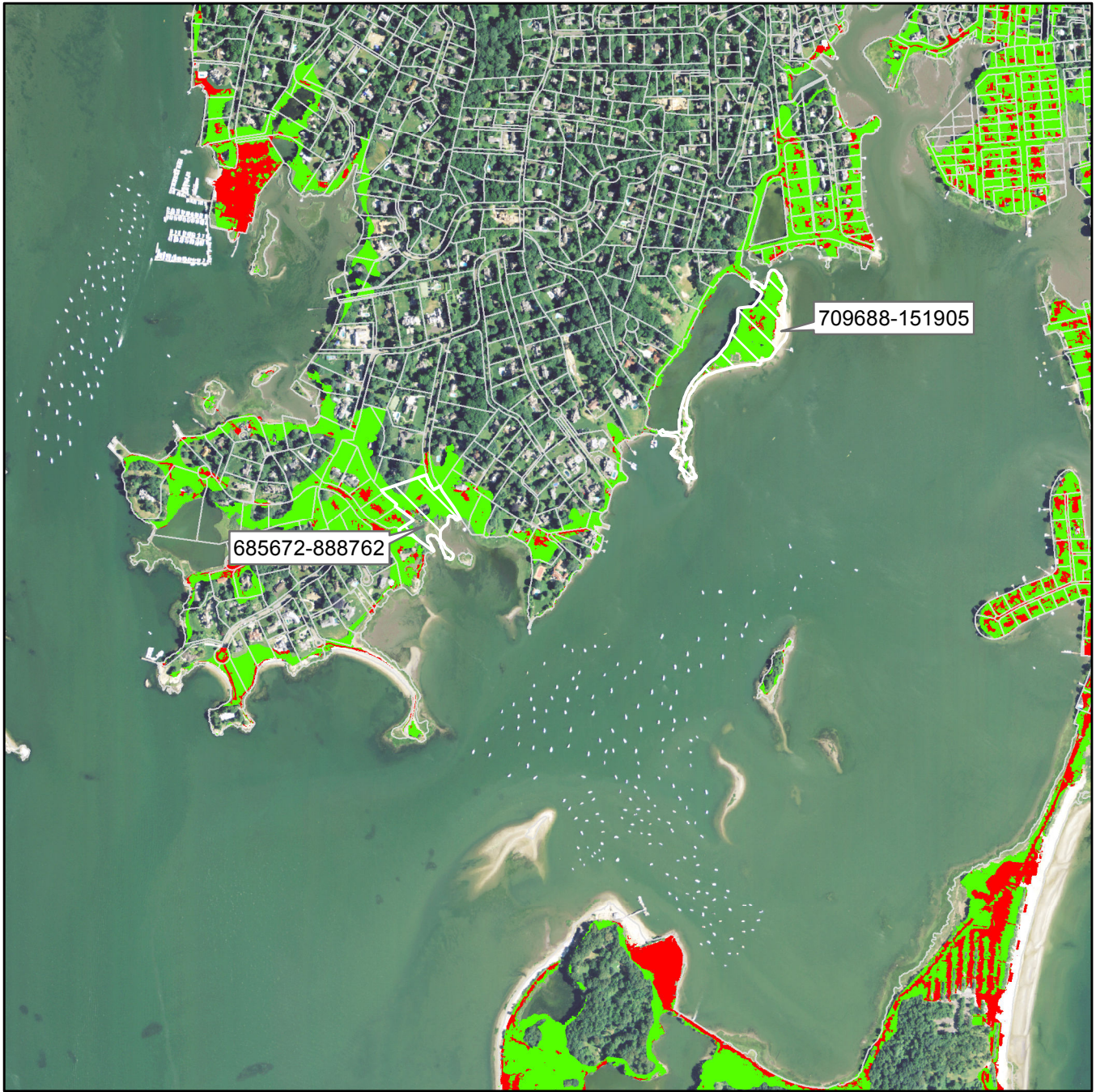
*Note: Only Non-OS parcels with > 3 acres of suitable marsh advancement are shown.*





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0 500 1,000 2,000 3,000 Feet

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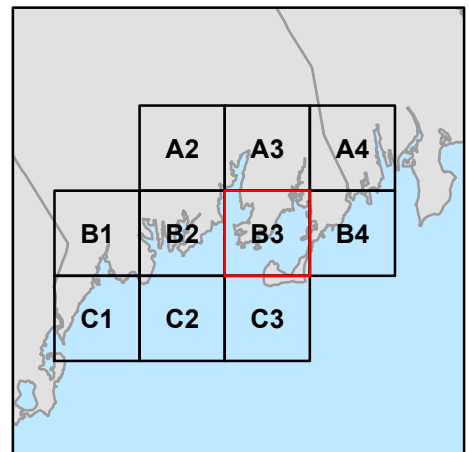
## Marsh Advancement by the 2080s

Town of Greenwich, CT

Unprotected Parcels - Map B3

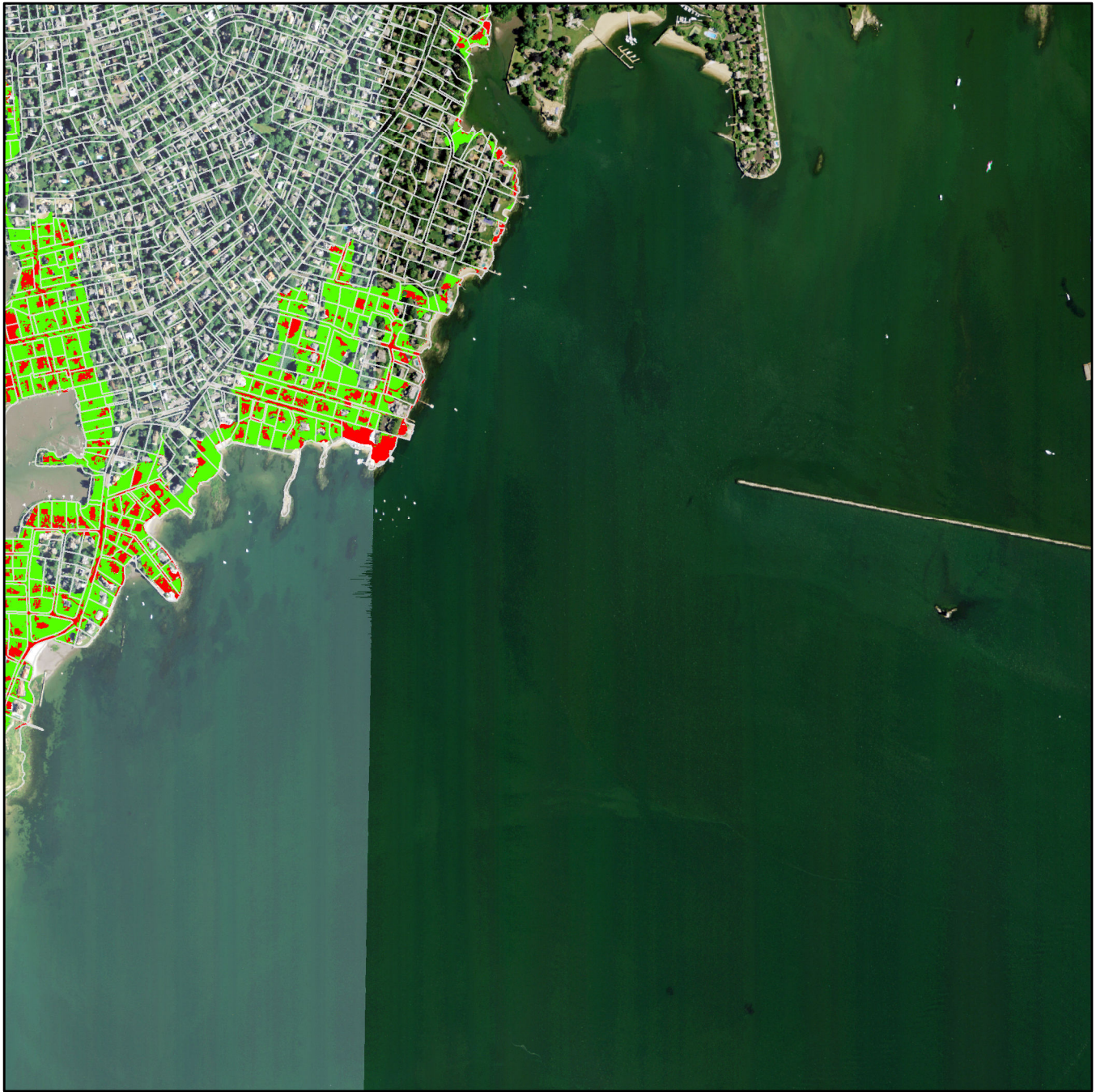


Note: Only Non-OS parcels with > 3 acres of suitable marsh advancement are shown.





