Sawmill Brook
Culvert and Green Infrastructure Analysis

Looking at Impacts of Climate Change in Both a Coastal and Riverine Environment

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Town of Manchester-by-the-Sea

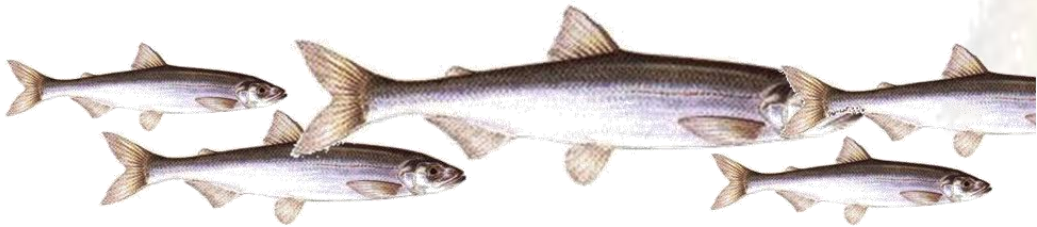
Massachusetts Office of Coastal Zone Management

Tighe&Bond

FEMA

How we got started…

- Town Administrator wanted to understand future impacts of climate change on the town.
- We started looking at grants that could fund a project to do this.
- Applied for a CZM Coastal Communities Resilience Grant to study the impacts of climate change in the Sawmill Brook Watershed
- Applied for a FEMA PDM Grant to "enhance" the town's Hazard Mitigation Plan to include the impacts of climate change.
- We were awarded both grants. YES!

