

Prepared for:
Herring River Technical Committee
Wellfleet, Massachusetts



Herring River Restoration Project – Low-lying Roadways Review and Discussion

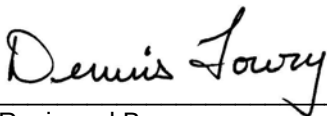
ENSR Corporation
April 2007 (revised June 25, 2007)
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1.0 Low-lying Roadways Review and Discussion

1.1 Purpose

ENSR completed a review of low-lying (or “low-laying”) roadways (LLRs) to determine what roads would be adversely affected by the modification of tidal control at Chequesset Neck Road. Planned modifications to tidal control at the existing restriction would result in a gradual increase in the range and elevation of daily tidal flooding in the Herring River floodplain. Under current project planning, the limit of tidal inundation upstream of Chequesset Neck Road will be restricted by the modified tidal control to elevation 5.1 feet (NAVD 88, or 6.0 feet NGVD 29). The various alternatives being considered for implementing tidal restoration are described in a separate report (DMJM-Harris and ENSR, June 2007). If full (i.e., unrestricted) tidal exchange returns to the Herring River floodplain, tidal elevations will more closely match those occurring in Wellfleet Harbor. Accordingly, ENSR's evaluation in this report has used the tide heights that occur in Wellfleet Harbor to classify the full potential of roadway flooding above Chequesset Neck Road. There are a number of roadways upstream of the existing tide gate considered LLRs due to the elevations of their paved or unpaved road surfaces. The 100-year flood elevation in Wellfleet Harbor is 9.44 feet (10.3 ft NGVD 29), and therefore low-lying roadways at or below this elevation have been considered in this assessment. However, it is stressed that tidal controls are proposed to be implemented to protect low-lying properties from tidal flooding while also promoting ecological restoration of the River and its bordering salt marshes.

1.2 Method of LLR Review and Roadway Categorization

ENSR performed a review of the LLRs in a Geographic Information System (GIS) environment, which included acquiring the Executive Office of Transportation (EOT) official state-maintained street transportation dataset from the Massachusetts GIS (MassGIS). The street names were then updated to match the Town of Wellfleet Assessors' Atlas prepared by Slade Associates (Slade). The road centerlines were overlaid on a Digital Elevation Model (DEM) to get approximate road elevations. The DEM was created using LiDAR data collected of the Cape Cod National Seashore in cooperation with the USGS, NPS, and NASA. The LiDAR was supplemented with hard survey points, collected by Slade Associates, of low-lying sections of the following roads.

- Black Pond Road
- Pole Dike Road
- Bound Brook Island Road
- Chequesset Neck Road
- Duck Harbor Road
- Gull Pond Road
- Chris' Drive
- High Toss Bridge Road
- Old County Road
- Old Chequesset Neck Road

Using road centerline elevations taken from the DEM, road segments were classified based on their elevations within one-foot increments from below 3 feet to greater than 10 feet (NAVD 88). The accompanying figure (see Appendix A: *Summary of Low-Laying Roads Analysis*), presents this classification of roadways within one-foot elevation increments via color-coding, and also presents data on the lengths of roadways within each increment. Note again that all elevations on this plan are in NAVD 88; to convert to the NGVD 29 datum, 0.86 feet should be added to the NAVD 88 figures. The survey plans of each area of low-lying roadways are presented in Appendix B to this report as Figures 1 through 16.

As noted above, under current project planning, the limit of tidal inundation above Chequesset Neck Road will be restricted to elevation 5.1 feet NAVD 88 (or 6 ft NGVD 29). Accordingly, the references in the evaluation to flooding occurrences above six feet in elevation are to cover only the hypothetical condition that could occur in the future where there would be no tidal controls in place on the Herring River.