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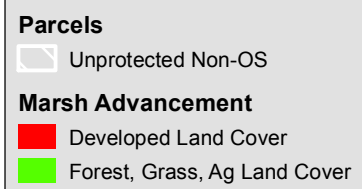


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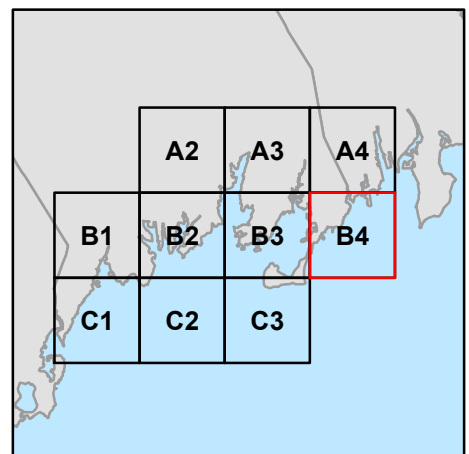
## Marsh Advancement by the 2080s

Town of Greenwich, CT

Unprotected Parcels - Map B4



*Note: Only Non-OS parcels with > 3 acres of suitable marsh advancement are shown.*







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0 500 1,000 2,000 3,000 Feet

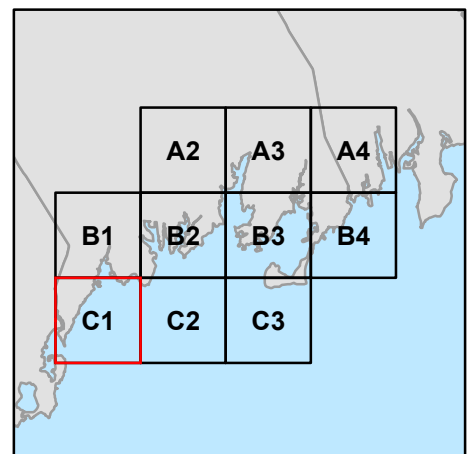
## Marsh Advancement by the 2080s

Town of Greenwich, CT

Unprotected Parcels - Map C1



Note: Only Non-OS parcels with > 3 acres of suitable marsh advancement are shown.



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0 500 1,000 2,000 3,000 Feet

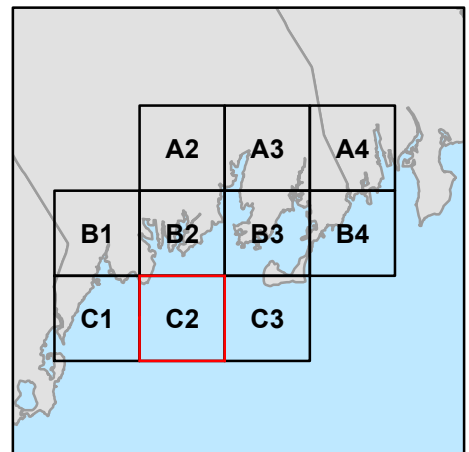
## Marsh Advancement by the 2080s

Town of Greenwich, CT

Unprotected Parcels - Map C2

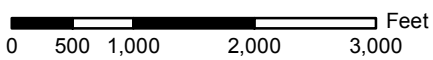
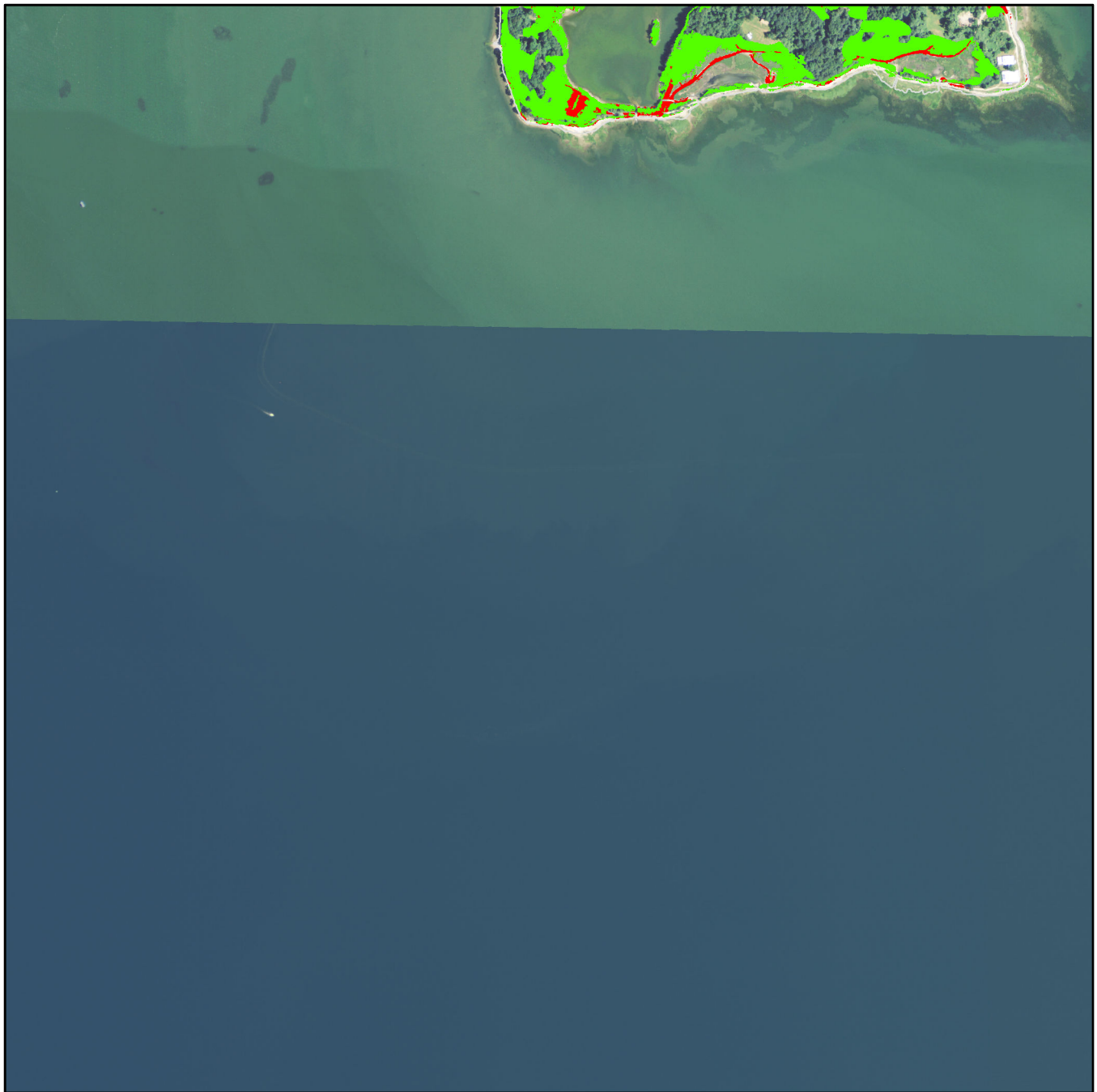


Note: Only Non-OS parcels with > 3 acres of suitable marsh advancement are shown.





