Section 4

Environmental Inventory & Analysis

Contents

Section 4.1:

GEOLOGY, SOILS AND TOPOGRAPHY

Introduction

Boston is situated in topographic lowland, referred to as the Boston Basin. This lowland is surrounded by a ring of hills that circle it from the Middlesex Fells to the north, inland to the Belmont Hills and Newton Highlands to the west, and around to the Blue Hills to the south. Boston's geology is attributed to several different geologic processes. The geology of Boston can be described by its bedrock, structural, and surficial features including glacial, fluvial, and wind deposited sediments. The soils of Boston reflect these geological factors, as well as influences due to vegetation and humans.

Geological History

The *Historic and Archaeological Resources of the Boston Area* provides information on the geological history of Boston and the landforms and resources that influenced the development of this place.

A distinctive grain of bedrock runs northeast through Boston and follows the Appalachian tectonic plate. This grain is most obvious in the course of the Neponset River, in the angle of the bedrock Harbor Islands, and in the angle of cliffs of the Middlesex escarpment north of the city. This ancient fault system is active and Boston is subject to earthquake shocks.

The existence of ancient volcanoes is evidenced in the granite outcrops to the north and west of the city. This rock was important to native people for tools, and was later quarried for local structures such as the Bunker Hill Monument and Quincy Market.

Much of Boston is located in a large lowland basin, which is underlain with blue clay and slate. Quarries in South Boston provided material for building foundations, roofing and gravestones for the early development of the city. Local clays were used to make pottery and bricks.

A conglomerate rock commonly known as Puddingstone is unique to the area, and gives Roxbury and Stony Brook their names. It can be found in Franklin Park and other parks throughout the city, that were likely created around rock formations that were difficult to remove or quarry. However, it was used as a building material in Roxbury, Brookline and throughout Boston, and also as a material for Victorian Gothic churches.

The Great Ice Age (Pleistocene Epoch) began to end around 10,000 BP as the glaciers and ice sheets that had covered North America for 1.8 million years retreated. As the glaciers melted, they changed the course of rivers like the Mystic, and created large bogs. Shallow kettle lakes formed throughout greater Boston, which later became important locations for natural ecology, prehistoric settlement, colonial country estates, ice harvesting, recreational areas and reservoirs for Boston's water supply.

The glacial retreat also formed the drumlin hills that shaped the landscape of Boston. Beacon Hill, Bunker Hill, and some of the Boston Harbor Islands remain as examples, though many of the gravel hills were removed during the filling of the wetlands.

Much of the glacial plain was flooded by sea level rise as the ice melted, so the level, well-drained soil in Boston is limited. Early development was limited to these areas.

Bedrock Geology

The principal bedrock in the Boston Basin include the Cambridge Argillite, Roxbury Conglomerate, Mattapan Volcanic Complex, and the Dedham Granite.

The Cambridge Argillite is classified as a shale or mudstone. This fine-grained sedimentary unit was most likely deposited in deep oceanic waters millions of years ago when the area was below sea level. This unit currently lies well below Allston, Back Bay, Central Boston, Charlestown, East Boston, South Boston, and the South End.

The Roxbury Conglomerate is known as Puddingstone. This unit consists of pebbles and cobbles within a matrix of varying rock types. The range of size of the cobbles suggests that a river or stream deposited this unit. The Roxbury Conglomerate underlies much of Boston including Brighton, Kenmore/Fenway, Jamaica Plain, Mission Hill, Dorchester, Roxbury, and the northern portions of Mattapan, Roslindale, and West Roxbury.

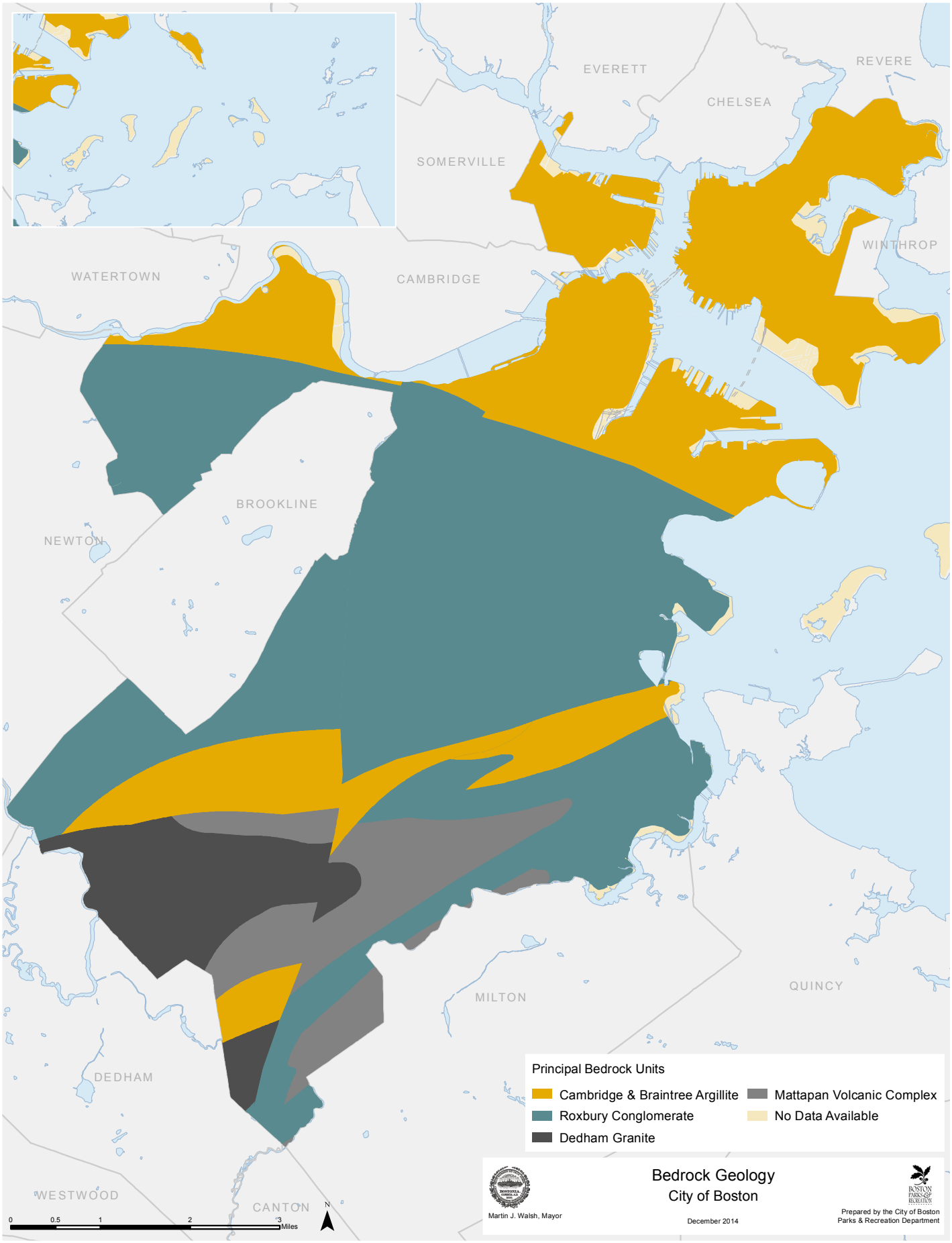
The Mattapan Volcanic Complex is one of the oldest rock units found in Boston. These volcanic rocks are primarily granite. Pebbles and cobbles from this unit have been found in the Roxbury Conglomerate. This suggests that the Mattapan Volcanic Complex is older than the Roxbury Conglomerate, having experienced erosion, producing pebbles and cobbles that later formed the Roxbury Conglomerate. The Mattapan Volcanic Complex lies under the southern portion of Mattapan and large portions of Hyde Park.

The Dedham Granite is most likely the oldest rock unit found in Boston. This unit, which is found below the southern portions of Hyde Park and West Roxbury, is a Precambrian age rock that indicates an age well in excess of 600 million years.

Structural Geology

Structurally, several features distinguish the Boston Basin. These include plunges, folds, anticlines, synclines, and faults. These structural features are found throughout the many rock units in the Boston Basin. Geologists use these features to date rock units relative to each other.

Plunges are physically represented by a significant dip in the bedrock. In the Boston Basin, the bedrock generally plunges east/northeast. This means that if a plunging rock unit were exposed at the surface in a southwest area of Boston, that same rock unit would be hundreds of feet deep in a northeast area of Boston.


EVERETT
REVERE
CHELSEA
SOMERVILLE
WINTHROP
WATERTOWN
CAMBRIDGE
BROOKLINE
NEWTON
MILTON
QUINCY
DEDHAM
WESTWOOD
CANTON
0 0.5 1 2 3 Miles
N
Principal Bedrock Units
Cambridge & Braintree Argillite
Roxbury Conglomerate
Dedham Granite
Mattapan Volcanic Complex
No Data Available
Bedrock Geology
City of Boston
Martin J. Walsh, Mayor
December 2014
Prepared by the City of Boston
Parks & Recreation Department

Folds in the bedrock occurred over 600 million years ago as the rocks were subjected to tectonic stress, causing the once flat-lying rocks to bend and fold.

Tectonic stress also resulted in the formation of anticlines and synclines. These features are simply bedrock that has been folded up or down, respectively.

Anticlines underlie Central Boston, Mattapan, and the Lower Mills. Synclines are found under the Charles River basin, Roslindale, and Hyde Park.

Inactive faults can also be located within the Boston Basin. These faults mark boundaries where different rock units once met and moved relative to one another.

Thrust faults, where one rock unit is lifted above the other, are found at Mt. Hope Cemetery, the Neponset Valley, and the Blue Hills.

Transverse faults, where units move in opposite directions, include the Stony Brook fault.

Surficial Geology

The surficial geology of the Boston Basin is the dominant factor of the landscape. The surficial geology of Boston includes glacial drift, glacial outwash, riverine deposits, and marine clays, as well as loess, which is fine silt deposited by wind.

Glacial landforms dominate the local topography. These landforms resulted from periods of extensive glaciation approximately 10,000 to 50,000 years ago. Repeated advances of thick glacial ice resulted in deformation of the earth's crust. Valleys that existed 50,000 years ago were scoured, deepened, and widened by the ice. Glacial till—unconsolidated, non-stratified glacial drift—was deposited in depths of up to 150 feet.

This till was commonly deposited as smooth, oval shaped hills known as drumlins. The Boston Basin has more than 100 of these drumlin features including the Harbor Islands, Breeds Hill, and Bunker Hill. A major factor in the Boston Harbor Islands' designation by the National Park Service as a National Recreation Area is that it is the only drumlin field in North America to intersect a coastline.

Deglaciation of the basin had a profound effect on the current landscape. As glacial ice began to melt, the run-off deposited sands, gravel, and silts that had been trapped in the glacial ice. Changing sea levels, freshwater streams, wind, and erosion then modified these glacial deposits, thereby forming varied, sorted layers throughout the basin.

The prominent deposits on Boston's current topography include sand, gravel, till, bedrock, and silt and clay deposited by both fresh and estuarine water. Sand and gravel deposits run north/south through Boston. These deposits represent glacial outwash that was deposited as glacial ice melted. These deposits are found in abundance in Allston, Hyde Park, Jamaica Plain, North Dorchester, Roslindale, the South End, and West Roxbury. These deposits are well suited for development, as they are relatively stable and flat. Sand and gravel deposits typically, however, have a high water table, which may cause basements to be more susceptible to flooding. A high water table and the speed at which fluids move through sand and gravel can increase a surface release's capability to pollute groundwater.

Till and bedrock are found throughout the city and are characteristic of areas which contain drumlin hills. Neighborhoods that are dominated by till and bedrock deposits include Brighton, Central Boston, Dorchester, Mattapan, Roslindale, Roxbury, and West Roxbury. Till and bedrock are considered to be extremely stable materials for development, although they also present constraints. Bedrock presents difficulties in excavation while till is commonly found as a drumlin hill, possibly causing topographic restraints for development.

Floodplain alluvium consists of fine-grained material such as fine sands and silts that are found adjacent to, and deposited by, rivers and tidal marshes. These deposits underlie the Back Bay, Fenway/Kenmore, and South Boston. These deposits are now covered by artificial fill that was laid down in the late 18th and 19th centuries to allow development of these lands. The obvious development constraints associated with this material include instability and a high water table. The material does, however, possess a low permeability, thus trapping pollutants and resulting in a slow migration which can be contained should a release of pollutants occur.

Soils

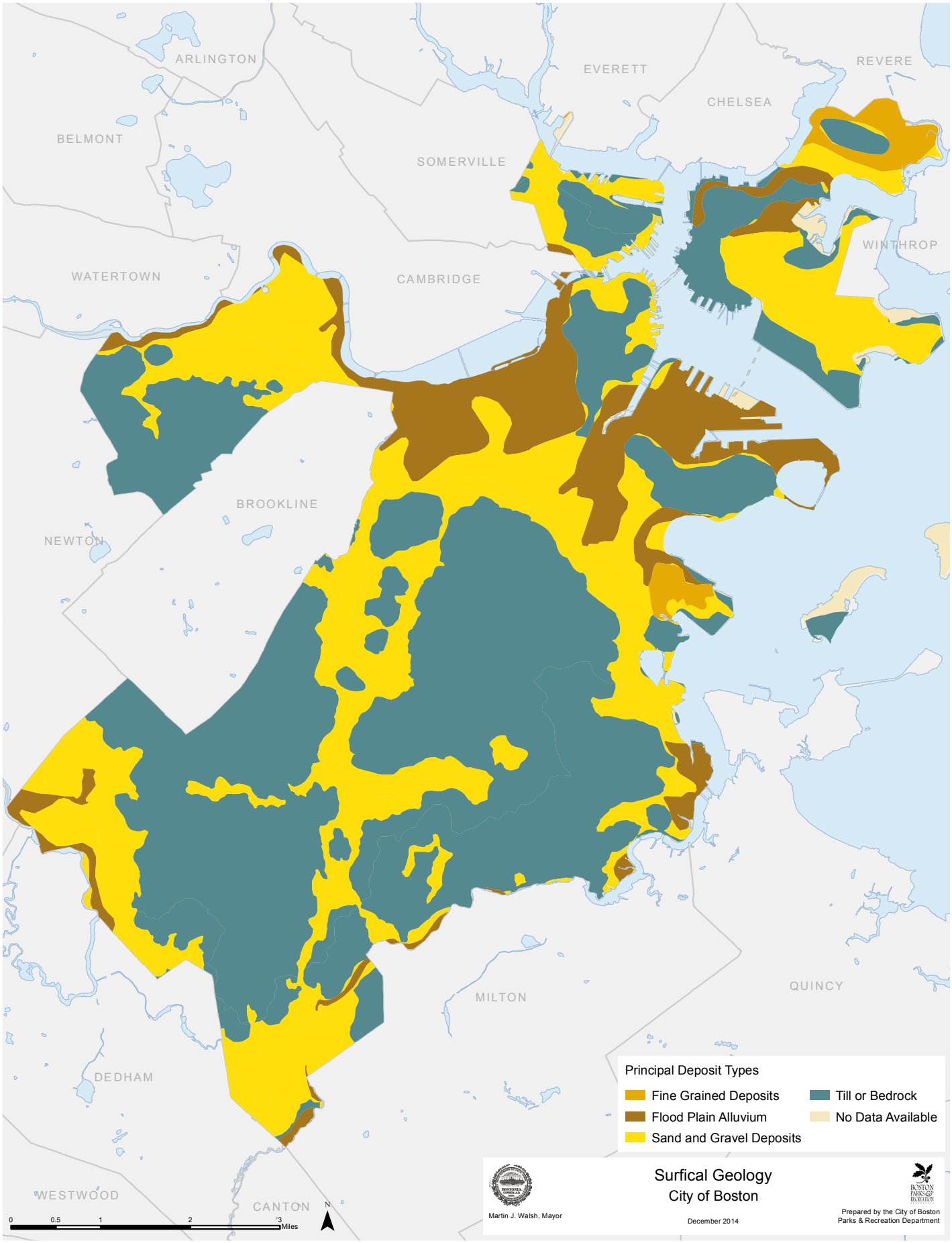
The soils of the Boston Basin are derived from natural glacial processes and artificial processes attributed to the extensive filling of lands by humans. The three largest generalized soil units in Boston are Udorthents-Urban Land, Canton-Charlton-Hollis, and Newport-Urban Land units. These units are typically deep deposits found on land with a topographic range from nearly level to moderately steep.

