H. Proposed Approach to Scope of Work

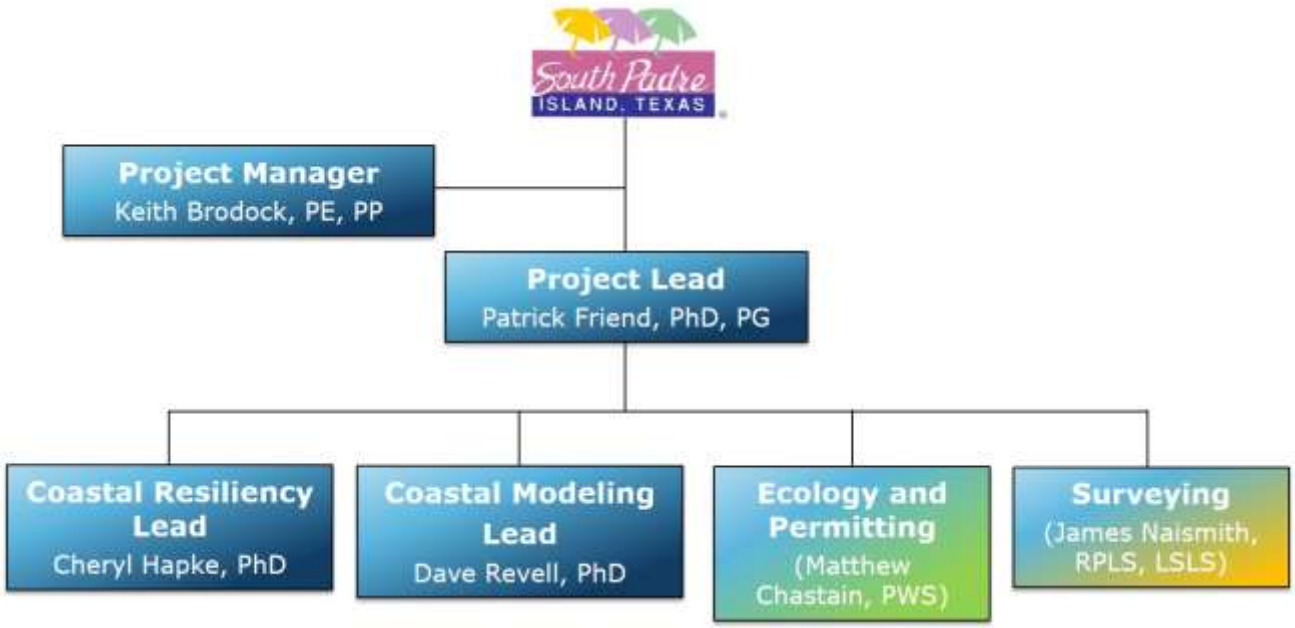
Our approach to this project is to leverage existing City and State data collection investments from past research, monitoring and modeling efforts. These leveraged historic data will be combined with a new survey and mapping of existing conditions. We will also conduct a geomorphic and statistical analysis to understand how existing conditions relate to historic storm and erosion patterns, evaluate historic recurrence intervals for storm patterns and wave climatology, model the impacts of various storms on existing conditions, and work with the City to identify a plausible set of potential dune and beach designs for evaluation.

The chosen set of potential dune and beach designs will be guided by the principles of maximizing storm protection while balancing the competing needs of access, ocean views, and economic development. Modeling the resiliency of each design to various storm events would allow for an informed discussion as to the community desired level of protection as well as the relative costs and maintenance requirements. One of the modeled scenarios will be the existing ordinance and practice of maintaining dune crest elevation of 10 -12 feet. Other scenarios to be informed by City engagement during the project may consider a wider beach, higher dune crests, emergency storm preparations at key vulnerable locations (e.g. volleyball courts), or different volume and location of sand placement based on information from the Nearshore Berm Tracer Study to provide a few examples. **Whatever the findings of the technical analysis, the Team will develop engineering design sketches, a dune vegetation and maintenance plan, as well as to make recommendations for the updating of existing ordinances and future work to prepare the City for a healthy coastal environment and future climate changes.**

Organization and Structure of Project Team

The structure of the project team is shown in the organizational chart. Integral technical leads will work closely with the sub-consultants, Bio-West and Naismith Marine, under the leadership of the Project Lead (Dr. Friend) and the Project Manager, Mr. Brodock, P.E..

It is anticipated that the majority of the proposed work will be completed by Integral (70%) and the sub-consultants will each contribute 10% (Naismith Marine) and 20% (Bio-West) to the overall project.



Organizational chart of Project Team: Integral staff shown in blue.

