Protecting the NJ Coast Using Large Stone Seawalls

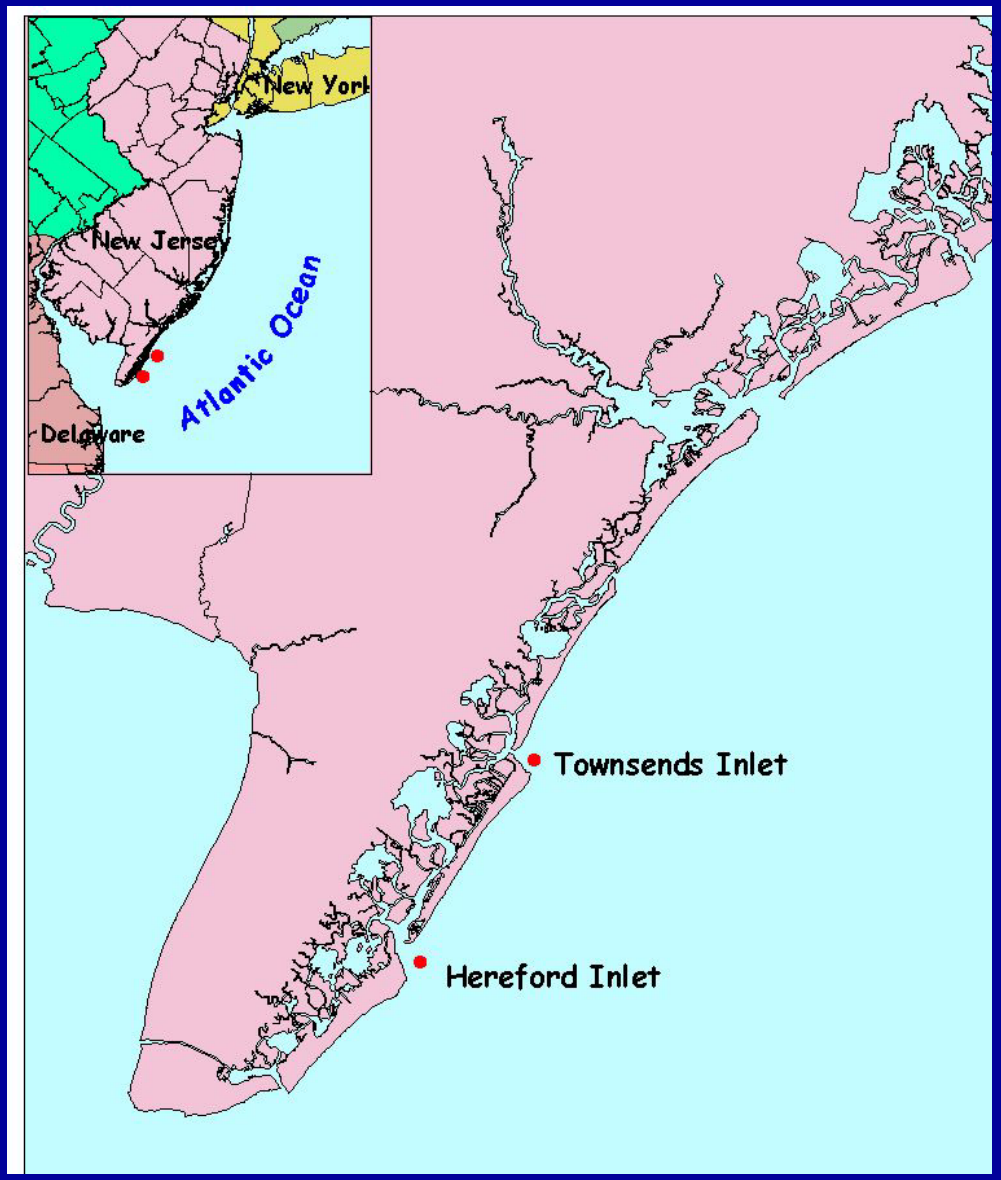
Cameron Chasten

Philadelphia District

Overview

- Project Description
- Design Overview
- Seawall Construction
- Deepwater Stabilization Construction
- Lessons Learned

Project Locations



Project Information

- Townsends Inlet
- Hereford Inlet
- Residential / commercial buildings
- Existing undersized seawalls
  - Damage
  - Failed sections