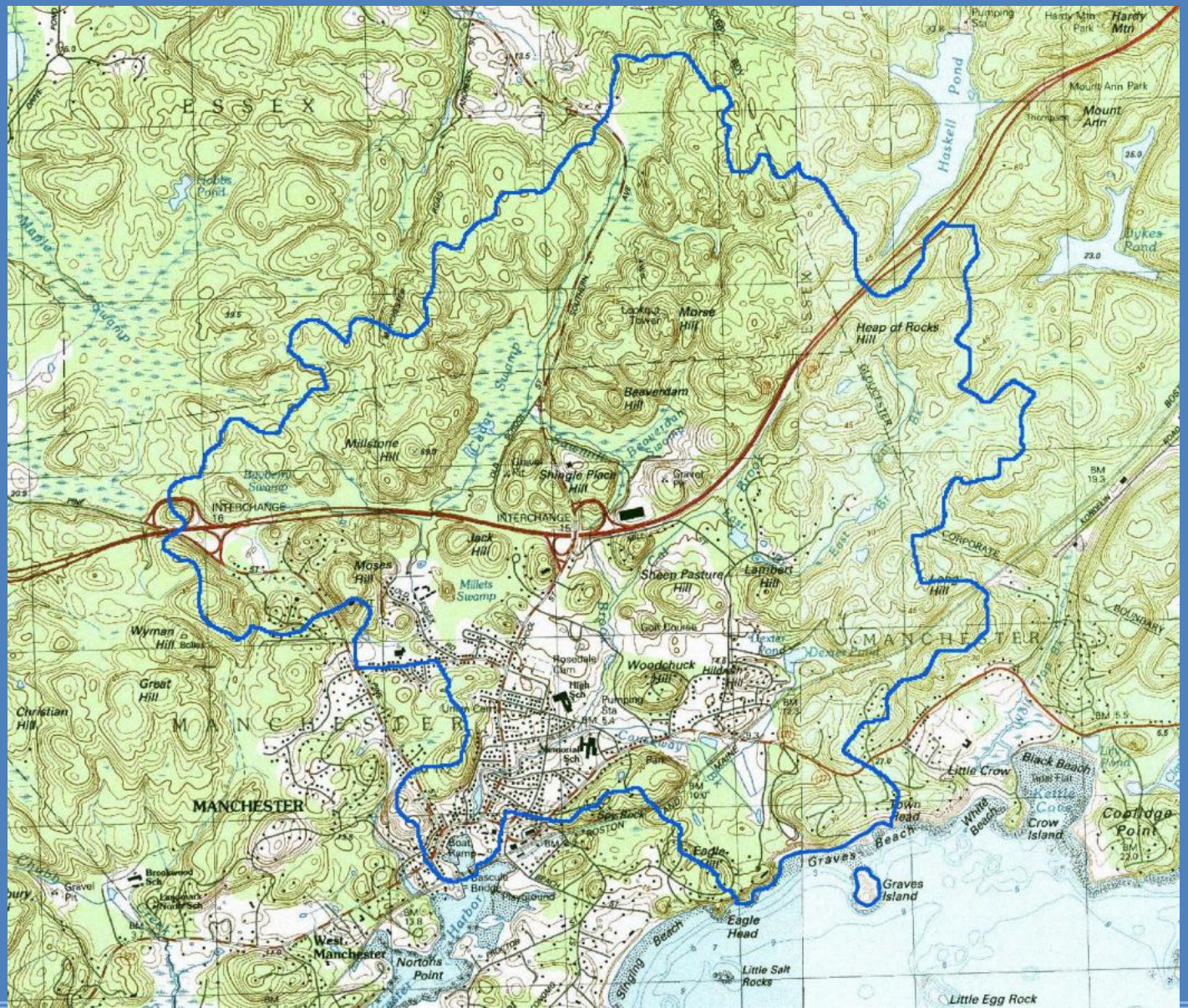


Project(s) Beginning

The Coastal Resilience Advisory Group or "CRAG"

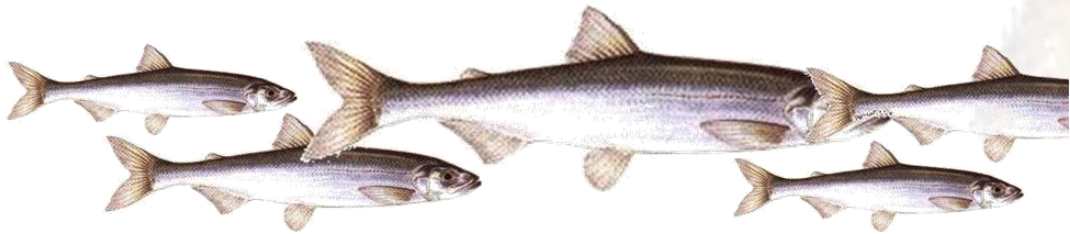
- Formation of advisory group which would provide input to both the CZM and FEMA projects
- CRAG included various town officials including DPW, Planning, Conservation, Fire and Emergency Management, Police, Harbormaster
- Included CZM's North Shore Regional Coordinator (Kathryn Glenn)
- Also included reps from Salem Sound Coastwatch, Manchester Coastal Stream Team, the Downtown Improvement Committee and two citizen volunteers.
- Worked closely with our consultants at Tighe and Bond who were selected for both projects

Sawmill Brook Watershed Project



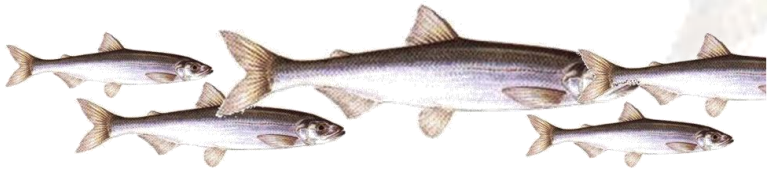
Purpose of Sawmill Brook Watershed project

- Understand future climate change impacts due to Sea Level Rise, Storm Surge and Extreme Precipitation – especially flooding
- Identify potential mitigation projects
- Identify which structural changes (e.g., culvert enlargements) would provide the biggest bang for the buck – start planning now
- Identify opportunities for additional flood storage and green infrastructure



