Final Report Salter's Grove Causeway Environmental and Public Access Improvements Project

PAWTUXET COVE
WARWICK, RHODE ISLAND

PREPARED FOR

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Project No. R316-000.4

November 15, 2004

SALTER'S GROVE CAUSEWAY ENVIRONMENTAL AND PUBLIC ACCESS IMPROVEMENTS PROJECT
Warwick, Rhode Island

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EXECUTIVE SUMMARY

The Rhode Island Department of Environmental Management (RIDEM) Division of Planning and Development contracted ESS Group, Inc. (ESS) to complete environmental investigations and document the existing conditions and potential impacts of providing public access for fishing opportunities, habitat value, odor control and other environmental benefits to Salter's Grove, Warwick, Rhode Island. ESS conducted these investigations in the spring and summer of 2004.

ESS completed wetland, water quality and sediment transport studies based on field data and existing resources. ESS also coordinated with stakeholders to identify existing projects in the area and to obtain federal and state agency input on the proposed improvements. The City of Warwick Harbor Management Commission held a public meeting on March 16, 2004 to introduce the Salter's Grove Causeway Environmental and Public Access Improvements Project and to receive public input on the existing conditions at the causeway.

The resources identified by ESS during technical investigations indicate that salt marsh vegetation has established in a thin band all along the causeway on both the north and south sides, varying in width between 1 and 3 feet and very sparse in some areas. Constructing new culverts has the potential to destroy approximately 258 square feet of salt marsh. Based on field observations only, the existing salt marsh along the causeway and associated habitats (primarily tidal flats) provide minimal habitat for fish and wildlife species within the Salter's Grove area. The salt marsh is sparse and disrupted by boulders and the abundance of common reed on the north side will likely result in a decline in species diversity in the area as it continues to spread. Although the salt marsh and tidal flats do provide habitat to several wildlife species (ribbed mussels and fiddler crabs), the salt marsh itself does not appear to function as a habitat for fisheries and birds.

Water quality sampling and analysis indicates the Pawtuxet River stations exhibit elevated nitrate and depleted dissolved oxygen levels and that out of the three potential water sources, (the Pawtuxet River, Narragansett Bay and the Unnamed Brook), the Pawtuxet River is the largest contributor of high nutrients and low dissolved oxygen to Salter's Grove. Consequently, any project that could increase water transport between Pawtuxet Cove and Salter's Grove South has the potential to negatively impact water quality conditions in Salter's Grove South.

ESS' analysis of the potential for sediment distribution and transport as a result of potential improvements to the causeway indicates that a range of up to 65 meters from the culvert could exhibit signs of bottom scour and promote sediment resuspension based on a 2 meter (m) culvert. Since the approximate minimum distance from a culvert to the edge of the proposed Federal Navigation Project (anchorage area) is 168 m the effects of rebuilding the culvert will not influence the sediment distribution in the vicinity of the Federal Navigation Channel dredge project.

Currently there are no other stakeholder projects occurring within the area which would be impacted by the Salter's Grove Causeway Environmental and Public Access Improvements project. Initial coordination with regulatory agencies should be conducted to present the information from this report prior to further design stages to identify any project constraints.

1.0 INTRODUCTION

The Rhode Island Department of Environmental Management (RIDEM) Division of Planning and Development contracted ESS Group, Inc. (ESS) to complete environmental investigations and document the existing conditions and potential impacts of providing public access for fishing opportunities, habitat value, odor control and other environmental benefits to Salter's Grove, Warwick, Rhode Island. ESS conducted these investigations in the spring and summer of 2004. The following report documents the existing conditions for wetlands, wildlife, water quality and sediment transport.

2.0 BACKGROUND

Salter's Gove Park is owned by RIDEM and leased long term to the City of Warwick (City). In 1966+/-, the United States Army Corps of Engineers (USACE) constructed a stone breakwater connecting Rock Island and Marsh Island to protect Pawtuxet Cove from storms. As part of the breakwater construction, the USACE constructed a temporary causeway connecting Salter's Grove and the breakwater. The causeway was originally scheduled to be removed after the breakwater was in place; however RI Department of Natural Resources (RIDEM's predecessor) requested that the causeway remain in place to provide recreational fishing opportunities. The USACE agreed, with the understanding that the state would take ownership of the causeway and be responsible for any long-term management and repair.

Originally, the causeway had two 20-foot openings that allowed water to flow between the northern cove and the southern cove at all stages of the tide. By 1971, both openings had partially failed and flow between the two coves was reduced. Local residents have been complaining to the City that objectionable odors sometimes emanate from the cove at low tide. Over the past 30 years, the causeway has eroded and wetland vegetation has become established along the causeway's side slopes. Currently, the two culverts in the causeway are not functional. The western culvert has filled in with sediment and an indeterminate amount of water passes through only when water breaches and passes over the causeway at times of very high water. The eastern culvert has been completely covered by sediment and it is not known if water passes through except at very high tides. No water passes at mid to low water levels over either culvert location.

As a result of community concern and RIDEM interest in continuing to provide recreational fishing access to the breakwater, the engineering firm of Robinson Green Beretta Corporation completed a preliminary feasibility and engineering report in August 2003. The purpose of the report was to identify a feasible engineering approach for maintenance repairs of the causeway and footbridges that would improve tidal flushing, recreational access and provide handicap and emergency vehicle access from the Salter's Grove Park across the causeway.

In addition to the Salter's Grove Causeway Environmental and Public Access Improvements project, the USACE proposes to dredge the Pawtuxet Cove Federal Navigation Channel. The project involves approximately 90,000 cubic yards of silty-sand and silt sediment from the northern, 100-foot wide by 6-foot deep channel, turning basin, the 6-foot deep channel and the 14 acre anchorage area located south of the entrance channel and approximately 168 feet north of the causeway.

3.0 EXISTING CONDITIONS

The following sections provide an overview of the existing conditions in the Project Area. The existing causeway includes two culverts which are not functioning. The western culvert (Figure 1) has collapsed and filled in. Water passes over this portion of the causeway at high tides only. The eastern culvert (Figure 1) has also collapsed and a footbridge was installed to span the culverted section.

3.1 Wetland Resources

ESS wetland scientists completed field investigations in May 2004 to identify the landward extent of salt marsh along both sides of the existing causeway area. As presented in Figure 1, the extent of salt marsh was delineated along the causeway on the Pawtuxet Cove (north) side and the Passeonquis Cove (south) side. A small area of salt marsh was also identified along the sheltering dike.

In general, the landward extent of salt marsh in the Project Area is a well-defined break between the armored bank of the causeway and salt marsh vegetation. In some instances, vegetation such as high tide bush (*Iva frutescens*) is growing within the spaces between the boulders (Figure 2). Where this occurs, ESS included some boulders within the limits of salt marsh. As indicated in Figure 1, salt marsh vegetation extends along both the north and south sides of the causeway between the upland and the breakwater. Although the salt marsh vegetation exists along most of the causeway length, it is a thin band varying in width between 1 and 3 feet and very sparse in some areas. Dominant vegetation within the salt marsh community on both sides of the causeway included; saltwater cordgrass (*Spartina alterniflora*) and high tide bush. Other vegetation noted included; little blue stem (*Schizachyrium scoparium*), common reed (*Phragmites australis*), sea milkwort (*Glaux maritima*), and common glasswort (*Salicornia europaea*). Common reed is found in small areas, mostly on the higher elevations above the observed wrackline, along the northern shoreline of the causeway.

Common reed is typically found in brackish and tidal fresh marshes and disturbed areas. Common reed presence on the northern side of the causeway could be due to several factors including lower salinity in Salter's Grove North and disturbed origins of the sediment in the area. In addition, the presence of the stormwater outfall in the southwestern most portion of Pawtuxet Cove may be contributing freshwater into the system and decreasing salinity.

In general, salt marshes produce significant amounts of organic matter and this material is exported as detritus and dissolved organics to estuarine and coastal waters, where it provides the basis for a large food web that supports many marine organisms. Salt marshes can provide spawning and nursery habitat for several important estuarine forage finfish as well as important food, shelter, breeding areas and migratory and overwintering areas for many wildlife species. Plants in salt marshes can also remove pollutants, by absorbing chlorinated hydrocarbons, heavy metals, and excess nutrients and can bind sediments together. The RI Coastal Resources Management Council (RICRMC) Coastal Resources Management Program (CRMP) considers Coastal wetlands to typically provide food and shelter for a variety of fishery species (RICRMC 1996).

Based on field observations only, the existing salt marsh along the causeway and associated habitats (primarily mud flats) provide minimal habitat for fish and wildlife species within the Salter's Grove area. The salt marsh is sparse and disrupted by boulders and the abundance of common reed on the north side will result in a decline in species diversity in the area as it continues to spread. Although the salt marsh and tidal flats do provide habitat to several wildlife species (ribbed mussels and fiddler crabs), the salt marsh itself does not appear to function as a habitat for fisheries and birds.

Although the salt marsh may not be a significant resource to the Pawtuxet Cove ecosystem, the data provided by RIDEM fish and Wildlife (Section 3.1.4) indicate that Pawtuxet Cove does provide significant winter flounder resources and field observations indicate bird species do utilize the waterbodies just north and south of the causeway. Further studies would need to be completed to understand the relationship between the causeway, tidal circulation and fishery habitat to further document the significance of the salt marsh presence within the system as it may contribute some value to stabilizing the causeway and sediments.

3.1.1 Tidal Flats

Tidal flats (or mudflats) extend from the salt marsh vegetation line (see Figure 2) and are exposed at low tides. Fiddler crabs (*Uca spp*.) and ribbed mussels (*Gaukensia demissa*) were also observed within the salt marsh and mudflat community. In general, tidal flats are important for marine fisheries and wildlife because they provide habitats for marine organisms such as polychaete worms and mollusks, which in turn are food sources for fisheries and migratory wintering birds. Tidal flats are sites where organic and inorganic materials may become entrapped and then returned to the photosynthetic zone of the water column to support algae and other primary producers of the marine food web. During field investigations, swans, seagulls and ducks were observed from a distance in Salter's Grove on the north and south sides of the causeway. These birds and migratory wintering birds may utilize the tidal flats on both sides of the causeway as foraging sites. However, more detailed field investigations documenting the abundance of benthic invertebrates and their relationship to marine fisheries and wildlife would need to be completed, to establish the current values the existing tidal flats provide.

3.1.2 Coastal Features

The RICRMC regulates activities in the coastal zone based on the type of coastal features and the activity proposed. Coastal features are defined by the CRMP and for the causeway include both salt marsh and manmade shoreline. The causeway itself would be defined as manmade shoreline by the CRMC, however, salt marsh vegetation has grown up around the causeway on both the north and south sides. There are areas where the coastal feature is salt marsh and other areas where it is manmade shoreline along the causeway.

