City of Amesbury

Community Resilience Building

Summary of Findings

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Section 1.0 - Introduction and Background

1.1 - Introduction and Project Overview

Massachusetts Executive Order 569 creates a framework for building climate resiliency in Massachusetts. As part of this state-wide capacity-building effort, the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) has provided grant funding to the City of Amesbury (Amesbury) to complete a Municipal Vulnerabilities Preparedness (MVP) Program vulnerability assessment and action-oriented resilience plan, including hosting a Community Resilience Building (CRB) Workshop. The results of the Amesbury MVP Program are available in the City of Amesbury Community Resilience Building Summary of Findings Report (2019) (Amesbury CRB Findings Report). In addition to providing funding for the city to complete the MVP program, EEA provided funding for Amesbury to conduct a Natural Resources Infrastructure Assessment (NRIA) project. The purpose of the NRIA project is to assess the existing natural resource infrastructure assets within the city, to evaluate their climate vulnerability and/or resiliency, and to evaluate their capacity to support Amesbury climate resiliency goals. These climate resiliency goals were identified during the MVP process, and are included in the Amesbury CRB Findings Report.

In contributing to achieving Amesbury climate resiliency goals, the NRIA project identified potential nature-based solutions that help offset hazards from our changing climate, such as increased flooding (both freshwater and tidal), increased severe storm damages, increased wind damages, fluctuating temperatures and increasing heat and drought. Amesbury contracted with certified MVP Providers BSC Group, Inc (BSC) to provide consulting support as part of the MVP certification process. Amesbury also contracted with BSC for BSC to provide the necessary consulting services to implement the NRIA project with Amesbury leaders. This report is intended to provide a planning-level assessment of opportunities to develop nature-based solutions and associated potential long-term management strategies for addressing the challenge of climate change. The report results from a coarse-scale screening of natural resource infrastructure assets within the city of Amesbury.

More specifically, the NRIA project has completed the following tasks:

- Desktop assessment (MAPPR Tool 2.0, The Nature Conservancy Resilient Land Mapping Tool, NRCS mapping, FEMA floodplain mapping, etc.) of existing natural infrastructure assets, their climate vulnerability/resiliency and their capacity to support the climate resiliency of the Amesbury community (See Attachment A).
- Creation of maps that identify ecological climate resiliency on the landscape (See Attachment A).
- Three meetings with city leaders and community members to collect information on community natural infrastructure resiliency priorities (See Attachment B).
- Field investigations to further refine desktop mapping and to identify opportunities for increasing the climate resiliency of natural infrastructure assets, particularly those that provide climate resiliency for adjacent and downstream human communities, and for creating new nature-based solutions to the challenge of climate resiliency (See Attachment B).
- Preparation of a report that identifies and prioritizes opportunities to protect, enhance

and/or create expanded nature-based climate resiliency that supports the climate resiliency of the Amesbury community and associated infrastructure.

- The final NRIA project task, to share ecological climate resiliency maps and the NRIA project results included in this report with the Amesbury Community at one public meeting, was completed at a public listening session from 7 pm – 8 pm on May 16, 2019.

While this report provides a conceptual menu of potential future projects (see ensuing discussion and Section 2 and Attachment C), it is not intended to provide specific design plans, detailed permitting or cost analysis, or otherwise detailed surveys, reporting, or scoping for specific projects.

1.2- Ecological and Community Climate Resiliency

The climate resiliency of human communities tends to be greater when communities are integrated into a landscape that includes healthy ecosystems (Massachusetts Executive Office of Energy and Environmental Affairs Adaptation Advisory Committee, 2011). Anderson et al (2016) cite Naiman (1993) and Fremier (2015), stating, "Protecting wetlands and riparian corridors has been suggested as one of the single best actions in promoting resilience and in sustaining biodiversity." Communities that are proximate to healthy and functioning floodplains, salt marshes, forests and freshwater wetlands generally experience fewer problems with flooding than similar communities with highly impacted aquatic and wetland ecosystems. A widely cited study by Narayan et al (2017) reports coastal wetlands prevented $625 million in direct flood damage in the Northeastern United States during Hurricane Sandy. Another study reports that in the U.S., coastal wetlands provide $23.2 billion in storm protection services each year (Costanza et al 2008). In Massachusetts, the Charles River Natural Valley Storage Project, in which 17 wetlands located in the middle and upper part of the Charles River watershed were purchased to provide flood storage, is estimated to have prevented $6 million in flood damages. The purchase of the 17 wetlands saved millions of dollars when compared to the cost of constructing a flood control structure.

