STRUCTURAL ASSESSMENT REPORT

For

Key West Bight Seawall

Key West, FL

Prepared by:

UNITED Engineering, Inc.

Certificate of Authorization No. 29691

UNITED Project No.: 0301-20

May 9, 2014

Christian Aquino, PE
Florida License No. 74647

Table of Contents

1. INTRODUCTION

On March 12, 2014, Mr. Oscar Bello from Chen Moore & Associates (CMA) authorized UNITED Engineering, Inc. (UNITED) to perform a limited "Structural Condition Assessment" at the Key West Bight Seawall located at 201 William Street, Key West, Florida.

1.1. Objectives

The objective of this report is to provide a visual structural assessment of the seawall with the purpose of providing the necessary information to assess the seawall above and below the waterline and determine any remedial work, if required.

1.2. Documents used in Review

UNITED utilized the following documents for reference purposes:

- Survey by Frederick H. Hildebrandt dated July 13, 2006.
- Aerial from Google Earth

1.3. Methods and Techniques

UNITED utilized the following methods and techniques:

- Visual observation/Digital camera
- Tape measure
- Folding ruler
- Open reel fiberglass tape
- Non Destructive Testing (NDT) Techniques

2. DESCRIPTION OF STRUCTURE

The site consists of a combination of a steel sheet pile and concrete seawall. The steel sheet pile seawall is located at the west side of the marina from the Conch Republic Restaurant to the corner of Greene Street and Elizabeth Street. The concrete seawall extends from the corner of Greene Street and Elizabeth Street to the end of the Ferry Terminal on Trumbo Road.

3. FIELD OBSERVATIONS

UNITED visited the site on April 3, 2014 for a preliminary walk-thru. UNITED re-visited the site on April 4 and 5, 2014 to observe and document the overall condition of the structure above and below the waterline. Please refer to Figures 1-14 in the appendix for location of the areas mentioned below. The following is a summary of our observations:

3.1. Steel Sheet Pile Seawall

Located from the Conch Republic Restaurant to the corner of Greene Street and Elizabeth Street. The first number in the photo number indicates in which figure the photo is located.

3.1.1. Vertical crack and concrete scaling/weathering with exposed aggregate in the concrete cap located about 54′ from the reference point (RP) 1. (Photo 1.1)
3.1.2. Crack/Delamination in the concrete cap and small hole in sheet pile located about 40′ from RP1. The hole is about 2″x2″ square in size. (Photo 1.2)
3.1.3. Crack in the concrete cap located about 28′ from RP1. Crack width varied between 0.035″-0.06″. (Photo 1.3)
3.1.4. Large hole in sheet pile about 12″x12″ square and crack/delamination in the concrete cap about 20′ from RP1. (Photo 1.4 & 1.5)
3.1.5. Spall with corroded rebar and concrete scaling/weathering with exposed aggregate in the concrete cap located about 11′ from RP1. (Photo 1.6)
3.1.6. Spall with corroded rebar in the concrete cap located at RP1. (Photo 1.7)
3.1.7. Corrosion stains in the concrete cap and within the splash zone of the steel sheet pile located about 4′ from RP1. (Photo 1.8)
3.1.8. Crack/Delamination in the concrete cap and corrosion stains within the splash zone of the steel sheet pile located about 10′ from RP1. (Photo 1.9)
3.1.9. Spall and cracks in the concrete cap located about 16′ from RP1. Crack width varied between 0.016″-0.03″. (Photo 1.10)
3.1.10. Delamination in steel sheet pile about 5″x5″ square located about 19′ from RP1.
3.1.11. Hairline cracks with corrosion stains in the steel sheet pile at the concrete cap interface and concrete scaling/weathering with exposed aggregate at underside of cap located about 27′ from RP1. Crack widths in the sheet pile were greater than 0.06″. Crack widths in the cap varied between 0.007″-0.10″. (Photo 1.11)
3.1.12. Hairline cracks in the sheet pile at the concrete cap interface and cracks with efflorescence at the underside of the concrete cap located about 32′ from RP1. Crack widths in the sheet pile were greater than 0.06″. Crack widths in the cap varied between 0.007″-0.10″. (Photo 1.12)
3.1.13. Hairline cracks in the sheet pile at the concrete cap interface and cracks/delamination about 1′ from top of concrete cap located from 30′-50′ from RP1. (Photo 1.13)
3.1.14. Spall with corroded rebar in the concrete cap and hairline cracks in the sheet pile at the concrete cap interface located about 67′-73′ from RP1. (Photo 1.14)
3.1.15. Spall with corroded rebar in the concrete cap and hairline cracks in the sheet pile at the concrete cap interface located about 75′-80′ from RP1.
3.1.16. Hairline cracks with corrosion stains in the sheet pile at the concrete cap interface and crack/delamination at the underside of the concrete cap located 3′-26′ from RP2. (Photo 1.15)
3.1.17. Hairline cracks with corrosion stains in the sheet pile at the concrete cap interface and spall with corroded rebar in the concrete cap located 21′ from RP2.

3.1.18. Hairline cracks with corrosion stains in the sheet pile at the concrete cap interface. Concrete scaling/weathering with exposed aggregate and crack/delamination in the concrete cap located 34′-40′ from RP2. (Photo 1.16)
3.1.19. Hairline cracks with corrosion stains in the sheet pile at the concrete cap interface and crack with efflorescence at underside of concrete cap located about 47′ from RP2.
3.1.20. Hairline cracks with corrosion stains in the sheet pile at the concrete cap interface. Concrete scaling/weathering with exposed aggregate and cracks in the concrete cap located 50′-55′ from RP2.
3.1.21. Hairline cracks with corrosion stains in the sheet pile at the concrete cap interface. Concrete scaling/weathering with exposed aggregate and spall with corroded rebar located 81′-90′ from RP2.
3.1.22. Hairline cracks with corrosion stains in the sheet pile at the concrete cap interface. Spall with corroded rebar located 99′-106′ from RP2.
3.1.23. Wide cracks with corrosion stains in the sheet pile at the concrete cap interface. Cracks and concrete scaling/weathering with exposed aggregate in the concrete cap located 113′ from RP2.

3.2. Concrete Seawall

Located from the corner of Greene Street and Elizabeth Street to the west wall of Thompson Fish House. The first number in the photo number indicates in which figure the photo is located.

3.2.1. Large hole/split between the main concrete wall and a second, wider, concrete wall underwater about mid-depth. The split runs approximately from 0′-34′ from RP3. (Photo 2.1)
3.2.2. Vertical crack from above water surface to underwater hole at seafloor located 33′ from RP3. Crack width varied between 0.04″-0.06″.
3.2.3. Hole at mid-depth of wall about 6″x12″ located 43′ from RP3. (Photo 2.2)
3.2.4. Vertical crack from top of wall to large hole at seafloor located 50′ from RP3. (Photo 2.3)
3.2.5. Crack/Delamination from top of wall to underwater located 71′ from RP3. (Photo 3.1)
3.2.6. Crack/Delamination with corrosion stains about 1′ below top of wall located 96′-107′ from RP3. Vertical crack from top of wall to underwater located at 107′.
3.2.7. Vertical crack from top of wall to underwater hole located at 144′ from RP3.
3.2.8. Spall/Delamination on top of concrete wall located at 154′ from RP3. (Photo 4.1)
3.2.9. Vertical crack from top of wall to bottom of wall underwater located at 21′ from RP4.
3.2.10. Crack/Delamination with heavy vegetation and concrete scaling/weathering located at 38′ from RP4. (Photo 4.2)
3.2.11. Spall at top of wall with vertical crack extending to the bottom of wall underwater located at 58′ from RP4.
3.2.12. Joint in concrete wall with voids located 94′ from RP4. (Photo 5.1)
3.2.13. Approximate 16″x16″ hole in the concrete wall located 108′ from RP4. (Photo 5.2)
3.2.14. Joint in concrete wall with voids located 121′ from RP4.
3.2.15. Joint in concrete wall with voids and hole at seafloor located 13′ from RP5. (Photo 5.3)
3.2.16. Vertical crack in underwater portion of wall located at 23′ from RP5.
3.2.17. Spall around drain pipe located 46′ from RP6.

3.2.18. Cracks and concrete scaling/weathering with exposed aggregate of wall above waterline located from 10'-90' from RP7. (5.4)
3.2.19. Cracks/Delamination with corrosion stains and concrete scaling/weathering with exposed aggregate of wall above waterline located from 0'-110' from RP8. (6.1)
3.2.20. Cracks/spalls with voids along the wall bottom and portions of the wall have scoured at the seafloor. This occurs approximately from 90'-105' from RP8. (Photo 6.2)
3.2.21. Cracks/Delamination with corrosion stains on top of concrete wall and face above waterline located 10'-52' from RP8. (Photo 7.1)
3.2.22. Cracks/spalls with voids along the wall bottom and portions of the wall have scoured at the seafloor located 52' from RP8.
3.2.23. Vertical crack and scour/hole at seafloor located 27' from RP9. (Photo 7.2)
3.2.24. Large vertical crack from top of wall to seafloor located 46' from RP9. (Photo 7.3)
3.2.25. Vertical crack from top of wall to hole on seafloor located 69' from RP9.
3.2.26. Portions of the wall have spalled/weathered away from 127'-153' from RP9 (Photo 8.1).
3.2.27. Large vertical crack from top of wall to seafloor located at 157' from RP9. (Photo 8.2)
3.2.28. Wall has a split/void that is approximately 6" deep and runs approximately 0'-20' from RP10. (Photo 8.3 & 8.4)
3.2.29. Wall has voids and cracks throughout the wall and void/scour at seafloor that runs approximately 22' from RP10 to Thompson Fish House. (Photo 8.5)

3.3. Concrete Seawall

Located from the east wall of Thompson Fish House to the end of the Ferry Terminal on Trumbo Road. The first number in the photo number indicates in which figure the photo is located.

3.3.1. Wall has significant holes/voids, scour, spalls, concrete scaling/weathering with exposed aggregate and cracks/delaminations from Thompson Fish House to RP11 (approximately 190'). (Photos 9.1-9.5)
3.3.2. Vertical cracks leading to a hole located 9' from RP11.
3.3.3. Wall has scour along waterline located 9'-36' from RP11.
3.3.4. Vertical crack running down to scour located 14' from RP11.
3.3.5. Vertical crack running down to scour located 17' from RP11.
3.3.6. Voids around pipe outlets located at 41' and 44' from RP11. (Photo 10.1)
3.3.7. Spall and delamination at the top of wall 3' from RP12. (Photo 10.2)
3.3.8. Large 1' tall by 28" deep scour at seafloor located 7'-14' from RP12. (Photo 10.3)
3.3.9. Large hole/void around pipe outlet located 30' from RP12. Scour at seafloor located 29'-34' from RP12. (Photo 10.4)
3.3.10. Large hole 4' tall and 3' deep located from 44' to 52' from RP12.
3.3.11. Vertical crack from top of wall to seafloor located at 52' from RP12.
3.3.12. Scour at seafloor located 52'-121 from RP12. (Photo 11.1)
3.3.13. Large horizontal crack at wall mid-height located 71'-80' from RP12.
3.3.14. Horizontal crack above waterline located 78'-110' from RP12. (Photo 11.2)
3.3.15. Vertical crack from top of wall to seafloor located at 108' from RP12.
3.3.16. Vertical crack from top of wall to seafloor located at 124' from RP12.
3.3.17. Vertical and horizontal cracking with voids located at 134' from RP12 (Photo 11.3).

3.3.18. Vertical crack and scour approximately 3′ wide located at 5' from RP13.
3.3.19. Scour that runs from 5'-104′ from RP13. Scour is approximately 16″ at certain locations.
3.3.20. Control joint with voids located at 29' from RP13.
3.3.21. Large hole at seafloor located 36′-41′ from RP13.
3.3.22. Wall has split/void located 179′-184′ from RP13. (Photo 12.1)
3.3.23. Wall has spall/scour at seafloor located 188′-224' and 245′-260′ from RP13. (Photo 13.1)
3.3.24. Cracks/Delamination at the concrete wall transition located at 260' from RP13. (Photo 13.2)
3.3.25. Voids around drainage outlet located at 9' and 36′ from RP14. (Photo 13.3)
3.3.26. Hole with backfill washout located at 73′ from RP14. (Photo 14.1)
3.3.27. Vertical crack from top of wall to hole at seafloor and concrete scaling/weathering with exposed aggregate located at 78′ from RP14.
3.3.28. Vertical crack from top of wall to seafloor located at 99′ from RP14.
3.3.29. Vertical crack from top of wall to hole/scour at the seafloor located 111' from RP14. (Photo 14.2 & 14.3)
3.3.30. Scour at seafloor that runs from 105′-127' from RP14.
3.3.31. Vertical crack from top of wall to seafloor and concrete scaling/weathering with exposed aggregate located 125' from RP14. (Photo 14.4 & 14.5)
3.3.32. Vertical crack from top of wall to hole at seafloor, concrete scaling/weathering with exposed aggregate and corrosion stains located at 135' from RP14.
3.3.33. Cracks/Delamination, spalls and concrete scaling/weathering with exposed aggregate and corrosion stains located at 150' from RP14. (Photo 14.6)
3.3.34. Vertical crack from top of wall to seafloor located 9' from RP15.
3.3.35. Wide vertical crack from top of wall to seafloor located 18′ from RP15. (Photo 15.1)
3.3.36. Wall split/void mid-wall and scour seafloor located 18'-69′ from RP15.
3.3.37. Vertical crack from top of wall to seafloor located at 35' and 43' from RP15.
3.3.38. Large hole/void below drainage outlet located 76′-78' from RP15.

4. CONCLUSION

Based on our field observations, the overall condition of the seawall is fair with some poor areas. The typical deficiencies encountered throughout the seawall are cracks/delaminations with corrosion stains, concrete scaling/weathering, spalls with corroded reinforcement, and scour/voids.

The areas with the worst cracks/delaminations and spalls are the steel sheet pile concrete cap and the concrete seawall located from Waterfront Market to Turtle Kraals Restaurant. The areas with the worst scour/voids and concrete scaling/weathering are the concrete seawalls located from Thompson Fish House to the Raw Bar Restaurant.

In our opinion, the areas of major concern are the concrete seawalls from Waterfront Market to Turtle Kraals Restaurant and Thompson Fish House to the Raw Bar Restaurant. Even though the seawalls at these areas are still in safe operation, delaying repairs could adversely affect the areas the seawalls support. In time, the scour/voids will increase leading to additional damage and, ultimately, failure of the seawalls due to significant cracking, spalls, and settlement from fill washing away.