3.1.3 Observed Wildlife

During the wetland field investigations, ESS scientists also completed a review of fish and wildlife within the Project Area. Fiddler crabs (*Uca* spp.) and ribbed mussels (*Gaukensia demissa*) were observed within the salt marsh and tidal flat communities (Figure 2). Swans, seagulls and ducks were observed from a distance in Salter's Grove on the north and south sides of the causeway. There were also several cats observed along the causeway and breakwater.

3.1.4 Fishery Resources

ESS contacted RIDEM Fish and Wildlife fishery biologist's Art Ganz and Chris Powell to identify existing fish and shellfish resources in the vicinity of Salter's Grove. According to Chris Powell, Pawtuxet Cove and the contiguous areas were sampled 10 times for juvenile winter flounder between 2002 and 2003 by the United States Environmental Protection Agency (USEPA). Density of winter flounder per square mile in Pawtuxet Cove was at least as high and in some cases better than juvenile winter flounder densities in the rest of Narragansett Bay and the coastal ponds (Personal Communication, Chris Powell, April 2004). There were no other fish or shellfish stations within the immediate study area. RIDEM Fish and Wildlife has a juvenile winter flounder sampling location at Gaspee Point in Warwick, south of Salter's Grove and there is a shellfish sampling station just outside the breakwater.

3.2 Water Quality

ESS reviewed and interpreted water quality data collected to establish baseline water quality conditions in Pawtuxet Cove, Salter's Grove, Passeonkquis Cove, and the Providence River. The water quality data was collected based on the June 2, 2004 Salter's Grove Causeway Environmental and Public Access Improvements Project Water Quality Sampling Plan. The sampling plan was designed to allow RIDEM and the City to compare the relative differences between water quality in the three areas during the sampling period. Appendix A includes a water quality report that provides a summary and analysis of the data.

For the purposes of the water quality assessment, the Salter's Grove study area includes the area west of the existing breakwater and Marsh and Rock Islands, south of the entrance to Pawtuxet Cove and north of the entrance to Passeonkquis Cove (Appendix A, Figure 1). The causeway divides the study area into two sections referred to by this plan as Salter's Grove North (SGN) and Salter's Grove South (SGS). Potential flushing sources of the study area include the Providence River and upper Narragansett Bay, the Pawtuxet River and the unnamed brook at the head of Passeonkquis Cove.

Two (2) sampling events were conducted during the summer months of 2004 on a spring tide (highest amplitude tide). Water quality samples were collected using two methods: physical/chemical parameters measured in the field with an electronic meter, and water samples pumped from depth for lab analysis. Dissolved oxygen measurements were taken at specific points and across transects as discussed in Section 2.3 of Appendix A. Water quality samples were analyzed for nutrients (nitrite, nitrate, ammonia, and phosphate). A YSI handheld multi-parameter instrument was used for the collection of salinity, dissolved oxygen, and temperature data.

3.2.1 Results

Based on the laboratory water sample analysis reports, nitrate levels at the Pawtuxet River stations were always the highest (ranging from 2.32 mg/L to 2.46 mg/L) while values at the stations in the southern portion of the study area were the lowest (ranging from 0.23 mg/L to 0.52 mg/L). Values in the SGN region were greater during the high tide sampling event (ranging from 0.69 mg/L to 1.94 mg/L) than during the low tide sampling event (ranging from 0.36 mg/L to 1.29 mg/L). One SGS Station (SGS1) had higher nitrate values during the high tide sampling event (0.52 mg/L vs. 0.24 mg/L) while the other two SGS stations exhibited similar values (ranging from 0.24 mg/L to 0.25 mg/L).

Based on the YSI readings of dissolved oxygen concentrations and direct observations of water levels and surface flow, it appears that low dissolved oxygen water is being transported from the Pawtuxet River along the western side of SGN and across the causeway at the western culvert[1]. The eastern culvert also passes some water over the causeway, but not as much as the western; a minimum in dissolved oxygen is also coincident with the eastern culvert. The lowest dissolved oxygen readings were observed at SGS1, a station just south of the causeway near a surface jet passing from north to south of the causeway.

Salinity values were lowest at the Pawtuxet River stations, suggesting the Pawtuxet River is the predominant source of fresh water to the study area. The nitrate and salinity data show a strong relationship implying that the nitrate distribution in the study area are primarily a function of the dilution of fresh water with marine water which implies that the nitrate distribution is controlled primarily by the mixing of Pawtuxet River water with Narragansett Bay water.

Neighboring property owners have complained about odors emanating from Salter's Grove and have associated them to poor water quality. ESS did not experience any odorous conditions during field investigations, but it is possible that these odors are a result of decaying macroalgae (seaweeds) and anoxic conditions in Salter's Grove. As water temperatures rise in the summer months and algae decays, the decomposition process depletes dissolved oxygen levels creating localized hypoxic or anoxic conditions (D'Avanzo and Kremer 1994). These conditions can lead to the generation of hydrogen sulfide, a gas formed by the decay of organic matter such as plant material.

3.3 Sediment Transport

Currently, the two culverts in the causeway are not functional. Water breaches and passes over the sections of the causeway where the culverts were installed at times of very high water, and no water passes at mid to low water levels. Sediment movement is limited to material moving in the water column during high tides.

[1] Note that water is only exchanged between SGN and SGS when the water level is very high.

4.0 PROJECT PURPOSE

This report considers three potential alternatives for the purposes of evaluating potential impacts to existing wetland resources, water quality, and sediment transport:

1. Take no action and allow the natural forces to further impact the causeway and the coves that it created. As a result public access to the breakwater would not be improved, but the wetland would remain intact and some tidal movement would continue at high tides.
2. Open the culverts to flushing and rebuild the causeway; this scenario assumes two 2 m wide culvert openings for the purposes of evaluating water quality, wetland, and sediment transport impacts.
3. Construct a boardwalk over the causeway so as to only minimally impact the wetland while still providing public access to the breakwater. No work to the culverts would be performed under this alternative.

5.0 POTENTIAL PROJECT IMPACTS

5.1 No Action Alternative

Based on the existing conditions at the causeway, if no action is taken to improve public access at Salter's Grove the salt marsh that has developed as a result of the causeway would remain and potentially expand depending on the sedimentation rates in the area. Water quality would generally continue to be within existing ranges and sedimentary processes would continue as they are now with an incremental increase in material around the causeway.

5.2 Culvert Reconstruction

5.2.1 Wetland Resources

If the culverts were to be reconstructed to allow increased flushing the salt marsh vegetation within the work area would be destroyed by construction activities. Assuming the culvert diameter is 2 meters and construction activities would impact at least three times the area of the culvert location, there will be approximately 6 m of salt marsh impacted on each side of the causeway, at each culvert for a total of 24 m of salt marsh impact. Since the width of the vegetation varies considerably it is difficult to estimate the total amount, but assuming a 1-meter width, there would be approximately 24 m^2 (258 square feet) impacted. This does not include any impacts to salt marsh vegetation due to work areas and access for culvert construction.

CRMC determines what activities can occur within its jurisdiction based on water types designated for all state waters. The waters around Salter's Grove are designated Type 2 Low-Intensity Use which are waters with high scenic value that support low-intensity recreational and residential use. Filling, removal and grading of shoreline features (activities that would be included in any culvert replacement) for manmade shorelines in Type 2 waters is permitted as a Category A or administrative permit. Filling, removal and grading of shoreline features in Type 2 waters is prohibited for coastal wetlands.

Further discussion with CRMC biologists and engineers would be necessary to determine how to proceed with a regulatory strategy to complete causeway improvements.

5.2.2 Water Quality

The existing water quality conditions indicate the Pawtuxet River exhibits elevated nitrate levels and depleted dissolved oxygen levels and of the three potential water sources, (the Pawtuxet River, Narragansett Bay and the Unnamed Brook), the Pawtuxet River is the largest contributor of high nutrients and low dissolved oxygen to Salter's Grove. Currently Salter's Grove South is being flushed primarily from the south with Narragansett Bay water. Consequently, any project that could increase water transport between Pawtuxet Cove and Salter's Grove South has the potential to negatively impact water quality conditions in SGS.

5.2.3 Sediment Transport

ESS completed an analysis of the potential for sediment distribution and transport as a result of potential improvements to the causeway which would allow increased flow between Pawtuxet Cove and Salter's Grove (south of the causeway). The analysis addresses the question of how potential options for the maintenance of Salter's Grove causeway will effect the distribution of sediments and the flow patterns in the region and potentially adversely influence the proposed dredging of the Federal Navigation Channel in Pawtuxet Cove.

5.2.3.1 Methods

This analysis assumes potential changes as a result of a preliminary engineering plan which would allow for a 2 m diameter culvert to be installed resulting in more flow between the northern and southern sections of Salter's Grove.

An extensive literature review was conducted to choose the most applicable method for predicting potential scour from a culvert installation given the data available. Most methods identified rely on numerical modeling and/or field studies, neither of which is available for this project. Therefore, an empirical formula based on easily acquired parameters was chosen. The formula was developed by the USACE and specifically estimates the maximum scour depth at tidal inlets.

Calculations were conducted for three sets of parameters referred to as High Estimate, Low Estimate, and Best Estimate. The Low Estimate and the High Estimate are used to establish a range of reasonable results. The Best Estimate is an attempt to predict the most likely outcome.

5.2.3.2 Results

Based on the sediment transport calculations presented in Appendix B, the High Estimate suggests a maximum scour depth of 6.5 m and a resulting scour range and sediment volume of 65 m and 845 m^3 respectively. Low Estimates suggests a maximum scour depth of 0.29 m and a resulting scour range and sediment volume of 2.9 m and 1.7 m^3 respectively. The Best Estimate suggests a maximum scour depth of 2 m and resulting scour range and sediment volume of 20 m and 75 m^3, respectively.

The High Estimate is intended to investigate the potential of the proposed culvert maintenance project having a significant influence on the proposed Federal Navigation Channel dredging project in Pawtuxet Cove. All values that went into this calculation were biased high for that purpose. Results from the analysis predict that a range of up to 65 m from the culvert could exhibit signs of bottom scour and promote sediment resuspension. The approximate minimum distance from a culvert to the edge of the proposed dredge channel is 168 m. Therefore it can be concluded that even in the worst case scenario the effects of rebuilding the culvert will not influence the sediment distribution in the vicinity of the Federal Navigation Channel dredge project.

The Low Estimate calculations provide estimates utilizing biased low values found in the literature for input, and the Best Estimate utilizes the most reasonable values found in the literature for input. Since the USACE analysis provides estimates of maximum scour depth, the most likely result will fall between the two curves for Low and Best on Figure 2. Based on the calculations in this report, the culvert maintenance project will most likely result in a maximum scour depth of 1 m and a maximum range on influence of 10 meters. This prediction represents a 50 percent reduction of the results obtained from the Best Estimate calculation.

Rebuilding the culverts has the potential to result in an increase in flow between the two sides of Salter's Grove and therefore change the bottom profile in the vicinity of the culverts. The results of this analysis suggest that the region influenced by the increase in flow should not be close to the region of proposed dredging. Furthermore, based on these calculations opening the culverts should not have any significant affect on the stability of the dredge channel.