Similarly, drought has less of an impact on community water supplies and streamflow when wetlands in the watershed are protected so that they are able to act as reservoirs for ground and surface water. Severe storms, sea level rise, and storm surge do less damage to coastal communities if coastal and estuarine wetlands, salt marshes, and sea grass beds are healthy and protected. Wetlands provide localized cooling because they store water, and forested areas create shade, which enhances climate resiliency for neighboring humans, wildlife, crops, and native vegetation. Wetlands, riparian areas and forests provide corridors for wildlife to traverse the landscape and move in response to changes in climate, thereby increasing the resiliency of wildlife populations (Anderson et al 2016). Additionally, healthy ecosystems (particularly wetlands and forests) store carbon, and thus contribute to deceleration of global warming and climate change (Moomaw et al 2018).

Section 2.0 - Natural Resource Infrastructure

2.1 - Climate Resiliency Assessment: Mapping

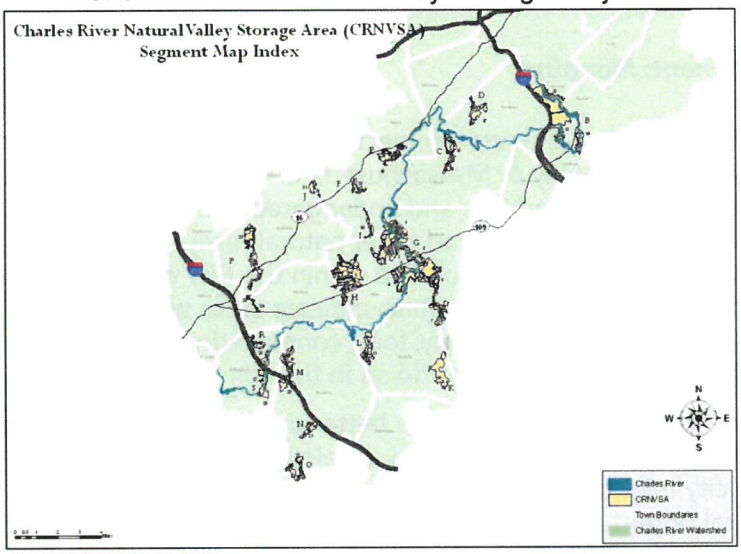
Using The Nature Conservancy's (TNC) "Resilient and Connected Landscapes for Terrestrial Conservation" (RCL) GIS datasets, the University of Massachusetts CAPS MA Index of Ecological Integrity dataset, the Massachusetts Natural Heritage and Endangered Species Program BioMap2 tool and MassAudubon's MAPPR Tool 2.0, and other natural resource mapping, the ecological climate resiliency and biological condition of land within the City of Amesbury was evaluated. Attachment A provides the resulting maps, which indicate areas within the city that provide the greatest level of ecological climate resiliency, local connectedness, and ecological and habitat integrity, and are most likely to continue to do so in the coming decades.

Citizens and leaders in Amesbury can utilize these maps to better understand the ecological climate resiliency or vulnerability of specific locations when developing and comparing potential project plans. For instance, the city might have the resources to fund a project, and during the planning process consider several potential sites for the project. Considering and comparing each site's ecological climate resiliency allows decision makers to select the site that offers the greatest ecological climate resiliency benefits. Other factors would of course be considered in decision-making as well. Another example would be to use the maps to identify opportunities for ecological restoration or enhancement. If a site receives an average or below ranking, then it could be further evaluated to see if specific actions would enhance the area's climate resiliency. A third example is to utilize the maps to identify adjacent communities with high value ecological resources in close proximity to similarly high value ecological resources in Amesbury. By identifying larger areas of ecological strength, or areas that provide corridors between large areas, Amesbury could collaborate with neighboring communities to protect and conserve regionally significant ecological resources and the ecological and climate resiliency ecosystem services that they provide.

One of the top climate resiliency action priorities that MVP CRB Workshop participants identified (see Amesbury CRB Findings Report) is the need for Amesbury to address existing and future flooding problems. Another identified resiliency need is to protect water quality during flooding and severe weather events. Workshop participants recognize the significant role that natural resource infrastructure and Nature Based Solutions to climate challenges play in achieving community climate resiliency.

