COASTAL RESILIENCE GRANT PROGRAM FY19
RFR ENV 19 CZM 03

Applicant: **Town of Chatham**

Address: **Town of Chatham**
Natural Resources Department
261 George Ryder Road
Chatham, MA 02633

Local Project Manager:
Name: **Robert A. Duncanson, PhD., Director**
Department: **Natural Resources**
Email: **rduncanson@chatham-ma.gov**
Phone: **508-945-5165**
Fax: **508-945-5163**

Project Type:

1. Local Bylaws, Adaptation Plans, and Other Management Measures
2. Redesigns and Retrofits (Planning, Feasibility Assessment, and Siting)

Project Title: ***Prioritization Assessment for Coastal Resiliency and Adaptive Management along Chatham's East-facing Shoreline***

Total Cost: $242,830.00

Match Amount: $60,708.00

Grant Request: $182,122.00

Project Summary: The Town of Chatham (Town) is requesting funding assistance through the *FY19 Coastal Resilience Grant Program* to develop a quantitative analysis of coastal processes to support a detailed analysis of potential shoreline management techniques that could be utilized to sustain the east-facing Chatham shoreline over the next 20-to-30 years. As the inlets and channel positions migrate due to the natural Nauset Beach evolution process, the Town is focused on maintaining storm protection in an environmentally responsible manner. Work performed to date includes an extensive evaluation of the barrier beach migration process, including the influence of relative sea-level rise on the barrier beach and estuarine system. It is anticipated that the quantitative analysis of coastal processes will build off of existing data and modeling tools; however, updated tidal information, bathymetric survey data, and expanded numerical modeling tools that incorporate tidal hydrodynamics, waves, and sediment transport will be required to provide appropriate analysis tools for evaluating management options. The overall goal of the planning analysis is to produce a "roadmap" that the Town can utilize to proactively plan for projects that will improve resiliency.

PROJECT PROPOSAL

PRIORITIZATION ASSESSMENT FOR COASTAL RESILIENCY AND ADAPTIVE MANAGEMENT ALONG CHATHAM'S EAST-FACING SHORELINES CHATHAM, MA

SECTION 1. COASTAL HAZARDS MANAGEMENT

Tidal waters flowing between the ocean, Chatham Harbor/Pleasant Bay estuarine system, and the developed uplands of southeastern Cape Cod continually changed through history. At present, water between the estuary and the sea is exchanged through three discrete tidal inlets. "North Inlet" (formed in 2007) lies immediately south of the southern terminus of the long (and unbroken for more than 10 miles) stretch of east-facing Nauset Barrier Beach system referred to as "North Beach" in Chatham. Geographically, it is located in North Chatham in the vicinity of Strong Island and Minister's Point. An approximate 2-mile long barrier island known as "North Beach Island" lies south of North Inlet and protects the area to the west known as "Chatham Harbor". The second tidal inlet ("South Inlet" formed in 1987) lies south of North Beach Island and north of the next section of the Nauset barrier system, referred to as "South Beach" (see photo, **Exhibit A**, for reference). Up until 2017, the north end of South Beach was attached to the upland; therefore, it demarcated the southern end of the estuary. The "April Fools Inlet" or "Fools Inlet" opened in April 2017, separating South Beach from the Chatham mainland. Since the 1987 formation of South Inlet, the Chatham Harbor/Pleasant Bay estuarine system has experienced significant morphologic changes that created flooding and coastal erosion concerns throughout the community. Although historical, and likely future, inlet migration patterns generally follow a predictable pattern, the implications of these migration patterns to shoreline development are less certain. Specifically, the migration/formation of various inlets, shoals, and tidal channels altered coastal erosion and tidal flooding patterns, often on a storm-by-storm basis.

Until this past year, South Inlet served as the main navigation channel to the estuarine system since its formation in 1987. However, over the past few years South Inlet has become increasingly shoal while North Inlet has been increasing in size and is now the preferred inlet for navigation. Initially, formation of this second inlet brought an increased tide range and associated tidal flushing to the estuary. In general, this increased tidal flushing was viewed as positive change based on improved tidal flushing and water quality. However, increased tidal flushing also allowed higher storm surge levels to propagate into the estuary, often leading to increased concerns over erosion and flooding resulting in more extensive coastal armoring and other measures to protect upland development. Following initial formation of North Inlet, a colony of beach cottages on North Beach, just north of the inlet, was destroyed by beach erosion as the inlet widened. Similarly, only two of an original twelve cottages on North Beach Island remain due to heightened erosion of the island. Ongoing widening of North Inlet has led to substantial shoal formation within the estuary, as well as increased open ocean wave activity within the exposed area of the Chatham mainland shoreline, both to the north and south of Minister's Point.

Subsequent formation of Fools Inlet that separated South Beach from the mainland further altered tidal flow pathways through the estuarine system and exposed portions of Chatham's low-lying mainland to direct ocean wave energy. This low lying area, known as Little Beach, located opposite Fools Inlet, experienced substantial repetitive flooding during this past winter's series of nor'easters. At present, three tidal inlets provide connections to the ocean. It is anticipated that the barrier beach system south of North Inlet will eventually break apart as North Beach and North Inlet migrate south. The anticipated morphologic change through 2100 is illustrated in Figure 1. Over the next several decades, rapid changes to the barrier beach system and associated inlets/tidal channels likely will create conditions that exacerbate coastal erosion and tidal flooding to areas that appear well-protected at present time. At present, overall management of the mainland shoreline is being performed in a reactive, site-specific manner, based on response to coastal erosion and storm-induced flooding issues. However, the Town is focused on developing a proactive approach to overall adaptive shoreline management, rather than continuing a piecemeal approach to shore protection. With this in mind, the project will focus on engineering solutions that not only address present concerns, but also include potential future concerns related to additional flooding and erosion hazards, as well as climate adaptation techniques for the next 20-to-30 years.

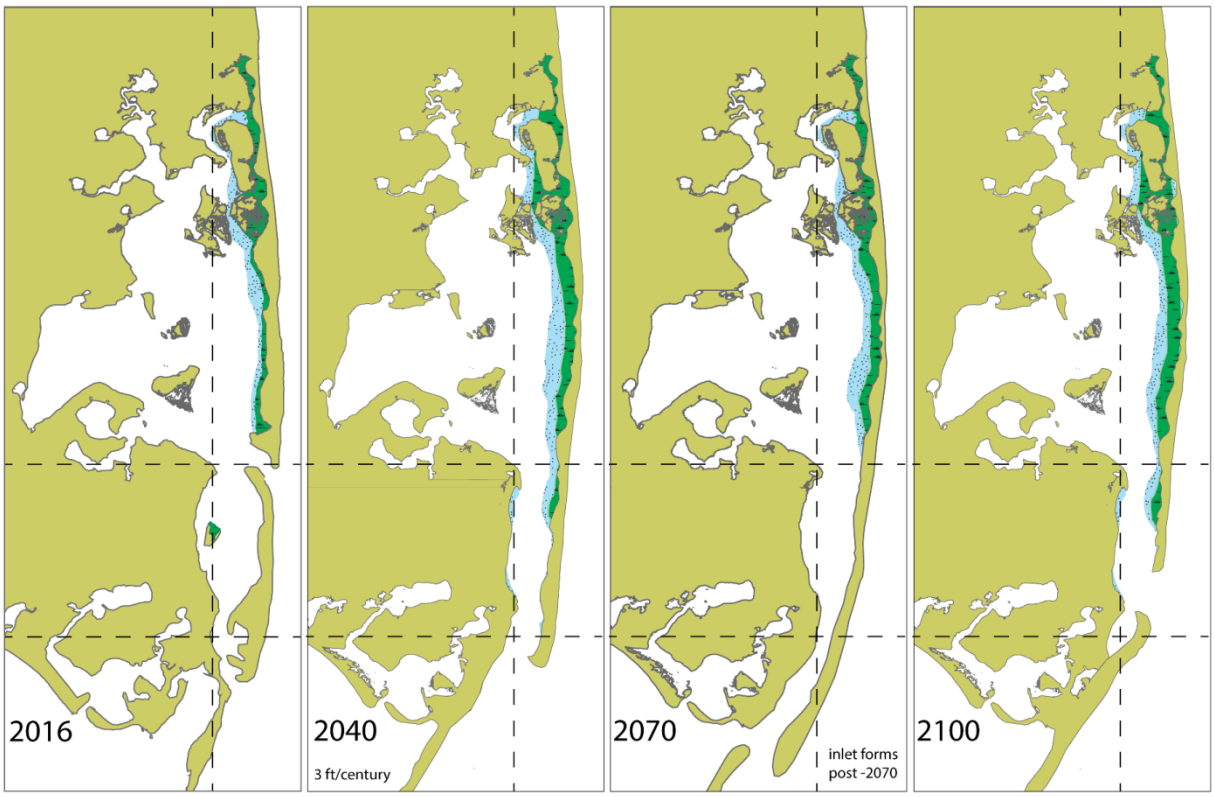

Figure 1. Time series for the 'high' sea level rise scenario (3 ft/century). The longest extent of Nauset Spit occurs around 2070. Inlet formation near Minister's Point will occur at some point in time between 2070 and 2100, likely closer to 2070 than 2100. This figure is focused on the changes to the barrier, which is to the right of the vertical dashed line. Changes to the inner shoreline will likely occur, but are not represented here (*courtesy of the Center*).

SECTION 2. CLIMATE ADAPTATION

Due to the rapidly changing morphology associated with inlet dynamics, as well as the influence of typical nor'easters, Chatham's mainland shoreline between Minister's Point and Morris Island is experiencing both tidal current and storm wave conditions that have not been experienced within this region since the late 1800's. Development of the Chatham shoreline since this time-period created a continually evolving landscape that exposes different waterfront properties to coastal hazards depending on the position of the inlets. Over the early 2018 timeframe, areas in the Minister's Point region, as well as south of "Fools Inlet", experienced erosion and coastal flooding not experienced over the past several decades. This flooding caused significant damage to coastal infrastructure and created a risk to public safety, as rapidly rising water levels inundated the entire Little Beach area and denied access to Stage and Morris Islands further south. During the same storm event, rapid coastal erosion of the beach system adjacent to Minister's Point caused substantial overwash of a beach and dune into a tidal marsh and closure of a salt marsh channel, adversely impacting natural resources. Changes in the shoal patterns and channel morphology within Chatham Harbor resulted in increased current velocities at Minister's Point leading to channel scour and resultant undermining and partial failure of a revetment at Minister's Point. All of this recent coastal storm damage can be directly attributed to the on-going morphologic changes associated with the Chatham Harbor/Pleasant Bay estuary system.

While the rapidly changing inlet and barrier beach morphology is the primary driver to flooding and erosion problems along the Chatham east-facing shoreline, sea level rise and associated higher storm surge levels will exacerbate potential risks to public safety, coastal infrastructure, and natural resources. The proposed assessment of shore protection needs is intended to improve coastal resiliency planning along the vulnerable Chatham east-facing shoreline. The project is focused upon working towards solutions to improve overall shoreline sustainability over the next 20-to-30 years, where solutions will be aimed at adapting more naturally to relative sea-level rise and rapidly changing inlet morphology.

