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UEP 0279

Final Term Paper

12/17/2021

Selected Water Source: Belle Isle Creek/ Winthrop Bay Watershed

Introduction

Winthrop, one of the oldest communities in the United States settled in 1630, is an oceanside city in Greater Boston, Massachusetts. It is situated at the north entrance to Boston Harbor, nearby the Logan International Airport, and connected to the Belle Isle Marsh Reservation to the west. At 1.6 square miles and an estimated population of 18,000 in 2021, it is also one of the smallest and the densest areas in Massachusetts.

As many coastal communities have experienced flooding, Winthrop is also not surprised by the increasing threats of climate-related hazards. As a result of climate change, Winthrop has suffered from unusual Nor'easters and sea-level rise. Indeed, according to the Metropolitan Area Planning Council (2020), the top two hazards identified in Winthrop during their Municipal Vulnerability Preparedness (MVP) Plan are sea level rise and flooding. Thus, it is critical for the Winthrop community to require extra management to help reduce the impact of flooding.

Furthermore, the selected water source to be studied – the Belle Isle Creek/ Winthrop Bay area – includes the Belle Isle Marsh Reservation, which is known as Boston's last remaining salt marsh. As an integral part of coastal ecosystems, salt marsh helps reduce the impact of flooding by trapping, storing, and slowly releasing water. It also helps reduce the risks of stronger waves and sea level rise; however, sea level rise is expected to increase a seaward marsh edge erosion by creating stronger waves (Royal Netherlands Institute for Sea Research, 2019). If the Belle Isle Marsh Reservation is not well maintained, we could expect an intensifying marsh loss that will lead to more severe flooding conditions. Therefore, the salt march also requires further management to help break down the impacts of sea level rise and to protect shorelines and the neighboring communities.

Goal statement

The goal of this project is to provide recommendations to the Winthrop community to maintain the Belle Isle Creek/ Winthrop Bay Watershed to prepare for flooding and improve resilience over climate-related threats. This project will first analyze existing conditions, and then provide recommendations to improve the watershed's resilience towards flooding and sea level rise.

Basic Information

The Belle Isle Creek/ Winthrop Bay Watershed covers approximately 4465.80 acres of ocean and lands. The area of the ocean is approximately 1620.30 acres, 36.28 % of the total area. The area of watersheds or lands is approximately 2845.5 acres, 63.72% of the total area. The water bodies in this watershed include Belle Isle Creek, Short Beach Creek, Lewis Lake, and Boston Harbor. Other features include the Belle Isle Marsh (Wetland), Orient Heights Beach, Constitution Beach, Snake Island, and Deer Island. This watershed also covers approximately half of the Boston Logan International Airport. For the sake of convenience, this paper will refer to the Belle Isle Cree/ Winthrop Bay Watershed as "Winthrop Watershed," or interchangeably.

Although it is to be referred as "Winthrop Watershed," the water drains through two municipalities – the Town of Winthrop and the City of Boston. Most water drains off on the lands of the Town of Winthrop while Belle Isle Marsh, Deer Island, Boston Logan International Airport, Orient Heights Beach, and Constitution Beach remain are settled within Boston's municipal boundary. In addition to knowing that the watershed boundary extends over Winthrop and Boston, it's essential to note that the Bells Isle Marsh Reservation is managed by the Department of Conservation of Recreation, and the Deer Island Treatment Plant, Winthrop's water & wastewater system and Boston Logan International Airport are managed or owned by the Massachusetts Water Resources Authority (MWRA).

Hydrologic Budget

A hydrologic budget (Table 1) is calculated to evaluate the sustainability of water supply – groundwater recharge and surface water runoff. The hydrological budget is calculated based on the soil data generated from the Web Soil Survey (Appendix 1, Table 3), Massachusetts Recharge and Runoff Table provided in lecture, and Winthrop's precipitation rate gathered from BestPlaces.net.

Here are the basic formulas used for the calculation: (1) Net Precipitation = precipitation – ET Evapotranspiration = Recharge + Runoff; (2) Total Precipitation = ET + Recharge + Runoff; (3) Discharge = Total Precipitation – Evaporation – ET; and (4) Discharge = Recharge + Runoff + Net Precipitation to Ocean.

The watershed delineation map (Appendix 2, Figure 11) shows that most water drains into Belle Isle Creek and Boston Harbor. 770.02 million cubic feet of water precipitate directly to the delineated watershed annually, and the total water discharge is 385.01 million cubic feet per year. The total precipitation or inlet and the total discharge or outlet reflect Winthrop's precipitation and evapotranspiration rates, 47.5 inches/year and 23.75 inches/year.

Looking into details, the total precipitation to the watershed area is 490.65 million cubic feet per year while 99.46 million cubic feet of water go into recharge, 145.88 million cubic feet of water runoff from land surfaces, and 245.32 million cubic feet of water evaporate. These numbers tell us that, slightly more than the amount of groundwater recharge, 145.88 million cubic feet of surface runoff water require stormwater management, which explain why flooding and sea level rise would be identify as the two major hazards in Winthrop. 99.46 and 145.88 entail that the percentages of Type A&B soils are slightly less than the percentages of Type C&D soils and urban lands.

Table 1 Belle Isle Creek/ Winthrop Bay Watershed Hydrologic Budget. Calculation: Belle Isle Creek/ Winthrop Bay Watershed Hydrologic Budget Calculation Excel Sheet (Appendix 3).

Winthrop Watershed Hydrologic Budget		
	Million Cubic Feet/Year	Million Gallon Per Day (MGD)
Total Precipitation (Inflow)	770.02	15.78
Total Groundwater Recharge	99.46	2.04
Total Surface Water Runoff	145.88	2.99
ET from Watershed	245.32	5.03
Total Precipitation to Watershed	490.65	10.06
Net Precipitation to Ocean	139.69	2.86
Total Discharge (Outflow)	385.01	7.89

Soils and Impervious Surfaces Analysis

Impervious surfaces are artificial structures, such as roads, sidewalks, driveways, and parking lots. Impervious surfaces are mostly impermeable, thus, generate more surface water runoff that would create more flooding and water pollution issues for surrounding environments. Percentage of impervious surfaces increases as urbanization expands.

Below, a Soil Table (Table 2) is generated based on the soil data that the Web Soil Survey provided. Soils are categorized into six categories – A, B, C, D, Urban Lands, and Unranked Lands. Any soils listed as A/D are categorized into D to avoid overestimating the existing resources. Also, since urban lands are highly impervious, urban lands are assumed to have the opposite recharge and runoff rate as Type A soil for the same purpose – a recharge rate of 0.49 inches/year and a runoff rate of 23.26 inches/year.

Furthermore, based on the soil data from Web Soil Survey, most unranked lands are – udorthents, wet substratum – which are areas where the upper soils have been removed or filled. In the *Soil Survey of Norfolk and Suffolk Counties, Massachusetts*, Peragallo (1989), writes, "This map unit consists of filled areas that were previously tidal marshes, river floodplains, bay, harbors, and swamps. The fill consists of rubble, refuse, and mixed soil material, typically, sand, gravel, and channel dredgings." Peragallo (1989) also describes that this type of soils has a moderate or slow permeability and a low or moderate water capacity, indicating that "water tends to pond on the surface after intensive rain." Therefore, due to the various filled materials, unranked lands are treated as Type D soils to avoid overestimation when calculating hydrologic budget (Table 1) and for the sake of convenience of this paper. However, since these soils have not been assigned to a subclass (Peragallo, 1989), further investigation is strongly recommended.

According to the soil table (Table 2), the Winthrop Watershed has 17.85% of Type A soil, 11.73% of Type B soil, 2.13% of Type C soil, 9.37% of Type D soil, 18.90% of urban lands, and 40.03% of unranked lands. This data reveals that the Winthrop Watershed has almost 30% of good quality soils, if viewing Type A and Type B soils jointly. However, it also reveals that the Winthrop Watershed has almost 70% of soils that have a quality equal or less than the Type D

soil, which has the least permeability and the highest runoff rate. Consequently, low impact development and/or green infrastructures, such as green roofs and rain gardens, are highly recommended to help control stormwater.