In reviewing the available ecological climate resiliency mapping, one area in Amesbury in particular, Woodsom Farm and surrounding undeveloped areas, stood out as providing significant ecological climate resiliency, flood control, water quality and wildlife habitat value. Woodsom Farm and surrounding undeveloped areas are the largest contiguous area within Amesbury that score in the slightly above average to far above average range on the TNC Ecological Climate Resiliency Map, meaning that this area is likely to be the most ecologically climate resilient within Amesbury. Adding to its value, this area connects to a large area of high ecological climate resiliency to the north of Amesbury, and therefore is part of a regionally significant area of ecological climate resiliency that provides migration pathways for species moving in response to changes in climate. BioMap2 identifies a portion of Woodsom Farm as BioMap2 Core Habitat. Floodplain (see Street & 100-Year Floodplain Map) and hydric soils (poorly drained and very poorly drained) (see NRCS SSURGO Soils Map) occur in the Woodsom Farm and surrounding areas, indicating high value for flood storage and for water quality.

Charles River Natural Valley Storage Project



Source: U.S. Army Corps of Engineers

Benefits

- Flood Control
- Stormwater Management
- Reduced Costs
- Education/Recreation
- Habitat Enhancement
- Pollution Mitigation
- Carbon Storage

Woodsom Farm is located northwest of the city center and provides significant wetland and flood storage areas associated with the Powwow River, which flows through Woodsom Farm to Lake Gardner, and thence through downtown Amesbury. The City had originally purchased Woodsom Farm to eliminate odors from the farm's piggery and have since recognized it's significant recreational and ecological values and ecosystem services. Of particular note is the use of the grassland habitat by bobolinks (*Dolichonyx oryzivorus*) for nesting. By protecting floodplains and wetlands at Woodsom Farm, the city currently is protecting the downtown area in a similar, if smaller scale, way to how the Charles River Natural Valley Storage Project protects community infrastructure in the lower Charles River watershed. Specific future conservation actions could include developing a flood and water quality protection zoning overlay and providing community education and outreach to increase awareness of the importance of this resource.

The Nature Conservancy's (TNC) "Resilient and Connected Landscapes for Terrestrial Conservation"

The TNC Resilient and Connected Landscapes datasets are based upon an evaluation of geologic setting, landform diversity, local connectedness, regional connectedness, and biological condition/ecological integrity. TNC's website http://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/terrestrial/Pages/default.aspx provides a detailed explanation of methods and the science behind their mapping tool. Additionally, the TNC "Resilient Sites for Conservation in the Eastern United States" fact sheet and their "Terrestrial Resilience Core Concepts" information page from their website are included in Attachment A. These fact sheets provide an explanation of the ecological concepts and science that underlie the TNC datasets. Mapping of ecological climate resilience, local connectedness, and ecological integrity is based on relative scores for locations on the landscape. These maps compare areas of similar geophysical setting to each other, within the larger ecoregion, and rank locations based on how far below or above average they are (in standard deviations). TNC RCL maps in Attachment A include:

- Ecological Climate Resiliency (Amesbury) Map
- Ecological Climate Resiliency Regional Map
- Priority Resilient and Connected Landscapes Map
- Local Connectedness Map
- Landforms Map
- Landscape Diversity Map

University of Massachusetts CAPS MA Index of Ecological Integrity

The Landscape Ecology Program at the University of Massachusetts (UMass) developed the Conservation Assessment and Prioritization System (CAPS) mapping program for evaluating the ecological integrity of land and waters. As part of this initiative, Index of Ecological Integrity maps are hosted on the UMass Landscape Ecology Lab website: https://www.umass.edu/landeco/research/caps/data/iei/iei.html

Attachment A includes a CAPS Ecological Integrity Index map for the City of Amesbury, which indicates low to average ecological integrity in the city. The "Five Color" Ecological Integrity Index Map identifies different habitat types by assigning them different colors. Citizens and leaders of Amesbury may find these maps useful as they evaluate different potential projects and wish to understand the ecological integrity of different areas in the city.

Massachusetts Natural Heritage and Endangered Species Program BioMap2

The Massachusetts Natural Heritage and Endangered Species program provides the following definition of BioMap2 at http://maps.massgis.state.ma.us/dfg/biomap2.htm :

> BioMap2 is designed to guide strategic biodiversity conservation in Massachusetts over the next decade by focusing land protection and stewardship on the areas that are most critical for ensuring the long-term persistence of rare and other native species and their habitats, exemplary natural communities, and a diversity of ecosystems. BioMap2 is also designed to include the habitats and species of conservation concern identified in the State Wildlife Action Plan.

