2017

CITY OF KEY WEST

POST-HURRICANE IRMA
SEAWALL CONDITION ASSESSMENT
AQUARIUM BASIN SEAWALL

SUBMITTED: December 19, 2017
REVISED: December 22, 2017

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FL PE No. 75507

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TETRA TECH

December 19, 2017

Submitted via email:
smcalearney@@cityofkeywest-FL.gov

Steve McAlearney
Senior Project Manager
City of Key West
1300 White Street
Key West, FL 33040

Subject: Post-Hurricane Irma Condition Assessment
Key West Aquarium Basin Seawall

Dear Mr. McAlearney:

Tetra Tech is pleased to submit this seawall condition assessment report for your review. The report discusses the condition of the seawall on the north and east sides of the Aquarium Basin and provides recommendations for its replacement.

If you have any questions or need any additional information, please contact me.

Sincerely,

Dave Frodsham PE
Project Engineer
FL PE No. 75507

cc: Stuart McGahee, Tetra Tech

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1.0 REPORT/INSPECTION TERMINOLOGY

Abrasion: The process of eroding, rubbing or wearing away a surface by friction.
Active cracks: Those cracks which the mechanism causing the cracking is still at work.
Aggregate: Granular material such as crushed stone in the concrete mix.
Bugholes: (slang) Industry term used to describe small cavities resulting from entrapment of air bubbles in the surface of concrete.
Concrete cover: The distance between the surface of embedded reinforcement and the surface of the concrete.
Corrosion: Destruction of metal by chemical, electrochemical or electrolytic reaction within its environment.
Crack: A complete or incomplete separation of concrete into two or more parts produced by breaking or fracturing.
Damage: Impairment to the value or usefulness of an element or component.
Deformation: A change in dimension or shape, see distortion.
Deflection: A movement of a structural element measured as linear displacement.
Delamination: A horizontal or planar separation of the surfaces of concrete.
Depression: A lowering of the surrounding surfaces
Deterioration: The decomposition of material during exposure to service.
Diagonal crack: A crack forming an angle other than 90 degrees with the centerline of the concrete member.
Discoloration: A departure of color from what is normal.
Disintegration: The deterioration into small fragments or particles due to any cause.
Dislodged: The movement of an object due to impact or force.
Distortion: A change in alignment of the components of a structure, see deformation.
Distress: The cracking or distortion in a concrete structure as the result of stress.
Dormant cracks: Cracks which are not currently moving.
Efflorescence: A white deposit on concrete caused by crystallization of soluble salts brought to the surface by moisture in the concrete due to capillary action.
FRP: Fiber reinforced plastic composites rebar
Galvanic corrosion: An electrochemical process in which one metal corrodes preferentially to another when both metals are in electrical contact and immersed in an electrolyte (seawater).
Gouges: A groove or hole caused by the impact or action of a hard object.
Hairline crack: A crack not greater than 0.003 inch in width or barely perceptible.
High tide: The highest level of the tide or the time at which the tide is highest.
Hollow area: An area of concrete which when struck with a hammer gives off a hollow sound indicating the existence of a horizontal fracture below the surface.
Honeycomb: Voids in concrete due to failure of the mortar to effectively fill the spaces between coarse aggregate.
Incrustation: A crust of coating, generally hard, formed on the surface of concrete.
Life safety: An act to protect people based on occupancy features and conditions.
Low tide: The lowest level of the tide or the time at which the tide is lowest.
Map crack: An interconnected crack forming networks of any size and similar to those see in dried mud flats.
Pile: A slender structural element that is embedded on end in the ground to support a load.
Pile batter: A pile installed at an angle to the vertical.
Pile bent: A row of bearing piles with a continuous concrete cap.
Pile cap: A structural element that transfers load to the top of one or more supporting piles.

Pile jacket: A prefabricated protective covering placed around the circumference of a pile for the purpose of preservation.

Pitting: Relatively small cavities in concrete or localized corrosion evident as minute cavities in steel.

Popouts: Shallow typical conical depressions in a concrete surface.

Preservation: The process of maintaining a structure in its present condition of arresting further deterioration.

PVC: Polyvinyl chloride used in the manufacture of conduit.

Random crack: A crack that meanders irregularly on the surface of concrete having no particular form.

Raveling: The wearing away of the concrete surface caused by the dislodging of aggregate particles.

Reflective cracks: A propagation of stresses in a concrete topping slab or asphalt layer due to traffic loads

Rehabilitation: The process of modifying a structure to a desired useful condition.

Repair: To replace or correct deteriorated or damaged components or elements of a structure.

Scaling: The local flaking or peeling away of the near-surface of hardened concrete.

Settlement: The lowering in elevation of pavement or structures.

Shrinkage crack: Cracking of a structure due to failure in tension caused by reduction on moisture content.

Sound: The absence of deficiencies or defects which would lessen the structural integrity or performance of the structural element.

Spall: A chip of concrete broken from the surface of a concrete member.

Small spall: A spall not larger than 0.8 depth or than 6 inches in any dimension

Large spall: A spall deeper that 0.8 and/or 6 inches in any dimension.

Splash zone: The area on an offshore structure that is regularly wetted by seawater but is not continuously submerged.

Substrate: Any material on the surface of which another material is placed.

Substructure: All of that part of a marine structure below the deck elevation.

Tidal range: The difference between high and low tide elevations.

Urgency: Priority or a pressing necessity of importance

Void: Volume of concrete that is missing. Term is used to describe an area near the toe of the wall where a considerable amount of concrete is missing.

2.0 EXECUTIVE SUMMARY

On November 9th and 30th of 2017, Tetra Tech, Inc. (Tt) performed a structural condition survey of the municipally-owned portions of the Key West Aquarium bulkhead on behalf of the City of Key West. The purpose of the site visits was to observe and evaluate the condition of the bulkhead and the damage sustained in the wake of Hurricane Irma. This survey was performed along the north and east reaches of the basin for a total length of approximately 257 linear feet. Observations were conducted at low tide and limited to those readily apparent to the naked eye. Recommendations are made based upon engineering judgement and standard industry practices. Data collected during the inspection included the following:

- Location of all buildings, boardwalks and docks along or adjacent to the seawall
- Water depths along the seawall
- Conversations/correspondence with City Staff & adjacent leaseholders to gather information about their facilities as related to the seawall
- Locations of seawall penetrations for drainage and other utilities
- Composition of seawall construction materials
- Seawall condition and deficiencies

The following exhibit is intended to show how the inspection transect was configured and referenced to provide a synopsis of the wall conditions. Figure 1 shows how the engineer delineated the stationing with two baselines from 0-feet to 30-feet for Baseline A, and from 0-feet to 227-feet for Baseline B along the top of the cap.

