1. Executive Summary

This General Condition Report for the Proposed East Chop Coastal Bank Restoration Project for an engineered coastal bank located along East Chop Drive in Oak Bluffs, MA was prepared by CLE Engineering, Inc. for the Department of Conservation and Recreation (DCR). The report reviews the history of the engineered coastal bank at East Chop along with a tabulation of existing historic work, engineering plans, environmental permits and post-Sandy inspection reports. The existing site conditions were assessed by reviewing historic plans since 1936 and documents along with the performance of topographic surveys, standard penetration tests (SPT) and yearly inspections from 2012 through 2017 and as shown on plans prepared by CLE dated May 25, 2017. The existing coastal bank and stone revetment structure has been downgraded to F-IV from a previously rated D-IV by the Coastal Infrastructure Inventory and Assessment" prepared for the Massachusetts Coastal Hazards Commission by Bourne Consulting Engineering in 2013, recommending reconstruction to regain full capacity to resist major coastal storms and protect vital infrastructure and property. Once the existing conditions plans were created, CLE and JCK Underground developed three (3) reconstruction alternatives and selected the Alternative No.1 to raise the new stone revetment for the 100-Year storm event plus two (2') feet for sea level rise and then slope and revegetate the reconstructed coastal bank, thereby reopening both lanes of East Chop Drive to vehicular traffic. A draft copy of this report was distributed to all stakeholders in July 2017, and a public meetings will be held over the course of one (1) year to review the proposed alternatives and receive comments from the public and state agencies.

Pursuant to public comments received during the hearings and input from the Department of Conservation and Recreation, CLE recommends the Alternative No.3 to raise the new stone revetment for the 100-Year storm event plus two (2') feet for sea level rise and then slope and revegetate the reconstructed coastal bank, thereby reopening both lanes of East Chop Drive to vehicular traffic for the estimated construction cost of $14,387,139 with design, permitting and construction management costs of $1,618,553, yielding a total project cost of $16,005,692 with an estimated yearly maintenance cost of $22,000. The entire project includes extensive repairs to existing engineered coastal bank area including the existing stone revetment along approximately 2,400 linear feet of East Chop Drive. The project will protect the existing roadway, infrastructure and properties located along East Chop Drive and restore/enhance public access areas. The existing stone jetty on the southeast end of the project site will remain. Raising the elevation of the reconstructed revetment above the existing 100 year flood elevation is critical to the long-term viability/protection of the existing coastal bank and public roadway. In order to ensure a long-term repair, the proposed revetment will extend both landward and seaward beyond the existing revetment with an overall revetment footprint increase of 65%, which provides adequate base for raising the existing revetment approximately 8-10' in height, to +20' NGVD29 (min. 5.0' above 100 year flood elevations +13' and +15'). This height has been established to account for wave run-up and 2' of future sea level rise. A 1.5H:1V stone revetment slope made up of angular armor stones is proposed, with well-graded fill extending up from the edge of the flat revetment bench at a 27 degree maximum slope, to be planted with vegetation. The design revetment and upper slope have been designed based on the soil boring investigations performed at the project site and in coordination with Geotechnical engineering recommendations provided by JCK Underground for the project site. The existing East Chop Drive drainage outfalls will also be re-built, as the drain pipes that discharge into Nantucket Sound have been damaged from the extensive erosion on the coastal bank. A new timber ramp and landings will be created near the intersection of Brewster Avenue and East Chop Drive to provide public ADA/MAAB access to the shoreline.

The Proposed East Chop Coastal Bank Restoration Project can be permitted and constructed over a two (2) year period and as funding becomes available from state and federal programs. DCR is recommending an immediate approval and funding of Alternative No. 1. Funding would be dedicated from local and state funds to improve public safety and ADA/MAAB access, protect vital municipal infrastructure and provide enhanced coastal storm protection.

The information contained in this report regarding the proposed project is intended for conceptual design purposes relating to restoration of the East Chop Coastal Bank.

2. Introduction

2.1. Engineer/Firm Assigned

Pursuant to a contract dated August 11, 2016, the Town of Oak Bluffs with a grant from the Department of Conservation and Recreation (DCR) contracted CLE Engineering, Inc. (CLE) to perform a Full Condition Survey for the Proposed East Chop Coastal Bank Restoration Project for an engineered coastal bank located along East Chop Drive in Oak Bluffs, MA. CLE performed the inspection services referenced in this report.