Udorthents-Urban Land

Udorthents-Urban Land soils occupy most of Boston. These soils are found in areas that were previously tidal marshes, flood plains, bays, harbors, and swamps. Udorthents are classified as areas where native soil has been removed and filled with artificial soil material. The fill consists of soil material, rubble, refuse, and channel dredgings. Depth of this unit ranges from 2 to 20 feet. Land that is 85% or more covered by an impermeable surface such as concrete and asphalt including roads, sidewalks, and buildings is defined as Urban Land. Urban Land overlays actual soil units that cannot be determined due to the urban coverage.

Canton-Charlton-Hollis

The Canton-Charlton-Hollis unit is characterized by well drained, loamy soils formed from glacial deposits. This unit is typically found on low hills and uplands in Hyde Park, Mattapan, and Roslindale. Canton soils are found on small undulating hills adjacent to valleys. Charlton soils are located in depressions between ridges at higher elevations. Hollis soils are found at the top of ridges and near rock outcrops. These soils are conducive to woodland growth, and are suitable for development.


ARLINGTON
EVERETT
REVERE
CHELSEA
BELMONT
SOMERVILLE
WINTHROP
WATERTOWN
CAMBRIDGE
BROOKLINE
NEWTON
MILTON
QUINCY
DEDHAM
WESTWOOD
CANTON
0 0.5 1 2 3 Miles
N
Principal Deposit Types
Fine Grained Deposits
Flood Plain Alluvium
Sand and Gravel Deposits
Till or Bedrock
No Data Available
Martin J. Walsh, Mayor
Surfical Geology
City of Boston
December 2014
Prepared by the City of Boston
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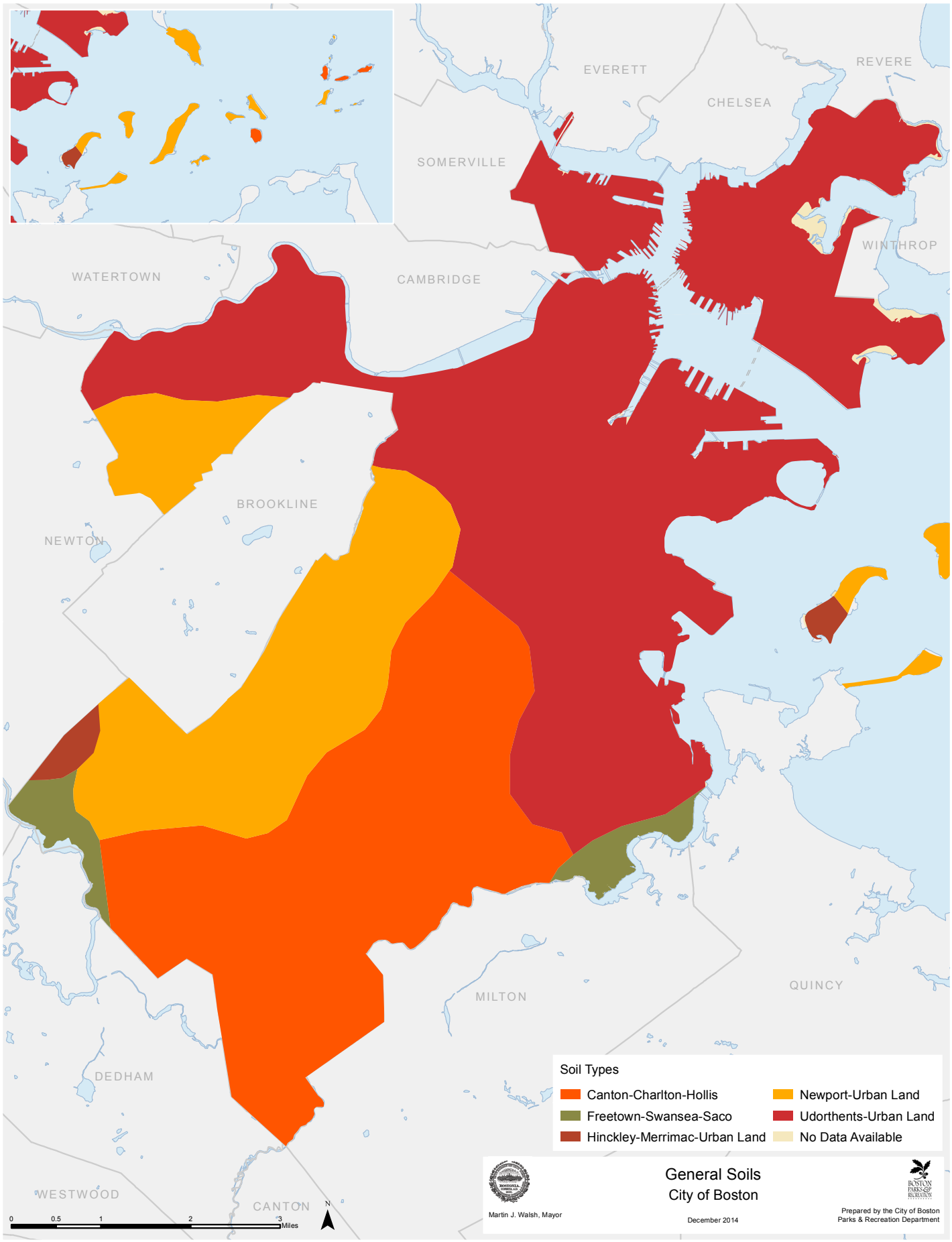
EVERETT
REVERE
CHELSEA
SOMERVILLE
WINTHROP
WATERTOWN
CAMBRIDGE
BROOKLINE
NEWTON
MILTON
QUINCY
DEDHAM
WESTWOOD
CANTON
0 0.5 1 2 3 Miles
N
Soil Types
Canton-Charlton-Hollis
Freetown-Swansea-Saco
Hinckley-Merrimac-Urban Land
Newport-Urban Land
Udorthents-Urban Land
No Data Available
General Soils
City of Boston
Martin J. Walsh, Mayor
December 2014
Prepared by the City of Boston
Parks & Recreation Department

Newport-Urban Land

Newport-Urban Land is commonly found on steep hillsides in the Boston Basin. This unit is found on top slopes and side slopes in Jamaica Plain and West Roxbury. Course fragments of flat dark gray shale and slate in the substratum characterize it. A layer of compacted glacial till causes low permeability and a perched water table, potentially contributing to wet basements in residential areas.

Topography

Ten to twelve thousand years ago, glaciers shaped the landscape that subsequently Native Americans inhabited and Europeans colonized. These massive sheets of ice moved across the land, totally displacing all flora and fauna in the area. The ice sheets' great weight caused the coastal lands to sink below the surface of the ocean.

After the glaciers retreated, the most prominent landscape features were the drumlins, hills made up of glacial till. They tend to have an oval shape, with the "points" of the oval aligned in the direction of the glacial retreat. (Many of the harbor islands are such drumlins.)

The glaciers also left sand and gravel deposits through many parts of Boston, such as along the Charles in West Roxbury and Allston-Brighton, in the Stony Brook Valley in Jamaica Plain, Roxbury, Roslindale, and Hyde Park, and near Dorchester Bay in Dorchester and South Boston.

Overall, the terrain of Boston is gently rolling, with heights ranging from near sea level along the coast to 370 feet above sea level at the highest point, Bellevue Hill in West Roxbury, within the Department of Conservation and Recreation's (DCR) Bellevue Hill Reservation.

Section 4.2:

LANDSCAPE CHARACTER

History of the Landscape

Boston's landscape is rich in history. It has been changing since the city's founding in 1630. These changes have left traces on the landscape of the city. The growth of the city's landmass has been the most significant evidence of the change of this landscape. The history of land making in Boston is discussed in Section 3.

Current Assessment

The current assessment of the landscape is also described in Section 3 and Section 7.

Boston has become a highly urbanized area. High- and low-density residential developments dominates the landscape throughout the neighborhoods of Boston. Despite this historical spread of development, the municipal and the metropolitan park systems preserve much of the original landscape character.

Water is a prominent part of the landscape character of Boston. With extensive miles of coastline and riverfront, Boston is blessed with aquatic resources, coastal and estuarine wetlands, and scenic vistas. Within city limits are many of the Boston Harbor Islands that now make up the Boston Harbor Islands National Recreation Area. Much of this area is considered a "noteworthy landscape," by the Department of Conservation and Recreation's statewide Landscape Inventory.

Boston's open lands are a mixture of uplands and wetlands. Most of the upland areas consist of forest, with the remainder in fields and meadows. These upland areas are generally either publicly owned parklands and cemeteries or privately owned cemeteries. The larger, expansive wetland areas are primarily under public ownership. Boston is a highly mature, developed community.

Developable land that is as yet undeveloped is extremely limited. The protection of the natural resources and open areas of Boston's landscape is as vital a function now as it was in the 19th and 20th centuries.


Scenic Landscapes
City of Boston
December 2014
Martin J. Walsh, Mayor
Prepared by the City of Boston
Parks & Recreation Department
Open Space
Boston City Boundary
Department of Conservation & Recreation Designated Scenic Landscapes
Boston Harbor Islands - Distinctive
Boston Harbor Islands - Noteworthy
BOSTON
BOSTON
HULL
WINTHROP
QUINCY
N
0
0.75
1.5
3 Miles

Section 4.3:

WATER RESOURCES

Introduction

The settlement of the Shawmut Peninsula took place due to the area's outstanding water resources. Mainland Boston is bordered by water to the north, south, and east. These water resources include an ocean harbor, rivers, streams, ponds, and wetlands.

Boston Harbor

To the east, ten miles of the city's shoreline lies on Boston Harbor. The Harbor consists of several unique areas which border Boston, more specifically, its Charlestown, Central Boston, East Boston, South Boston, and Dorchester neighborhoods. Sections of the Harbor include the Inner Harbor, the Outer Harbor, and Dorchester Bay.

The Inner Harbor is bounded by Charlestown, East Boston, Central Boston, and South Boston. The Inner Harbor stretches from the confluence of the Mystic and Chelsea Rivers to the Fort Independence and Fort Winthrop sections of South and East Boston, respectively. The Inner Harbor is used for recreational fishing and boating, and maritime/industrial uses. Freighters and ferries are common in its shipping channels and designated deep port areas. The Inner Harbor includes three channels: the Little Mystic, Fort Point, and the Reserved Channel. These channels are large capacity docking points that can provide protection during rough seas.

The Outer Harbor includes dozens of islands, many of which were once used as military forts, hospitals and industrial plants but have generally reverted to a more natural state. The City owns four islands: Long Island, Moon Island, Rainsford Island, and a large portion of Spectacle Island. The islands are partly submerged drumlin hills formed through glacial action. Rounded hills, open fields, forests, and historical sites characterize these islands. Beaches are found on Spectacle Island, Long Island, Lovell's Island, Thompson Island, and Gallops Island. The water of the Outer Harbor is typically used for swimming, boating, fishing, and navigation by commercial ships.

Constitution Beach Bay (aka Orient Heights Bay) is located on the eastern coast of East Boston between Logan Airport and Orient Heights. Swimming and fishing are common activities there. The bay includes 275 acres in Belle Isle Marsh, which is part of the designated Rumney Marshes Area of Critical Environmental Concern (ACEC).

These marshes are important biological resources and are host to numerous species of waterfowl, wading shore birds, migrant songbirds, invertebrates, and fish. Constitution Beach is a small beach area on tidal flats located in the northern section of the bay. Marshes to the west and the Belle Isle Marsh to the east border the beach.

Dorchester Bay stretches from Castle Island at Pleasure Bay in South Boston to the mouth of the Neponset River at Commercial Point in southern Dorchester. Dorchester Bay is used primarily for boating, fishing, and swimming. Swimmers gain access to the water at several locations along the bay in both South Boston and Dorchester. Access points include the beaches of Pleasure Bay, L and M Street Beaches, and Carson Beach in South Boston, and Savin Hill and Malibu Beaches in Dorchester.

Watersheds

Boston Harbor Watershed

Boston is located within the Boston Harbor Watershed which encompasses about 293 square miles of land, including all or part of 45 municipalities. This watershed includes the Mystic River Watershed to the north, the Charles River Watershed to the north and west, and the Neponset, Fore, Back, and Weir river watersheds to the south.

The Boston Harbor watershed has metropolitan beaches such as Constitution Beach, Pleasure Bay, Carson Beach, Savin Hill Beach, and Tenean Beach. It also contains the Boston Harbor Islands National Recreation Area in the Outer Harbor. These islands contain trails, paths, campsites, beaches, and vistas that attract many visitors.

A publicly accessible, privately owned HarborWalk is being developed on waterfront properties through the Coastal Zone Management program and the Chapter 91 regulations, as well as Boston Redevelopment Authority (BRA) policy.

Boston is contained within the Mystic River Watershed, the Charles River Watershed, and the Neponset River Watershed. These watersheds are described below.

Charles River Watershed

The Charles River is 80 miles long and flows through 23 towns and cities southwest of Boston, beginning at Echo Lake in Hopkinton and ending in Boston Harbor. The river forms part of the southwest boundary of Boston, and also follows the north boundary of the city. The watershed comprises 308 square miles and includes 35 towns and cities.

The Charles River watershed has heavily used park systems such as the Charles River Reservation and the Emerald Necklace, as well as Stony Brook Reservation, Cutler Park, and Millennium Park.

Neponset River Watershed

The Neponset River Watershed includes about 130 square miles of land southwest of Boston. The river starts in Foxboro near Gillette Stadium and runs for 30 miles, through 14 cities and towns. It forms the southern boundary of the Boston and ends in Dorchester Bay / Boston Harbor, near the landmark gas tank along I -93.

Mystic River Watershed

The Mystic River Watershed covers 76 square miles and includes 21 municipalities. It begins north of Boston in Reading, then flows into the Upper Mystic Lake in Winchester, to Lower Mystic Lake, through Arlington, Somerville, Medford, Everett, Chelsea, Charlestown, East Boston and into Boston Harbor.


ARLINGTON
BELMONT
EVERETT
CHELSEA
REVERE
SOMERVILLE
Mystic River
Chelsea Creek
WINTHROP
MYSTIC
WATERTOWN
CAMBRIDGE
Charles River
Muddy River
BROOKLINE
Chestnut Hill Reservoir
NEWTON
BOSTON HARBOR (PROPER)
Dorchester Bay
BOSTON HARBOR
Jamaica Pond
CHARLES
WEIR
River
Charles River
Neponset
NEPONSET
MILTON
QUINCY
Mother Brook
DEDHAM
WESTWOOD
CANTON
0 0.5 1 2 3 Miles
N
Water Resources
Major Watershed
Charles
Boston Harbor
Subwatershed
Wetlands
Martin J. Walsh, Mayor
Water Resources
City of Boston
December 2014
Prepared by the City of Boston
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Rivers

The City of Boston is traversed by five rivers: the Charles River, the Muddy River, the Neponset River, the Chelsea River, and the Mystic River.

Charles River

The Charles River comprises eight miles of shoreline within the city including the Charles River Reservation and the parkways of Soldiers Field Road and Storrow Drive. The portion of the Charles between the Charles River Dam and Boston University Bridge is referred to as the Charles River Basin. This section of the river, which once inundated the Back Bay, is a wide and deep impoundment of freshwater used extensively for rowing and sailing.

Neponset River

The Neponset River flows east along seven miles of natural, meandering banks to the south of Boston through Hyde Park and along Mattapan and South Dorchester. This section of the River is bordered by the Neponset River Reservation, which includes a large tidal wetland in South Dorchester. The lower four miles of the river from Dorchester Bay to the Lower Mills Dam in southern Dorchester are tidal and frequently used for bird watching, picnicking, canoeing, and fishing.

Muddy River

The Muddy River originates at Jamaica Pond and flows north 3.5 miles before joining the Charles River. It flows through four distinct parklands designed by Frederic Law Olmsted: Olmsted Park from Ward's Pond to Leverett Pond, the Riverway from Leverett Pond to Park Drive and Brookline Avenue, the Back Bay Fens from Park Drive and Brookline Avenue to the Boylston Street Bridge, and Charlesgate from the Boylston Street Bridge to the Charles River.