The deficiencies observed are most likely a result of the aggressive, corrosive environment the seawalls are located in. As cracks form in the concrete, chlorides from the ocean water enter the cracks causing the steel reinforcement to corrode and expand. This expansion causes the concrete to begin to delaminate, causing further cracks, and ultimately spall (break off). Spalls that have occurred in areas that do not have corroded reinforcement present are due to organic material and abrasion erosion. Over time, as organic material (i.e. marine plants, barnacles, etc.) grows in cracks, it breaks apart the concrete by expanding. The abrasion erosion caused by tidal changes and wave action further weakens the concrete by dissolving the cement paste and aggregates on the surface and washing away loose material. The tidal changes and wave actions also lead to scour which further exacerbates cracking and spalls. As voids form due to scour and organic growth, the wall begins to settle (move) which causes cracks to form. This allows for chlorides to corrode the steel reinforcement and organic material to grow in the cracks causing the concrete to delaminate and spall. The process continues until failure.

The formation of initial cracks could be a result of excess water in the concrete mix at the time of placing and inadequate expansion/contraction joints. Excessive water reduces strength, increases curing and drying shrinkage, increases porosity, and reduces the abrasion resistance of concrete. This low durability of the concrete allows for the aforementioned causes to attack the concrete. Concrete with inadequate joints will crack and make a joint wherever a joint was needed. These newly formed cracks become a point of attack for chlorides and organic material.

5. RECOMMENDATION

Based on field observations, it is recommended that aforementioned areas of the seawall be repaired. A Florida licensed Structural Engineer shall be retained to fully develop construction documents. The following types of repairs are recommended:

Concrete Repair

Epoxy Injection: Cracks that are in sound concrete (do not have corrosion stains, sound hollow when struck with a hammer indicating delamination, etc.) and have a crack width between 0.005 and 0.25 inches may be injected with an epoxy resin. Prior to epoxy injection, cracks being repaired shall be cleaned to remove any loose debris and organic material.

Concrete Spall/Delamination Repair (without reinforcement): Concrete that is not sound (loose, delaminated, etc.) shall be removed and the sound concrete surface shall be cleaned of any debris and organic material. The area being repaired shall be saw cut to a minimum depth of 1-1/2 inches and form a square/rectangular area with 90 degree sides. Interior corners should be rounded to a minimum radius of 1 inch. Feather edges must be avoided. The area receiving new concrete shall be roughened/keyed in order to provide adequate bond. A bonding agent may be provided in addition for added bond or as a substitute to roughening the concrete surface. Once the area has been prepped, patch with repair mortar that is suitable for extremely aggressive environments.

For areas that are deeper than 2 inches and/or have section loss greater than 20%, repairs shall be made by shotcrete. Care shall be taken not to adversely affect adjacent, sound concrete. The concrete surface receiving shotcrete shall be prepared as aforementioned.

Concrete Spall/Delamination Repair (with reinforcement): Remove concrete that is not sound (loose, delaminated, etc.) above oxidized (corroded) reinforcement beginning with a ½″ deep saw cut perimeter. Use only light, 15 LB electric chipping hammers. Once initial removal is complete, proceed with the undercutting of all exposed oxidized reinforcement providing 1″ minimum clearance between exposed reinforcement and sound concrete. Concrete removal shall extend along oxidized reinforcement to a location that is free of bond inhibiting conditions and where reinforcement is well bonded in sound concrete. Repair area shall form a square/rectangular area with 90 degree sides. Interior corners should be rounded to a minimum radius of 1 inch. Feather edges must be avoided.

Oxidized reinforcement shall be sandblasted or mechanically cleaned. Splice reinforcement with equal size bar where section loss of 15-20% occurs. All exposed reinforcement shall be coated with a corrosion inhibitor. Patch area with repair mortar that is suitable for extremely aggressive environments.

Steel Sheet Pile Repair

Oxidized areas above the waterline shall be cleaned by sandblasting or mechanically removing any oxidation and organic material. Once all detrimental material has been removed, abrasive-blast the exposed steel and immediately coat steel with coal tar-epoxy coating. Provide two coats with first coat yielding a dry film thickness of 8-10 mils. Apply second coat to achieve a final total dry film thickness of 16-20 mils. Steel not coated immediately after the surface preparation will need to be re-blasted.

At locations where there is a hole in the sheet pile, fill hole by pumping grout until all voids are filled.

6. OPINION OF PROPABLE COST

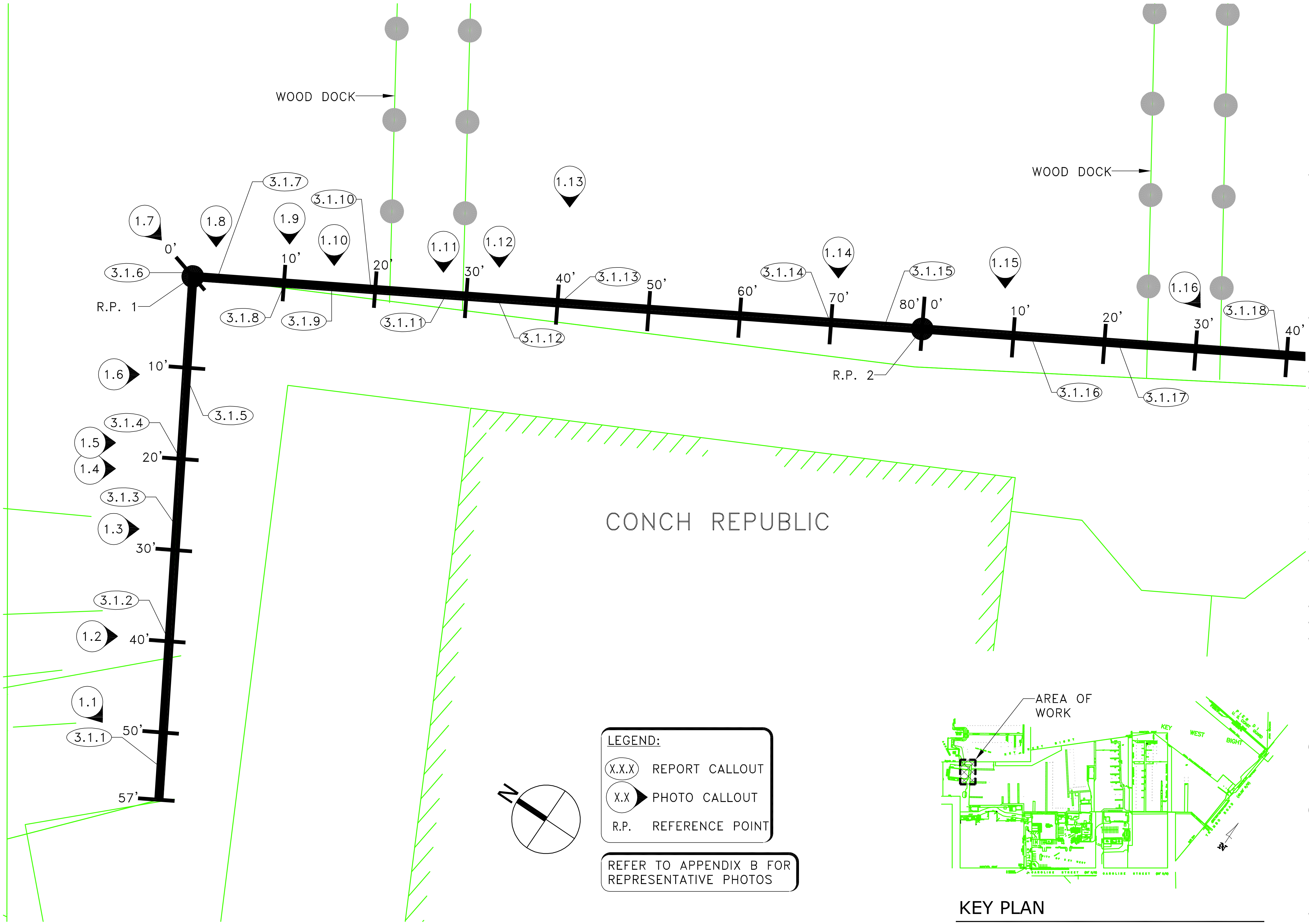
Repair Type	Qty	Unit	Unit Price	Total
Spall/Delamination	368	CF	$250.00	$92,000
Epoxy Injection	348	LF	$10.00	$3,480
Grout Fill (Scour/Voids)	824	CF	$150.00	$123,600
Corrosion Protection (Steel Sheet Pile)	300	SF	$13.50	$4,050
		Subtotal		$223,130
		50%	Contingency	$111,565
		Total		**$334,695**

7. DISCLAIMER

The opinions and comments in this report are based on visual observation only, limited structural analysis, and limited non-destructive testing. There is no claim, either stated or implied. This report does not address any other portions of the structure other than those areas mentioned, nor does it provide any warranty, either expressed or implied, for any portion of the existing structure. This report is created solely for the Client's benefit, and no other entity shall have any rights or claim against the conditions assessment professional because of the performance or non-performance of the observations, opinions, conclusions or recommendations contained herein.

APPENDIX A

FIGURES



KEY PLAN

N.T.S.

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To the best of my knowledge these plans and specifications comply with the applicable minimum building codes.
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Submittals / Revisions

Drawn: DE
Checked: CA
Reviewed: JJF

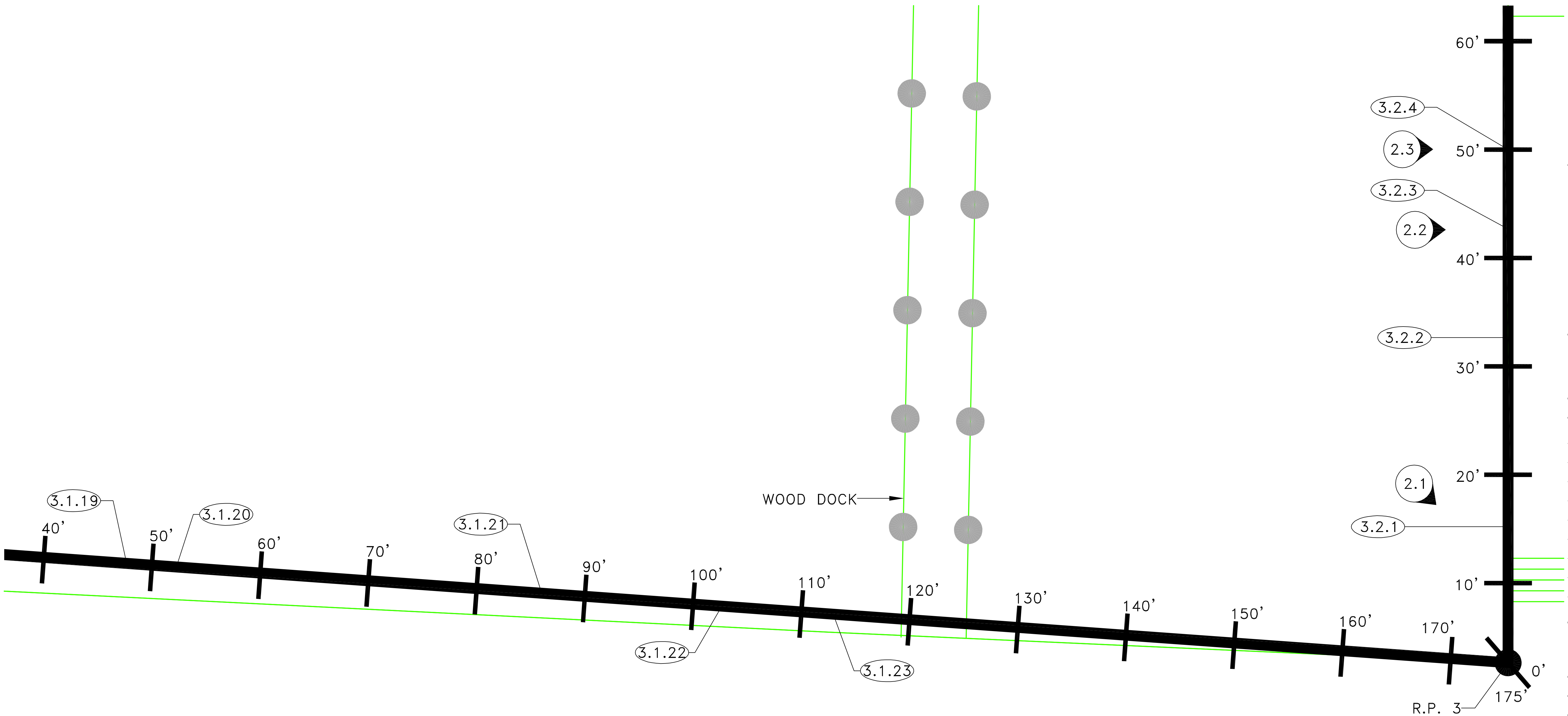
UE Project No.: 0301-20

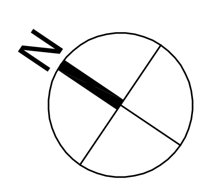
Date: 05-09-14

KEY WEST BIGHT SEA WALL SURVEY

CITY OF KEY WEST, FL

FIG. 1





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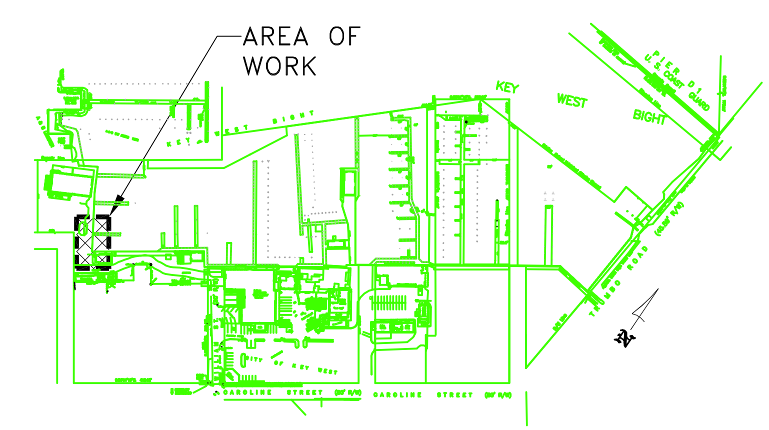
X.X PHOTO CALLOUT