1.2.1 Roadway Modification

Road segments with elevations below 5.1 feet NAVD 88 (or 6 ft NGVD 29) were further reviewed to estimate how the LLRs might potentially be modified to lessen the adverse effects from flooding. The elevation was selected because it represents the critical elevation that tidal restoration is desired to achieve for salt marsh restoration, as it approximates the mean high tide elevation. For this analysis roads were compared to the topography of adjacent land and based upon this were further classified into two potential mitigation categories: raise or raise/realign. Please refer to accompanying figure entitled *Low-lying Roads Restoration Alternatives Analysis* (Appendix A). Roads that are not adjacent to higher ground would need to be raised above a certain, to-be-determined elevation. Roads that are adjacent to higher ground might either be raised in their current horizontal alignment, or might be horizontally realigned to higher adjacent ground to reduce anticipated flooding frequency.

1.2.1.1 Road Raising

Raising a road involves placing fill to create new road beds with paved or unpaved surfaces above a specific elevation. A number of the LLRs in the Herring River floodplain traverse areas of relatively low elevation and are not adjacent to higher ground. This is the case with High Toss Bridge Road (Photos 1 and 2; see Appendix C), Old County Road (Photos 3), and Pole Dike Road (Photo 4). In order to raise these roadways and avoid costly retaining wall construction, the toe of each roadway embankment would need to extend horizontally into adjacent wetland resource area, such as Bordering Vegetated Wetland (310 CMR 10.55) and Riverfront Area (310 CMR 10.58), which would alter these areas. In addition, raising a road that traverses a wetland area would likely adversely affect tidal exchange between areas upstream and downstream of the road by creating a causeway. Including supplemental surface water conveyance(s) along the raised road would mitigate this type of adverse affect to a degree and be in the interest of the habitat restoration goals of the larger project. In addition, if certain roadways have sewer lines or stormwater collection facilities, then the rims of the structures would need to be raised, or the structures would need to be re-set to match proposed grades.

1.2.1.2 Road Realignment

In the context of this project, realignment of the roads involves relocating segments of road that will be inundated frequently to nearby higher ground. Realignment would entail tasks such as acquiring new rights-of-way for the roads, transitioning relocated road segments into remaining segments, relocating stormwater facilities, and possibly relocating other utilities.

1.3 Additional Discussion of Specific LLRs

ENSR visited certain LLRs in order to document observed conditions along these roads including the cross-culverts that convey the Herring River and its tributary streams and the adjacent wetland resource area. LLRs that were not easily passable or accessible by vehicle at the time of our site visit on January 12, 2007, were not observed. Only LLRs in Wellfleet were observed during the January site visit.

1.3.1 High Toss Bridge Road

High Toss Bridge Road (Figure 8 and Photos 1 and 2) is an infrequently traveled, unpaved, single-lane road that provides an access from Pole Dike Road to Griffin Island. For the portion of High Toss Bridge Road west of its intersection with low-lying Rainbow Lane and nearest the Herring River channel (Photo 5), wetland habitat abuts both the northern (Photo 6) and southern margins of this road. This portion of road is at

elevations between 3.0 and 3.5 feet (NAVD88). Much of the surrounding wetland area is at or just below the road surface elevations. It appears that raising this portion of High Toss Bridge Road west of Rainbow Lane by fill placement to an elevation a few to several feet above the existing elevation would necessitate construction of sloped roadway embankments. This construction would result in substantial alteration to vegetated wetland areas and create a causeway.

Avoiding or minimizing wetland impacts by road relocation or lateral realignment in this section would not be possible due the lack of adjacent land at higher elevations and a close proximity to existing wetland areas. Using vertical retaining walls in place of embankments to minimize direct wetland alteration, while possible, will very likely be considered cost prohibitive and the causeway that would result would not serve the interests of the larger restoration project in our opinion.

The elevations along portions of High Toss Bridge Road between Rainbow Lane and Pole Dike Road are at or above 5.5 feet (NAVD88). These portions of road have wetland habitat immediately abutting its northern margin, but generally lacks wetland habitat along its southern margin and therefore any lateral realignment of this portion of road onto adjacent higher ground and avoid wetland alteration may be possible.

A 60-inch diameter, 24-foot long culvert conveys the Herring River beneath High Toss Bridge Road near its western end (Photos 7 and 8). Replacing this pipe culvert with a larger conveyance structure, such as an open-bottom arch or box culvert, would alleviate the apparent flow restriction caused by the existing culvert and create better conditions for fish passage.