The river's watershed drains 8.6 square miles of land, only 25% of which are in Boston. From Jamaica Pond to Leverett Pond, the 2% gradient is steep—an average of a two-foot drop in elevation every 100 feet downstream. This section flows through Olmsted Park, including Ward's Pond, Willow Pond, and several small waterfalls.

The lower section of the river flows from Leverett Pond to the Charles River with a gradient of less than 0.01%, causing the river to be essentially flat with little current. From Leverett Pond, the Muddy meanders through the Riverway before reaching the Brookline Avenue gates at Park Drive. When these gates are opened during times of flood, a portion of the river's flow is directed through the Muddy River Conduit under Brookline Avenue and is emptied directly into the Charles River. During periods of normal flow, river water travels one and one-half miles through the Back Bay Fens to the Charles River.

Since October of 1996, the Muddy River has flooded three times, causing damage to residences, businesses, academic, medical and cultural institutions and the public transit system in Boston and Brookline. To alleviate this problem, a dredging and ecological restoration project for this river, managed by the US Army Corps of Engineers, began construction in 2013. The objectives of the Muddy River Restoration project are:

- Improvement of flood control;
- Improvement of water quality;
- Enhancement of aquatic/riparian habitat;
- Rehabilitation of landscape and historic resources; and
- Implementation of Best Management Practices (BMPs).

Planned work includes channel improvements, removal of undersized culverts, installation of two new culverts, and daylighting two sections (about 700 linear feet) of the Muddy River; dredging approximately 200,000 cubic yards of sediment from the Fens, Riverway, Leverett, Willow and Wards Ponds; eradication of Phragmites from wetland and riparian areas by dredging and cutting/herbicide treatment; and preservation and restoration of the historic shoreline and vegetation in construction areas. The multi-phase project is anticipated to be complete by spring of 2016.

Chelsea Creek

Chelsea Creek (a.k.a. Chelsea River) is 2.6 miles long. It runs along Revere, Chelsea and East Boston and feeds part of the Belle Isle Marsh Reservation. The creek starts as Mill Creek in Revere, and flows east for .5 miles, then turns south where it becomes Chelsea Creek. It widens as it runs between Chelsea and East Boston, then turns southwest and runs into the Mystic River shortly before it empties into Boston Harbor.

Mystic River

There are approximately two miles of Mystic River frontage on Charlestown's north shore, and most of this is dominated by industrial marine transportation enterprises. The Mystic meets the Chelsea River under the Tobin Bridge to form the northern part of the Inner Harbor.

Brooks and Streams

Stony Brook

Stony Brook once traversed Boston for approximately seven miles. Most of the stream has been culvertized to accommodate development and stormwater conveyance. Currently, the only portion remaining above ground is at its origin in the Stony Brook Reservation in West Roxbury. The conduit carries mostly brook flow in dry weather and combined sewer overflows and stormwater flows in wet weather.

Canterbury Brook

Canterbury Brook is a tributary of Stony Brook. It is a partially culvertized and partially exposed body of water that is fed by Scarborough Pond in Franklin Park, and storm drains from Mattapan and Roslindale. The brook flows southwest through sections of the former Boston State Hospital, along the edge of the Boston Nature Center, through part of the Canterbury I Urban Wild on the edge of the Greenleaf Composting operation, through part of St. Michael's Cemetery, and then briefly along the northern side of American Legion Highway south of Walk Hill

Street. The brook disappears and reappears at various points along its route, dropping underground south of Walk Hill Street and ultimately merging with the Stony Brook Conduit.

Mother Brook

Mother Brook was the first canal constructed in the New World. Originating at a diversion dam on the Charles River in Dedham, it flows east through Hyde Park where it joins the Neponset River. The first three-quarter mile section of Mother Brook, located in Dedham, is an artificial canal excavated to connect the Charles River to a branch of the Neponset River formerly known as East Brook. Mother Brook diverts one-third of the flow of the Charles River.

Bussey Brook

Bussey Brook flows through portions of West Roxbury, Roslindale, and Jamaica Plain before discharging underground into the Stony Brook Conduit near the Forest Hills MBTA station. Like other streams in Boston, it has been almost completely buried, though remnant above-ground sections can be found in Allandale Woods and the Arnold Arboretum. Though seriously degraded by culverting and urban run-off, these remaining sections of Bussey Brook represent an important aquatic resource in Boston.

Sawmill Brook

Sawmill Brook traverses the perimeter of both Millennium Park (the former Gardner Street landfill) and the DCR Brook Farm Reservation in West Roxbury. Though channelized in sections and diverted by construction of the landfill, it is an important tributary to the Charles River. Small, wooded sections of Sawmill Brook occurring within the Brook Farm Reservation are critical habitat to a number of wildlife species, including a state-listed rare amphibian (see Wildlife section).

Dana Brook

Dana Brook was formerly the main drainage channel in West Brighton. It now lays completely underground from Chandler Pond to the Charles River, a distance of approximately one and one-half miles. Segments of Dana Brook still exist upstream of Chandler Pond, on the Newton Commonwealth Golf Course within Newton. This is the main inlet for Chandler Pond.

Ponds

Boston contains several ponds and a reservoir. These bodies of water vary in nature and origin from glacial ponds to river ponds to artificial ponds and reservoirs. Glacial ponds, called kettle ponds" were formed by glacial processes involving melting water and large blocks of ice deposited upon Boston's landscape, forming ponds. Kettle ponds are common in the Boston Basin. One example is Jamaica Pond, at approximately 80 acres the largest natural pond in Boston.

Turtle Pond is located within the Stony Brook Reservation in Hyde Park and is another natural pond of great significance. It is a popular fishing spot and, despite the presence of the adjacent Turtle Pond Parkway, is relatively undisturbed and has generally good water quality. In addition, several small, unnamed ponds within the Stony Brook Reservation provide critical habitat to a number of important wildlife species. Other small woodland ponds occur in Allandale Woods.

Boston also contains many artificial ponds, and ponds that are part of river systems. One of the most notable artificial ponds is the Public Garden Lagoon. This pond was created in 1838 during the construction of the Public Garden. Mill Pond in Hyde Park is an artificial pond that was created through an impoundment of Mother Brook. Chandler Pond, located in Brighton, was originally excavated for the purpose of producing ice. It is the last of more than 20 ponds once found in Brighton. Scarborough Pond in Franklin Park was dug out in the 1890s during the park's construction.

The DCR Chestnut Hill Reservoir, located in Brighton, is an artificial impoundment of water that once served as Boston's only water supply. The Reservoir was discontinued as a source of drinking water following completion of the Quabbin Reservoir in Western Massachusetts. The largest body of water located within Boston, the Reservoir is now used for scenic recreation purposes.

Among Boston's ponds that are part of river systems are Cow Island Pond which is a still water section of the Charles River in West Roxbury. The DCR-owned Havey Beach borders this pond. Ward's, Willow and Leverett Ponds are part of the Muddy River system located in Olmsted Park in Jamaica Plain.

Wetlands

Wetlands serve a vital function for Boston. They assist in flood control, treat stormwater run-off, and provide food and shelter to fish, birds, amphibians, and other important animals. However, in the last 100 years, 6,000 acres of coastal wetlands and approximately 50% of Boston's inland wetlands have been destroyed.

The largest single wetland in Boston, at 275 acres, is the Belle Isle Marsh in East Boston. Other substantial wetlands are found in the Neponset River Reservation in South Dorchester, the Stony Brook Reservation in Hyde Park, and the Brook Farm Reservation in West Roxbury.

Smaller yet still significant forested wetlands are found near the Leatherbee/Hancock Woods in West Roxbury, and at Allandale Woods in Roslindale/West Roxbury. Wetlands associated with rivers and streams include those along the banks of the Muddy River, Mother Brook, the Charles River, and Saw Mill Brook (see Section 4.4 for further description of wetland resources).

Aquifer Recharge Areas

Aquifers are areas beneath the surface of the earth that contain water, whether composed of permeable rock or unconsolidated materials such as gravel, sand, silt or clay. If they are uncontaminated and of sufficient yield, aquifers serve as a source of drinking water for people throughout the world, as well as here in Massachusetts.

In Boston, high and medium yield aquifers are found in two limited locations. Both types are found in West Roxbury along the Charles River, where open spaces uses, such as Cutler Park,

Millennium Park, the Rivermoor Urban Wild, Havey Beach, the West Roxbury High School athletic fields and marsh, and cemeteries dominate the landscape. Some residential, commercial, and industrial uses are also located in this area.

The second area is associated with the Fowl Meadows Area of Critical Environmental Concern (ACEC) in Hyde Park, at the southernmost tip of the city. Most of this medium yield aquifer is within the Fowl Meadows ACEC. Some of this aquifer lies within parklands held by DCR. Other portions are overlain by a residential area. One large portion is overlain by a warehouse complex.

The city of Boston is dependent on the DCR-MWRA regional system of water supply, which is based on surface water reservoirs located at great distances from Boston. Therefore, aquifer recharge area protection is not a critical issue for drinking water supply for this community. However, should the City desire at some point in the future to extract groundwater for non-drinking water supply purposes, development over these recharge areas may become an issue worth some consideration. The fact that much of these high and medium yield aquifers found within Boston's city limits are located in areas with some form of protection from development will help future generations, should the need ever arise.

Flood Hazard Areas

Areas with a greater chance of severe flooding are known as flood hazard areas. For purposes of federal and State law and policy, they are known to be areas where there is a 1% annual chance of flooding (aka the "100-year floodplain" or "FEMA Zone A"), or a 1% annual chance of flooding and an additional hazard associated with storm waves for coastal areas (aka "100-year floodplain" or "FEMA Zone V").

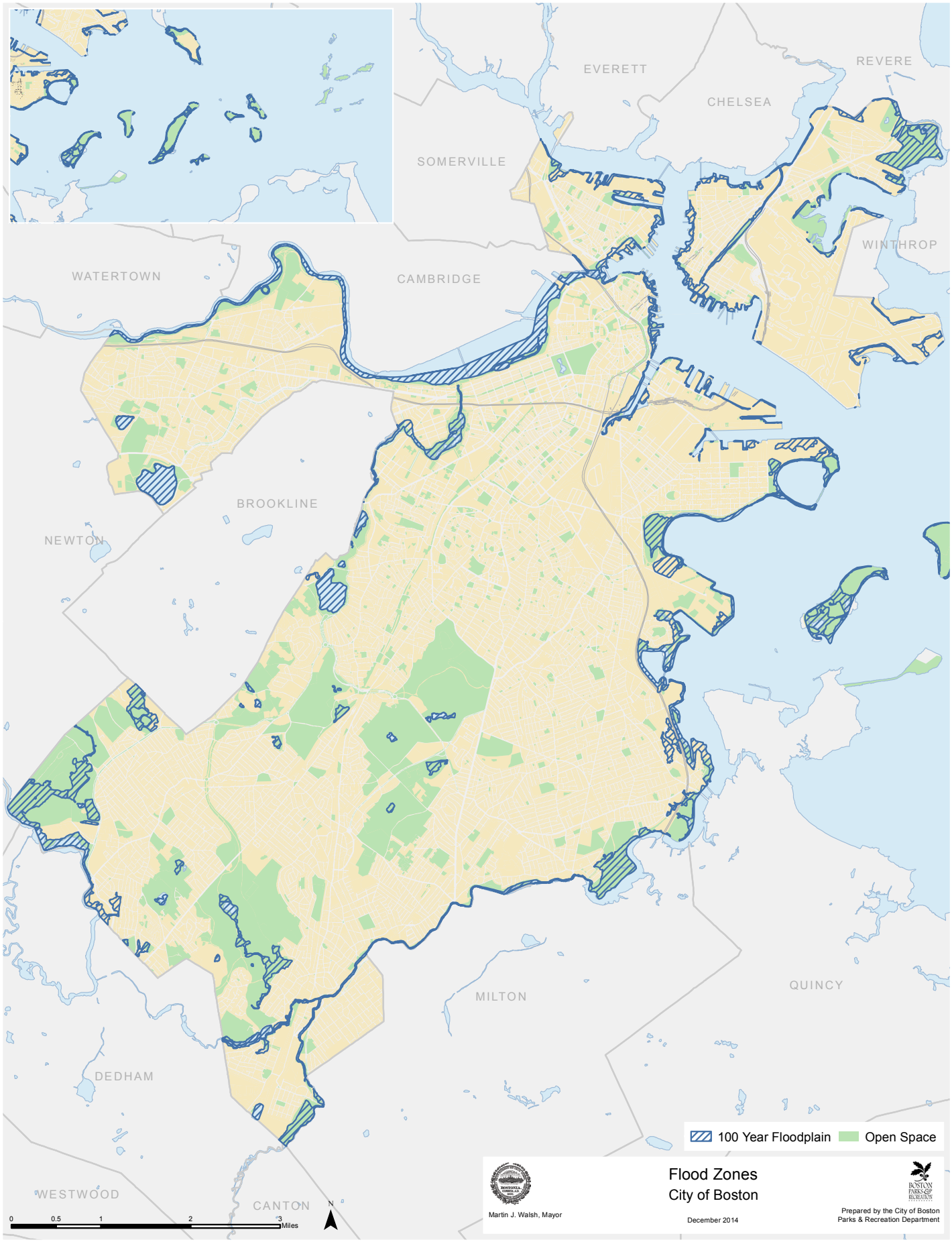
The city wide map titled "Flood Zones" shows the location of both FEMA Zones A and V (this map shows the official designations prior to the anticipated new FEMA maps to be issued in the fall of 2015, and effective in spring of 2016). These areas tend to be associated with major freshwater or coastal surface water bodies, such as Boston Harbor, Dorchester Bay, the Charles River, the Neponset River, and the Muddy River. The Flood Zones map also shows open space in the city, and these areas often overlap. Major exceptions tend to be found along coastal areas, such as the downtown, East Boston, Charlestown, South Boston, and Dorchester waterfronts. Flood hazard areas not within designated open spaces are found in some smaller inland areas in East Boston, West Roxbury, Hyde Park, and the Kenmore sub-neighborhood.

Many of the flood hazard areas are found within protected open spaces, ensuring that development in these areas, if any, will be limited. In those flood hazard areas not within open spaces, protected or not, such sites are typically highly developed. Whatever redevelopment takes place in such areas will be the subject of the State Wetland Protection Act and other laws affecting development in flood hazard areas. Flood hazard mapping is periodically revised to reflect changing flood risk factors such as sea level rise. Such a map revision is currently underway at the time of this writing.

The Chapter 91 regulations mandate public access and use along the water's edge and can help reduce flood impacts along flood hazard areas that may be valuable resources.

The Boston Redevelopment Authority (BRA), has developed municipal harbor plans that cover such areas as the downtown, Fort Point Channel, East Boston, and South Boston waterfronts in accordance with Chapter 91 and Coastal Zone Management policies. These plans and associated policies work with applicable regulatory review processes to ensure that development in coastal areas does not harm the environment, and is resilient in the face of coastal flooding.

The BRA also seeks to extend the HarborWalk along the coastal shoreline of Boston (except in working waterfront areas including Logan Airport and Designated Port Areas). BRA is assisted by the City's Conservation Commission which encourages public access along the water as part of its approvals, and by non-profit groups such as the Boston Harbor Association and Save the Harbor/Save the Bay.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100 Year Floodplain
Open Space
Martin J. Walsh, Mayor
Flood Zones
City of Boston
December 2014
Prepared by the City of Boston
Parks & Recreation Department

Section 4.4:

VEGETATION

Introduction

The natural vegetation of Boston is chiefly influenced by the city's geographic position along the Atlantic coast, the presence of landforms resulting from glaciation, and a long history of human land use and manipulation of native habitats.

Upland Vegetation

Forested Uplands

The Boston area, like most of eastern Massachusetts, lies in the Appalachian oak-hickory forest zone. This forest type occurs from southern Maine, throughout southern New England, south to Georgia at higher elevations, and west to western New York. Red, white, and black oaks, with lesser densities of pignut, shagbark, bitternut, and mockernut hickories are species found in the plant communities that dominate the Appalachian oak-hickory forest zone. Other trees commonly found are white ash, black cherry, black birch, hophornbeam, and red maple.

Numerous species of shrubs including lowbush blueberry, maple-leafed viburnum, witchhazel, flowering dogwood, and beaked hazelnut.