Quality Assurance and Quality Control

Integral follows an internal quality assurance review process for all project deliverables and follows a quality management plan specific to each project. See A. Introduction for more details on Quality Assurance and Control.

Project Management

Project management and technical co-ordination with the City of South Padre Island will be through Integral's Houston, TX office. See A. Introduction for more details on Project Management.

Project Work Plan

Our approach to the work in this proposal is to undertake a phased approach (Figure 5) to assess, investigate, and evaluate the beach and dune conditions at SPI in their present state (RFP Scope A). Building on the existing conditions assessment (Integral Phase or Task 1), the study will conduct a vulnerability assessment to examine the likely impacts to the beaches and dunes with storms and sea level rise now, and under future conditions with climate change (Integral Phase or Task 2). Beaches and dunes that are presently stable and have been historically maintained with via nourishment programs may require new configurations (widths, elevations, vegetation) to remain stable under future conditions and provide the highest-level of protection to the community (RFP Scope B). In our Phase 3, we will model and evaluate the impact of various storms on potential dune/beach configurations Integral considers a healthy and stable, ecologically functional dune habitat to be a key component part of the maintenance plans for dunes; it is for this reason that we will review, in conjunction with Bio-West, the most suitable dune vegetation types capable of

reinforcing or offering new, improved resilience against existing storm erosion hazards as well as sea level rise accelerated coastal hazards in the future.

The proposed phased approach provides an overarching framework that will provide the science and solutions for both Scopes A and B of the RFP. As such, Scope A and B are not addressed separately in the details of our work plan below; rather they are combined as part of a holistic approach to develop a past, current, and future assessment of the beach-dune system and the protection it provides to the community of SPI. The four phases will be accomplished as a series of tasks and subtasks, detailed in Table 2. Our goal is to leverage existing previous work, fill data gaps, and complete the project efficiently with a clear roadmap of alternatives that may be considered to maintain the beaches and dunes and provide the community with the greatest level of protection.

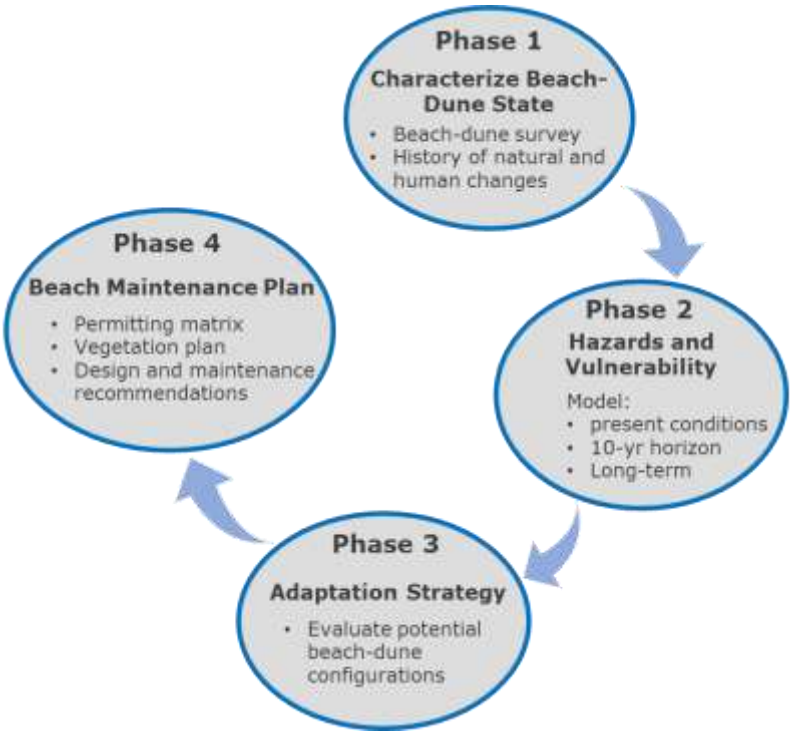


Figure 5. Framework to accomplish assessment and investigation of beach and dune conditions and develop maintenance plan at South Padre Island.

Phase 1—Characterize and Evaluate State of Beaches and Dunes

A substantial amount of data exist for SPI, both in a long record of historical shorelines and a variety of LiDAR topographic data and field surveyed beach profiles. Our proposed beach and dune assessment and investigation will leverage previous studies and utilize existing data wherever possible.