1.3.2 Pole Dike Road

Pole Dike Road (Figure 16) is a frequently traveled, paved public road, the northernmost portion of which (Photos 4 and 9) crosses Pole Dike Creek. This portion of roadway, which is approximately 300 feet in length, is at elevations below 4.0 feet (NAVD88) for most of this length. The elevation of the road at the creek crossing is 4.67 feet. The densely vegetated wetland areas that border the creek are in close proximity to both margins of the road. Avoiding or minimizing wetland impacts by road relocation or lateral realignment would not be possible here due to both the lack of adjacent land at higher elevations and a close proximity to existing wetland resource areas. It appears that raising the roadway by the necessary number of feet would result in some amount of wetland alteration from construction of sloped roadway embankments. If retaining walls were used in place of sloped embankments, wetland alteration could be greatly reduced or unnecessary.

A 32-inch diameter (approx.), 40-foot long (approx.) culvert conveys Pole Dike Creek beneath the road (Photo 10). Replacing this pipe culvert with a larger conveyance structure, such as an open-bottom arch or box culvert, would alleviate the apparent flow restriction caused by the existing culvert and create better conditions for fish passage.

1.3.3 Bound Brook Island Road

Much of Bound Brook Island Road between its intersections with Pole Dike Road and Old County Road (Figures 9 through 11) is considered low-lying. Elevations of the roadway along this stretch of road are predominantly below 5.0 feet (NAVD88). The portions at the lowest elevations (between 1.8 and 2.6 feet) are just south of the Herring River crossing (Figure 11 and Photo 11) where this road has wetland in close proximity to both margins. Avoiding or minimizing wetland impacts by road relocation or lateral realignment would not be possible in these locations due to the lack of adjacent land at significantly higher elevations and a close proximity to existing, densely vegetated wetland areas. Raising the roadway by the necessary number of feet would result in substantial wetland alteration from construction of sloped roadway embankments. If retaining walls were used in place of sloped embankments in these lowest road segments, the potential for wetland alteration would be greatly reduced.

The two segments of Bound Brook Island Road that are at slightly higher elevations, which is the portion that abuts Merrick Island and the portion located to the west of the Pole Dike Road intersection, abut lands that are at higher elevations. It therefore may be possible to realign these road segments onto higher ground so that wetland impacts are avoided or minimized. A 60-inch (approx.) concrete culvert conveys the Herring River beneath Bound Brook Island Road. This culvert (Photos 13 and 14) may be adequately sized for current conditions. Replacing this pipe culvert with a larger conveyance structure, such as a wide box culvert, may be necessary to accommodate increased tidal flooding.

1.3.4 Old County Road

Old County Road is a frequently traveled, paved public road that crosses the Truro-Wellfleet town boundary. In Wellfleet, this road has two stream crossing locations, one at Bound Brook (Figure 12) and the second located to the north at Paradise Hollow (Figure 13). A separate discussion is provided for each below.

1.3.4.1 Bound Brook Crossing

Along its southernmost portion in Wellfleet this road crosses Bound Brook and the densely vegetated wetland areas that border this stream (Photo 15). This wetland is in close proximity to both margins of the road. The elevations of the road in this segment are between 2.0 and 3.5 feet and the abutting wetland areas appear to be at elevations just below this range. The 24-inch diameter culvert that conveys Bound Brook beneath the road (Photo 16) appeared damaged and/or otherwise obstructed at the time of site inspection.

Avoiding or minimizing wetland impacts by road relocation or lateral realignment would not be possible in this segment of Old County Road due to both the lack of adjacent land at higher elevations and a close proximity to proximity of existing wetland resource areas. It appears that raising this section of roadway by the necessary number of feet would result in substantial wetland alteration from construction of sloped roadway embankments. Using vertical retaining walls in place of embankments to minimize direct wetland alteration, while possible along this segment of roadway, will likely be considered cost prohibitive and the causeway-like structure that would result would not serve the interests of the larger restoration project in our opinion.