In Boston, the oak-hickory forest is mixed with patches of other forest types found in adjacent northern and southern regions. Elements of the northern hardwood forest, such as sugar maple, eastern hemlock, yellow birch, and American beech can be found in Boston's forested areas, especially on north and west facing ridges. These species are generally prevalent throughout northern New England and southeast Canada.

Conversely, areas in the city with well-drained, sandy soils and southeast exposures support woodland species more typical of Cape Cod and other coastal areas, such as pitch pine, scrub oak, and sweet fern. White pine is a ubiquitous species throughout the region, frequently occurring in abandoned pastures and other open, sunny locations.

Given the long history of industrial and residential development within Boston, it is not surprising that natural forests and other native plant communities occur today in remnants and small patches. The largest forested area remaining in the city is the 466-acre Stony Brook Reservation in Hyde Park, Roslindale, and West Roxbury.

Other significant forested areas are Allandale Woods (100 acres, West Roxbury), Hancock Woods (55 acres, West Roxbury), Sherrin Street Woods (25 acres, Hyde Park), the Wilderness (100 acres, Franklin Park), Olmsted Park (50 acres, Jamaica Plain), Brook Farm (120 acres, West Roxbury), parts of the Arnold Arboretum (Jamaica Plain), and sections of several Boston Harbor Islands.

Boston's forests provide a range of recreational, scenic, and ecological benefits. They are the city's lungs, cleansing the air of carbon dioxide and producing oxygen. Summer temperatures are up to ten degrees cooler in city forests, helping to mitigate the warming effects of urban development and activity. They also help control stormwater and filter pollutants from urban runoff. Healthy forest communities are essential for preventing excess sedimentation of waterways, wetlands, storm sewers, and catch basins by stabilizing erodible soils and steep slopes.

Many of Boston's forested areas are open to the public providing both formal and informal environmental education opportunities to schoolchildren, families, and adults. Recreational activities such as hiking, trail running, cross country skiing, wildlife viewing and tracking, and nature photography offer city residents and visitors the unique opportunity to experience and observe nature up close within the confines of an urban environment.

Though many of these areas are publicly owned and protected from outright development, they still suffer from a host of problems. Some, such as the Stony Brook Reservation, have been fragmented by the construction of parkways, creating more edge habitat, less interior habitat, and interrupting established wildlife corridors.

The habitat value of all forested areas is seriously degraded by the prevalence of non-native, invasive plant species. These plants were either purposely or accidentally introduced to the area and, because of their tolerant and hardy nature, have become major threats to the sustainability of native forest ecosystems. Among the most destructive non-native invasive plants in Boston forests are Norway maple, Japanese knotweed, European buckthorn, multiflora rose, Asiatic bittersweet, and Japanese barberry. In addition, people sometimes subject forested areas in Boston to direct abuse. Severe littering, illegal dumping, vandalism, and trampling by foot and vehicles are chronic problems in many urban forests.

Serious pests, blights, and diseases currently threaten several tree species. Most notable is the marked decline of the eastern hemlock caused by an insect parasite, the wooly adelgid. More recently, in 2014, the Emerald Ash Borer has been found in Suffolk County, placing another important canopy tree species at risk for decline. This discovery, along with the early detection in 2010 and successful containment from 2011 to 2014 of the Asian Long-Horned Beetle, have raised public awareness about threats to the City's tree canopy and overall environmental health.

Conservation through public ownership by itself is insufficient to protect Boston's forests from degradation. Funding, staffing, and active, hands-on management is also required to ensure the long term sustainability of Boston's forests. Non-native, invasive plants need to be controlled, eroding soil needs to be stabilized and revitalized, and native species of trees and shrubs must be planted in order to restore a healthy forest ecosystem. Early detection, control, and monitoring of invasive plants, pests, blights, and diseases must play a larger role in parks management.

In addition, activities that damage the forests—illegal dumping, fires, uncontrolled mountain biking, and off-road vehicles—must be curtailed, while beneficial and productive recreational and educational activities are promoted. It is of paramount importance to maintain the remaining forests to maximize the benefits they provide and ensure that they continue to function as viable ecosystems for future generations.

The global warming phenomenon will also affect plant hardiness zones. The effect of rising temperatures, and the impact on the growth of invasive plant species and pests, diseases, and blights could negatively affect some native species' sustainability.

Non-Forested Uplands

Non-forested uplands, primarily meadows, are a dwindling resource in Boston. Often a remnant of past agricultural use, virtually all meadows and pastures throughout the city have been subject to intense residential and commercial development. Most of those not developed have been left to grow into shrubby thickets and early successional forests dominated by non-native, invasive plant species.

Meadows and pastures provide critical habitat to many species of plants and wildlife that are rarely found in Boston and are increasingly uncommon throughout the northeast. These habitats offer great scenic value, breaking up the monotony of dense residential areas and providing expansive views of the city, Boston Harbor, and the surrounding landscape. Boston's meadows are frequently found atop hills and other steep slopes subject to erosion problems. Viable, healthy meadow plant communities are thus important to stabilize vulnerable soil.

Significant upland meadows today can be found in the Arnold Arboretum, Franklin Park, the Boston Nature Center, Calf Pasture, the Walter Street Tract, Allandale Farm, and on several Boston Harbor Islands. Most of these sites are current or former agricultural or horticultural sites. Turf grasses and opportunistic wildflower species of Eurasian origin are dominant. Farmers during the 17th and 18th centuries deliberately or accidentally introduced these species and turf grasses.

The acreage of meadow found in Boston increased substantially in 2000 with the opening of Millennium Park, a new park on top of the former Gardner Street landfill in West Roxbury. This 100-acre park includes over 70 acres of grassland comprised of both native and Eurasian grass species.

Because of the suppression of natural wildfires and the disappearance of farming practices such as haying and grazing, meadows now require regular intentional maintenance to sustain their open, pastoral character. Mowing is the most common method of maintenance; however in many cases mowing is done too frequently to allow for the development of a diverse meadow plant community. Such areas are generally devoid of any habitat value. To maximize floristic diversity and ecological value, most meadow habitats should be mowed only once per year, at the most, in the late summer.

The Parks Department through its Urban Wilds Initiative, conducts selective, low-impact mowing regimes at several meadows throughout the city's urban wilds and other natural areas. Community groups and other volunteers have also been involved in introducing native meadow plants, such as goldenrod and aster, and controlling non-native, invasive plant species at many sites.

Wetland Vegetation

Freshwater Wetland Vegetation

As throughout all of Massachusetts, Boston has lost a substantial percentage of its original freshwater wetlands to development. Intense filling and subsequent construction has occurred in the extensive marshes once found along Stony Brook, Bussey Brook, and the upper Charles River. Isolated wetlands, bogs, vernal pools, and small ponds have been filled for residential development. Remaining wetlands have been affected by changes to hydrology as streams have been buried and diverted to storm sewers.

Wetlands serve a vital function for the city. They help to store, control, and cleanse stormwater run-off, a function that becomes increasingly important as additional impervious surfaces are created. They also provide essential habitat for a wide array of wildlife (see Section 4.5).

Several distinct plant communities are present in freshwater wetlands in Boston. Forest wetlands—such as red maple swamps and floodplain forests—are typified by large trees, such as red maple, willows, basswood, green ash, silver maple, and a diverse shrub layer of dogwoods, alder, winterberry holly, viburnums, and swamp azalea.

An outstanding remnant of the southern New England floodplain forest, a rare community type recognized by the Massachusetts Natural Heritage Program, occurs along the Charles River shoreline of Millennium Park in West Roxbury. Other significant forested wetlands are found in the Stony Brook Reservation, Brook Farm, Sherrin Street Woods, and Leatherbee/Hancock Woods.

Non-forested wetlands – marshes, shrub swamps, and wet meadows – are dominated by shrubs, such as buttonbush, highbush blueberry, dogwoods, and elderberry, along with an extremely diverse collection of grasses, grass-like plants, and herbs typified by cattails, water willow, pickerel weed, arrow arum, bulrushes, and sedges. Typical marshes are found at Allandale Woods, West Roxbury High School, Brook Farm, along the West Roxbury stretch of the Charles River, and the Boston Nature Center.

Coastal Wetland Vegetation

Coastal wetlands, primarily salt marshes in Boston, were once the most dominant plant community within the city. Thousands of acres occurred along the harbor shoreline and up into the estuaries of the Charles, Chelsea, Mystic, and Neponset Rivers. Over the past 350 years, these salt marshes have been lost to filling, alterations to hydrology, pollution, and other drastic changes to the shoreline. Today only about 400 acres of salt marsh remain. These are primarily found at the DCR's Belle Isle and Neponset River Reservations in East Boston and Dorchester, respectively, and at Massport's Wood Island Marsh in East Boston.

Salt marshes comprise one of the richest and most biologically productive ecosystems on Earth. The precisely balanced cycles of tide, sedimentation, and decomposition all contribute to the production of up to ten tons per acre per year of vital nutrients, minerals, and organic material to nearby aquatic and terrestrial

habitats. Healthy salt marshes support dozens of animal species. Some species (ribbed mussel, salt marsh dragonfly, fiddler crab, for example) are restricted to this habitat for the duration of their lives, while other animals (sharp-tailed sparrow, mummichogs, meadow vole) use salt marshes for breeding or feeding but can also be found in other habitats.

Overwhelmingly dominated by salt marsh cordgrass and salt meadow grass, salt marshes also protect sensitive, low-lying coastal areas from flooding and other damage resulting from strong storms. They are vital to the maintenance of clean water in Boston Harbor. Other plants adapted to withstand the unique physical conditions in and around salt marshes include marsh elder, black rush, spike grass, glasswort, and sea lavender.

Both coastal and freshwater wetlands are particularly susceptible to the deleterious effects of urban development because they form the interface between surface waters and groundwater and developable or developed uplands. Public ownership alone is insufficient to protect them and preserve the vital functions they provide.

All of the wetlands occurring in Boston are degraded to a certain extent. They have been at least partially filled or drained, have received either too much or too little water, have been subjected to pollutants, and have been invaded by non-native, invasive plants that have out-competed the native species. The most destructive non-native plants in Boston wetlands are giant reed (Phragmites australis) and purple loosestrife.

The City of Boston is pursuing a number of programs to restore some natural functions to the city's degraded wetlands. The prime example of this is the restoration of the Muddy River and Back Bay Fens. This project, estimated at $43 million, aims to remove years of accumulated sediment and restore a diverse native wetland plant community.

The Condor Street Urban Wild in East Boston was a major remediation and salt marsh restoration project completed in 2003. It resulted in the removal of hazardous materials, the creation of a healthy salt marsh, upland meadow, pier, sculpture, pathways, benches and scenic overlooks for habitat and passive recreation uses.

The Belle Isle Coastal Preserve in East Boston, was completed in 2005 and culminated in the remediation and restoration of a previously degraded salt marsh, the reconnection and re-integration of land within the vast DCR Belle Isle Marsh Reservation, and the construction of a trail segment for the future East Boston Greenway extension.

Public Shade Trees

The urban forest is an ecosystem that provides benefits such as filtering dust, pollution, and the harmful rays of the sun, providing shade, protecting people and property from wind and weather, reducing air conditioning and heating costs for adjacent buildings, helping to filter storm water, and generally contributing to the physical well-being of the city's residents. Street trees also link highly developed spaces with more forested areas.

Further, trees consume and store carbon through absorption of carbon dioxide, and produce oxygen. By this carbon sequestration, the return of carbon to the atmosphere is slowed, especially if the tree is long-lived. Thus, the urban forest can help contribute to the slowing of global warming.

Current Initiatives

The city of Boston Climate Action Plan has established a target of reaching 35% tree canopy coverage in the city by 2030. To meet this goal, a detailed, actionable, Tree Canopy Plan that incorporates the City of Boston's Comprehensive Public Shade Tree Policy must be developed by government agencies and our non-profit and private sector partners.

Substantive tree canopy expansion can only be achieved through coordinated efforts to develop new policies that will better protect existing trees, both public and private, as well as grown and sustain new trees. The Boston Urban Forest Council, a group of non-profit, city, state, and federal organizations working to improve the urban forest ecosystem, public health, and the quality of life for Boston's residents, can play a key role in advancing tree canopy goals in the city.

In addition to caring for trees in its own parklands, the Parks Department is the agency with regulatory and operational responsibilities for city-owned shade trees in the street right-of-way. The ability to develop policy and day-to-day management plans in the same organization, the Parks Department, is a key part of the framework to ensure that the future of Boston is green.

Statutory Responsibility and Regulations

The Parks Commissioner is by statute (Chapter 87, Massachusetts General Laws) the Tree Warden of the city. Together with the Superintendent of Trees, the Commissioner is responsible for establishing a work plan for trees within the statutes and regulations that have already been established.

The City is in the process of revising its public shade tree policy, in order to make all regulations, technical specifications, operations, and programs current.

Inventory, Planting, and Maintenance

Over the Parks Commission's 130-year history the tree inventory has been replenished through budget expenditures on improvements to streets and parks. With the exception of the Emerald Necklace, little data existed to substantiate a sense among advocates that the inventory contains too few young trees relative to the percentage of mature trees. A visual inspection of streets provided subjective confirmation; however, the exact number, condition, and age of the canopy was unknown.

Inventory

With increasing competition for funding, the ability to identify critical problems quickly and efficiently has become crucial for the Parks Department. Through the use of inventory analysis, the city foresters can identify problems, or potential problems, easily and develop and implement precise and accurate management plans. The most recent street tree inventory was compiled in 2007.

The Emerald Necklace Conservancy drafted the Emerald Necklace Tree Inventory, Conditions Assessment and Management Plan for 7000 trees across 630 acres of the Emerald Necklace parks in 2014. This significant undertaking complements existing inventories of the trees in the Boston Common, Public Garden, and Commonwealth Avenue Mall.

A city-wide canopy assessment using remote sensing data was completed by Boston University in 2014 using imagery from 2005–2007 and 2009.

Planting

A major goal of the Parks Department's Urban Forestry Unit is to spread the benefits of tree planting—heat-island effect-reduction, water quality and air quality improvements, increase in well-being and property values—to all neighborhoods, especially those with a lower percentage of tree canopy cover, thus making it an environmental justice initiative.

On streets where sidewalk widths limit the viability of street trees, the city's front yard tree planting program can help achieve the public benefits of street tree plantings using private property. Expansion of this program can help meet the city's tree canopy goals over the next 16 years.

In fiscal year 2014, the Urban Forestry Unit anticipates planting 1350 street and front lawn trees (fall 2013 and spring 2014 planting seasons).

Maintenance

The Maintenance Division's Urban Forestry Unit is responsible for the pruning and removal of all trees under the jurisdiction of the Parks Department. In addition they supervise specialized treatments for disease such as Dutch Elm Disease and respond to such emergencies as snowstorms and hurricanes. The Department pruned over 2,106 trees, removed 681 trees, responded to 3155 maintenance requests, and answered 927 emergency tree calls in calendar year 2013.

Rare Species

Given the history of scholarly study in the Boston area, it is not surprising that the city's natural areas were well-traveled by knowledgeable botanists and naturalists during the 19th century and the city's flora well documented. The Massachusetts Natural Heritage and Endangered Species Program (MNHESP) lists several dozen rare plant species that are known to have occurred in Boston. Currently threatened plant species still present in Boston include Pale Green Orchis, Long's Bulrush, and Britton's Violet.

The vast majority of rare plant species habitat is long gone in Boston, but isolated occurrences may still exist in a few locations. In 2003, the New England Wildflower Society conducted botanical inventories at selected urban wilds in Boston. These inventories noted two potentially rare species that are listed by the MNHESP on their "watch" list. These species are Black Oat Grass (*Piptochaetium avenaceum*) and Violet Bush Clover (*Lespedeza violacaea*).

Cultural Communities

As one of the oldest cities in the U.S., Boston has a very long tradition of agriculture and horticulture. At one time, the majority of what is now the city was comprised of farmland. Jamaica Plain, Mission Hill, Dorchester, Roxbury, and Hyde Park were all intensely farmed into the early 20th century, providing food and supplies to the burgeoning industrial and commercial center in central Boston. Pieces of this activity still remain. Allandale Farm in West Roxbury and Brookline is the lone remaining working farm in Boston. It is planted with vegetables, fruit, hay, and cover crops that are sold at the farm's retail stand.