Previous investigations of the beach and dune system at SPI include evaluation and assessment of shoreline position and annual averaged rates of change, dune elevation and width, and dune vegetation reported in the 2012 Erosion Response Plan (ERP). The shoreline positions and rates of change in the ERP were obtained from the Texas Shoreline Change Project (https://www.beg.utexas.edu/research/programs/coastal/the-texas-shoreline-change-project). The ERP divides SPI into three areas - north, central, and south, and presents the averaged shoreline change rate within each area, as opposed to providing a detailed alongshore perspective. The dune elevations are reported as averages or ranges for each of the three areas. Lastly, the ERP provides descriptions of dune "depth" or how wide the dune field is in a cross-shore direction, and concludes and recommends that a 200 foot wide dune field needs to be maintained to prevent the beaches and dunes from rapidly eroding, which would result in the loss of protection to community infrastructure. In addition to the largely qualitative 2012 ERP, a statewide shoreline change assessment by Paine and Caudle (2019) includes South Padre Island and provides an update to the 2012 rates of change reported in the ERP.

In addition to the analyses presented in the ERP, HDR Engineering, Inc. conducted the design and permitting of several beach-dune nourishment projects. As part of their effort, they established an annual monitoring program (2008-2015) to assess how the beach changed over time on profiles spaced approximately 1000 feet apart at long-established survey control monuments. In addition to beach profile changes, shoreline positions were extracted from the profiles to evaluate shoreline change over the project period. The study included a wave modeling component to assess alongshore variability in wave forcing to provide insight for the variable alongshore rates of coastal change. This analysis and monitoring is very useful and forward thinking and the data will help inform projections of long term change.

However, both of these studies miss an analysis of storm recurrence frequencies and resultant erosion impacts, which is a key factor in considering the stability and level of protection provided by the dunes. Can our dunes handle a 20 year winter storm event, or a Category 3 hurricane? We will provide insight into the questions regarding the level of protection provided by the dunes from a major hurricane and a series of more traditional storm wave events that might typically represent a stormy winter season. Our aim is to provide information on how vulnerabilities to these coastal hazards may change over time and with future sea level rise.

The Integral team proposes to conduct a substantially more quantitative assessment of the beach-dune system at SPI than was completed for the ERP, but it will be complimentary so as to provide an update to the previous information. We will incorporate as much as possible about coastal change and processes from the previous efforts, and plan to expand the investigation to produce a more systems-wide evaluation of the coastal processes driving beach and dune change at SPI. This will include an evaluation of the level of protection afforded by the existing dune system and potential enhancements of the dunes. Our goal is to determine the optimal configuration and needed enhancements for a variety of seasonal wave conditions as well as an extreme storm event.

1.1 Characterize the present coastal state

The first subtask will characterize the current state, or configuration, of the beaches and dunes (RFP Scope A) using a variety of metrics extracted from field surveys. **The metrics will include beach width, dune width, elevation of the dune crest and toe, beach and dune volume, and shoreline position.** A series of cross-shore profiles that extend seaward across the dune and beach, and into the nearshore to water depths of 25-30 ft. will be surveyed in the field using standard surveying techniques to capture the both the subaerial and subaqueous portions of the beach profile. The subaqueous portion of the beach is especially important for understanding the sediment budget along SPI, as it can serve as both a source and sink of sediment that's reworked by waves during stormy and calm conditions. The profiles will be surveyed at the location of established survey control markers along which numerous historical data exist. Naismith Marine, a proven and certified contractor, will conduct the beach profile survey using the same protocol they have established for past surveys at SPI. Metrics will also be extracted from the most recent available LiDAR data that was collected in 2019 by the TX GLO to examine short-term changes to the beach-dune system.

The 2019 survey also included the collection of aerial photographs which will aid in characterizing the state of the dune vegetation (percent area), which is an important component of dune stability. Healthy dune vegetation provides a stabilizing root network that enhances the stability of the dunes. **During field surveys of the beach profiles, measurements will also include identifying the vegetation extent along each profile, to evaluate whether there have been significant changes since the most recent aerial photographs (2019).**

In addition to the beach and dune metrics, Integral will evaluate the available wave data from nearby buoys and previously developed wave models to quantitatively characterize the dominant southeast wind and wave direction as well as the more northerly wind and waves associated with winter cold fronts. The wave and climatological analysis will be used to run an extreme value analysis to identify the recurrence interval of wave heights and directions over different periods of time (e.g. 1 year, 5 year, 10 year, 100 year). The extreme value wave events will then be used for modeling present and future impacts described in detail in Task 2 below. Following this analysis we will identify a final set of wave conditions to evaluate using XBeach geomorphic modeling to assess the resiliency of the various dune configurations to different types of storms and hurricanes and identify potential changes to the profiles and a measure of impact (e.g. number of structures).