5.3 Boardwalk Construction Alternative

If a boardwalk is constructed over the causeway, there will be temporary impacts to the salt marsh vegetation from construction of the boardwalk assuming the boardwalk is not constructed over the salt marsh vegetation. There would also be some minimum impacts from any fill needed to level the causeway surface. In the event that the boardwalk is constructed over the vegetation, then a minimum height should be considered to minimize impacts to salt marsh vegetation. Since there would be no changes to the culverts, there should be no change in sediment transport as a result of this alternative.

Further discussion with CRMC biologists and engineers would be necessary to determine how to proceed with a regulatory strategy to construct a boardwalk over the causeway.

6.0 STAKEHOLDER COORDINATION

ESS contacted stakeholders identified by RIDEM, the City and ESS to determine the potential for any conflicts with the Salter's Grove Causeway Environmental and Public Access Improvements Project and ongoing projects. The City Harbor Management Commission also held a public meeting to introduce the project to community members. Details on stakeholder activities are provided below.

6.1 Ongoing Projects

ESS contacted Save The Bay, CRMC, the Pawtuxet River Watershed Council, the USACE, the Saltwater Fishermen's Association, and the Pawtuxet Village Association. The Pawtuxet River Watershed Council is currently conducting a fish passage feasibility study of the Pawtuxet River dam. None of the alternatives are expected to have an impact on any alternative selected for the fish passage project.

The USACE proposes to dredge the Pawtuxet Cove Federal Navigation Channel. The project involves approximately 90,000 cubic yards of silty-sand and silt sediment from the northern, 100-foot wide by 6-foot deep channel, turning basin, the 6-foot deep channel and the 14 acre anchorage area located south of the entrance channel and north of the causeway. The RIDEM Water Quality Certification for the Federal Navigation Project required a fixed siltation fence to be installed along the north side of the causeway to ensure that sediment would not discharge through the culverts during dredging because of the potential to impact RIDEM shellfish beds and other aquatic resources on the south side of the causeway (May 4, 2004 RIDEM correspondence).

Based on the sediment transport assessment completed, the High Estimate is intended to investigate the potential of the proposed culvert maintenance project having a significant influence on the proposed Federal Navigation Channel dredging project in Pawtuxet Cove. Results from the analysis predict that a range of up to 65 m from the culvert could exhibit signs of bottom scour and promote sediment resuspension. The approximate minimum distance from a culvert to the edge of the proposed dredge channel is 168 m. Therefore, it can be concluded that even in the worst case scenario the effects of rebuilding the culvert will not influence the sediment distribution in the vicinity of the proposed dredge channel.

6.2 Public Meetings

The City Harbor Management Commission held a public meeting on March 16, 2004 to introduce the Salter's Grove Causeway Environmental and Public Access Improvements Project and to receive public input on the existing conditions at the causeway. RIDEM and ESS explained the environmental studies that would be conducted and the public had an opportunity to ask questions and provide comments. Minutes from the meeting are included as Appendix C.

6.3 City of Warwick Planning Department

ESS received feedback from the City of Warwick Planning Department indicating that residents on Pawtuxet Cove had complained of noxious odors emanating from the Salter's Grove area and wanted to see some improvement in water quality as a result of the causeway improvement project. The City of Warwick Planning Department indicated they would like to see the causeway project increase flushing between Salter's Grove North and Salter's Grove South to address water quality improvements.

7.0 CONCLUSIONS

The resources identified by ESS during technical investigations indicate that salt marsh vegetation has established in a thin band all along the causeway on both the north and south sides and provides habitat to wildlife resources. Constructing new culverts has the potential to destroy approximately 258 square feet of salt marsh. Because of the presence of the salt marsh vegetation, consultation with CRMC will be necessary to determine the extent of any causeway improvements allowed under the RICRMP regulations prior to design.

Fish and wildlife resources exist north and south of the causeway and current management of activities in the Pawtuxet Cove area requires best management practices to prevent sediment movement from the north to the south portions of Salter's Grove.

Water quality sampling and analysis indicates the Pawtuxet River stations exhibit elevated nitrate and depleted dissolved oxygen levels and that out of the three potential water sources, (the Pawtuxet River, Narragansett Bay and the Unnamed Brook), the Pawtuxet River is the largest contributor of high nutrients and low dissolved oxygen to Salter's Grove. Based on direct observations of water movement in the study area it appears that water movement from Pawtuxet Cove to Salter's Grove South is restricted by the causeway whereas water flows freely between Narragansett Bay and Salter's Grove South. Consequently it appears that Salter's Grove South is currently flushed primarily from the south with Narragansett Bay water. Therefore, any project that could increase water transport between Pawtuxet Cove and Salter's Grove South has the potential to negatively impact water quality conditions in Salter's Grove South.

ESS' analysis of the potential for sediment distribution and transport as a result of potential improvements to the causeway indicates that a range of up to 65 meters from the culvert could exhibit signs of bottom scour and promote sediment resuspension based on a 2 m diameter culvert. Since the approximate minimum distance from a culvert to the edge of the proposed Federal Navigation Project (anchorage area) is 168 m the effects of rebuilding the culvert will not influence the sediment distribution in the vicinity of the Federal Navigation Channel dredge project.

Currently there are no other stakeholder projects occurring within the area which would be impacted by the Salter's Grove Causeway Environmental and Public Access Improvements project. Initial coordination with regulatory agencies should be conducted to present the information from this report prior to further design stages to identify any project constraints.

8.0 LITERATURE CITED

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Figure

Click here for aerial photo of project location

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Photo 1: Ribbed Mussels (*Gaukensia demissa*)

Photo 2: Tidal Flat

Photo 3: High Tide Bush (*Iva frutescens*)

Appendix A

Water Quality Sampling Report

Water Quality Sampling Report

SALTER'S GROVE CAUSEWAY ENVIRONMENTAL AND PUBLIC ACCESS IMPROVEMENTS PROJECT

PREPARED FOR	Rhode Island Department of Environmental Management Division of Planning and Development 235 Promenade Street Providence, Rhode Island 02908
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September 14, 2004

WATER QUALITY SAMPLING REPORT
Salter's Grove Causeway Environmental and Public Access Improvements Project

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1.0 INTRODUCTION

The Rhode Island Department of Environmental Management, Division of Planning and Development (RIDEM) contracted ESS Group, Inc. (ESS) to review and interpret water quality data collected to establish baseline water quality conditions in Pawtuxet Cove, Passeonkquis Cove, and the Providence River as part of the Salter's Grove Causeway Environmental and Public Access Improvements project. The water quality data was collected based on June 2, 2004 Salter's Grove Causeway Environmental and Public Access Improvements Project Water Quality Sampling Plan. The sampling plan was designed to allow RIDEM and the City of Warwick to compare the relative differences between water quality in the three areas during the sampling period. The water quality sampling project was contracted out to ESS Labs. The samples were collected by ESS (as a subcontractor to ESS Labs) in coordination with RIDEM Fish and Wildlife. RIDEM Fish and Wildlife provided a boat and staff to operate the boat and ESS coordinated the field events and necessary equipment between RIDEM and ESS Labs. Water quality samples were analyzed by ESS Labs (the two companies are not associated). The following is a summary and analysis of the data.

1.1 Study Area Description

For the purposes of this report, the Salter's Grove study area is defined as the area west of the existing breakwater and Marsh and Rock Islands, south of the entrance to Pawtuxet Cove and north of the entrance to Passeonkquis Cove (Figure 1). The causeway divides the study area into two sections referred to by this plan as Salter's Grove North (SGN) and Salter's Grove South (SGS). Potential flushing sources of the study area include the Providence River and upper Narragansett Bay, the Pawtuxet River and the unnamed brook at the head of Passeonkquis Cove.

The Salter's Grove study area is a semi-isolated estuarine environment. Water quality in estuarine environments is influenced by the quality of bottom sediments and the level of interaction between the water column and these sediments. Water quality within Salter's Grove is also affected by the quality of the waters responsible for flushing the area and the level of interaction with nearby water sources (Pawtuxet Cove, Pawtuxet River, and Passeonkquis Cove). These two factors are interrelated because an increase in flushing may result in an increase in sediment/water column interaction, and given situations where sediments are heavily contaminated, the benefits of increased flushing may be outweighed by the detrimental effects of sediment resuspension and the flux of other pollutants from sediments into the water column.

During the field site visits, ESS identified a stormwater outfall northwest of the causeway with water flowing during dry weather and noted that at high tide, some portions of the causeway are flooded.

1.2 Water Quality Background

Historically, water and sediment quality for the general vicinity surrounding Salter's Grove has been qualified as poor. Isolated areas in the vicinity are known to exhibit periodic severe hypoxic/anoxic conditions (Deacutis 1999). Furthermore, the entire source water region is known to be at high risk for aperiodic hypoxic/anoxic conditions (Deacutis 1999).

2.0 SAMPLE COLLECTION

2.1 Location

To determine baseline water quality conditions in Salter's Grove during the study period, six (6) stations were sampled: three (3) within SGN, and three (3) within SGS (Figure 1). To determine the conditions of the source waters, five (5) stations were sampled: two (2) to characterize the waters of Narragansett Bay, two (2) to characterize the waters of the Pawtuxet River, and one (1) to characterize the waters of the unnamed brook. A Global Position System (GPS) was used to identify station locations in the field. Actual GPS acquired latitude/longitude collection locations are noted in Table 1. All stations were accessed with a small boat on loan from the RIDEM Fisheries and Wildlife Department.

For each sampling event, one water sample was collected at each station. The minimum observed water depth was 0.6 m. All samples were collected at either 0.5 m depth or approximately one half the total water depth, whichever was less (Table 1).

2.2 Sampling Schedule

Two (2) sampling events were conducted during the summer months of 2004 on a spring tide (highest amplitude tide). Figure 2 illustrates the exact times and the relationship to Newport predicted tides (local Providence River area tides lag Newport tides by approximately 0.5 hours). The August 2 event was centered around low water. The August 3 event was scheduled around high water, but logistics caused the sampling to begin 2 hours late and therefore it coincided with early ebb. Wind conditions for both days were light and no heavy rain events (with accumulations of 0.5 inch) occurred immediately before (most recent rain event with greater than 0.5 inch accumulation occurred on July 28 – 0.66 inches).

ESS staff William DeLeo, with the assistance of one RIDEM Fisheries and Wildlife intern, conducted the sample collection.