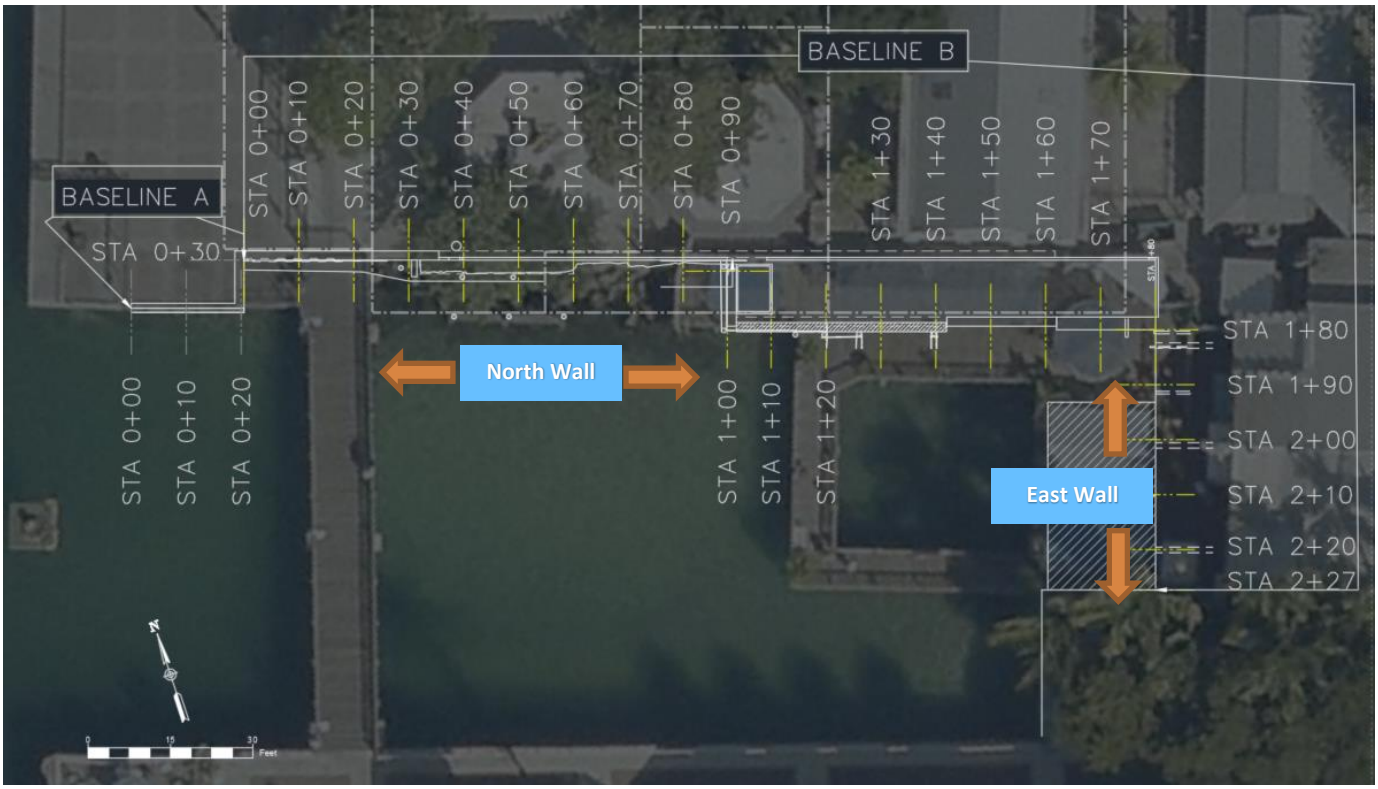


Figure 1: Survey Stationing Layout for Cataloging Deficiencies

Tape measurement wheels were used to station the seawall cap along Baseline A (from STA 0+00 feet at the west end near the wrought iron fencing to STA 30+00 feet, the beginning of steel sheet pile) and Baseline B (from STA 0+00, the beginning of the steel sheet piling, along the north wall and east walls to STA 2+27, at the southeast corner of the elevated concrete turtle tanks). Measurements were then taken as needed perpendicular to the tape-marker on the cap to the points of interest to develop the plan and cross sections of existing conditions. The inspection included data collection sufficient to determine existing conditions, develop preliminary remedial measures, and to satisfy permitting requirements associated with proposed repair or replacement of the bulkhead.

The purpose of the seawall assessment was to perform a visual inspection of the seawall conditions and develop an existing conditions report that could be coupled with future topographical surveys, geotechnical explorations or other pertinent efforts made toward a repair or replacement as applicable. This report catalogs the deficiencies of the seawall and discusses possible remedial measures that can then be used to develop engineering plans for the repair of the wall.

The seawall is comprised of several types of construction materials and methods implemented as repairs or replacements sequentially over time. It is estimated that the wall age ranges from approximately twenty five years old to in excess of eighty years old. Portions of the wall are steel sheet pile, while others are formed as cast-in-place walls or masonry walls utilizing native coquina stone and mortar. Remnants of older walls can be seen behind the current wall at some locations. Riprap abuts the wall along a portion of its western length. It is evident that the wall has been patch repaired piece-meal over time with small masonry unit style construction techniques to afford smaller transport of materials in an effort to negotiate site constraints. These repairs were likely conducted as smaller efforts to repair defects presented at a given time.

Generally, the seawall is in very poor condition, particularly along the north wall. This has been further revealed by the impacts of Hurricane Irma and associated surge, waves, rain and other hurricane related effects that have caused acute failure at several locations.

At the time of this writing, no drawings or as-builts were available to verify the exact configuration, embedment depth, lateral support or other specified construction requirements for any portion of the seawall that may not have been visually apparent.

3.0 INTRODUCTION

The project area is located along the north and east boundary of the Key West Aquarium Basin, west of the Key West Aquarium and south of the Western Union Cable Huts. Global Positioning System (GPS) coordinates for the center of the site are as follows: Latitude 24° 33.558' North, Longitude 81°48.466' West.

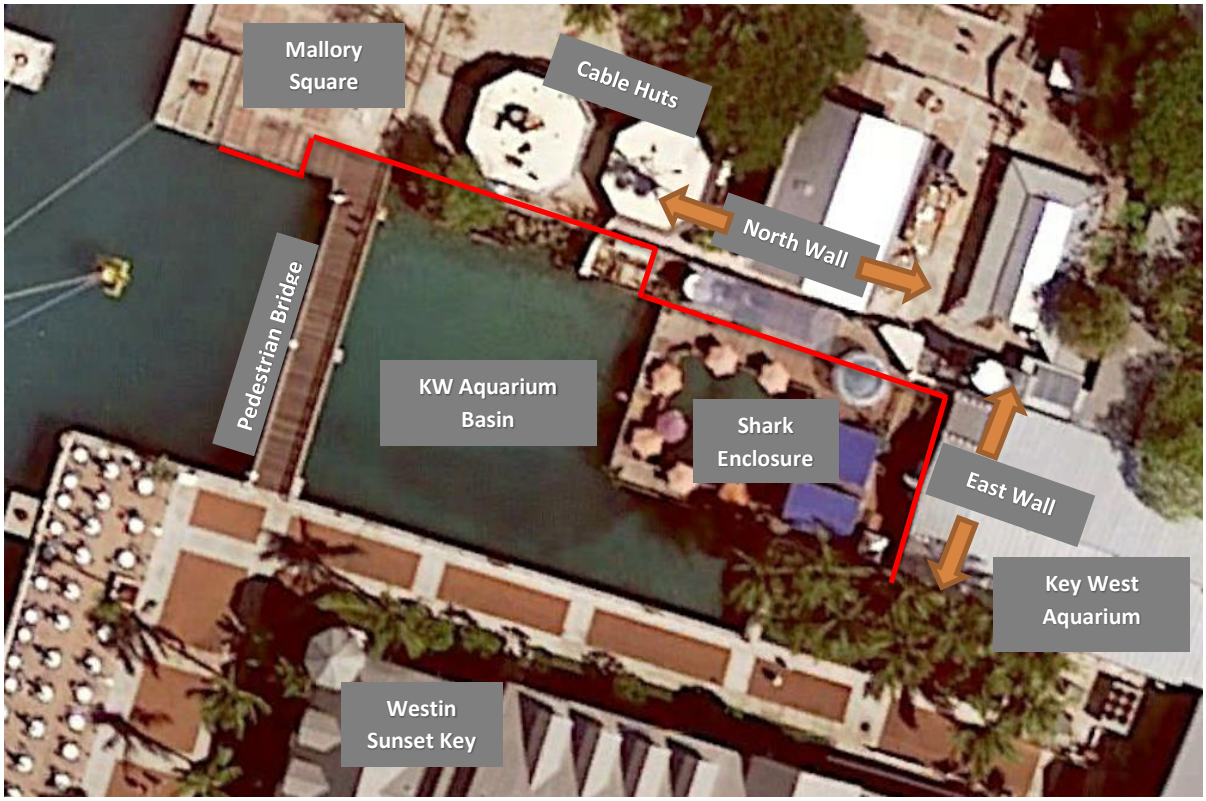


Figure 2: Project limits and surrounding area

4.0 SITE DESCRIPTION

The survey area is an approximately 257 linear feet of bulkhead along the northern and eastern reaches of the Key West Aquarium Basin. The bulkhead is a hardened shoreline surrounding the basin that supports a variety of amenities. Water depths ranged from 1.5 to 16 feet of sea water. The deepest water within the limits of the project are at the western end, tapering to shallower depths at the eastern end. To the north of the site are the cable huts and Mallory Square, and to the east of the site is the Key West Aquarium. Within the basin are various exhibits associated with the aquarium, including elevated concrete sea turtle tanks and a PVC fenced kraal area that contains sandbar and nurse sharks among other aquatic fauna. The decking and supporting pilings surrounding these exhibits were demolished during the storm and will require replacement.