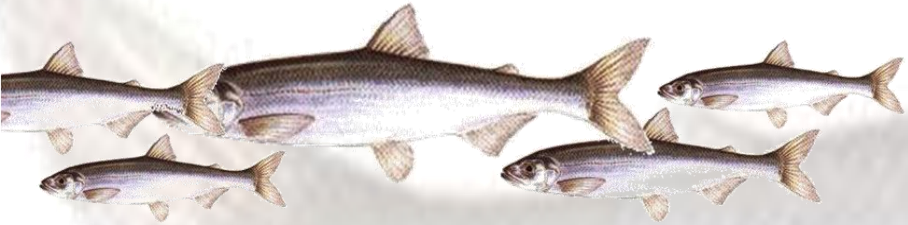
Why the Sawmill Brook Watershed?

- Includes the most densely populated and developed area in town
- Location of critical town services: Town Hall and Police, Fire, Waste Water Treatment Plant, downtown businesses
- High school and elementary school, elderly housing
- History of flooding in the watershed and along coastal and inland areas in town
- Known issues:
  - Tide gate and culvert at the mouth of Sawmill Brook to Manchester Harbor
  - Undersized and aging culverts along the stream

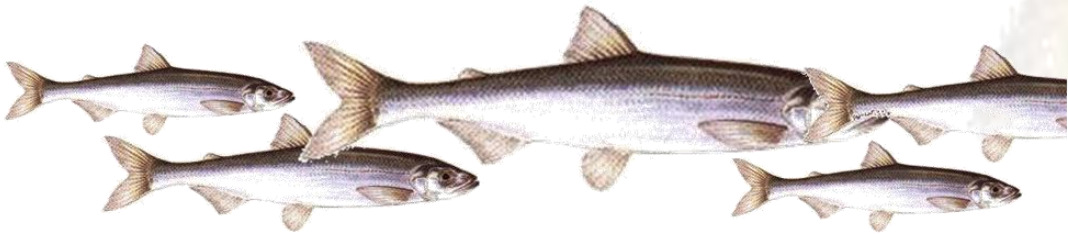


Lower Sawmill Brook and the Harbor

another factor… fish passage



- **Desire on the part of Manchester Coastal Stream Team and Salem Sound Coastwatch to explore tide gate removal and restoration of Sawmill Brook.**
- **Remove the barrier (tide gate) to fish passage.**
- **Desire to make Sawmill Brook habitable to the once-abundant rainbow smelt and other diadromous fish species.**
- **Potential for BOTH flood mitigation and fish habitat**



Scope of Sawmill Brook Watershed project

- Gather and review information that characterizes existing and future conditions, including studies and GIS data (parcels, stormwater systems, buildings, land cover, natural resources, etc.).
- Conduct stream crossing surveys (involved volunteers)
- Hold public forums and perform outreach to community members
- Identify opportunities to reduce runoff volumes and flows and store floodwaters. ID locations that are favorable for improvements.
- Model culvert capacity under peak flow conditions under sea level rise and extreme precipitation scenarios.
- Create several conceptual designs and cost estimates for stream crossing reconstruction and flood management. Develop 3 planning level designs and refined costs.

Technical Challenges
Modeling Future Conditions

Had to take <u>both</u> coastal and riverine conditions into account

Needed models to analyze three scenarios:

- **Extreme Precipitation**
- **Sea Level Rise**
- **Storm Surge**

for the years 2025, 2050 and 2100

Model Selection by CRAG

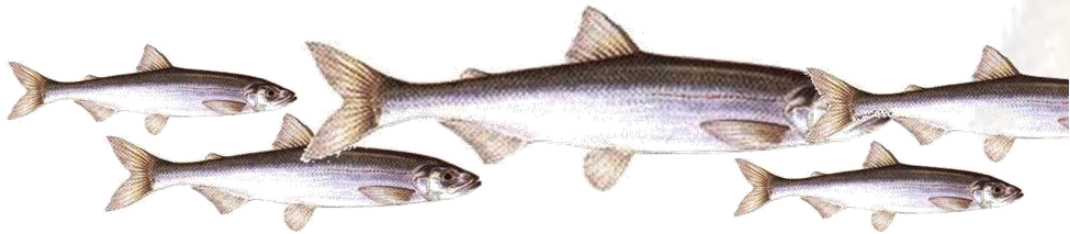
NOTE: Model research and selection was funded as part of the FEMA PDM Grant but was used for both projects