The Massachusetts Natural Heritage and Endangered Species Program, at http://maps.massgis.state.ma.us/dfg/biomap2.htm, provides the following definitions for BioMap2 designations in Massachusetts:

Core Habitat totals 1.2 million acres, of which 680,000 acres remain unprotected.

Core Habitat includes:

- Habitats for rare, vulnerable, or uncommon mammal, bird, reptile, amphibian, fish, invertebrate, and plant species
- Priority Natural Communities
- High quality wetland, vernal pool, aquatic, and coastal habitats
- Intact forest ecosystems

- Critical Natural Landscape totals 1.8 million acres, of which 1 million acres remain unprotected.
- Critical Natural Landscape includes:
- The largest Landscape Blocks in each of 8 ecoregions
- Adjacent uplands that buffer wetland, aquatic, and coastal habitats

The Amesbury BioMap2 Map indicates areas of BioMap2 Core Habitat along the Merrimack and Powwow Rivers and in the vicinity of Lakes Gardner, Lake Attitash, and Tuxbury Pond, and in an area adjacent to Middle Road. BioMap2 can be utilized by Amesbury citizens and leaders to identify and protect high value habitat within the city.

MassAudubon's MAPPR Tool 2.0

Massachusetts Audubon (MassAudubon) has developed the Mapping and Prioritizing Parcels for Resilience (MAPPR) Tool 2.0, which is hosted on their website at https://www.massaudubon.org/our-conservation-work/advocacy/shaping-the-future-of-your-community/current-projects/mappr-project/mappr-tool . MassAudubon states,

Mapping and Prioritizing Parcels for Resilience (MAPPR) allows land conservationists to identify the parcels within an area of interest that are the highest priorities for protection based on habitat quality, climate change resilience, and other metrics such as parcel size and adjacency to existing protected parcels.

MAPPR Tool 2.0 identifies parcels in the vicinity of Woodsom Farm, Lake Attitash, Tuxbury Pond, the Merrimack River, Lake Gardner, and the Back River as being of greatest climate resiliency and conservation value (see Amesbury MAPPR Resilience Model and MAPPR Aquatic Model Maps).

Other Natural Resource Mapping

Street & 100-Year Floodplain Map

This map provides an Amesbury street map and map of the FEMA 100-year floodplain in Amesbury. Floodplains occur in the vicinity of the major rivers (Merrimack, Powwow, and Back Rivers) and their tributaries, Lakes Gardner and Attitash, Tuxbury, Clark's and Bailey's Ponds, and at Woodsom Farm and surrounding areas. Floodplain associated with the Powwow and Back Rivers occurs in downtown Amesbury and in the vicinity of the National GRID power station.

CZM/NOAA Sea Level Rise Inundation Map

The Amesbury Sea Level Rise Inundation Map (based on MassCZM and NOAA data) indicates the mean high water elevation under different sea level rise (SLR) scenarios, from 1 foot of SLR to 6 feet of SLR. Areas along the Merrimack, Powwow and Back Rivers will experience increases in mean high water elevations under all scenarios from 1 foot to 6 feet, with greater increases occurring the greater the SLR.

Hurricane Storm Surge Map

The Hurricane Storm Surge Map (based on MassGIS and MassCZM data) indicates the level of flooding caused by coastal storm surge that Amesbury has experienced under different hurricane scenarios (Categories 1 through 4). Areas along the Merrimack, Powwow and Back Rivers experience coastal storm surge flooding under all scenarios from hurricane categories 1 through 4, with greater increases occurring the higher the hurricane category number.

NRCS SSURGO Soils Map

The NRCS SSURGO Soils Map provides a guide to soil types and drainage classes. The drainage class mapping indicates areas of poorly drained and very poorly drained soil in the Woodsom Farm and surrounding areas, confirming that this area is particularly valuable for flood storage and water quality ecosystem services. In addition, poorly drained and very poorly drained soils often have higher than average soil organic carbon content, and therefore provide carbon storage services.