2.3 Sampling Method

Water quality samples were collected using two methods: physical/chemical parameters measured in the field with an electronic meter, and water samples pumped from depth for lab analysis. Water samples were pumped through acid-rinsed (1 percent HCL) tubing. Nutrient samples were filtered by the lab with a 0.6 um Nucleopore filter. The filters were soaked in 1 percent HCl for one to two days and rinsed thoroughly with distilled de-ionized water (>18.2 uOhm) before use. Filters were stored in distilled de-ionized water (>18.2 uOhm) prior to use. The samples were not analyzed for metals (as indicated in the Water Quality Sampling Plan). Samples were stored on ice and delivered to the laboratory on the same day they were collected

The RIDEM Department of Fisheries and Wildlife provided a YSI handheld multi-parameter instrument for the collection of salinity, dissolved oxygen and temperature data. This instrument is designed to transmit data from the probe to a handheld display unit via a 4 meter cable. Although the unit has internal logging capability, the SOP of the RIDEM Department of Fisheries and Wildlife group was to manually record data and therefore no internal logging was conducted. Given the limited cable length, the lack of internal logging and, most significantly, the lack of a pressure sensor on the unit, water column profiles were not practical. Point measurements of physical/chemical parameters were collected at the pump intake for each water sample collected. The instrument was calibrated by RIDEM Fisheries and Wildlife personnel.

As noted in Section 2.2, the high tide sampling event began about 2 hours after planned (Figure 2). This slight change of schedule meant that the "high tide" observations were actually collected during the early stages of the ebb tide. It was visually obvious that although the water level was very high (indicative of a spring high tide), there was significant water movement which suggests that it was not slack high (the tides in the upper bay are approximately standing waves and currents are at a minimum at high and low water). Some regions of the causeway were totally submerged (especially the region around the western culvert), and disturbances of the sea surface clearly suggested that there was water movement from the northern section of Salter's Grove (SGN) into the southern section (SGS).

ESS personnel recognized this as an opportunity to investigate the dissolved oxygen content of an isolated water mass (namely the jet observed across the submerged culvert) being transported from SGN into SGS. By collecting data in transects across the observed surface current, the characteristics of SGN water could be directly contrasted with that of SGS water with the understanding that the SGN water was being transported across the causeway. These observations would then provide an indication of what would result if the culverts were restored and water was allowed to move freely between the two areas during all stages of the tide. To this end, three transects were sampled (Figure 3a): one parallel to the causeway just to the south, one parallel to the causeway just to the north, and one across the opening to Salter's Grove further to the north.

2.4 Sample Analysis

Each water sample was subdivided into bottles for laboratory analysis of the following nutrients, listed with the associated EPA method:

- Nitrate (NO_3) - EPA Method 353.4
- Nitrite (NO_2) - EPA Method 353.4
- Ammonia (NH_3 + NH_4) - EPA Method 349.0
- Phosphate (PO_4) - EPA Method 365.5

3.0 RESULTS

3.1 Physical/Chemical Parameters

As noted in Section 2, point measurements of physical/chemical parameters were collected at the depth and location of the sample collection apparatus intake. Those data are presented in Table 1 and discussed in this section. Additional dissolved oxygen data collected across three transects of the study region are discussed in Section 4.

3.1.1 Dissolved Oxygen

Dissolved oxygen data ranged in value from 4.5 mg/L to 8.7 mg/L. The Pawtuxet River station (PR1 and PR2) data were consistently below 6 mg/L (ranging from 5.4 mg/L to 5.8 mg/L). The Narragansett Bay and Unnamed Brook station (NB1, NB2 and UB1) data were consistently above 6 (ranging from 6.4 mg/L to 7.8 mg/L). Results for the Salter's Grove station (SGN1, SGN2, SGN3, SGS1, SGS2, and SGS3) data were clearly higher during the low tide sampling event (ranging from 7.0 mg/L to 8.7 mg/L) than on the high tide sampling event (ranging from 4.5 mg/L to 7.6 mg/L).

The threshold dissolved oxygen concentrations considered by the EPA critical for marine life in bottom waters is 5.0 mg/L. Although all but one measurement was above 5.0 mg/L, it is expected that dissolved oxygen levels would decrease with depth. The Pawtuxet River dissolved oxygen results for this study were slightly higher than data collected in August 1992, 1993, and 1994 where values were found to range from 2.5 mg/L to 4.5 mg/L (Kerr 1996).

Figure 3a exhibits the location of the three dissolved oxygen transects. Figure 3b exhibits the results from the three dissolved oxygen transects. The x-axis represents an approximate relative location of the data. The primary feature of note is the minimum in both Transect 1 and Transect 2. This coincides spatially with the surface jet observed and the western culvert. In addition, the lowest dissolved oxygen values were observed to the west of Transect 3. Based on these three observations, it seems that low dissolved oxygen water is being transported from the Pawtuxet river along the western side of SGN and across the causeway at the western culvert. Note that water is only exchanged between SGN and SGS when the water level is very high. The eastern culvert also passes some water over the causeway, but not as much as the western; a minimum in dissolved oxygen is also coincident with the eastern culvert.

3.1.2 Salinity

Salinity is considered a conservative tracer and is often used to track contaminant plumes in estuarine systems. The major sources of contaminants to the study region are river input and waste water treatment facility effluent, both constituting fresh water (salinity approximately equal to zero psu). The salinity of Rose Island Sound water is approximately 32 psu.

Salinity values were lowest at the Pawtuxet River stations which suggests that the Pawtuxet River is the predominant source of fresh water to the study area. Previous studies have identified the Pawtuxet River as the second largest source of fresh water to Narragansett Bay, contributing almost 25% (Turner 1997). The Salter's Grove North stations had the next lowest salinity, especially so during the high tide sampling event. The highest values were observed at the stations in the southern portion of the study region (NB2, UB1, SGS1, SGS2, and SGS3).

3.1.3 Temperature

Temperature observations in the study region ranged from 24.8 C to 27.2. Temperature is often used to distinguish the depth of various water masses by locating the "thermocline". The exact location of the thermocline at each station was not determined since profiles were not collected. Samples were collected at 0.5 m or less to ensure that all samples represent the same water mass (surface water).

3.2 Nutrients

Nutrient concentrations were determined by the collection and laboratory analysis of water samples. Water samples were collected by lowering an intake tube to depth and pumping water directly into sample bottles. All samples were filtered by the lab and therefore all results depict the dissolved fraction.

3.2.1 Nitrate

Elevated nitrogen concentrations are problematic in estuarine systems because they can lead to diminished dissolved oxygen levels and conditions inhospitable for marine life. In estuarine systems, nitrogen in the form of nitrate (NO_3) is often significantly more abundant than either nitrite (NO_2) or ammonia (NH_3 and NH_4).

Nitrate levels between stations exhibited significant differences and consistent trends. Similar to the observations of salinity noted above, nitrate levels at the Pawtuxet River stations were always the highest (ranging from 2.32 mg/L to 2.46 mg/L) while values at the stations in the southern portion of the study area were the lowest (0.23 mg/L to 0.52 mg/L). Values in the Salter's Grove North region were greater during the high tide sampling event (ranging from 0.69 mg/L to 1.94 mg/L) than during the low tide sampling event (ranging from 0.36 mg/L to 1.29 mg/L). Observed concentrations are generally consistent with previous observations (Doering 1990).

3.2.2 Nitrite and Ammonia

With the exception of one ammonia measurement in the Pawtuxet river (1.7 mg/L), measurements of nitrite (ranging from 0.01 mg/L to 0.05 mg/L) and ammonia (ranging from <0.3 to 0.7) were very similar between stations and sampling events. Most results were only slightly above detection limits and no clear trends may be identified. Observed concentrations are generally consistent with previous observations (Doering 1990).

3.2.3 Phosphate

Phosphate concentrations were consistently higher at the Pawtuxet River stations (ranging from 0.6 mg/L to 0.7 mg/L) than the Salter's Grove stations (ranging from 0.2 mg/L to 0.3 mg/L), but the highest observed concentration was actually at NB1 (1.2 mg/L) during the high tide sampling event. Observed concentrations are generally consistent with previous observations (Doering 1990).

4.0 DISCUSSION

This section presents second order data interpretation. Section 5 will summarize the results of both Section 3 and Section 4.

4.1 Nitrate and Dissolved Oxygen

Figures 4a and 4b present bar graphs which compare the dissolved oxygen and nitrate concentrations between stations.

For the Spring low tide sampling event, the Pawtuxet River stations have high nitrate levels and low dissolved oxygen levels. In contrast, all Salter's grove stations, the Narragansett Bay stations and the unnamed brook station have relatively high dissolved oxygen levels and low nitrate levels. Of these stations, the highest nitrate levels are found at SGN1 which is located closest to the Pawtuxet River stations.

For the high tide sampling event, these relationships are not nearly as apparent. The Pawtuxet river stations again have elevated nitrate and diminished dissolved oxygen, but NB1 and SGN3 have higher Nitrate levels, and dissolved oxygen levels for all stations within Salter's Grove have lower dissolved oxygen concentrations. The worst water quality observed at any time within Salter's grove was at SGS1 where dissolved oxygen levels at the surface fell below the 5.0 mg/L threshold.

4.2 Nitrate and Salinity

It is a common practice to investigate the relationship between a non-conservative parameters, such as nitrate, and a conservative parameter, such as salinity. Salinity is considered "conservative" because it varies primarily due to dilution alone; nitrate could be considered "non-conservative" because it can be produced and taken up by other processes. If a strong relationship exists between a non-conservative parameter and a conservative one, it can be deduced that the non-conservative parameter is behaving conservatively, and therefore it's distribution is controlled primarily by dilution.

Figure 5 presents the results of this comparison where a linear trend has been calculated for the entire data set, combining data from both sampling events. As quantified by the R^2 value of 0.96, there exists a strong relationship between salinity and nitrate concentration (the one outlier had little effect on the strength of the relationship). This implies that the nitrate distribution in the study area are primarily a function of the dilution of fresh water with marine water. Or, since we have already determined that the Pawtuxet River is the primary source of fresh water, it could be stated that this result implies that the nitrate distribution is controlled primarily by the mixing of Pawtuxet River water with Narragansett Bay water. Given that we have a strong relationship, one additional point may be gained from this analysis by the value of the y-intercept. The y-intercept represents the nitrate value that corresponds to a salinity value of zero. In other words, it represents the nitrate concentration up-stream where there is no interaction with bay water. Therefore, this analysis also suggests that the up-stream nitrate concentrations are approximately 3.16 mg/L.

5.0 CONCLUSIONS

ESS assessed the existing water quality conditions based on the data available from the two sampling events. Based on this assessment, the observations indicate the following:

- The Pawtuxet River exhibits elevated nitrate levels and depleted dissolved oxygen levels;
- Of the three potential water sources, the Pawtuxet River, Narragansett Bay and the Unnamed Brook, the Pawtuxet River is the largest contributor of high nutrients and low dissolved oxygen to Salter's Grove;
- Nitrate concentrations in the study area are controlled by the mixing of Pawtuxet River water with Narragansett Bay water;
- When water levels are high enough to breech the causeway, water was observed moving from the northern section of Salter's Grove into the southern section; and
- The lowest dissolved oxygen concentration was observed at SGS1 in the region of a surface jet passing from SGN into SGS.