Pre-Conditions - Avalon

Pre-Conditions - Hereford

Pre-Conditions - Hereford

Pre-Condition - Hereford

Pre-Condition - Hereford

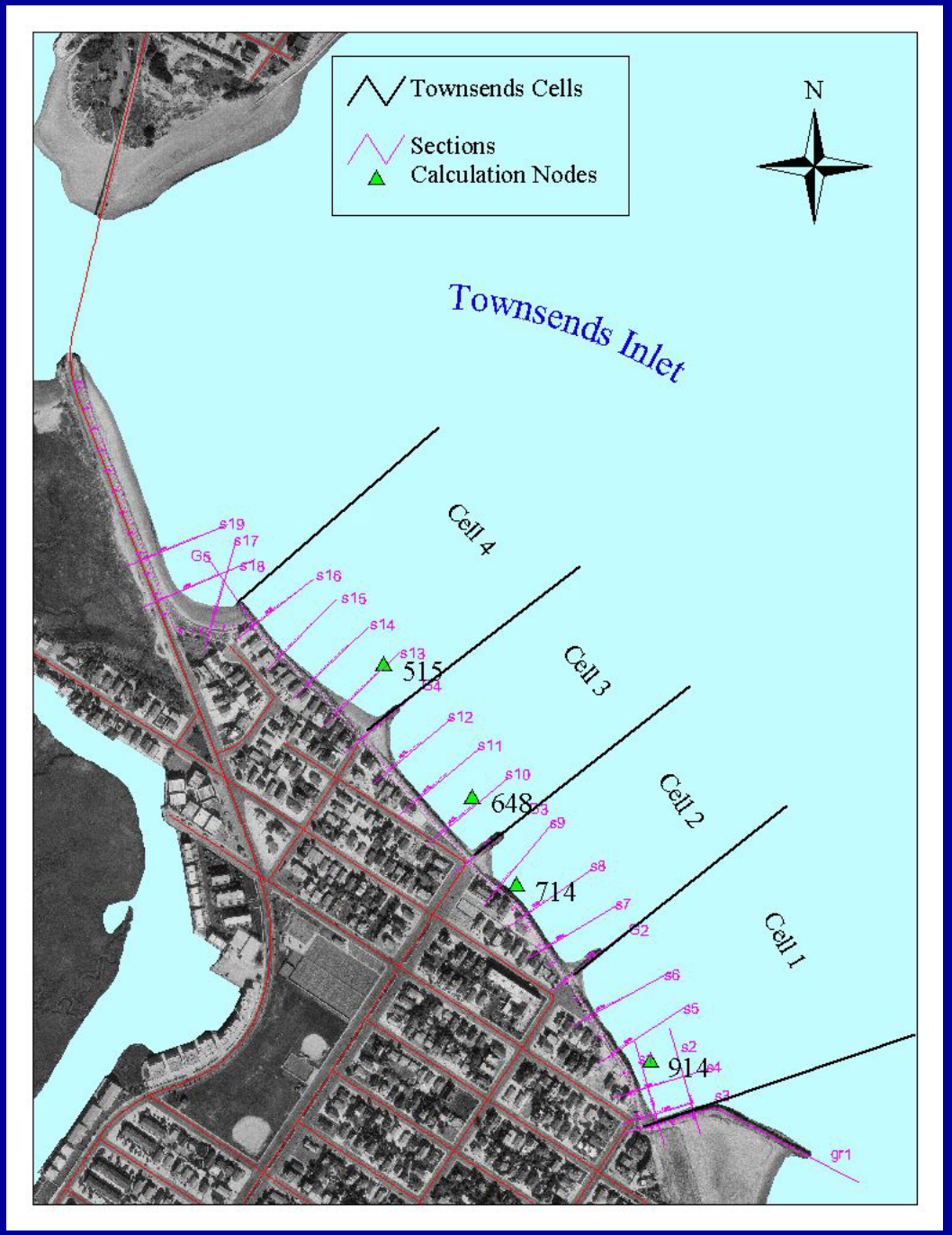
Design Basis
Seawall

- Based on set of historical storms
- Design forcing parameters based on Modeling
  - wave
  - water level
  - currents at each inlet
  - 50-yr return period equivalent

Design Criteria - Seawall

- SPM and CEM guidance
- Armor stone evaluated based on structural stability
  - <5% damage (stone displacement)
  - Hudson equation; double layer armor
- Crest height
  - Allowable wave overtopping w/ no damage
- Toe scour
  - Potential wave
  - Current-induced scour

Avalon Seawall



Avalon Seawall Structure

- 3,000 ft rubble seawall
- New construction “over” existing
- 4-6 / 6-10 ton capstone
- 700-1,400 lb corestone
- Marine mattress
- Sand infill

Avalon Seawall

- Two rounds of bids
  - Round 1: $25 M
  - Round 2: $13 M

Avalon Seawall “VE”