SECTION 3. NEED FOR ASSISTANCE

The Town has actively engaged and collaborated locally and with state and federal agencies to evaluate and improve conditions along its entire coast, with a primary focus on the rapidly changing and vulnerable Chatham Harbor shoreline and infrastructure. The Town plans to continue those collaborative efforts to evaluate and develop solutions to improve the overall stability of the east-facing Chatham mainland shoreline that will address not only local, state, and federal regulations but also provide increased coastal resilience as the Town faces increasing sea levels associated with climate change. In addition to shoreline stability and flooding issues, the Town also collaborates with our federal partners, the U.S. Army Corps of Engineers, to maintain navigation channels in Chatham Harbor for the commercial fishing fleet which is the largest commercial fishing fleet on Cape Cod.

SECTION 4. PROJECT DESCRIPTION AND PUBLIC BENEFIT

The Town plans to further evaluate ongoing hydrodynamic and morphologic processes, and potential engineering alternatives to mitigate long-term shoreline erosion along the Chatham shoreline from the Bassing Harbor entrance, north of Ministers Point, to the Stage Harbor entrance at the southwest end of Morris Island. This effort is aimed at developing an overall coastal shore protection strategy for the next 20-to-30 years to improve the sustainability and resiliency of the shoreline. While shoreline stabilization and flood protection are the primary goals, it also is critical to ensure any potential management alternative continues to maintain a healthy littoral system and protects the function of the overall Chatham Harbor shoreline. To this end, the analysis of shore protection alternatives will be focused on ensuring management of the regional littoral system.

Project Approach

The Town is proposing a quantitative analysis of coastal processes to support a detailed analysis of potential shoreline management techniques that could be utilized to sustain the east-facing shoreline over the next 20-to-30 years. As the inlets and channel positions migrate due to the natural Nauset Beach evolution process, the Town is focused on maintaining storm protection in an environmentally responsible manner. Work performed to date consists of an extensive evaluation of the barrier beach migration process, including estimates of inlet positions over the next 80+ years and the likely influence of relative sea-level rise on the barrier beach and estuarine system. In addition, numerical hydrodynamic modeling of the Pleasant Bay estuary has been performed for conditions that existed in 2001 (post-1987 Breach single inlet system) and 2007 (post-2007 Breach two inlet system).

The quantitative analysis of coastal processes will build off of the existing data and modeling tools; however, updated tidal information, bathymetric survey data, and expanded numerical modeling tools that incorporate tidal hydrodynamics, waves, and sediment transport will be required to provide appropriate analysis tools for evaluating management options. The overall goal of the planning analysis is to produce a "roadmap" that the Town can utilize to proactively plan for projects that will improve resiliency of the shoreline between the Bassing Harbor entrance and Morris Island. By basing future shoreline stabilization and management decisions on a quantitative analysis of area-wide coastal processes, it is anticipated that more cost-effective and sustainable solutions can be developed as part of a long-term planning process.

Project Goals & Objectives

The proposed project is intended to meet the following goals and objectives:

- Utilize existing tidal, bathymetric, coastal processes, and environmental information to inform development of the baseline models needed to support the project.
- Collect additional bathymetry and tidal data to support model development for the estuarine system as it exists in 2018.
- Incorporate historical and predicted information to develop anticipated migration of tidal inlets, tidal channels, and shoals to develop projected estuarine morphology over the next 20-30 years.

- Utilize numerical tidal hydrodynamic, wave, and sediment transport models to quantitatively evaluate coastal processes along the shoreline between the entrance of Bassing Harbor and Morris Island. This modeling will be performed for existing conditions, as well as for future conditions, based on projected estuarine morphology scenarios.
- Perform a screening analysis of various engineering and/or management alternatives that can be used to improve sustainability of the Chatham shoreline between the Bassing Harbor entrance and Morris Island
- Develop recommended alternatives for potential management options, where evaluation criteria will be focused on both long-term sustainability, as well as overall protection of the estuarine and coastal environment.
- Promote transferability of the project through development of a clear concise summary report that demonstrates the steps taken to support the alternatives evaluations and derive a recommended shoreline management approach.

Project Tasks

The following Tasks are proposed to accomplish the goals of the proposed project:

Task 1: Field Data Collection: In order to provide the most up-to-date data for modeling effort, the Center for Coastal Studies (Center) will collect bathymetric data in and around the three currently active inlets as well as tidal data outside of the estuary (in the Atlantic Ocean). Bathymetric data will be collected using a Phase-Measuring Sidescan Sonar (PMSS) in the inlets formed in 1987, 2007, and 2017. Bathymetric data will be collected in September of 2018 and will be used to develop a 3-dimensional surface for the model.

An Acoustic Doppler Current Profiler (ADCP) will be stationed offshore between the 1987 and 2007 inlets for approximately 30 days (2 spring to neap tidal cycles) in approximately 30 ft of water in order to measure the open ocean tides unaffected by inlet processes. A Teledyne RDI® Sentinel V will be used to collect offshore tidal data. This instrument can also collect surface wave data and tidal currents throughout the water column and those data sets will be collected with the tidal data as determined by the model input parameters.

Two ongoing tidal studies funded by the Town and Pleasant Bay Alliance (PBA) have Center staff, led by Dr. Graham Giese, collecting and analyzing tide data at Stage Harbor and Outermost Harbor (Town), and Meeting House Pond and Chatham Fish Pier (PBA). These data will be central to parameterizing the model to simulate the complex tidal flow that moves through the three inlets at the present time. Data collection for these four tidal stations is ongoing and will be provided to support the modeling effort. Dr. Giese has been collecting data and studying the tidal stations at Meeting House Pond and Fish Pier prior to the inlet opening in 2007.

Task 2: Kick-off Meeting: As part of the MCZM Grant process team members from the Town, Applied Coastal, and Center will attend a kick-off meeting with MCZM. The purpose of the kick-off meeting will be to discuss the technical approach in more detail and to address any refinements to the overall scope prior to initiating the detailed analysis.

Task 3: Inlet/Channel Migration and Evolution Analysis: Team members have been involved with the evaluation of inlet dynamics in Chatham since before the 1987 breach. The expertise of both Drs. Giese and Borrelli, and the coastal engineering staff at Applied Coastal, will provide necessary scientific understanding of coastal sedimentary processes controlled by both wave action and tidal hydrodynamics. Specifically for the Chatham Harbor/Pleasant Bay estuarine system, the influence

of the coastal sedimentary processes that govern inlet migration and evolution will be critical to understanding future management implications for the Chatham shoreline. Applied Coastal and the Center have worked well together in past efforts within Pleasant Bay and Chatham Harbor. The most recent project, funded by the PBA, looked at future scenarios of coastal morphology with regards to sea level rise including inlet migration and evolution of Nauset Beach barrier island/barrier spit system through 2100. Building on that study, we will provide analyses at a more refined spatial and temporal scale needed to address short-term channel and shoal evolution (i.e. over the next 20-to-30 years).

This short-term refined analysis will evaluate historical bathymetry throughout Pleasant Bay and Chatham Harbor. Based on a combined understanding of the previous inlet cycle (that began with a breach of the Nauset barrier directly east of Minister's Point in 1846) and the observed evolution of the present inlet cycle (initiated by the 1987 breach), predictions of channel and shoal evolution will be developed and limits to those migrations will be evaluated to the extent possible. Information based on this evaluation of historical information will be combined with the results of the quantitative coastal processes evaluation described below to provide predictions for the next 20-to-30 years with regards not only to inlet evolution, but also to tidal channel and shoal migration. This understanding will assist the Town with planning efforts for issues related to coastal flooding and coastal erosion potential.

Task 4: Quantitative Analysis of Coastal Change and Sediment Transport Processes: The evaluation of recent and anticipated morphologic processes of the eastern coastline will be developed utilizing standard reference materials (maps, aerial photographs, and regional geologic data developed in Task 3), as well as the team's knowledge regarding local coastal geology and its role in shaping this portion of the Massachusetts Coast. This evaluation also will include how anthropogenic changes may have altered the natural sediment transport processes and the influence of sea-level rise upon the long-term stability of the regional coastline.

In addition to an overall analysis of historical channel and shoal evolution, an evaluation of recent local shoreline change will be performed for the project shoreline; specifically, for the time period since the 1987 breach. For sandy portions of the coastline, it is anticipated that a shoreline survey of the 2018 observed high water line will be performed to evaluate recent changes in shoreline position. Comparison of the 2018 surveyed shoreline position with historic shorelines developed as part of this project will provide needed information for the evaluation of sediment movement in this region.

As part of the process for developing a predictive modeling tool that can be utilized to assess shore/flood protection options for the Chatham mainland coast, a quantitative analysis of coastal processes will be required to develop defensible 'baseline' conditions. The model proposed for evaluating tidal hydrodynamics, wave transformation, and sediment transport is the Coastal Modeling System (CMS), developed by the U.S. Army Corps of Engineers. Applied Coastal has successfully used this modeling suite to evaluate both tidal-influenced and wave-driven sediment transport for projects in Alabama, South Carolina, and most recently in Falmouth, Massachusetts. CMS is ideally suited to evaluate the combined influence of currents and waves on sediment transport, as well as evaluating morphology change associated with changes in transport patterns.

The tidal hydrodynamics will be calibrated using the long-term data sets developed by the Center, where the offshore Atlantic Ocean boundary conditions will be derived from the 30-day offshore ADCP deployment. A similar technique was utilized to calibrate previous hydrodynamic modeling efforts performed by Applied Coastal, most recently after the 2007 formation of North Inlet.

Updated bathymetry based on the 2018 survey will be incorporated into the model grid, along with older bathymetry in portions of the estuary that have not been influenced by recent changes to the channel and/or shoal system.

Offshore wave conditions for the model will be derived from the U.S. Army Corps Wave Information Studies (WIS). WIS provides 20-year historical records of wave height, period, and direction. The Chatham shoreline fronted by the Nauset barrier beach system tends to be protected during typical offshore wave conditions; therefore, for this evaluation the analysis of waves within CMS will focus on more energetic conditions that allow propagation of waves to the mainland shoreline. Based on observations over the past several years, these higher energy wave conditions, typically associated with nor'easters, have the most pronounced effect on coastal erosion. The CMS modeling tool will be developed to assess tidal and wave conditions that most strongly influence coastal erosion and flooding along the mainland shoreline. The sediment transport model will be validated by assessing storm-induced trends in shoal migration and coastal erosion/accretion. Once the overall CMS model has been evaluated, a series of future channel and shoal alignments (developed as part of Task 3) will be simulated to quantitatively evaluate anticipated changes to coastal flooding and erosion potential. This aspect of the modeling effort is critical for assessing the viability of potential shore protection alternatives. Within the context of ongoing coastal evolution, the influence of relative sea-level rise also will be accounted for within the analysis. In this manner, quantitative information can inform the evaluation of engineering alternatives for appropriate time horizons.

Task 5: Initial Engineering Analysis to Screen Potential Alternatives: Combining the results developed in Tasks 3 and 4 with the extent of existing coastal armoring along the east-facing Chatham shoreline, an engineering analysis of potential shore protection options will be developed separately for each identified shoreline 'reach'. Results from the sediment transport analyses will inform the viability of different shore protection strategies at meeting the long-term sustainability goals of the project. Specifically, the alternatives evaluation will assess the relative role of inlet position, as well as major channel and shoal locations, on the erosion/flooding potential for each reach. Shore protection strategies will be evaluated for present conditions and two future time periods, based on discussions with the Town. Therefore, strategies may change over time due to anticipated evolution of the inlet system.

