Sluiceway and Tide Gate Structure
Green Harbor River
Marshfield, Massachusetts

Inspection Report

Massachusetts Office of Coastal Zone Management
Wetlands Restoration Program

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Project Purpose

As part of the Green Harbor Wetland Restoration Project, a visual field inspection was performed at the Dyke Road sluiceway and tide gates in order to assess the existing condition and state of deterioration of the structure. This assessment was required to determine if the structure possesses a sufficient remaining service life such that modifications to the tide gates could be accomplished to increase the tidal exchange through the sluiceway without having to perform major modifications or replacement of the existing structure. The Louis Berger Group, Inc. (Berger) performed field inspections on December 13 and 28, 2006.

Structure Location and Description

The sluiceway and tide gate structure is located on Route 139 (Dyke Road) at Green Harbor in the Town of Marshfield, MA. The dyke, originally constructed in 1872 for agricultural proposes, was modified in the 1920's with the addition of the present sluiceway structure. In the 1960's, the sluiceway was repaired and modified resulting in its current configuration today. The basic structure is comprised of a double-barrel concrete culvert with each barrel being approximately 6'-0" wide by 16'-6" high separated by a full height center wall. Within the inlets on each end of the structure, the barrels split into two chambers resulting in four openings at each inlet. On the estuary inlet, keyways in the concrete walls were provided for the installation stop logs (flashboards). On the ocean side inlet the four 3'-6" wide by 6'-0" high openings are each fitted with wooden tide gates. The tide gates close during the in coming tide cycle, preventing the influx of ocean water into the estuary.

The sluiceway, positioned perpendicular to the roadway above, has very minimal fill above its roof slab to the top of the roadway surface. The structure supports Dyke Road which is comprised of a 42'-0" wide roadway carrying two lanes of traffic *(shown on left)*. The roadway is posted for 40 mph and has highway guard rail extending along both sides of the roadway for the length of the dyke structure. This guardrail lines up with metal bridge rail fastened to the sluiceway (*shown on right below)*. Utilities present at the site include a water line along the west side of the roadway; a gravity sewer line extending down the middle of the roadway; and a gas line along the east side of the roadway. In addition, overhead lines extend along the east side of the roadway on timber poles positioned close to the highway guardrail. Riprap lines the slopes of the dike on either side of the road.

Available Plans

The following plans were available to aid in the understanding of the overall layout, geometry, and construction of the sluiceways.

Titled:	Proposed Reconstruction of Tidegates and Sluiceways Green Harbor Marshfield, MA
For:	Department of Public Works of Massachusetts - Water Division
Prepared by:	Congdon, Gurney & Towle, Inc.
Drawings:	1 to 5 of 5, dated May 1963

Field Inspection Access

The Town of Marshfield obtained the services of a contractor, Offshore Marine, to provide access to the interior of the sluiceway for inspection. In order to maintain water flow through the sluiceway, the contractor chose to provide access first to the southerly barrel and then at a latter time to the northerly barrel. Access to the southerly barrel was accomplished during an outgoing tidal cycle by blocking the southern barrel of the sluiceway on the estuary side to prevent water discharge through the sluiceway. A submersible pump, placed on top of the invert slab, was utilized to pump down the water within the sluiceway. Approximately 4-5 inches of water remained in the sluiceway during the inspections due to the limitations of the submersible pump and lack of a sump within the invert slab. A ladder was secured to the back of the bridge railing *(shown on left below)*, on the northwest corner of the sluiceway, to allow personnel to access the catwalk inside the sluiceway. From the catwalk, timber planks were arranged to provide access to the face of the trash racks. The top section of the trash racks were removed to allow personnel to climb over and down the face of the racks to the invert slab below *(shown on right below)*. This same process was repeated to allow access to the northerly barrel of the sluiceway.

Field Inspection Findings

South Sluiceway Barrel

On December 13, 2006, Mark Gershman, P.E. and Nick Goulas, P.E. from Berger performed a visual inspection of the southerly barrel of the sluiceway. Also present were two Offshore Marine employees, who provided access into the sluiceway. In addition to the following observations, a strong organic / septic odor was present in the sluiceway. The air monitoring equipment present at the time was not functioning so air quality readings could not be taken.

Utilities

A waterline *(shown at right)* spans between the westerly walls (estuary side) of the sluiceway. The outer steel sleeve supporting this line is severely deteriorated with areas of complete section loss. As an interim measure, Offshore Marine has supported the waterline via strapping anchored to the concrete roof slab of the sluiceway.