The western end of the seawall is spanned by a heavily trafficked pedestrian bridge affording access for cruise patrons and other pedestrians to and from Mallory Square. The bridge was also damaged during Hurricane Irma, and has undergone recent reconstruction. To the west of the bridge is a mooring area for cruise ships, with a mooring structure mono pile located at the mouth of the basin.

5.0 INSPECTION METHODS

Field activities were performed by a licensed Florida Professional Engineer and engineering intern with experience in seawall assessments, design, and construction. For the portions of wall that were only accessible by water, a team of qualified scientific divers provided access and video documentation. Data was collected utilizing still cameras, submersible video cameras, and measuring tapes to visually inspect the wall and catalog deficiencies. The team recorded general areas of visible deficiencies where they were noteworthy and/or typical.

Videos of the bulkhead and upland facilities were taken above and below the waterline and include the interspatial area between the waterline and the dry portions of the wall. Still images were collected from these video feeds and combined with underwater photography which were used together to record specific and representative images of wall condition within the survey area.

6.0 TYPICAL SEAWALL ASSESSMENT SUMMARIES

The following summary assessment sheets describe the general conditions for wall segments and proposed remedial measures recommended. The wall segments were grouped together where conditions and materials were found to be similar. For example, the first condition assessment was for the first 30-feet of wall (Baseline A from 0+00 to 0+30). This segment of wall was grouped together because the wall is a pile supported cap of more recent construction, and appears to be largely intact. Recommendations for remedial efforts for each segment are likely to be uniform throughout its limits. This grouping methodology was repeated for the entire length.

Typical Area 1 – Baseline A from Station 0+00 to 0+30

SE Corner of Mallory Square Pier

Date of Inspection: November 9, 2017

Figure 3: Plan view of Baseline A

Figure 4: STA 0+00 to STA 30+00 from Bridge

Figure 5: STA 0+10, looking West

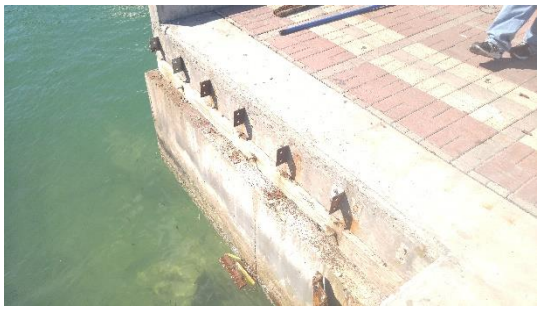


Figure 6: STA 0+30, looking South

Description	Baseline A (STA 0+00 to 30+00)
Condition Index	GOOD, no repairs required
Service Life	40-50 years
Age of Structure	10-15 Years

Condition: The seawall through Baseline A is a pile supported cast-in-place concrete cap of relatively recent construction. There is open access beneath the cap and between piles to the open air and water area beneath the Mallory Square Pier. The cap and piles appear to be in good condition, although there is construction debris and a broken piling found at the base of the supporting pilings. The adjoining deck along the east boundary was damaged during Hurricane Irma, and is in the process of being replaced as of this writing. The overall condition of this area is good.

Typical Area 2 – Baseline B from Station 0+00 to 0+18

Area beneath Pedestrian Bridge

Date of Inspection: November 9, 2017

Figure 7: Plan view of Baseline B

Figure 8: STA 0+00 to STA 0+18 beneath Bridge

Figure 9: View of soil loss behind wall

Figure 10: STA 0+00, looking East

Description	Baseline B (STA 0+00 to 0+18)
Condition Index	FAILED: Replacement Required
Service Life	25 years
Age of Structure	>30 Years

Condition: The first portion of Baseline B is a severely corroded steel sheet pile wall for a length of 18 feet. The wall has several holes of 1 foot diameter, pitting, severe corrosion, and loss of substantial soil and rock from behind the wall. The western end of the sheets is unattached, and moves freely with wave action. Subsidence was noted in the adjacent upland area, but had been filled at the time of inspection to facilitate restoration of the bridge. Large coquina stones and concrete debris have broken through the wall underwater, and remnants of a concrete pour beneath the deck may be seen floating freely where it had been previously poured at grade. The overall condition of this area is failed, and a replacement is required.

Typical Area 3 – Baseline B from Station 0+18 to 1+00

Area from Bridge to Return Wall

Date of Inspection: November 9, 2017

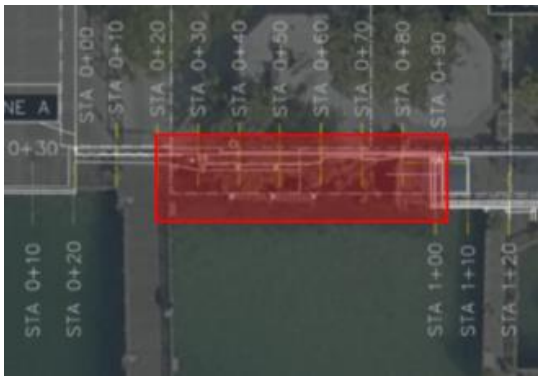


Figure 11: Plan view of Baseline B

Figure 12: STA 1+00 looking West

Figure 13: STA 0+18 looking Northeast

Description	Baseline B (STA 0+18 to 1+00)
Condition Index	Fair to Poor, Should be Replaced
Service Life	25 years
Age of Structure	>50 Years

Figure 14: STA 0+60, looking West

Condition: The second portion of Baseline B is a combination of cast-in-place concrete and mortar-bonded native coquina stone. A parapet wall was constructed atop the cap for soil retention. On the waterside of the wall is 8-10 feet of rubble riprap, obscuring much of the wall face from view. However, the upland area adjacent to the wall shows signs of soil subsidence, likely due to tidal soil migration through the wall. This area is in close proximity to the historically designated cable huts. The area as noted includes a mortared rubble return wall that extends 10' into the water at the east end. The overall condition of this area is fair to poor.

Typical Area 4 – Baseline B from Station 1+00 to 1+62

Area along Shark Enclosure

Date of Inspection: November 9, 2017

Figure 15: Plan view of Baseline B

Figure 16: STA 1+00 looking East

Figure 17: View of STA 1+00

Description	Baseline B (STA 1+00 to 1+62)
Condition Index	FAILED: Replacement Required
Service Life	25 years
Age of Structure	>50 Years

Figure 18: STA 1+60, looking West

Condition: The third portion of Baseline B is a mortared native stone wall with a cast-in-place concrete cap. Approximately 42 linear feet of the wall has collapsed as a result of Hurricane Irma, having rotated forward. The collapsed wall is currently supported only by the timber pilings for the adjacent dock. Remnants of a previous seawall may be seen behind the collapsed wall. The eastern portion of the wall is still standing, though being of similar vintage and construction, it is considered to be in hazardous condition. This wall segment has failed and requires replacement.