1.2 Establish baseline metrics

To evaluate the present "health" and resiliency of the beaches and dunes on SPI, a baseline condition is required for comparison to understand how vulnerable the system is today, as compared with periods in the past. The baseline condition will be established using the same metrics derived in Task 1.1 (width, height volume, etc.) and will be developed from older LiDAR and beach profile data, which are available dating back to 2000 (LiDAR) and the 1990s (beach profiles). We will evaluate which historical dataset(s) best represent a low-vulnerability system, due to nourishment projects, lack of recent large storms, or both. The baseline and the current states will then be compared to generate an evaluation of the health of the present system and to understand

the temporal component of change which will be critical to the development of the beach maintenance plan (Phase 4; Figure 1). The historical data will also be examined to understand how the beach and dunes have changed in response to past wave events, including from a major storm event such as Hurricane Dolly in 2008, and several "typical" winter storm seasons for which we have before and after data.

Deliverables: geospatial data, interim report with description of present state of coast, maps of present island vulnerability

Phase 2—Hazard Identification and Vulnerability Assessment

The vulnerability of the beach-dune system will be assessed by investigating the processes that drive coastal change. XBeach will be used to model coastal erosion potential under a range of storm wave and future sea level rise conditions. XBeach is particularly suited for modeling coastal erosion (e.g., volume, width, elevation) processes on timescales of single storm and wave events, as it simulates tidal and wave driven sediment transport and coastal erosion, and is a readily available free open-source model. The model will be forced with offshore wave conditions and will utilize the available historical buoy data, hindcast of Federal Emergency Management Agency (FEMA) waves (used in the Flood Insurance Rate Maps), and total water level outputs from FEMA. A statistical extreme value analysis will be conducted on the hindcast and historic wave conditions from available buoys and hindcast data sets to identify a set of characteristic storm conditions associated with various recurrence intervals.

Figure 6. Dune scarping near E. Sunset Dr. at the northern end of the City where some of the highest erosion rates are occurring

The historic and future modeling of storm and water-level scenarios will be evaluated relative to the existing profiles of the beach-dune system (Task 1.1) to determine the water levels most likely to cause erosion and overtopping of the beach and dunes in their current state, as well as on the baseline system identified in Task 1.2. The outcome of this phase will be the identification of what storm wave conditions, would most likely result in beach and dune erosion currently, and under future conditions with elevated water levels associated with climate change. Dune vegetation loss

will be approximated with % cover and projected dune erosion based on the results of Task 1.1. As a value-add, and to support the City in communicating study results, we will also report various storm, dune configurations and scenarios in terms of a single measure of impact (e.g. number of structures).

Deliverables: Technical memorandum of results of vulnerability assessment, including maps of future erosion and vulnerability

Phase 3—Evaluate Beach and Dune Adaptation Strategy

Results of the vulnerability assessment and the modeling framework will be used to determine what the optimal beach-dune configuration(s) are to provide the best protection for the City of South Padre Island. Various potential adaptation strategies, focused on beach-dune nourishment and vegetation planting, will be evaluated to understand what the nourishment engineering design specifications will need to be, and how these engineering considerations are likely to change in the future as conditions continue to change. Design specifications will be developed in relation to the metrics identified in Task 1.1, including recommendations for beach and dune-field width, elevation of the beach berm and primary dune crest and toe, and shoreline position. The modeling in Phase 2 will also help to establish an adaptation pathway that identifies points in the future when, along some portions of the island, the beach and dunes may not be able to be maintained. That threshold, as well as alternative adaptation strategies, will be considered for the development of the beach maintenance plan (Phase 4).

Although, the beaches and dunes provide the first-line protection to the community from storm waves, the optimal profile may not be an acceptable alternative if assets like views or beach access are reduced. Arriving at a balance of the potentially conflicting issues of protection versus maintaining assets will require regular communication and interaction with the City and community members. In cases where the optimal configuration and close alternatives are not acceptable, we will provide recommendations for alternative adaptations such as storm preparation (e.g. temporary protective berms).

Figure 7. Beach nourishment at South Padre Island using a piped sand/water slurry

Deliverables: Technical memorandum describing optimal configurations(s) and adaptation pathway

Phase 4—Design configurations and Beach/Dune Maintenance Plan

Integral (working with Bio-West) will make recommendations for a monitoring program to identify when the beach-dune system has changed significantly enough (a trigger point) to warrant action (e.g., nourishment). The monitoring can be done using field surveys or be based on remotely collected data such as LiDAR or new, innovative techniques such as Structure from Motion (SfM).

Integral will develop a beach maintenance plan based on the results of our modeling, and vegetation considerations, that will take into account design modifications required to provide a beach and dune profile for achieving maximum practicable resiliency. The plan will include recommendations for the frequency and type of nourishment (i.e. direct beach placement, offshore berm placement), and will include the identification of thresholds in time or water level, when the original design specification may no longer provide the desired protection.