R.P. REFERENCE POINT

REFER TO APPENDIX B FOR REPRESENTATIVE PHOTOS



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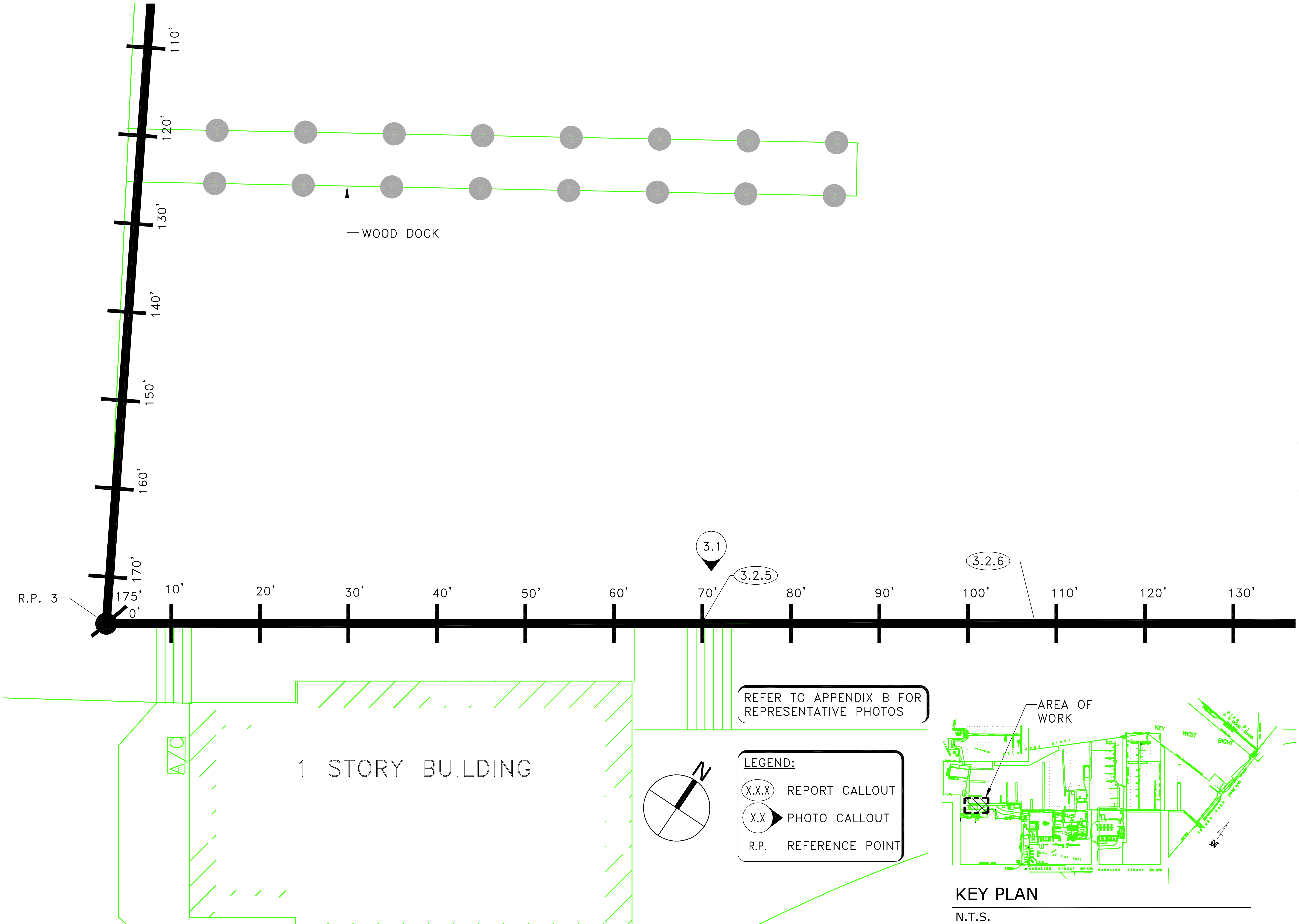
KEY WEST BIGHT SEA WALL SURVEY

CITY OF KEY WEST, FL

FIG. 2



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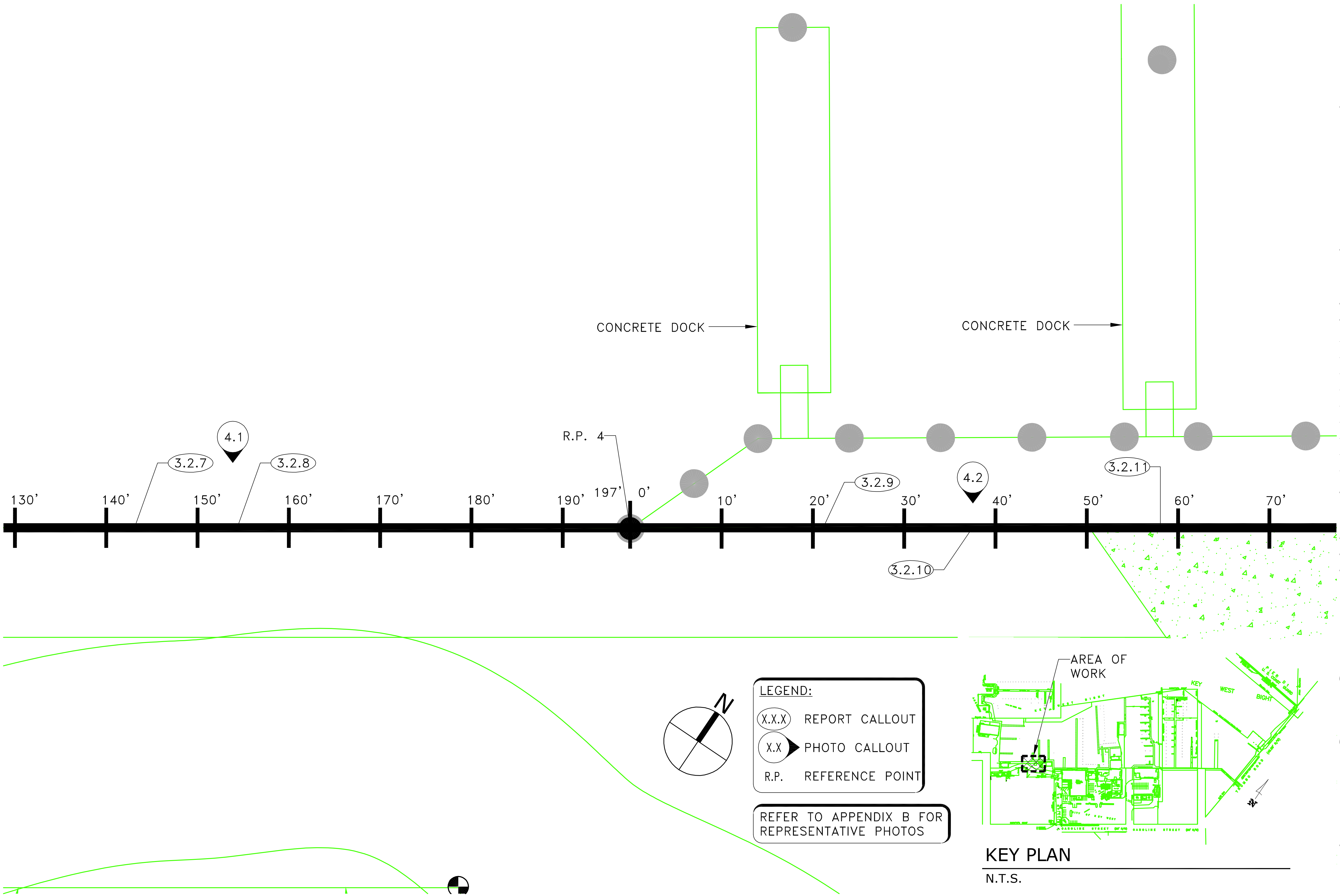
KEY WEST BIGHT SEA WALL SURVEY

CITY OF KEY WEST, FL

FIG. 3



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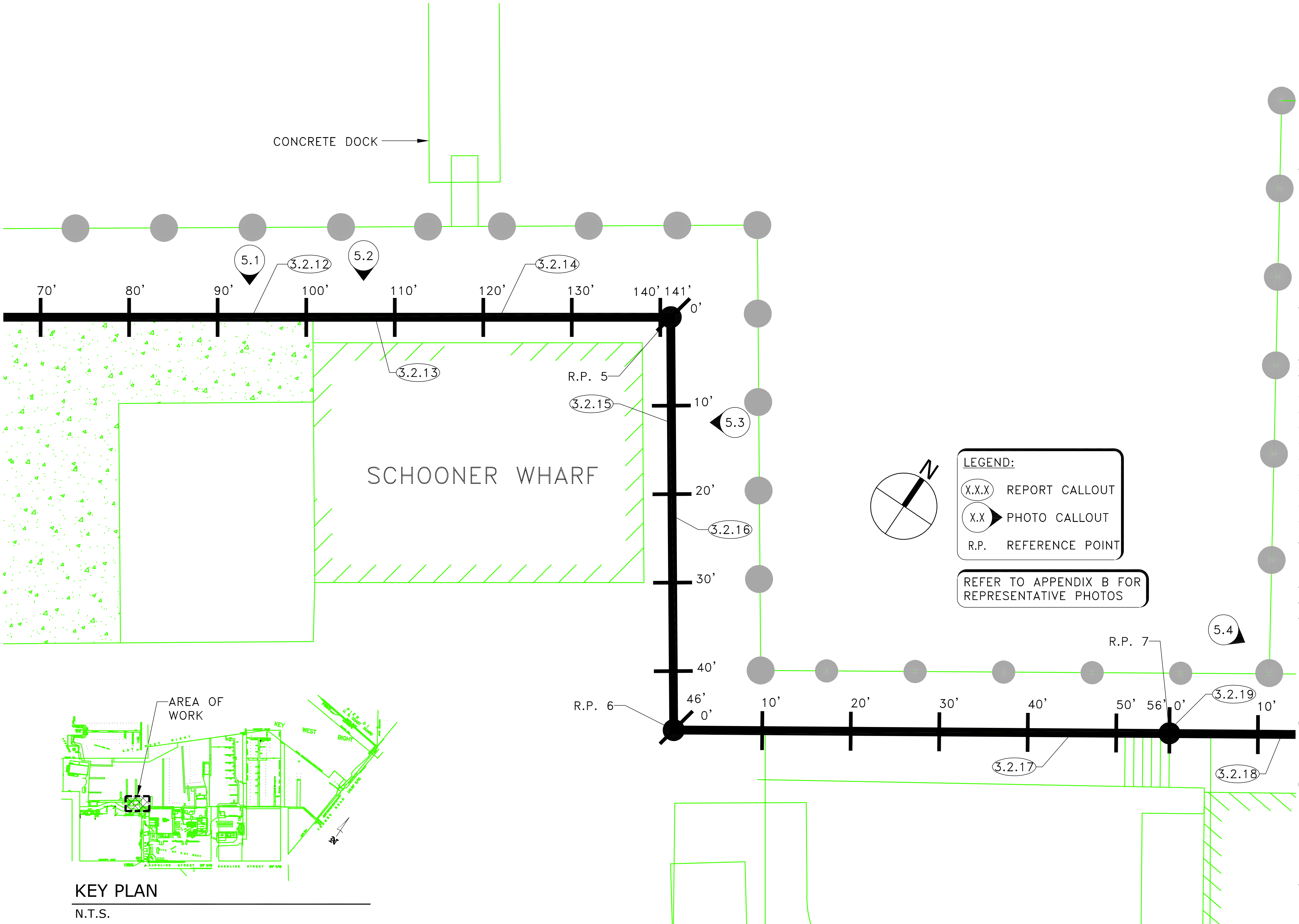
KEY WEST BIGHT
SEA WALL SURVEY

CITY OF KEY WEST, FL

FIG. 4



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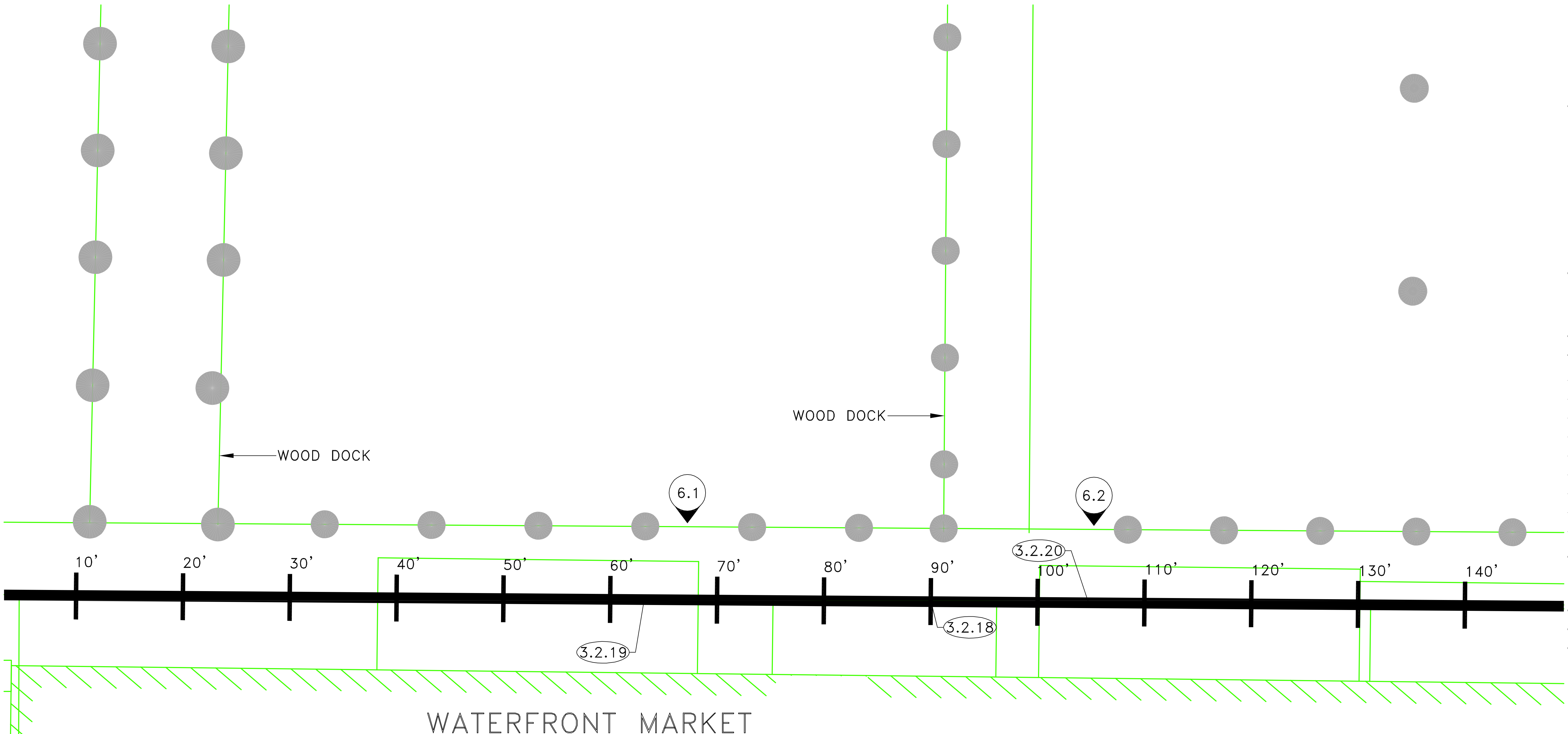
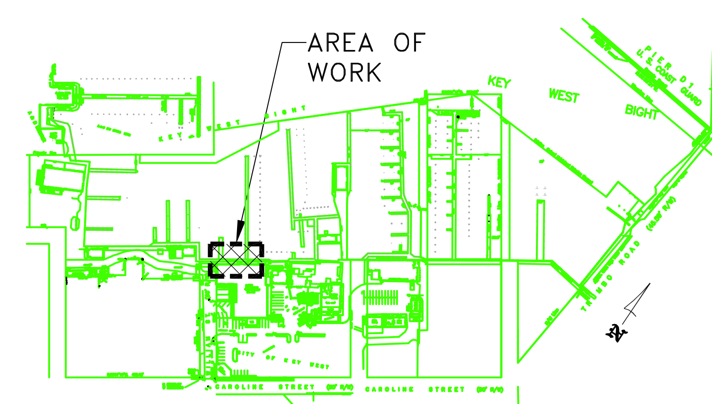
KEY WEST BIGHT SEA WALL SURVEY