- Toe scour design and structural feature modification
- Build with existing seawall in place

Avalon VE: Revised Toe Scour Design

- Original Design Conservative wide berm; -15 ft depth
  - *Moderate to severe* scour potential
  - Scour based on vertical wall empirical relationships
- Revised design; no berm; - 12 ft depth
  - Low to moderate scour potential based on historical evidence
  - Consider sloping face, Reduce depth by 30%

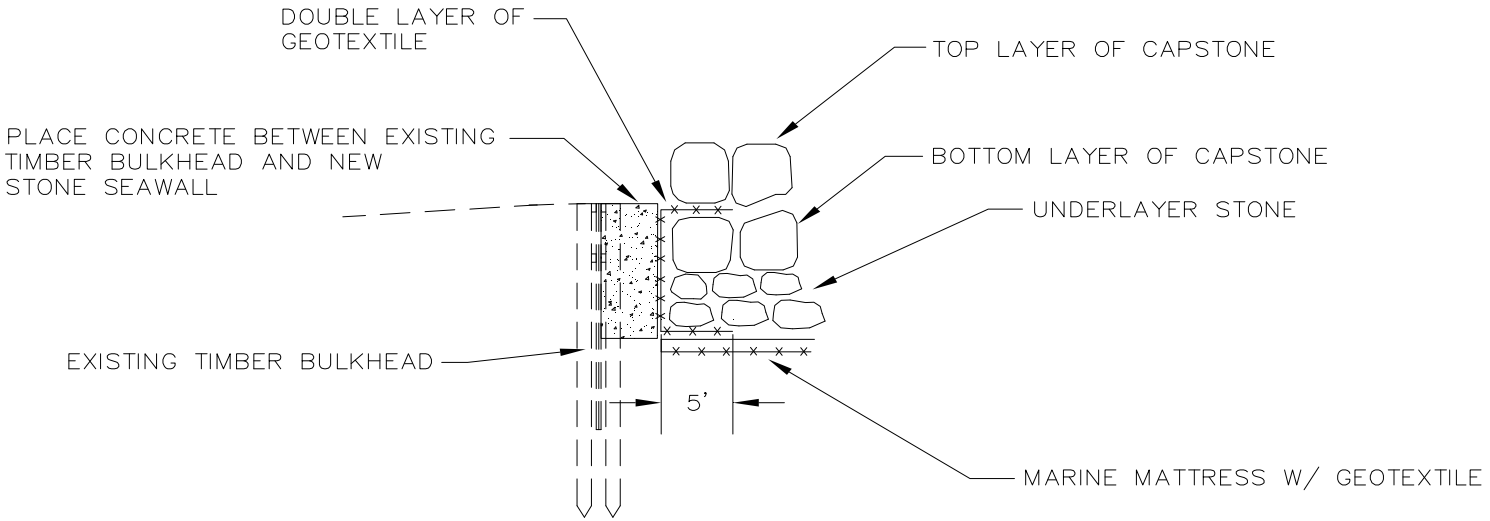
Avalon VE: Revised Toe Scour Structure

- Change structural feature
  - Marine mattress scour apron
  - Reduce
    - Cost
    - excavation depth
    - Overall structure footprint