These observations are not conclusive of the water quality status for the water sources around Salter's Grove. Further data collection and modeling would be necessary to be conclusive about the potential impacts of increasing water movement from Pawtuxet Cove to Salter's Grove South. More extensive dissolved oxygen monitoring through water column profiles accompanied by circulation data would provide more evidence of how dissolved oxygen moves from Salter's Grove North to Salter's Grove South. Circulation modeling would also be advantageous to documenting the tidal exchange between Pawtuxet Cove and Salter's Grove South versus the influence of Narragansett Bay from the south.

6.0 LITERATURE CITED

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Table

TABLE 1
Results Summary

Tide	Station	Latitude	Longitude	Date	Time	Water Depth	Sample Depth	DO	T	S	NH^4	NO^3	NO^2	PO^4
						m	m	mg/L	°C	psu	mg/L	mg/L	mg/L	mg/L
Spring Low	NB1	41.7607	71.3836	8/2/2004	15:05	1.0	0.5	6.8	26.3	23.2	0.5	0.55	0.05	0.2
	NB2	41.7479	71.3769	8/2/2004	13:50	1.8	0.5	7.1	25.9	25.8	0.3	0.34	0.04	0.2
	PR1	41.7644	71.3897	8/2/2004	14:30	1.4	0.5	5.8	24.9	8.4	0.3	2.32	0.05	0.6
	PR2	41.7613	71.3875	8/2/2004	14:35	1.8	0.5	5.5	25.4	11.5	0.3	2.37	0.05	0.6
	SGN1	41.7576	71.3853	8/2/2004	14:55	1.2	0.5	8.6	26.5	17.8	0.3	1.29	0.03	0.3
	SGN2	41.7556	71.3824	8/2/2004	14:50	0.6	0.25	8.4	25.8	23.9	0.3	0.47	0.05	0.2
	SGN3	41.7551	71.3841	8/2/2004	14:45	1.5	0.5	8.7	25.9	24.2	0.3	0.36	0.05	0.2
	SGS1	41.7534	71.3815	8/2/2004	12:51	0.8	0.4	7.3	25.7	26.4	0.7	0.24	0.03	0.2
	SGS2	41.7522	71.3814	8/2/2004	13:05	0.9	0.5	7.0	25.5	26.6	0.4	0.25	0.03	0.3
	SGS3	41.7511	71.3812	8/2/2004	13:26	1.0	0.5	7.3	25.4	26.8	0.3	0.25	0.03	0.2
	UB1	41.7463	71.3851	8/2/2004	13:39	0.8	0.4	6.8	27.2	25.8	0.3	0.25	0.03	<0.1
Spring High	NB1	41.7611	71.3831	8/3/2004	11:45	3.2	0.5	7.8	25.4	22.9	<0.3	1.04	0.04	1.2
	NB2	41.7477	71.3768	8/3/2004	10:48	3.2	0.5	7.1	25.2	26.5	0.3	0.23	0.03	0.2
	PR1	41.7644	71.3897	8/3/2004	12:02	3.6	0.5	5.4	24.8	4.2	1.7	2.43	0.01	0.6
	PR2	41.7613	71.3875	8/3/2004	11:54	3.5	0.5	5.6	25.4	5.8	<0.3	2.46	0.02	0.7
	SGN1	41.7574	71.3851	8/3/2004	11:26	2.8	0.5	6.2	25.3	10.8	<0.3	1.94	0.03	0.2
	SGN2	41.7556	71.3825	8/3/2004	11:20	2.2	0.5	7.6	25.9	20.3	<0.3	0.69	0.04	0.2
	SGN3	41.7551	71.3837	8/3/2004	11:15	3.2	0.5	6.4	25.5	15.5	0.3	1.36	0.03	0.3
	SGS1	41.7553	71.3817	8/3/2004	10:00	1.7	0.5	4.5	25.1	22.4	0.5	0.52	0.04	0.2
	SGS2	41.7522	71.3814	8/3/2004	10:10	1.8	0.5	5.5	25.2	26.2	0.4	0.24	0.04	0.3
	SGS3	41.7511	71.3812	8/3/2004	10:15	1.9	0.5	5.5	25.1	26.2	0.6	0.24	0.03	0.3
	UB1	41.7464	71.3850	8/3/2004	10:40	1.7	0.5	6.4	25.3	26.0	0.4	0.25	0.03	0.3

Figures

Location: G:\GIS-Projects\R316\Salters-Grove.apr Layout: 11x17

ESS Group, Inc.
Engineers
Scientists
Consultants

SALTER'S GROVE CAUSEWAY
ENVIRONMENTAL/ PUBLIC ACCESS IMPROVEMENTS
Warwick, Rhode Island

Scale: 1" = 600'

Source: 1) USGS, Orthophotography, 2001
2) ESS, Water Quality Samples, 2004

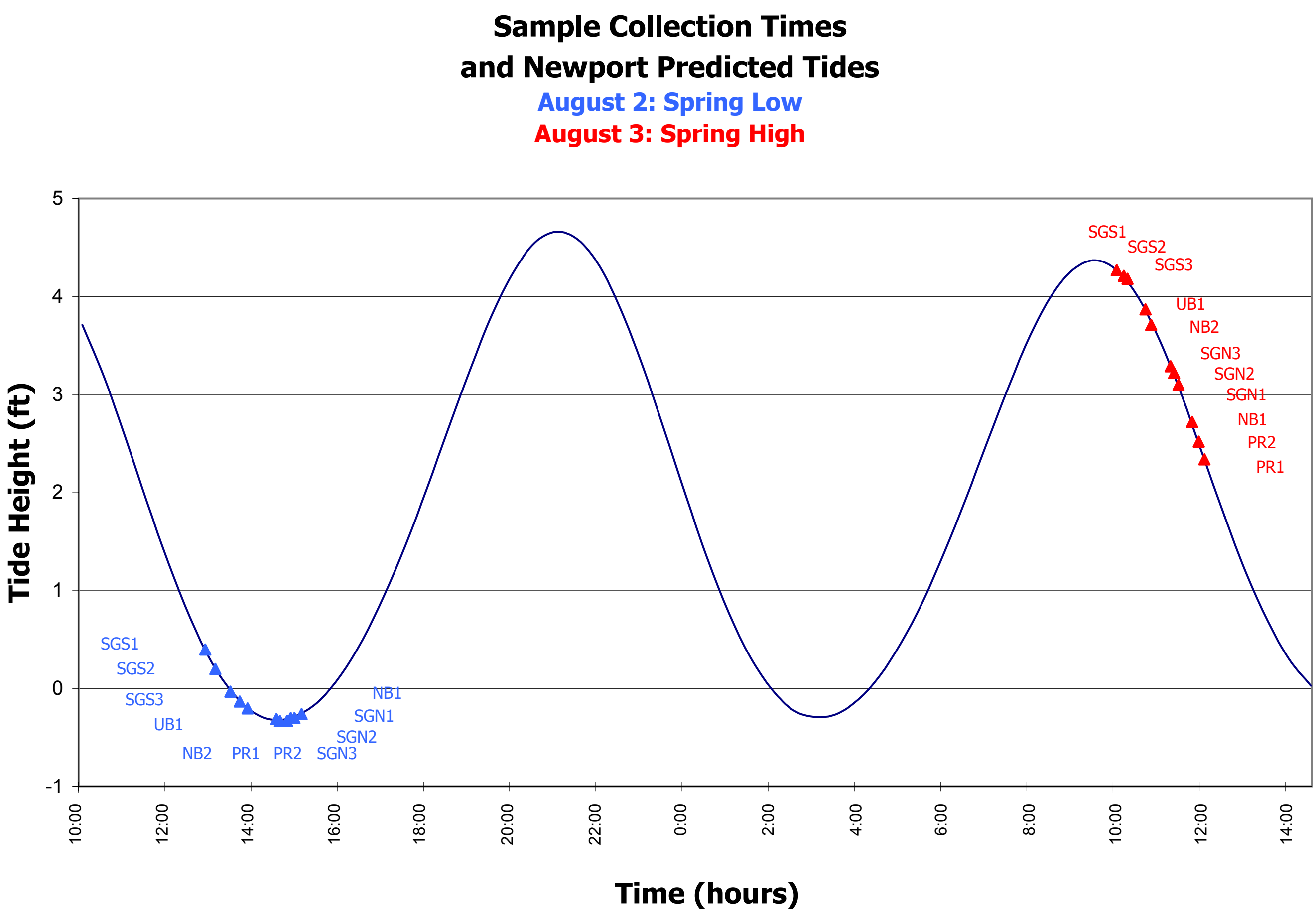
LEGEND

Water Quality Sample

Salter's Grove
Salt Marsh Extent

Figure
1

FIGURE 2



Sample Collection Times
and Newport Predicted Tides
August 2: Spring Low
August 3: Spring High
Tide Height (ft)
Time (hours)
5
4
3
2
1
0
-1
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
SGS1
SGS2
SGS3
UB1
NB2
PR1
PR2
SGN3
SGN2
SGN1
NB1
SGS1
SGS2
SGS3
UB1
NB2
SGN3
SGN2
SGN1
NB1
PR2
PR1