Table 2 Belle Isle Creek/ Winthrop Bay Watershed Soil Table. Calculation: Belle Isle Creek/ Winthrop Bay Watershed Hydrologic Budget Calculation Excel Sheet (Appendix 1 & 3).

Winthrop Watershed Soil Table		
Soil Type	Acre	Percentage of Watershed
A	508	17.85%
B	334	11.73%
C	61	2.13%
D	267	9.37%
Urban Lands	538	18.90%
Unranked Lands*	1139	40.03%

*Mostly udorthents, wet substratum

Land Use Analysis

Since the Town of Winthrop covers most of the Belle Isle Creek/ Winthrop Bay Watershed, this paper focuses on the land use of the Town of Winthrop.

Historic Considerations

The following description of the history of Winthrop is a summary based on the Centre Business District Master Plan by Town of Winthrop (2017, March):

> "Winthrop was a town based on agriculture and fishing industry before the early 19th century. In 1839, it constructed its first bridge over to the Bell Isle Marsh in seeking autonomy. In 1842, the Taft Inn, the fist hotel in Winthrop, was built at the far end of Point Shirley. Cumulatively, the Town of Winthrop was incorporated in 1852.
>
> In the late 1800s, as railroads were introduced to Winthrop, the hotels and resorts industry began to sprout. The town became a significant vacation destination, and the residential population increased three-fold.
>
> In 1900s, the town continued to grow. Winthrop Hospital opened, employed as many as 200 people. However, Winthrop began to decline after the Great Depression and the World War II as the number of automobile and regional shopping malls started to boost."

Although the population declined and the economy deteriorated during and after the Great Depression, Winthrop has transformed from an agriculture and fishing community to a tourism-focused town. This piece of history explained why now Winthrop has a higher percentage of residential properties than industrial properties.

Current Conditions

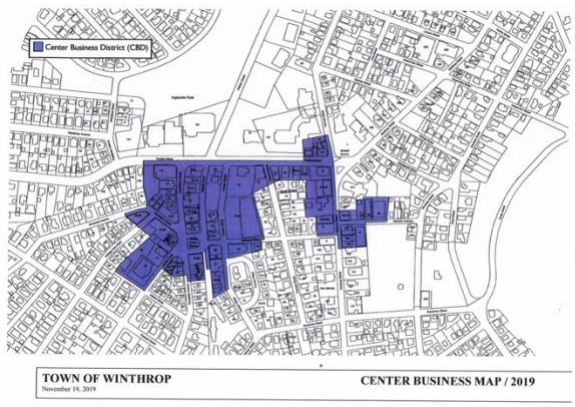
As the Town of Winthrop does not require a comprehensive plan, no current land use data is available based on the research. The most recent Winthrop zoning map could be found on the Town's website and was created in 2006, which has been used in recent public meetings and the 2019 Winthrop Central Business District Zoning Map Analysis. Like the Winthrop zoning map which hasn't been updated since 2006, this paper assumes that zoning hasn't change so much since then and not much development has been constructed.

Based on the zoning map provided by the Town of Winthrop (2006), most of the lands are being used for residential purposes. Figure 17 (Appendix 8) also shows us that more than 80% of the Town's property tax revenues are from residential properties (MAPC Metropolitan Area Planning Council, 2021). According to the Centre Business District Master Plan (Town of Winthrop, 2017), little commercial activities were focused in the past. In other parts of the research, nearly none of the other types of properties has been mentioned.

Future Considerations

As a non-plan town, Winthrop does not have a comprehensive plan that includes any future land use map. Nevertheless, according to the *Town of Winthrop Centre Business District Master Plan* prepared by FORM+PLACE, Inc., MassDevelopment & Metropolitan Area Planning Council (2017) and the Win2030 Vision: Community Visioning for Planning by MACP (2021), the Town of Winthrop plans to create more commercial zones as well as mix-used properties to attract younger groups of people to reside in the community and boost its economy.

The finalized version of the Centre Business District was generated by the Town of Winthrop in 2019 (Figure 1). The Town has also prepared an overlapping map of the Center Business District and Winthrop flood Zones (Figure 2) in their Centre Business District Master Plan. This map indicates that parts of the business district will be in a flood zone.



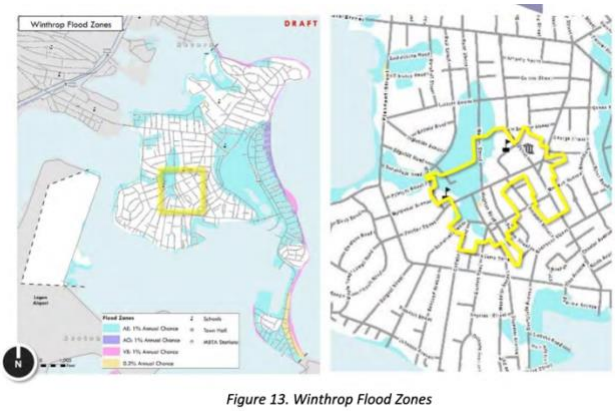


Figure 13. Winthrop Flood Zones

Figure 1 (Left) Finalized Center Business District Map (2019). Source: Town of Winthrop.

Figure 2 (Right) Winthrop Flood Zones. Source: Centre Business District Master Plan (2017).

Flooding and Sea Level Rise

Past Flooding Challenges

The Town of Winthrop has always experienced challenges related to the impacts of hazardous water events from the past, which are likely to occur in the future and be exacerbated by climate change. According to the Community Resiliency Building Workshop prepared by the Town of Winthrop (2018), the Winthrop community had been impacted by two large coastal storm events in the first quarter of 2018 alone; other major coastal storms in the past include: Tropical Storm Irene in August 2011, Tropical Storm Sandy in October 2012, and NEMO in February 2013.

Identified Vulnerable Areas

Created in 2015 by a team of University of Massachusetts Boston scientists and Woods Hole Group modelers, Figure 5 & 6 (Appendix 4 & 5) separately demonstrate how the Boston Harbor would look like when see level rises to 5 feet in 2030 and 7.5 feet in 2070. These maps identify and predict coastal flood risk and flood depths from coastal storms and sea level rise (Boston Harbor Now, 2015). The two significant changes shown in the maps are that the Belle Isle Marsh will completely disappear by 2030 and that the Boston Logan International Airport will mostly disappear in 2070.

Meanwhile, the Massachusetts Office of Coastal Zone Management has selected a Sea Level Affecting Marshes Model (SLAMM) to evaluate the impact of sea level rise on coastal resources. The results of SLAMM show minor wetland expansion and loss of upland area in 2030, regularly flooded marsh, expansion of wetlands, expansion of tidal flat areas, and expansion of open ocean water areas in 2070 as results of sea level rise. (Town of Winthrop et al., 2017 July)

Figure 7 (Appendix 6) is a map of 2030 flood areas and adaptation locations that was provided by the Town of Winthrop (2017). The map suggests several shoreline adaptation sites, such as Morton Street, Donovan's Beach, Lewis Lake, and Shirley Street. The flood areas identified in the map are as the followings (listed from north to south):

1. Nahant Avenue Flood Area
2. Belle Isle Marsh Flood Area
3. Winthrop Beach Flood Area
4. Lewis Lake Flood Area
5. Ingleside Park Flood Area
6. Fishermen's Bend Flood Area
7. Point Shirley Flood Area

Identified Vulnerable Infrastructures

This section a summary based on section 2.3 from the *Community Resiliency Building Workshop* (Town of Winthrop, 2018) and the *Resilient Winthrop: Designing Coastal Community Infrastructure for Climate Change* (Town of Winthrop et al., 2017). In addition, the Town of Winthrop has conducted a more in-depth infrastructure study on Ingleside Park and Point Shirley in 2017. The concept plan can be found on the Town's website or here.