For each time period evaluated, the CMS modeling tool will be utilized to assess the utility and long-term viability of the strategy for coastal resiliency. The evaluation will consider positive erosion and/or flooding mitigation effects of the strategy, as well as any potential environmental drawbacks (e.g. exacerbating downdrift erosion, impacts to environmental resources, etc.). For armored shoreline reaches along the mainland shoreline, the influence of the existing armoring will be evaluated relative to potential alternative shore protection measures that could enhance or replace existing infrastructure. The screening level analysis will focus on the viability of a particular management strategy, rather than a site specific engineering design.

Once alternatives are evaluated relative to their applicability to shore protection, screening of these options will be performed to determine the most appropriate alternatives. In general, both exclusionary and discretionary criteria will be utilized to assess the applicability of different options, considering aspects of each alternative including engineering, economics, and potential environmental impacts. Once the alternatives screening process is completed, a matrix of potential shore protection options will be developed for each shoreline reach.

Task 6: Working Session #1: A critical aspect of the overall prioritization plan for shore protection is public "buy-in" regarding both the process and the findings of this planning effort. It is anticipated that two public "working sessions" will be needed, as stakeholder input is critical to the overall process of coastal planning efforts. For Chatham this is especially critical due to the level of potential local funding required to address ongoing issues associated with the natural inlet evolution process for the Chatham Harbor/Pleasant Bay estuarine system, as well as extensive involvement by homeowners affected by coastal storm damage.

After completion of the assessment through Task 5, a public working session will be scheduled to present the findings of the coastal processes analysis, the initial screening analysis, and the overall cost analysis for these shore protection alternatives. Prior to the public meeting, draft findings and meeting materials will be presented to the Project Team (Town and MCZM staff). Meeting feedback will be reviewed and incorporated into the draft report, as appropriate.

Task 7: Prioritize Shore Protection and Other Management Strategies: Once potential shore protection options, anticipated plus historical shoreline erosion and flood damage, and potential infrastructure improvement costs have been identified for each of the shoreline reaches in Town, an assessment of vulnerability will be developed based on the overall risk. While it is important to protect all coastal properties to the extent practical, the Town realizes that developing a plan for addressing coastal hazards in the most critical areas needs to be the priority. The effect of recent inlet and channel evolution on coastal erosion and flooding demonstrate the need for the Town to establish an organized, strategic approach to shore line management so that priorities are in focus so that coastal resiliency issues are addressed proactively rather than in a reactive (emergency) manner.

Utilizing the coastal processes and engineering alternatives data developed from the above tasks, a prioritization scheme for shore protection from the entrance to Bassing Harbor to Morris Island will be developed. This scheme likely will include both 'hard' and 'soft' shore protection measures, based on project need within each of the reaches identified. In general, both economic drivers and environmental impacts will be critical to this prioritization process; however, coastal resiliency also will need to be addressed, as future shore protection expenditure planning will require that a sustainable outcome will be achieved based upon a 20-to-30-year planning horizon. The outcome of the prioritization will be a matrix of shore protection management strategies based on "need", economic drivers, and potential environmental impacts that will help guide future Town planning efforts.

Task 8: Working Session #2: After completion of the prioritization analysis described above, a public working session will be scheduled to present the findings of the overall analysis. Prior to the public meeting, draft findings and meeting materials will be presented to the Project Team (Town and MCZM staff). Meeting feedback will be reviewed and incorporated into the draft report, as appropriate.

Task 9: Draft Report: The results of the shoreline management prioritization will be summarized in a technical report that includes a description of methods, appropriate tables and figures of analysis results, and management/prioritization recommendations developed from the assessment. The draft report will incorporate feedback from the public working sessions described above. Applied Coastal prides itself in developing reports that provide the proper amount of technical information, yet can be understood by the general public, as well.

Task 10: Final Report: Based on a review of the draft report, a final report will be prepared that incorporates comments and feedback from the draft report.

Public Benefit

The overall return on investment to improving/sustaining coastal resiliency along the east-facing Chatham shoreline can be depicted in both a direct benefit and the opportunity cost of not implementing the project. The cost of not addressing critical erosion and flooding issues, as well as the associated reduced resiliency of the Chatham shoreline, is the eventual loss of public infrastructure, salt marsh and other coastal resource areas, access to private and public docking/marina facilities, and private residences.

Ongoing piecemeal efforts to maintain the Chatham Harbor system have not considered the ongoing dynamics of the multi-inlet system; therefore, efforts have been insufficient. A more proactive approach to shoreline stabilization and management is warranted to ensure the long-term viability of the coastal resources and the critical roadway infrastructure along many portions of the shoreline. This effort is aimed at developing a comprehensive coastal shore protection strategy over the next 20-to-30 years to improve sustainability and resiliency of the Chatham shoreline. Although shoreline stabilization and flood protection are primary goals, it also is critical to ensure that any potential solution to stabilize the beach system continues to protect the natural functions of the shoreline. To this end, the analysis of shore protection alternatives will be focused on ensuring management of the regional littoral system that benefits public resources.

SECTION 5: TRANSFERABILITY

An integral part of this effort will be public outreach and education as Community "buy-in" is crucial to the overall prioritization assessment for shore protection needs. The project will include two public presentations and workshops, as stakeholder input is critical to the process of coastal planning efforts. This is especially critical for the Town due to the level of potential local funding required to address on-going issues associated with coastal storm damage mitigation, as well as extensive involvement by homeowners affected or potentially affected in the future by coastal storm damage. For coastal resiliency to be maximized, the Town recognizes that it will require a public-private partnership from the onset, understanding that shore protection needs along Chatham's east-facing shoreline will require that private and public entities team together to develop the most pragmatic proactive approach to shoreline sustainability.

This project will provide an approach that attempts to simplify the difficult and complex issues of sea level rise, climate change, and coastal adaptation for the public and town officials. It will bring groups together for sharing information and education, rather than a political forum. The topics presented will include the science of coastal processes and sea level rise, innovative adaptation strategies and recommended actions, cost benefits, sustainability of existing coastal infrastructure and other traditional options which are typically not in question, and fiscal issues for towns, which are infrequently discussed. The approach proposed for this project is transferrable to other communities faced with similar challenges for shoreline protection and coastal resiliency, in particular, Towns on the Outer Cape, Martha's Vineyard, and Nantucket. Many of these regional communities are facing very similar challenges as much of their shorelines include naturally

migrating and/or ephemeral inlet systems, where shoreline development can be threatened periodically due to morphologic changes to the inlet and/or barrier beach systems.

SECTION 6: PROJECT TIMELINE

The proposed project will be completed by June 30, 2019, within the timeframe allotted under the FY19 Coastal Resilience Grant Program. Presented below is the anticipated project timeline:

WORK TASK	ESTIMATED COMPLETION DATE
Award to Consultant	**September 1, 2018**
Task 1: Field Data Collection	**September 1, 2018 – October 31, 2018**
Task 2: Kick-Off Meeting	**September 15, 2018**
Task 3: Inlet/Channel Migration and Evolution Analysis	**November 1, 2018 – January 31, 2019**
Task 4: Quantitative Analysis of Coastal Change And Sediment Transport Processes	**September 1, 2018 – February 28, 2019**
Task 5: Initial Engineering Analysis to Screen Alternatives	**January 1, 2019 – March 31, 2019**
Task 6: Working Session #1	**April 1, 2019**
Task 7: Prioritize Shore Protection and Other Management Strategies	**March 15, 2019 – May 15, 2019**
Task 8: Working Session #2	**May 15, 2019**
Task 9: Draft Report	**April 15, 2019 - June 1, 2019**
Task 10: Final Report	**June 15, 2019 – June 30, 2019**
Completed Project	**June 30, 2019**

SECTION 7: PROJECT BUDGET

The project budget has been included as **Exhibit B** following the format provided in the RFR. Based upon the total budget required for the project, the Town respectfully submits this grant application, herein, requesting a total of $182,122 (75% of total project cost of $242,830) in state funding assistance. The Town fully understands that if selected to receive state funds under this program that a 25% local match valued at $60,708, consisting of cash, in-kind services or a combination of both is required. The Town further understands that state funding will be provided

on a reimbursement basis. An authorized statement signed by the Town Manager acknowledging the grant program requirements is provided in **Exhibit C**.

SECTION 7: PROJECT MANAGEMENT

The Town will be responsible for leading the Project Team that will be assembled for this project. The Town has strategically formulated this team to consist of municipal experts in the fields of planning, as well as coastal and environmental resources. The Town previously and successfully managed dozens of coastal projects which received funding assistance from the following state and federal agencies: Massachusetts Coastal Zone Management (CZM), Department of Fish and Game – Division of Ecological Restoration (DER), USDA Natural Resources Conservation Service (NRCS), U.S. Army Corps of Engineers, Federal Emergency Management Agency (FEMA), and Massachusetts Emergency Management Agency (MEMA). The Town plans to hire the consulting team of Applied Coastal Research and Engineering and Center for Coastal Studies. These two groups of experienced coastal experts, scientists and engineers are specifically proficient in performing the quantitative analysis of coastal change and sediment transport processes, assessing and designing shore protection measures including beach nourishment, and planning/developing strategic coastal management practices that will result in sustainable, long-term coastal resiliency along the Chatham east-facing shoreline. The Project Team will be responsible for overall management of the project and consultants, and will take the lead in public outreach efforts.

Presented below are the key members that have been selected to lead the Project Team. The resumes of key Town and Consultant personnel are provided in **Exhibit D**.

PROJECT TEAM QUALIFICATIONS

Robert Duncanson, PhD., Director, Health and Natural Resources

Dr. Duncanson serves as Chatham's Director of Health and Natural Resources with over 30 years' experience in overall management of the Town's natural resources including in-depth knowledge of coastal and inland resource areas and expansive knowledge of the Town's infrastructure. He has been involved in oversight of multiple beach nourishment and dredging projects, inlet widening, culvert replacement, and stormwater management projects.

Theodore Keon, Director, Coastal Resources

Mr. Keon is the Director of Coastal Resources (since 1998) and serves as Chatham's primary contact regarding coastal processes and issues related to the marine and shoreline environment. He is directly responsible for the Town's comprehensive dredging, shoreline change and sediment management program. Prior to his position with Chatham, Mr. Keon was the Chief of the Coastal Planning Section of the Philadelphia District of the U.S. Army Corps of Engineers.

John Ramsey, Principal Coastal Engineer (Applied Coastal)

Mr. Ramsey is a co-founder and Principal Coastal Engineer at Applied Coastal and has served as Project Manager and/or Principal Investigator for coastal embayment restoration projects, regional shoreline management plans, beach nourishment and coastal structure designs, estuarine water quality/flushing studies, geotechnical engineering, hydrodynamic and sediment transport

evaluations, and environmental studies required for permitting of coastal projects. He has co-authored several papers related to littoral processes analysis and has employed innovative numerical methods to develop alternative solutions for complex coastal engineering problems. Mr. Ramsey is well-versed in modern analytical and numerical techniques for evaluating coastal, estuarine, and salt marsh processes. In addition, he is responsible for oversight of engineering services at Applied Coastal

Sean Kelley, P.E., Senior Coastal Engineer (Applied Coastal)

Mr. Kelley is a senior coastal engineer at Applied Coastal Research and Engineering, Inc. specializing in the measurement and modeling of coastal processes. His past modeling work includes the application of state-of-the-art wave, hydrodynamic, and sediment transport models in a broad range of coastal engineering and analysis projects. This experience includes the determination of coastal structure design criteria, the design of beach nourishments, and the analyses of estuarine circulation and water quality.