1.3.4.2 Paradise Hollow Crossing

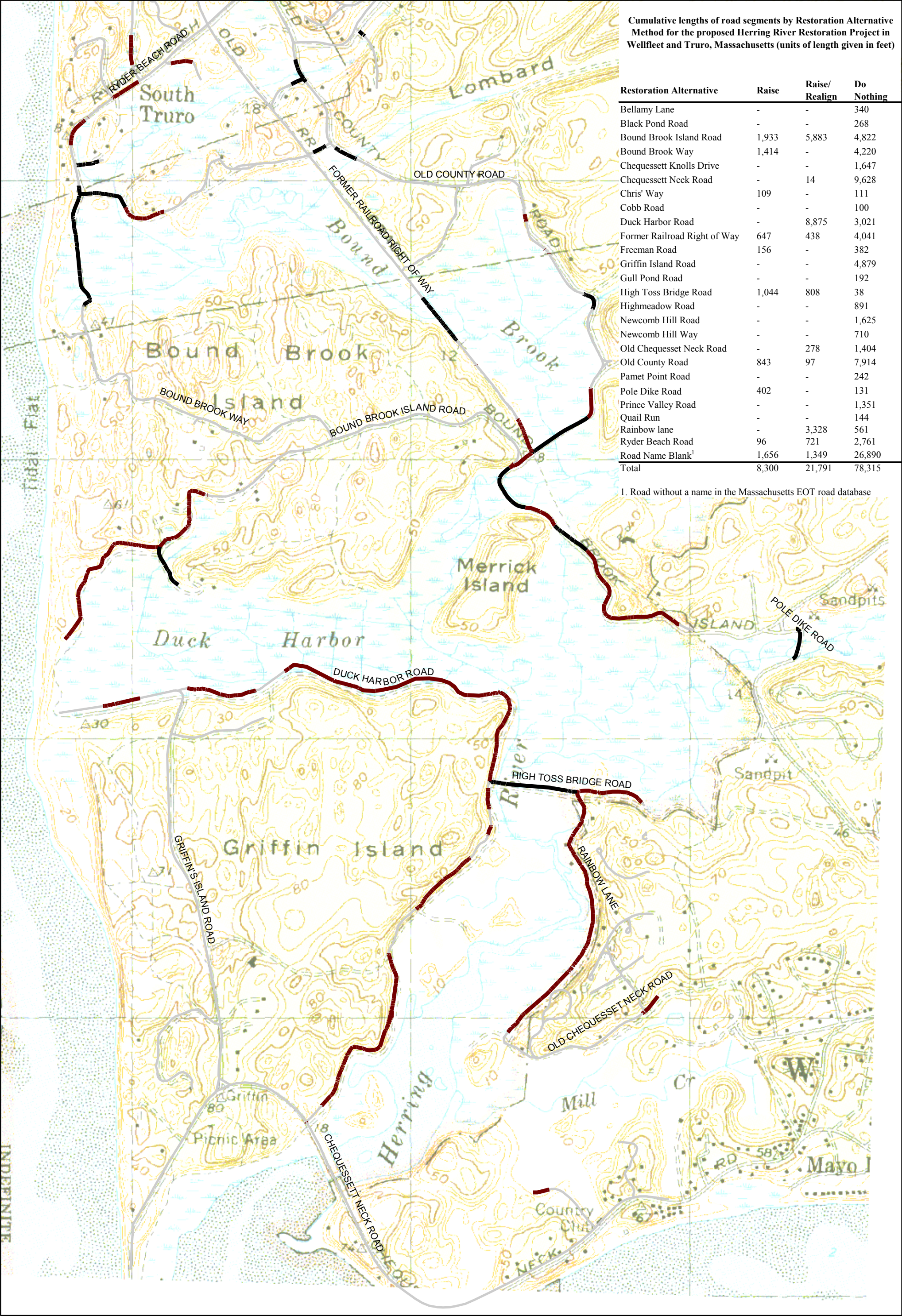
The northernmost portion of Old County Road in Wellfleet crosses a stream within Paradise Hollow (Figure 13, Photo 17), which is tributary to Bound Brook. The elevation at the centerline of the road was surveyed to be 3.37 feet (NAVD 88). As with other LLR segments that cross streams, completely avoiding or minimizing wetland impacts by road relocation or lateral realignment would not be possible here due to both the lack of adjacent land at higher elevations and a close proximity to existing wetland resource areas. Using vertical retaining walls in place of embankments to minimize direct wetland alteration and increase the road elevation may be practical in this location.