1. Two Main Roadways to Access Winthrop

As an isolated town, there are only two main roadways to access Winthrop: (1) Winthrop Parkway in the north of Winthrop or (2) the Belle Isle Bridge/Main Street in the south. The Winthrop Parkway is connected with the Town of Revere and is sometimes closed by the Town of Revere due to storm events. Because there are only two main roadways to access and leave Winthrop, managing the roadway infrastructures is critical for emergency evacuation. Both roadways are within the Belle Isle Marsh Flood Area listed in the previous section (Appendix 6). (Town of Winthrop, 2018)

2. MWRA's Deer Island Wastewater Treatment Plant

The underlying issues of the Deer Island Wastewater Treatment Plant are its isolated location, its location within floodplain areas, and the condition of the pipeline (Town of Winthrop et al., 2017). Owned by the Massachusetts Water Resources Authority (MWRA), the Deer Island Sewage Treatment Plant treats wastewater from 2.5 million people in Greater Boston; however, being even more isolated than the Town of Winthrop, travel routes to the Treatment Plant are limited and could be compromised (Town of Winthrop, 2018).

MWRA owns and maintains two sewer systems that run to the Deer Island Wastewater Treatment Plant. One is a two-mile 24-inch diameter sewer main that channels sewage from the Town of Revere boundary through Winthrop, and another one is a 108-inch main that channels from East Boston through and was built in 1891 (Winthrop Town of Winthrop et al., 2017). Although the Deer Island was designed to withstand sea level rise (MWRA Online, 2020), it's critical that the conditions of pipelines require a close examination to comprehend what is needed to repair; besides, sea level rise could also contribute significant damage to pipelines as it causes soils to shift and groundwater elevations to rise (Winthrop Town of Winthrop et al., 2017).

3. Wastewater and Stormwater Sewer System

Winthrop's water and wastewater systems are owned by the Department of Public Works and the Massachusetts Water Resources Authority (MWRA). According to the *Resilient Winthrop: Designing Coastal Community Infrastructure for Climate Change* (Winthrop Town of Winthrop et al., 2017), "The stormwater system within Winthrop includes over 20 miles of underground piping, outfalls, catch basins, and manholes. Approximately 115 outfalls are installed throughout the Town of Winthrop in low-lying areas to help relieve inland flooding. The majority of these outfalls do not have check valves to block water from the ocean from entering the system at the headwalls." The drainage system can be filled up when a heavy storm event occurs; future sea level rise is also likely to worsen the conditions of the drainage system by blocking outfall locations (Winthrop Town of Winthrop et al., 2017). Thus, it's critical to seek opportunities to upgrade and improve this infrastructure.

4. Shoreline Structures

The Town of Winthrop has a variety of shoreline structures, including stone revetment, concrete seawalls, bulkheads, breakwaters, and groins. Winthrop has six structures owned by the Massachusetts Department of Conservation and Recreation (DCR) and twenty-seven town-owned structures in various conditions. Half of the public shoreline structures (Appendix 9) require moderate to significant levels of repair.

Recommendations

The goal of this paper is to provide recommendations to help the Winthrop community to build resilience in preparation of climate-related threats. In accordance with the analyses above, this paper provides several recommendations to the Town of Winthrop. This section firstly introduces some of the limitations that should be taken into consideration while implementing the recommended policies or plans, and then moves on to explain how these recommendations can be implemented and how they will achieve the stated goal. The main three strategies this paper provides are (1) public education, (2) low impact development and green infrastructures, and (3) wetland preservation.

Limitations

This paper identifies the top three challenges that the Town of Winthrop is likely to encounter while implementing the provided recommendations. First, the Town is lack of financial resources. According to MassAnalysis (2021) the total general fund of the Town of Winthrop in the fiscal year (FY) of 2020 was $53,801,033, comparing to Boston's $3,503,373,924 and Revere's $191,475,701. The budget for FY 2022 increases slightly to $54,994,887 (Freedman, 2021).

Next, as Winthrop is geographically isolated, the Town is not receiving enough attention to its rising climate crisis from both the state and federal governments. The Town of Winthrop received $11,984,290 in total from the state in FY 2020; however, Boston received $481,870,879, and Revere received $82,811,042 (MassAnalysis, 2021). More specifically, only around $4,400,000 could be used for purposes other than school, veterans, elderly, etc., a.k.a. unrestricted general government aid (Freedman, 2021).

Lastly, the community of Winthrop is lack of political will. Based on the author's research, the Municipal Vulnerability Preparedness (MVP) Action Grant is the only external funding that the Town receives, which is around $99,000 for the Winthrop Climate Resilient Land Use Project (MAPC, 2020). Besides, only around four dozen residents attended the Win2030 Vision Workshops; Win2030 is a community planning process that provide an opportunity for community input into developing community goals (MAPC, 2021). MAPC, Metropolitan Area Planning Council, is hired by the Town of Winthrop to serve as the public consultants and facilitators for the community participatory process.

Recommendation 1: Public Education and Outreach

Taking the limitations into consideration, the very first recommendation is public education and outreach. The Town should lead the community with visions, which means to inform the problem, pivot it to solutions, and assign actions to community's stakeholders. This section outlines the three steps below without particular order.

1. Introduce the Problem:

In step one, the Town should help improve public understanding of climate-related threats and how the community can help with emergency preparedness. To begin, the Town can reach out to climate education organizations such as Spring Forward, or public water authority like the Massachusetts Water Resources Authority.

Spring Forward is a youth-led climate education organization that aims to improve understanding around climate change and environmental justice. They have taught over 100 workshops and over 1,000 students from age 4 to 15+. They have partnered with more than 25 youth programs, including Boston Public Schools, Andover Public Schools, YWCA Cambridge, Girls Scouts of Eastern Massachusetts, and International School Los Angeles. The link to their completed events can be found here. (Spring Forward, n.d.)

Massachusetts Water Resources Authority (MWRA), established in 1984 to provide wholesale water and sewer services to 3.1 million people and more than 5,500 large industrial users in 61 metropolitan Boston communities, also provides an environmental school program that aims to educate student the importance of environmental issues such as water conservation and pollution. (MWRA, 2021)

To encourage more community engagement, the Town is recommended to partner with community organizations such as the above. Collaboratively, they can perform public outreach that promotes engagement and awareness to a greater extent. Informing the issues would help residents to know what to expect and what is being done by the Town to mitigate the problem.

2. Pivot to Solutions:

This step is to pivot the problem to solutions. This step aims to change inactiveness to becoming activeness. In this stage, the Town is recommended to hold public workshops, similar to the Win2030 Vision Workshop that provide opportunities for community to contribute through developing goals and prioritizing their needs while having limited resources.

The Community Resiliency Building Workshop held in 2018 was also a great example of pivoting the problem to solutions. Nonetheless, the Town is encouraged to hold workshops to further discuss some of the societal solutions that were generated during the Community Resiliency Building Workshop by residents and local business owners, such as an emergency evacuation plan for vulnerable populations, residents' displacement in response to flooding, increasing community support, increasing local funding, and fostering an insurance system.

The Town is also strongly encouraged to increase budget on advertising, if allowed. The Win2030 Vision gathered a total of 765 poll responses; however, that was only 4% of the Winthrop population, 19,316 of the 2020 census.

3. Assign Action

The third step for this section is assigning action – actions that can be taken by the public. For example, after the Town has finished preparing the emergency evacuation plan, the Town shares all the information with all resident.

Another example of assigning action would be continuing the home rain harvesting program that was adopted by the Town 11 years ago (Town of Winthrop Department of Public Works, 2010). This program is suggested because many Winthrop households still have pipes that connect water from rooftops to other impervious surfaces like sidewalks, as observed by the author in November 2021.