FIGURE 3


Transect Locations
A
B
A
B
A
B

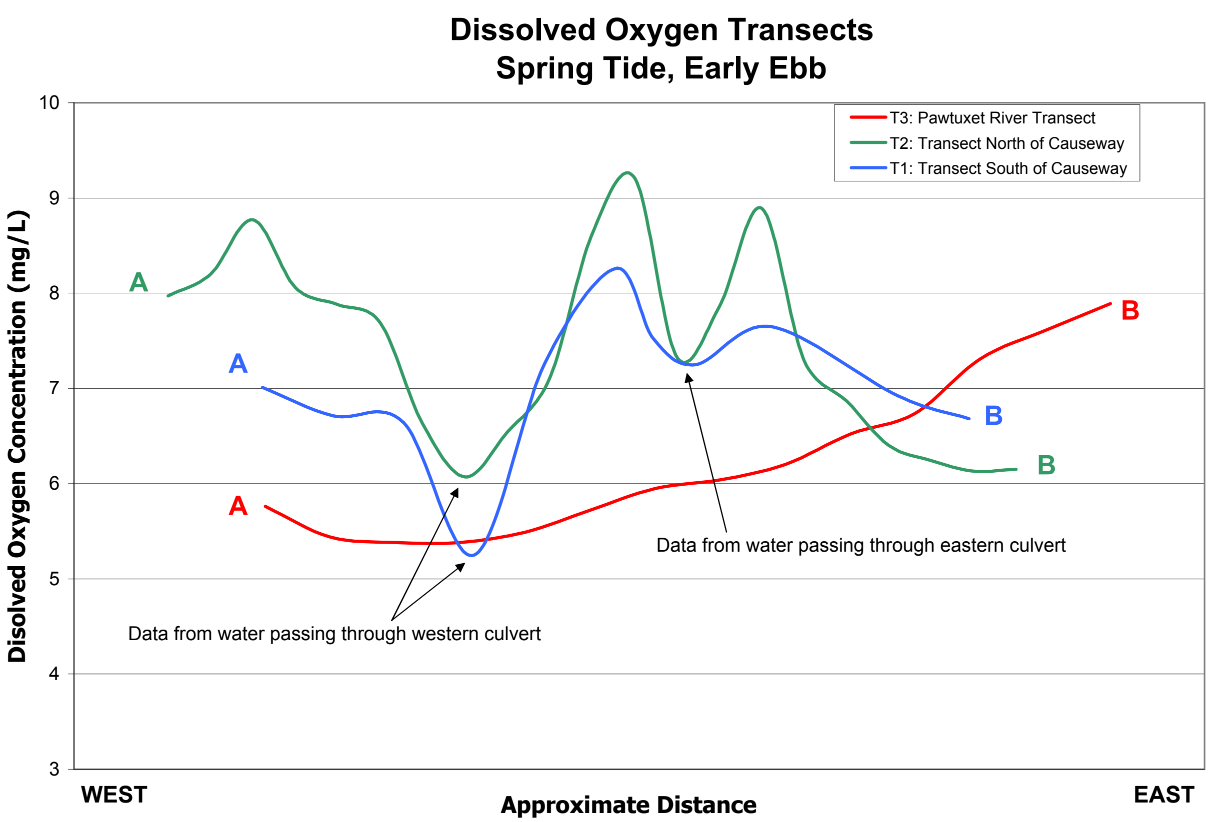
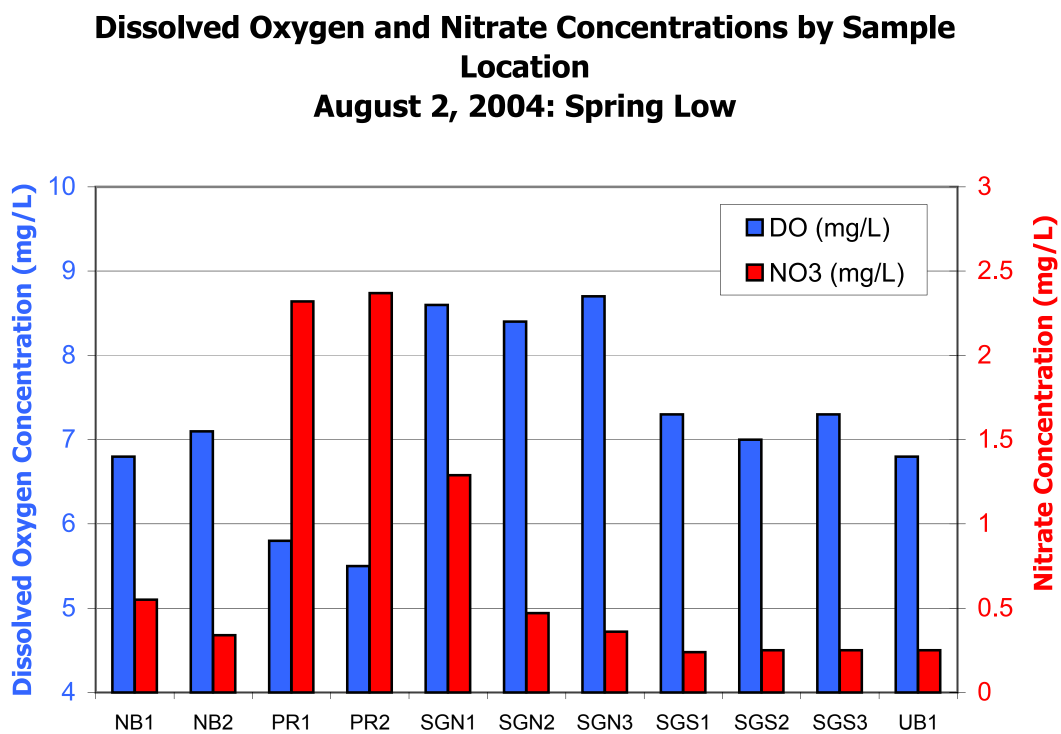
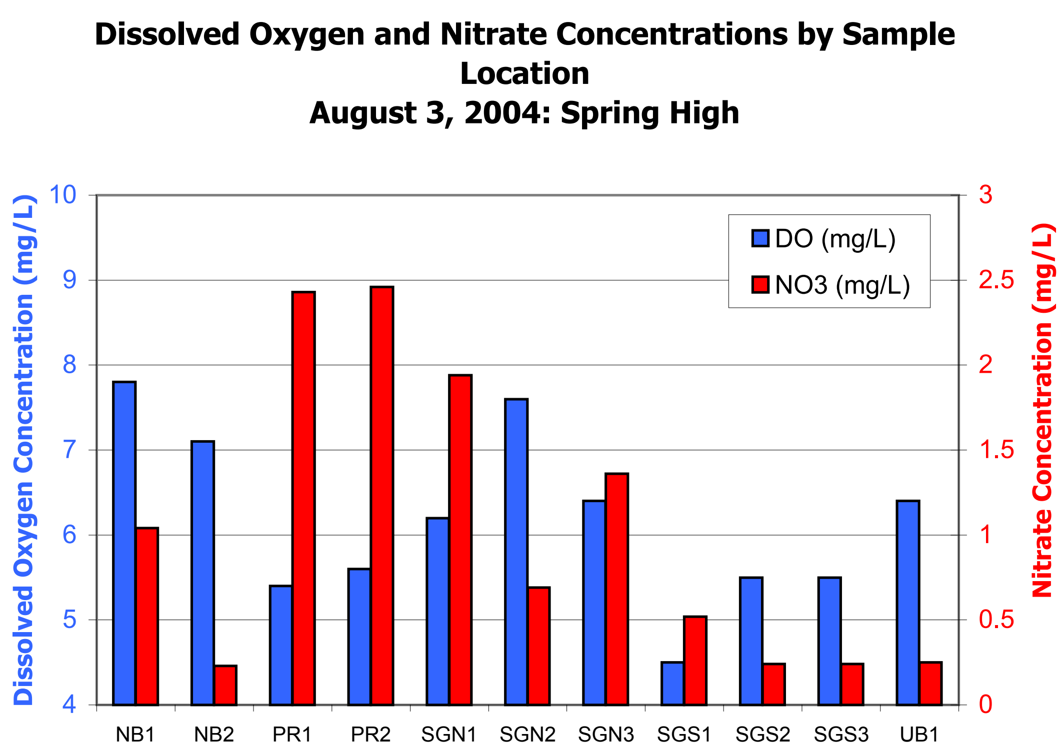

Dissolved Oxygen Transects
Spring Tide, Early Ebb
T3: Pawtuxet River Transect
T2: Transect North of Causeway
T1: Transect South of Causeway
Disolved Oxygen Concentration (mg/L)
10
9
8
7
6
5
4
3
A
A
A
B
B
B
Data from water passing through western culvert
Data from water passing through eastern culvert
WEST
Approximate Distance
EAST

FIGURE 4

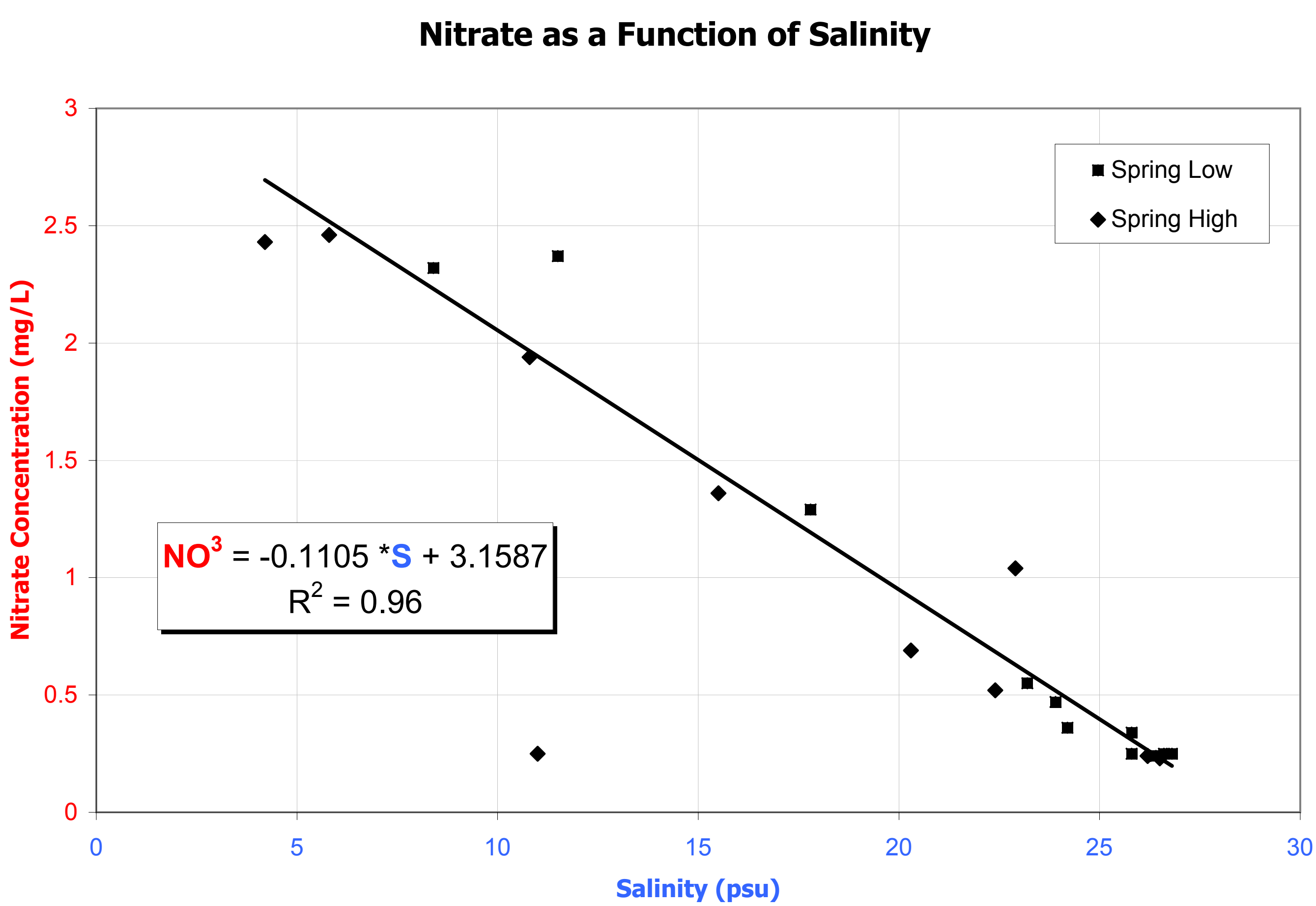


Dissolved Oxygen and Nitrate Concentrations by Sample Location
August 2, 2004: Spring Low
Dissolved Oxygen Concentration (mg/L)
Nitrate Concentration (mg/L)
DO (mg/L)
NO3 (mg/L)
10
9
8
7
6
5
4
3
2.5
2
1.5
1
0.5
0
NB1
NB2
PR1
PR2
SGN1
SGN2
SGN3
SGS1
SGS2
SGS3
UB1