The primary intent of this report is to develop several alternatives to protect the existing roadway, infrastructure and properties located along East Chop Drive and restore/enhance public waterfront access areas.

This report has been prepared for the Town of Oak Bluffs and DCR with the intent that it will be utilized to determine the existing condition of the East Chop Coastal Bank and adjacent coastal protection structures and to develop preliminary plans and cost estimates for the Proposed East Chop Coastal Restoration Project. Any other use, publication, or the like of any data contained herein, by other parties without express consent of CLE Engineering is prohibited.

3. Site Characterization

3.1. Site Characterization

The existing East Chop Coastal Bank coastal protection structures are referenced to their CZM Coastal Infrastructure Inventory and Assessment (CIIA) Structure ID: 053-002-000-003-100 and authorized by the following Massachusetts Department of Public Works (MA DPW) projects:

- MA DPW Contract No. 472 dated July 1936
- MA DPW Contract No. 817 dated January 1945
- MA DPW Contract No.1015 dated November 1947
- MA DPW Contract No. 1075 dated December 1948
- MA DPW Contract No. 1244 dated June 1952
- MA DPW Contract No. 1338 dated September 1953
- MA DPW Contract No. 1429 dated September 1954
- MA DPW Contract No. 1592 dated March 1956
- MA DPW Contract No. 2130 dated April 1960

The project site is further characterized by the following reports:

- "Coastal Infrastructure Inventory and Assessment" prepared for the Massachusetts Coastal Hazards Commission by Bourne Consulting Engineering dated June 2013.

- Deer & Ault Geotechnical Report dated October 31, 2008
- JCK Underground Condition Update Report dated March 10, 2017
- JCK Underground Preliminary Design Report dated March 23, 2017

- CLE Inspection Report dated November 2, 2012
- CLE Inspection Report dated May 30, 2013
- CLE Inspection Report dated April 17, 2014
- CLE Inspection Report dated October 27, 2015
- CLE Inspection Report dated February 12, 2016
- CLE Inspection Report dated January 24, 2017
- CLE Design Report dated June 12, 2017

3.2. Project Site FEMA Designation

The project site is located in a FEMA VE (EL. 15') on Map Number 25007C0108J dated July 20, 2016 and VE (EL. 13') on Map Number 25007C0106J dated July 20, 2016. Wetland Resource Areas include Land Under the Ocean (10.25), Land Containing Shellfish (10.34), Coastal Beach (10.27), Coastal Dunes (10.28), and Coastal Bank (10.30), along with Land-Subject to Coastal Storm Flowage. Public infrastructure within the project area include coastal revetments and seawalls, groins, drainage and flood control structures, sidewalks, scenic roadways, public utilities and private properties. Private homes and public areas exist landward of the East Chop Coastal Bank and protected by the coastal structures and banks. The average tidal range is 2.2'.

3.3. Project Site Area

The project site is located along the northeastern shoreline of Oak Bluffs adjacent to Nantucket Sound and extends approximately 2,400 linear feet along East Chop Drive in the town of Oak Bluffs, MA. Oak Bluffs is the only town that has roads with uninterrupted public coastal water views from one island boundary to the other, with East Chop linking the two ends together. This shoreline area is protected by a variety of engineered coastline protection features including a stone revetment, a stone jetty, a timber bulkhead, and vegetated coastal bank. These features have historically provided protection to the existing public roadway (East Chop Drive) and adjacent private properties from coastal storms. Repairs and improvements to the bluff over the past century have provided stabilization of the area to the upland; however, over the past decade the engineered coastal bank area has experienced increased erosion that has undermined the paved roadway (East Chop Drive) to the point of imminent failure. Accordingly, this road has been closed to traffic since 2012 and inspection monitoring events have been ongoing in order to ensure public safety.

The residences located adjacent to East Chop Drive were constructed during the late 1800's and early 1900's, the majority being listed under the state register of historic places. Revenue generated from these properties supports the local economy and East Chop Drive provides access to these residences. The roadway is also a very popular walking, biking, and touring location for locals and visitors throughout the year, offering unique vistas absent from other parts of the

island. The road also provides access to the historic East Chop Lighthouse and the most direct emergency access route for emergency response vehicles in this part of Oak Bluffs.