T&B researched different models and narrowed it down to 8 possibilities:

1. **CHAMP (FEMA)**
2. **SLR Viewer (NOAA)**
3. **WHG (Woods Hole Group)**
4. **EP (Extreme Precipitation – USDA)**
5. **ADCIRC (FEMA, USCG, USACE, NOAA, et al)**
6. **IRM (Keil Schmid)**
7. **BBNEP (MCZM)**
8. **ORCPM (Oyster River)**

T&B created detailed matrices showing different characteristics of each.
CRAG evaluated the models based on:

- **Applicability (could model more than one scenario**
- **Model accuracy**
- **Bathymetric Effects (e.g., static vs dynamic)**
- **Level of error (cost)**
- **Riverine data**
- **and more…**



Models selected by the CRAG

PRECIPITATION:

Oyster River Culvert Analysis – Extreme Precipitation Model (ORCPM)

- **Used to determine precipitation depths for future conditions in 2025, 2050 and 2100.**
- **Oyster River is located in Durham, NH—60 miles north of Manchester – similar conditions to Manchester**
- **Looked at conditions based on both a "balanced" energy use scenario and a "fossil-intense" energy use (the CRAG decided on using the balanced model)**

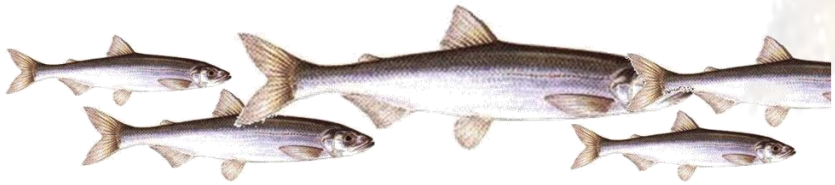
SEA LEVEL RISE AND STORM SURGE:

Inundation Risk Model (IRM)

- **Developed by Keil Schmid of Geoscience Consultants for the Salem Sound communities in northeast MA, including Manchester**
- **Dynamic model, created regionally**
- **Low effort (lower cost)**

However, this model required adjustments…

- **IRM Model didn't automatically generate site specific elevations needed to evaluate conditions at the interface between the fresh and saltwater bodies (tide gate).**
- **T&B worked with Keil Schmid to obtain elevations for future flooding conditions due to SLR and storm surge at the tide gate location, and more accurately model tailwater impacts on the inland watershed model.**



Watershed Model

In addition to the two models selected by the CRAG…

WATERSHED MODEL:

Developed by Tighe & Bond based on USACE HEC-RAS Model

- **Needed to evaluate culvert adequacy and green infrastructure opportunities to reduce flooding in the watershed**
- **Essential to evaluate future river flooding conditions due to increased duration and frequency of rainfall under climate change conditions**
- **Was set up by consultants to take input from both the Oyster River and IRM modeling output**

For a detailed discussion, see the following document:

Potential Climate Change Impacts to MbtS:

www.manchester.ma.us/DocumentCenter/Home/View/625

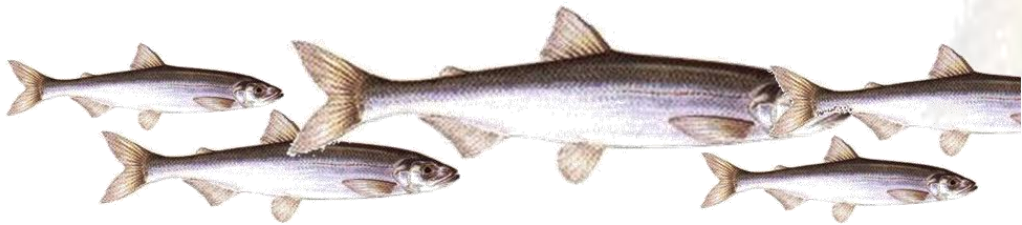
Prioritization and Selection of Projects