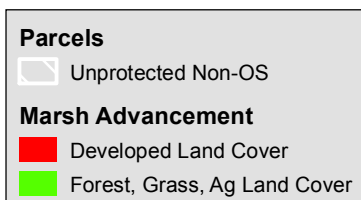
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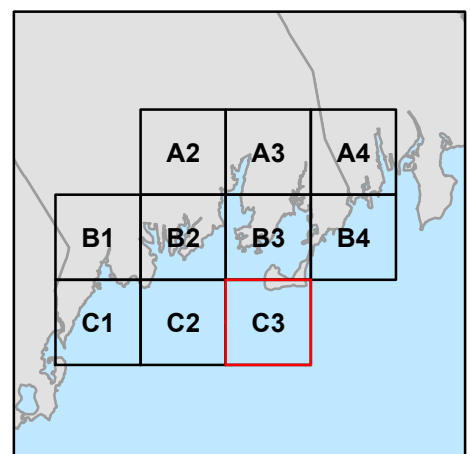
## Marsh Advancement by the 2080s

Town of Greenwich, CT

Unprotected Parcels - Map C3



*Note: Only Non-OS parcels with > 3 acres of suitable marsh advancement are shown.*



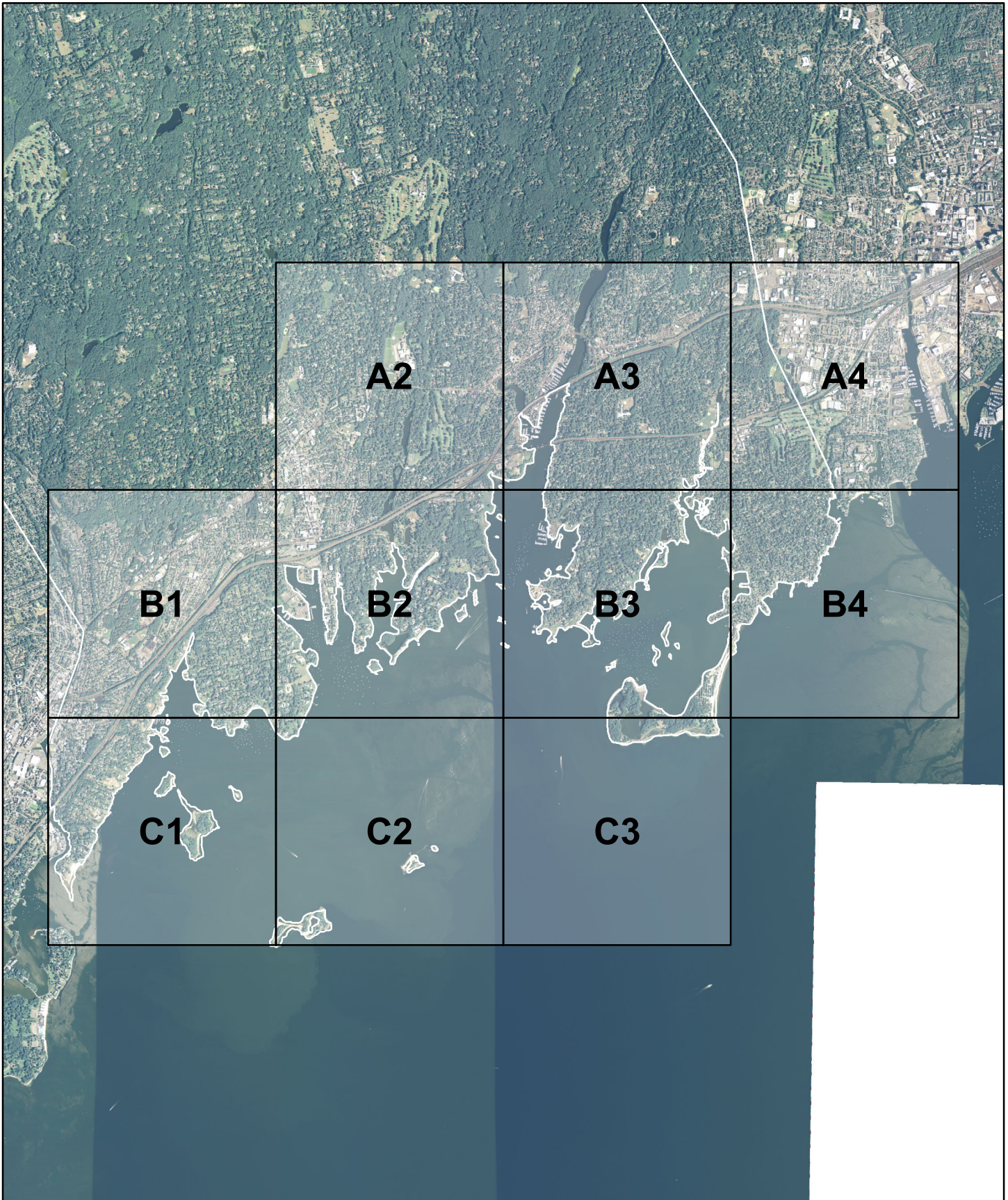
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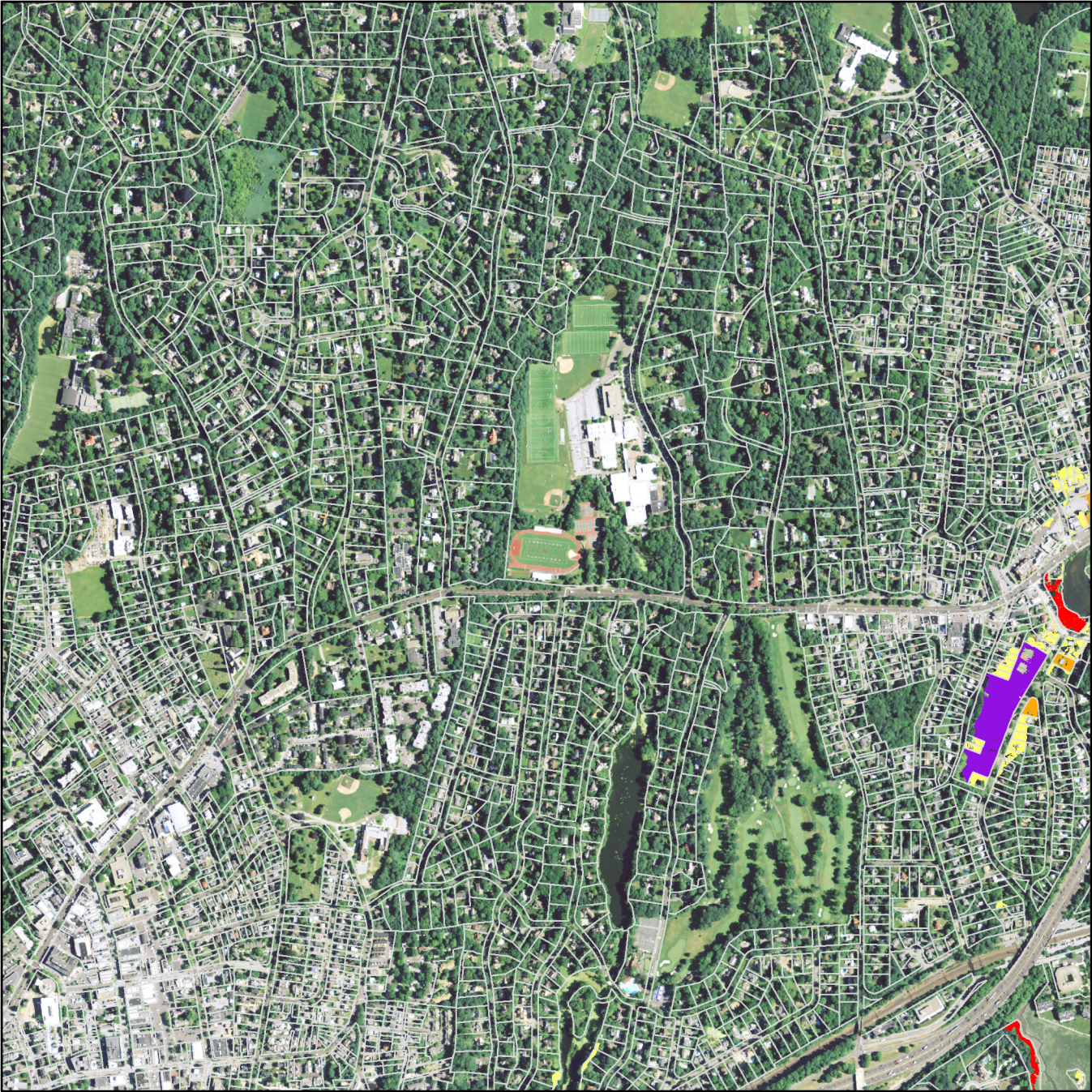
# Marsh Advancement by the 2080s