CITY OF KEY WEST, FL

FIG. 5





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KEY WEST BIGHT SEA WALL SURVEY

CITY OF KEY WEST, FL

FIG.6

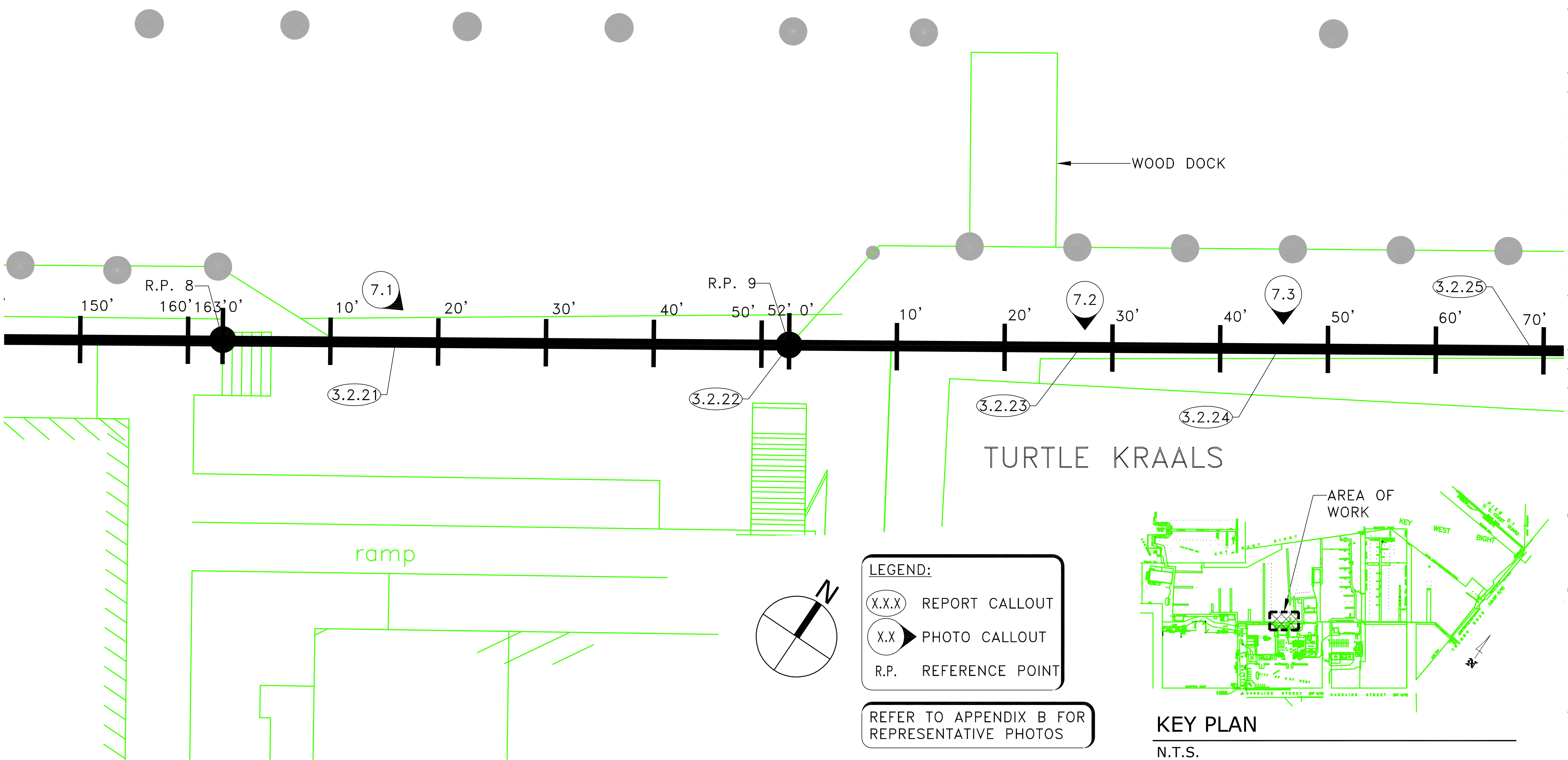

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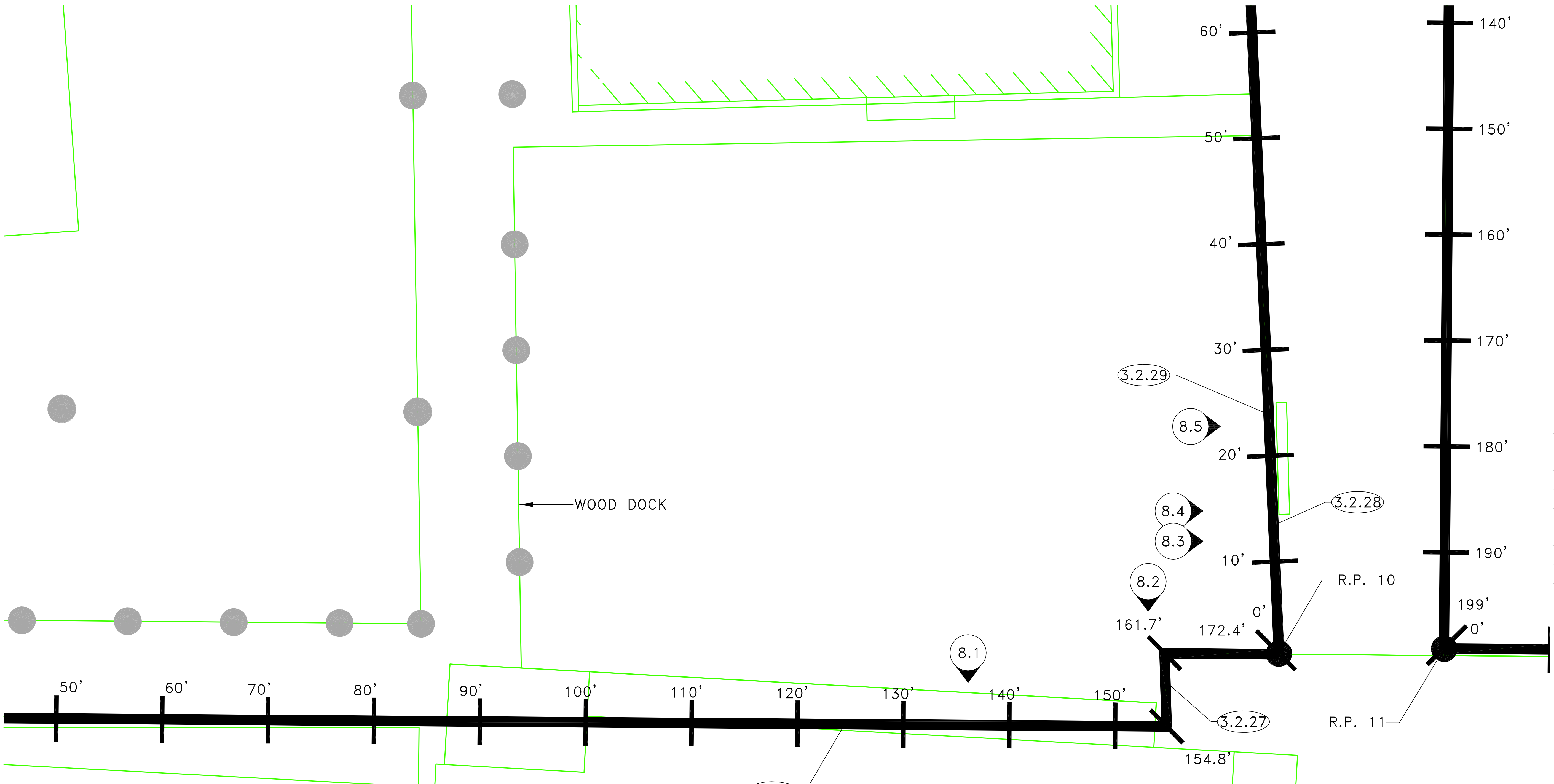
FIG. 7



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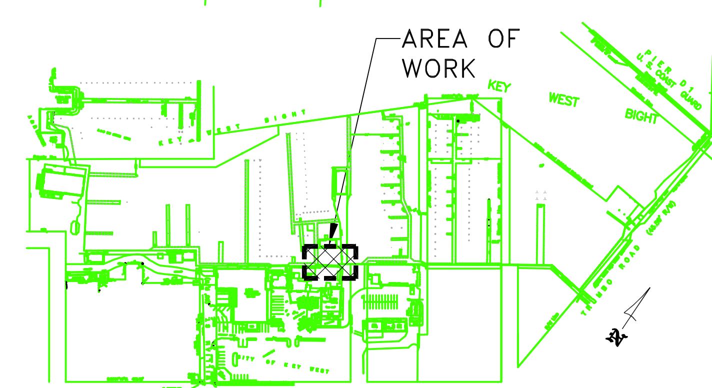

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Certificate of Authorization No. 29691

To the best of my knowledge these plans and specifications comply with the applicable minimum building codes.
CHRISTIAN AQUINO, P.E.
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Florida License No. 74647

Submittals / Revisions

Drawn: DE
Checked: CA
Reviewed: JJF

UE Project No.: 0301-20

Date: 05-09-14

KEY WEST BIGHT SEA WALL SURVEY

CITY OF KEY WEST, FL

FIG. 8

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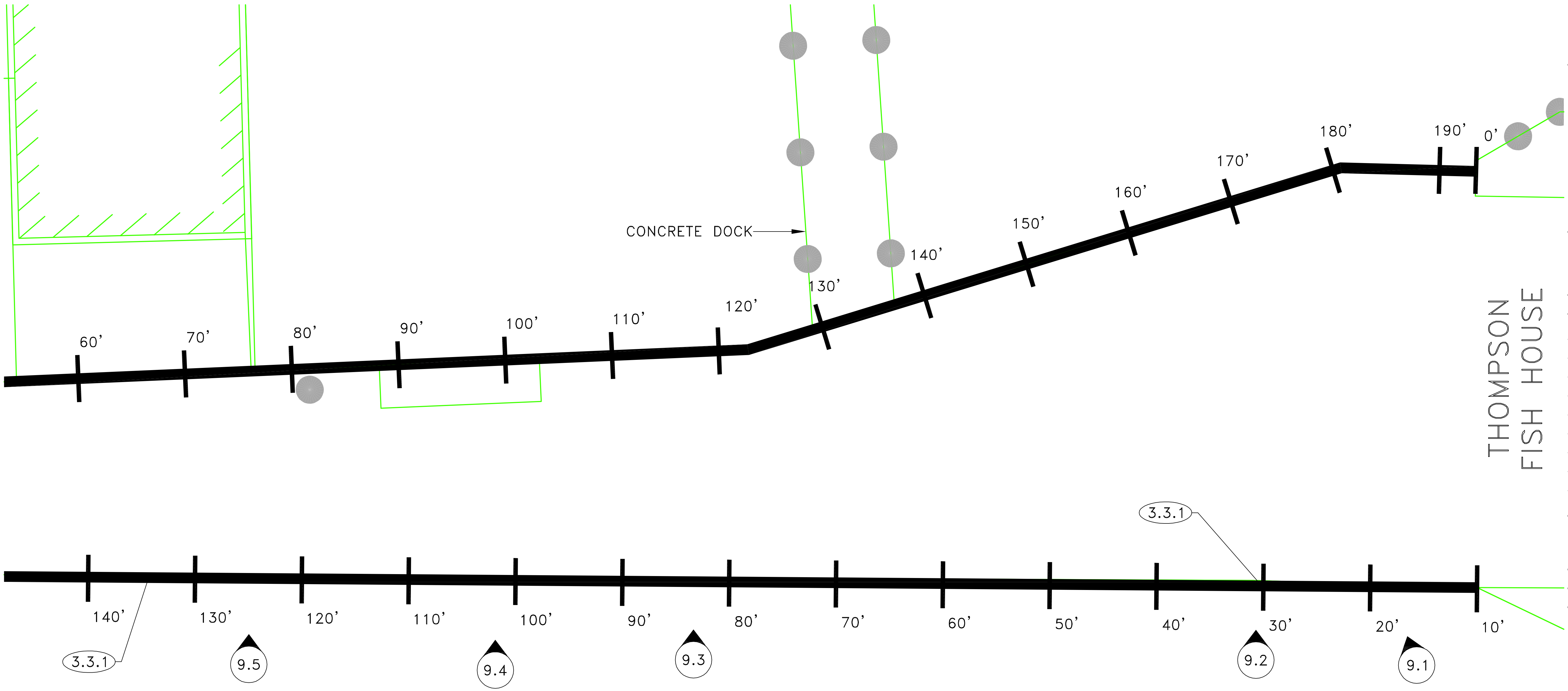

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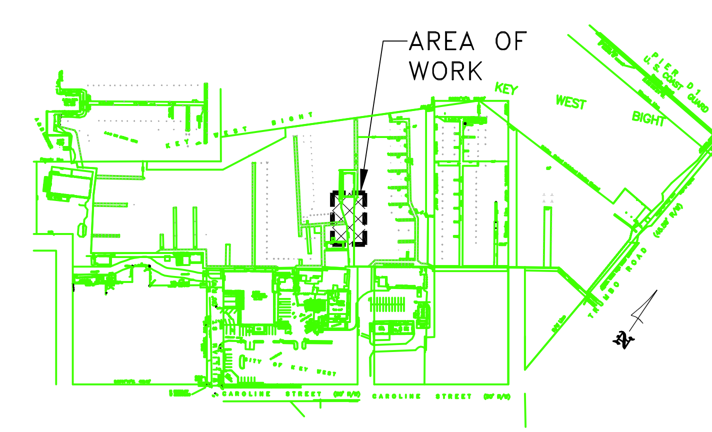
X.X	PHOTO CALLOUT
R.P.	REFERENCE POINT