Graham Giese, PhD., Geophysical Scientist (Center for Coastal Studies)

Graham Giese is a geophysical scientist specializing in coastal processes. While he has studied and reported on geological and oceanographic processes affecting coasts globally, his major focus has been on those of Outer Cape Cod. Increased understanding of the physical processes responsible for the behavior of the Nauset-Monomoy barrier system is presently his major research objective.

Mark Borrelli, PhD., Coastal Geologist (Center for Coastal Studies)

Dr. Borrelli is a coastal geologist specializing is non-cohesive sediment transport with a particular interest in tidal inlets. He joined the Center for Coastal Studies in 2009 after completing is doctoral work in 2008 which focused on inlet evolution in Pleasant Bay/Chatham Harbor. He has worked regularly in this system and has been lead or co-author on 5 technical reports or journal articles having to do with inlet evolution and/or sediment transport in Pleasant Bay/Chatham Harbor. He is the Director of the Coastal Processes and Ecosystems Lab, a joint research laboratory between the School for the Environment at UMass-Boston and the Center for Coastal Studies.

SECTION 9: PARTNERS

The Town has successfully implemented many coastal restoration projects through committed partnerships. For example, the community routinely works with the Pleasant Bay Alliance to evaluate those factors which impact the long-term resiliency of public and private shorelines, infrastructure, and sensitive resources. It is vital to our success to collaborate with local, state, and federal partners in making important decisions due to present and future shoreline conditions. Letters of Support for this project from key elected State Representatives, Departments, Committees, and Stakeholder Groups are provided in **Exhibit E**.

EXHIBIT A

Aerial Photo- Project Site

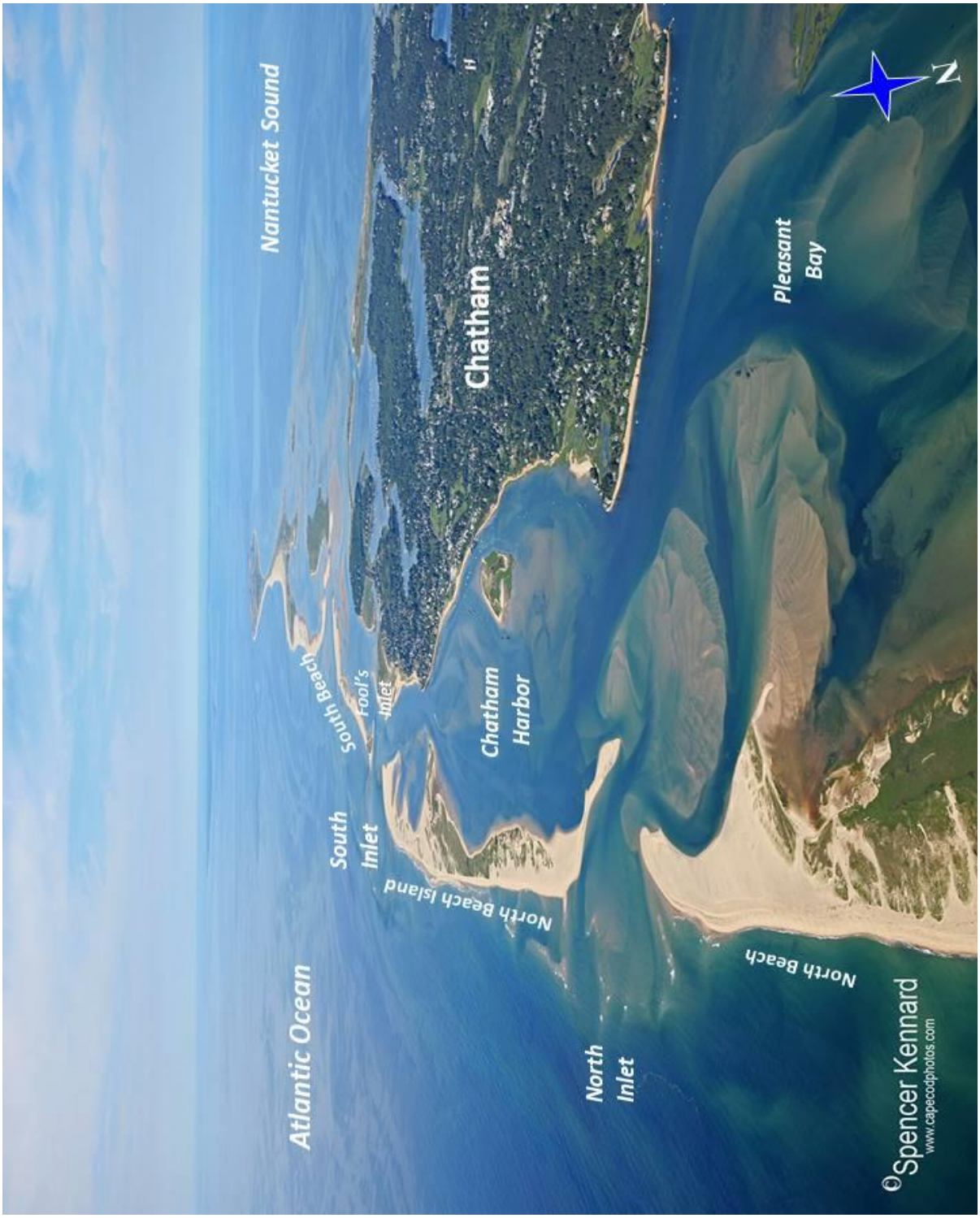

EXHIBIT B

Project Budget

FY19 - Prioritization Assessment for Coastal Resiliency and Adaptive Management along Chatham's East-facing Shorelines

Project Task Description	Deliverables	Due Date	Grant	Match	Total
Task 1:					
Field Data Collection	Data Disk	30-Nov-18	$30,315.00	$10,105.00	$40,420.00
Total Task 1 Cost			$30,315.00	$10,105.00	$40,420.00
Task 2:					
Projec Kick-Off Meeting	Meeting Minutes	30-Sep-18	$2,685.00	$895.00	$3,580.00
Total Task 2 Cost			$2,685.00	$895.00	$3,580.00
Task 3:					
Inlet/Channel Migration and Evolution Analysis	Update Memorandum 1	31-Jan-19	$29,400.00	$9,800.00	$39,200.00
Total Task 3 Cost			$29,400.00	$9,800.00	$39,200.00
Task 4:					
Quantitative Analysis of Coastal Processes	Update Memorandum 2	28-Feb-19	$47,437.50	$15,812.50	$63,250.00
Total Task 4 Cost			$47,437.50	$15,812.50	$63,250.00
Task 5:					
Initial Engineering Analysis to Screen Alternatives	Working Session 1 Powerpoint	1-Apr-19	$17,790.00	$5,930.00	$23,720.00
Total Task 5 Cost			$17,790.00	$5,930.00	$23,720.00
Task 6:					
Working Session 1	Working Session 1 Powerpoint	1-Apr-19	$7,095.00	$2,365.00	$9,460.00
Total Task 6 Cost			$7,095.00	$2,365.00	$9,460.00
Task 7:					
Prioritize Shore Protection and Management Starategies	Working Session 2 Powerpoint	15-May-19	$23,730.00	$7,910.00	$31,640.00
Total Task 7 Cost			$23,730.00	$7,910.00	$31,640.00
Task 8:					
Working Session 2	Working Session 2 Powerpoint	15-May-19	$7,095.00	$2,365.00	$9,460.00
Total Task 8 Cost			$7,095.00	$2,365.00	$9,460.00
Task 9:					
Draft Report	Draft Report	1-Jun-19	$12,720.00	$4,240.00	$16,960.00
Total Task 9 Cost			$12,720.00	$4,240.00	$16,960.00
Task 10:					
Final Report	Final Report	30-Jun-19	$3,855.00	$1,285.00	$5,140.00
Total Task 10 Cost			$3,855.00	$1,285.00	$5,140.00
TOTAL PROJECT COST			$182,122.50	$60,707.50	$242,830.00

FY19 Coastal Resilience Grant Budget - Prioritization Assessment for Coastal Resiliency and Adaptive Management along Chatham's East-facing Shorelines

	GRANT															IN-KIND / CASH MATCH															
	Project Team Hours										Direct Costs				Total Task (Grant)	Project Team Hours										Direct Costs				Total Task (Match)	Total Project Cost
	Project Mgr		Sr Engineer II		Sr Engineer I		Coastal Engr		GIS Specialist		Unit	Quanity	Unit Cost	Total		Project Mgr		Sr Engineer II		Sr Engineer I		Coastal Engr		GIS Specialist		Unit	Quanity	Unit Cost	Total		
Hourly Rate	$255.00		$180.00		$175.00		$105.00		$115.00		X	X	X	X		$255.00		$180.00		$175.00		$105.00		$115.00		X	X	X	X		
Task 1:	Hours	Total	Hours	Total	Hours	Total	Hours	Total	Hours	Total						Hours	Total	Hours	Total	Hours	Total	Hours	Total	Hours	Total						
Field Data Collection	6	$1,530.00	12	$2,160.00	0	$0.00	0	$0.00	0	$0.00	each	1	$26,625.00	$26,625.00	**$30,315.00**	2	$510.00	4	$720.00	0	$0.00	0	$0.00	0	$0.00	each	1	$8,875.00	$8,875.00	**$10,105.00**	**$40,420.00**
Total Task 1 Cost															**$30,315.00**															**$10,105.00**	**$40,420.00**
Task 2:																															
Kick-Off Meeting	6	$1,530.00	0	$0.00	0	$0.00	6	$630.00	0	$0.00	each	1	$525.00	$525.00	**$2,685.00**	2	$510.00	0	$0.00	0	$0.00	2	$210.00	0	$0.00	each	1	$175.00	$175.00	**$895.00**	**$3,580.00**
Total Task 2 Cost															**$2,685.00**															**$895.00**	**$3,580.00**
Task 3:																															
Inlet/Channel Migration + Evolution	30	$7,650.00	12	$2,160.00	0	$0.00	30	$3,150.00	0	$0.00	each	1	$16,440.00	$16,440.00	**$29,400.00**	10	$2,550.00	4	$720.00	0	$0.00	10	$1,050.00	0	$0.00	each	1	$5,480.00	$5,480.00	**$9,800.00**	**$39,200.00**
Total Task 3 Cost															**$29,400.00**															**$9,800.00**	**$39,200.00**
Task 4:																															
Analysis of Coastal Processes	45	$11,475.00	75	$13,500.00	0	$0.00	180	$18,900.00	30	$3,450.00	each	1	$112.50	$112.50	**$47,437.50**	15	$3,825.00	25	$4,500.00	0	$0.00	60	$6,300.00	10	$1,150.00	each	1	$37.50	$37.50	**$15,812.50**	**$63,250.00**
Total Task 4 Cost															**$47,437.50**															**$15,812.50**	**$63,250.00**
Task 5:																															
Initial Screening of Alternatives	24	$6,120.00	24	$4,320.00	24	$4,200.00	30	$3,150.00	0	$0.00				$0.00	**$17,790.00**	8	$2,040.00	8	$1,440.00	8	$1,400.00	10	$1,050.00	0	$0.00				$0.00	**$5,930.00**	**$23,720.00**
Total Task 5 Cost															**$17,790.00**															**$5,930.00**	**$23,720.00**
Task 6 + Task 8:																															
Working Sessions	18	$4,590.00	6	$1,080.00	6	$1,050.00	48	$5,040.00	12	$1,380.00	each	1	1050	$1,050.00	**$14,190.00**	6	$1,530.00	2	$360.00	2	$350.00	16	$1,680.00	4	$460.00	each	1	$350.00	$350.00	**$4,730.00**	**$18,920.00**
Total Task 6 +8 Cost															**$14,190.00**															**$4,730.00**	**$18,920.00**
Task 7:																															
Prioritize Management Strategies	30	$7,650.00	0	$0.00	30	$5,250.00	90	$9,450.00	12	$1,380.00				$0.00	**$23,730.00**	10	$2,550.00	0	$0.00	10	$1,750.00	30	$3,150.00	4	$460.00				$0.00	**$7,910.00**	**$31,640.00**
Total Task 7 Cost															**$23,730.00**															**$7,910.00**	**$31,640.00**
Task 9:																															
Draft Report	18	$4,590.00	18	$3,240.00	6	$1,050.00	30	$3,150.00	6	$690.00				$0.00	**$12,720.00**	6	$1,530.00	6	$1,080.00	2	$350.00	10	$1,050.00	2	$230.00				$0.00	**$4,240.00**	**$16,960.00**
Total Task 9 Cost															**$12,720.00**															**$4,240.00**	**$16,960.00**
Task 10:																															
Final Report	6	$1,530.00	3	$540.00	3	$525.00	12	$1,260.00	0	$0.00				$0.00	**$3,855.00**	2	$510.00	1	$180.00	1	$175.00	4	$420.00	0	$0.00				$0.00	**$1,285.00**	**$5,140.00**
Total Task 10 Cost															**$3,855.00**															**$1,285.00**	**$5,140.00**
TOTAL PROJECT COST															**$182,122.50**															**$60,707.50**	**$242,830.00**

