Herring River Restoration, Wellfleet, Massachusetts

Preliminary Analysis of Alternatives for Modifying Tidal Flooding Controls at the Chequesset Neck Road Dike

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1.0 Introduction

The Herring River Salt Marsh Restoration project was conceived to restore the Herring River back to its natural state as a tidal salt marsh. The major factor to resolve in restoring sufficient tidal flooding involves the approach for modifying the existing tidal flooding controls at the dike across the River on Chequesset Neck Road (the Dike; Figure A). Currently, water flow from Wellfleet Harbor into and out of the Herring River is restricted by a three (3) cell concrete box culvert with a total horizontal opening of twenty-four feet (24'). All three cells flow on the ebb tide and one flows on the flood tide, the others having check gates that close as the water pressure builds. To reach the goal of restoring the river back to its natural state, the total width of opening must be increased to between 100 feet and 130 feet (30 to 40 meters). The final width will be determined following a more detailed hydraulic analysis. For preliminary planning and study purposes the smaller dimension has been used, with consideration in the analyses given to the implications of expanding the width ultimately to 130 feet or even greater. In addition, to address flooding concerns on properties that are above the elevation of historical salt marsh areas, the new tide gate controls will need to restrict the limit of tidal flooding to elevation 6 feet (NGVD 29). Also, implementation of the modified tide gate controls is desired on a gradual or incremental basis to ensure that changes progress in a controlled manner while minimizing any adverse effects.

This report summarizes preliminary design analyses performed by DMJM-Harris/AECOM and ENSR/AECOM for the Herring River Technical Committee (HRTC) on possible alternative means of modifying the existing tidal controls on the Herring River. The process that has led to this summary has involved a roughly six-month period that began with a broad scoping or consideration of design options for modifying the existing tidal control structures at the Dike. In October of 2006 the HRTC was presented with conceptual plans that considered four alternative approaches. Upon review and consideration of these options, three modified alternatives were selected for further development. In addition to these options of modifying the structures at the Dike, another alternative being evaluated would involve replacing tidal controls at the existing Dike on Chequesset Neck Road (opening this location with a bridge structure) with a series of smaller structures at upstream locations to regulate the limit of tidal flooding as deemed necessary by further hydraulic analyses. This report summarizes only the options developed for modifying conditions at the Dike. The three alternatives presented herein and on the accompanying plans (Appendix A) are:

1). Alternative 1: Cast in place culverts with 8-foot wide cells.

2). Alternative 2: Pre-cast arch spans.

3) Alternative 3: A 2-span bridge structure.

Figure A: Aerial View of Chequesset Neck Road Dike at the Mouth of the Herring River

2.0 Existing Conditions and Design/Construction Considerations

Preliminary site investigations and previous reports indicate that the visible components of the existing culvert are in good condition and acceptable for continued use in the future arrangement. Therefore it has been assumed that the existing culvert would remain in place and would account for twenty-four feet (24') of the required total 'opening' dimension. Prior to the construction of the existing culvert, another culvert existed centered at station 61+00. This culvert was demolished when the existing culvert was completed in the 1970's. A brief evaluation of optional alignments to the existing dike/roadway resulted in a decision that there were no obvious advantages to altering the alignment or footprint of the dike/roadway in this project. It has existed in roughly this location since the turn of the last century. Geotechnical conditions as reported from previous investigations in the 1970's were reviewed and considered in the evaluation of options; additional geotechnical studies will be needed eventually in the design process.

Initially, building two (2) structures of equal length on either side of the existing culvert was considered to maintain the center of the existing channel. However, for the arch (Alt. 2) and stringer bridge (Alt. 3), this meant doubling the construction of abutment units and cofferdams and lengthening the construction duration. This approach was abandoned and the alternative of building to just the east side of the existing structure is currently anticipated; Alternative 1 (culverts) is the most flexible option in this respect.

Due to the light traffic volumes encountered in the off season (September through May), it was assumed that Chequesset Neck Road would be closed for the duration of construction of all alternatives. Traffic would be detoured to an alternate route and construction would be completed in the off season. This would allow for significantly shorter construction duration, due to the lack of staging that would be required if Chequesset Road had to remain open to traffic. Construction costs would also be reduced by eliminating additional support of excavation provisions which would be required for staged construction to keep one lane of traffic open at all times.

Many issues effect the decision of which alternate should be selected. These include:

- Aesthetics – Sluice gates will be placed on the Wellfleet Harbor side of the structure. Therefore from the Wellfleet Harbor side, all alternatives have nearly similar aesthetics; however, the Herring River side of the structures is different.
- Cost – according to preliminary estimates, initial construction costs of all the three alternatives are approximately the same (within 10%). All costs shown are based on a 100' opening and will increase should a larger opening be required. Costs given in the following paragraphs are for the structure cost only – not the affiliated site work which may cost another $2,000,000.
- Lifetime cost – this is a function of the future maintenance cost and harder to quantify, however certain alternatives have more maintenance cost over the lifetime of the structure.
- Construction Duration – obviously where closing a road is planned, the community will be very concerned which options have the shortest construction duration.
- Ease of opening up channel completely in the future – Some alternatives (2 and 3) are more conducive to a future condition of eliminating tidal controls at this location of the Herring River completely.
- Consequences of 130' vs 100' opening - Some of the alternatives (1 and 3) easily accommodate the larger opening without increasing the cost of the structure significantly, while the arch alternative is more involved.
- Allowance for future recreational boat navigation from the Herring River to Wellfleet Harbor.
- Hydraulics – deep foundations may be required in some alternatives to resist the hydrostatic pressure created by channelizing the water flow.