Proposed Projects were based on:

- **Watershed wide assessment of historic flooding**
- **Culvert conditions**
- **Desktop evaluation**
- **Modeling iterations**
- **Probable permitting requirements**

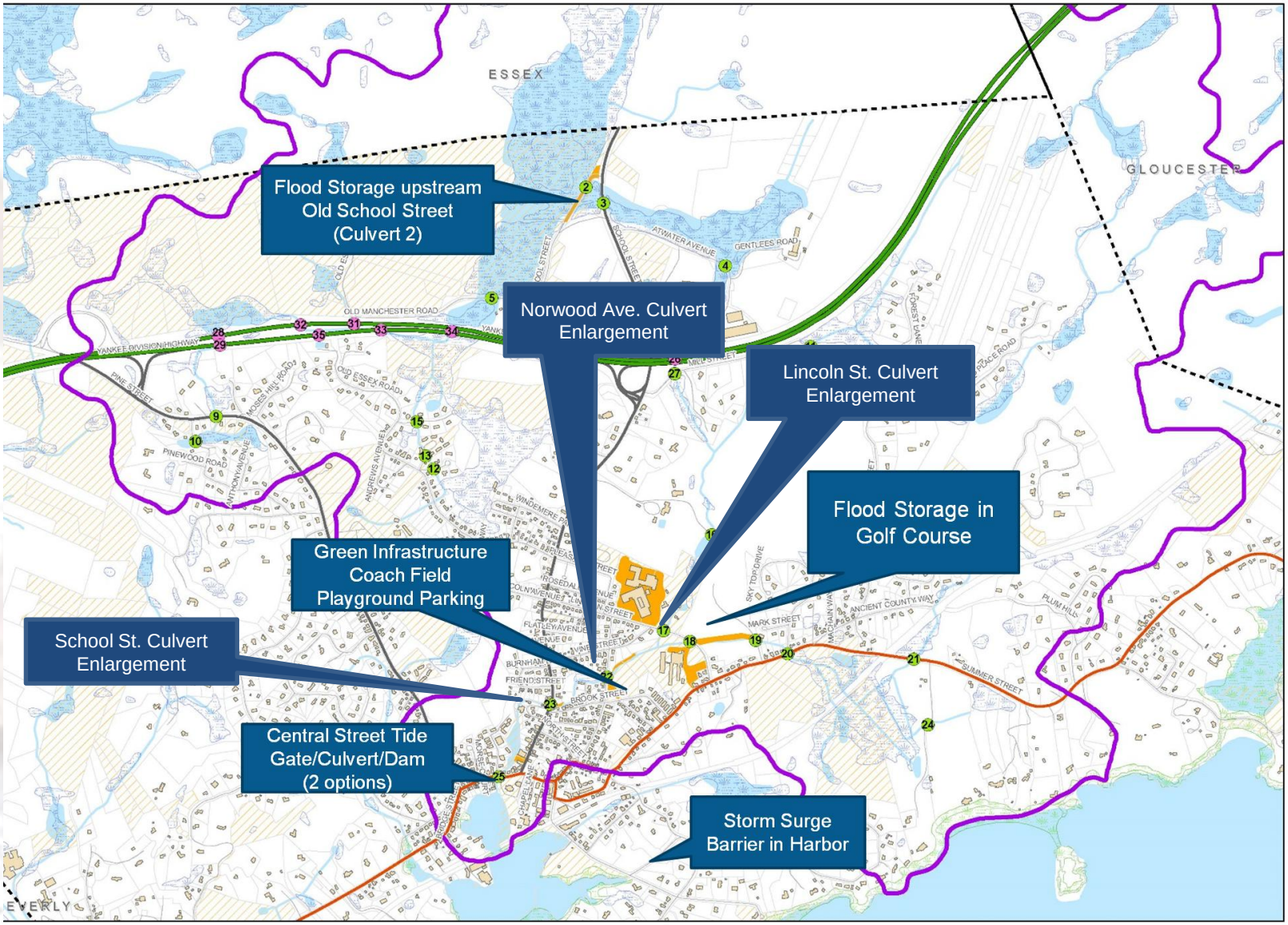
Tighe & Bond created 9 conceptual plans for the CRAG and town to consider. These included:

- **Culvert improvements**
- **Central St. Tide Gate removal or Improvement**
- **Porous asphalt parking lot**
- **Improved flood storage at Golf Course**
- **Storm Surge barrier in Manchester Harbor**



Unexpected Outcome of Modeling

- **Green Infrastructure and flood storage projects didn't appear to have much impact**
- **The project with the most impact was removal of the tide gate at Central St.**
- **CRAG still wanted to investigate possibilities of flood storage and green infrastructure**



SAWMILL BROOK CULVERT LOCATIONS

LEGEND

- Sawmill Brook Watershed
- Buildings
- MassDOT Culvert
- Culvert
- FloodBMPs
- Town Owned Property
- Inland Wetlands
- Coastal Wetlands
- HYDRO25K_ARC
- Waterbodies

LOCUS MAP

N

0 875 1,750
Feet
1:14,242

NOTES

Data sources: Town of Manchester-by-the-Sea, Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs.

Figure 7

Sawmill Brook Culvert & Green Infrastructure Analysis Manchester-by-the-Sea, Massachusetts

October 2015

Tighe&Bond
Consulting Engineers
Environmental Specialists

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Narrowing it down by weighing the options

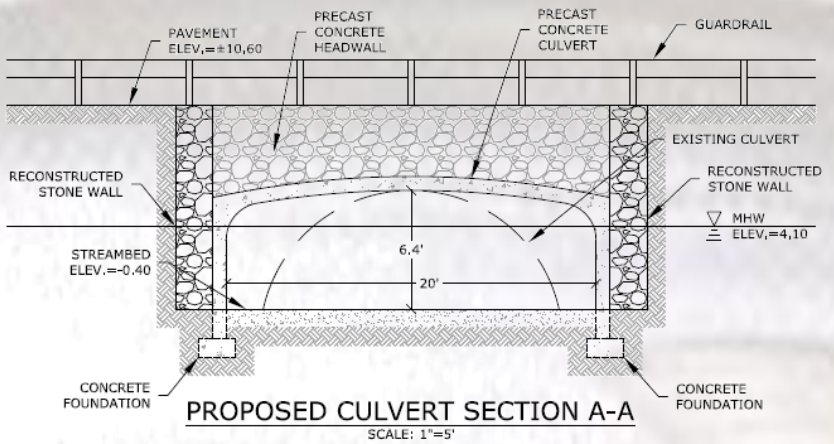
TABLE 6-3

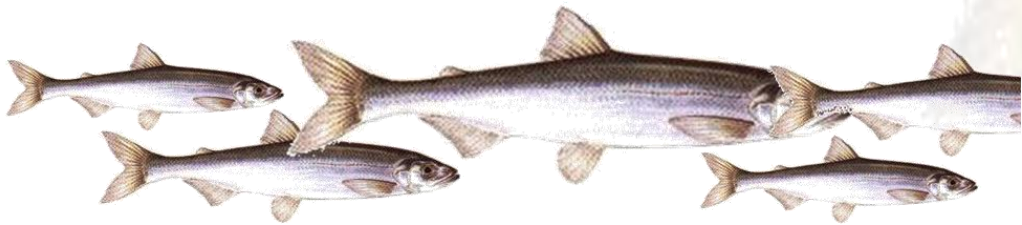
Weighted Evaluation of Conceptual Projects