25.00% (Note: Match must be at

FY19 - Prioritization Assessment for Coastal Resiliency and Adaptive Management along Chatham's East-facing Shorelines					
DIRECT COSTS SUMMARY					
	Mileage (Applied Coastal	**Coastal Studies**			
Task 1 - Field Data Collection		$35,500.00			
Task 2 - Project Kick-Off Meeting	$50.00	$650.00			
Task 3 - Inlet/Channel Migration and Evolution Analysis		$21,920.00			
Task 4 - Quantitative Analysis of Coastal Processes	$150.00				
Task 5 - Initial Engineering Analysis to Screen Potential Alternatives					
Task 6 - Working Session 1	$50.00	$650.00			
Task 7 - Prioritize Shore Protection and Other Managent Strategies					
Task 8 - Working Session 2	$50.00	$650.00			
Task 9 - Draft Report					
Task 10 Final Report					
Total	**$300.00**	**$59,370.00**			
Center for Coastal Studies (Coastal Studies) costs are listred by task, but can be provided as man-hour breakdown, if required.					

EXHIBIT C

Grant application authorization letter

Town of Chatham

Office of the Selectmen
Town Manager
549 Main Street
Chatham, MA 02633

Jill R. Goldsmith
TOWN MANAGER

Tel: (508) 945-5105
Fax: (508) 945-3550
www.chatham-ma.gov

May 23, 2018

Patricia Bowie, Coastal Resiliency Specialist
Massachusetts Office of Coastal Zone Management
251 Causeway Street, Suite 800
Boston, MA 02114

Dear Ms. Bowie,

The Town of Chatham is submitting the attached Application under the Coastal Resiliency Grant Program FY19.

As required by the Application I acknowledge:

1. A Town commitment of 25% match ($60,708) that will be provided in the form of cash, in-kind services, or a combination of both. And that the necessary funds will be available for the Project

2. That funding is provided on a reimbursement basis.

Our team of elected officials and professional staff will work together, with the larger community, to bring local knowledge to the planning process to develop priority actions to improve the Town's resiliency to climate related hazards.

If you have any questions regarding the foregoing, please contact me at 508-945-5105 or jgoldsmith@chatham-ma.gov.

Sincerely,

Jill R. Goldsmith
Town Manager

EXHIBIT D

Resumes of key personnel

Robert A. Duncanson, Ph.D.

Experience

- Director of Health & Natural Resources, Department of Natural Resources, Town of Chatham, 2014 to present. As Director of Health & Natural Resources manages staff and programs in the areas of public health, conservation, environmental protection, coastal resources, harbormaster, and shellfish.
- Director of Health and Environment, Town of Chatham, 2002 to 2014.
- Director, Water Quality Laboratory, Town of Chatham, 1987 to present.

Education

Ph.D. Biological Sciences, University of Rhode Island, 1993.

B.S. Biology, University of Miami, 1979.

Aquaculture for Regulators, Marine Biological Laboratory (resident course), 1995; Marine Pollution and Control, 1985; Field Marine Science, 1979, Shoals Marine Laboratory (Cornell University); Marine Microbiology, Gulf Coast Research Laboratory, 1980.

Recognition

Chatham Rotary Club Person of the Year, 2017
APCC Paul Tsongas Environmental Excellence Award, 2013
APCC Environmental Champion, 2009

Representative Certifications/Continuing Education (selected)

- Managing Stormwater for Low Impact Development (LID), 2011
- Ocean Outfall Symposium: Exploring Ocean Outfalls as a Wastewater Management Alternative for Cape Cod, 2011
- 2011 Northeast Regional Cyanobacteria Workshop, 2011
- Water Quality Monitoring: What do we do with all of this data?, 2011
- OSHA 10 Hour Construction Training, 2010
- Science-based Adaptive Management: The Path for Cape Cod's Wastewater, 2010
- Protecting the Cape's Water Resources: Water Reuse and Groundwater Recharge as Keys for Sustainable Water Management, 2010
- Planning and Implementing Wastewater Solutions, 2010
- Beyond Pipe and Pond: Research Based Stormwater Treatment System Design Workshop, 2010
- The 10th *Ponds in Peril* Workshop, 2010
- Community Sanitation Program Annual Spring Seminar, 2010
- Workshop on Planning for Sustainable Stormwater Financing, 2009.
- Stormwater Financing Workshop, 2009.
- Environmental, Health & Safety Regulatory Update Seminar, 2008.
- Infectious Disease Surveillance, Reporting and Control, 2005, 2008.
- Wastewater Workshop Series, 2008. Dealing With Emerging Contaminants, Altering Tidal Inlets; Community Planning Process: Lessons Learned & Best Practices; Centralized Wastewater Treatment: Sewer Systems; Innovative and Alternative Onsite Septic Systems & Nitrex Reactive Barrier.
- Restore America's Estuaries Conference, 2006, 2008.
- Monitoring Meeting for Small Municipal Separate Storm Sewer (MS4) Phase II Communities, 2008.
- Revisions to Mass. Wetlands Regulations for Stormwater Management, 2008
- Water Reuse in New England: Drivers, Technologies & Examples, 2007.
- Restoring and Protecting Coastal Waters – Local and Regional Efforts to Implement total Maximum Daily Loads and Opportunities for the Future of Cape Cod, 2006.
- Breaking the Barriers: Moving Forward with Low Impact Stormwater Design on Cape Cod, 2006.
- Nitrogen from the Air: How Important is this Source to Coastal Pollution on Cape Cod?, 2006.
- Stormwater BMP Technology Demonstration Workshop, 2005.

- Developing Construction & Post-Construction Programs: A Workshop for Stormwater Phase II Communities, 2005.

Professional Affiliations

American Society for Microbiology; Water Pollution Control Federation; New England Water Pollution Control Association; American Water Works Association; National Shellfisheries Association; Barnstable County Coastal Resources Committee, Co-chair 1999 to present; Chatham Conservation Commission, Associate Member, 1988-1996; Cape Cod Wastewater Implementation Committee; Cape Cod Water Protection Collaborative – Technical Advisory Committee; Association of Watershed & Stormwater Professionals

Publications

Co-authored 45+ Sanitary Survey Reports and Triennial updates of Chatham shellfish growing areas, 1989 to present.

Mitchell, David, S. MacDougall, R. Duncanson and S. Cook, 2009, Evaluation of Lake Restoration Methods for Two Kettle Hole Ponds on Cape Cod, North American Lake Management Society 2009 Annual Symposium.

Armon, R., V.J. Cabelli, and R. Duncanson. 2007. “Survival of F-RNA Coliphages and Three Bacterial Indicators During Wastewater Chlorination and Transport in Estuarine Water”. Estuaries and Coasts, Vol. 30 (6).

Duncanson, R. A., 1993, "Enumeration and Differentiation of Chloramine-Stressed Total Coliform Bacteria". Doctoral Dissertation. University of Rhode Island.

White, H.H., A.F.J. Draxler, R.A. Duncanson, D.L. Saad, and A. Robertson. 1993. "Distribution of *Clostridium perfringens* Spores in Sediments Around the 106-Mile Dumpsite in the Mid-Atlantic Bight". Marine Pollution Bulletin, Vol 26 (1).

Duncanson, R.A. and D. L. Saad. 1989 "Alternative Indicators for the Sanitary Quality of Shellfish Resources". Woods Hole Oceanographic Institution Technical Report: WHOI-89-35.

Duncanson, R.A. and V.J. Cabelli. 1986. "Membrane Filter Method for the Enumeration of Chlorine Damaged Coliforms in Drinking Water." Proceedings: Water Quality Technology Conference, American Water Works Association.

Duncanson, R.A., D.L. Saad, H. Namdari, M.R. Rodgers and V.J. Cabelli. 1986 "Monitoring Fecal Contamination of Marine Waters by Measuring *C. perfringens* Spores in the Sediments." Conference Record: Oceans '86, Marine Technology Society.

Cabelli, V.J., R.A. Duncanson, J.L. Gaines, D. Pedersen, R.R. Sims and R.F. Shokes. 1984. "Chemical and Microbiological Tracers for the Deposition and Movement of Sewage Particulates." Conference Record: Oceans '84, Marine Technology Society.

Cabelli, V.J., D. Pedersen and R.A. Duncanson. 1984 "The Use of Bacterial Indicator Systems to Predict Swimming-Associated, Pollution-Related Health Effects and to Follow the Deposition and Movement of Sewage Particulates. Abstracts: 2nd International Colloquium of Marine Bacteriology.

Duncanson, R.A. and V. J. Cabelli. 1983. "Membrane Filter Method for the Enumeration of Total Coliforms." Abstracts of the Ann. Meet. of the American Society for Microbiology. Abstract

Theodore L. Keon

Experience: 1998-Present: Director of Coastal Resources, Town of Chatham, MA
Serves as the primary liaison for Chatham's marine and shoreline related activities. Oversees the planning and implementation of projects affecting Chatham's waterways, coastal shorelines and water dependent infrastructure. Provides oversight of town landings and water related access. Responsible for the Town's comprehensive dredging, shoreline change and sediment management program.