REFER TO APPENDIX B FOR REPRESENTATIVE PHOTOS



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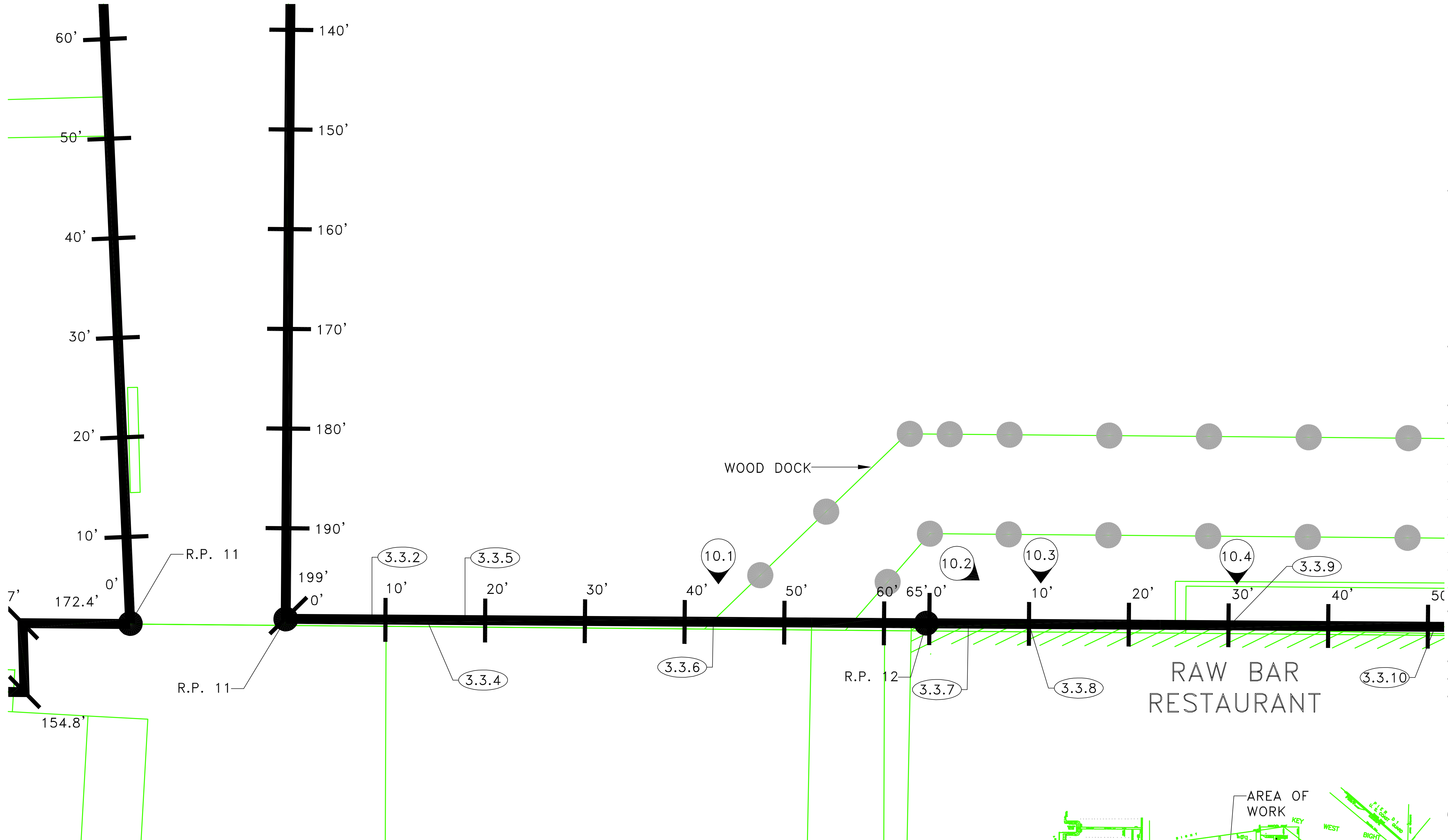
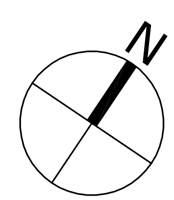
KEY WEST BIGHT
SEA WALL SURVEY

CITY OF KEY WEST, FL

FIG. 9





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X.X PHOTO CALLOUT

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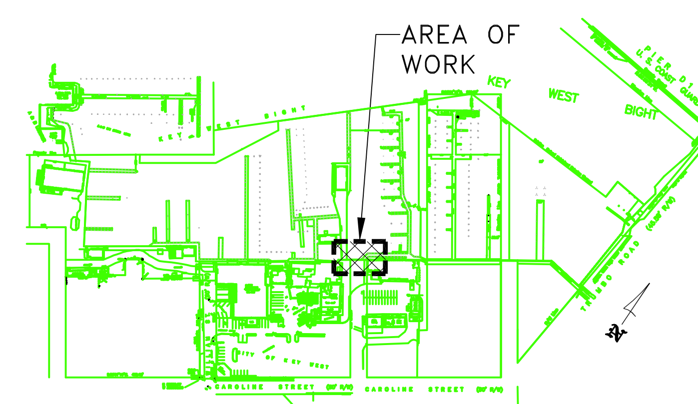
REFER TO APPENDIX B FOR REPRESENTATIVE PHOTOS



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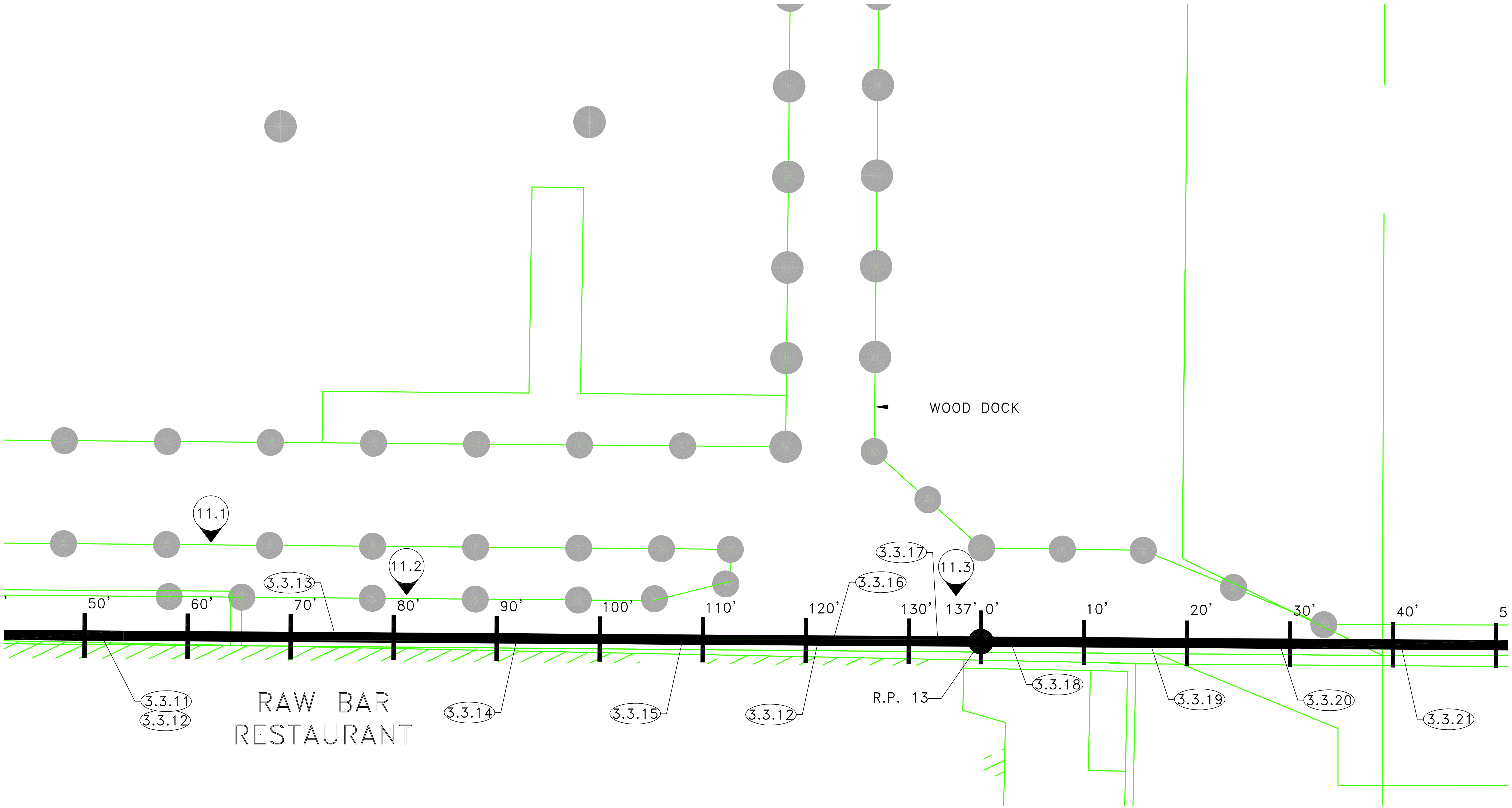
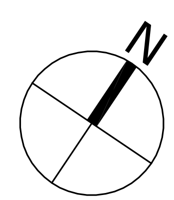
KEY WEST BIGHT
SEA WALL SURVEY

CITY OF KEY WEST, FL

FIG. 10





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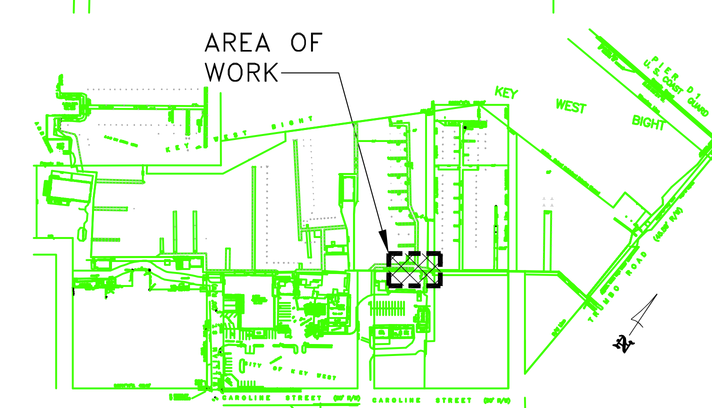
X.X	PHOTO CALLOUT
R.P.	REFERENCE POINT

REFER TO APPENDIX B FOR REPRESENTATIVE PHOTOS



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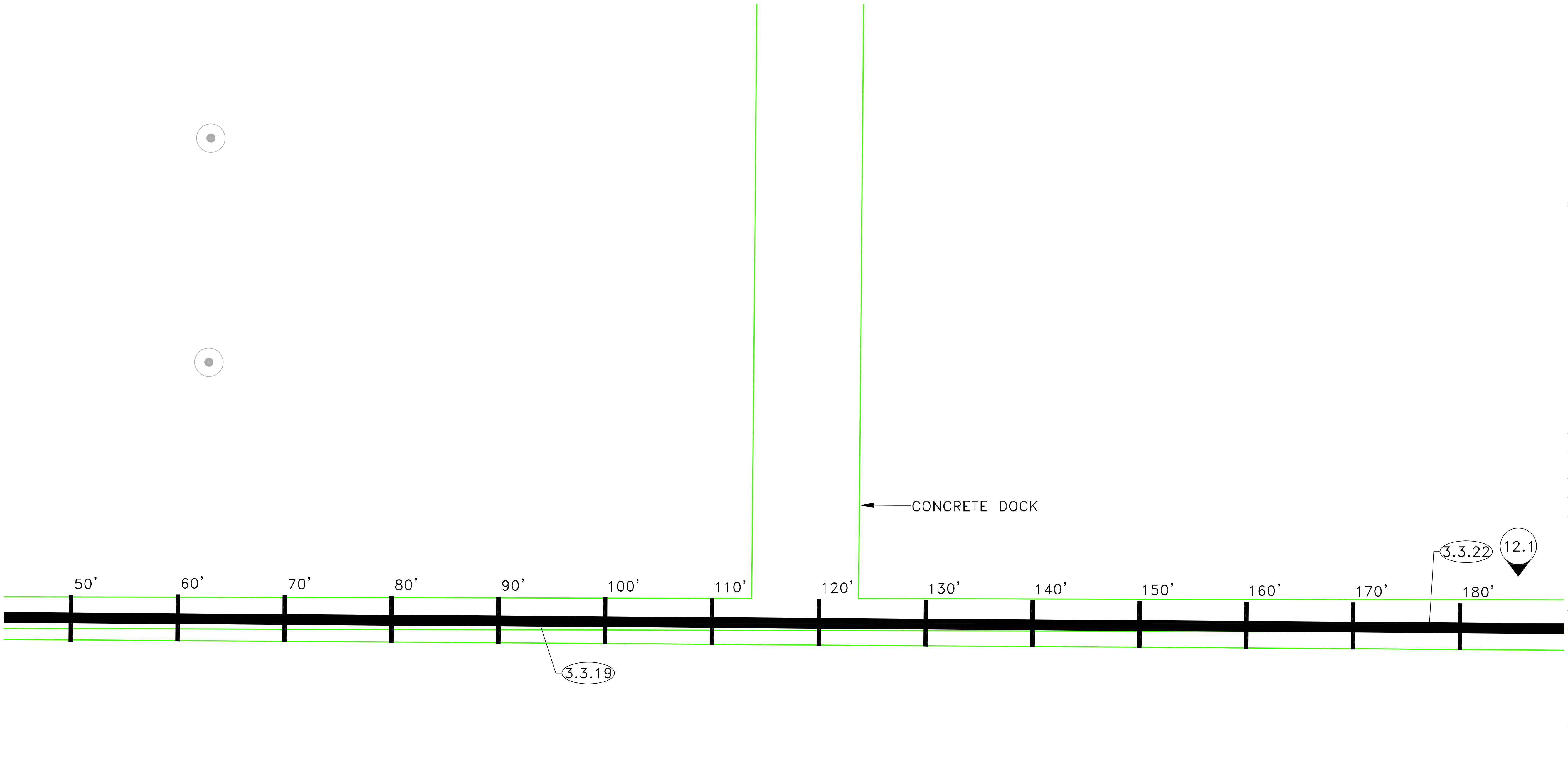
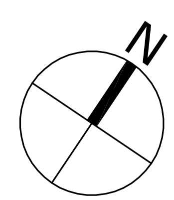
CITY OF KEY WEST, FL