Amesbury Data Viewer

As part of the MVP CRB project, BSC developed an online data viewer specific to the City of Amesbury that allows the viewer to access various online data layers superimposed on the City of Amesbury, including some of the mapping discussed in this report. This represents a valuable tool for city leaders and citizens engaged in the process of planning for a climate-resilient future. The Amesbury Data Viewer can be accessed at:
https://bscgroup.maps.arcgis.com/apps/webappviewer/index.html?id=adb2e1484d4440ddbc493fba53f09f8a&extent=-7912961.7606%2C5280505.4813%2C-7876271.987%2C5297837.5775%2C102100

2.2 - Ecological Restoration and Climate Resiliency Planning: Actions and Projects

The NRIA Team members held 3 meetings, including a site walk, to evaluate opportunities within Amesbury to improve community and ecological climate resiliency, based on the understanding that ecological climate resiliency enhances the capacity of a community to respond with resilience to the changes in climate. At meetings and on the site walk, ideas for specific resiliency actions and projects were discussed, with reference to specific locations. Text and photographs below describe issues and potential actions at specific locations. Based on the meeting and site walk discussions and on the CRB Workshop resiliency priorities (see Amesbury CRB Findings Report), BSC developed a menu of planning level project descriptions, which are provided in the Opportunities Table and associated Memoranda and mapping (Attachment C) that collectively indicate which projects could be implemented in which locations within Amesbury. By implementing projects identified in the text and attachments that follow, cumulatively and over time, greater ecological function and climate resiliency can be achieved in Amesbury. Following the principles of ecological restoration, consideration of stressors and disturbance to the natural function of rivers, lakes, ponds, wetlands, forests and associated floodplains is a key component for this analysis. Discussion of potential Nature Based Solutions and climate resiliency enhancement opportunities is provided below.

24 South Hampton Road

A ditch along the north side of the Amesbury elementary school property passes through a culvert beneath South Hampton Road and discharges into a ditch with many invasive species. Potential Nature Based Solutions could include:

- Conducting a culvert replacement study that could support replacement of the culvert with
  a new culvert that meets Massachusetts stream crossing standards.
- The stream and wetlands upgradient and downgradient from the culvert could be restored and invasive species removed, which could restore more natural flow dynamics and wildlife habitat, and potentially could reduce flooding.

Attachment C provides more specific information on potential projects that could enhance climate resiliency in this location.

Culvert replacement study could evaluate feasibility of replacing currently clogged and undersized culvert with one that meets Massachusetts stream crossing standards.

Ecological restoration project could restore more natural flow dynamics, reduce invasive species, and restore wildlife habitat.

Woodsom Farm and Environs

Woodsom Farm is located northwest of the city center, adjacent to Lions Mouth Road, and provides significant wetland and flood storage associated with the Powwow River, which flows through Woodsom Farm to Lake Gardner, and thence through downtown Amesbury. Bobolinks (*Dolichonyx oryzivorus*) inhabit and nest in the grassland habitat at Woodsom Farm. Woodsom Farm and other nearby undeveloped properties provide significant flood storage and water quality ecosystem services. Protecting this resource as severe storms and flooding increase in severity and frequency increases in importance over time. By protecting floodplains and wetlands, the city is protecting the downtown area in a similar, if smaller scale, way that the Charles River Natural Valley Storage Project protects community infrastructure in the lower Charles River watershed. Specific actions could include:

- Conduct study to evaluate for flooding, cooling and water supply services.
- Based on results of study, develop zoning overlay based on ecosystem services.
- Provide community education and outreach. City government and residents may not be fully aware of important resiliency services provided by this land, and how critical this area is for protecting the downtown area from flooding.

Attachment C provides more specific information on potential projects that could enhance climate resiliency in this location.

Flood storage, water quality improvement, storm damage prevention, pollution attenuation, and wildlife habitat are provided by wetlands and floodplains at Woodsom Farm and surrounding properties.

Flood storage, water quality improvement, storm damage prevention, pollution attenuation, and wildlife habitat are provided by red maple (Acer rubrum) swamp wetlands at Woodsom Farm.

The Woodsom Farm area is able to store large volumes of water, reducing peak flows in the Powwow River and associated flooding in downstream areas such as downtown Amesbury and the National GRID power station.

Upper Millyard, Amesbury Downtown, National GRID Power Station, and Powwow River

The Powwow River flows through the Upper Millyard, downtown Amesbury, and the National GRID power station site, putting all of these areas at risk for flood damages from precipitation-driven freshwater flooding events. The Back River contributes to freshwater flooding as well and flows from Clark's Pond through the downtown area to the Powwow River (see comments below). Exacerbating this freshwater flooding, coastal storm surge moves up the Powwow River from the Merrimack River, reaching the National GRID power station site and as far as Sparhawk Street (Powwow River) and Clinton Street (Back River) in the downtown area.