Rain barrels store rooftop runoff and allow rooftop runoff to be reused for future. The installation of rain barrels would help relieve the impact of heavy rainstorms as it helps reduce stormwater runoff. In addition, it would also help property owners save money on water bill. Some cities or towns have already adopted the program, such as the followings:

- District of Columbia Riversmart Homes – Rain Barrels
- Milwaukee Metropolitan Sewerage District Rain Barrels
- San Mateo County Home Rain Barrel Rebate Program
- Philadelphia Rain Check Program

The above programs offer rain barrels with prices ranging from $0 to $70 or with a $50-$100 government rebate. In 2010, the Town of Winthrop offered limited rain barrels with a $20 advance pay (Town of Winthrop Department of Public Works, 2010). The new rain harvesting program, though, is recommended to provide unlimited rain barrels to residents, and should be advertised enough prior to launching.

Workshops and educational programs are great places to advertise green infrastructure, the transfer of development right (TDR) program and the conservation easement program! These two programs will be introduced later.

Recommendation 2: Low Impact Development/ Green Infrastructures

The next recommendation for the Town of Winthrop is low impact development, such as rain barrels, green roofs, rain gardens, and planter boxes. If implemented, these green infrastructures will help trap, store, and slowly release water, thus, prevent water backup and flooding. Below, this paper recommends two main areas where the green infrastructures can be installed.

1. Middle School Rezoning Area: Green Roofs, Rain Barrels, Rain Gardens, and Planter Boxes

One place that the Town can start to build green infrastructure is the middle school rezoning area, of where the zoning process is still in progress. Because the rezoning process is still in progress, this would be a good place for the Town to start building green infrastructures like green roofs, rain barrels, and rain gardens. The Town only has to add it to their existing plans.

This area has previously been studies in the Centre Business District Plan (FORM+PLACE, Inc., MassDevelopment & Metropolitan Area Planning Council ,2017), and the study showed that this rezoning area is on the Belle Isle Marsh Flood Zone (See Figure 2 & Appendix 7). This indicates that it’s important to build green infrastructures at as many places as possible, rather than just the

rezoning area. The paper is suggesting that the rezoning area is a good place to start, instead of the only place to implementing green infrastructures.

Figure 3 shows the areas that are considered for rezoning. Area one, 151 Pauline Street, includes an auditorium around 27,000 square feet, a skating rink around 25,200 square feet, and 2.94 acres of lands; area two, 141 Pauline Street, includes the former middle school around 25,200 square feet and 0.82 acres of lands. Figure 4 shows the most voted scheme of Winthrop Visioning 2030; approximately 50% of the respondents voted for scheme 3: classroom and auditorium redevelopment, rather than scheme1: reuse of existing middle school for office, scheme 2: classroom building redevelopment, and scheme 4: entire site redevelopment.

If scheme 3 is adopted, there is a possibility of building a total of 52,200 (27,000 + 25,200) square feet of green roofs. Rain barrels can be installed at the appropriate places. Rain gardens and planter boxes can be built on the rest of the lands.

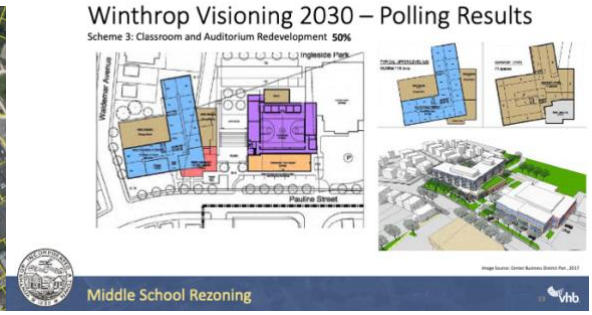


Figure 3 Middle School Rezoning Site Imagery. Source: [Draft of Middle School Rezoning: Summary Findings (2020)](#).

Figure 4 Winthrop Visioning 2030 – Polling Results Scheme 3: Classroom and Auditorium Redevelopment. Source: [Draft of Middle School Rezoning: Summary Findings (2020)](#).

2. Green Street and Alleys – Planter Boxes and Rain Gardens

The other places where green infrastructures can be implemented are sidewalks (see Figure 5) and traffic islands in between intersections and streets (see Figure 6). As observed in November 2021, Winthrop has many places like Figure 5 & 6. Some areas are larger, and some smaller. Planter boxes can be built at the smaller areas. Rain gardens can be built at the larger areas.

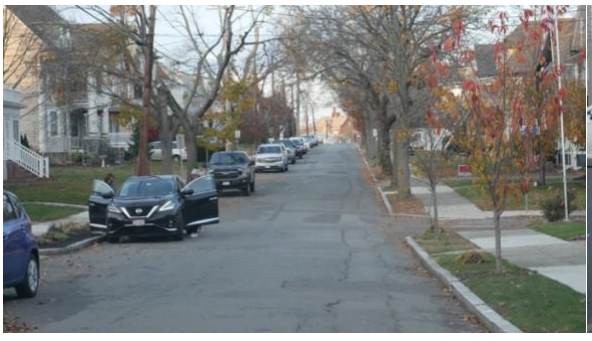


Figure 5 (Left) A Photo of a Street in Winthrop, taken in November 2021.

Figure 6 (Right) A Photo of a Traffic Island in Winthrop, taken in November 2021.

Ideally, installing rain gardens at each household is desirable, such as Figure 7. However, most households in Winthrop that were being observed have a relatively small front yard, and most sidewalks are very narrow. Thus, planter box, such as the one shown in Figure 8, is a more appropriate and preferable option. Appendix 10 illustrates the structure of a planter box. This paper suggests that the Town replaces the current sidewalks (Figure 5) with green streets (Figure 8).

There are also many Green Infrastructure Funding Opportunities listed on the United States Environmental Protection Agency website that the Town may consider applying: link.

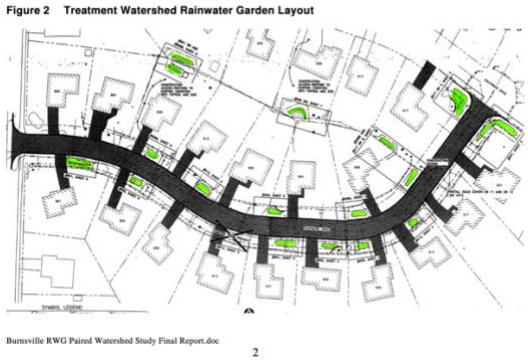


Figure 7 (Left) Treatment Watershed Rainwater Garden Layout. Source: Burnsville Stormwater Retrofit Study (2006).

Figure 8 (Right) Infiltration Planter at Beaumont Village Lofts, NE Portland. Source: Low Impact Development Approaches Handbook

Recommendation 3: Transfer of Development Right & Conservation Easement

The third recommendation for the Town of Winthrop and the Town of Revere is to encourage the transfer of development program and the conservation easement program. As shown in Figure 6, there are many houses adjacent to the Belle Isle Marsh, which could indicate a serious problem as those properties have the ability to contaminate the water of the Marsh in long term if those homes continue to be there. The Towns could increase the buffer zone and encourage transfer of development rights for a more sustainable development. For the existing condition, the best way is probably conservation easement.

Both programs help protect and preserve lands for environmental reasons. A transfer of development program helps move the right to build a house from a location where development is prohibited to another location where development is encouraged. Owners who buy development rights can build at densities higher than allowed under base zoning. For example,

the Town can encourage developer to build at the Centre Business District (Figure 7), where a higher density is desired.

A conservation easement program is a voluntary, legal agreement between a landowner and a land trust or the government. The landowner retains legal title and some private property rights, but the uses of the lands are permanently limited for conservation purposes. In return, the conservation easements are recognized for legal and tax purposes.