Typical Area 5 – Baseline B from Station 1+62 to 1+80

North Wall near Aquarium

Date of Inspection: November 9, 2017

Figure 19: Plan view of Baseline B

Figure 20: STA 1+60 looking East

Figure 21: View of East Wall

Description	Baseline B (STA 1+62 to 1+80)
Condition Index	Fair
Service Life	25 years
Age of Structure	>35 Years

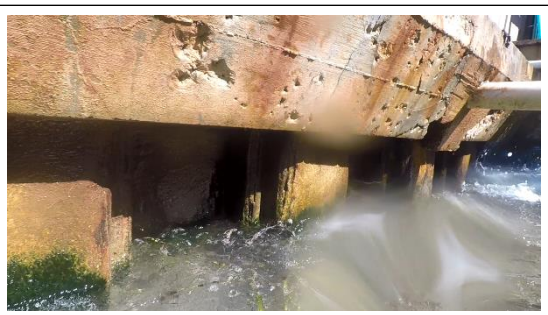


Figure 22: STA 1+60 looking East

Condition: The fourth portion of Baseline B is a steel sheet pile wall. The cap is pitted, and cracked with spalled rust from exposed rebar. The steel sheets show signs of corrosion at their seams. While the steel portion does not exhibit any signs of soil loss or rotation, it is of short enough span that a seawall project on the aforementioned segments should include it to provide for a complete system. The overall condition of this area is fair.

Typical Area 6 – Baseline B from Station 1+80 to 2+27

East Wall near Aquarium

Date of Inspection: November 9, 2017

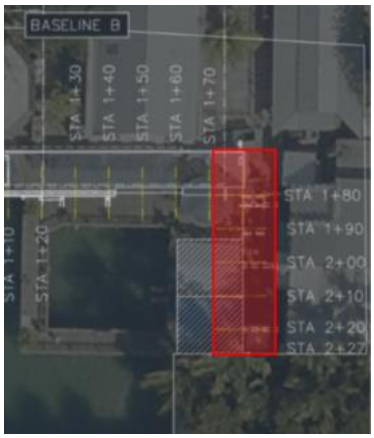


Figure 23: Plan view of Baseline B

Figure 24: East Wall Face

Figure 25: View of East Wall

Figure 26: View of pile supported turtle enclosure

Description	Baseline B (STA 1+80 to 2+27)
Condition Index	Fair
Service Life	50 years
Age of Structure	>50 Years

Condition: The fifth and final portion of Baseline B is a cast-in-place concrete wall that is visible only for the northern 15 feet. There is surficial cracking, pitting and delamination of concrete with exposed aggregate along the visible length. Several structural cracks are visible within the visible portion of the wall. The remaining 32 feet of wall are blocked from view behind concrete pile supported turtle enclosures, and as such could not be observed during the inspection. The overall condition of this wall section is fair.

7.0 ENVIRONMENTAL & PERMITTING DISCUSSION

The waters adjacent of the Key West Aquarium Basin and project area are classified by the Florida Department of Environmental Protection (FDEP) as a Class III water body (Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife), and they are located inside the limits of the National Oceanic and Atmospheric Administration (NOAA) Florida Keys National Marine Sanctuary (FKNMS).

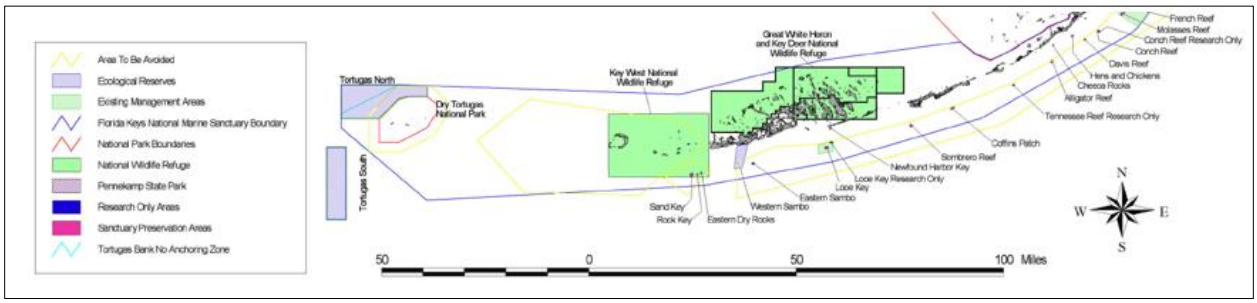


Figure 27: Limits of the FKNMS (http://floridakeys.noaa.gov/fknms_map/sanctuaryzoneboundaries.pdf)

Permitting along the shoreline, inside the FKNMS, normally involves submitting an environmental resource permit application to the Florida Department of Environmental Protection (FDEP) and the US Army Corp of Engineers (ACOE). Under normal circumstances, the project would be subjected to coral and benthic surveys to satisfy the requirements of the FKNMS. The National Oceanic and Atmospheric Administration (NOAA) would need to be consulted due to the existence of corals in the area.

However, as a portion of the damage noted is directly attributable to Hurricane Irma, any permitting for a new seawall would be a candidate for expedited permitting reviews subject to the conditions of Statewide Emergency Orders. After discussions with the regulatory agencies, our understanding is that such benthic survey efforts would be deferred as a result of these Emergency Orders. While this does not absolve the project from all regulatory requirements, the City is afforded an expedited path to seawall permitting, and should take advantage of filing applications prior to the February 1, 2018 deadline.

In general the nationwide permitting process allows for improvements that extend up to 18-inches in front of the existing wall. There is some flexibility in this guideline depending on engineering constraints and/or local site conditions. However, given the state of disrepair and the recommendation of a seawall replacement, it is advisable that this 18" minimum separation be adhered to when formulating a design solution.

8.0 CONCLUSIONS

In reviewing the wall condition, the most concerning locations were along Baseline B at the steel sheet pile from STA 0+00 to STA 0+18 and STA 1+00 to 1+42 for the mortared coquina rock. In both of these locations the wall has failed to a degree that patch repairs are not recommendable and replacement is required. Given the timing of the failures, it is reasonable to conclude that they are the combined result of age as well as the sizable loading of hydrostatic pressure, storm surge, and wave action experienced by the seawalls during Hurricane Irma. The seawall is no longer supporting the upland soils at these locations and the condition of the wall presents a hazard to both the public and adjacent properties.

To a lesser degree, the adjoining portions of the northern wall from STA 0+18 to STA 1+00 and from STA 1+42 to STA 1+80 cause appreciable concern. While these sections have not yet failed to the degree noted above, they present similarities in terms of dimensions, age, construction methods, and the observance of soil migration from the uplands due to tidal activity. Given the correlation that similarly constructed walls of comparable age are susceptible to similar modes of failure, it is reasonable to conclude that these portions of the wall are in tenuous condition. Therefore, a project to replace the failed seawall sections would be practical to include the entirety of the north wall. In so doing, the proposed wall would benefit from an integrated and homogenous seawall system with no particular portion weaker than another.

The east wall, to the degree observable along its northern third, exhibited delamination, structural cracking, soil migration at drainage penetrations, exposed aggregate in the concrete, and general wear from age. However, this portion of the wall did not appear to display significant damage directly relatable to the storm. That stated, the undertaking of a seawall project within the basin is bound to include several considerations that may make replacing this wall worthwhile. A seawall project, regardless of size, will include mobilization costs, reduced access to patrons, and other similar construction-related inconveniences. The pedestrian bridge at the mouth of the basin may need to be taken out of service for a portion of time to provide barge access, requiring pedestrian detours and adverse impacts to nearby businesses. For these reasons, it may be in the City's best interests to replace the east wall at the same time, and reset the clock on future replacement work.

Should the City elect to only replace the north wall, it's advisable that the east wall be monitored on a yearly interval for signs of degradation and future repairs or replacement.

9.0 RECOMMENDATIONS

We recommend that the City of Key West conduct a seawall replacement project for the north wall of the Aquarium basin within the limits of Baseline B with an alternate bid item to include the east wall of the basin as well. Any repairs or enhancements to the aquarium's exhibits, although beyond the scope of this assessment, may be incorporated to take advantage of nearby heavy equipment.

The layout of the new seawall may take one of two configurations:

Layout Option 1: Replace the wall in the same footprint, or within 18" waterward of the existing seawall face. Advantages to this layout are that permitting is anticipated to be more streamlined or subject to exemption. Requirements for benthic resource assessment work, and coral investigation/relocation may be waived. Among the drawbacks to this approach are construction vibrations near historic structures, unnecessary 90 degree wall turns, and reflective wave action that may subject the wall to scour.