The Arnold Arboretum, managed by Harvard University on land owned by the Parks Department, is a world-famous facility with a collection of trees and shrubs from around the globe. The site contains several expansive, naturalistic meadows and unmanicured woodlands that provide excellent wildlife habitat and give visitors a sense of the area's pastoral history. The 25-acre Bussey Brook Meadow Urban Wild is one of the few areas within the Arboretum that is truly managed as a natural area.

Section 4.5:

FISH AND WILDLIFE

Introduction

Approximately half of Boston's 7,200 acres of open space, about 3,500 acres, is comprised of land that provides important habitat for a large number of plant and animal wildlife species. These areas are made up of reservations, beaches, urban wilds, portions of parklands, sections of the Boston Harbor Islands, campus areas, and privately-owned land. The diversity of these areas and the plant communities found at each, support an abundant collection of both native and non-native animal species.

Fish

The city's most diverse habitat for fish is Boston Harbor. This is probably one of the few habitats in Boston that supports a generally native wildlife population. It is also a major recreational resource for sport fishing. The commercial aspect of fishing, though integrally tied to the historic economic development of Boston, is almost completely limited to charter boats and other activity supporting sport fishermen.

The most significant fish in Boston Harbor are striped bass, winter flounder, cod, mackerel, bluefish, and monkfish. Other important species are pout, hake, dogfish, menhaden, and killifish. The clean-up of Boston Harbor has improved the habitat for all marine wildlife, though populations of several fish species are still imperiled by over-fishing and degraded habitats. Good access for onshore fishing is found at Castle Island, Long Island, Harbor Point and along the Dorchester and East Boston shorelines.

Boston's shellfish beds have been officially closed for many years. Abundant populations of clams, mussels, quahogs, and to a lesser extent, oysters, are still found within Boston Harbor. However, water quality has still not improved to the level required for state officials to allow their consumption, except for those found in certain small beds in Dorchester Bay and Constitution Beach Bay. Shellfish in those beds can be harvested with the proper license and made fit for human consumption with post-harvest cleansing at a shellfish purification facility.

Sport fishing also occurs on several of Boston's rivers and ponds such as Scarborough Pond, Chandler Pond, Turtle Pond, the Charles River, and most notably Jamaica Pond. The State stocks Jamaica Pond with hatchery-raised trout and smallmouth bass. Native species found in Boston's ponds include golden shiner, bluegills, pumpkinseed, chain pickerel, and American eel. These populations have suffered from generally poor water quality and non-native species such as carp, bass, trout, and goldfish.

The Charles River still supports seasonal migrations of some anadramous fish (species that generally live in salt water and return to freshwater for breeding), most notably Atlantic herring and American shad.

One State-listed rare species of fish occurs in Boston, the three-spined stickleback. This small, inconspicuous fish lives in a small pool in the Olmsted Park area. The species occurs commonly in marine habitats, but freshwater populations are rare in New England. The Boston population is the southern-most freshwater occurrence and the only one in Massachusetts.

Birds

Urban natural areas provide important, valued habitat for birds, other fauna, and wild plant species. More than 200 species of birds can be seen within Boston in one calendar year. This diversity stems from Boston's location on the Atlantic Flyway migration corridor and the diverse collection of habitats found within the city limits. Boston Harbor and its associated estuaries, salt marshes, beaches, and mud flats support numerous species of waterfowl, shorebirds, and seabirds. Forested areas and wetlands are home to resident songbirds and dozens of species of neotropical migrants in the spring and fall. Meadows and other open areas attract raptors and owls.

Birdwatching is an increasingly popular recreational activity in urban areas as more people discover the great array of birds found even in the midst of extensive development. In the Back Bay Fens area, over 170 species of birds have been documented by local birders, all within the shadows of Fenway Park and the Hancock Tower. At the Boston Nature Center in Mattapan, naturalists have documented approximately 150 species of birds. Other important and well-documented habitat areas for birds are the Arnold Arboretum, the Belle Isle Reservation, Franklin Park, and the Stony Brook Reservation.

The Massachusetts Natural Heritage Program lists six species of rare birds that have nested in Boston: Vesper Sparrow, Common Tern, Least Tern, Barn Owl, Peregrine Falcon, and Upland Sandpiper. Currently, the Upland Sandpiper is listed as endangered, the Grasshopper Sparrow is listed as threatened, and the Least Tern and Common Tern are listed as of special concern. In addition, several state-listed rare species, such as Pied-billed Grebe and Piping Plover, have nested in towns adjacent to Boston and could just as easily nest within the city boundaries.

Wild Turkeys have returned to the city after an absence of many years. Several Boston Harbor Islands host nesting colonies of egrets and herons. Given the colonial and sensitive nesting habits of these birds, these rookeries are of great regional significance.

The city also contains significant wintering habitat for several important bird species. Examples of this are the Snowy Owls and other birds of prey that spend most winters along the runways at Logan Airport. This phenomenon has been well documented by researchers at the Massachusetts Audubon Society with the cooperation of Massport.

Falling partly within the limits of the City of Boston are three Important Bird Areas (IBAs). Important Bird Areas have been identified and designated in more than 130 countries in order to focus attention on the significance of protecting critical bird habitats. The Massachusetts Audubon Society has taken the lead in identifying IBAs in Massachusetts. The Massachusetts IBA program may be viewed online through the Mass Audubon website. The three IBAs falling partly in the city of Boston are Belle Isle Marsh, the Boston Harbor Islands National Recreation

Area, and the Mystic River Watershed. Mass Audubon has urged that any public open space within these areas be managed in a manner compatible with the goals of the IBA program.

Several species of birds, both native and non-native, have grown in population to be considered public nuisances. The Common Pigeon, for example, was developed from the European Rock Dove and introduced into this country as a domesticated bird, but many of these birds escaped and formed feral populations. Today the pigeon is found in association with human habitations and regarded as a pest.

Other non-native bird species, such as the House Sparrow, European Starling, and House Finch, are also abundant in Boston and wreak havoc among populations of native birds. Humans introduced all of these species to North America. These non-native species have grown to a population size where they outcompete native species for food, nesting sites, and other resources.

Canada Goose and American Crow, both native species, have also experienced recent population explosions, causing a variety of problems among other native bird populations. The Canada Goose population has also created a negative impact on the quality of lawns and playing fields in parks, as well as water run-off from park lands.

Mammals

Like the rest of eastern Massachusetts, Boston is experiencing rapid and dramatic changes to its resident wild mammal population. A combination of factors—explosive residential development in the suburbs, intentional and inadvertent creation of forested wildlife corridors, and the continued habituation of animals to human activity, among others—has caused the sighting of species traditionally associated with remote wilderness areas to be an increasingly common occurrence within the city.

White-tailed deer, rarely seen within the Route 128 beltway only 20 years ago, are now year-round residents in Boston. Deer and signs of their presence—tracks, scat, antler rubbings, and browse—are frequently seen in Franklin Park, the Arnold Arboretum, Allandale Woods, and near Millennium Park, among other locations. As the presence of deer has become more common, concern may develop over the possible impacts deer have on public and private lands and public safety. Shrubbery browsed by deer, the prevalence of Lyme Disease, and the potential for deer-car collisions all contribute to the public's eventual intolerance for large populations of deer in dense residential areas.

Coyotes have also made a dramatic comeback to eastern Massachusetts, after being almost completely extirpated by a government-sponsored eradication program during the 19th century. Coyote sightings in areas of the city, such as along the Neponset River, have become more common in recent years.

Small mammals adaptable to humans and human settlements, such as raccoons, possum, striped skunk, and cottontail rabbits, abound throughout the city, in both developed and undeveloped areas. Less conspicuous mammals, such as mice, voles, shrews, and moles, though rarely seen, are also common in natural habitats.

Other Vertebrates

Reptiles and amphibians, commonly grouped as herpetiles, are imperiled animals, and their presence is used as an ecological indicator to gauge the health of an ecosystem. Common species found in Boston include green frog, bullfrog, painted turtle, red-eared slider (non-native), snapping turtle, garter snake, red-backed salamander, and two-lined salamander. Though these species are common elsewhere, their occurrence in Boston is sporadic at best, with only scattered records existing in a few neighborhoods.

The Massachusetts Natural Heritage Program lists the Blue-Spotted Salamander as a species of special concern in Boston. In addition, two state-listed rare herpetiles occur in West Roxbury. Species that should occur in Boston but have not been recently documented include milk snake, black racer, Northern-water snake, ribbon snake, American toad, and wood frog. Significant herpetile habitats are in the Stony Brook Reservation, the Brook Farm Reservation/Millennium Park area, and Allandale Woods.

Invertebrates

Insects and other invertebrates are also commonly used indicators of ecosystem viability, particularly for aquatic ecosystems. Preliminary studies of benthic macroinvertebrates conducted by the Parks Department at Chandler Pond, Scarborough Pond, Wards Pond, Willow Pond, and the Muddy River have shown very low species diversity, thereby confirming the poor water quality of these water bodies.

Wildlife Corridors

The undeveloped vegetated lands and the water bodies of the City of Boston play an important role in supporting wildlife. While in some cases, these are islands in a sea of urbanization, many of these lands and water bodies are connected so that even species with lesser mobility than birds and insects can traverse the cityscape.

Corridors associated with water bodies are the dominant corridors in the City of Boston. Much of the undeveloped harborfront serves as a wildlife corridor, and the Harbor itself and associated bays and estuaries serve as aquatic wildlife corridors. The Chelsea, Mystic, Charles, and Neponset Rivers also serve as terrestrial and aquatic wildlife corridors. Thanks to state, city, and federal agencies, these water-based corridors have protected lands that are vegetated and provide the ability for wildlife to move along them. The Charles River Reservation, the Neponset River Reservation, and the Belle Isle Marsh Reservation are among the largest of such land holdings. Smaller holdings also help, such as Millennium Park along the Charles, Constitution Beach along Winthrop Bay, and the Old Harbor Reservation along Dorchester Bay.

Then there are corridors that connect inland from these river- and harbor-based corridors. One of the most significant of these is the Emerald Necklace park system from Charlesgate at the Charles to the Back Bay Fens, the Riverway, Olmsted Park, and Jamaica Pond Park, linked by the Muddy River tributary to the Charles. There is a further land-based connection via the Arborway to the Arnold Arboretum. Then again, there is another land connection, either from the Arboretum to the nearby Allandale Woods tracts, or from Jamaica Pond Park through vegetated lands in the Jamaica Hills neighborhood and southern Brookline to Allandale Woods. From Allandale Woods, wildlife can connect via two parkways to two large vegetated areas of the city. Southward from West Roxbury Parkway, wildlife can connect to the Stony Brook Reservation & George Wright Golf Course area, and then connect to the Neponset via the Mother Brook, which is tributary to both the Charles and the Neponset. Westward from the VFW Parkway, wildlife can connect through the large group of lands in northwest West Roxbury, primarily cemeteries, but also conservation lands such as Hancock Woods and Brook Farm, and parkland such as Millennium Park, to the Charles River. The Neponset Valley Parkway serves as a corridor from the Stony Brook Reservation southward to the Neponset River Reservation and the Blue Hills Reservation in Milton and Canton.

A more isolated wildlife corridor of lands exists in what was once termed "the Heart of the City." This assemblage of vegetated lands exists surreounded by the neighborhoods of Jamaica Plain, Roxbury, Dorchester, Mattapan, and Roslindale. The biggest parcel is Franklin Park, but this corridor also includes the Boston Nature Center, and the following cemeteries: Forest Hills Cemetery, St. Michael's Cemetery, Calvary Cemetery, New Calvary Cemetery, and Mount Hope Cemetery.

Railroad corridors and associated lands can also serve as wildlife corridors. With Boston as a rail hub, many rail corridors from more rural parts of the state cross into the city. The Southwest Corridor and its associated Park serves as a wildlife corridor linking the highly developed Back Bay neighborhood to both the Emerald Necklace corridor and the Heart of the City corridor. It is likely that such a rail corridor or perhaps the Charles River Reservation was the likely route for the deer sighted in May 2009 in such downtown locations as Boston Common, the Public Garden, and City Hall Plaza. (It was killed when struck by a car on the Massachusetts Turnpike near Fenway Park.)

Section 4.6:

SCENIC RESOURCES AND UNIQUE AREAS

Scenic Landscapes

Boston has many scenic and significant landscapes that define the city's character. The most extensive landscape type is the waterfront. Whether along Dorchester Bay, the Inner Harbor, Belle Isle Inlet, the Mystic, or the Chelsea, saltwater-oriented landscapes form much of the basis for Boston's attractiveness.

Freshwater-oriented landscapes, such as the Neponset, Mother Brook, Bussey Brook, Scarborough Pond, and Chandler Pond also have great scenic charm. The two most notable scenic landscapes based on fresh water are the Charles River Reservation and the Emerald Necklace. In the midst of a densely developed urban area, these green corridors provide a visual and recreational respite. As envisioned by Frederick Law Olmsted and Charles Eliot, the views they afford, and the opportunity to stroll away from streets and through naturalized and recreational landscapes, provide relief from the hectic pace of urban life.

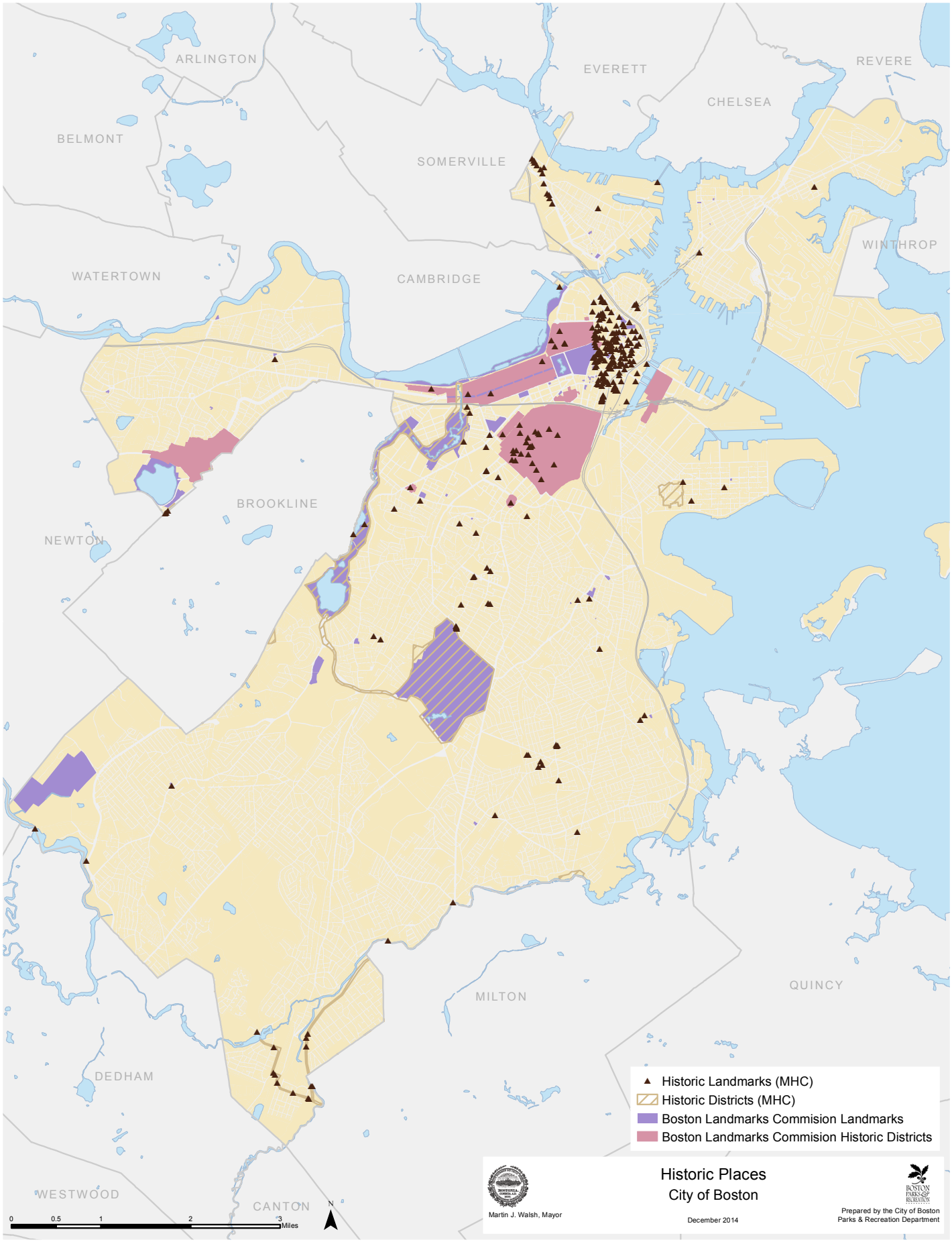
Some parklands developed on former landfills provide scenic landscapes themselves as well as the opportunity for viewing scenic vistas. Pope John Paul II Park along the Neponset in southern Dorchester provides views of the Neponset Estuary, including extensive estuarine wetlands. Millennium Park in West Roxbury forms a prominent hill along the banks of the Charles, a unique landform in the valley of a mature, meandering river. It provides vistas, especially to the west, that some have said are more typical of views from hilltops in rural Central Massachusetts. Of course, the exception is the view to the northeast, which shows the top of the glass Hancock Tower peeking over a wooded skyline.