3.0 Description of Alternatives

3.1 Modified Tide Gate Controls at Chequesset Neck Road Dike

Three alternatives have been evaluated for modifying tide gate controls at the Dike. All alternatives assume that the existing culvert remains in place and in use.

Alternative 1 – Culvert (Figure 1)

This alternative involves the use of cast-in-place culverts with 8'-wide cells. This option is similar to the existing condition and can easily accommodate any length of opening required by adding as many cells as are necessary. The approximate cost of this option is estimated at $2,200,000 (structure only).

Advantages:

- Low maintenance cost
- More conventional
- Increase of opening from 100 to 130' could be accommodated with the addition of extra cells.
- No deep foundations required

Disadvantages:

- Aesthetics
- Longest construction duration
- Difficult to inspect interior of structure
- No possibility to completely open channel
- No possibility of future recreational boat traffic

Alternative 2 – Precast Arch (Figures 2 & 4)

This option consists of 2 or 3 Span (depending on length of opening required by the hydraulic analysis) – precast arch structures. Arch segments are proprietary items which are 8' wide segments and can vary in length from 12' to 48' (48' shown for Alt. 2). Wingwall and headwall panels are also precast and will be placed on cast in place footings. Cast in place channel beds will be used. Deep vs. shallow foundations will be evaluated when additional geotechnical information becomes available, but will most likely be similar to the bridge alternative. If a structure longer than 100' is required, a 3 span arch will be required. The approximate cost of this option is estimated at $2,200,000 (structure only).

Advantages:

- Aesthetics
- Low maintenance cost
- Quickest construction schedule due to the precast arch elements

- Can be opened up completely (without gates) in the future
- Possibility of opening for recreational small boat traffic

Disadvantages:

- Gate dimensions are a function of predetermined arch span lengths
- Cost efficiency of this option decreases if the length of opening is increased as 3 arches would be required instead of 2.
- Not as easy to open to boat traffic as bridge option (Alt 3)
- May require pile (battered or vertical) foundation.

Alternative 3 – Bridge (Figures 3 & 5)

This option consists of a 2 span bridge with either precast concrete box beams or steel girders. Cast in place abutments, pier and channel beds will be used. Abutments and piers will be supported by either spread footings or pile foundations, depending on geotechnical requirements. The bridge can easily be lengthened to accommodate an increased opening size without increasing the number of spans. Also, if it is determined later that the existing culvert is not viable for future use, the bridge may be built directly over the existing culvert and the culvert demolished at a future date. The approximate cost of this option is estimated at $2,400,000 (structure only).

Advantages:

- Aesthetics
- Easiest to completely open up in the future
- Easy to inspect
- Flexibility of accommodating larger openings by increasing span lengths with the least amount of cost increase.
- Easiest to open to boat traffic (highest vertical clearance)
- May be constructed over existing culvert if existing culvert is deemed not viable

Disadvantages:

- Longer construction duration than Alternative 2.
- Higher lifecycle cost (due to larger future maintenance cost)
- May require pile (battered or vertical) foundation.

A trestle bridge, comprised of multiple short spans with solid bent structures, was also originally investigated, however it was eliminated due to high construction costs and construction duration associated with the additional substructure elements.

3.2 Open Bridge Option at Chequesset Neck Road with Upstream Tide Gate Controls

As noted previously, another alternative being evaluated would involve replacing tidal controls at the existing Dike on Chequesset Neck Road (opening this location with a bridge structure) with a series of smaller structures at upstream locations to regulate the limit of tidal flooding as deemed necessary by further hydraulic analyses. This option has received only cursory consideration to this point, and therefore this alternative is only briefly discussed in this report. It is recognized that a series of upstream control points are likely to be needed to provide protection from flooding of properties in proximity to the floodplain. These include the following, with reference to Figure B:

- Mill Creek: Mill Creek extends easterly off of the Herring River just south of Old Chequesset Neck Road and north of the Chequesset Yacht and Country Club (see Figure B). A dike with tide gate controls would be required across the mouth of Mill Creek to regulate the limit of tidal flooding easterly along Mill Creek .

Figure B: Herring River Area with Key Roadways for Reference Points

- High Toss Road: High Toss Road extends across the Herring River roughly one mile upstream of the Chequesset Neck Road Dike. It is a key location in the Herring River system to evaluate options under future conditions relative to tidal controls as well as public access.
- Pole Dike Creek Road: This road (indicated on Figure B as the crossing near the West Main Street label) is a key location to consider future conditions relative to flooding in the Pole Dike Creek system to the east of this crossing.
- Bound Brook Island/Old County Roads: As indicated on Figure B at the "Old County Road North" label, the Herring River flows under this roadway between the mid- and upper-basin portions of the floodplain. As such, it is another key location to consider potential future tide gate control options.

3.3 Selection of the Preferred Alternative

The selection of the preferred alternative for this project is currently deferred to future phases of the project when all parameters, including the completion of the hydraulic analysis, have been fully evaluated.

4.0 Sluice Gate Considerations

For the application of modified tide gate controls at Chequesset Neck Road Dike, a series of sluice gates 6 to 8 feet wide and 6 to 10 ft tall positioned across the width of the channel is anticipated. A total of 13 to 17 units will be required to span a 100 ft width. The sluice gates will be fabricated of a cast iron/nickel alloy or stainless steel, with hardware of stainless steel or nickel/copper alloy. Higher quality materials are more expensive but more resistant to corrosive environments. Self-contained actuators will limit the amount of ground space needed for installation, and can be hydraulically, electrically, or manually powered. The operating stem and stem cover will extend approximately 14-ft above the top of culvert. Sluice gates may be constructed with a combined flap gate feature to allow for multiple uses of the structure.

APPENDIX A

PRELIMINARY PLANS FROM DMJM HARRIS

Figures 1-5