Layout Option 2: Replace the wall in a straight line along the most waterward face of the current wall as depicted in the image below, effectively filling the western half of the north wall to the current lease lines. Some advantages to this configuration are a more efficient construction path with more dry land for leaseholder use, and increased distance from historic structures will reduce vibrations during construction. The most significant drawback is that the configuration may be considered an encroachment on Sovereign Submerged Lands, and permitting is likely to be more complex.

Should Layout Option 2 be preferable to the City, the permitting may be undertaken with that in mind as the goal with the ability to modify to Option 1 if permitting conditions prove unpalatable.

Figure 28: Layout Option 2

The seawall replacement should be made via steel sheet piling installed as a cantilever wall (without tieback supports) of a length, gauge, thickness, coating as determined by structural analysis. The hard substrata typically encountered within the project limits the ability to use of other competing sheet pile materials. Among the advantages to a steel wall is speed of installation in tandem with higher levels of structural viability. To that end, the project could be completed relatively quickly to minimize adverse effects to the aquarium and neighboring businesses. Segmental barges could be brought into the basin around the cruise ship mooring mono pile and possibly the bridge mid-span bent to lessen reconstruction efforts. Construction should be scheduled to occur within the preferred May to November window when cruise traffic is decreased. Aquarium exhibits may be temporarily relocated within the basin to facilitate construction. We recommend including an effort within the prospective contractor's scope of work to conduct pre- and post- construction surveys and videos to document the condition of the adjacent structures, as well as an effort to monitor vibrations on adjacent structures during construction activity to help provide reasonable assurance that those buildings will not be negatively impacted by the seawall installation. In the event that vibrations exceed established tolerances within the contract, adjustments may be made to construction methods to preserve those facilities.

Steel sheets piling seawalls, when properly designed, installed and maintained, can carry a service life of 25-35 years. A drawback of the steel option is decommissioning the pedestrian bridge for a period of 2-3 months during seawall installation. However, once construction has completed and the bridge is restored, the new seawall should be viable for decades to come.

In reviewing possible alternatives for construction repairs, we investigated the option of performing the seawall installation from land, staging a crane on the north side of the cable huts and extending over them to preserve the bridge during construction. However, the cost impacts associated with a larger crane and the inherent complexity and precariousness of flying sheet piles over the huts rendered this option infeasible.

Additionally, we explored replacing the wall with a gravity cast-in-place concrete wall. However, given the requirement to construct the new wall within 18" of the existing wall, we found that there would be inherent excavation behind the wall that would likely be considered dredging from a permitting perspective, and forestall any expedited permit acquisition.

A fourth option of a concrete pile and panel wall would be slower to construct, and with limited ability to embed concrete panels to adequate depth. A fascia pour limited to the 18" permissible space would not provide the structural integrity necessary to support the adjacent developments.

10.0 ENGINEER'S OPINION OF PROBABLE COST

For the purposes of cost estimating, we have assumed a steel sheet pile cantilever installation with a concrete cap installed via crane on segmental barges from the aquarium basin. Costs presented are for construction, and do not include design, permitting, replacement of decking and supporting pilings. Any secondary fiscal effects related to decommission of the bridge, relocation of aquarium exhibits, or other impacts to businesses are not included, but should be considered.

Key West Aquarium Basin Seawall
Engineer's Opinion of Probable Cost
Steel Sheet Pile Cantilever Wall

BASE BID: NORTH SIDE SEAWALL

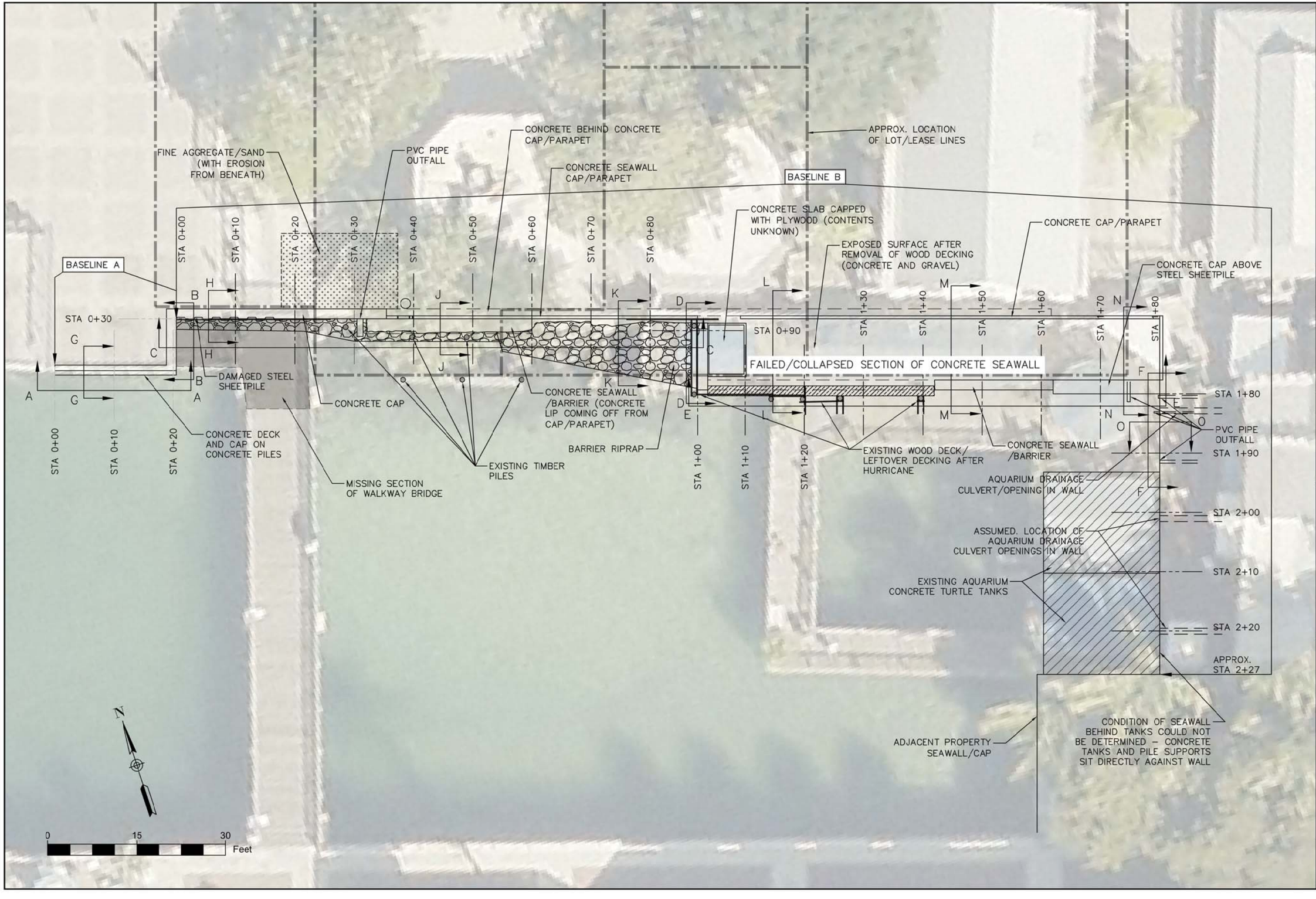
ITEM NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	SCHEDULED VALUE
1	Bond & Insurance	1	LS	$ 25,000.00	$ 25,000.00
2	Mobilization/Demobilation	1	LS	$ 60,000.00	$ 60,000.00
3	Preconstruction Video Survey	1	LS	$ 8,000.00	$ 8,000.00
4	Bridge Demolition (North Span)	1	LS	$ 30,000.00	$ 30,000.00
5	Seawall Demolition, Relocate Riprap	1	LS	$ 50,000.00	$ 50,000.00
6	Relocate Shark Kraal	2	LS	$ 20,000.00	$ 40,000.00
7	Seismic Monitoring	1	LS	$ 11,500.00	$ 11,500.00
8	Steel Sheet Pile	180	LF	$ 1,500.00	$ 270,000.00
9	Concrete Cap	180	LF	$ 327.00	$ 58,860.00
10	Closure Pour (West End)	1	LS	$ 7,500.00	$ 7,500.00
11	Stormwater/Utility Extensions	12	EA	$ 3,500.00	$ 42,000.00
12	Backfill	1	LS	$ 18,000.00	$ 18,000.00
13	Replace Timber Pilings	12	EA	$ 1,500.00	$ 18,000.00
14	Site Restoration	1	LS	$ 20,500.00	$ 20,500.00
15	Bridge Construction (North Span)	1	EA	$ 60,000.00	$ 60,000.00
16	Construction Administration/Inspections	1	LS	$ 35,000.00	$ 35,000.00
17	CONTINGENCY	20%			$ 150,872.00
	BASE BID SUBTOTAL:				**$ 905,232.00**