Town of Greenwich, CT

## Map Index - Advancement per Parcel







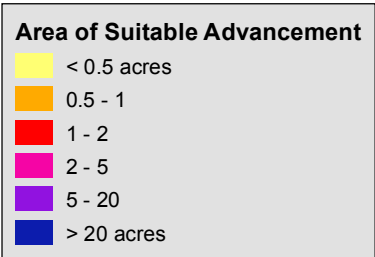
0 500 1,000 2,000 3,000 Feet

see page 25

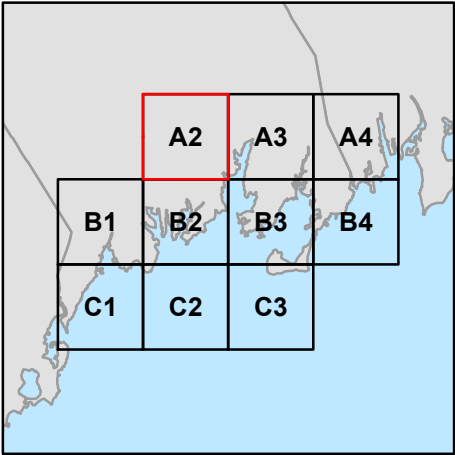
# Marsh Advancement by the 2080s

Town of Greenwich, CT

## Advancement per Parcel - Map A2



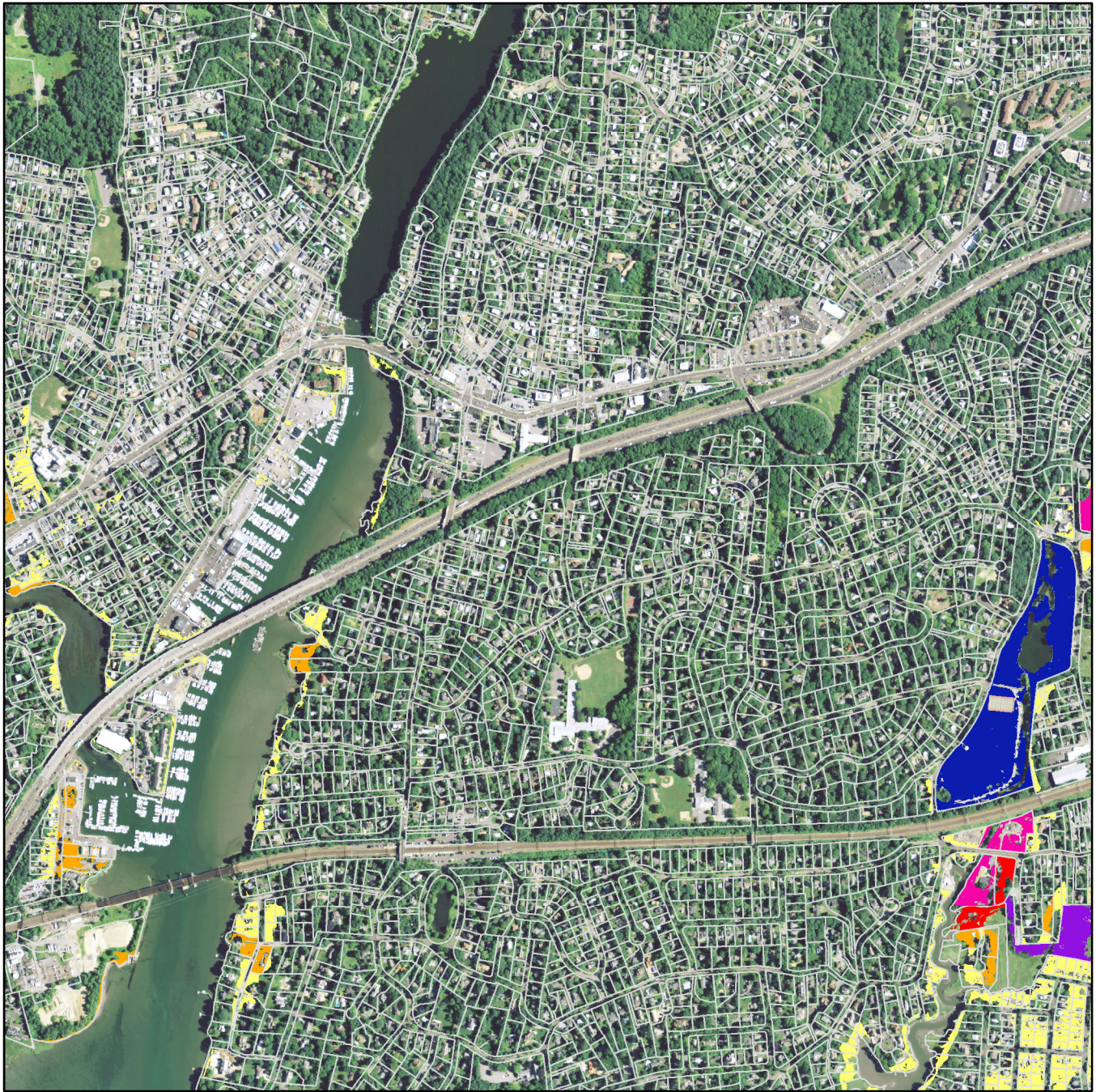
*Note: Only Non-OS parcels with > 3 acres of suitable marsh advancement are shown.*





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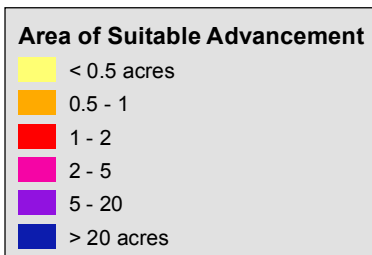
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see page 26