The existing coastal bank is in failed (F) condition and the stone revetment is in poor (D/F) condition and both need to be reconstructed to adequately provide protection for current FEMA 100-Year Storm event and for an additional still water increase of two (2') feet to accommodate predicted sea-level rise over the next fifty (50) years.

4. Site Inspection

4.1. General Discussion

This inspection report presents the results of a surveying and engineering assessments of the existing conditions of the project area for the Existing Conditions Plan dated August 14, 2015. The services were provided in conformance to the following:

- Surveys: All surveying and plan development shall be in accordance to the Master Services Agreement for Topographic and Hydrographic Services and the DCR-Guidelines for Consultants (GFC) dated March 2011.
- Civil Engineering: All civil engineering services shall be performed in accordance with prevailing federal, state, and local laws, regulations, and codes.

4.2. Inspections

CLE performed topographic surveys at the site on the following dates:

- September 9, 15 & 21, 2016
- November 10 & 11, 2016

CLE performed hydrographic surveys at the site on September 14, 2016

CLE performed a resource and eelgrass assessment at the site on September 16, 2016

CLE performed site inspections at the site on the following dates:

- November 2, 2012
- May 30, 2013
- April 17, 2014
- October 27, 2015
- February 12, 2016
- January 24, 2017

4.3. Existing Condition

CLE commenced work on this project in September 2016 and scheduled all field and office work necessary to complete all the tasks outlined for this report. The condition of the waterfront structures was visually evaluated according to the following criteria:

Condition	Classification
A	Excellent Condition and/or New Structure
B	Good Condition with Continued Maintenance
C	Poor Condition Requires Moderate Rehabilitation
D	Deteriorated Condition Requires Significant Rehabilitation
F	Failed Condition, Replace or Abandon Structure

The location of site features and existing conditions are shown on the attached plans dated May 25, 2017 with a 2,400 foot project baseline extending along East Chop Drive (south to north).

The existing structures located within the project locus, their condition (as per visual inspection), and *required action* are as follows:

Station	Structure	Material	Length	Cond.	Required Action
0+00	East Chop Revetment	Stone	2,400'	D/F	Reconstruct & Raise to FEMA + 2'

The existing stone revetment is constructed with 2 to 6 ton weathered granite blocks with an imbedded timber bulkhead (circa 1936). The structure is in poor condition (D/F) and is currently unravelling as coastal bank failure dislodge and deform the existing structure. The limited height of the existing stone revetment has allowed storm waves to attack the toe of the coastal bank and destabilize the engineered coastal protection structure.

View North of the Deteriorated Stone Revetment & Eroded Coastal Bank (Typical) in November 2016

Station	Structure	Material	Length	Cond.	Required Action
0+00	Coastal Bank	Eng. Fill	2,400'	F	Reconstruct w/ veg. 27 deg. slope

The existing engineered coastal bank was originally constructed at a slope of approximately 34 degrees exceeding the fill material angle of repose and has been repeated repaired since the 1940's. The coastal bank was partially stabilized by primarily beach grass and other coastal vegetation. The recent increase in storm intensities and waves from the 2012 Super-Storm Sandy over-washed the existing stone revetment washed away and significant section of the coastal bank toe. The undermined toe triggered a series of slope failures and threatened the roadway on East Chop Drive. The Town of Oak Bluffs closed the seaward lane of East Chop Drive in the fall of 2012 and has monitored the slow progression of continuing toe and slope failures with each passing storm. As of March 2017, the failing coastal bank slope had begun to undermine the edge of the roadway pavement.

View South of the Failing Coastal Bank and adjacent roadway (Typical) in January 2017

5. East Chop Coastal Bank Restoration Design Alternatives

5.1. East Chop Coastal Bank Restoration Design Requirements

The East Chop Coastal Bank has failed and continues to threaten the East Chop Drive roadway, municipal infrastructure, public safety and adjacent properties. The project objective is to reconstruct the coastal bank at a stable slope and to adequately protect it against coastal storm events and predicted sea-level rise. Once the project is completed the Town of Oak Bluffs will be able to reopen both lanes of traffic on East Chop Drive, the public will have ADA/MAAB access to the waterfront and the restored coastal bank will be able to function as a resource area and meet the performance standards for a Coastal Bank under 310 CMR 10.30.