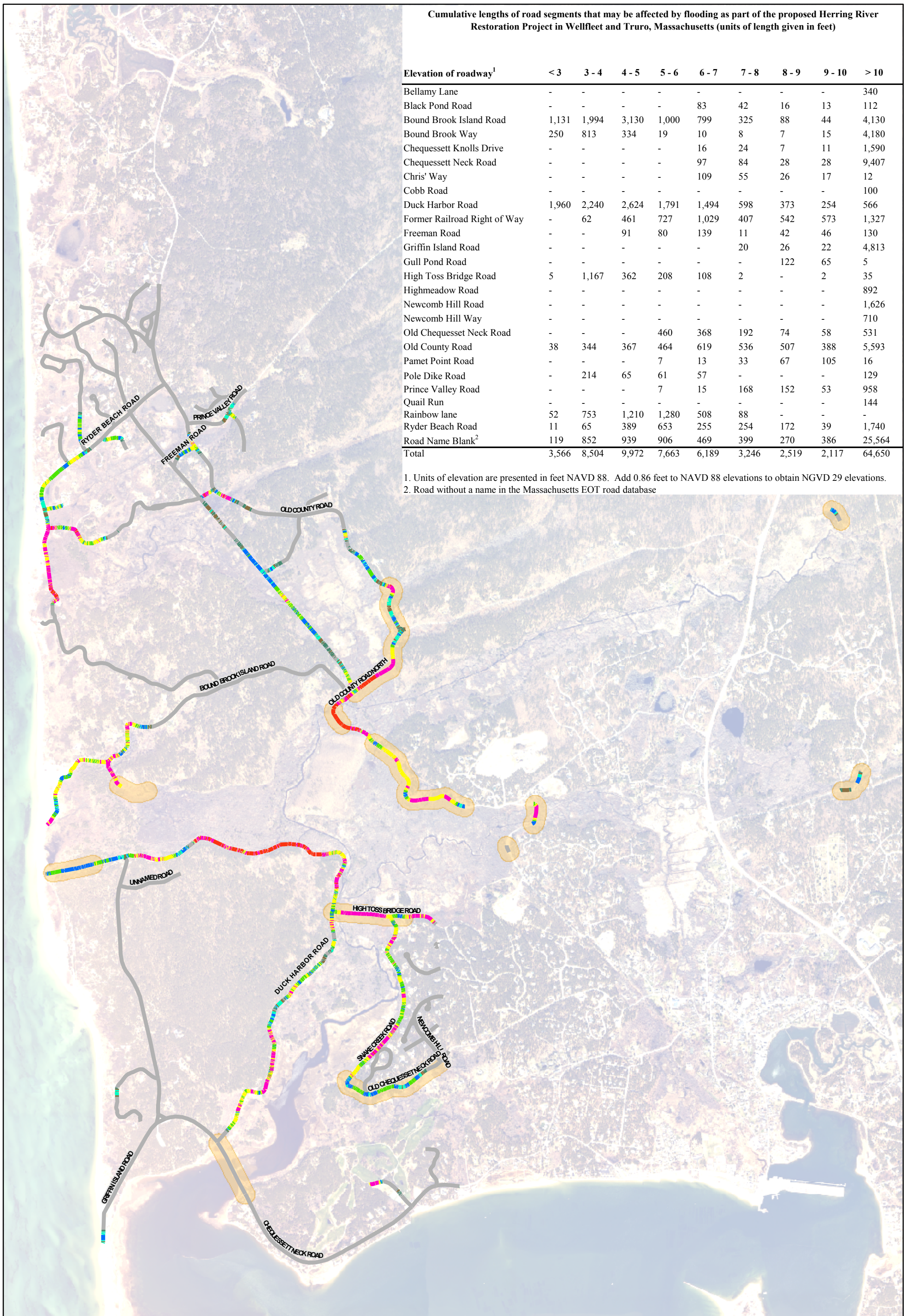
A measurement by the land surveyor indicates that the existing cross-culvert in this location has an 8-inch diameter. The pipe appeared partially obstructed by sediment and other debris upon inspection (Photo 18). Replacing this pipe culvert with a larger conveyance structure, such as an open-bottom arch or box culvert, may be appropriate here.