Dissolved Oxygen and Nitrate Concentrations by Sample Location
August 3, 2004: Spring High
Dissolved Oxygen Concentration (mg/L)
Nitrate Concentration (mg/L)
DO (mg/L)
NO3 (mg/L)
10
9
8
7
6
5
4
3
2.5
2
1.5
1
0.5
0
NB1
NB2
PR1
PR2
SGN1
SGN2
SGN3
SGS1
SGS2
SGS3
UB1

FIGURE 5



Nitrate as a Function of Salinity
Nitrate Concentration (mg/L)
Salinity (psu)
Spring Low
Spring High
NO3 = -0.1105 *S + 3.1587
R2 = 0.96
0
0.5
1
1.5
2
2.5
3
0
5
10
15
20
25
30

Appendix B

Potential Changes in Sediment Distribution and Flow Patters

Potential Changes In Sediment Distribution And Flow Patterns

SALTER'S GROVE CAUSEWAY ENVIRONMENTAL AND PUBLIC ACCESS IMPROVEMENTS PROJECT

PREPARED FOR	Rhode Island Department of Environmental Management Division of Planning and Development 235 Promenade Street Providence, Rhode Island 02908
PREPARED BY	ESS Group, Inc. 401 Wampanoag Trail, Suite 400 East Providence, Rhode Island 02915

Project No. R316-000.5

September 14, 2004

POTENTIAL CHANGES IN SEDIMENT DISTRIBUTION AND FLOW PATTERNS
Salter's Grove Causeway Environmental and
Public Access Improvements Project

Prepared For:

Rhode Island Department of
Environmental Management
Division of Planning and Development
235 Promenade Street
Providence, Rhode Island 02908

Prepared By:

ESS Group, Inc.
401 Wampanoag Trail, Suite 400
East Providence, Rhode Island 02915

ESS Project No. R315-000.6

September 14, 2004

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3.0 RESULTS 2

4.0 DISCUSSION 2

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TABLE

Table 1 Empirical Calculations of Maximum Scour Depth and Maximum Volume Sediment Resuspended

FIGURE

Figure 1 Sensitivity of Scour Range Expanse to Peak Velocity

1.0 INTRODUCTION

ESS completed an analysis of the potential for sediment distribution and transport as a result of potential improvements to the causeway which would allow increased flow between Pawtuxet Cove and Salter's Grove (south of the causeway). This analysis addresses the question of how potential options for the maintenance of Salter's Grove causeway will effect the distribution of sediments and the flow patterns in the region. The analysis was completed based on calculations from previous studies completed by the Army Corps of Engineers (ACOE).

Currently, the two culverts in the causeway are not functional. Water breaches and passes over the sections of the causeway where the culverts were installed at times of very high water, and no water passes at mid to low water levels. This analysis will assess the potential changes as a result of a preliminary engineering plan which would allow for a 2 meter diameter culvert size to be rebuilt allowing for more flow between the northern and southern sections of Salter's Grove.

The primary concern is whether changes in flow patterns and sediment distribution resulting from the rebuilding of the culverts will adversely influence the proposed dredging of a federal navigation channel in Pawtuxet Cove. The methods used to complete the analysis are based on a literature review of calculations most appropriate for making the sediment transport estimates. Neither numerical modeling nor field studies were available to support a more detailed estimate.

The calculations will be conducted for three sets of parameters referred to as High Estimate, Low Estimate and Best Estimate. The High Estimate will be the largest expected contribution of sediment. The Low Estimate and the High Estimate will be used to establish a range of reasonable results. The Best Estimate will be an attempt to predict the most likely outcome. The implications of the results will be addressed in the Discussion section.

2.0 METHODS

An extensive literature review was conducted to choose the most applicable method for predicting scour related to installed culverts given the data available. Most methods identified rely on numerical modeling and/or field studies, neither of which is available for this project. Therefore, an empirical formula based on easily acquired parameters was chosen. The formula was developed by the ACOE and specifically estimates the maximum scour depth at tidal inlets (Hughes 1999). The culvert in this case will be treated as a tidal inlet. The formula is:

$$h_e = \frac{0.234 q_e^{8/9}}{\left[g(S_s - 1)\right]^{4/9} d_e^{1/3}}$$

Where h_e is the equilibrium scour depth, q_e is the maximum discharge per unit width, g is gravitational acceleration, S_s is the specific gravity of the sediment, and d_e is the sediment grain size. Ranges of values for S_s and d_e were chosen from the literature, and a wide range of possible flow values are investigated for q_e.

Three scenarios are investigated: High Estimate, Low Estimate, and Best Estimate. For the High Estimate calculations, the values that are chosen from the range of reasonable values found in the literature all weigh high on the depth of scour calculation. For example, small grain size, low specific gravity and high flow all promote a greater scour depth. A similar approach is used for the Low Estimate. For the Best Estimate, select values were chosen from the range of values found in the literature based on best professional judgment. It should be noted that each of the calculations provides a *maximum* scour depth for the given parameters and therefore the expected actual scour depth will most likely be less than the calculated value. True expectations for the depth of scour based on the results of the calculations will be addressed in the Discussion section.

The calculated values for maximum depth of scour, h_e, are used to estimate the range of the erosional environment from the culvert and the total sediment volume resuspended. This extrapolation is conducted by first approximating the shape of the resulting bottom depth profile as a function of scour depth at the culvert, and the relative width of the scour region as a function of the culvert width. A first order approximation of the shape of the resulting bottom depth is a simple wedge. The width of the wedge is calculated as twice the diameter of the culvert opening, and the base of the wedge is calculated as ten times the depth of scour at the culvert. These values are based in the literature (DeLeo 2001, Liriano 2002, Stumm 2001) and considered to be very conservative (i.e., producing higher values of range and overall sediment volume resuspended than are expected to be observed).

3.0 RESULTS

The results are summarized in Table 1. The High Estimate suggests a maximum scour depth of 6.5 meters and a resulting scour range and sediment volume of 65 m and 845 m^3 respectively. Low Estimates suggests a maximum scour depth of 0.29 m and a resulting scour range and sediment volume of 2.9 m and 1.7 m^3 respectively. The Best Estimate suggests a maximum scour depth of 2 m and resulting scour range and sediment volume of 20 m and 75 m^3 respectively.

The estimated maximum current velocity (used to calculate q_e) is the least constrained of all the estimated parameters (S_s, d_e and q_e). The reasonable range of values was approximated at 0.25 – 1 m/s based on observed flow under the current conditions and the range of tidal currents observed throughout Narragansett Bay. Figure 1 illustrates the sensitivity of the scour range calculations to the estimated maximum current velocity. The results posted in Table 1 are identified with an "X". All values between the curves for High Estimate and Low Estimate are considered in the reasonable range.

4.0 DISCUSSION

The analysis conducted for this report addresses the question of how rebuilding the culverts with a preliminary engineering design will affect the sediment distribution and flow patterns of Salter's Grove. An empirical formula developed by the ACOE for predicting the maximum scour depth at tidal inlets is used as a basis for further estimates and for discussion. The formula was used to investigate three scenarios: High Estimate, Low Estimate, and Best Estimate.

The High Estimate is intended to investigate the potential of the proposed culvert maintenance project having a significant influence on the proposed federal navigation channel dredging project in Pawtuxet Cove. All values that went into this calculation were biased high for that purpose. Results from the analysis predict that a range of up to 65 meters from the culvert could exhibit signs of bottom scour and promote sediment resuspension. The approximate minimum distance from a culvert to the edge of the proposed dredge channel is 168 m. Therefore it can be concluded that even in the worst case scenario the effects of rebuilding the culvert will not influence the sediment distribution in the vicinity of the proposed dredge channel.

The Low Estimate and the Best Estimate provide more reasonable estimates for the affected range. The Low Estimate provides a biased low estimate of the *maximum* scour depth, and is therefore believed to be a much more reasonable scenario than the High Estimate. The Best estimate utilizes the most reasonable values found in the literature for input. The most likely result will fall between the two curves for Low and Best on Figure 1. Based on the calculations in this report, the culvert maintenance project will most likely result in a maximum scour depth of 1 m and a maximum range on influence of 10 meters. This prediction represents a 50% reduction of the results obtained from the Best Estimate calculation.

In conclusion, maintenance activities considered in this report have the potential to result in an increase in flow between the two sides of Salter's Grove and therefore change the bottom profile in the vicinity of the culverts. The region influenced by the increase in flow is not believed to come close to the region of proposed dredging. Furthermore, it is not believed that opening the culverts will in any significant way affect the stability of the dredge channel.

5.0 LITERATURE CITED

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Hughes, S. 1999. Equilibrium Scour Depth at Tidal Inlets. *Coastal Engineering Technical Note IV-18*. U.S. Army Corps of Engineers Publication.

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Table

Table 1

Empirical Calculations of Maximum Scour Depth and Maximum Volume Sediment Resuspended

KNOWNS

diameter of culvert opening (m)[1]:	2.0
maximum water depth within culvert (m)[2]:	1.4

High

ESTIMATES

v_{MAX} (m/s):	1.0
s.g. (kg/m^3)[3]:	1.57
grain size diameter (mm)[4]:	0.005
scour range factor (unitless)[5]:	10
scour width factor (unitless)[6]:	2

CALCULATIONS

maximum discharge / unit width [7]	max scour depth [8]	scour range	scour width	volume sediment resuspended
(m^2/s)	(m)	(m)	(m)	(m^3)
1.03	6.5	65	4	845

Low

ESTIMATES

v_{MAX} (m/s):	0.25
s.g. (kg/m^3)[3]:	2.56
grain size diameter (m)[4]:	0.02
scour range factor (unitless)[5]:	10
scour width factor (unitless)[6]:	2

CALCULATIONS

maximum discharge / unit width [7]	max scour depth [8]	scour range	scour width	volume sediment resuspended
(m^2/s)	(m)	(m)	(m)	(m^3)
0.09	0.29	2.9	4	1.7

Best

ESTIMATES

v_{MAX} (m/s):	0.5
s.g. (kg/m^3)[3]:	1.57
grain size diameter (m)[4]:	0.01
scour range factor (unitless)[5]:	10
scour width factor (unitless)[6]:	2