5.2. Design Alternatives

In general, schematic designs for proposed the proposed coastal bank restoration shall be of sufficient detail to clearly demonstrate the intent of the work to be done. There shall be two (2) alternative schematic designs including no-build. Each design shall have an initial cost, long-term costs for the life of the structure, a cost-benefit estimate for each, a discussion of the pros & cons of each alternative, and all other required information to meet a Full Condition Survey in accordance with the guidelines.

The three (3) alternatives for the proposed project the "East Chop Coastal Bank Restoration Project" are as follows:

5.2.1. Alternative No. 1: **No-Build**

The objective of Alternative No. 1 is to neglect the continuing scour of the coastal bank toe from coastal storm events and the subsequent failure of the engineered coastal bank. The no-build alternative places public health and safety at risk and threatens the adjacent roadway, public infrastructure and private properties as the coastal bank continues to erode and retreat landward.

Public Value: The public cost of this alternative is high and threatens health and safety. The yearly cost for a 10-year project life has not been calculated.

Project Pros:

- None. No action threatens the roadway, public infrastructure and private property along East Chop Drive.

Project Cons:

- The no-build alternative does not serve nor protect the public and private interests.

5.2.2. Alternative No. 2: **Restore Coastal Bank Restoration w/ Dual Construction Access**

The objective of Alternative No. 2 is to restore the coastal bank and stone revetment utilizing both north and south construction access points, thereby allowing phasing of the project as funding becomes available. The alternative includes the following features and associated preliminary initial costs and long term costs:

Item	Unit	Number	Unit Cost	Cost	%/Yr	Maint./Year
Mob & Demob	Each	1	$ 100,000.00	$ 100,000.00	0%	$ -
Sell Exist. Rip-Rap	Tons	11,933	$ (25.00)	$ (298,325.00)	0.0%	$ -
Geotextile	SF	125,000	$ 3.00	$ 375,000.00	0.0%	$ -
12" Filter Stone Layer	CY	4,380	$ 40.00	$ 175,200.00	0.0%	$ -
1,200 LB Interm. Stone	Tons	20,751	$ 100.00	$ 2,075,100.00	0.0%	$ -
6-8 Ton Cap Stone	Tons	36,761	$ 125.00	$ 4,595,125.00	0.1%	$ 4,595.13
Coastal Bank Fill	CY	18,270	$ 60.00	$ 1,096,200.00	0.5%	$ 5,481.00
Beach Grass Plantings	SF	118,550	$ 3.00	$ 355,650.00	1.0%	$ 3,556.50
Rosa Rugosa Plantings	SF	7,700	$ 30.00	$ 231,000.00	1.0%	$ 2,310.00
ADA/MAAB Access	SF	980	$ 150.00	$ 147,000.00	2.0%	$ 2,940.00
Roadway Safety Rail	LF	2,431	$ 200.00	$ 486,200.00	0.1%	$ 486.20
4' Wide Asphalt Path	SF	14,063	$ 50.00	$ 703,150.00	0.1%	$ 703.15
Misc. Items	Each	5	$ 25,000.00	$ 125,000.00	1.0%	$ 1,250.00
Sub-Total				**$ 10,166,300.00**		**$ 21,321.98**
lorth Construct. Entrance						
Sheetpile (780' x 40')	SF	31,200	$ 100.00	$ 3,120,000.00	0%	$ -
Geotextile (500' x 12')	SF	6,000	$ 3.00	$ 18,000.00	0%	$ -
12" Crushed Gravel	CY	222	$ 40.00	$ 8,880.00	0%	$ -
Guard Rail	LF	360	$ 200.00	$ 72,000.00	0%	$ -
Sub-Total				**$ 3,218,880.00**		
outh Construct. Entrance						
Sheetpile (650' x 40')	SF	26,000	$ 100.00	$ 2,600,000.00	0%	$ -
Geotextile (360' x 12')	SF	4,320	$ 3.00	$ 12,960.00	0%	$ -
12" Crushed Gravel	CY	160	$ 40.00	$ 6,400.00	0%	$ -
Guard Rail	LF	300	$ 200.00	$ 60,000.00	0%	$ -
Sub-Total				**$ 2,679,360.00**		
Construction Sub-Total				$ 16,064,540.00		$ 21,321.98
Contingency		7.0%		$ 1,124,517.80		
State Retainage		5.0%		$ 803,227.00		
Eng. & Permits		8.9%		$ 1,429,744.06		
CM Services (52 Wks)		3.7%		$ 594,387.98		
Totals				**$ 20,016,416.84**		
				Total Cost - 50yr Life	50	$ 21,082,515.59
				Public Value	50	$ 421,650.31

Public Value: The public value of this alternative includes the phased restoration of the coastal bank. The yearly cost for a 50-year project life is approximately $ 421,650.31.