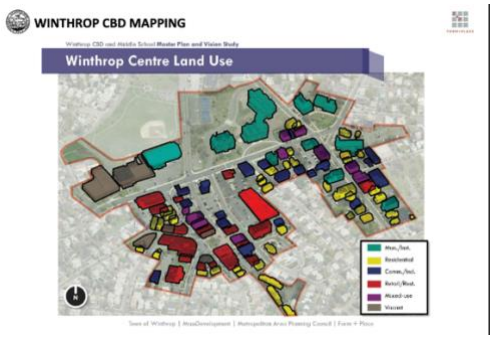


Figure 6 (Left) A Photo of the Belle Isle Marsh Preservation, taken in November 2021.

Figure 7 (Right) Winthrop Center Business District Land Use. Source: Winthrop CBD Zoning Map Analysis (2019, April)

Other Recommendations

1. Update Existing Land Use and Zoning Map:

The Town of Winthrop must update the existing land use and zoning map (Appendix 7) as the most recent Winthrop zoning map was created in 2006 and is still being used in recent public meetings. The Town is also encouraged to write a comprehensive plan to include an in-depth land use analysis, future development plan, and infrastructure analysis.

2. Conduct a Risk Assessment of the Deer Island Wastewater Treatment Plant

Managing the Deer Island Treatment Plant, the Massachusetts Water Resources Authority (MWRA) is encouraged to conduct an in-depth analysis on the conditions of the two sewer pipelines. It is critical to comprehend how the infrastructures would be impacted by flooding and sea-level rise.

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Appendix 1

Table 3 Belle Isle Creek/ Winthrop Bay – Soil Data. Source: Web Soil Survey US Department of Agriculture

Belle Isle Creek/ Winthrop Bay – Soil Data (https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx)				
Map Unit Symbol	**Map Unit Name**	**Rating**	**Acres in AOI**	**Percent of AOI**
1	Water		1,620.3	36.3%
65	Ipswich mucky peat, 0 to 2 percent slopes, very frequently flooded	A/D	237.5	5.3%
71B	Ridgebury fine sandy loam, 3 to 8 percent slopes, extremely stony	D	13.9	0.3%
254B	Merrimac fine sandy loam, 3 to 8 percent slopes	A	6.9	0.2%
325B	Newport silt loam, 3 to 8 percent slopes	B	7.9	0.2%
325D	Newport silt loam, 15 to 25 percent slopes	B	128.9	2.9%
345B	Pittstown silt loam, 2 to 8 percent slopes	C	60.7	1.4%
602	Urban land, 0 to 15 percent slopes	Unranked	47.3	1.1%
603	Urban land, wet substratum, 0 to 3 percent slopes	Unranked	490.6	11.0%
604A	Urban land-Boxford complex, 0 to 3 percent slopes	D	15.2	0.3%
609	Beaches, Boulders	Unranked	8.1	0.2%
610	Beaches, sand	Unranked	69.5	1.6%
626B	Merrimac-Urban land complex, 0 to 8 percent slopes	A	351.6	7.9%
627C	Newport-Urban land complex, 3 to 15 percent slopes	B	196.9	4.4%
643	Beaches, cobble	Unranked	6.7	0.2%
652	Udorthents, refuse substratum	A	15.2	0.3%
653	Udorthents, sandy	A	61.3	1.4%

654	Udorthents, loamy	A	72.8	1.6%
655	Udorthents, wet substratum	Unranked	1,054.7	23.6%
Totals for Area of Interest			4,465.8	100.0%

Appendix 2

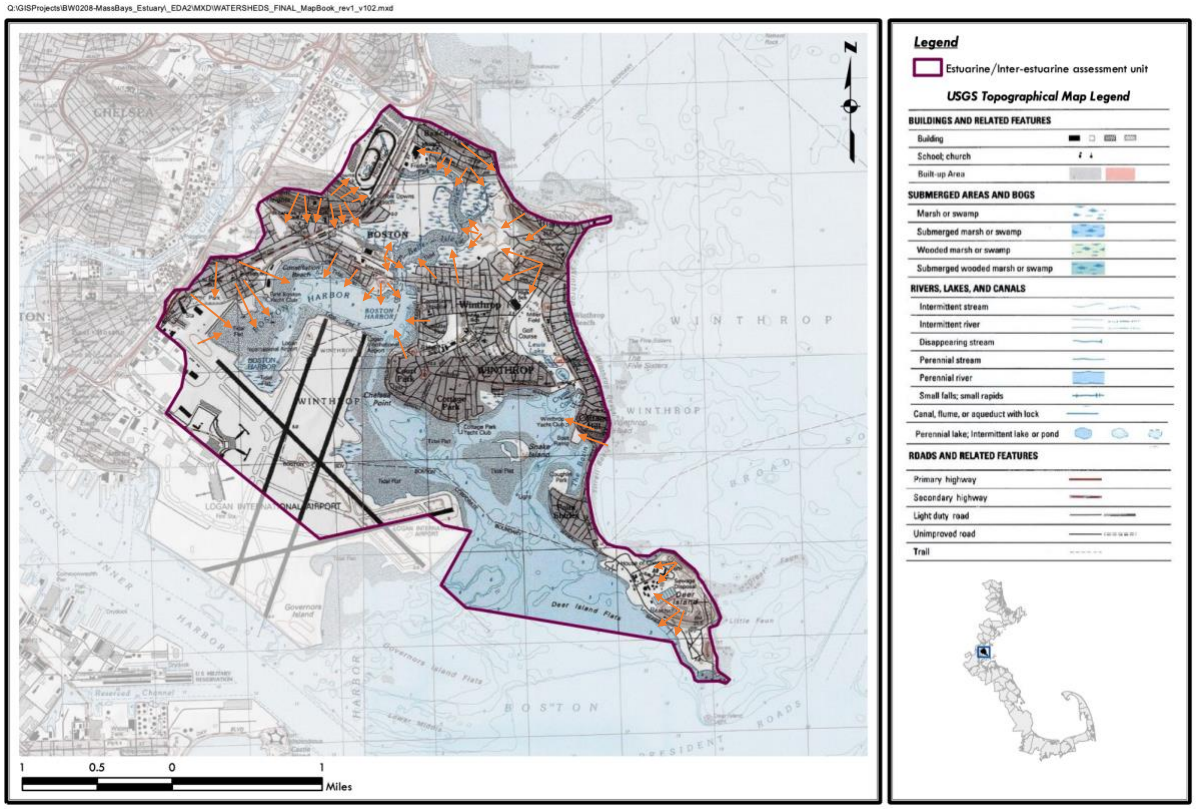

Figure 11 Belle Isle Creek/ Winthrop Bay Watershed Assessment Area Boundary. (2017). Source: [Mass.gov Ecosystem Delineation and Assessment.]

Appendix 3

nthrop Bay – Soil Data (https://websoilsurvey.sc.egov.usda.gov/App/W				
Map Unit Sy	Map Unit Na	Rating	Acres in AOI	Percent of AOI
1	Water		1,620.30	36.30%
65	Ipswich muc	A/D	237.5	5.30%
71B	Ridgebury fir	D	13.9	0.30%
254B	Merrimac fir	A	6.9	0.20%
325B	Newport silt	B	7.9	0.20%
325D	Newport silt	B	128.9	2.90%
345B	Pittstown sil	C	60.7	1.40%
602	Urban land,	Unranked	47.3	1.10%
603	Urban land,	Unranked	490.6	11.00%
604A	Urban land-E	D	15.2	0.30%
609	Beaches, Bo	Unranked	8.1	0.20%
610	Beaches, san	Unranked	69.5	1.60%
626B	Merrimac-Ur	A	351.6	7.90%
627C	Newport-Urb	B	196.9	4.40%
643	Beaches, cob	Unranked	6.7	0.20%
652	Udorthents,	A	15.2	0.30%
653	Udorthents,	A	61.3	1.40%
654	Udorthents,	A	72.8	1.60%
655	Udorthents,	Unranked	1,054.70	23.60%
Totals for Area of Interest			4,465.80	100.00%
Total Watershed Area			2,845.50	63.72%
Total Ocean Area			1,620.30	36.28%