Avalon VE: Leave Existing

- Eliminate removal effort and risk
- Sand infill

Sand Infill Design
Original



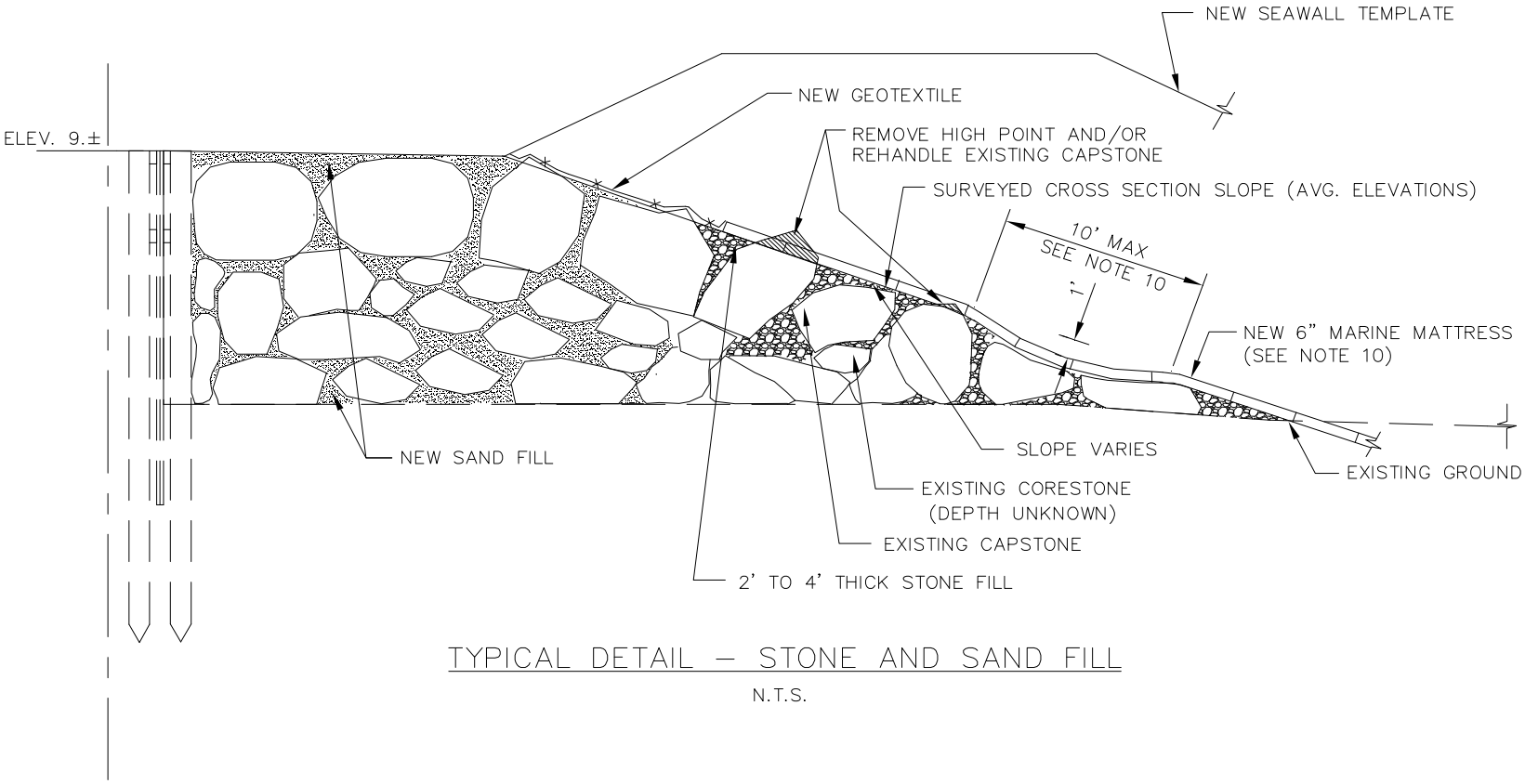
NOTE:
GAP BETWEEN NEW STONE/MARINE MATTRESS AND BULKHEAD SHOWN FOR CLARITY ONLY.

PLACEMENT DETAIL

GEOTEXTILE BETWEEN NEW SEAWALL & EXISTING BULKHEAD

N.T.S.