1992-1997: Chief, Coastal Planning Section, US Army Corps of Engineers, Philadelphia District, Philadelphia, PA

1988-1992: Project Manager, Coastal Planning Section, US Army Corps of Engineers, Philadelphia District, Philadelphia, PA

1985-1988: Hydrologist, Hydrology and Hydraulics Branch, US Army Corps of Engineers, Philadelphia District, Philadelphia, PA

Education: Master of Arts: Geography, Arizona State University, Tempe, AZ
Bachelor of Arts: Geography, University of Delaware, Newark, DE

Recent Professional Presentations/Publications:

Keon, T.L., "Chatham's Dynamic Shoreline", *Presentation to the Chatham Alliance for Preservation and Conservation*, 2017, Chatham, MA

Keon, T.L., "Dredging, Sand Management, and Habitat Restoration of a Jettied Inlet System, Chatham, MA", *Presentation at the Annual Meeting of the American Shore and Beach Preservation Association*, 2016, Long Branch, NJ

Keon, T. L., Giese, G. S. "Management Challenges Linked to Geomorphological Changes to the Nauset/Monomoy Barrier Beach System, Cape Cod, MA" *Proceedings of the Eighth International Symposium on Coastal Engineering and Science of Coastal Sediments 2015,* San Diego, CA. 14 p

Keon, T. L., "Dredging and Sand Management", *Presentation to the Environmental Business Council*, 2014, Boston, MA

Keon, T. L., "Development and Potential Impacts of the New Inlet on Nauset Beach", *Presentation for the Orleans Pond Coalition*, 2011, Orleans, MA

Keon, T. L., "Regional Sediment Management at the Local Level, A Perspective from Chatham, MA", Invited Panel Participant for Special Session entitled "Shifting Sands- A Broader Management Strategy: Discussion on the National Shoreline Management Study", 2011, *Presentation at Coastal Zone 2011*, Chicago, IL

Keon, T. L., Andres A., "Waiting for Equilibrium: Human Reaction and Resulting Conflicts Associated with Shoreline Change Following a New Inlet Formation, Chatham, MA", *Presentation at Coastal Zone 2011*, Chicago, IL

Weishar, L., Keon, T.L., Markunas, P. "Regional Sediment Management Combined with an Ecosystem Restoration Project in Chatham, MA; A Local Approach", *Proceedings of the Seventh International Symposium on Coastal Engineering and Science of Coastal Sediments 2011*, Miami FL. 14 p

Keon, T.L., Kelley, S. W. "New Inlet Formation on Cape Cod, Massachusetts: Geomorphic Evolution and Management Challenges", 2011, *Proceedings of the Seventh International Symposium on Coastal Engineering and Science of Coastal Sediments 2011*, Miami FL. 14 p

Keon, T. L., "Early Assessment of a Two Inlet System, Chatham, MA", *Presentation at the Annual Meeting of the Northeast Shore and Beach Preservation Association*, 2009, Woods Hole, MA

Giese, G. S., Adams, M. B, Keon, T. L., Mague, S. T., Rogers, S. S., Observations of a Pre-migration Phase in a Natural Tidal Inlet Migration "Cycle", *Presentation at the Annual Meeting of the Northeast Shore and Beach Preservation Association*, 2009, Woods Hole, MA

Giese, G. S., Keon, T. L., Adams, M. B., "Science In Aid of a Community Adapting to an Unexpected New Tidal Inlet: Chatham, Massachusetts", 2009, *Presentation for Coastal Zone, 2009*, Boston, MA

Contact Information:

Theodore L. Keon, Director
Coastal Resources
261 George Ryder Road
Chatham, MA 02643
(508) 945-5176
tkeon@chatham-ma.gov

APPLIED COASTAL

JOHN S. RAMSEY, PE, D.CE
Principal Coastal Engineer

Evaluation and design of coastal structures and beach nourishment
Numerical modeling of estuarine hydrodynamics and water quality
Analysis of tidal inlet dynamics and sediment transport
Coastal processes analysis

YEARS OF EXPERIENCE
31 (19 with Applied Coastal; 12 with others)

EDUCATION
M.C.E., Civil (Coastal) Engineering, University of Delaware, 1991
B.S., Civil and Environmental Engineering, Cornell University, 1985

REGISTRATION
Professional Engineer:
Commonwealth of Massachusetts #38532
State of Connecticut #27392
State of Louisiana #38818

AFFILIATIONS
American Society of Civil Engineers
- Coastal Zone Management Committee
- Coastal Engineering Practice Committee

Association of Coastal Engineers
- President (2006-2014)
- Vice-President (2004-2006)

Florida Shore and Beach Preservation Association
American Shore & Beach Preservation Association

PROFILE
Mr. Ramsey is a co-founder and Principal Coastal Engineer at Applied Coastal Research and Engineering, Inc. (Applied Coastal) and has served as Project Manager and/or Principal Investigator for coastal embayment restoration projects, regional shoreline management plans, beach nourishment and coastal structure designs, estuarine water quality/flushing studies, geotechnical engineering, hydrodynamic and sediment transport evaluations, and environmental studies required for permitting of coastal projects. He has co-authored several papers related to littoral processes analysis and has employed innovative numerical methods to develop alternative solutions for complex coastal engineering problems. Mr. Ramsey is well-versed in modern analytical and numerical techniques for evaluating coastal, estuarine, and salt marsh processes. In addition, he is responsible for oversight of engineering services at Applied Coastal.

RELEVANT EXPERIENCE

Chatham Embayments Water Quality Analysis, Chatham, Massachusetts

- Mr. Ramsey served as project manager and lead coastal engineer/modeler for a project that incorporated numerical modeling to evaluate tidal hydrodynamics and water quality (total nitrogen) within a series of estuarine systems in Chatham. In support of the Chatham Comprehensive Wastewater Management Planning (CWMP), an evaluation of tidal flushing was been performed for the coastal embayments within the Town Limits of Chatham, Massachusetts, on Cape Cod. The field data collection and hydrodynamic modeling efforts for this project provided the first step towards evaluating the water quality of these estuarine systems, as well as understanding nitrogen loading thresholds. The hydrodynamic modeling effort served as the

basis for the total nitrogen (water quality) model, which incorporated upland nitrogen load and benthic regeneration within bottom sediments. In addition to the tidal flushing evaluation for these estuarine systems, alternatives analyses of tidal flushing improvement strategies were performed for selected sub-embayments. Numerical models provided a cost-effective method for evaluating tidal hydrodynamics, as they required limited data collection and could be utilized to numerically assess a range of management alternatives. Once the hydrodynamics of an estuary system were understood, computations regarding related coastal processes became relatively straight-forward extensions to the hydrodynamic modeling.

Cockle Cove Sediment Transport Study and Design Guidance for Beach Nourishment, Chatham, MA.

- Mr. Ramsey served as project manager for this study to develop engineering alternatives for addressing shoreline recession on Cockle Cove Beach, in Chatham, MA. A quantitative approach was used to evaluate dominant coastal processes along this stretch of coastline. Two numerical models were used for this evaluation; a wave refraction model and the shoreline change model GENESIS. With the development of a calibrated GENESIS model for Cockle Cove, it was possible to test different scenarios for possible fill designs along the beach. Model results for each beach fill help to evaluate the expected longevity, and general effect of the adjusted profile. Five fill scenarios where considered for this part of the study. In addition to the fill scenarios, two additional cases were modeled to represent the range of future shorelines that may result if no action is taken to nourish Cockle Cove Beach. Beach nourishment was implemented in 2003 following the modeling recommendations and the subsequent performance of the fill project agreed with model predictions.

The Massachusetts Estuaries Project, Southeastern Massachusetts

- Mr. Ramsey was one of the key developers of the methodology adopted by the State to develop the appropriate technical information needed to determine estuarine nitrogen loading limits. The MEP is performing the data collection, modeling, and assessments required to establish embayment specific nitrogen threshold levels for the management and restoration of the 89 estuarine systems of southeastern Massachusetts needed to support the TMDL regulatory process. As well as being one of the developers, Mr. Ramsey serves as project manager and lead numerical modeler for the hydrodynamic and estuarine water quality modeling aspects of the program. The modeling effort for each estuary consists of site-specific two-dimensional hydrodynamic and water quality models, as well as particle tracking analyses for selected estuarine systems. *The work was performed for Massachusetts DEP under a contract with the University of Massachusetts, Dartmouth (SMAST).*

APPLIED COASTAL

Sean W. Kelley, P.E., M.C.E., B.S.

Numerical modeling of estuarine hydrodynamics and water quality
Analysis of tidal inlet dynamics and sediment transport
Coastal processes analysis

YEARS OF EXPERIENCE 22 (19 with Applied Coastal; 3 with others)

EDUCATION M.S., Ocean Engineering, Texas A&M University, 1999
B.S., Marine Engineering Technology, Maine Maritime Academy, 1993

REGISTRATION Professional Engineer: State of Maine, Commonwealth of Massachusetts,

AFFILIATIONS Association of Coastal Engineers

PROFILE

Mr. Kelley is a senior coastal engineer specializing in the measurement and modeling of coastal processes. His past modeling work includes the application of state-of-the-art wave, hydrodynamic, and sediment transport models in a broad range of coastal engineering and analysis projects. This experience includes the determination of coastal structure design criteria, the design of beach nourishments, and the analyses of estuarine circulation and water quality. Mr. Kelley is also skilled in the techniques and equipment used to make measurements in the coastal environment, including tides, currents, and bathymetry.

RELEVANT EXPERIENCE

Town of Chatham, Massachusetts, Chatham South Shore

- A comprehensive study of the entire southern coast of the Town of Chatham on Nantucket Sound was performed in order to help quantify erosion rates and develop possible management solutions to help maintain public beach recreational resources. The entire Town shoreline was modeled using a one-line shoreline change model developed by Mr. Kelley. Inputs to the model included average wave conditions computed using the 2-D wave model SWAN. Beach fill scenarios in the range between 10,000 and 50,000 cubic yards were simulated for different sections of the coast.

Coastal Processes Analysis for the South Coast of Chatham, Massachusetts

- An analysis was performed of littoral sediment movement along the shoreline in the vicinity of two tidal creeks. Mr. Kelley performed the analysis, utilizing two-dimensional hydrodynamic models of the two creeks that he developed during a previous study, and a separate shoreline model developed using the GENESIS computer code. The models were used to assess impacts by inlet shoal on tidal flushing in each system, and asses the performance of a beach fill that he designed, and that was constructed in 2002.

Long Beach, Rockport, MA (Under contract with the Town of Rockport, MA (2014)

- The Town of Rockport, MA has become concerned with the condition of the aging seawall infrastructure, as well as the longevity of the barrier beach system. Following an in-depth evaluation of beach management history and a quantitative assessment of coastal processes, beach management scenarios were tested to assess their viability toward long-term sustainability of the beach system and the adjacent infrastructure. A

dynamic shoreline model was developed for the Long Beach shoreline, in order to assess the performance of different beach fill scenarios proposed for the shoreline. The model was driven using wave output from a 2D spectral SWAN wave model of Massachusetts Bay, and was used to determine the engineering design of the different beach fill alternatives selected for modeling.

Conceptual Coastal Engineering Alternatives for West Beach, New Bedford, MA

- Engineering alternatives were evaluated to enhance the design life and storm survivability of an existing seawall at West Beach in New Bedford, MA. The seawall protects the main sewer line to the treatment plant at the southern tip of the City. The selected alternative needs to be protective of seagrass beds that exist in close proximity to the project shoreline. A 2D wave model and a one-line shoreline model were created to determine the performance of different design options, including beach fill alone, beach fill with a toe berm, and beach fill with T-head groins to maintain the fill. Based on a screening analysis of the modeled alternatives, the beach fill with T-head groins was determined to be the best option to provide protection of the critical upland infrastructure and also the offshore seagrass.