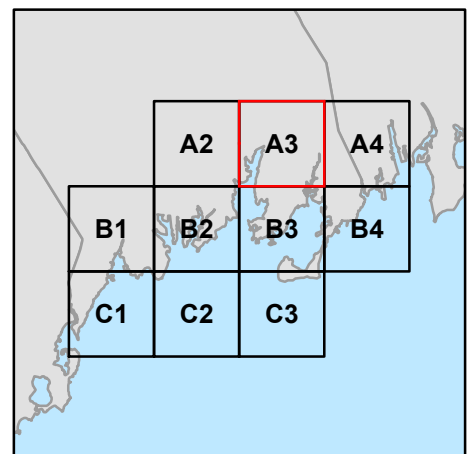
## Marsh Advancement by the 2080s

Town of Greenwich, CT

### Advancement per Parcel - Map A3

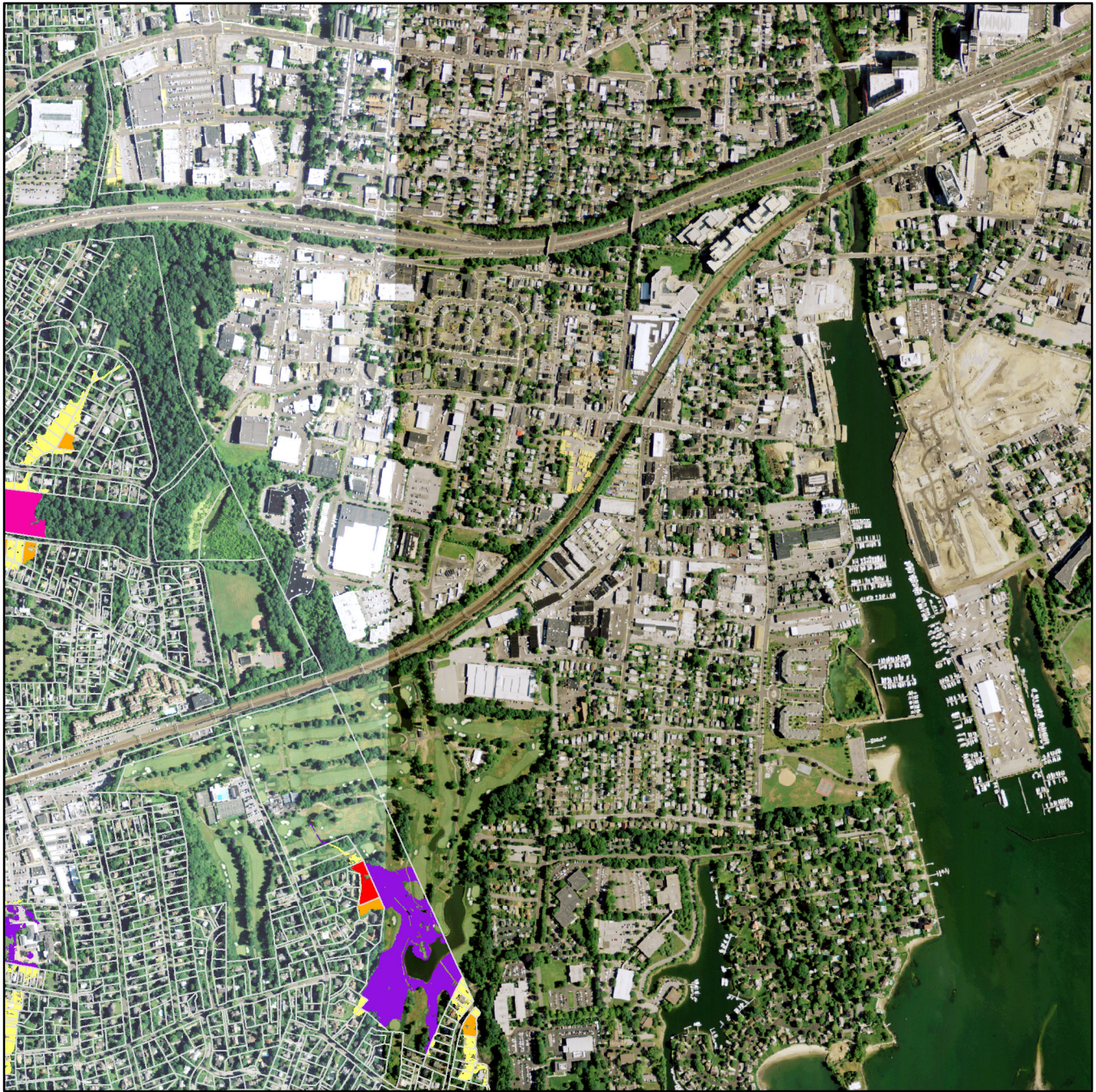


*Note: Only Non-OS parcels with > 3 acres of suitable marsh advancement are shown.*





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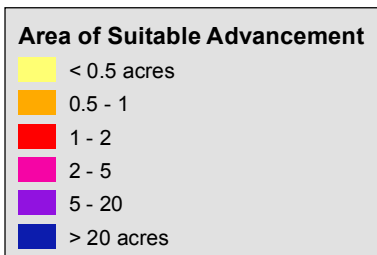
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see page 27

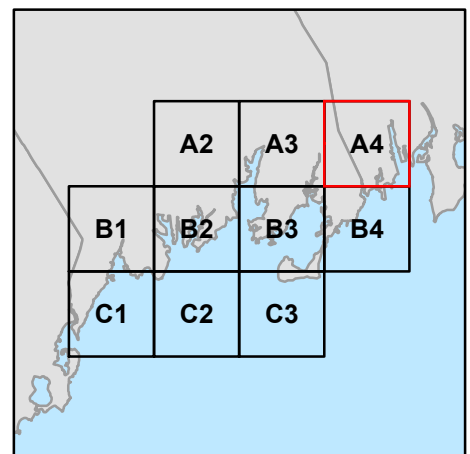
## Marsh Advancement by the 2080s

Town of Greenwich, CT

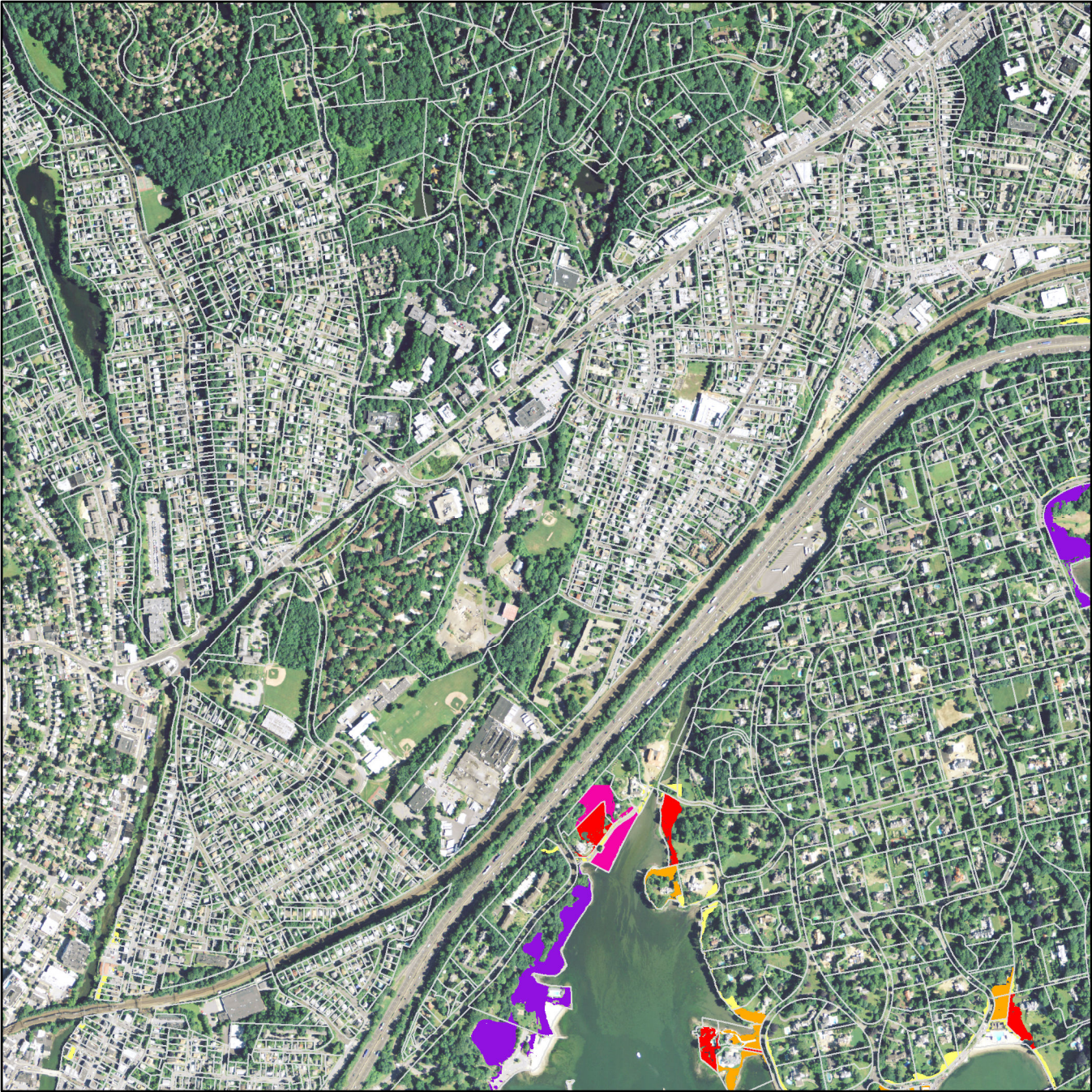
### Advancement per Parcel - Map A4



*Note: Only Non-OS parcels with > 3 acres of suitable marsh advancement are shown.*