A 24" sewer line *(shown on left below)* spans between the northerly, center and southerly wall of the sluiceway, on the easterly side of the trash racks, and is located approximately 3 feet above the invert slab to the bottom of the sewer line.

An abandoned, heavy rusted, 4" diameter steel conduit spans between the southerly and center walls, on the easterly side of the trash racks, approximately 12 feet above the invert slab and offset 3 feet west of the sewer line below. This conduit within the northern barrel of the sluiceway is broken and hanging from the center wall *(shown on right above).*

Invert Slab

At the time of the inspection, approximately 4-5 inches of standing water was present within the sluiceway. In addition, the concrete invert slab was heavily coated with barnacle and marine growth preventing a detailed visual inspection. Water was observed to be piping up from the expansion joint within the invert slab at the face of the southerly wall.

South Wall

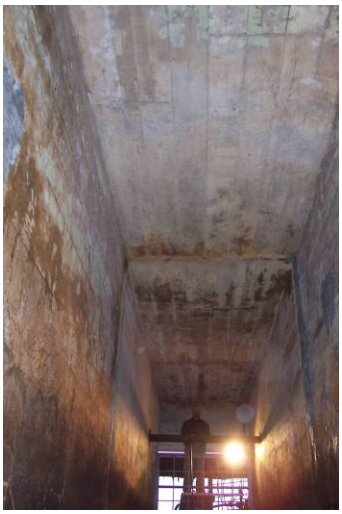
Commencing from the westerly end of the wall, an area of concrete abrasion and spalling was observed along the angled portion of the southerly wall between the sluice boards and trash racks. Only the lower 4 ½ feet of the wall (at and below the normal waterline) is abraded and spalled to an approximate depth of 3-4" with the exposed steel reinforcement exhibiting 100% section loss. Within various sections of the wall, previous attempts have been made to repair the concrete via patching. In all instances, it was found that the patch material has delaminated from

the substrate resulting in hollow sounding areas. These areas occur above and partially around the sewer line penetration through the wall, on either side of the vertical expansion joint, and in an area just before the angle point in the wall approaching the tide gates; approximately 6 feet above the invert slab. In addition, several fine to median cracks were observed particularly extending vertically from the patch area above the sewer line to the bottom of the roof slab. As mentioned above, the patching material has delaminated either side of the vertical expansion located in the wall. In addition, it appears that the construct joint has opened by approximately 3" at the bottom of the roof slab. As a result, what appears to be the waterproofing membrane, placed on the top of the roof slab, is clearly visible *(shown on left).* The opening of the expansion joint could be from the rotation or settlement of the easterly portion of the sluiceway structure in reference to the westerly section. Due to the very limited fill over the structure, the opening of the expansion joint has reflected through the roadway pavement above *(shown on right).*

Over the entire length of the wall, from the normal water line to the top of the invert slab (approximately 4 feet) there is a heavy coating of barnacle and marine growth which prevented a detailed visual inspection of the lower portion of the wall.

Roof Slab

Though the roof slab was physically inaccessible due to its height above the invert slab, it appeared to be in generally good condition with no exposed reinforcing or visible concrete spalling *(shown on left below).* Minor areas of hair link cracking with moderate efflorescence were observed particularly above the ocean inlet area just west of the tide gates *(shown on right below).*



Center Wall (South Face)

Similarly to the south wall, various sections of the center wall have been attempted to be repaired by patching the concrete. Again, in all areas it was found that the patch material has delaminated from the substrate below resulting in hollow sounding areas. These areas occur above and partially around the sewer line penetration through the center wall; on either side of the vertical expansion joint; and in a large area just before the angle point in the wall approaching the tide gates. This large area of de-lamination has areas of exposed and heavily rusted steel reinforcing with failed and flaking patch material *(shown at right).*

The condition and opening of the vertical expansion joint on the center wall is the same as previously described for the south wall above.

Again, over the entire length of the wall, from the normal water line to the top of the invert slab (approximately 4 feet) there is a heavy coating of barnacle and marine growth preventing a detailed visual inspection of the lower portion of the wall. In general, the south face of the center wall of the sluiceway is in fair to poor condition having experienced a higher state of deterioration than the south wall.