APPENDIX A

SUMMARY PLANS OF LOW-LYING ROADS:

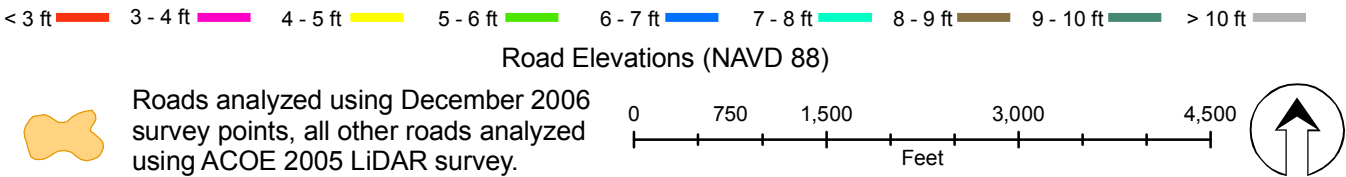
- *SUMMARY OF LOW-LAYING ROADS ANALYSIS*
- *LOW-LAYING ROAD ALTERATION ALTERNATIVE ANALYSIS*





Herring River Restoration Project

Summary of Low-Laying Roads Analysis



APPENDIX B

LOW-LYING ROAD SURVEY PLANS (SHEETS/FIGURES 1-16)

APPENDIX C

PHOTOGRAPHS OF LOW-LYING ROADWAYS

HIGH TOSS BRIDGE ROAD / HERRING RIVER CROSSING



PHOTO 1

SUBJECT: Location along High Toss Bridge Road where it crosses the Herring River. Intersection with Duck Harbor Road in background.

DATE: 12 January 2007 **ASPECT:** west

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PHOTO 2

SUBJECT: Portion of High Toss Bridge Road at elevations between 3.0 and 3.5 feet (NAVD88). Both roadway margins abut wetland habitat, which is at similar surface elevation of the road.

DATE: 12 January 2007 **ASPECT:** west

PROJECT / No.: Herring River Restoration – Low-lying Roadways Evaluation / 04479-003-100



PHOTO 3

SUBJECT: Portion of Old County Road that traverses Bound Brook and its marsh. Road surface elevations measure between 2.5 and 3.5 feet (NAVD88). Cross-culvert is a 24-inch diameter pipe with inverts at -2.13 and -2.35 feet. **DATE:** 12 January 2007 **ASPECT:** northeast

PROJECT / No.: Herring River Restoration – Low-lying Roadways Review / 04479-003-100



PHOTO 4

SUBJECT: Portion of Pole Dike Road at Pole Dike Creek crossing where elevations of paved surface is between 3.0 and 3.5 feet (NAVD88). Wetland habitat abuts the margins of both grassed road shoulders.

DATE: 12 January 2007 **ASPECT:** northern

PROJECT / No.: Herring River Restoration – Low-lying Roadways Evaluation / 04479-003-100

HIGH TOSS BRIDGE ROAD / HERRING RIVER CROSSING



PHOTO 5

SUBJECT: Segment of Herring River immediately south of High Toss Bridge Road culvert.

DATE: 12 January 2007 **ASPECT:** southern / downstream

PROJECT / No.: Herring River Restoration – Low-lying Roadways Review / 04479-003-100



PHOTO 6

SUBJECT: Emergent marsh and scrub-shrub wetland habitat located just to the north of High Toss Bridge Road and to the east of the Herring River.

DATE: 12 January 2007 **ASPECT:** northern

PROJECT / No.: Herring River Restoration – Low-lying Roadways Review / 04479-003-100

HIGH TOSS BRIDGE ROAD / HERRING RIVER CROSSING



PHOTO 7

SUBJECT: Downstream (southern) end of culvert that carries the Herring River beneath High Toss Bridge Road. Culvert is approximately 60 inches in diameter (inside) and is approximately 24 feet in length. **DATE:** 12 January 2007 **ASPECT:** northwest

PROJECT / No.: Herring River Restoration – Low-lying Roadways Evaluation / 04479-003-100



PHOTO 8

SUBJECT: Upstream (northern) end of High Toss Bridge Road culvert that conveys the Herring River. Top of culvert is 1.66 feet and invert elevation is -3.76 feet (NAVD88).