ALTERNATE 1: EAST SIDE SEAWALL

18	Demolish Elevated Turtle Tanks	2	LS	$ 15,000.00	$ 30,000.00
19	Steel Sheet Pile	47	LF	$ 1,200.00	$ 56,400.00
20	Concrete Cap	47	LF	$ 327.00	$ 15,369.00
21	Stormwater/Utility Extensions	5	EA	$ 3,500.00	$ 17,500.00
22	Reconstruct Elevated Turtle Tanks	2	LS	$ 75,000.00	$ 150,000.00
23	CONTINGENCY	20%			$ 53,853.80
	ALTERNATE SUBTOTAL:				**$ 323,122.80**
	TOTAL WITH ALTERNATE 1:				**$ 1,228,354.80**

APPENDIX

Existing Seawall Plan, Elevation (Front Face) and Cross Section Views



Stuart E McGehee
Florida PE No. 57536

Designed by:
Drawn By: F. MARTINEZ
Reviewed By: D. FRODSHAM
Date: 12/8/17
Design file no.: KWAQUARIUM_SEAWALL_0.dwg
Scale: AS SHOWN

TETRA TECH INC.
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STUART, FL 34994-2936
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CITY OF KEY WEST
KW AQUARIUM SEAWALL INSPECTION

SEAWALL PLAN VIEW

KEY WEST, MONROE COUNTY, FLORIDA

Sheet Reference:
C-001
Sheet 1 of 4

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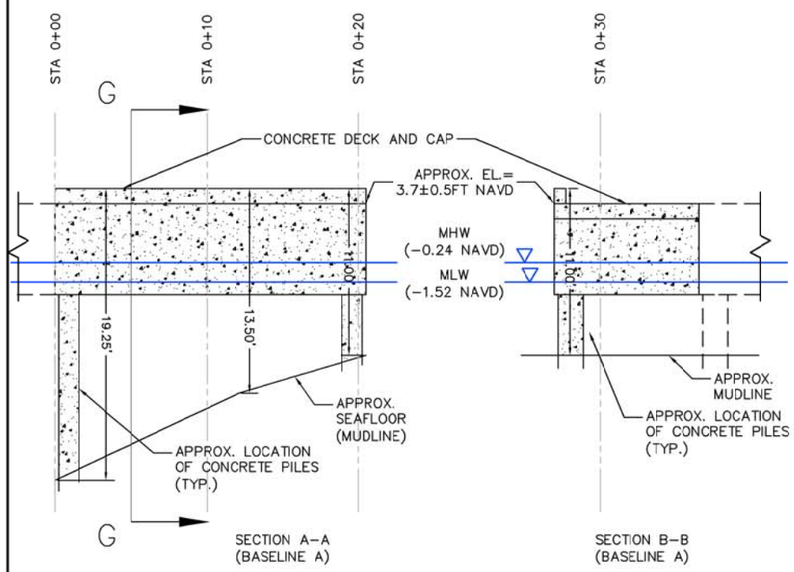