FIG. 11





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X.X	PHOTO CALLOUT
R.P.	REFERENCE POINT

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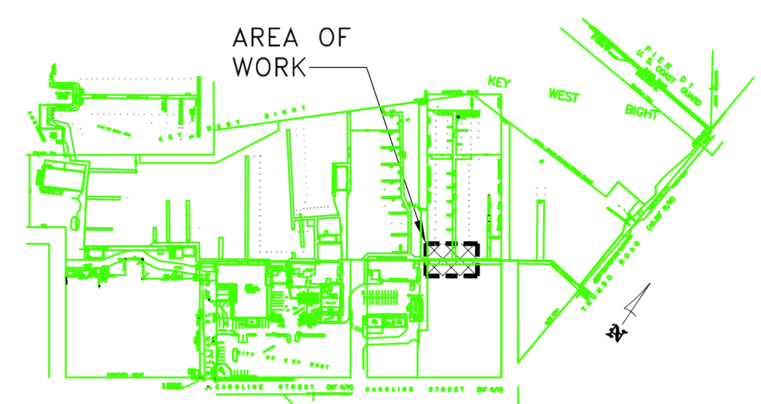

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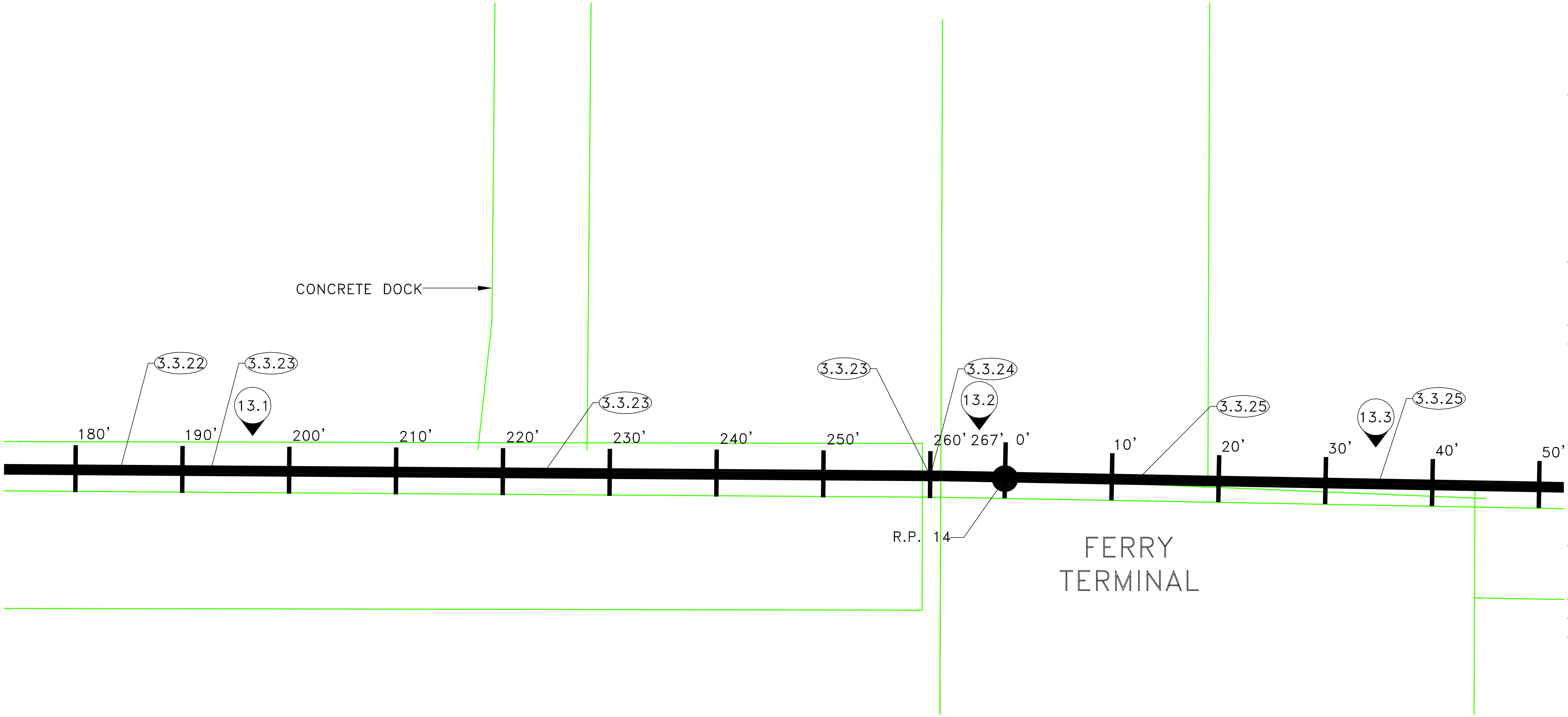
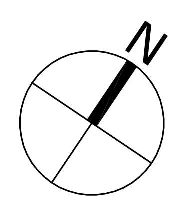
KEY WEST BIGHT SEA WALL SURVEY

CITY OF KEY WEST, FL

FIG. 12





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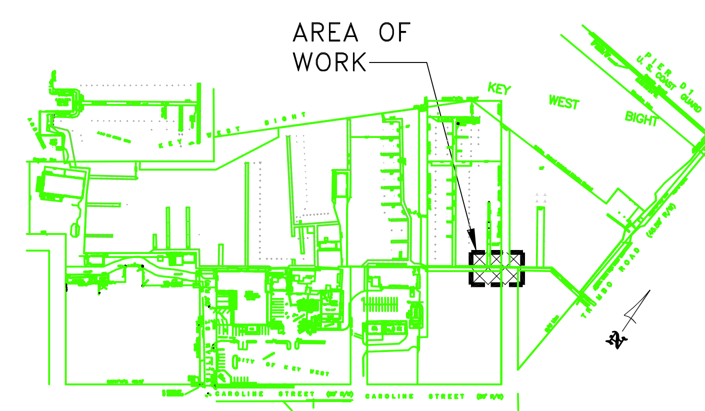
X.X	PHOTO CALLOUT
R.P.	REFERENCE POINT

REFER TO APPENDIX B FOR REPRESENTATIVE PHOTOS



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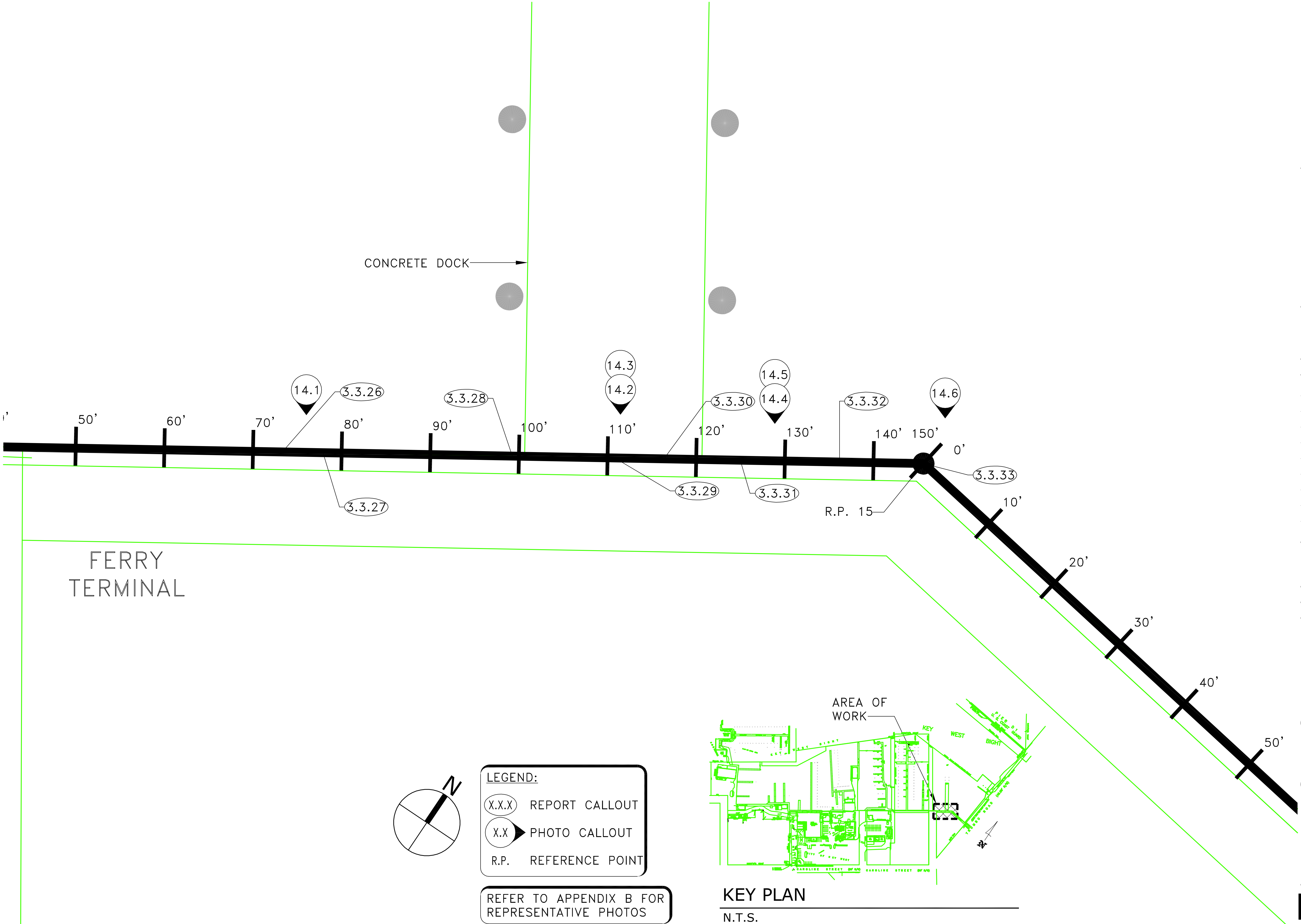
KEY WEST BIGHT
SEA WALL SURVEY

CITY OF KEY WEST, FL

FIG. 13



LEGEND:

X.X.X REPORT CALLOUT

X.X PHOTO CALLOUT

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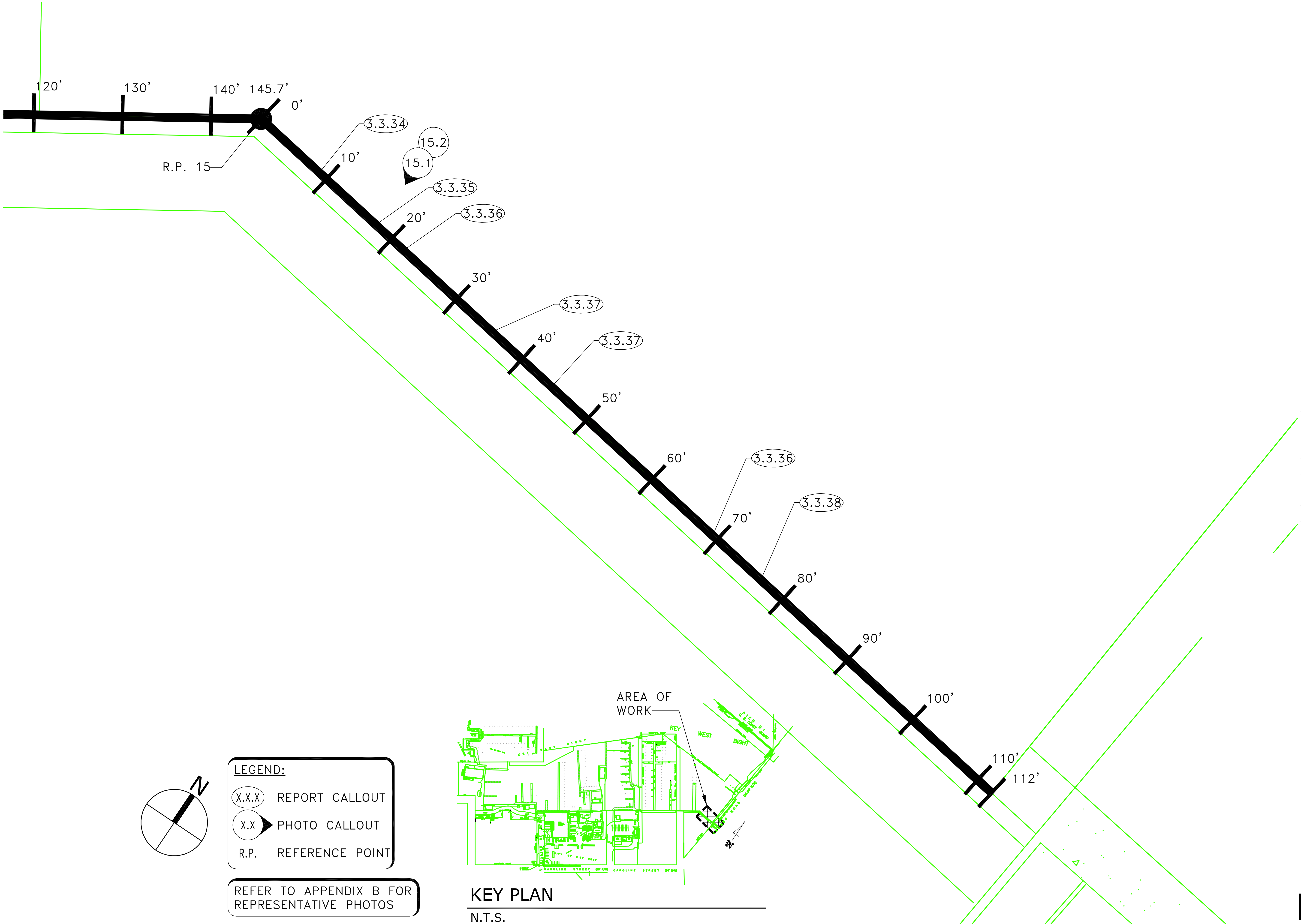
CITY OF KEY WEST, FL