DATE: 12 January 2007 **ASPECT:** southwest

PROJECT / No.: Herring River Restoration – Low-lying Roadways Evaluation / 04479-003-100

POLE DIKE ROAD / POLE DIKE CREEK CROSSING



PHOTO 9

SUBJECT: Portion of Pole Dike Road at Pole Dike Creek crossing where road surface elevation is 4.67 feet at centerline.

DATE: 12 January 2007 **ASPECT:** southeastern

PROJECT / No.: Herring River Restoration – Low-lying Roadways Review / 04479-003



PHOTO 10

SUBJECT Downstream end of 36-inch diameter culvert that conveys Pole Dike Creek beneath road. Culvert invert elevations are -1.00 feet and -1.30 feet.

DATE: 12 January 2007 **ASPECT:** southeastern

PROJECT / No.: Herring River Restoration – Low-lying Roadways Review / 04479-00

BOUND BROOK ISLAND ROAD / HERRING RIVER CROSSING



PHOTO 11

SUBJECT: Bound Brook Island Road at Herring River crossing. Road surface elevation at crossing is 4.45 feet while elevations along road centerline just south of this crossing are between 1.75 and 2.5 feet.

DATE: 12 January 2007 **ASPECT:** northeastern

PROJECT / No.: Herring River Restoration – Low-lying Roadways Review / 04479-003-100



PHOTO 12

SUBJECT: Herring River as seen from Bound Brook Island Road crossing. (Blue pipe visible in left portion of frame is posted as a fire department water supply.)

DATE: 12 January 2007 **ASPECT:** upstream / eastern

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BOUND BROOK ISLAND ROAD / HERRING RIVER CROSSING



PHOTO 13

SUBJECT: Downstream (west) end of culvert that carries Herring River beneath Bound Island Brook Road in Wellfleet. Culvert diameter is approximately 60 inches. Top of concrete headwall is at elevation 2.80 feet. **DATE:** 12 January 2007 **ASPECT:** eastern / upstream

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PHOTO 14

SUBJECT: Upstream (east) end of same culvert that carries Herring River beneath Bound Island Brook Road. Road elevation at the centerline is 4.45 feet (NAVD88). Top of headwall is 2.92 feet.

DATE: 12 January 2007 **ASPECT:** western / downstream

PROJECT / No.: Herring River Restoration – Low-lying Roadways Review / 04479-003-100

OLD COUNTY ROAD / BOUND BROOK CROSSING

**PHOTO 15**

SUBJECT: The southernmost portion of low-lying Old County Road that crosses Bound Brook and the marsh that abuts the brook. Elevations measured along the centerline of this road are between 2.0 and 3.5 feet. **DATE:** 12 January 2007 **ASPECT:** northeastern

PROJECT / No.: Herring River Restoration – Low-lying Roadways Review / 04479-003

**PHOTO 16**

SUBJECT: Downstream end of the cross-culvert that conveys Bound Brook beneath Old County Road. The 24-inch diameter pipe is submerged and appeared damaged and/or obstructed upon observation. Road centerline elevation is 2.69 feet at crossing. **DATE:** 12 January 2007

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OLD COUNTY ROAD / PARADISE HOLLOW CROSSING

**PHOTO 17**

SUBJECT: The low-lying portion of Old County Road that crosses Paradise Hollow just south of the Wellfleet-Truro town boundary. The road surface centerline elevation at the culvert is 3.37 feet, which is the lowest elevation point along this portion of road. **DATE:** 12 January 2007 **ASPECT:** southern
PROJECT / No.: Herring River Restoration – Low-lying Roadways Review / 04479-003-100

**PHOTO 18**

SUBJECT: The downstream end of the cross-culvert that conveys the stream beneath Old County Road. This culvert is approximately eight inches in diameter and appeared partially obstructed to flow. **DATE:** 12 January 2007
PROJECT / No.: Herring River Restoration – Low-lying Roadways Review / 04479-003-100