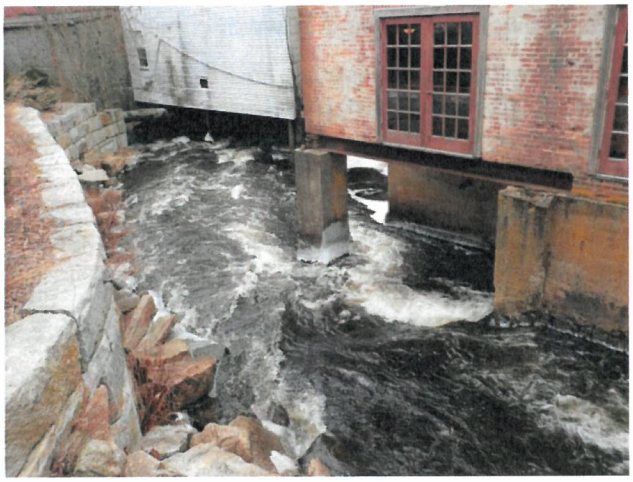
The downtown area is densely developed and includes extensive impervious surfaces, providing opportunities to implement green infrastructure and to improve and increase the urban tree canopy.

Climate resilient actions include:

- Assess for opportunities to restore and stabilize Powwow River embankments, including removal of asbestos-lined pipe that runs over and along the Powwow River.
- Assess opportunities to reduce impervious cover and increase tree canopy at parking lot adjacent to Upper Millyard, and other downtown areas.
- Replace undersized catch basins, install raingarden tree wells, etc.
- Install stormwater sidewalks (divide width into raingarden and reduced walking area).
- Offer incentives for businesses to implement green roofs & walls.
- Work with National GRID to address hazards associated with substation adjacent to Powwow River.
- Assess for flooding and stormwater management, to inform Green Infrastructure design.

Attachment C provides more specific information on potential projects that could enhance climate resiliency in this location.

Powwow River flows through the Upper Millyard area.



Will future storms put structural integrity of downtown Amesbury infrastructure at risk due to Powwow River flooding?

National GRID power station is located on eroding banks of the Powwow River, putting the power station at risk for flood damages.

National GRID power station is located on eroding banks of the Powwow River, putting the power station at risk for flood damages. Note asbestos-covered pipe (not part of National GRID site) on deteriorating supports over the river.

Deteriorating, asbestos-covered pipe poses a contamination risk, should future severe storms and Powwow River flooding cause supporting structures to collapse.

Deteriorating, asbestos-covered pipe poses a contamination risk, should future severe storms and Powwow River flooding cause supporting structures to collapse.

Note river water beneath cement wall.

Back River and Clark's Pond

The Back River crosses the Amesbury city boundary from New Hampshire and almost immediately flows into Clark's Pond. Clark's Pond is an impoundment controlled by a dam. River water flows over the dam and joins the Powwow River in downtown Amesbury. In some areas, Back River banks are eroding, and invasive species have colonized some land adjacent to the river. The NRIA Team discussed Nature Based Solutions for these resource areas on the site walk, and developed the following potential actions:

- Plan and design a streambank & wetland restoration project (including invasive species removal) on town-owned land adjacent to Back River.
- Hydrologic study and project to replace undersized culverts to meet stream crossing standards.
- Develop community process and possible plan for river restoration project.

Attachment C provides more specific information on potential projects that could enhance climate resiliency in this location.

Invasive species such as Japanese knotweed (Fallopia japonica) occur along the banks of the Back River.

Hydrologic study to evaluate undersized culverts and river/wetland/floodplain restoration planning could enhance hydrologic management of stormwater and river flows, enhance wildlife habitat, and remove invasive species, while creating recreational and aesthetic amenities for the community.

Nature Based Solutions such as living shorelines could provide riverbank restoration options in areas where riverbanks are eroded and deteriorating.

Nature Based Solutions such as living shorelines could provide riverbank restoration options in areas where riverbanks are eroded and deteriorating.

City-owned land along the Back River could be a location for wetland, floodplain, and riverbank restoration. Restoration of flood storage capacity could enhance community resilience to flooding events, while reducing invasive species, removing impervious surfaces/increasing stormwater infiltration, improving wildlife habitat, and increasing recreational and aesthetic opportunities, all of which would likely increase the value of surrounding properties.