Discharge = Total Precip - EVAP - ET
Discharge = Recharge + Runoff + Net Direct Precip to Ocean
Net Precipitation = precipitation - ET = Recharge + Runoff
Precipitation = ET + Recharge + Runoff

1. Recharge & Runoff of the Watershed (Million Cubic Feet/Year)

Recharge of Soil Type A =	42.87
Recharge of Soil Type B =	20.38
Recharge of Soil Type C =	2.94
Recharge of Soil Type D =	6.13
Total Recharge =	**72.32**
Runoff of Soil Type A =	0.91
Runoff of Soil Type B =	8.39
Runoff of Soil Type C =	2.29
Runoff of Soil Type D =	16.86
Runoff of Urban Land =	46.37
Recharge of Other Unranked Soils =	98.20
Total Runoff =	**173.02**

2. Calculate Total Precip, EVAP, ET, and Net Direct Precip to Ocean

Total Precip =	**770.02**
ET from Watershed =	245.32
Total Precip to Watershed =	490.65
EVAP from Ocean =	139.69
Total Precip to Ocean =	279.36
Net Precip to Ocean =	**139.67**

3. Calculate Total Discharge (Million Cubic Feet/Year)

Total Discharge =	**385.01**

4. Inflows & Outflows (Million Cubic Feet/Year)

Inflow =	770.02
Outflow =	385.01

Soil Type	Acres	Percentage o	Square Foot
A	507.8	17.85%	22119768
B	333.7	11.73%	14535972
C	60.7	2.13%	2644092
D	266.6	9.37%	11613096
Urban Land	537.9	18.90%	23430924
Other Unran	1,139.00	40.03%	49614840

(Unranked soils are treated as urban land in calculation to be conservatice)

Massachusetts Recharge and Runoff (Inches/year)

Soil Type	Recharge	Runoff
A	23.26	0.49
B	16.82	6.93
C	13.36	10.39
D	6.33	17.42

Winthrop Precipitation

	inches/year	feet/year
Precip =	47.5	3.96
ET =	23.75	1.98

(Source: https://www.bestplaces.net/climate/zip-code/maine/winthrop_town/02152)

Unit Conversion

1 acre =	43560	squar foot
1 foot =	12	inches
1 million =	1000000	

Grace Wu

Figure 12 *Belle Isle Creek/ Winthrop Bay Watershed Hydrologic Budget Calculation Excel Sheet*.

Appendix 4

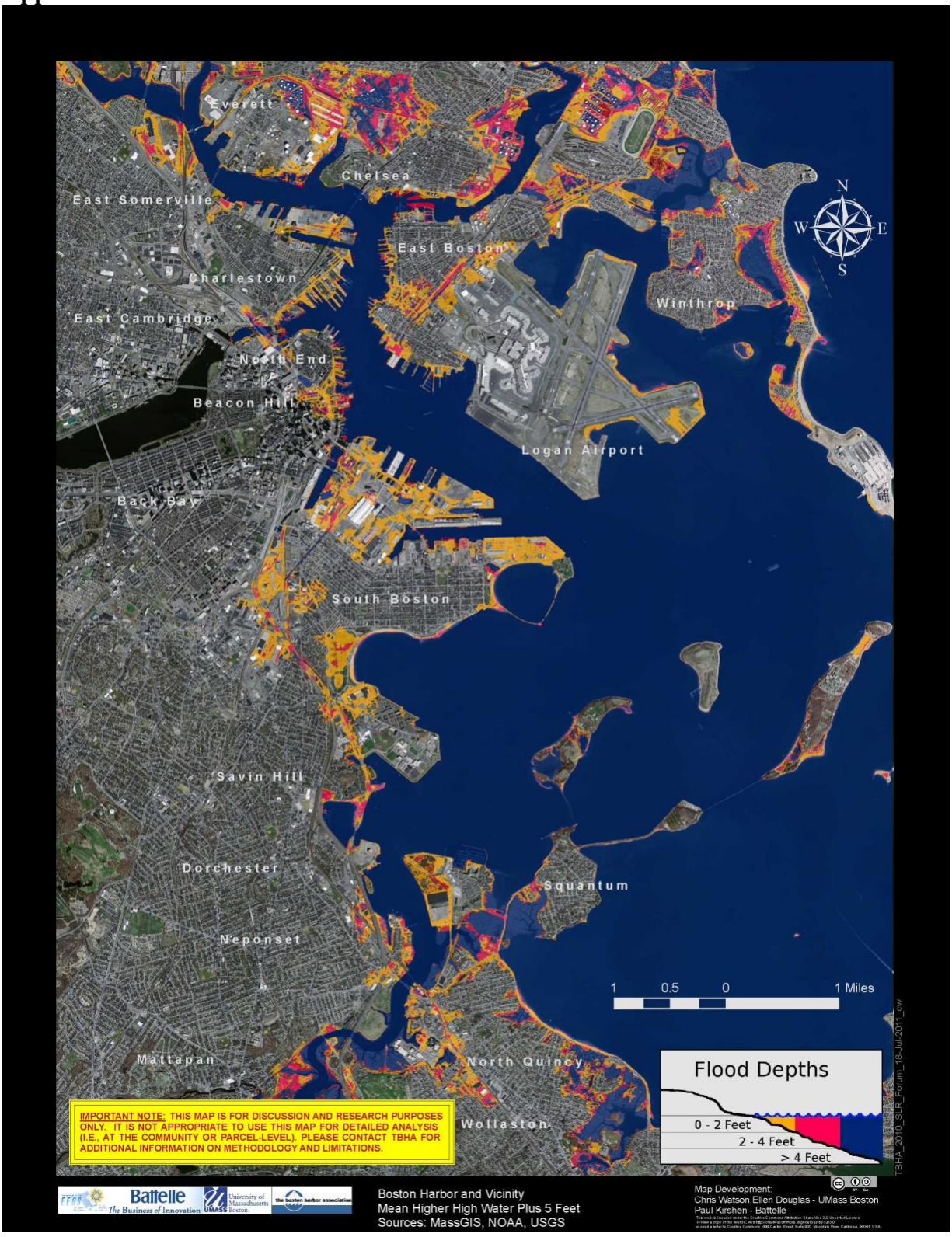

Figure 13 2010 High Tide + 5 Feet Study Area. (2015). Source: [Boston Harbor Now Flood Maps](#).