Geological Features

Geologic features are described elsewhere in this section. The one geologic feature most appropriate for discussion in this particular section is Roxbury Conglomerate, also known as Roxbury Puddingstone, the State Rock of Massachusetts. This particular bedrock unit is unique to the Boston Basin, yet quite prevalent within the Basin. Its presence as a rock outcrop is seen occasionally in parts of the city, oftentimes because of the expense of blasting it to provide room for development. It forms a prominent feature in some parks and natural areas/urban wilds, such as Franklin Park, Allandale Woods, Hancock Woods, and Stony Brook Reservation. Such outcrops are natural play areas for children, who love to climb them.

Cultural and Historic Areas

Boston has numerous properties designated as historically significant, as well as entire districts so designated. Much of the Emerald Necklace is so designated as well as several other parks. The protection of such cultural and historical resources has become City policy and a facet of the character and strategy for redevelopment of neighborhoods, commercial areas, and parklands.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Historic Places
City of Boston
December 2014
Martin J. Walsh, Mayor
Prepared by the City of Boston
Parks & Recreation Department

A map has been included in this plan that shows the extensive designation of districts and sites throughout the city. These designations offer some degree of protection with a review process if federal or state monies, approvals, or licenses are required. Preservation of these areas not only protects the cultural heritage of Boston, but also maintains the visual character of the city.

Areas of Critical Environmental Concern

The Massachusetts Department of Conservation and Recreation (DCR) administers the Area of Environmental Concern (ACEC) program in order to identify, inventory, and ensure careful stewardship of the Commonwealth's outstanding natural resource areas. The City of Boston contains portions of three ACECs—Rumney Marshes, Neponset Estuary, and Fowl Meadow/ Ponkapoag Bog.

The Rumney Marshes

According to DCR's Office of Natural Resources, the U.S. Fish and Wildlife Service has characterized the Rumney Marsh ACEC as one of the most biologically significant estuaries in the state. The area includes approximately 1,000 acres of highly productive salt marsh, tidal flats, and shallow channels. The Belle Isle Marsh in East Boston is wholly included in the Rumney Marsh ACEC and is comprised of 275 acres of salt marsh, salt meadow, and tidal flats, providing critical wildlife habitat, flood storage, and water quality improvement functions. All of the Belle Isle Marsh is publicly owned by the DCR, except for small parcels owned by the Town of Winthrop and the City of Boston-owned Belle Isle Coastal Preserve, formerly known as Belle Isle Fish Company Urban Wild.

The Neponset Estuary

The Neponset Estuary ACEC extends from the mouth of the Neponset River to the Lower Mills Dam, which separates the tidal and freshwater sections of the river. About 435 acres of the 1,260-acre ACEC are located in Boston with the remainder located in Milton and Quincy. The Neponset Estuary provides valuable habitat for anadramous fish species, including smelt and blueback herring. Most of the open space along the Boston side of the estuary is owned by the DCR, providing a variety of public open space and recreational opportunities. The DCR's Lower Neponset River Reservation Master Plan provides a vision for the long-term development of these properties.

The Fowl Meadow/Ponkapoag Bog

The Fowl Meadow/Ponkapoag Bog ACEC is also located along the Neponset River, from the Readville section of Hyde Park and through the towns of Canton, Dedham, Milton, Norwood, Randolph, Sharon, and Westwood. Large areas of the 8,350-acre ACEC are part of the DCR's Blue Hills Reservation. This ACEC protects habitat for at least 13 rare species, several aquifers and public water supplies, floodplains, and wetlands associated with the Neponset and its tributaries. In Boston, Sprague Pond and the privately-held Sprague Pond Lakeside Access Area are located within the ACEC.

Section 4.7:

ENVIRONMENTAL CHALLENGES

Introduction

Boston's intense land use can pose threats to several different components of the environment. Recognizing and planning for these different threats is essential for the environmental protection of Boston and the region.

For example, most reflective of an environment's health is its water quality. Threats to water quality include hazardous waste sites, landfills, and sewer discharges. However, water itself poses a threat to the landscape. Flooding, erosion, and sedimentation threaten the constructed and natural landscapes of Boston.

The preservation and expansion of Boston's green spaces contribute to both climate mitigation and adaptation. Green spaces keep the city cooler in summer, thereby reducing the urban heat-island effect (black pavement and other urban structures absorb more solar energy than grass and trees). This reduces the amount of electricity (and associated greenhouse gases) needed for air conditioning and reduces the risks of more frequent heat waves posed by climate change. Greenery also increases the amount of groundwater recharge, thereby lowering flood risks.

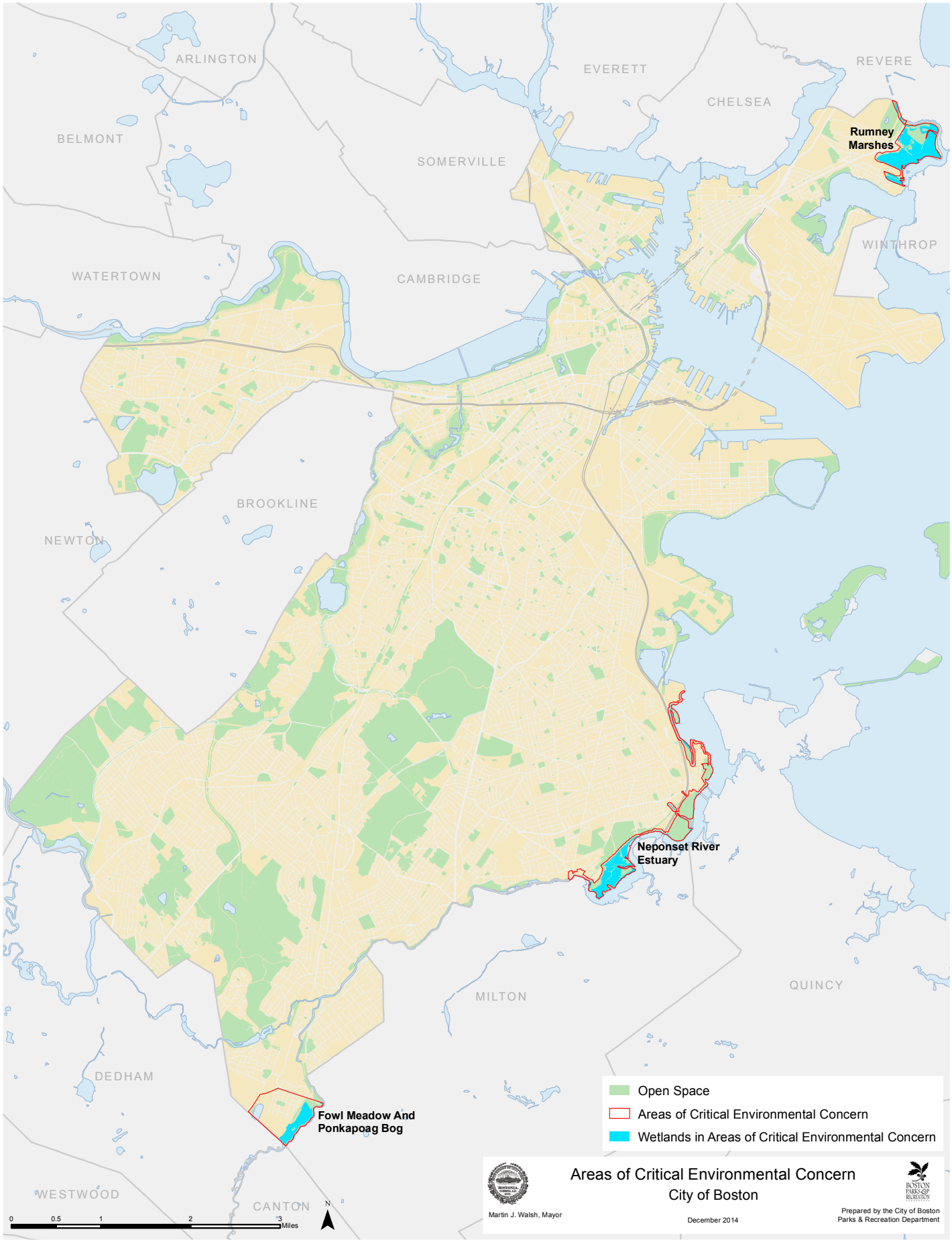
Hazardous Waste Sites

As of January 2014, there were 137 hazardous waste sites in the city of Boston.

A hazardous waste site is an area in which a hazardous substance has been released into the ground. The most common hazardous waste released is petroleum-based. Therefore, the most common hazardous waste site is one that has a land use associated with motor vehicles. This may be a gas station, service garage, or junkyard. Leaking underground tanks are responsible for a substantial amount of contaminated sites. These tanks commonly hold fuel oil for homes and businesses, or gasoline for service stations. Other typical locations of hazardous waste include dry cleaners and industrial land uses which use various chemicals in manufacturing or processing.

Once released into the ground, pollutants may migrate towards ground and surface water resources. If the contaminated soil is exposed to the air (not covered by concrete or asphalt) the pollutant may vaporize causing unusual odors and harmful vapors. Physical contact with contaminated soil may cause skin irritation. Remediation or cleansing of contaminated soils is necessary because of these threats.

The Massachusetts Department of Environmental Protection (MADEP) is responsible for enforcing laws that require remediation of contaminated sites (primarily MGL Chapter 21E). The 137 sites in Boston are either considered to be of highest priority for clean up, and therefore require MADEP permitting, or where classification is unconfirmed or not yet determined, so that many of these sites may not be seriously contaminated, making remediation a financially feasible possibility for reuse.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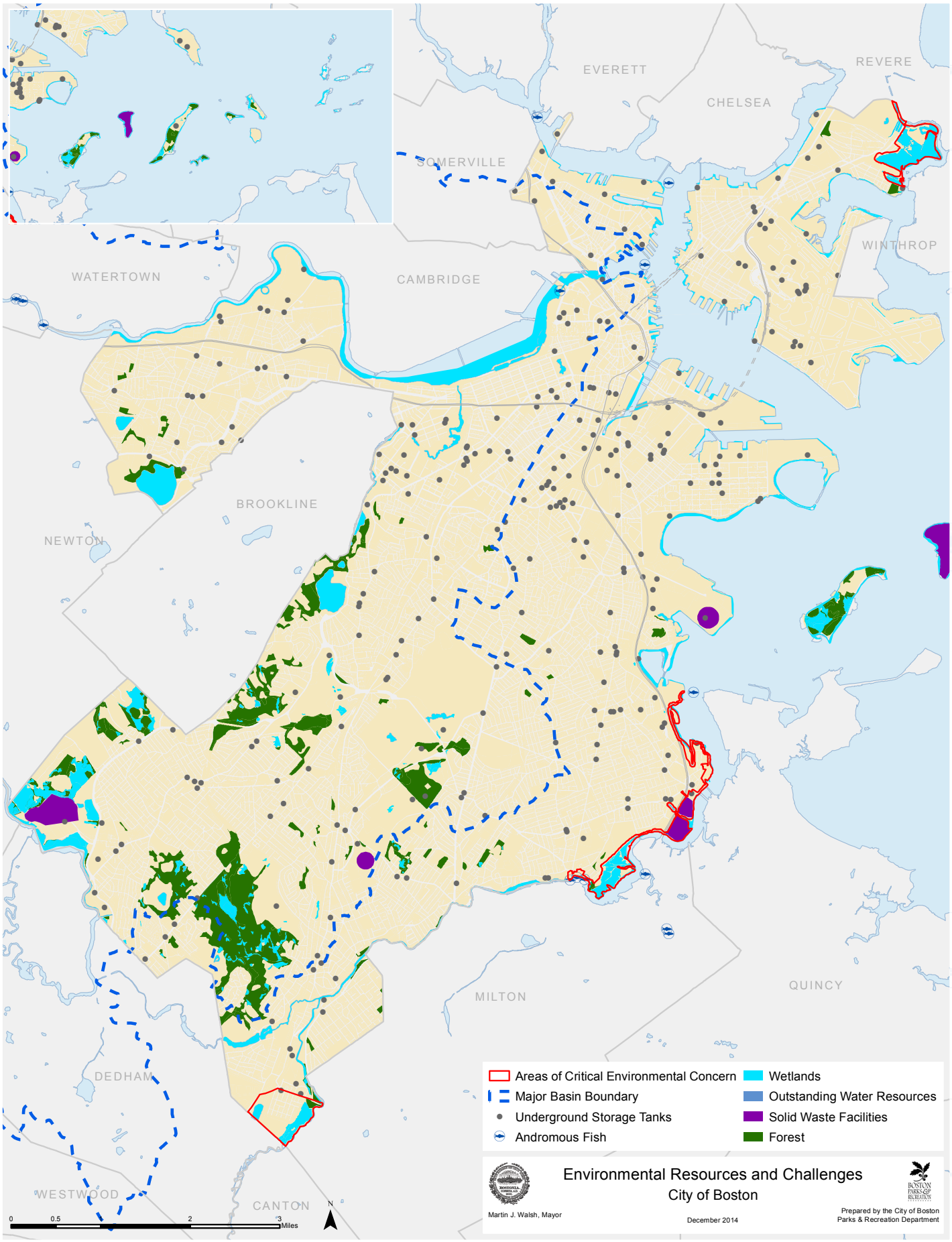
Areas of Critical Environmental Concern
City of Boston
Martin J. Walsh, Mayor
December 2014
Prepared by the City of Boston
Parks & Recreation Department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Underground Storage Tanks
Andromous Fish
Wetlands
Outstanding Water Resources
Solid Waste Facilities
Forest
Environmental Resources and Challenges
City of Boston
Martin J. Walsh, Mayor
December 2014
Prepared by the City of Boston
Parks & Recreation Department

Landfills

Boston does not currently have an active landfill, but does have several areas that have operated as landfills, dumps, or waste transfer stations. Former landfills include the Spectacle Island and Gardner Street landfills. Both facilities have undergone a capping that has resulted in the safe containment of waste and the creation of open space.

The Gardner Street landfill site is located on the banks of the Charles River in West Roxbury. The landfill's operation began in the 1930s and closed in 1980 but not capped. Contaminated surface runoff and groundwater flow posed a threat to the water quality of the nearby Charles River and its associated wetlands and groundwater resources. Excess material from the Central Artery Project was used to cap the landfill in 1997, which created the 105-acre Millennium Park which was dedicated in 2000. This park features several athletic fields, passive recreation areas, a canoe/kayak launch on the Charles River, six miles of paths, grasslands, and nature study areas.

The Spectacle Island landfill was located on Spectacle Island in the Boston Harbor. It operated until the 1950s. In an uncapped state, the dump presented a threat to water quality in the Boston Harbor. Excess material from the Central Artery Project was used to cap the landfill, which created 105 acres of primarily passive parkland. The park was opened to the public in 2006 with the completion of a visitor's center, walking paths, and a swimming beach. The Parks Department and the Massachusetts Department of Conservation and Recreation jointly manage this park.

The Hallet Street and Neponset Avenue Landfills are also capped and used as open space. DCR closed and capped the landfills, and created the Pope John Paul II Park which opened in 2000 as part of the Lower Neponset River Reservation. This park includes active and passive features as well as improvements for access to the water.