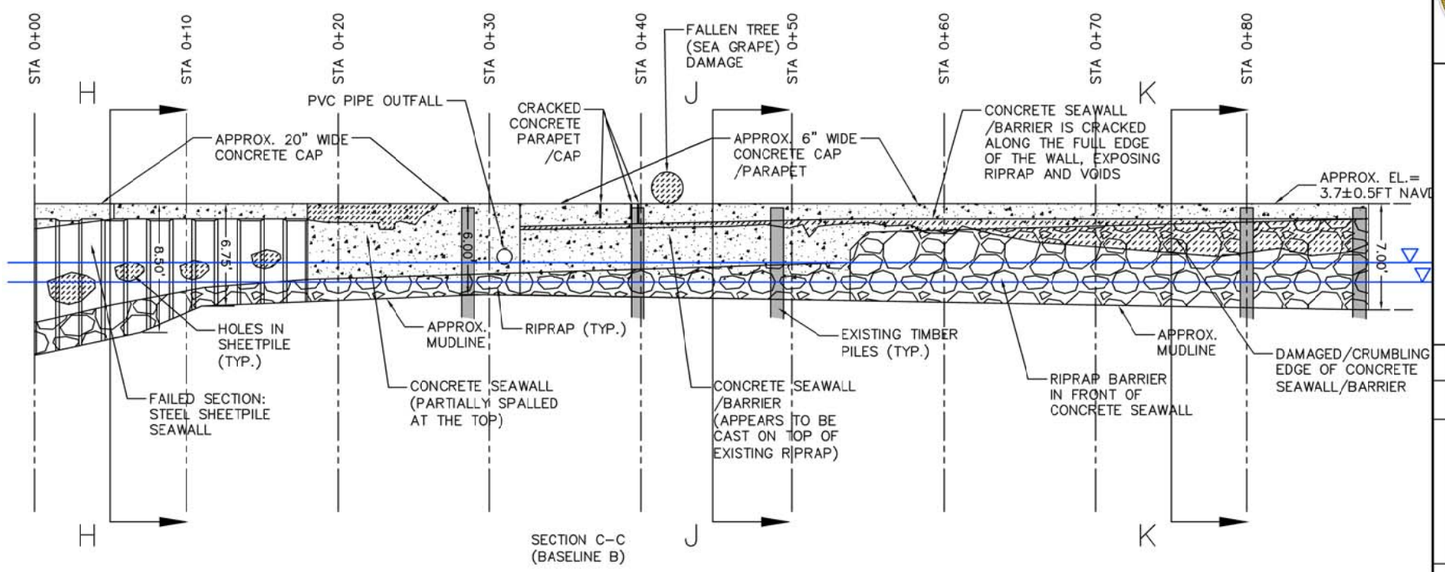

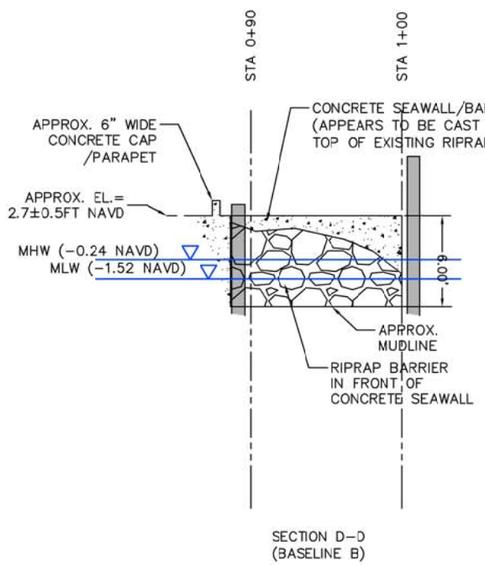

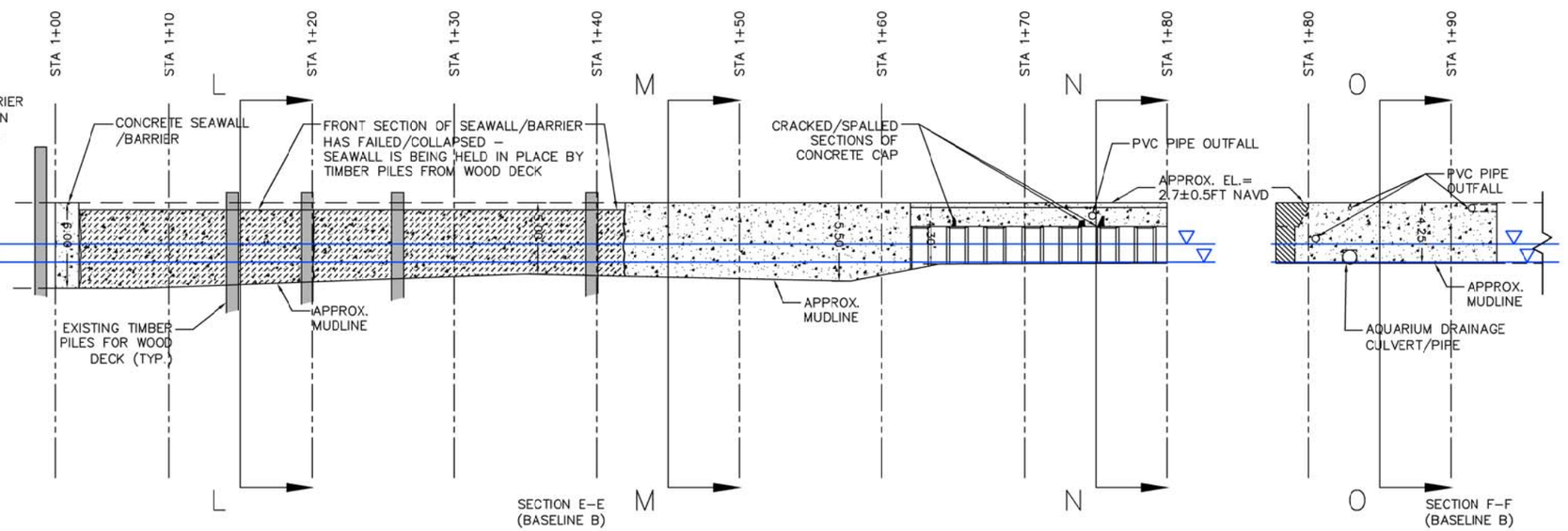

0 10 20 Feet

Stuart E McGehee
Florida PE No. 57536

Mark	Description	Date	Appr.
-	-	-	-

Designed by:
Drawn By: F. MARTINEZ
Reviewed By: D. FRODSHAM
Date: 12/8/17
Design file no.: Model_SEAWALL.dgn
Scale: AS SHOWN

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CITY OF KEY WEST
KW AQUARIUM SEAWALL INSPECTION

SEAWALL FACE VIEW

KEY WEST, MONROE COUNTY, FLORIDA

Sheet Reference:
C-002
Sheet 2 of 4

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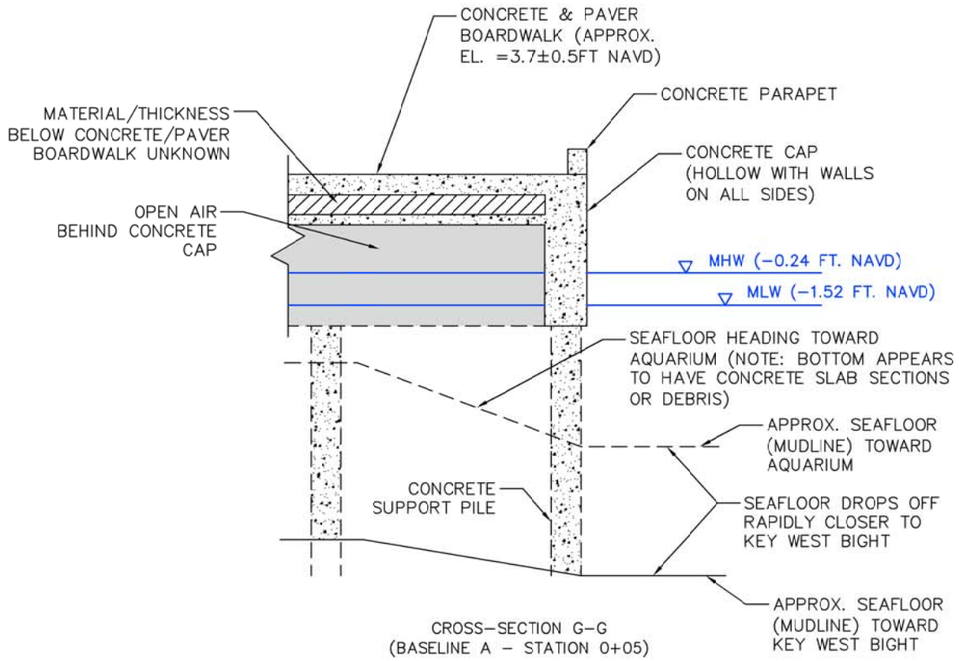
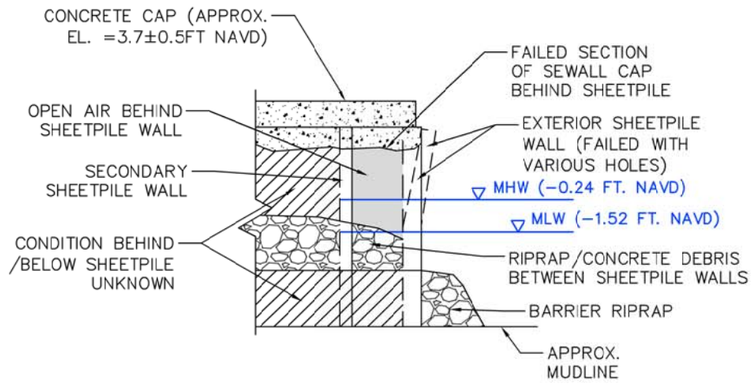
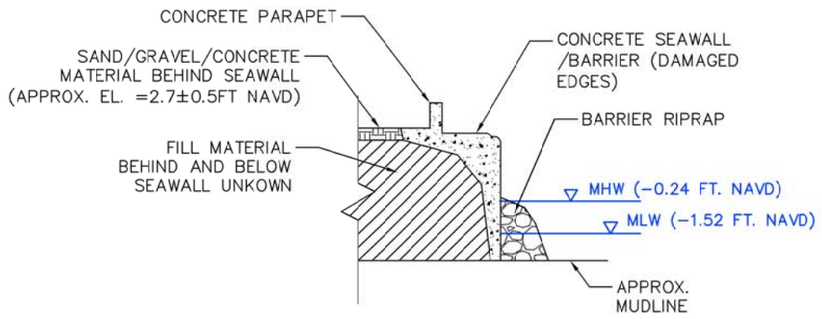


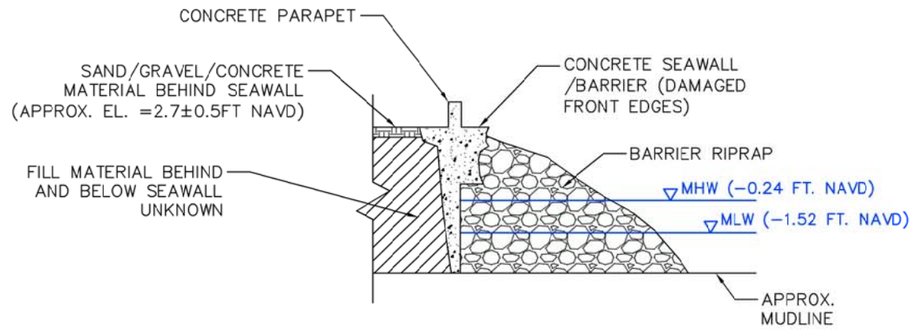
CROSS−SECTION G−G
(BASELINE A − STATION 0+05)



CROSS−SECTION H−H
(BASELINE B − STATION 0+05)



CROSS−SECTION J−J
(BASELINE B − STATION 0+45)



CROSS−SECTION K−K
(BASELINE B − STATION 0+75)