Tide Gates

The back side of both tide gates in the south sluiceway barrel appeared in good condition with no visible signs of deterioration or distress. In limited areas, the concrete abutting the gate's steel frame has deteriorated resulting in the ability of water to leak through the joint between the concrete and the frame *(shown on right below).* At the time of the inspection, there was approximately 4 feet of head behind the tide gates *(shown on left below).*

North Sluiceway Barrel

On December 28, 2006, Mark Gershman, P.E. from Berger performed a visual inspection of the northerly barrel of the sluiceway. Also present were two Offshore Marine employees, who provided access into the sluiceway, and two employees from the Town of Marshfield. In addition to the following observations, a strong organic / septic odor was present in the sluiceway though to a much lesser extent than was noticed during the inspection of the southerly barrel.

Utilities

See description of utilities from south barrel inspection above.

Invert Slab

At the time of the inspection, approximately 4-5 inches of standing water was present within the sluiceway. In addition, the concrete invert slab was heavily coated with barnacle and marine growth preventing a detailed visual inspection. Water was observed to be piping up from the expansion joint within the invert slab at the face of the center wall *(shown on right).*

North Wall

Over the entire length of the north wall, from the normal water line to the top of the invert slab (approximately 4 feet) there is a heavy coating of barnacle and marine growth which prevented a detailed visual inspection of the lower portion of the wall. The remaining exposed areas of the wall appeared in much better condition than the south sluiceway wall with only limited areas of delamination and cracking. A 1/16" crack was observed extending vertically from the sewer line penetration towards the roof slab as well as minor vertical cracking and efflorescence just before the tide gates. At the limited areas that have been previously patched, the patch material has delaminated resulting in hollow sounding areas. These occur on the angled portion of the northerly wall on the west side of the trash racks approximately 4'-6" above the invert slab and within the patch material either side of the vertical expansion joint. At this location, the patch material has lifted away from the wall. Similarly to the south wall, the vertical expansion joint has appeared to have opened up by approximately 3" at the bottom of the roof slab *(shown on right below).* However, unlike the south wall, the patch material filling the joint appears to be still bonded to the substrate *(shown on left).*

Roof Slab

Though the roof slab was physically inaccessible due to its height above the invert slab, it appeared to be in generally good condition with only one area of exposed reinforcement near the expansion joint *(shown on left below).* Minor areas of hair link cracking with moderate efflorescence were observed particularly above the ocean inlet area just west of the tide gates *(shown on right below).*

Center Wall (North Face)

Over the entire length of the north face of the center wall, from the normal water line to the top of the invert slab (approximately 4 feet), there is a heavy coating of barnacle and marine growth preventing a detailed visual inspection of the lower portion of the wall. The remaining exposed areas of the wall appeared in much better condition than the south sluiceway wall with only limited areas of delamination and cracking. Two 1/8" wide cracks were observed extending vertically, one from the sewer line penetration towards the roof slab, and again approximately 4 ft from the angle point in the wall adjacent to the ocean inlet *(shown on right).* At the limited areas that have been previously patched, the patch material has delaminated resulting in hollow sounding areas. These occur on the 8 ft half height center wall adjacent to the estuary inlet; the vertical expansion joint; and in limited areas either side of the vertical crack previous noted near the ocean inlet.

Tide Gates

The back side of both tide gates in the north sluiceway barrel appeared in good condition with no visible signs of deterioration or distress. In limited areas, the concrete abutting the gate's steel frame has deteriorated resulting in the ability of water to leak through the joint between the concrete and the frame. In particular, the contact point between the most northern gate and the invert slab is not sealed when the gate is in the closed position. Water can be observed piping into the sluiceway at this location *(shown on left).*

Catwalk

The concrete catwalk along the inside face of the northwest wingwall appeared in generally good condition with minor concrete spalling along its bottom edges *(shown on left below).* However, the catwalk extending perpendicular between the inside faces of the wingwalls had extensive areas of spalling concrete and exposed steel reinforcement *(shown on right below).*

Vertical Walls at Ocean Inlet

On the vertical walls within the ocean inlet, where the sluiceway barrel splits into two channels, the lower 4 ½ feet of the exposed nose of the walls (below the normal waterline) are abraded and spalled to an approximate depth of 3-4".

Summary

As a result of the visual inspection performed, we believe that the existing structure possesses a sufficient remaining service life that modifications can be made to the existing tide gates, to increase the water exchange into the estuary, without having to perform major modifications or replacement of the existing structure. However, in order to maintain the service life of the structure it is recommended that areas of existing concrete spalls and cracks, including all previous concrete patching material that has become delaminated from its substrate, be repaired. In addition, periodic monitoring of the structure should be undertaken to ensure that no further movement or opening of the expansion joint is occurring.