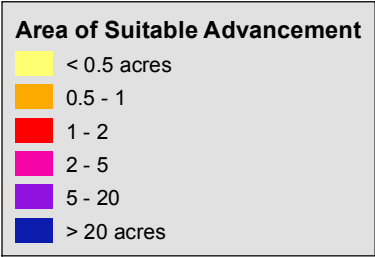
0 500 1,000 2,000 3,000 Feet

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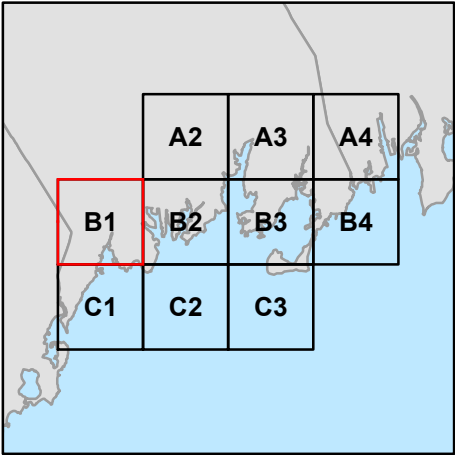
# Marsh Advancement by the 2080s

Town of Greenwich, CT

Advancement per Parcel - Map B1



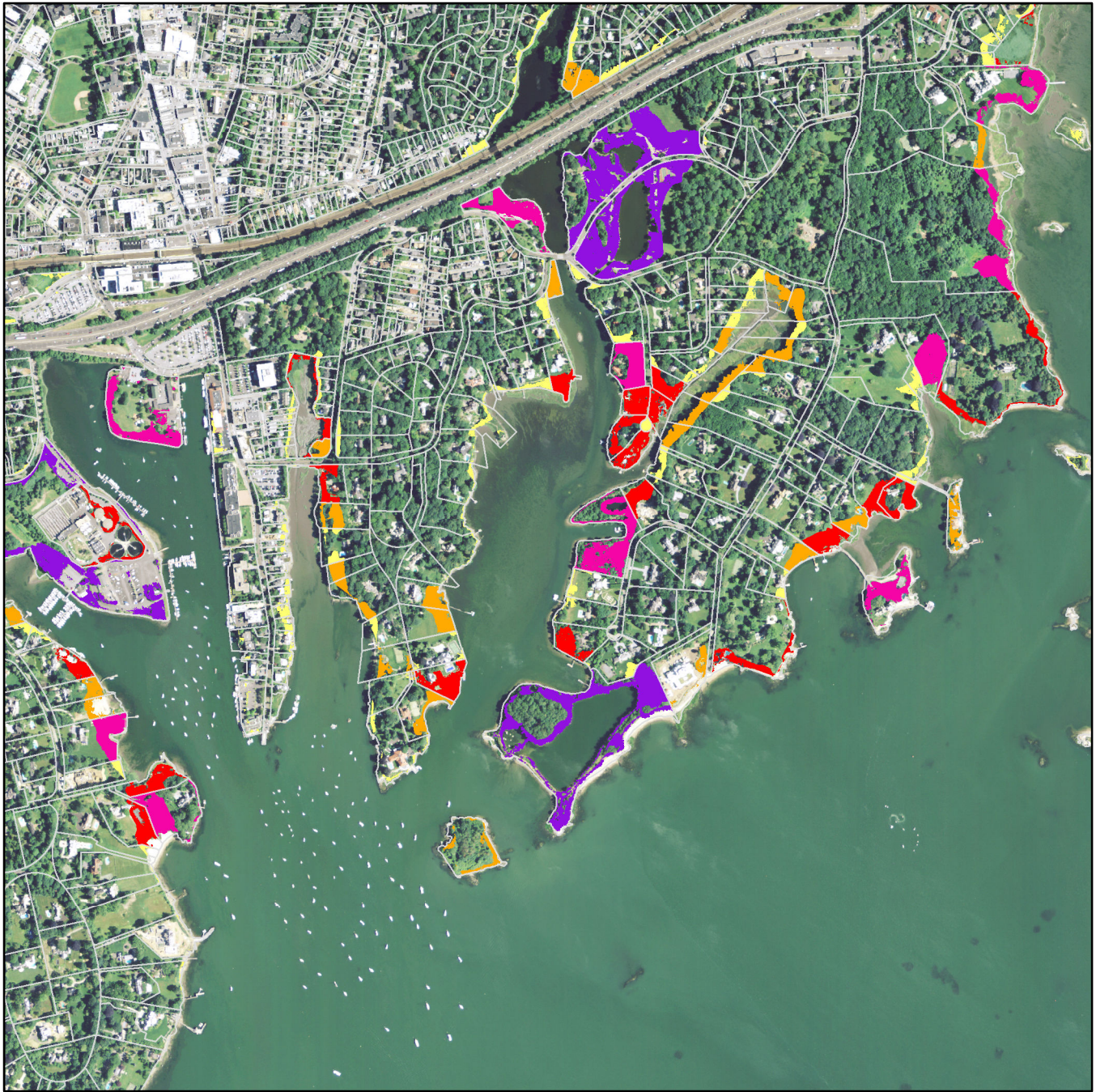
*Note: Only Non-OS parcels with > 3 acres of suitable marsh advancement are shown.*





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0 500 1,000 2,000 3,000 Feet

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## Marsh Advancement by the 2080s