FIG. 14



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KEY WEST BIGHT SEA WALL SURVEY
CITY OF KEY WEST, FL

FIG. 15

APPENDIX B

REPRESENTATIVE PHOTOS

Photo 1.1 – Concrete Scaling/Weathering

Photo 1.2 – Crack/Delamination in Pile Cap

Photo 1.3 – Crack in Pile Cap

Photo 1.4 – Hole in Steel Sheet Pile

Photo 1.5 – Crack/Delamination in Pile Cap

Photo 1.6 – Spall with Corroded Reinforcement

Photo 1.7

Photo 1.8 – Cracks with Corrosion Stains

Photo 1.9

Photo 1.10 – Concrete Spall

Photo 1.11 – Cracks in Sheet Pile and Concrete Scaling/Weathering in Cap

Photo 1.12 – Crack in Pile Cap with Efflorescence

Photo 1.13 – Cracks/Delamination in Concrete Cap

Photo 1. 14 – Spall with Corroded Reinforcement

Photo 1.15 – Cracks in Sheet Pile & Crack/Delamination in Concrete Cap

Photo 1.16

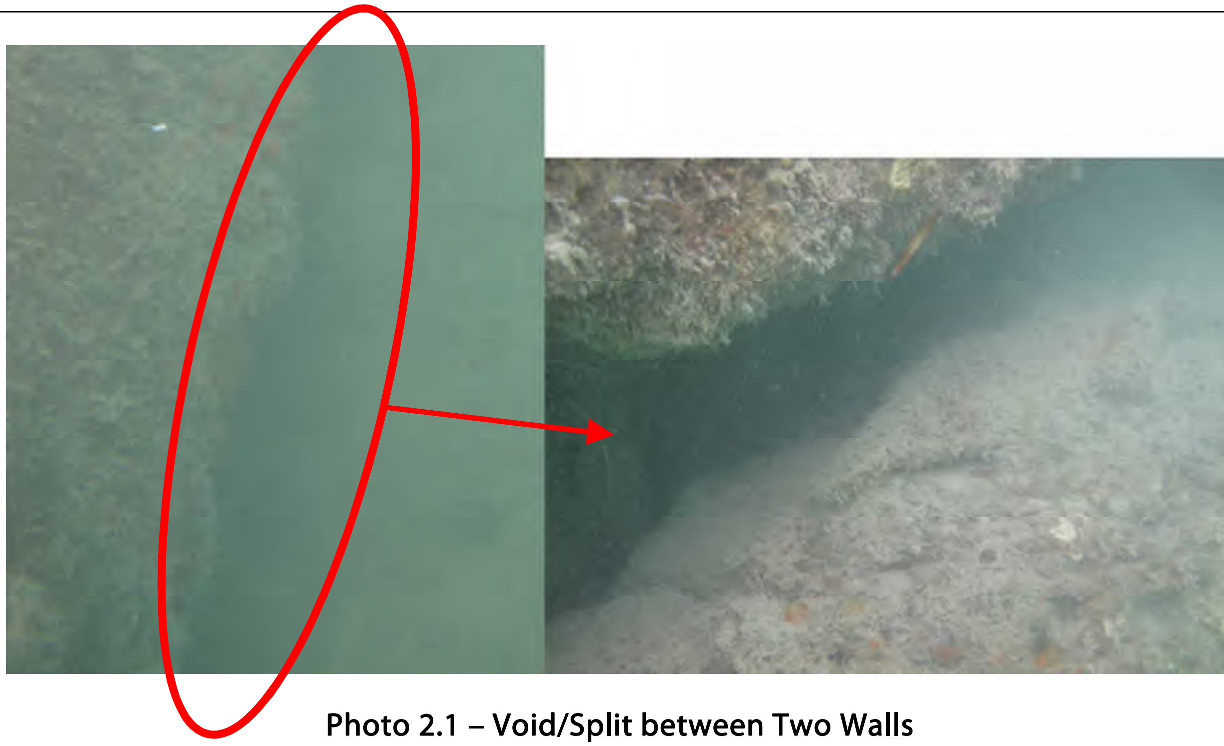

Photo 2.1 – Void/Split between Two Walls
(Picture on the left is a top view)