Golden Triangle

An area locally known as the Golden Triangle is the last large undeveloped area near Route 495. This area provides flood storage for Route 495 as well as the surrounding neighborhood.

The NRIA Team discussed Nature Based Solutions for these resource areas on the site walk, and developed the following potential actions:

- Conduct hydrologic study that facilitates culvert replacement so that culverts meet stream
  crossing standards. Undersized culverts are located under Rt 110 and under Elm Street.
- Develop plans for streambank and ecological restoration: invasive species removal, potential increase in flood storage capacity, stabilize streambanks.

Attachment C provides more specific information on potential projects that could enhance climate resiliency in this location.

The Golden Triangle provides important flood storage, water quality improvement, pollutant attenuation and storm damage ecosystem services.

Pleasant Valley Road

Pleasant Valley Road parallels the Merrimack River. In some locations, river bank erosion has the potential to undermine the stability of the road, or to erode properties. Increasingly severe storms, sea level rise, coastal storm surge, winter river ice action, and boat wakes are all contributing to the worsening of river bank erosion. In addition, Pleasant Valley Road currently experiences flooding that can isolate residents during severe storm events. The following actions to remediate current and future riverbank erosion and flooding problems were discussed:

- Hydrologic study and project to replace undersized culverts to meet stream crossing standards.
- Coastal storm surge study to assess medium to long term outlook for embankment, road and property viability over the coming decades, development of NBS-based responses.
- Address Merrimack River embankment erosion with living shorelines solutions.
- Discuss ecological restoration of abandoned road (in Merrimac) with Merrimac.

Attachment C provides more specific information on potential projects that could enhance climate resiliency in this location.

Severe storms, sea level rise, coastal storm surge, winter river ice action, and boat wakes are all contributing to the worsening of erosion of the banks of the Merrimack River at Pleasant Valley Road.

Erosion of Merrimack River embankment in close proximity to Pleasant Valley Road.

Erosion of Merrimack River embankment in close proximity to Pleasant Valley Road.

2.3 - Generalized Project Planning Process

For all projects suggested below and in the attachments to this report, a multi-step planning process would be required, likely entailing the following elements:

1. Identification of project goals, in collaboration with city leaders, stakeholders, property owners, potential partners, community members.
2. Identification of project scope.
3. General feasibility assessment.
4. Development of specific project and design plans and sequencing, including:
    - feasibility and constructability studies,
    - stakeholder, community, and volunteer outreach and involvement,
    - permit planning and implementation,
    - assessment and resolution of subsidiary issues that are identified during planning process (such as disposal of contaminated sediments, historical, archaeological, and rare species issues, etc.),
    - define performance standards and measures of project success,
    - plans for post-construction or post-implementation monitoring,
    - plans for long-term maintenance, where necessary.
    - Project implementation.
    - Post-project monitoring, assessment and reporting.
    - Long-term maintenance, where necessary.

2.4 - Generalized Project Permitting Process

The City of Amesbury includes sections of the Merrimack River (a major tidal river) and the Powwow and Back Rivers. The Powwow and Back Rivers are tidally influenced in lower reaches, and flow through downtown Amesbury. All three rivers are affected by coastal storm surge and sea level rise. Additionally, Lake Attitash, Lake Gardner, Tuxbury Pond, Bailey's Pond and Clark's Pond all occur within the City. Although Amesbury is a city, extensive forested, wetland, floodplain and agricultural land remains, and contributes to the ecological health and climate resiliency of the more developed areas, thereby reducing risks and costs to citizens and infrastructure.

With regard to permitting, numerous federal, state and local laws and regulations apply to projects undertaken in Amesbury. Once a specific project design has been selected and developed, the permit requirements specific to that project will be identifiable. As general guidance, projects should be screened for permits/authorizations required under the following laws and regulations:

- Section 401 Clean Water Act/Water Quality Certification program,
- Section 404 of the Clean Water Act,
- Section 10 of the Rivers and Harbors Act,
- National Pollutant Discharge Elimination System (NPDES) permit program,
- Federal Endangered Species Act,
- Section 106 of the National Historic Preservation Act of 1966,
- Massachusetts Environmental Policy Act (MEPA),
- Chapter 91 Massachusetts Public Waterfront Act,
- Massachusetts Wetlands Protection Act,
- Amesbury Wetlands Protection Ordinance,
- Amesbury Zoning Bylaw,
- Amesbury Ordinances pertaining to natural resources such as Lakes, Rivers and Ponds (Ch. 326), Trees (427),
- Other Amesbury Ordinances and regulations that could pertain to a specific project
- Massachusetts General Laws Chapter 9, sections 26-27c (Massachusetts Historical Commission - historical and archaeological review/authorization),
- Massachusetts Endangered Species Act,
- Potential soil/sediment contamination issues would need to be considered where soil or sediment removal/disturbance occurs.