The other closed landfills in Boston are at Columbia Point in Dorchester along Dorchester Bay where UMass Boston and housing uses are found, and the Barry Quarry in Hyde Park, which is also known as the Oak Lawn Driving Range.

Erosion/Sedimentation

Channelized streams and ocean walls have historically controlled erosion along the city's waterways. Pavement or structures cover a large percentage of Boston's surface area, served by an extensive stormwater drain system. This minimizes most land erosion, yet also contributes to localized erosion problems both by increasing surface run-off volume and speed, and by concentrating flows at specific discharge points. Erosion also occurs in areas that are undeveloped and not served by storm drains.

Urbanization is associated with impervious surfaces that speed the delivery of water to the river channel and result in larger and quicker peak flows. These increased peak flows transport large sediment loads that are dumped upon reaching low energy environments (i.e., slower moving waters contained in broader, shallower channels).

In association with chronic erosion and uncontrolled run-off in Boston's open spaces, deposition of sediments has posed a threat to areas such as the Back Bay Fens and Muddy River system. The Muddy River is an area of intensive sedimentation within Boston (and Brookline). The Muddy River receives a large volume of inorganic sediment from storm runoff caused by the intense urbanization within the river's drainage basin. Large deposits of sediments are concentrated along the Riverway and Back Bay Fens sections of the Muddy River.

Construction of the Charles River Dam in 1910 prevented tidal flow into the Muddy therefore decreasing salinity and preventing flushing of river sediment. This river sediment has remained along the Muddy River's banks, creating point bars that contribute to the proliferation of the non-native, invasive Phragmites—a tall freshwater grass with robust, hollow stems and dense, tasseling flower heads that can be seen flourishing, up to 20 feet tall, along the banks of the Muddy River. Phragmites contributes to sedimentation of the river by trapping sediment, which then encourages further Phragmites growth. While the Phragmites trap sediment, pollutants chemically bound to the sediment seriously degrade water quality in the river. Pollutants found in sediment include trace metals, inorganic nutrients, and organic compounds.

Flooding

Boston is served by an extensive stormwater drainage system of dams, berms, and seawalls that have been designed to prevent flooding. However, changing weather patterns, coupled with aging infrastructure, will soon begin to strain the system. Annual precipitation is expected to increase by 5%–8% by 2050, and 7% to 14% by 2100 according to the *2011 Massachusetts Climate Adaptation Report*. In addition, the National Oceanic and Atmospheric Administration anticipates sea levels in Boston to rise by up to 2.2 feet by 2050 and up to 6.86 feet by 2100.

Recent major storms between 2010–2013 have caused substantial flooding in both coastal and inland neighborhoods. During a storm in March 2010, the City of Boston broke the record of 11 inches of rain previously set in 1953. Storm surge reached 6.5 feet. Major flooding was experienced. The MBTA's Green Line D branch was hindered by a sinkhole that washed out a track.

From December 2010 through February 2011, the City of Boston saw a series of winter storms that led to a record snowfall of over 70 inches, more than 45 inches above the average. Heavy snow, combined with rain led to numerous collapsed roofs, downed trees and utility lines and flooding problems throughout the City.

In October 2012, Hurricane Sandy brought high winds and coastal flooding to Boston. Sustained wind speeds of 41 mph and gusts to 62 mph were reported at Logan Airport. Seas were 20–25 feet just off the coast with a storm surge generally about 2.5 feet to 4.5 feet. Luckily, storm surge peaked at 4.57 feet in between high tide cycles, and as a result only moderate coastal flooding occurred within Boston. If the peak surge had hit five hours earlier at high tide, the city would have experienced severe flooding.

In February 2013, a blizzard known as Winter Storm Nemo, produced moderate to major coastal flooding, most notably during the time of the high tide Saturday morning. The 5th largest snow accumulation ever recorded of 24.9 inches occurred at Logan.

The City of Boston anticipates working with the Commonwealth of Massachusetts on planning for climate adaptation for the parks along the coast in light of the predicted increased flooding and sea level rise in the foreseeable future. City parks such as Condor Street Beach, the East Boston Greenway, Umana School Park, LoPresti Park, Porzio Park, Charlestown Naval Shipyard Park, Ryan Playground, Barry Playground, Little Mystic Access Area, Menino Park, Langone Park, Puopolo Park, Christopher Columbus Park, Long Wharf, Children's Wharf Park, L Street Beach, and McConnell Park will be affected by more frequent and intensive salt water inundation.

State parks along the coast in Boston are numerous and large in size. City and State parklands are often located side-by-side so an integrated system of adaptation is possible. Areas under the control of National Park Service, Massport, and private owners of the publicly accessible HarborWalk will also be affected by coastal flooding and its aftereffects, and could share common adaptation policies and practices.

Flooding in the Fenway/Longwood area is caused by the Muddy River system. High water levels in the Muddy River can occur as a result of intense surface runoff from storm events, high water levels in the Charles River, and the nearly level gradient of the

Muddy River in the Fenway area. These high water levels impede discharge from the Stony Brook Conduit, which carries stormwater, brookflows, and combined sewage from West Roxbury, Hyde Park, Roslindale, Jamaica Plain, and Roxbury.

Sewage Discharge

Approximately 380 million gallons of effluent (treated sewage) are released into Massachusetts Bay each day. Sewage from Boston and outlying communities is treated by the MWRA at the Deer Island Sewage Treatment Plant. The volume discharged is roughly equivalent to the combined flow of the Charles, Mystic, and Neponset Rivers. The Deer Island treatment facility now also treats sewage that is pumped under the Harbor from the former Nut Island treatment plant in Quincy.

The Deer Island treatment plant is the second largest in the nation. It uses two phases of treatment, primary and secondary. Primary treatment separates the sewage by allowing sludge (primarily human waste) to settle from the water. Secondary treatment uses microorganisms to consume the remaining human waste and toxic chemicals. The effluent is then disinfected with chlorine and is 90% free of human waste and 70% free of toxic chemicals. It is released from the facility via a 9.5-mile, 24-foot diameter deep rock tunnel. At its end, the tunnel diffuses the effluent into Massachusetts Bay where ocean currents mix and further dilute the effluent. This largely minimizes the impact of treated wastewater on Boston Harbor.

The most prominent point source pollution in Boston is discharge from combined sewer overflow systems (CSOs). Combined sewer overflow systems collect both sewage and surface water runoff from rainfall and snowmelt. During wet weather conditions, surface runoff causes sewer lines to overload. To prevent this overload from backing up into streets or basements, designated overflow discharge points are located along Boston Harbor and the Charles and Muddy Rivers.

Due to the various sources of CSO discharges, many pollutants may be present. These pollutants include fecal coliform bacteria, suspended solids, nutrients, metals, and floatable material. Discharges containing such pollutants create potential health impacts near areas such as swimming beaches and shellfish beds.

Substantial efforts have been made by the MWRA to reduce CSO discharge. Among these efforts is the expansion of the Deer Island Treatment Plant, which treats 89% of total overflow during an average rainfall year. An additional 6% of that overflow is treated by CSO treatment facilities that provide screening and disinfection of overflows. This accounts for treatment of 95% of discharges. Upon completion of further CSO improvements in the near future (anticipated by August 2015), the MWRA expects to treat 99.6% of overflows from combined sewer systems.

Water Quality

Water quality data used for this section was obtained from a *2002-2006 Charles River Watershed Water Quality Assessment Report* and the *2004–2008 Boston Harbor Watershed Water Quality Assessment Report* produced by the Massachusetts Department of Environmental Protection (MADEP).

Chelsea River

Locally known as Chelsea Creek, this river flows through a highly urbanized watershed dominated by industrial and commercial uses. Chelsea Creek is a Designated Port Area where water-dependent industrial and commercial uses are favored. Most of the petroleum for this region, and therefore the oil tanker traffic, travels through this river, which has been dredged to a depth of 38 feet. The City of Boston and Massport store road salt on its banks. CSO discharges to the river are allowed under the approved MWRA CSO Facilities Plan. MADEP classifies Chelsea Creek as SB_{CSO}.

In 2001, the EPA stated that the creek "is one of the most polluted tributaries of the Boston Harbor." Chelsea Creek was on the MADEP 2004 303(d) list of impaired waters, due to priority organics, unionized ammonia, organic enrichment/low DO, pathogens, oil and grease, taste, odor and color, turbidity, and objectionable deposits.

The first direct public access to the Chelsea River from East Boston was developed when the City's Parks and Recreation Department and the Urban Wilds Initiative, constructed a hazardous waste remediation and urban open space reuse project at the Condor Street Beach urban wild. The public now has access to view the river and the industrial activity and traffic. A portion of the site is now a restored coastal wetland.

Mystic River

Much of the Mystic River in Charlestown is classified as a Designated Port Area, with mainly industrial and commercial uses on both sides of the river, a channel depth of 40 feet for industrial and commercial shipping, and CSO discharges allowed under the MWRA CSO Facilities Plan. MADEP has classified the Mystic River as SB_{CSO}.

The Mystic River was on MADEP's 2004 303(d) list of impaired waters for metals, other inorganics, priority organics, unionized ammonia, organic enrichment/low DO, pathogens, oil and grease, taste, odor, and color.

During summer months, the river is on "Alert Status" due to organic enrichment and low DO that can impact aquatic life. During wet weather, elevated pathogen counts can impact primary and secondary contact recreation.

The MWRA CSO Control Program has installed a CSO storage tunnel in Charlestown near Barry Playground that has helped reduce CSO discharges.

The only public access to the Mystic River in Charlestown is from Ryan Playground, where the Parks Department recently installed a shoreline boardwalk, and at the Schraffts Center, which has a boardwalk installed as a result of the state-mandated Chapter 91 and the BRA-mandated HarborWalk requirements.

Inner Harbor

The Boston Inner Harbor consists of the Chelsea Creek and Mystic River confluence, the Upper Inner Harbor, Fort Point Channel, the Lower Inner Harbor, and the Reserved Channel. Land uses along the shores of the Inner Harbor include industrial, commercial, residential and recreational. The start of secondary treatment at Deer Island and the disposal of effluent via a 9.5-mile outfall tunnel into Massachusetts Bay, has helped to clean up the Inner harbor and has improved clarity.

The MADEP has classified the Inner Harbor as SB_{CSO} waters. The SB_{CSO} classification allows for fishing, but due to public health concerns MADEP's *2004–2008 Boston Harbor Watershed Water Quality Assessment Report* does not support consumption of fish or shellfish caught in the Inner Harbor. Wet weather discharges, discharges from Municipal Separate Storm Sewer Systems (MS4), and industrial point source discharge impact aquatic life, though primary and secondary contact recreation is supported. The Inner Harbor is on the 2008 Integrated list of Waters in Category 5: Waters Requiring a Total Maximum Daily Load (TMDL) for priority organics and pathogens.

Pleasure Bay

Pleasure Bay is part of the Olmsted-designed waterfront recreation area on the South Boston shoreline. It is mostly enclosed, with flow restricted to two channels between Castle and Head Islands. A beach stretches for two-thirds of its shoreline, and a pedestrian causeway linking Castle and Head Islands for the remainder of the length. Its use is primarily recreational, but the watershed generates urban storm runoff and storm sewer discharges. It is classified SB Shellfishing (Restricted).

Fish consumption is not supported, per the 2004–2008 MADEP report. The water body was not assessed for aquatic life or aesthetics in this report. Support with alert status is given for primary recreational contact with full support for secondary contact. Pleasure Bay is also on the 2008 Integrated list of Waters in Category 5: Waters Requiring a Total Maximum Daily Load (TMDL) for priority organics and pathogens. In 2013, Pleasure Bay was closed for one day.

Dorchester Bay

Dorchester Bay stretches from Head Island along the South Boston beaches to Columbia Point, then southward past Savin Hill to the mouth of the Neponset River and out to Thompson Island. Dorchester Bay's watershed has a mix of industrial, commercial, residential, and recreational uses. The MWRA CSO Control Program has reduced CSO discharges and improved water quality in the bay.

The surface water quality classification for Dorchester Bay is SB Shellfishing (Restricted), and it is listed on the 2008 Integrated list of Waters in Category 5: Waters Requiring a Total Maximum Daily Load (TMDL) for priority organics and pathogens.

The 2004–2008 MADEP report does not support consumption of fish and shellfish due to PCBs and other contaminants. It does not support primary contact due to discharges from municipal separate storm sewer systems and urban stormwater. Support is given for secondary contact recreation, and support with alert status for aquatic life.

Progress is being made in the improvement of water quality for primary contact recreation. In the 2006 season, Tenean Beach was posted against swimming for a total of 19 days, Savin Hill Beach for a total of five days, Malibu Beach for a total of five days, Carson Beach for a total of 14 days, M Street Beach for a total of eight days, and City Point Beach for a total of 12 days. For the 2013 season, conditions improved, with Savin Hill Beach not subject to any closure, Malibu Beach closed for three days, Carson Beach for three days, M Street Beach for two days, and City Point Beach for one day. On the other hand, for 2013, Tenean Beach was closed for 24 days.

Outer Harbor

Water quality for the Outer Harbor and the Harbor Islands typically meets water quality standards for bacterial contamination. The 2004–2008 MADEP report supports aquatic life and primary and secondary contact recreation in this surface water body. Fish consumption is not supported, nor is shellfishing for most of this area. The 2008 303(d) list includes the Outer Harbor (here called "Boston Harbor") as a water requiring a TMDL due to priority organics and pathogens.

Spectacle Island was capped with soils from the Central Artery project. This has helped to improve water quality, and created recreational amenity on the island. The Spectacle Island and Lovell's Island beaches were not closed due to water quality in 2013.

Winthrop Bay/Orient Heights Bay

Winthrop Bay is between East Boston and Winthrop. The 2004–2008 MADEP report indicates support for aquatic life and secondary contact recreation. Excessive pathogen levels have caused the bay to remain on the 2008 303(d) list of impaired waters. In the 2006 season, Constitution Beach was posted against swimming for a total of 16 days. For the 2013 season, this beach was posted for five days.

Neponset River

MADEP has reviewed the Neponset River in four segments that appear in whole or in part within Boston, three segments representing portions of the Neponset mainstem, and one segment representing the Mother Brook, a tributary to the Neponset.

The most upstream Neponset segment is eight miles long, from the confluence with the East Branch in Canton to the confluence with Mother Brook in Hyde Park. Approximately the two most downstream miles are within Boston city limits, north of the point where the boundaries of Dedham, Canton, Milton, and Boston meet.

Portions of this segment, including some portion of the segment within Boston, are within the Fowl Meadow/Ponkapoag Bog ACEC. Many portions of the banks in this segment are owned by the DCR as part of the Neponset River Reservation, with some of these parklands developed for land-based and water-based recreation.

This segment is classified as Class B Warm Water Fishery surface water quality. The 1999 MADEP report assesses conditions in this segment to be in partial support of primary and secondary contact recreation, while fish consumption is in non-support due to elevated PCB levels in certain fish. The 2004 MADEP 303(d) list of impaired waters includes this segment due to metals, priority organics, organic enrichment/low DO, oil and grease, pathogens, turbidity, and objectionable deposits.

Mother Brook is the first canal dug in the United States. It is 3.6 miles long, from its headwaters at the diversion of the Charles River in Dedham to the confluence with the Neponset in Hyde Park. A mix of land uses are along its banks, including parkland, residential, commercial and industrial. The DCR owns a considerable amount of the shore. The main public access to this river segment is in Hyde Park at Mill Pond.

This segment is classified as Class B surface water quality. The 1999 MADEP report assesses conditions in this segment to be in partial support of primary contact recreation and aquatic life, while secondary contact recreation is in full support. The 2004 MADEP 303(d) list of impaired waters includes this segment due to nutrients, organic enrichment/low DO, flow alteration, pathogens, taste, odor, and color.

The next Neponset mainstem segment starts at the confluence with Mother Brook and ends at the Milton Lower Falls Dam. For most of this length, the southern banks are within Milton town limits, and the northern banks are within Boston city limits. The land uses nearby are residential, with some industrial and commercial. Much of the banks are owned by DCR. They are wooded and often narrow and steep. Some limited public access to the river through these lands has been developed in recent years.