CALCULATIONS

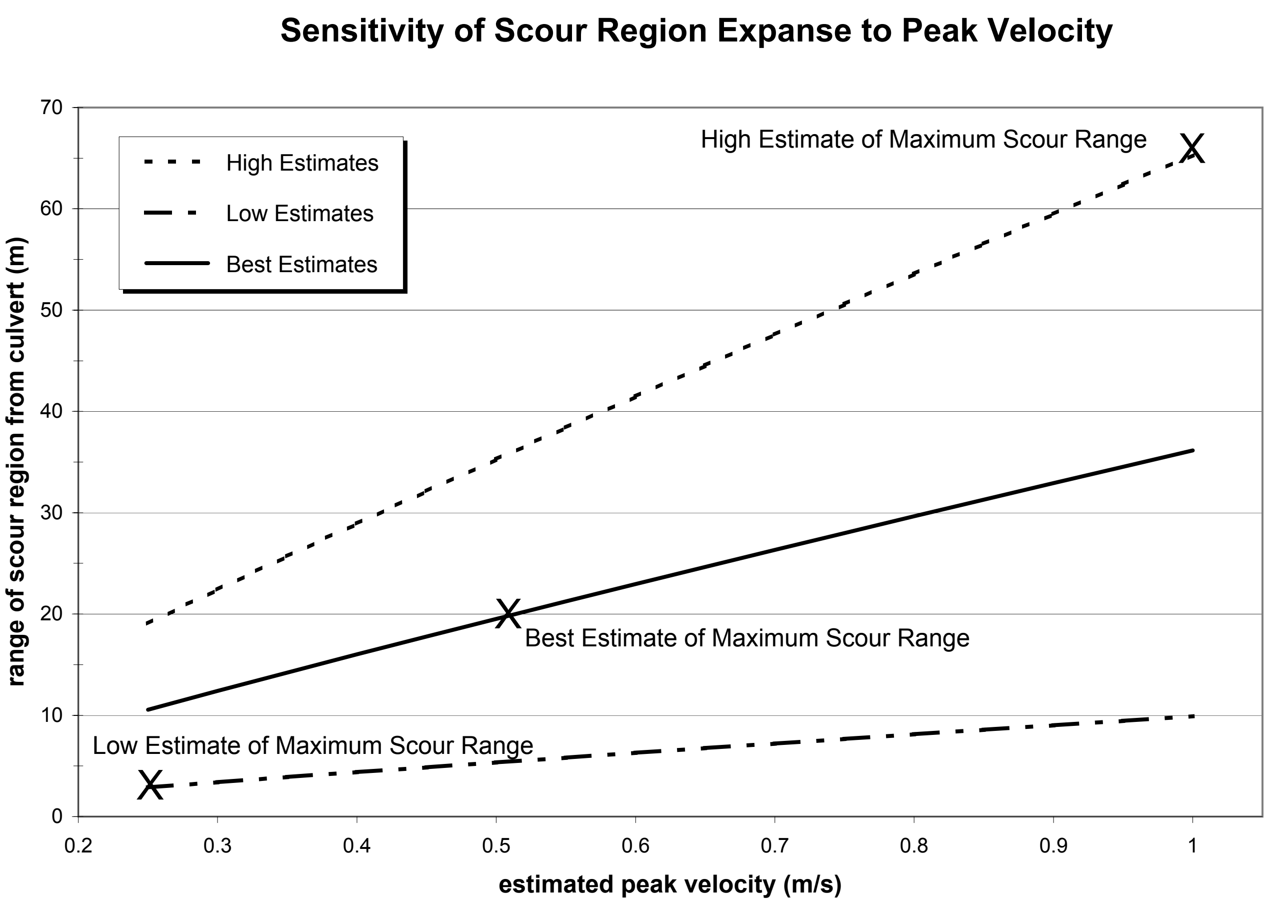
maximum discharge / unit width [7]	max scour depth [8]	scour range	scour width	volume sediment resuspended
(m^2/s)	(m)	(m)	(m)	(m^3)
0.34	2.0	20	4	75

NOTES

1 Culvert diameter aquired from "S.G. Causeway Maintenance and Recreational Improvements" ducument (RGBC 2003).
2 Maximum Water depth aquired from "S.G. Causeway Maintenance and Recreational Improvements" ducument (RGBC 2003).
3 Specific Gravity range determined from "Providence River Maintenance Dredging EIS" Army Corp of Eng. Report (USACE 2001).
4 Grain size range determined from "Suitablility of Pawtuxet Cove for Federal Navigation" memorandum (Nimeskern 2003).
5 Ratio of scour depth to range empirically determined from multiple sources (DeLeo 2001, Liriano 2002, Stumm 2001).
6 Ratio of culvert width to scour region width determined empirically.
7 Water depth at time of maximum flow determined empirically as 3/4 (high), 1/4 (low), and 1/2 (best) max water depth.
8 Maximum scour depth calculated with Army Corp of Eng. Empirical formula (Hughes 1999).
9 Grain size range is in general agreement with sediment data collected 08/07/04 for this project.

Figure

Figure 1


Sensitivity of Scour Region Expanse to Peak Velocity
High Estimates
Low Estimates
Best Estimates
High Estimate of Maximum Scour Range
Best Estimate of Maximum Scour Range
Low Estimate of Maximum Scour Range
range of scour region from culvert (m)
estimated peak velocity (m/s)
0
10
20
30
40
50
60
70
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

Appendix C

March 16, 2004 City of Warwick Harbor Management Commission Meeting Minutes

SALTER'S GROVE CAUSEWAY
PUBLIC INFORMATIONAL MEETING
March 16, 2004
Warwick Harbor Management Commission

Nancy Dickerman, Chair of the Warwick Harbor Management Commission, opened the public meeting, which was attended by approximately 30 Warwick residents.

Mrs. Dickerman introduced Harbor Management Commissioner, Robert Connors, who explained the proposed environmental study and process to the attendees. Mr. Connors explained that the RI Department of Environmental Management (DEM) would fund the study.

Mr. Connors introduced James McGinn of the RI Department of Environmental Management Office of Planning and Development. Mr. McGinn explained some of the history of the causeway, which was created to provide temporary access during the construction of the breakwater that connects Rock Island and Marsh Island. The causeway was originally scheduled to be removed after the breakwater was completed, however, the RI Department of Natural Resources requested that the causeway remain. The causeway originally had two 20-foot openings that allowed water to flow between the northern and southern coves. By 1971, both openings in the causeway had partially failed and flow between the two coves was slowed.

DEM has funds available through the RI Capital Development Funds for Recreational Development to upgrade the causeway to improve public access in the most environmentally responsible fashion. DEM has selected a consultant to evaluate three scenarios to upgrade the causeway.

1. Do nothing.
2. Rebuild the openings.
3. Build an elevated over the walkway structure.

Mr. McGinn introduced Laura Ernst of the ESS Group who explained that the scientific study would provide a baseline study for this area. The scientific study will include the following:

1. Salt marsh/coastal feature mapping.
2. Water quality-sampling plan and analysis.
3. Sediment transport will be studied to determine which way the sediment moves and how this will affect the federal navigation dredging proposed for the Pawtuxet Cove area and vice versa.
4. Gathering existing fisheries information.
5. Stakeholder coordination –permitting authorities, community groups, Save the Bay, Pawtuxet River Watershed Council, etc.

After the study is completed, another public informational meeting will be held to discuss its findings. DEM and the City of Warwick will then decide which scenario will be used to upgrade the causeway.

State Representative Joseph McNamara asked to go on the official record of this meeting. He introduced himself as the State Representative of the 19th District and prior to that, of the 29th District. (The following is Rep. McNamara's comment taken from the tape recording and my notes. The acoustics in the room and the quality of the tape recording do not allow these comments to be an exact transcription of his speech, but are 99% accurate.) "In 1996 legislation was submitted to form a committee to study point and non-point pollution in Pawtuxet Cove. The study included general assemblymen, individuals, Save the Bay, Henry Brown, Representatives from DEM, other environmental groups. The number one objective that was identified to improve water quality was the opening the culverts in Salter's Grove Causeway. The Causeway was built in 1966 as an access way for heavy equipment then the RI Department of Natural Resources requested to the Army Corps that they be allowed to keep the access way to the breakwater. The Army Corps is on record as having a plan from the RI Department of Natural Resources. The RI Department of Natural Resources submitted plans that basically was the causeway, as it existed with the two culvert openings that are currently collapsed. Subsequently, within eight years, both of these culverts collapsed, causing kind of what is displayed in the photographs at this meeting. In 1996 the bridges next to the causeway also collapsed. It should be placed on the record and noted that during that time there were two drownings attributed to individuals and you can see in the third photograph that was displayed you can see what probably is the tide coming in the individual was capable of walking out at low tide, then fishing, recreating out on the causeway and the high tide coming back they were denied access. I believe that contributed to two of the drownings that took place there. In 1997, I wrote a letter to the City Planner, Jonathan Stevens and that I believed there is a liability problem if access from those collapsed bridges is not improved. At that time, he put in what is now the boards that goes towards one of the culverts leading out. I also believe that the environmental studies, that when you come into Salter's Grove and approach the causeway on the left is a growth of Phragmites has increased in number considerably. If you notice on the south side of the causeway, there are very few of the Phragmites, maybe an expert marine biologist can make the assumption that there is a problem with salinity in that cove. I believe, that if you are going to maintain that area, you should rebuild the culverts with access that will be minimally safe. And further, that the northern side and you are looking for some scientific data, my son when he was in junior high a few years ago had a junior high science project tested water on the northern side of the causeway, excuse me the northern side and southern side and with junior high science ability he found differences in pH and excessive salinity, again junior high science, took a black piece of paper put 3ml taken from two feet out on both side and you could see again rudimentary science that salinity was greater on the left hand side. Furthermore, I believe if you look at the waterfowl that are in the area you can see that this has created problems probably with fecal coliform in that the water has become so stagnated that now it has become very attractive to migratory birds that are not natural to this habitat. So I think for all of those reasons, the option of opening those culverts to supply adequate water flow supplying a safe means to address transportation to walk out to the causeway would greatly enhance the quality of water in that side of the area. Furthermore for those that are here we did include in the Department of Environmental budget $100,000 to address this particular situation so I think it has been made I know it has been a priority for many, many people for many years and Mr. Fred Vincent, the acting director, was a field agent when he started, I would like to see it completed, and I would hope that when you study the biology that has taken place here you look at the science you do so with an open mind and look at what has developed because of the construction has taken place. Thanks."

Mrs. Ernst explained that the study is expected to be completed in the fall of 2004 and, depending on funding and the project schedule, work could commence in the winter or spring of 2005. Mr. McGinn indicated it would probably be later than that considering the preferred alternative would need to be engineered and permitted.

During this meeting, the public asked questions concerning the environmental study, possible dredging, public access, making the breakwater an attractive nuisance, CAD cell usage, engineering of the culverts, funding, which were addressed by the various City, DEM and ESS representatives available at the meeting.

A sign up sheet was circulated for attendees to be notified of the future progress of this study.

Mr. McGinn stressed that at this point we are looking for everyone's input and the environmental study to help make the decision of what should be done to the causeway.

Mrs. Dickerman thanked the people for coming and closed the meeting at 7:50 pm.

Submitted by Susan W. Cabeceiras, Planning Department Liaison to the Warwick Harbor Management Commission.