Town of Greenwich, CT

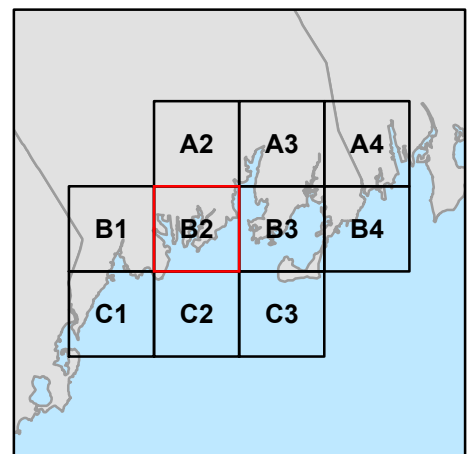
### Advancement per Parcel - Map B2

#### Area of Suitable Advancement

- < 0.5 acres
- 0.5 - 1
- 1 - 2
- 2 - 5
- 5 - 20
- > 20 acres



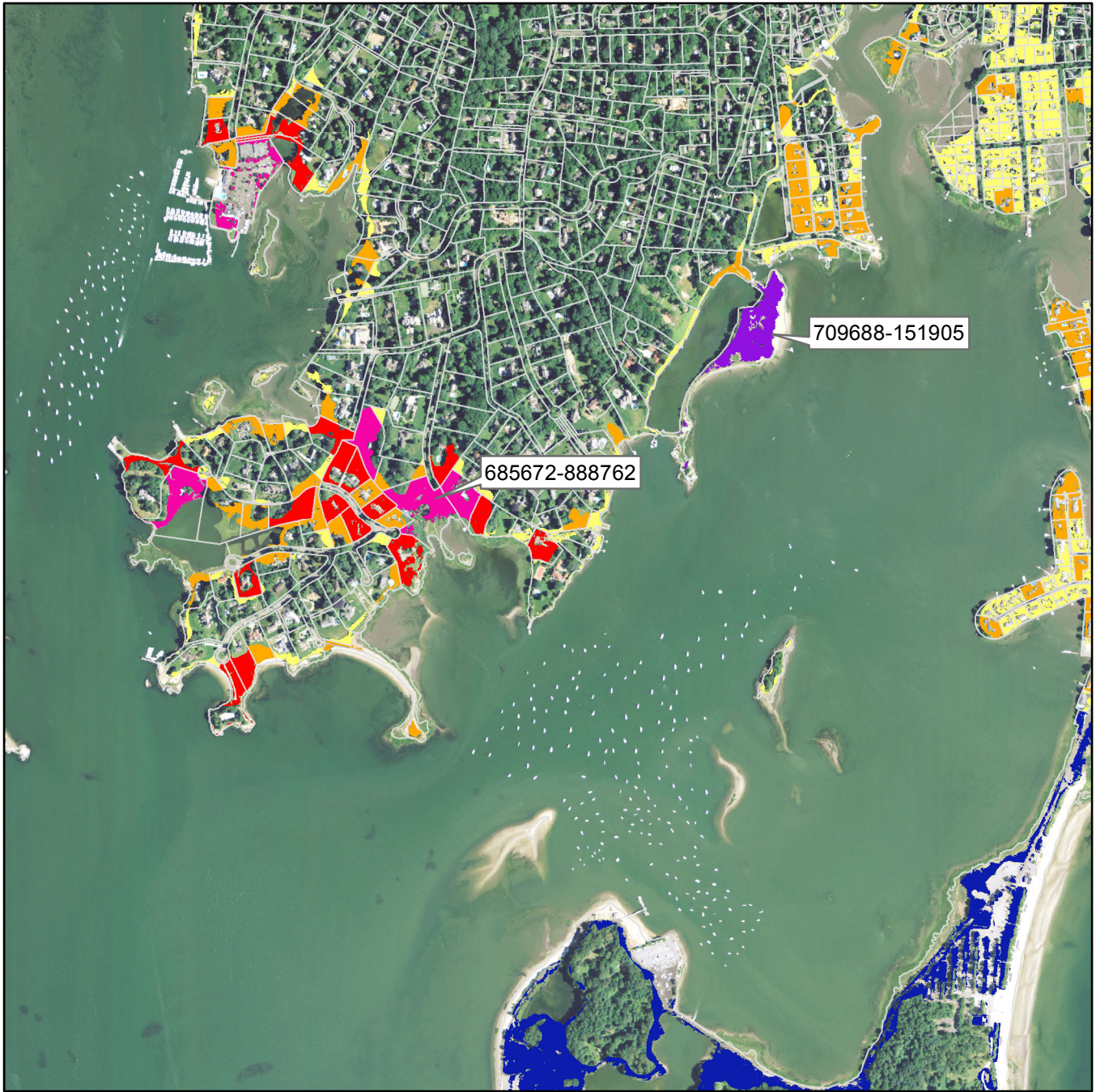
*Note: Only Non-OS parcels with > 3 acres of suitable marsh advancement are shown.*





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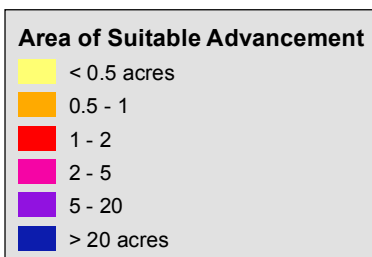
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see page 30

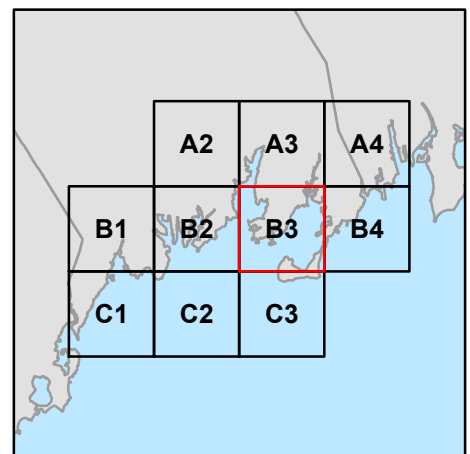
## Marsh Advancement by the 2080s

Town of Greenwich, CT

Advancement per Parcel - Map B3

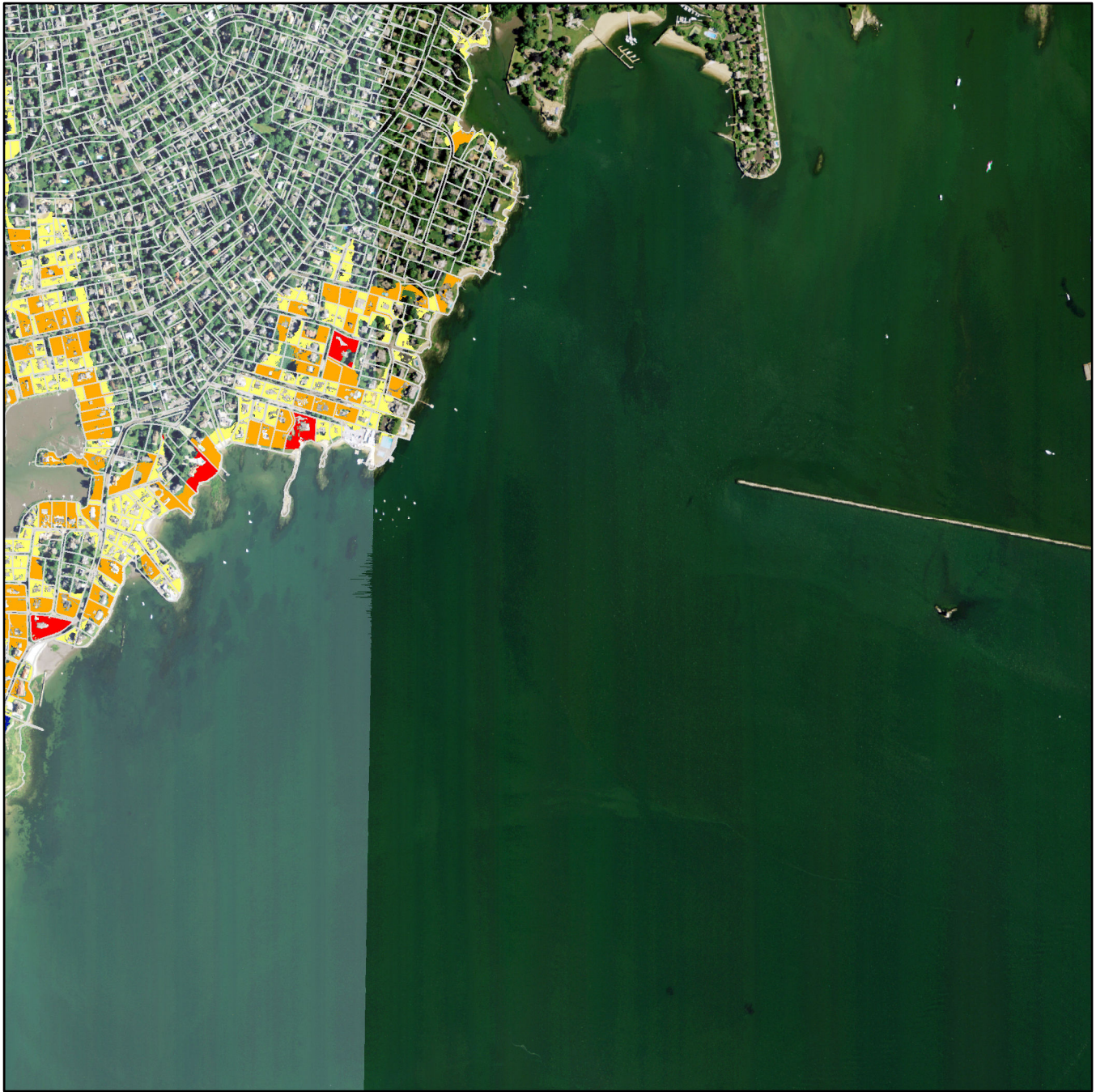


*Note: Only Non-OS parcels with > 3 acres of suitable marsh advancement are shown.*





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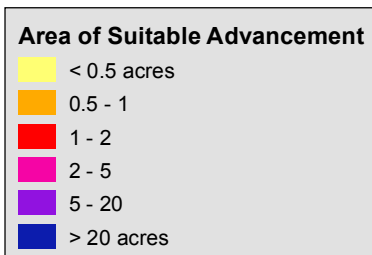