Appendix 5

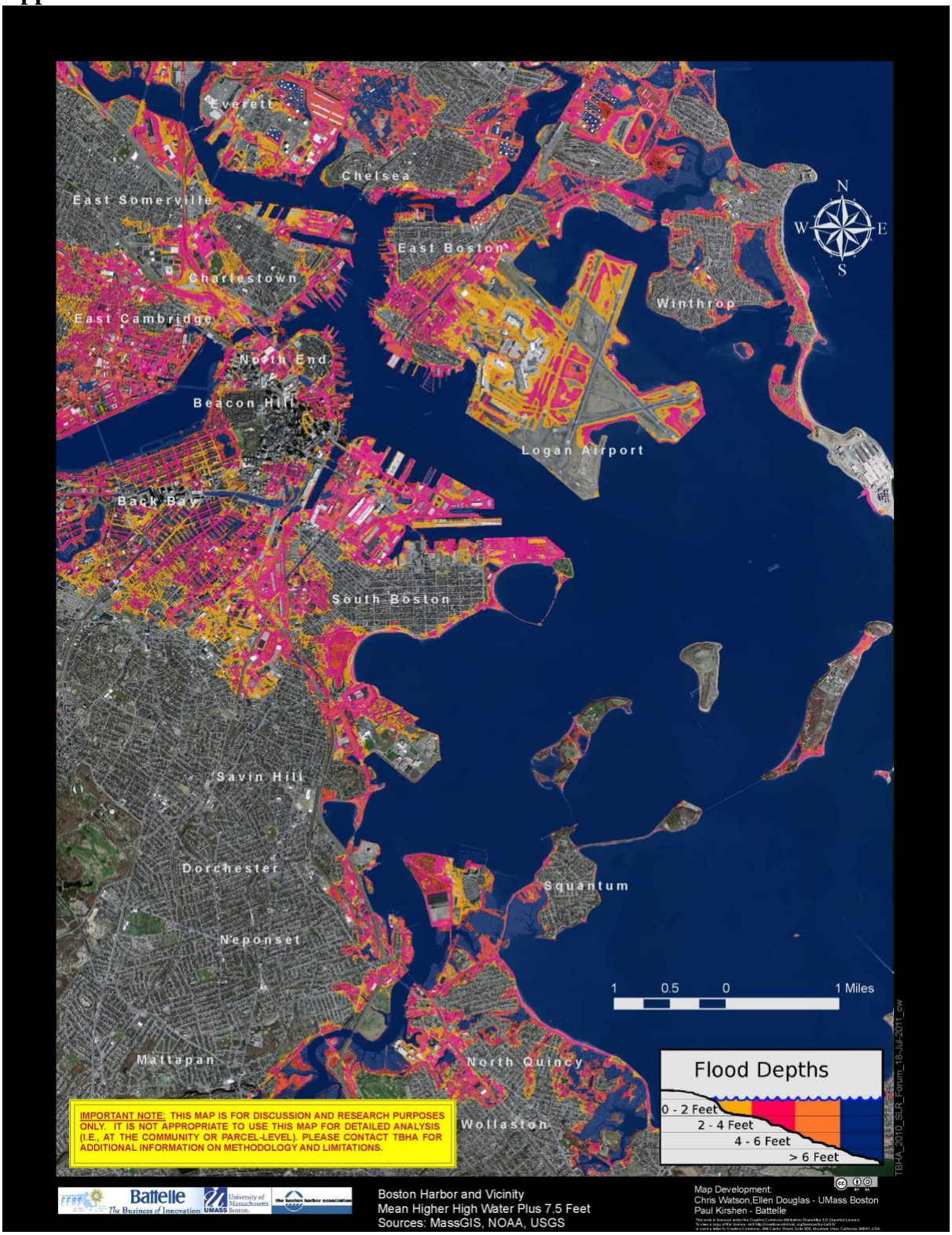

Figure 14 2010 High Tide + 7.5 Feet Study Area. (2015). Source: [Boston Harbor Now Flood Maps](#).

Appendix 6

Figure 15 Map of 2030 Flood Areas and Adaptation Locations. (2017). Source: [Resilient Winthrop: Designing Coastal Community Infrastructure for Climate Change]

Appendix 7

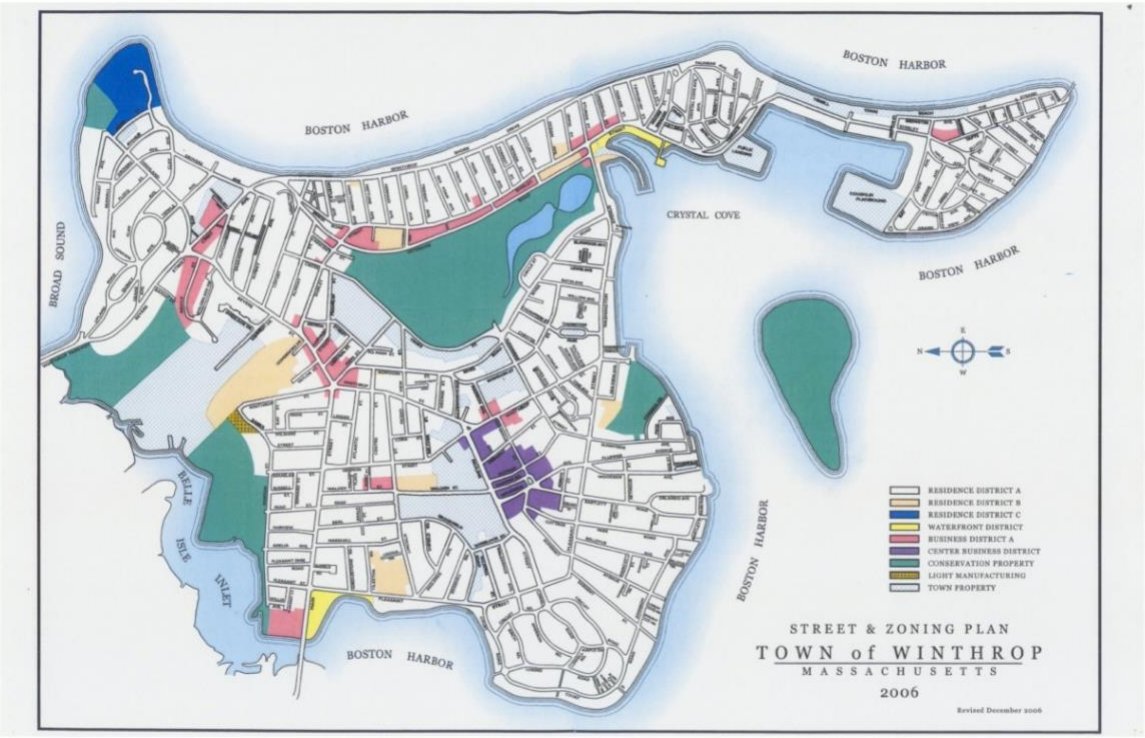

Figure 16 Street & Zoning Plan. (2006). Source: [The Town of Winthrop Massachusetts](#).

Appendix 8

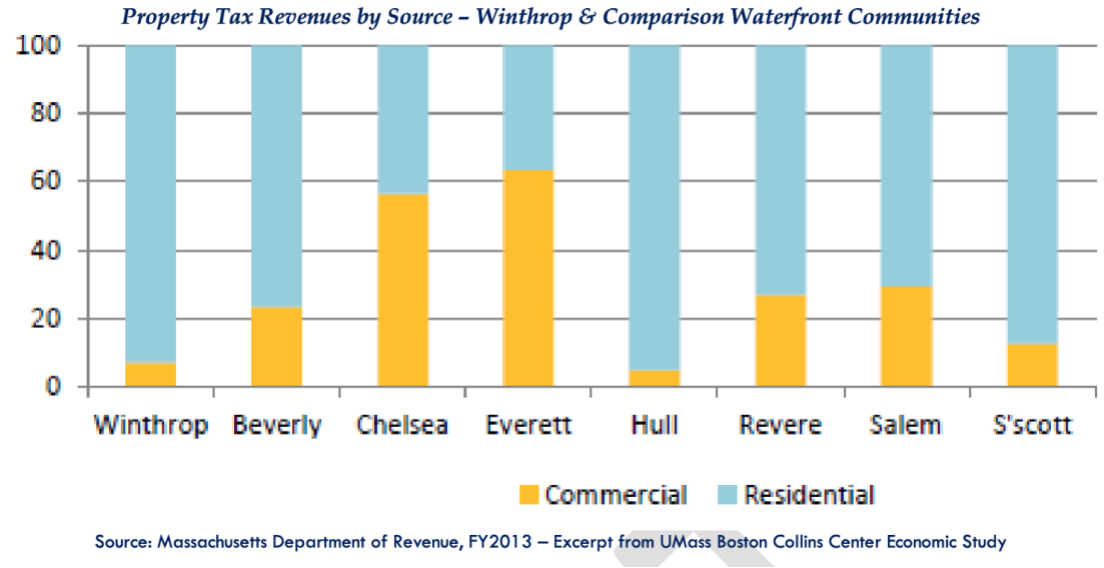

Figure 17 Property Tax Revenues by Source – Winthrop & Comparison Waterfront Communities. Source: [Win2030 Vision](#).