Section 3.0 - Conclusions

The Amesbury NRIA Team worked concurrently with the MVP CRB Workshop Core Team and supported the work of the CRB Core Team and CRB Workshop participants by developing a more in-depth assessment of Amesbury natural resource infrastructure that is now available to help support community and ecological resilience to our changing climate. The resulting information from both the NRIA and the CRB processes provides a guide for city leadership and citizens that furthers city goals for increasing the capacity to manage climate-related threats, such as increased freshwater flooding, coastal storm surge, sea level rise, severe storm events, fluctuating and extreme temperatures, and drought.

The resulting reports (this one and the Amesbury CRB Findings Report) provide detailed descriptions of climate resiliency actions and opportunities, and community-driven prioritization of these actions and opportunities. The natural resource maps provided in Appendix A of this report are a resource for the city in evaluating opportunities to implement Nature Based Solutions, as is the Amesbury Data Viewer, an interactive website developed by BSC during the MVP CRB process (see text above).

With greater understanding of the challenge that climate change presents, and advances in the science of ecological restoration and natural resource conservation and management, the importance of, and opportunities for Nature Based Solutions to the climate challenge have never been clearer. This report is intended to facilitate implementation of projects that will lead to durable, climate-resilient and sustained improved ecological function in the city of Amesbury, in the service of improving social, infrastructural, and community resiliency to our changing climate.

Priorities

Participants at the Municipal Vulnerabilities Preparedness Community Resilience Building Workshop, the MVP Core Team and the NRIA Team all identified addressing management of stormwater, flood water and the natural and built water management/drainage infrastructure throughout the city, including riverbank restoration, as one of the two top priorities in efforts to increase Amesbury's climate resiliency. The other identified top priority was addressing social vulnerability and increasing the resilience of vulnerable populations. Following these top two priorities, CRB Workshop participants identified climate resiliency education and outreach for both city staff and residents as the third highest priority. Other climate resilient actions related to management of natural resources infrastructure that CRB Workshop participants ranked as high (see Amesbury CRB Findings Report) in importance included:

- planning for and addressing the potential threat to the National GRID power station from the Powwow River,
- improve stormwater and flood water management in downtown Amesbury by encouraging and implementing Green Infrastructure, Low Impact Development, and improved street tree management,
- integrate climate resiliency into city ordinances, regulations, guidance, plans, and reports, including zoning, wetlands, floodplain, Open Space Plan, Hazard Mitigation Plan, Master

Plan,

- address water quality issues at Lakes Attitash and Gardner,
- address invasive species issues at various locations.

Climate resilient actions related to management of natural resources infrastructure that CRB Workshop participants ranked as medium in importance included:

- conduct a study to restore and expand flood storage capacity of wetlands, streams, ponds, and rivers,
- assess the Lake Gardner dam for earthquake vulnerability,
- assess opportunities to move wastewater treatment plant discharge location from the Merrimack River to another location,
- permanently protect open space,
- repair crack in the old Tuxbury Pond flood control structure or replace the structure,
- Develop bank and river corridor management/maintenance plans for the Back River and Clark's Pond. Deepen/remove silt from Clark's pond, improve gate to allow for adjustments, continue invasive species control, and consider a fish ladder.

Climate resilient actions related to management of natural resources infrastructure that CRB Workshop participants ranked as low in importance included:

- Protect the flood storage value at Woodsom Farm (such as with a zoning overlay).

In Attachment C, the Opportunities Table provides a selection of project types derived from an assessment of feasibility, context, and impact. Feasibility is assessed by identifying a lack of impediments to modification of the site, what sort of equipment can be used, and what physical and social constraints affect the alteration of the site. Context is assessed by evaluating onsite and adjacent vegetation, proximity to rivers, lakes and/or ponds, soil volumes/slopes, infrastructure and human activities. Impact is assessed by evaluating the potential for creation of ecological and community climate resiliency, habitat, improvement of water/soil quality, and public engagement.