Photo 2.2 – Spall/Void in Concrete Seawall

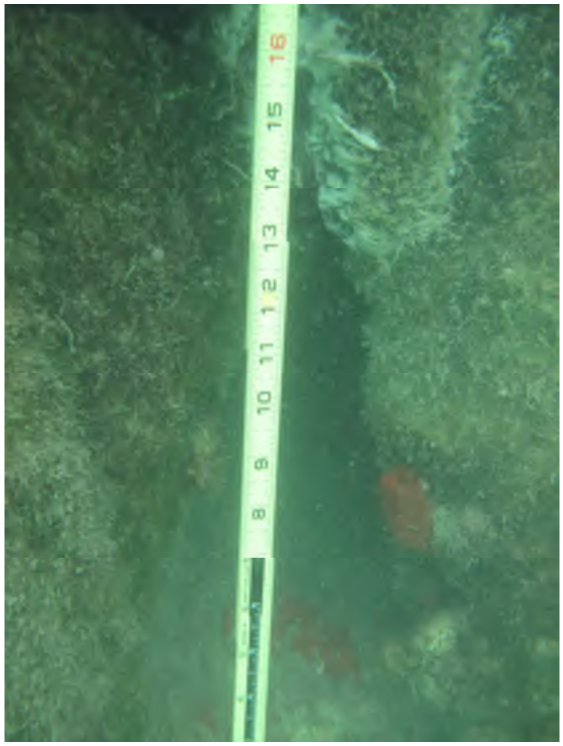

Photo 2.3 – Void in Concrete Seawall

Photo 3.1 – Crack/Delamination in Concrete Seawall

Photo 4.1 – Spall/Delamination top of Concrete Seawall

Photo 4.2 – Crack/Delamination in Concrete Seawall

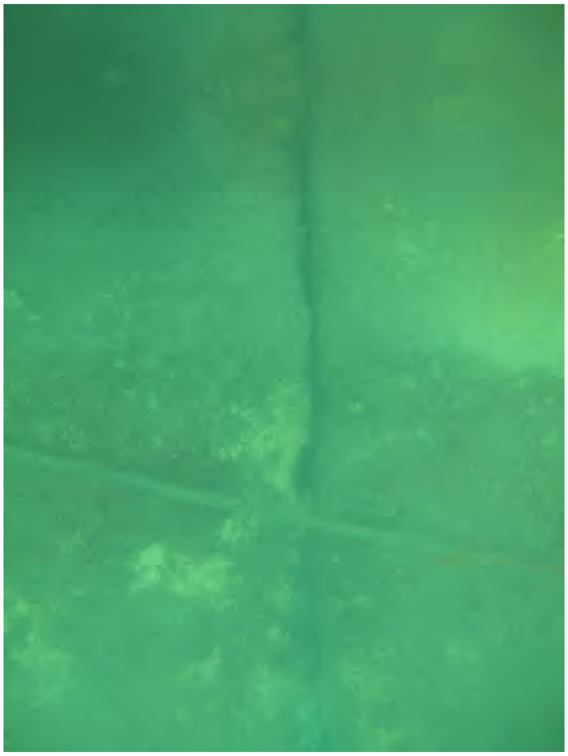

Photo 5.1 – Seawall Joint with Voids

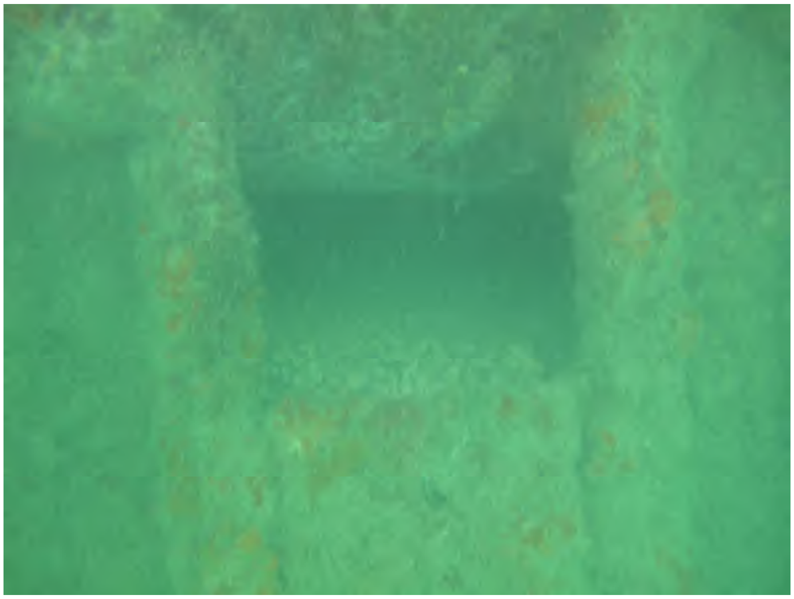

Photo 5.2 – Hole in Concrete Seawall

Photo 5.3 – Seawall Joint with Voids

Photo 5.4 – Cracks and Concrete Scaling/Weathering in Seawall

Photo 6.1 – Cracks/Delamination in Concrete Seawall

Photo 6.2

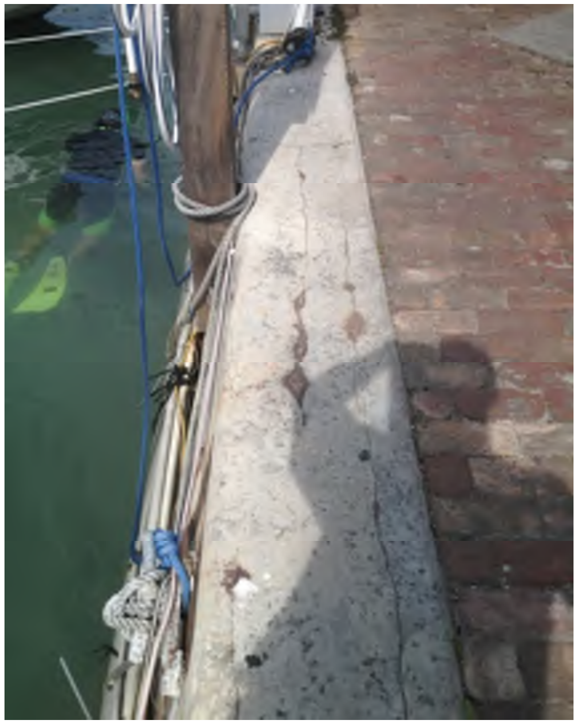

Photo 7.1 – Cracks/Delamination with Corrosion Stains top of Seawall

Photo 7.2 – Scour at Seafloor

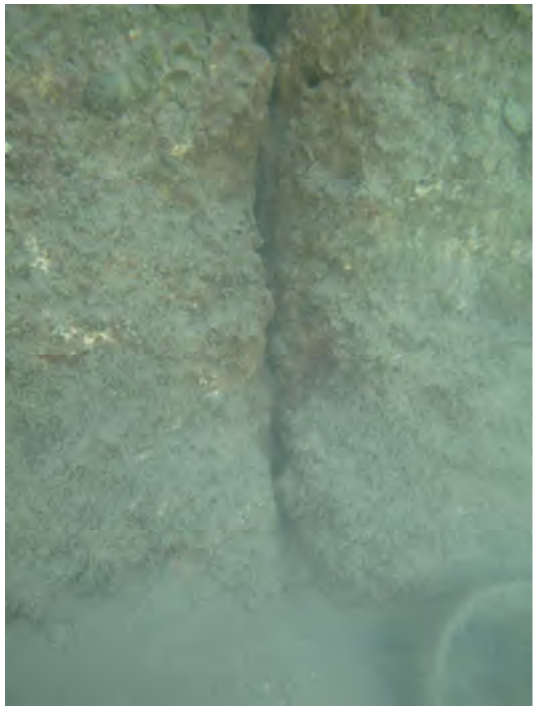

Photo 7.3 – Vertical Crack in Seawall

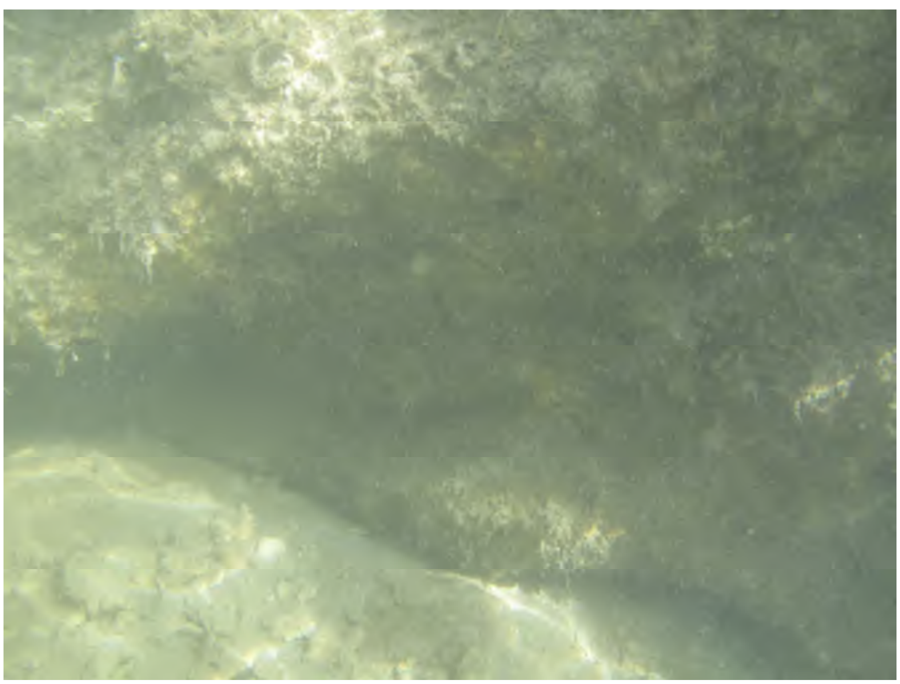

Photo 8.1 – Spall and Scour at Seafloor

Photo 8.2 – Vertical Crack/Delamination in Seawall

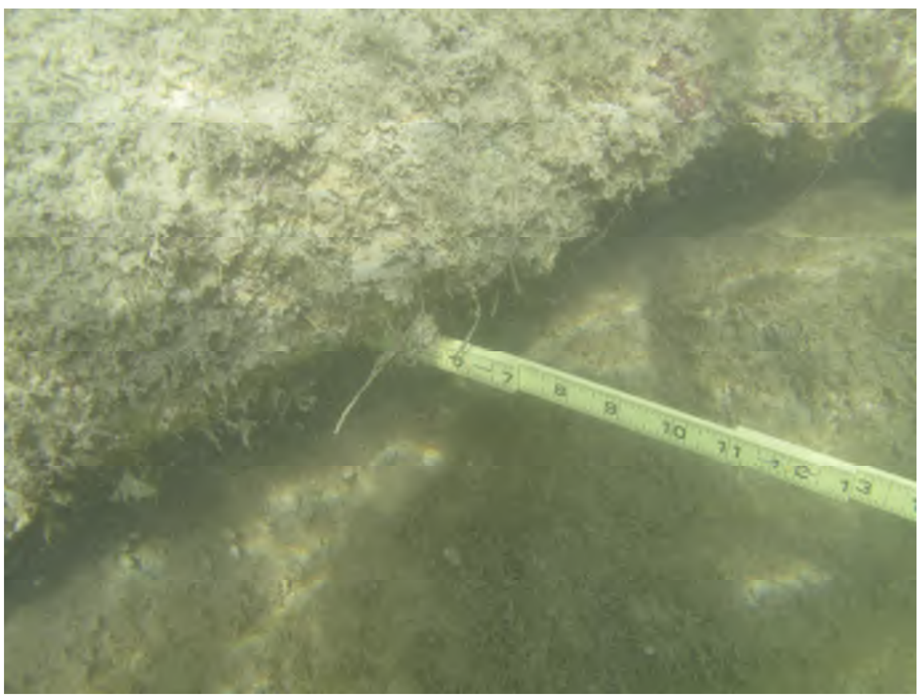

Photo 8.3 – Split/Void in Seawall

Photo 8.4

Photo 8.5

Photo 9.1 – Large Hole in Seawall

Photo 9.2 – Spall and Concrete Scaling/Weathering

Photo 9.3

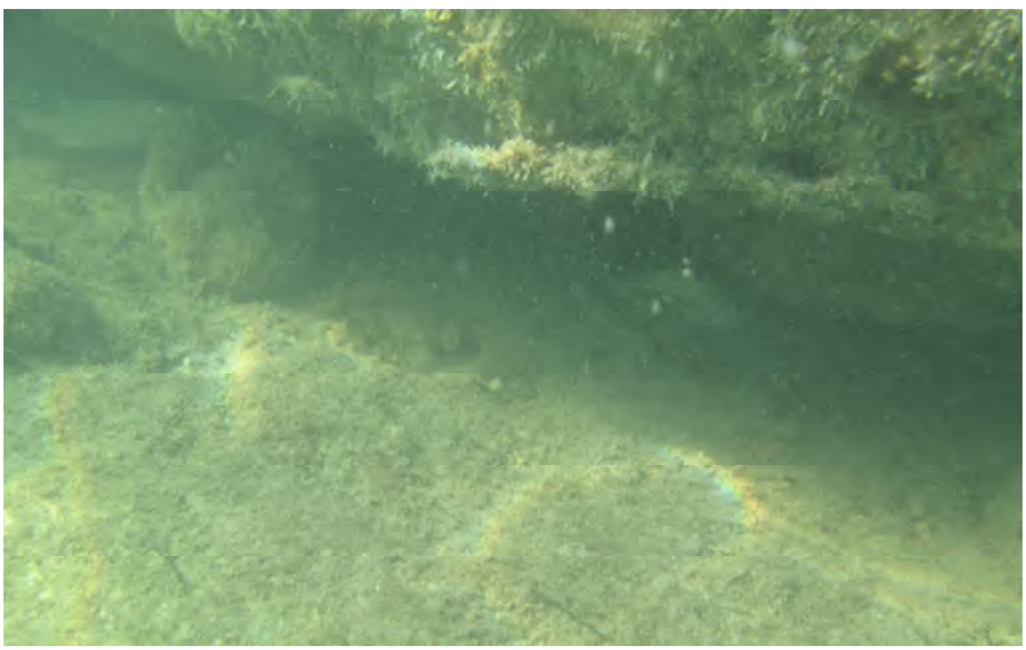

Photo 9.4 – Scour at Seafloor

Photo 9.5

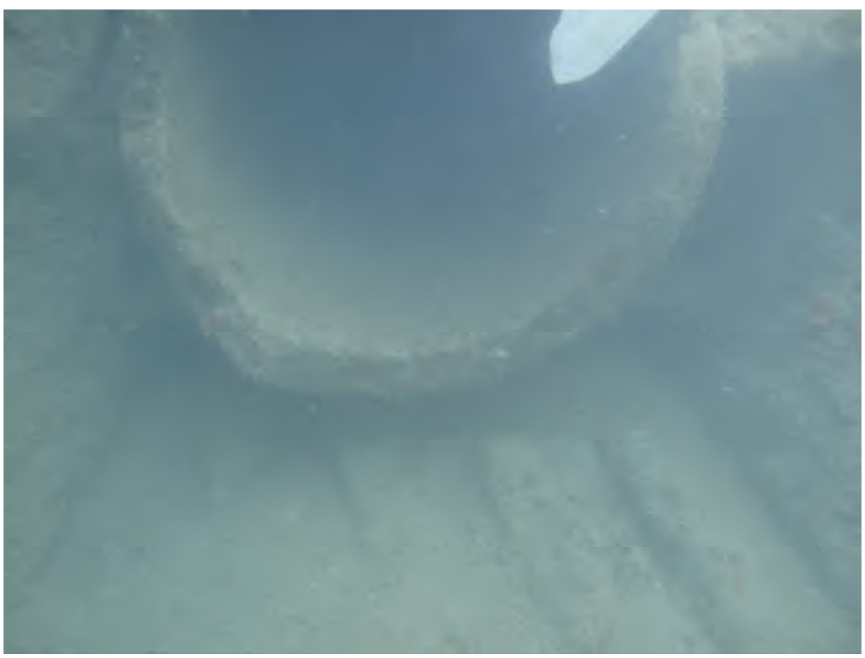

Photo 10.1 – Voids around Pipe Outlet

Photo 10.2 – Spall and Delamination top of Seawall

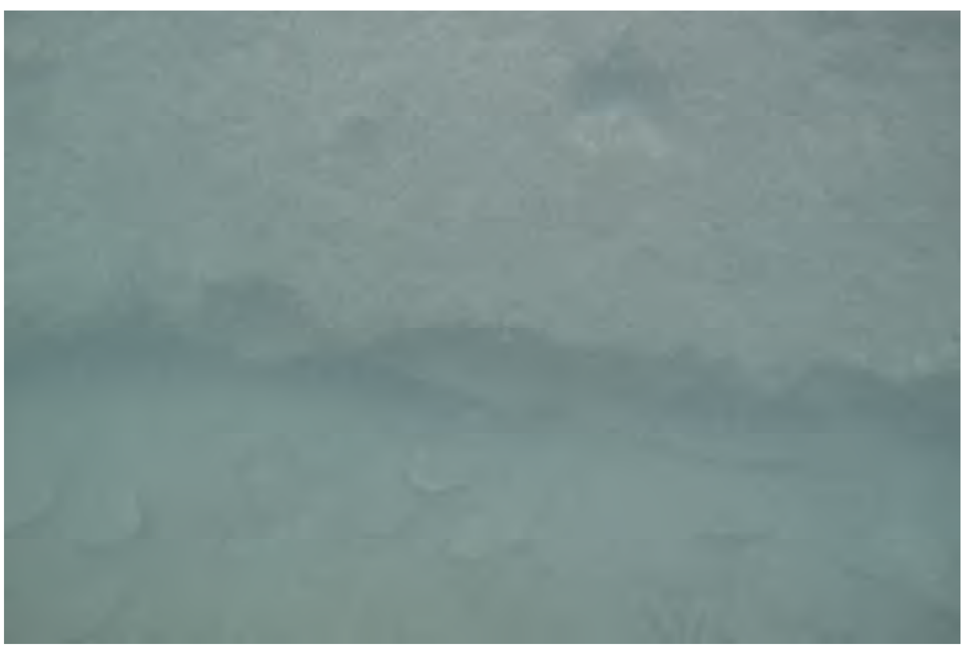

Photo 10.3 – Scour at Seafloor

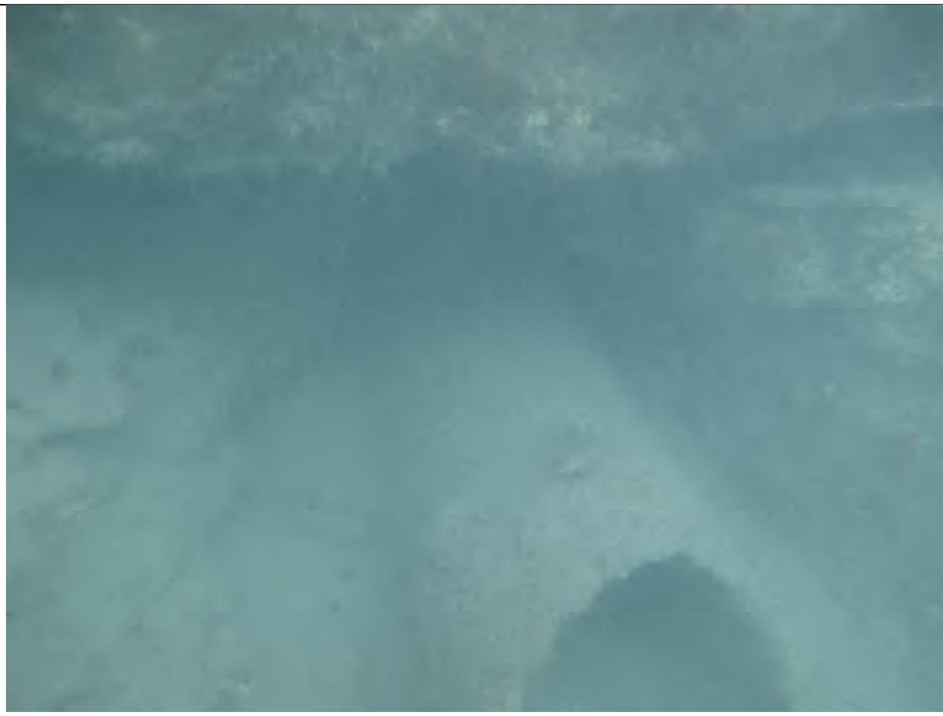

Photo 10.4 – Void around Pipe Outlet

Photo 11.1 – Scour at Seafloor

Photo 11.2 – Crack/Delamination in Seawall

Photo 11.3

Photo 12.1

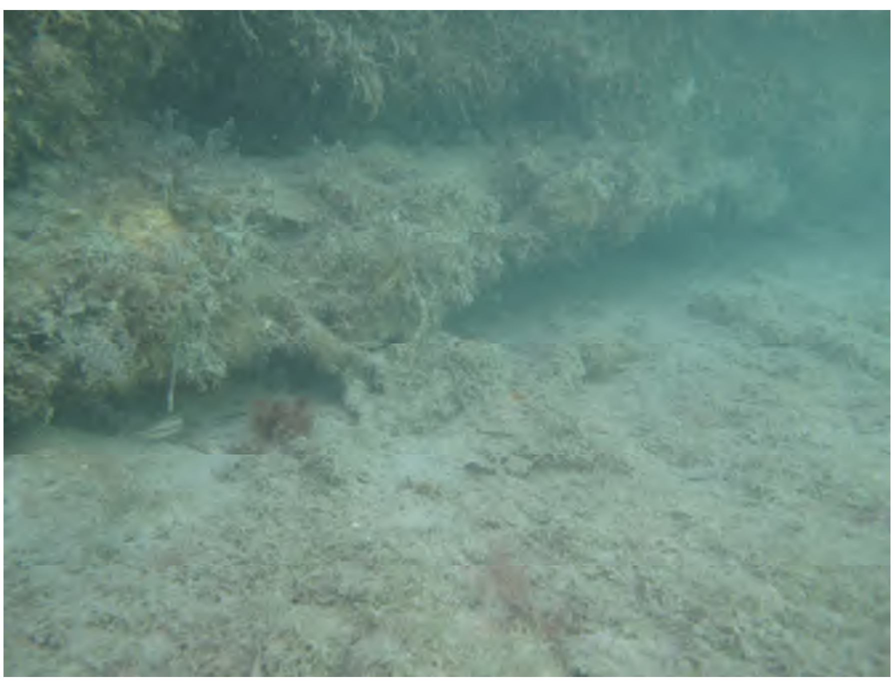

Photo 13.1

Photo 13.2 – Crack/Delamination at Seawall Transition

Photo 13.3 – Voids around Pipe Outlet

Photo 14.1 – Void with Backfill Washout

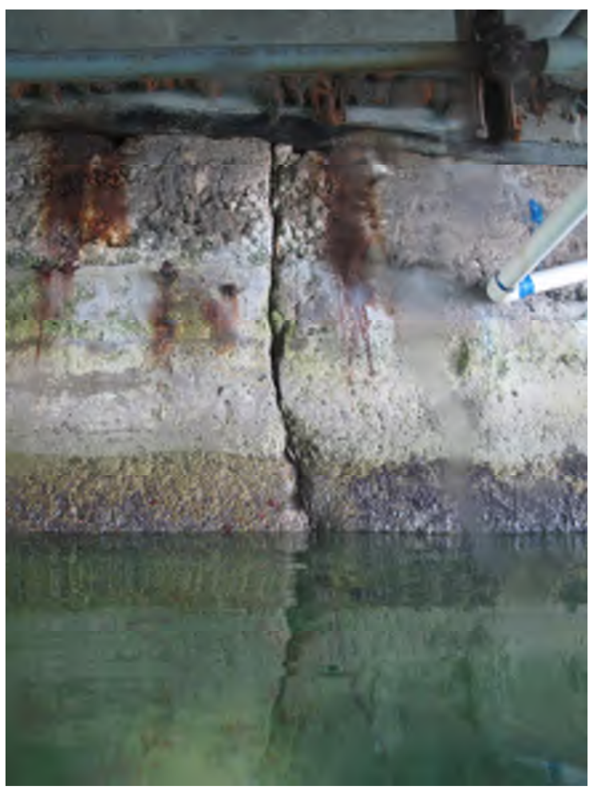

Photo 14.2

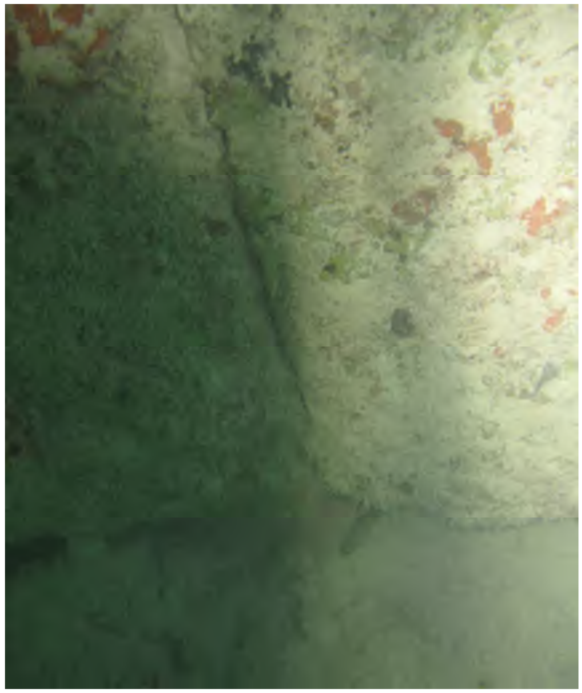

Photo 14.3

Photo 14.4

Photo 14.5 – Vertical Crack in Seawall

Photo 14.6 – Cracks/Delamination, Spalls, & Concrete Scaling/Weathering with Corrosion Stains

Photo 15.1 – Large Vertical Crack in Seawall