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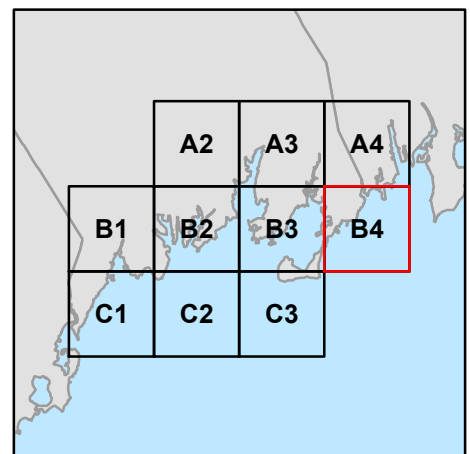
## Marsh Advancement by the 2080s

Town of Greenwich, CT

Advancement per Parcel - Map B4



*Note: Only Non-OS parcels with > 3 acres of suitable marsh advancement are shown.*







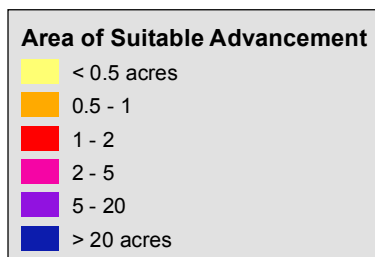
see page 29

0 500 1,000 2,000 3,000 Feet

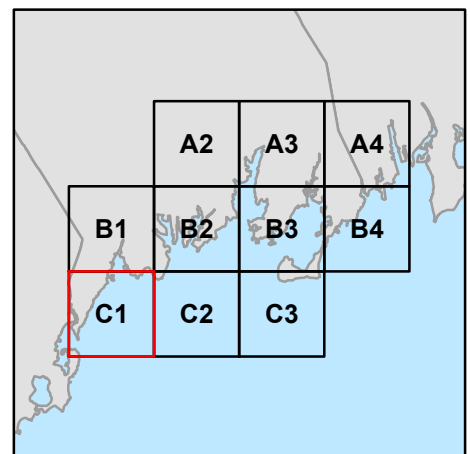
## Marsh Advancement by the 2080s

Town of Greenwich, CT

Advancement per Parcel - Map C1



*Note: Only Non-OS parcels with > 3 acres of suitable marsh advancement are shown.*



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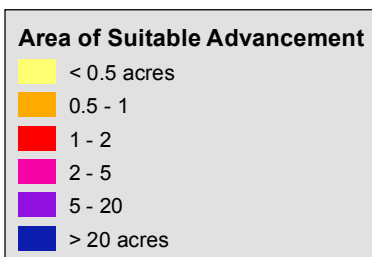


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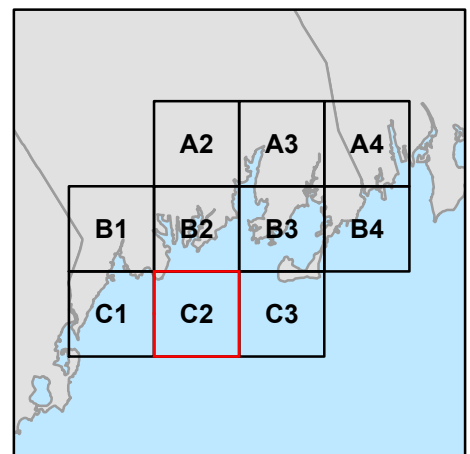
## Marsh Advancement by the 2080s

Town of Greenwich, CT

Advancement per Parcel - Map C2

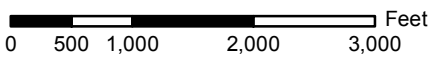
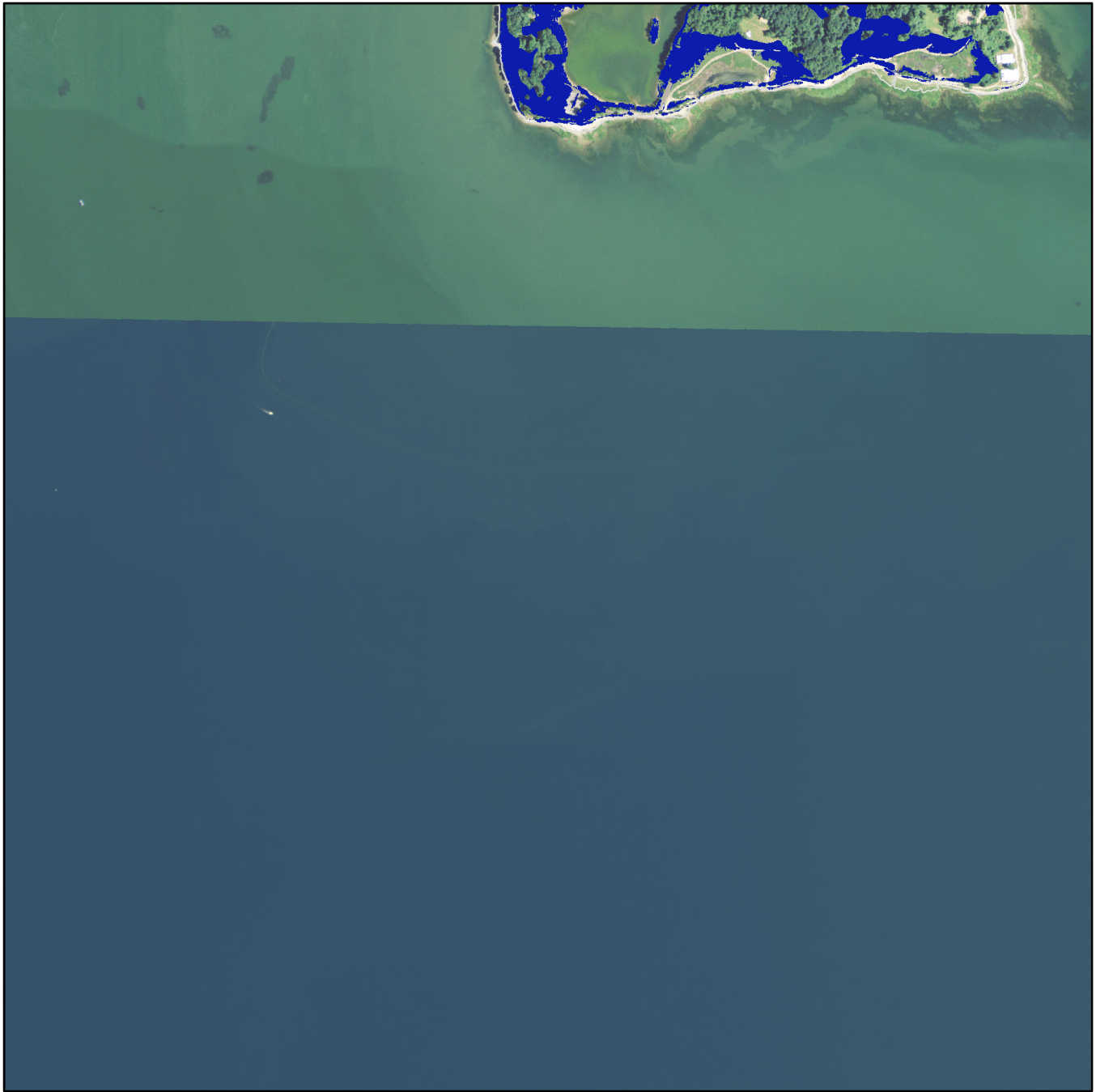


*Note: Only Non-OS parcels with > 3 acres of suitable marsh advancement are shown.*





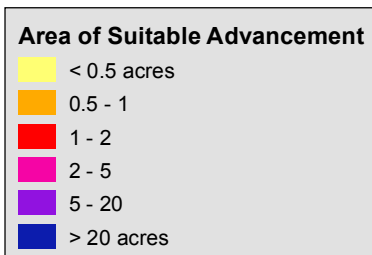
see page 29



## Marsh Advancement by the 2080s

Town of Greenwich, CT

Advancement per Parcel - Map C3



*Note: Only Non-OS parcels with > 3 acres of suitable marsh advancement are shown.*