A beach and dune design, and habitat maintenance plan will be led by Bio-West and developed in collaboration with the rest of the team based on the findings and outcomes of Phases 1-3. The Integral team will work closely with Bio-West in the plan development, review all subcontractor contributions and sharing results from modeling and vulnerability outcomes to devise the most practicable strategy.

4.1 Permitting Coordination and Strategy

To assist with potential permitting efforts and navigate the regulatory process, Integral will coordinate a number of teleconference meetings between the City, and USACE as lead permitting agency to ask questions, solicit feedback, and receive project information and permitting updates for any necessary approvals to implement new design recommendations and modifications to existing beach and dune design configurations, nourishment intervals or placement methods and

areas offshore recommended as a result of this proposal. Other regulatory agencies, e.g. Texas GLO, will be included as appropriate and identified by the City.

Integral, through its subcontractor Bio-West, will assist the City with a permitting roadmap, a document that lays out the design, organization, and permitting strategies for all aspects of the project, including the formulation of desktop reviews and field survey protocols, identifying potential construction techniques and schedules, and delineating and drafting proactive responses to potential issues.

Integral, through its subcontractor Bio-West will assist the City in proactively addressing issues and agency requirements as well as preparing conceptual plans and outlines, meeting minutes, and agendas to address agency comments and answer any pertinent questions prior to any formal permitting effort. Once a final strategy is decided, a permitting matrix will be produced for the City, outlining the various regulatory approvals that will be required to incorporate any design recommendations and modifications proposed as a result of the project evaluations.

Bio-West will provide a single point of contact to Integral for the purposes of project interface, budget tracking and forecasts, project updates, and scheduling. Bio-West Project Manager will provide project updates, field data, and progress reports on a regular schedule through both telephone and email correspondence, and will assume the role of QA/QC, participating in interactive review and revision of project data, documentation, permits, and agency submittals as necessary.

4.2 Beach and Dune Maintenance and Management Plan

Integral's subcontractor Bio-West will draft a Dune Habitat Maintenance and Management Plan ("Plan") that incorporates the findings from Phases 1-3 of the proposed project. The general purpose of the Plan will be to provide guidance to SPI to maintain and adopt a stable, ecologically functional beach-dune system appropriate for the south Texas coast that reduces maintenance costs, alleviates public safety concerns, and benefits the aesthetic and culture of the community of South Padre Island. The plan will include all applicable figures, exhibits, typical plan and cross-sections, adaptive long-term management techniques, planting regimes, new plant types, and other necessary components to meet the City's needs. Development of the plan will be guided by the most recent available research and protocols, including the Texas General Land Office's (GLO's) The Dune Protection and Improvement Manual (Fifth Edition), Galveston Parks Board 2014 Dune Maintenance Manual, National Oceanic and Atmospheric Administration (NOAA) Sea Grant Consortium 2016 Dunes Manual, and various other industry standard manuals, models, and practices, as applicable, to assist with the development of the Plan. Note: it is proposed to assess new habitat types that may be more salt-tolerant or provide enhanced dune resilience to mitigate future sea level rise and climate change hazards.

Approach to Project Management

The overall Integral approach to project management and management systems are outlined in the Introduction and Past Experience sections (Sections A and E through G). For the presently proposed work, we will additionally include the following:

- Local contact Dr. Patrick Friend available 281-732-7961
- Project Management Plan developed during project kickoff
- Quality Management Plan developed during project kickoff
- Regular updates on project schedule, costs, and progress provided to SPI
- Participation in stakeholder meetings as needed
- Reporting - Progress reports as necessary throughout the project, as well as live updates by web meeting or in person to City of SPI at least monthly
- Final report to include Presentation Support as required by SPI.

Project Timeline

The proposed project schedule and timeline are detailed in Table 2. From award of contract, we anticipate completion of the project within an 18 month period. All deliverables will be electronic submittals, and there will be both DRAFT and FINAL versions of deliverables with comments and feedback provided by the City in a single consolidated set of comments.

Table 2. Timeline and schedule for completing the project

Project Timeline		2020		2021												2022			
South Padre Island Beach and Dune Study	**Subtask**	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Task 1 Characterize beaches and dunes	1.1 Present state																		
	1.2 Baseline metrics																		
Task 2. Hazard and vulnerability assessment																			
Task 3. Adaptation strategies																			
Task 4. Design and beach maintenance plan	4.1 Permitting strategy																		
	4.2 Maintenance plan																		