This segment is classified as Class B Warm Water Fishery surface water quality. The 1999 MADEP report assessed conditions in this segment to be in non-support of primary and secondary contact recreation due to pathogens, while fish consumption is in non-support due to elevated PCB levels. This report puts aquatic life in the segment on "Alert Status" due to historically contaminated sediments. The 2004 MADEP 303(d) list of impaired waters includes this segment due to metals, priority organics, organic enrichment/low DO, oil and grease, pathogens, and objectionable deposits.

The most downstream segment of the Neponset mainstem is estuarine, flowing from the Milton Lower Falls Dam to the mouth of the river at Dorchester Bay. Portions of the southern and eastern banks are within Milton and Quincy city limits; the northern and western banks are within Boston city limits. A variety of land uses, including estuarine wetlands and former landfills can be found on its shores. The landfills have been capped and made into a State park, Pope John Paul II Park. Most of the wetlands are under DCR management. A path for walking, bicycling, and other linear-oriented recreation has been established near the banks on lands primarily controlled by DCR.

This segment is classified as Class SB, Shell Fishing (Restricted) surface water quality. The 1999 MADEP report assesses conditions in this segment to be in non-support of primary and secondary contact recreation due to pathogens, while fish consumption is in non-support due to public health concerns. The 2004 MADEP 303(d) list of impaired waters includes this segment due to priority organics, organic enrichment/low DO, pathogens, turbidity, and objectionable deposits.

Shad, river herring, and rainbow smelt still return to the Neponset River. The US Army Corps of Engineers and the Massachusetts Riverways Program engaged in a feasibility study to evaluate alternatives for fish passage at the Walter Baker (Milton Lower Falls) and Tilestone and Hollingsworth dams along the river, as well as to examine opportunities for channel improvements and habitat restoration.

The BWSC sewer separation project in Dorchester has led to the elimination of CSO discharges to this segment of the Neponset, helping to improve conditions during and following wet weather events.

Charles River

The Charles River traces the northern edge of Boson and a portion of the southwestern edge of the city in West Roxbury. Much of the banks along this stretch are protected parklands and wetlands, while some land uses along these banks are industrial, commercial, and residential. The *2002–2006 Charles River Watershed Water Quality Assessment Report* produced by MADEP includes the 23-mile segment of the Charles from Chestnut Street in Needham to the Watertown Dam in Watertown.

A major effort to improve water quality in this section of the Charles was the capping of the Gardner Street Landfill in West Roxbury, which is now known as Millenium Park. This park provides public access to the river for secondary contact recreation. Such recreational use promotes watershed awareness, a necessary component to help change the public's behavior

toward best management practices at the individual level. Individual practices include cleaning up pet waste, discouraging feeding of waterfowl, and proper disposal of waste motor oil and household hazardous wastes.

This segment is classified as Class B, Warm Water Fishery surface water quality. The 2002–2006 MADEP Report indicates non-support for all categories for this segment. The 2008 MADEP 303(d) list of impaired waters includes this segment due to priority organics, nutrients, organic enrichment/low DO, pathogens, noxious aquatic plants, turbidity, and exotic species.

The Sawmill Brook is a 2.7 mile tributary to the Charles River that begins in southern Brookline, then travels through residential areas of southern Newton, through cemeteries, wetlands, and parklands in Boston before its confluence with the Charles at Millennium Park. The 2002–2006 MADEP Report indicates support for aesthetics only for this segment. The 2008 MADEP 303(d) list of impaired waters includes this segment due to other organics, organic enrichment/low DO, pathogens, noxious aquatic plants, and other habitat alterations.

The most downstream segment of the Charles River runs 8.6 miles from the Watertown Dam to the Science Museum Dam in Boston. This segment of the Charlese River is like a lake, due to the Science Museum Dam and the Charles River Dam downstream. Its highly urbanized watershed contrasts to the DCR parklands along much of its banks in this segment. Historically, water quality in this section was degraded by CSO discharges, urban stormwater runoff, and the contributions from tributaries. The 2002–2006 MADEP Report indicates non-support for aquatic life, fish consumption, and primary and secondary contact recreation for this segment. The 2008 MADEP 303(d) list of impaired waters includes this segment due to priority organics, metals, unknown toxicity, nutrients, organic enrichment/low DO, pathogens, oil and grease, taste, odor, and color, turbidity, noxious aquatic plants, and unknown causes.

The EPA has been working with the MWRA, the BWSC, and the Charles River Watershed Association (CRWA), and many other partners on its Clean Charles Initiative. Through negotiations, settlements, and joint projects, these partners have been able to achieve significant improvements to the number of days this segment of the Charles River can be used for primary and secondary contact recreation.

The MWRA CSO control program will achieve 99.5% reduction in CSO discharges to this segment from 1995 levels. Other efforts include the elimination of illegal cross-connections that contaminate municipal storm sewers that drain to the Charles or its tributaries, and negotiations and settlements with individual producers of discharges to the Charles. Public education to keep fertilizers, automotive care products, household hazardous wastes, excessive runoff, and pets and wildlife waste from entering the river has started to become an important strategy for improving water and recreation quality.

Muddy River

The Muddy River is a tributary to the Charles that forms the "backbone" for three of the Olmsted-designed Emerald Necklace parks—Olmsted Park, the Riverway, and the Back Bay Fens. While almost all of its banks are parkland, the river drains a highly urbanized watershed. Transportation corridors cross the river, such as State Route 9, the Massachusetts Turnpike, and commuter rail tracks.

The 2002–2006 MADEP Report indicates non-support for aquatic life, fish consumption, and primary and secondary contact recreation for this segment. The 2008 MADEP 303(d) list of impaired waters includes this segment due to priority organics, metals, nutrients, siltation, other habitat alterations, organic enrichment/low DO, pathogens, oil and grease, taste, odor, and color.

The Muddy River's flow is lake-like, as it has been affected for much of its length by the Charles River Dam. With historical CSO discharges, and ongoing urban stormwater discharges to the river, it has been highly impacted by sedimentation. This has consequently reduced the flood flow capacity of the river. The Army Corps of Engineers is currently undertaking an effort to improve flood control and water quality, as well as enhance riparian and aquatic habitat on the Muddy River

Environmental Equity

The environment provides resources such as open space and tree cover that is not uniformly distributed to all persons. For example, just one Beacon Hill townhouse may have a small but attractive backyard with trees and other plantings on a residential block with no other backyards. A residential block in West Roxbury may have each house with an ample backyard, frontyard, and sideyards. The residents of that Beacon Hill block may not have equal access to open space and tree cover *on that block*, while the West Roxbury block residents appear to on their block, on the other hand, within a short walking distance, those Beacon Hill residents have access to the Boston Common and The Public Garden (not to mention The Esplanade), while a car trip from that West Roxbury block will likely be needed to visit a similarly sized open space in West Roxbury, Millennium Park.

Overall for the city of Boston, there appears to be a reasonable amount of environmental equity. For example, the Trust for Public Land, a national non-profit organization with an interest in urban open space, has developed city park system rankings, called ParkScore. The city of Boston is one of three cities tied for third place among the 60 top ranked cities. One of the categories it ranks cities on is access to open space. Out of a possible 40 points, Boston received 40 points in that category. Further, they determined that neither age nor income had a significant influence on access to open space.

Access to open space is further discussed in Section 7.2 – Community Open Space and Recreation. While overall open space equity exists in Boston, there are pockets of need that are identified on a sub-community basis in that section.

Regarding tree cover (canopy), there too we find a counterintuitive result. An August 2014 article in *Science of the Total Environment* by current and former Boston University scientists (Raciti, Hutyra, and Newell) concluded "[i]n contrast to studies from other cities, we did not find strong correlations between neighborhood demographics and biomass. Boston is an old and

dense city with some of the wealthiest neighborhoods located in areas with the lowest biomass." The demographic characteristics studied included income, education, race and population density, and no correlations were found on those characteristics.

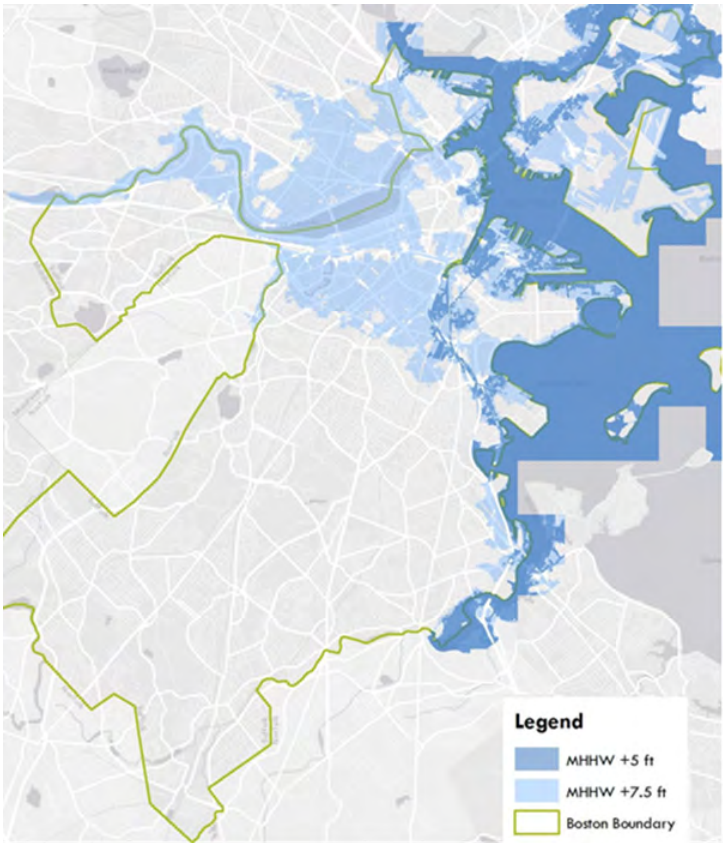
These authors provide a possible hypothesis for this result. They suggest that Boston being an older city, and trees being long-lived (especially in non-street conditions), that "today's neighborhoods have inherited the preferred landscapes of past communities." Boston in its earliest days was confined to the Shawmut Peninsula, connected by a narrow neck to the mainland at Roxbury. Surrounded by water in the humid summers, the wealthy sought relief in summer homes in Roxbury where breezes could be obtained. In the early nineteenth century, the filling in of Back Bay and the South Bay expanded the developable land near downtown Boston, creating sections of the South End, South Boston, the Back Bay, and the Fenway neighborhoods, which were then densely developed. This new land, filled at great cost, necessitated dense development with little land available to remain open and landscaped. As growth continued further, it spread to Roxbury, Dorchester and other outer areas, which made subdividing the summer estates there for denser housing an economic proposition. Yet while triple deckers, for example were developed, yard space was also provided, allowing the older tree stock to remain, in some sense preserving the original "preferred" landscape while the wealthier downtown residents sought second homes further afield, in towns farther away from Boston, such as along the North and South Shores in Massachusetts, and now even further out, such as Cape Cod, New Hampshire, Maine, Vermont, and Western Massachusetts. And the weekly exodus to second homes in greener landscapes on Friday evenings and the migration back at the end of two- and three-day weekends provides wealthier downtown residents living in denser parts of Boston that have excellent transportation access and access to entertainment and job opportunities, but little tree canopy, relief from this density and lack of tree canopy and access to nature.

The less dense areas of Boston such as Roxbury, Dorchester, Mattapan, Brighton, and Jamaica Plain have greater access to open space and tree canopy, and many residents rely on these close-to-home environmental resources for relief from the cityscape, as they have no second homes to visit. Thanks to the remains of the former summer estates and the good planning related to Frederick Law Olmsted, Sr. (Emerald Necklace and other pastoral parks), Charles Eliot (regional park system), and Joseph Lee (well distributed play-oriented parks), these areas did not suffer as much in terms of environmental equity from the relentless, unplanned spread of development associated with the "streetcar suburb" phenomenon. Current environmental justice populations which replaced the earlier immigrant populations in these areas benefit from the legacy of the open spaces and tree canopy still found in these neighborhoods. While some pockets in the city do exhibit open space and environmental need, it is not to the widespread degree that is generally thought of in other cities on the United States. These pockets are discussed in Section 7.2, Community Open Space and Recreation, and in Section 7.3.4, Public Shade Trees.

Climate Change, Mitigation and Adaptation

The map below shows that the areas of Boston that are vulnerable to climate change and sea level rise include parts of Charlestown, East Boston, South Boston, the South End, Fenway, Downtown, and along the Charles, Muddy and Neponset Rivers. According to *Climate Ready Boston: Municipal Vulnerability to Climate Change*:

- The number of days over 90 degrees in Boston could rise from the current average of 10 per year to an average of 31 to 62 per year by the end of the century; and days over 100 degrees could become a regular occurrence.
- Rainfall will likely stay about the same or slightly increase over the next 100 years. However, precipitation (including snow) will fall in fewer, more intense storms.
- There may be more time between precipitation events, producing more severe periods of drought. By the end of the century, droughts lasting one to three months could increase from about four in every ten years to about six or seven every ten years. Snow or rain, when it does fall, will likely fall in more concentrated bursts. This can overburden storm water management systems and lead to inland flooding
- There is a greater than 90 percent chance that average global sea level will rise between eight inches and 6.5 feet by the end of the century. Sea-level rise in Boston is likely to be greater than the global average, because Boston's land mass is subsiding, or sinking, at about six inches per century, and changing ocean currents and other features affecting the distribution of ocean water.



Projected Inundated Areas Due to Sea Level Rise

Benefits of Open Space

Open space can provide benefits that help to mitigate climate change and its impacts:

- Design of parks call allow these landscapes to adapt to and remain resilient in the face of climate change.
- Parks can be designed to mitigate flooding with the park, and can be an efficient means of addressing flood control.
- Well designed, constructed and maintained parks can help sequester carbon dioxide.
- Parks can also reduce ambient temperatures by provide shading and evaporative cooling, thus helping to reduce energy use needed for mechanized cooling.

Open Space and Climate Change

Given these vulnerabilities, the City of Boston is taking a multi-faceted approach to mitigating the impacts of climate change on city lands and city residents. The Parks Department has identified the following opportunities to address climate change:

Planning and Design

Conduct a citywide climate change impact survey for new and existing park areas to identify park sites and other landscaped amenities that are vulnerable to sea level rise, damage from violent storms, invasive species and pests, landscape succession, temperature related impacts, saltwater intrusion, and flooding from inland waterbodies or extreme precipitation. Give special attention to waterfront landscapes, geographically exposed landscapes, and sites with a history of flooding. Develop climate adaptation plans for vulnerable existing parks and landscapes. Design new parks to minimize risks related to climate change.

Flooding

Parks located near harbors or rivers may see increase in flooding. The Parks Department will assess the infrastructure in each park for vulnerability to flooding, as well as infrastructure alternatives in order to determine what action, if any, is needed to manage storm water retention and flooding in parks. Additional drainage may be needed in designs, as well as using hardy coastal plant materials and locating utilities in safe locations. New parks and other open spaces subject to storm surge and wave action may need to have wave breakers integrated in their designs. The Parks Department will utilize tools being developed by the Environment Department to incorporate sea-level rise considerations in the design of new projects.

Storm Water

The Parks Department will work with the BWSC to invest in infrastructure to reduce storm water run-off and retain water on site to reduce flooding hazards and provide irrigation for trees and plants. This can be achieved by use of rain gardens, retention basins, irrigation systems, permeable paving systems and less soil compaction.

Health and Safety

The Parks Department will work with the Boston Public Health Commission to develop educational materials and a campaign directed to park users regarding the health risks of mosquitoes (EEE and West Nile Virus currently) and high exposure to sunlight. Work schedules for maintenance workers will be reviewed for heat risks. Athletic permits will be reviewed to determine if extended hours and lighting are needed to schedule events that avoid peak hours of heat and sun.

Trees and Plant Materials

The Parks Department will replace or increase tree canopy on sidewalks and open spaces to reduce heat island effect. It will continue to survey the health and level of tree canopy with new survey information and continue to direct resources for replanting as needed to ensure shade. The Parks Department will continue to modify and update recommended tree species, plants, and turf lists to reflect current research and tree health concerns with regard to climate change issues such as heat, drought, wind, pests, and increased pollen production that can lead to an increase in allergies.

Power Consumption

The Parks Department will reduce energy consumption by upgrading systems and equipment such as field lights, street lighting, fountains, and irrigation systems.