Project Pros:

- Restore coastal bank on a phased approach as funding becomes available.

Project Cons:

- Higher project costs due to dual construction access.

5.2.3. Alternative No. 3: **Restore Coastal Bank Restoration w/ Single Construction Access**

The objective of Alternative No. 2 is to restore the coastal bank and stone revetment utilizing only the south construction access point, thereby requiring the project to be complete in one phase. The alternative includes the following features and associated preliminary initial costs and long term costs:

Item	Unit	Number	Unit Cost	Cost	%/Yr	Maint./Year
Mob & Demob	Each	1	$ 100,000.00	$ 100,000.00	0%	$ -
Sell Exist. Rip-Rap	Tons	11,933	$ (25.00)	$ (298,325.00)	0.0%	$ -
Geotextile	SF	125,000	$ 3.00	$ 375,000.00	0.0%	$ -
12" Filter Stone Layer	CY	4,380	$ 40.00	$ 175,200.00	0.0%	$ -
1,200 LB Interm. Stone	Tons	20,751	$ 100.00	$ 2,075,100.00	0.0%	$ -
6-8 Ton Cap Stone	Tons	36,761	$ 125.00	$ 4,595,125.00	0.1%	$ 4,595.13
Coastal Bank Fill	CY	18,270	$ 60.00	$ 1,096,200.00	0.5%	$ 5,481.00
Beach Grass Plantings	SF	118,550	$ 3.00	$ 355,650.00	1.0%	$ 3,556.50
Rosa Rugosa Plantings	SF	7,700	$ 30.00	$ 231,000.00	1.0%	$ 2,310.00
ADA/MAAB Access	SF	980	$ 150.00	$ 147,000.00	2.0%	$ 2,940.00
Roadway Safety Rail	LF	2,431	$ 200.00	$ 486,200.00	0.1%	$ 486.20
4' Wide Asphalt Path	SF	14,063	$ 50.00	$ 703,150.00	0.1%	$ 703.15
Misc. Items	Each	5	$ 25,000.00	$ 125,000.00	1.0%	$ 1,250.00
Sub-Total				**$ 10,166,300.00**		**$ 21,321.98**
outh Construct. Entrance						
Sheetpile (650' x 40')	SF	26,000	$ 100.00	$ 2,600,000.00	0%	$ -
Geotextile (360' x 12')	SF	4,320	$ 3.00	$ 12,960.00	0%	$ -
12" Crushed Gravel	CY	160	$ 40.00	$ 6,400.00	0%	$ -
Guard Rail	LF	300	$ 200.00	$ 60,000.00	0%	$ -
Sub-Total				**$ 2,679,360.00**		
Construction Sub-Total				$ 12,845,660.00		$ 21,321.98
Contingency		7.0%		$ 899,196.20		
State Retainage		5.0%		$ 642,283.00		
Eng. & Permits		8.9%		$ 1,143,263.74		
CM Services (52 Wks)		3.7%		$ 475,289.42		
Totals				**$ 16,005,692.36**		
				Total Cost - 50yr Life	50	$ 17,071,791.11
				Public Value	50	$ 341,435.82

Public Value: The public value of this alternative includes the single phase restoration of the coastal bank. The yearly cost for a 50-year project life is approximately $ 341,435.82

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Project Pros:

- Restore coastal bank on a single phase approach incumbent on securing funding for the entire project budget. The single phase approach will expedite construction and minimize the project duration and associated disruption of public access and use of East Chop Drive.

Project Cons:

- Lower project costs will require full funding before the project can begin.

In general the restoration of the East Chop Coastal Bank is critical should proceed on an emergency basis. Any delays in the implementation and funding of this project will result in the eventual collapse of the roadway and threatens public safety, infrastructure and private properties.

Upon resolution and acceptance of a conceptual plan and required agreements by all stakeholders, a future review of permit requirements and engineering evaluations and studies should be undertaken to confirm preliminary assumptions and stated cost estimates.