0 6 12 Feet

Stuart E McGehee
Florida PE No. 57536

Mark	Description	Date	Appr.
-	-	-	-

Designed by: S. McGEHEE
Drawn By: F. MARTINEZ
Reviewed By: —
Date: 12/8/17
Design file no: KWAQUARIUM_SEAWALL.dgn
Scale: AS SHOWN

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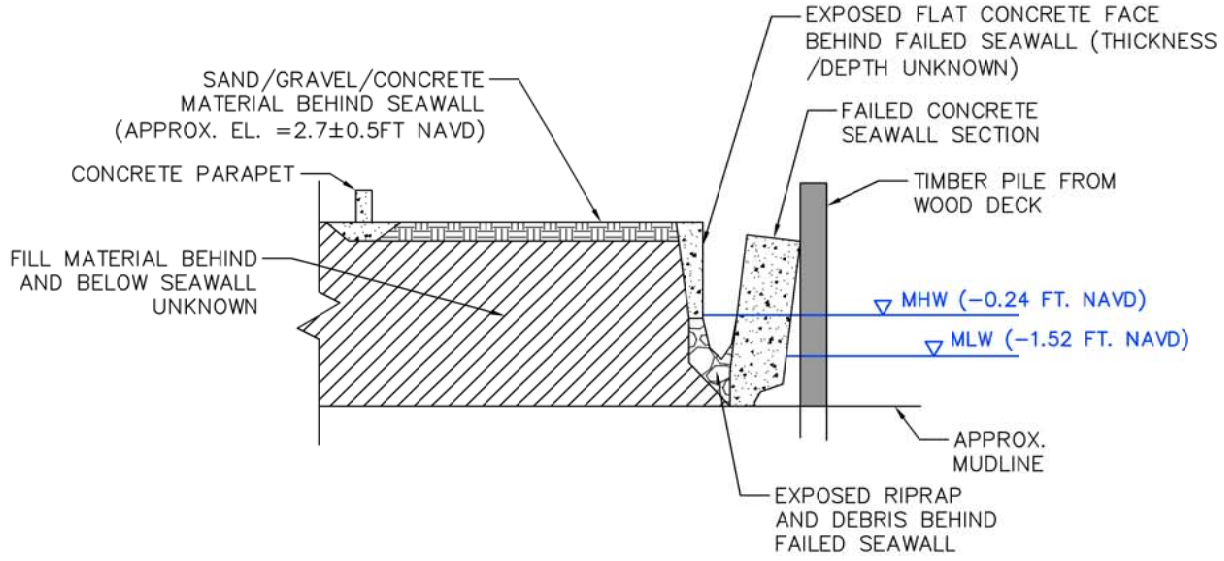
CITY OF KEY WEST
KW AQUARIUM SEAWALL INSPECTION

SEAWALL CROSS-SECTIONS

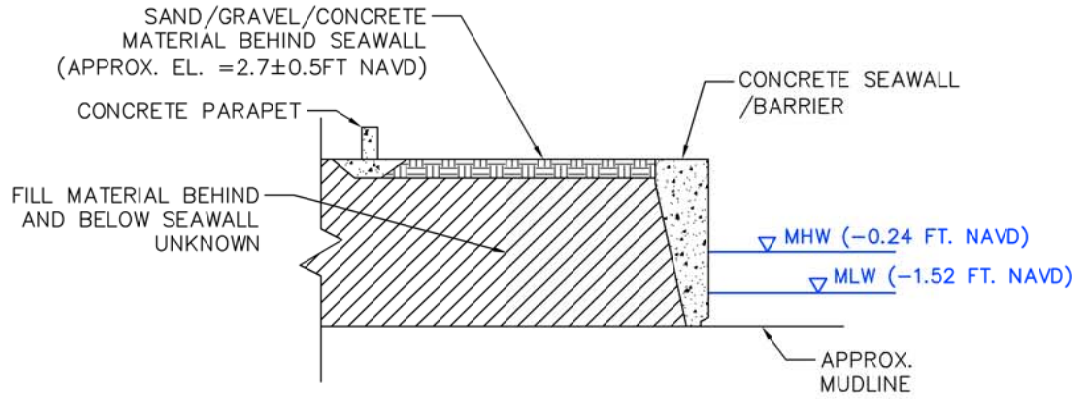
KEY WEST, MONROE COUNTY, FLORIDA

Sheet Reference:
C-003
Sheet 3 of 4

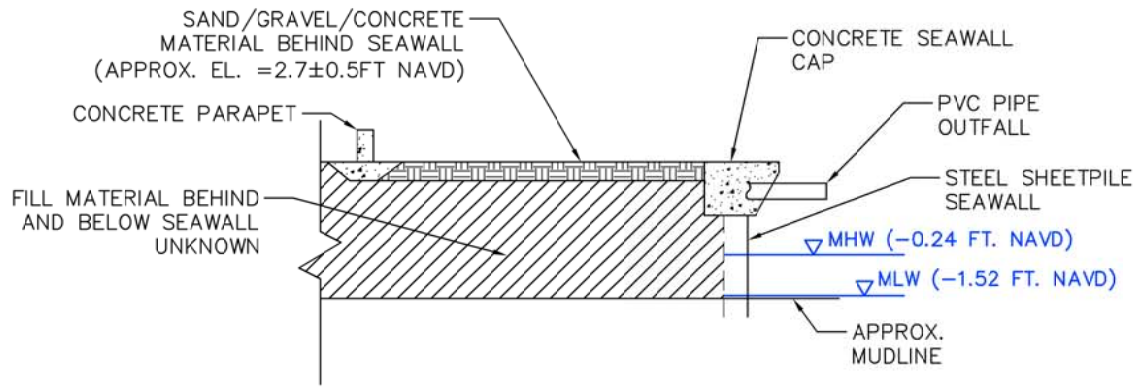
P:\CITY OF KEY WEST\TASK 1B. AQUARIUM SEAWALL\KWAQUARIUM_SEAWALL_V2.DWG



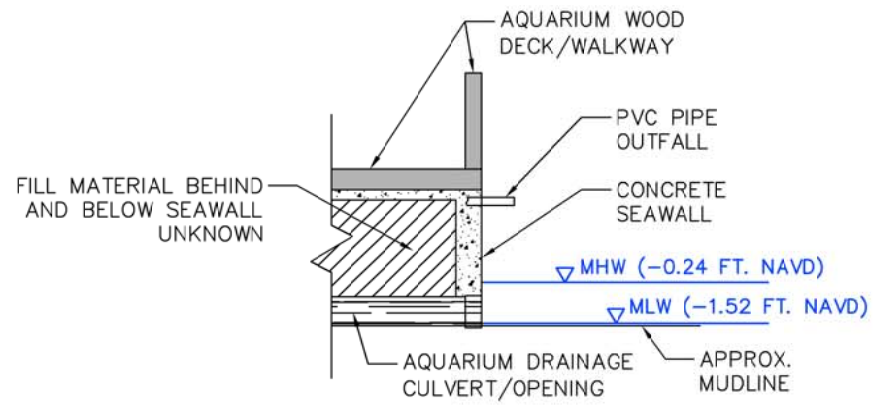
CROSS–SECTION L–L
(BASELINE B – STATION 1+15)



CROSS–SECTION M–M
(BASELINE B – STATION 1+45)



CROSS–SECTION N–N
(BASELINE B – STATION 1+75)



CROSS–SECTION O–O
(BASELINE B – STATION 1+85)

0 6 12 Feet

Stuart E McGehee
Florida PE No. 57536

Mark	Description	Date	Appr.
-	-	-	-

Designed by:
S. MCGEHEE
Drawn By:
F. MARTINEZ
Reviewed By:

Date:
12/8/17
Design file no:
KW_AQUARIUM_SEAWALL.dgn
Scale:
AS SHOWN

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CITY OF KEY WEST
KW AQUARIUM SEAWALL INSPECTION

SEAWALL CROSS-SECTIONS

KEY WEST, MONROE COUNTY, FLORIDA

Sheet Reference:
C-004
Sheet 4 of 4