National Park Service, Jacob Riis Landing, Rockaway, NY

- Design wave conditions were computed for a small harbor located on Rockaway Inlet, at the opening to Jamaica Bay, NY. The long term meteorological record from JFK international Airport was used to develop - year and 25-year return period storm conditions for all 10 compass sectors between ENE and WSW. This storm winds were input into the 2-D wave model SWAN to compute the resulting wave heights at specific locations within the harbor basin. The wave model included fine resolution grids of the harbor, and coarser resolution meshes of the offshore area of the New York Bight.

Massachusetts Department of Conservation and Recreation, Georges Island, Boston Harbor

- An analysis was performed to determine engineering design requirements for future improvements to the shore protection structures of 28-acre Georges Island, the site of historic Fort Warren. Mr. Kelley determined design wave conditions around the island, which has open ocean exposure. He performed an overtopping analysis and determined armor stone sizes and crest elevations required for several revetment sections around the island.

CURRICULUM VITAE 18 May 2018

GRAHAM SHERWOOD GIESE
Scientist Emeritus
Provincetown Center for Coastal Studies Tel: (508) 487-3622 (x123)
5 Holway Avenue
Provincetown, MA 02657

EDUCATION:
University of Chicago, Ph.D. Department of Geophysical Sciences 1966
University of Rhode Island, M.S. Graduate School of Oceanography 1964
Trinity College, Hartford, CT, B.S. 1953

PROFESSIONAL POSITIONS:
Scientist Emeritus (2017 – present), Senior Scientist (2004 - 2017)
Center for Coastal Studies, Provincetown, MA

Oceanographer Emeritus (1997 - present), Research Specialist (1987 – 1996)
Woods Hole Oceanographic Institution, Geology and Geophysics Dept.

Guest Investigator/Visiting Investigator (1985-1987)
Woods Hole Oceanographic Institution, Geology and Geophysics Dept.

Associate Director (1983-1985) and Adjunct Professor (1983-1987)
Marine Sciences Research Center, SUNY, Stony Brook, NY

Senior Scientist (1981-1983) and Executive Director (1979-1982)
Center for Coastal Studies, Provincetown, MA

Associate Scientist (1976-1981)
Center for Coastal Studies, Provincetown, MA

Associate Scientist (1972-1976)
Marine Consulting Associates, Inc., Provincetown, MA

Associate Professor (1970-1972)
University of Puerto Rico, Department of Marine Sciences

Assistant Professor (1967-1970)
University of Puerto Rico, Department of Marine Sciences

Assistant Scientist (1967)
Woods Hole Oceanographic Institution, Geology and Geophysics Dept.

Research Assistant (1956-1962)
Woods Hole Oceanographic Institution, Department of Geology

PUBLICATIONS
Author or co-author of more than 100 scientific publications and reports
in the fields of Coastal Geology and Coastal Oceanography

PROFESSIONAL AFFILIATIONS:
American Geophysical Union
Geological Society of America

CURRICULUM VITAE
Mark Borrelli
May 2018

Research Scientist
University of Massachusetts, Boston
Boston, MA 02125

Telephone: 508.487.3623
FAX: 508.487.4695
E-Mail: mark.borrelli@umb.edu

EDUCATION

Institution	Major	Degree	Year
Tufts University	Geology	B.S.	1999
Univ. of North Carolina at Chapel Hill	Geological Sciences	M.S.	2001
Univ. of Rhode Island	Geoscience	Ph.D.	2008

PRINCIPAL PROFESSIONAL EXPERIENCE

01/2018 – Present	**Director:** The Coastal Processes and Ecosystems Laboratory. Joint Research Lab, Univ. of Massachusetts, Boston and Center for Coastal Studies
09/2014 – Present	**Research Faculty**: School for Environment, University of Massachusetts-Boston Provincetown, MA
06/2012 – Present	**Associate Scientist**: Dept. of Marine Geology, Center for Coastal Studies, Provincetown, MA
09/2009 – 08/2014	**Adjunct Professor**: Dept. of Environmental, Earth and Ocean Sciences, University of Massachusetts-Boston
06/2009 – 05/2012	**Staff Scientist**: Seafloor Mapping Program, Dept. of Marine Geology, Center for Coastal Studies, Provincetown, MA

FIVE REPRESENTATIVE PUBLICATIONS RELATED TO THE PROPOSED PROJECT

[1] Borrelli, M., Shumchenia, E. J., Kennedy, C. G., Fox, S. E., Oakley, B. A., Hubeny, J. B., Love, H., Smith, T. L., Legare, B., Mcfarland, S. & Giese, G. S. (in press). Submerged Marine Habitat Mapping, Cape Cod National Seashore: A Post-Hurricane Sandy Study. *Natural Resource Report.* Fort Collins, CO., National Park Service. NPS/XXXX/NRR—2018/XXX. p. 127.

[2] Borrelli, M., Oakley, B.A., Smith, T.L., Mabee, S.B., Legare, B., McFarland, S.J., Woodruff, J.D. and Giese, G.S., 2017. Onshore-offshore surficial geologic map of the Wellfleet quandrangle and portions of eastern Cape Cod Bay, Barnstable County, Massachusetts, 1:24,000 scale, 3 sheets. Massachusetts Geological Survey.

[3] Borrelli, M., Kennedy, C. G., Smith, T. L., Legare, B. & Shumchenia, E. J. (2016) Creating Benthic Habitat Maps in a U.S. National Park a Phase-Measuring Sidescan Sonar. *Marine Geological and Biological Habitat Mapping (GEOHAB) 15th International Symposium.* Winchester, UK.

[4] Borrelli, M., Smith, T.L., Kennedy, C.G., Oakley, B.A., Hubeny, J.B., 2015. Science and Mapping in Very Shallow Coastal Waters with Phase-Measuring Sidescan Sonar, Geological Society of America Abstracts with Programs, Baltimore, MD, p. 266.

[5] Borrelli, M., Smith, T.L., Oakley, B.A., Shumchenia, E.J., Wilson, J., Gontz, A., Giese, G.S., 2014. Onshore-offshore surficial geologic map of the North Truro Quadrangle, Barnstable County, Massachusetts. 1:24,000. Massachusetts Geological Survey, p. 2 sheets and digital product: Adobe PDF and ESRI

d. Synergistic activities.

1. Developing new method to quantify shellfish populations with ecologists using ultra-high, dual frequency sidescan sonar (Edgetech 4125, op freq. 600/1600 kHz) in Wellfleet Harbor, Wellfleet MA.
2. Seamless Onshore/Offshore geology map of two quadrangles in Massachusetts. Coupling Lidar with phase-measuring sidescan sonar for terrestrial/marine surficial geology and ground penetrating radar and seismic reflection profiling for terrestrial/marine subsurface geology.
3. Using phase-measuring sidescan sonar to improve the detection and retrieval of derelict fishing gear in Cape Cod Bay, MA. This gear has been implicated in entanglements of marine animals which can lead to mortality

EXHIBIT E

Grant support letters

COMMONWEALTH OF MASSACHUSETTS

THE GENERAL COURT

STATE HOUSE, BOSTON 02133-1053

May 23, 2018

Patricia Bowie, Coastal Resiliency Specialist
Massachusetts Office of Coastal Zone Management
251 Causeway Street, Suite 800
Boston, MA 02114

RE: Coastal Resilience Grant Program FY19- Letter of Support

Dear Ms. Bowie,

We are writing to express our strong support for the Town of Chatham's application for a Coastal Resilience Grant through the Massachusetts Office of Coastal Zone Management.

The Chatham community understands the importance of evaluating vulnerabilities to all climate change hazards so that steps can be taken to improve the Town's resiliency. Leaders in Chatham are particularly concerned about the vulnerability of the town's coastline to rising sea levels and ways that climate change may further heighten these impacts.

A quantitative analysis of coastal processes and analysis of potential shoreline management techniques for Chatham's east-facing shorelines, as proposed in their grant application, will be invaluable in guiding town officials and the community in planning and implementation of appropriate measures to address coastal resiliency and climate change. We look forward to assisting the Town in bringing local knowledge to the planning process to develop priority actions that will improve the town's resiliency to natural climate related coastal hazards. We fully support the Town's grant proposal in this endeavor and encourage CZM's positive review of their grant application.

Respectfully,

Sarah K. Peake
State Representative
Fourth Barnstable District

Julian Cyr
State Senator
Cape and Islands District

Town of Chatham
Department of
Natural Resources

Health (508) 945-5165
Water Quality Laboratory (508) 945-5188
Conservation (508) 945-5164
Coastal Resources (508) 945-5176
Shellfish (508) 945-5184
Harbormaster (508) 945-5185

FAX (508) 945-5163
261 George Ryder Road Chatham, MA 02633

May 23, 2018

Patricia Bowie, Coastal Resiliency Specialist
Massachusetts Office of Coastal Zone Management
251 Causeway Street, Suite 800
Boston, MA 02114

RE: Coastal Resilience Grant Program FY19 Letter of Support

Dear Ms. Bowie,

As director of the Chatham Department of Natural Resources I am writing to express support for the Town's application for a Coastal Resilience Grant through the Massachusetts Office of Coastal Zone Management.

Chatham has, and is, experiencing first-hand the impacts of sea level rise, and increased severity and incidence of destructive storms brought about by climate change. Our community understands the importance of evaluating vulnerabilities to all climate change hazards so that steps can be taken to improve the Town's resiliency. We are particularly concerned about the vulnerability of Chatham to coastal impacts and how climate change may further heighten these impacts. The quantitative analysis of coastal processes and analysis of potential shoreline management techniques for Chatham's east-facing shorelines, as proposed, will be invaluable in guiding town officials and the community in planning and implementation of appropriate measures to address coastal resiliency and climate change. I look forward to bringing local knowledge to the planning process to develop priority actions that will improve the Town's resiliency to natural climate related coastal hazards. I support the Town's grant proposal in this endeavor and encourage MACZM's positive review of the grant application.

Sincerely,

Robert A. Duncanson, Ph.D.
Director of Health & Natural Resources

Town of Chatham
Department of
Community Development

TOWN ANNEX 261 GEORGE RYDER ROAD 02633 CHATHAM, MA

TELEPHONE (508) 945-5168 FAX (508) 945-5163

May 23, 2018

Patricia Bowie, Coastal Resiliency Specialist
Massachusetts Office of Coastal Zone Management
251 Causeway Street, Suite 800
Boston, MA 02114

RE: Coastal Resilience Grant Program FY19- Letter of Support

Dear Ms. Bowie,

The Town of Chatham Department of Community Development is writing to express support for the Town's application for a Coastal Resilience Grant through the Massachusetts Office of Coastal Zone Management. Our community understands the importance of evaluating vulnerabilities to all climate change hazards so that steps can be taken to improve the Town's resiliency. We are particularly concerned about the vulnerability of Chatham to coastal impacts and how climate change may further heighten these impacts. The quantitative analysis of coastal processes and analysis of potential shoreline management techniques for Chatham's east-facing shorelines, as proposed, will be invaluable in guiding town officials and the community in planning and implementation of appropriate measures to address coastal resiliency and climate change. We look forward to assisting the Town in bringing local knowledge to the planning process to develop priority actions that will improve the Town's resiliency to natural climate related coastal hazards. We fully support the Town's grant proposal in this endeavor and encourage MACZM's positive review of their grant application.