Appendix 9

Figure 1: Winthrop, MA Shoreline Structures

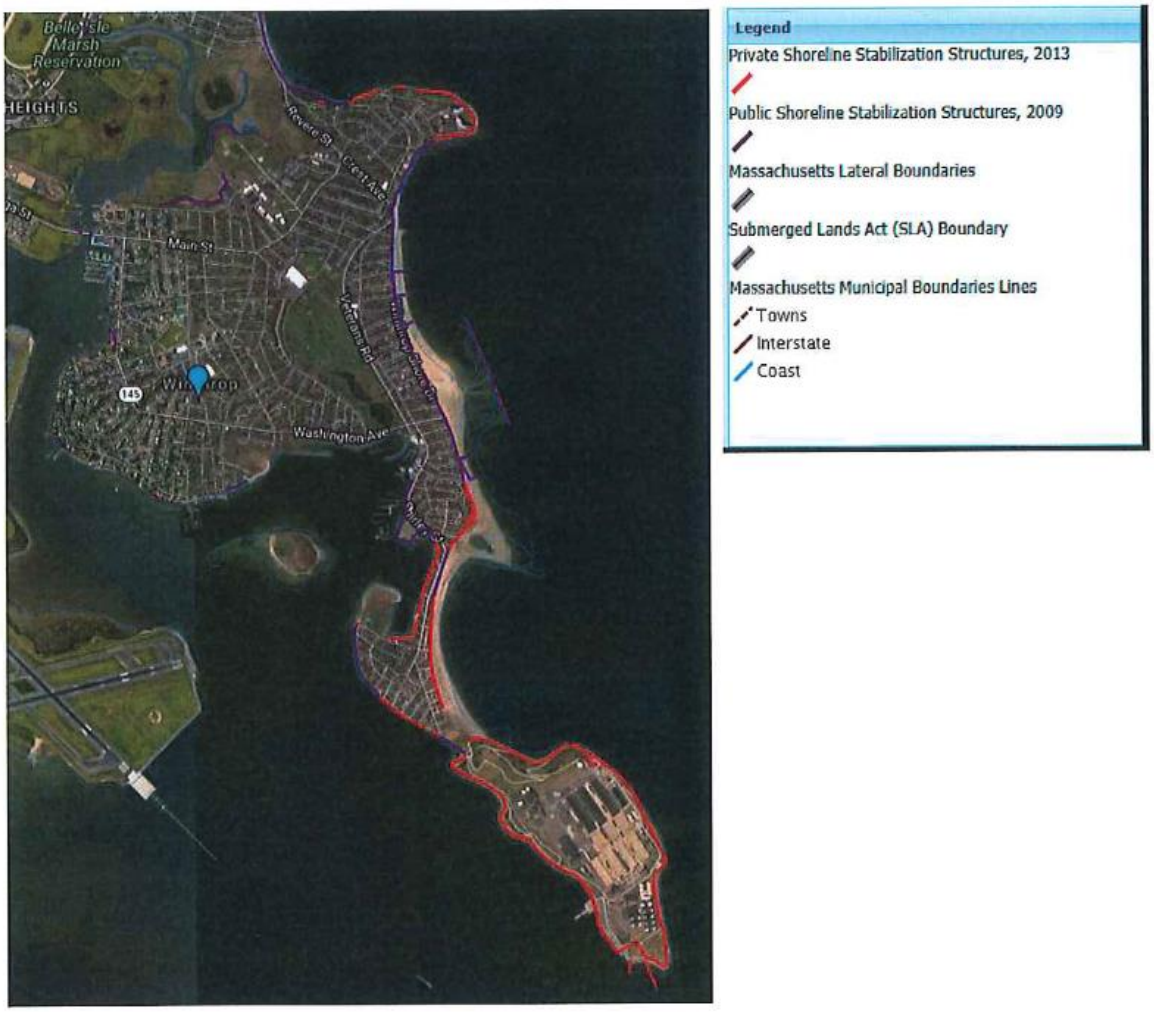

Figure 18 Winthrop, MA Shoreline Structures. Source: [Resilient Winthrop: Designing Coastal Community Infrastructure for Climate Change.]

Appendix 10

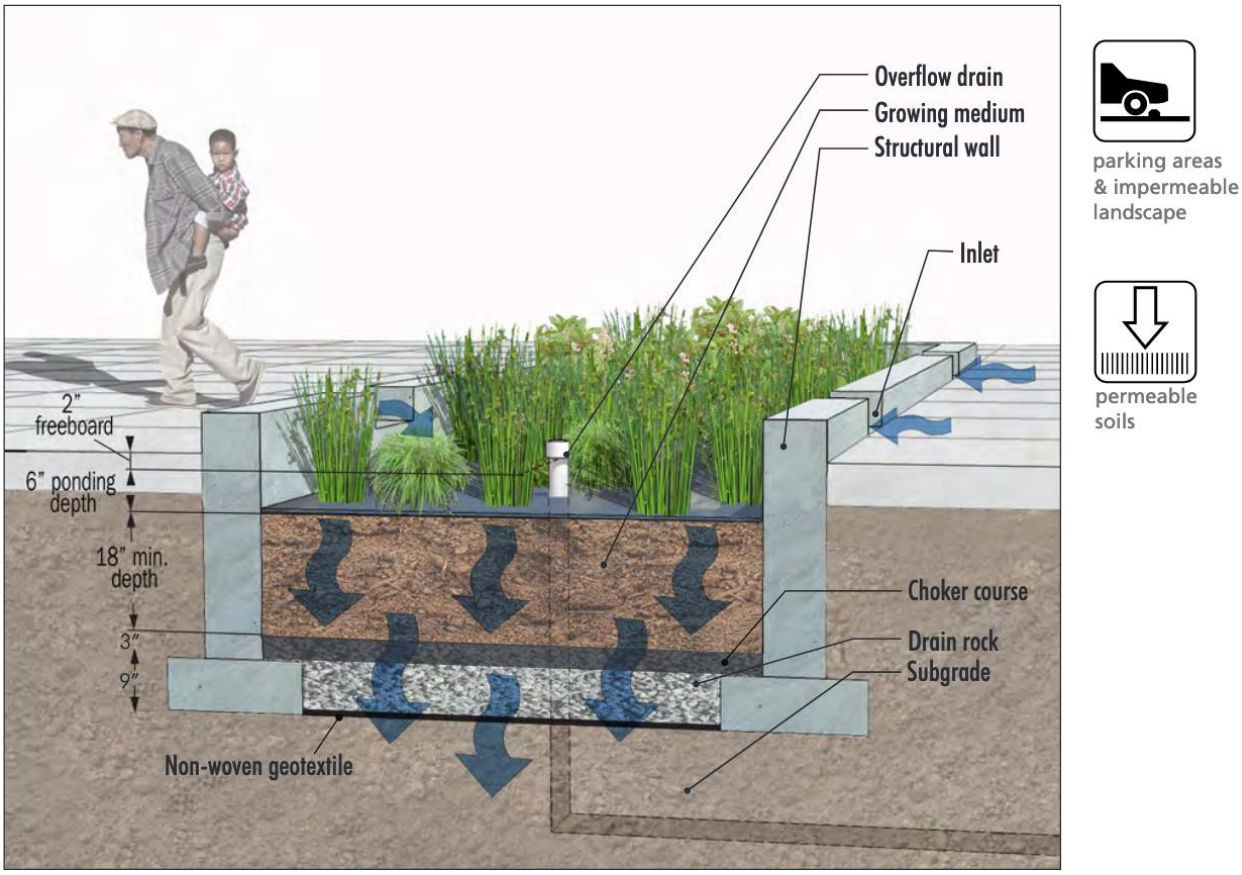

Figure 19 Infiltration Planter/Rain Garden. Source: [Low Impact Development Approaches Handbook]