PROJECT:		Lincoln Street Culvert	School Street Culvert	Coach Field Parking Lot	Norwood Avenue Culvert	Central Street Tide Gate (#1)	Central Street Tide Gate (#2)	Golf Course	Old School Street	Hurricane Barrier
Screening Criteria	Weight	Score	Score	Score	Score	Score	Score	Score	Score	Score
Flood Mitigation / Health & Safety	21.1%	4	4	1	3	4	5	1	2	4
Coordination with Other Town Project	11.6%	1	5	3	1	5	5	1	1	1
Habitat Improvement	20.7%	4	4	1	4	5	5	1	1	1
Additional Community Benefit	10.2%	3	4	5	3	5	5	4	1	5
Water Quality Improvement	19.4%	4	4	4	2	5	5	1	1	1
Permitting Difficulty	9.9%	3	3	5	3	2	2	3	3	1
Long-term Maintenance	7.1%	1	1	5	1	3	3	2	1	5
Weighted Score		**3.24**	**3.80**	**2.90**	**2.64**	**4.35**	**4.56**	**1.57**	**1.41**	**2.33**
Rank		**4**	**3**	**5**	**6**	**2**	**1**	**8**	**9**	**7**

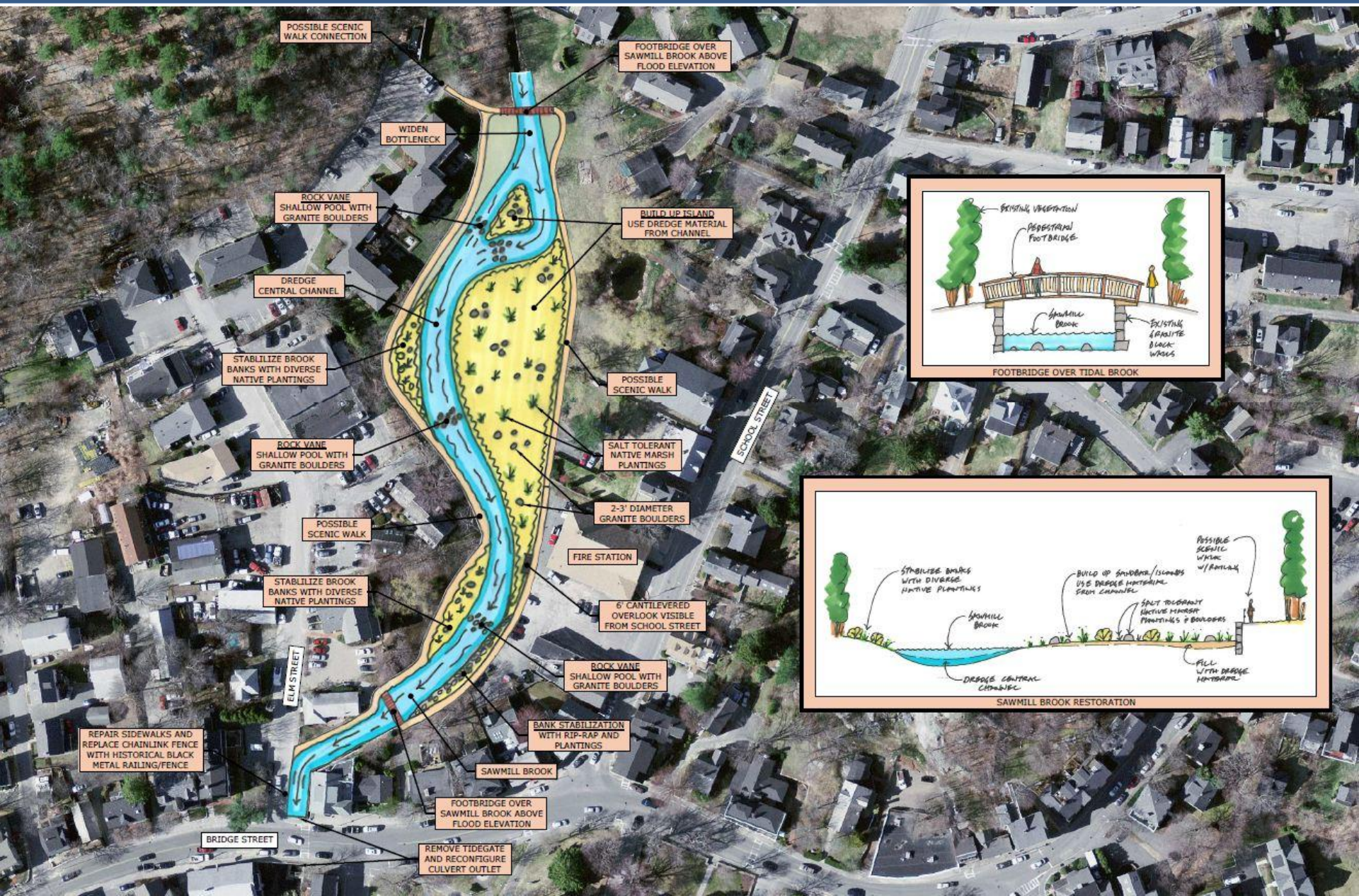
The Winners

1. **Removal of the Central Street Tide Gate and Replacement of the Culvert, including restoration of stream.**
2. **Culvert Improvements at School Street.**
3. **Culvert Improvements at Norwood Ave.**
4. **Installation of Porous Parking Lot at Coach Field Playground**



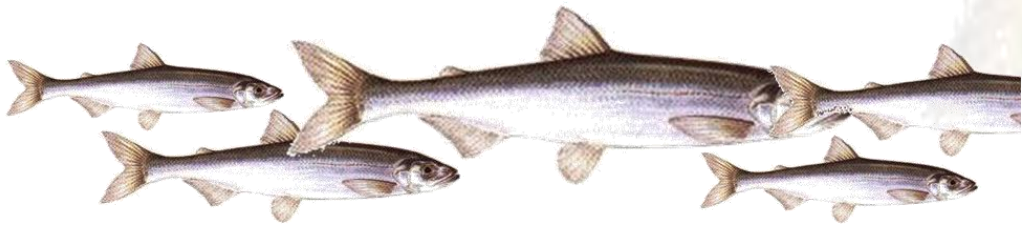


Stream Restoration



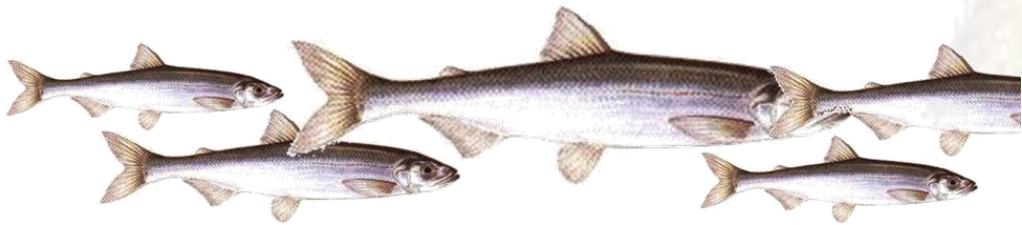
Next Steps

- Establish a partnership with technical agencies to ensure that permitting requirements are being met
- Perform additional public outreach and education – get public support
- Perform detailed physical studies including a sediment characterization study and sediment transport; a hydraulic and hydrologic (H&H) evaluation of the lower reaches of Sawmill Brook; establish a water monitoring program to capture flow data; perform a detailed topographic and structural survey.
- Produce 25% designs for the Central Street Tide Gate and Culvert, Central Street Pond restoration, Sawmill Brook stream channel and the School Street and Norwood Avenue culverts.
- Apply for grants!



Lessons Learned

- **Build extra time into your projects for the unforeseen issues that <u>will</u> arise**
- **Don't underestimate time needed to select and perform the modeling—especially in a mixed environment (coastal and riverine, dams)**
- **Involve the public – get their support**



Questions?

Thank You!

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Documents can be found the Manchester town website at:
www.manchester.ma.us/354/Sawmill-Brook-Watershed-Project
and
www.manchester.ma.us/355/FEMA-PDM-Grant-Projects