Sincerely,

Kathleen Donovan
Director of Community Development

TOWN OF CHATHAM

HARBORMASTER DIVISION
OLD MILL BOATYARD
613 STAGE HARBOR ROAD

STUART F. X. SMITH
HARBORMASTER

23 May 2018

Patricia Bowie, Coastal Resiliency Specialist
Massachusetts Office of Coastal Zone Management
251 Causeway Street, Suite 800
Boston, MA 02114

RE: Coastal Resilience Grant Program FY19- Letter of Support

Dear Ms. Bowie,

The Chatham Harbormaster is writing to express support for the Town's application for a Coastal Resilience Grant through the Massachusetts Office of Coastal Zone Management. Our community understands the importance of evaluating vulnerabilities to all climate change hazards so that steps can be taken to improve the Town's resiliency. We are particularly concerned about the vulnerability of Chatham to coastal impacts and how climate change may further heighten these impacts. The quantitative analysis of coastal processes and analysis of potential shoreline management techniques for Chatham's east-facing shorelines, as proposed, will be invaluable in guiding town officials and the community in planning and implementation of appropriate measures to address coastal resiliency and climate change. We look forward to assisting the Town in bringing local knowledge to the planning process to develop priority actions that will improve the Town's resiliency to natural climate related coastal hazards. We fully support the Town's grant proposal in this endeavor and encourage MACZM's positive review of their grant application.

Sincerely,

Stuart F.X. Smith

Stuart F.X. Smith

MAILING ADDRESS:
549 MAIN STREET • CHATHAM, MASSACHUSETTS 02633
TEL. (508) 945-5185 • (508) 945-5186 • FAX: (508) 945-5121

South Coastal Harbor Plan Committee

Town of Chatham
549 Main Street, Chatham, MA 02633
(508) 945-5176

May 22, 2018

Patricia Bowie, Coastal Resiliency Specialist
Massachusetts Office of Coastal Zone Management
251 Causeway Street, Suite 800
Boston, MA 02114

RE: Coastal Resilience Grant Program FY19- Letter of Support

Dear Ms. Bowie,

The South Coastal Harbor Plan Committee (SCHPC) is writing to express support for the Town's application for a Coastal Resilience Grant through the Massachusetts Office of Coastal Zone Management. Our community understands the importance of evaluating vulnerabilities to all climate change hazards so that steps can be taken to improve the Town's resiliency. The SCHPC is particularly concerned about the vulnerability of Chatham to coastal impacts and how climate change may further heighten these impacts. The existing South Coastal Harbor Plan (Plan), originally adopted in 2005, was subsequently updated and approved by the Commonwealth in 2015. The updated Plan includes the recommendation to consider the effects of sea level rise due to climate change as follows:

Consider the effects and incorporate where appropriate the potential for future sea level rise when, and not limited to, planning for resource protection, land acquisition, waterfront development and changes to building codes and zoning. Encourage the incorporation of "Coastal Resiliency" strategies for existing and future activities along the coastline.

The quantitative analysis of coastal processes and assessment of potential shoreline management techniques for Chatham's east-facing shorelines, as proposed, will be invaluable in guiding town officials and the community in planning and implementation of appropriate measure to address coastal resiliency and climate change. The SCHPC looks forward to assisting the Town in bringing local knowledge to the planning process to develop priority actions that will improve the Town's resiliency to natural climate related coastal hazards. We fully support the Town's grant proposal in this endeavor and encourage MACZM's positive review of their application.

Sincerely,

Michael Westgate, Chairman

PLEASANT BAY
ALLIANCE

Patricia Bowie, Coastal Resiliency Specialist
Massachusetts Office of Coastal Zone Management
251 Causeway Street, Suite 800
Boston, MA 02114

May 23, 2018

RE: Coastal Resilience Grant Program FY19- Letter of Support

Dear Ms. Bowie,

The Pleasant Bay Alliance is writing in support for the Town of Chatham's application for a Coastal Resilience Grant through the Massachusetts Office of Coastal Zone Management.

The Alliance is an organization of Chatham and three other towns that share the watershed of Pleasant Bay, which includes Chatham Harbor. The effect of climate change on the Pleasant Bay system is an important management issue addressed in the *Pleasant Bay Resource Management Plan*. The Alliance recently prepared an assessment of sea level rise impacts on the inner and outer shoreline of Pleasant Bay. The next step is to work with our member towns to use this information to develop resiliency strategies. The quantitative analysis of coastal processes and analysis of potential shoreline management techniques for Chatham's east-facing shorelines, as proposed, will be invaluable in guiding town officials and the community in planning and implementing appropriate measures to address coastal resiliency and climate change.

The Alliance understands the importance of evaluating vulnerabilities to all climate change hazards so that steps can be taken to improve resiliency system-wide. We look forward to working with the Town in the planning process to develop priority actions that will improve the Town's resiliency to natural climate related coastal hazards. We fully support the Town's grant proposal in this endeavor and encourage MACZM's positive review of their grant application.

Thank you for your consideration of these comments.

Sincerely,

Carole Ridley

Carole Ridley
Coordinator

PO Box 1584 Harwich MA 02645 • Tel. 508 430 2563 • www.pleasantbay.org

Town of Chatham
Department of
Natural Resources

Health (508) 945-5165 | Water Quality Laboratory (508) 945-5188 | Conservation (508) 945-5164

Coastal Resources (508) 945-5176 | Shellfish (508) 945-5184 | Harbormaster (508) 945-5185

FAX (508) 945-5163
261 George Ryder Road Chatham, MA 02633

May 23, 2018

Patricia Bowie, Coastal Resiliency Specialist
Massachusetts Office of Coastal Zone Management
251 Causeway Street, Suite 800
Boston, MA 02114

RE: Coastal Resilience Grant Program FY19- Letter of Support

Dear Ms. Bowie,

The Chatham Conservation Commission is writing to express support for the Town's application for a Coastal Resilience Grant through the Massachusetts Office of Coastal Zone Management. Our community understands the importance of evaluating vulnerabilities to all climate change hazards so that steps can be taken to improve the Town's resiliency. We are particularly concerned about the vulnerability of Chatham to coastal impacts and how climate change may further heighten these impacts. The quantitative analysis of coastal processes and analysis of potential shoreline management techniques for Chatham's east-facing shorelines, as proposed, will be invaluable in guiding town officials and the community in planning and implementation of appropriate measures to address coastal resiliency and climate change. We look forward to assisting the Town in bringing local knowledge to the planning process to develop priority actions that will improve the Town's resiliency to natural climate related coastal hazards. We fully support the Town's grant proposal in this endeavor and encourage MACZM's positive review of their grant application.

Sincerely,

Chair, Chatham Conservation Commission

Commissioners:

207 205 7046
Bill Hoffman

Little Beach Association
C/o William and Mary Hoffman
P. O. Box 766, Chatham, Massachusetts

May 24, 2018

Patricia Bowie, Coastal Resiliency Specialist
Massachusetts Office of Coastal Zone Management
251 Causeway Street, Suite 800
Boston, MA 02114

RE: Coastal Resiliency Grant Program FY 2019- Letter of Support

Dear Ms. Bowie:

The Little Beach Association is writing to support the Town on Chatham's application for a Coastal Resilience Grant through the Massachusetts Office of Coastal Zone Management. This association was formed as a collaborative of the Stage Island, Little Beach, and Morris Island neighborhoods, which includes 168 properties assessed at 313 million dollar by the Town of Chatham. Our express purpose is to contribute to the study, design, permitting, and implementation of measures to restore and enhance the resiliency of our neighborhoods to protect against changes in the shoreline that threaten our neighborhoods.

We understand the need to respond to the coastal changes and increased vulnerability of Chatham to the impacts of coastal changes aggravated by climate change. The quantitative analysis will assist the Town and our association in planning and implementing appropriate measures to reestablish and address future measures to provide resiliency and protection of our coastal resources.

We intend to work cooperatively with the Town in providing local knowledge to the planning process and develop measures that will improve the resiliency and benefit not only our 168 properties but also the entire coastal area of the Town. We fully support the Town's grant proposal and expect to make a contribution to the local share should this application be reviewed and a grant tendered to the Town of Chatham.

Sincerely,

William G. Hoffman
President

CHATHAM CONSERVATION FOUNDATION, INC.

104 Crowell Road • Chatham, MA • 02633
508 945-4084
CCFinc@comcast.net
www.chathamconservationfoundation.org

Mayo House
540 Main Street
Chatham, MA 02633

24 May 2018

Patricia Bowie, Coastal Resiliency Specialist
Massachusetts Office of Coastal Zone Management
251 Causeway Street, Suite 800
Boston, MA 02114

RE: Coastal Resilience Grant Program FY19- Letter of Support

Dear Ms. Bowie,

On behalf of the Chatham Conservation Foundation, Inc. I am writing to express support for the Town's application for a Coastal Resilience Grant through the Massachusetts Office of Coastal Zone Management. Our community understands the importance of evaluating vulnerabilities to all climate change hazards so that steps can be taken to improve the Town's resiliency. We are particularly concerned about the vulnerability of Chatham to coastal impacts and how climate change may further heighten these impacts.

The quantitative analysis of coastal processes and analysis of potential shoreline management techniques for Chatham's east-facing shorelines, as proposed, will be invaluable in guiding town officials and the community in planning and implementation of appropriate measures to address coastal resiliency and climate change.

We look forward to assisting the Town in bringing local knowledge to the planning process to develop priority actions that will improve the Town's resiliency to natural climate related coastal hazards. We fully support the Town's grant proposal in this endeavor and encourage MACZM's positive review of their grant application.

Sincerely,

Eunice D. Burley

Eunice D. Burley
President

Chatham Chamber of Commerce

Chatham, Cape Cod, Massachusetts

P.O. BOX 793, CHATHAM, MA
02633-0793 TELEPHONE: (508)
945-5199 (800) 715-5567 FAX:
(508) 430-7919 *web:*
www.chathaminfo.com *email:*
chamber@chathaminfo.com

May 23, 2018

Patricia Bowie, Coastal Resiliency Specialist
Massachusetts Office of Coastal Zone Management
251 Causeway Street, Suite 800
Boston, MA 02114

RE: Coastal Resilience Grant Program FY19- Letter of Support

Dear Ms. Bowie,

The Chatham Chamber of Commerce is writing to express support for the Town's application for a Coastal Resilience Grant through the Massachusetts Office of Coastal Zone Management. Our community understands the importance of evaluating vulnerabilities to all climate change hazards so that steps can be taken to improve the Town's resiliency. We are particularly concerned about the vulnerability of Chatham to coastal impacts and how climate change may further heighten these impacts. The quantitative analysis of coastal processes and analysis of potential shoreline management techniques for Chatham's east-facing shorelines, as proposed, will be invaluable in guiding town officials and the community in planning and implementation of appropriate measures to address coastal resiliency and climate change. We look forward to assisting the Town in bringing local knowledge to the planning process to develop priority actions that will improve the Town's resiliency to natural climate related coastal hazards. We fully support the Town's grant proposal in this endeavor and encourage MACZM's positive review of their grant application.

Sincerely,

Stephen W. Williams

Stephen Williams, President
Chatham Chamber of Commerce
P.O. Box 793
Chatham, MA 02633