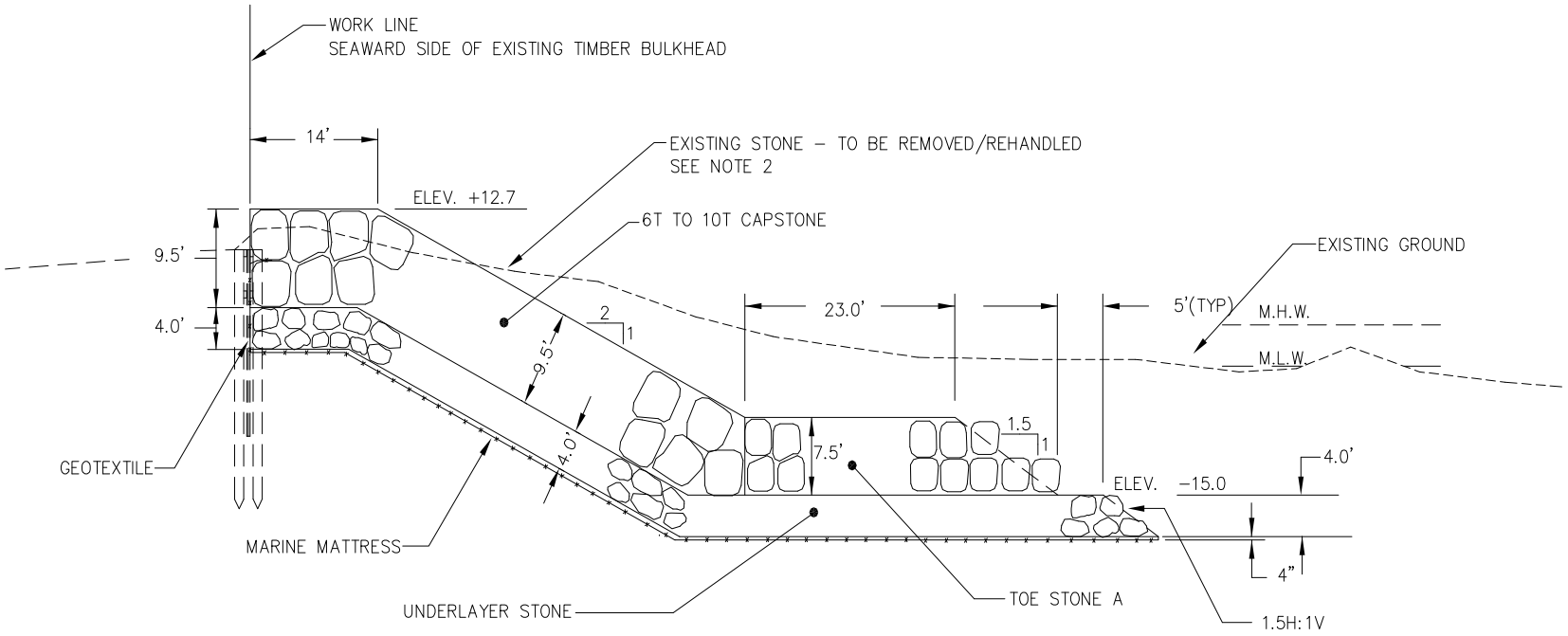
Sand Infill Design
Revised



TYPICAL DETAIL – STONE AND SAND FILL

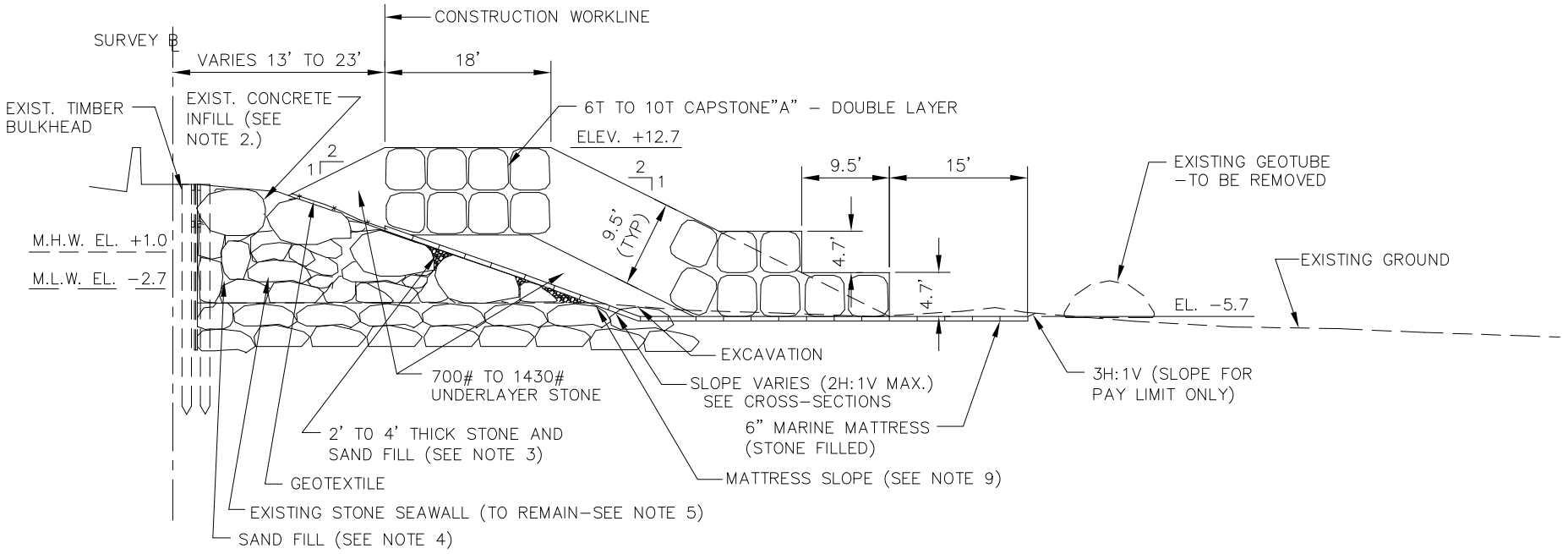
N.T.S.

Avalon original - $25M



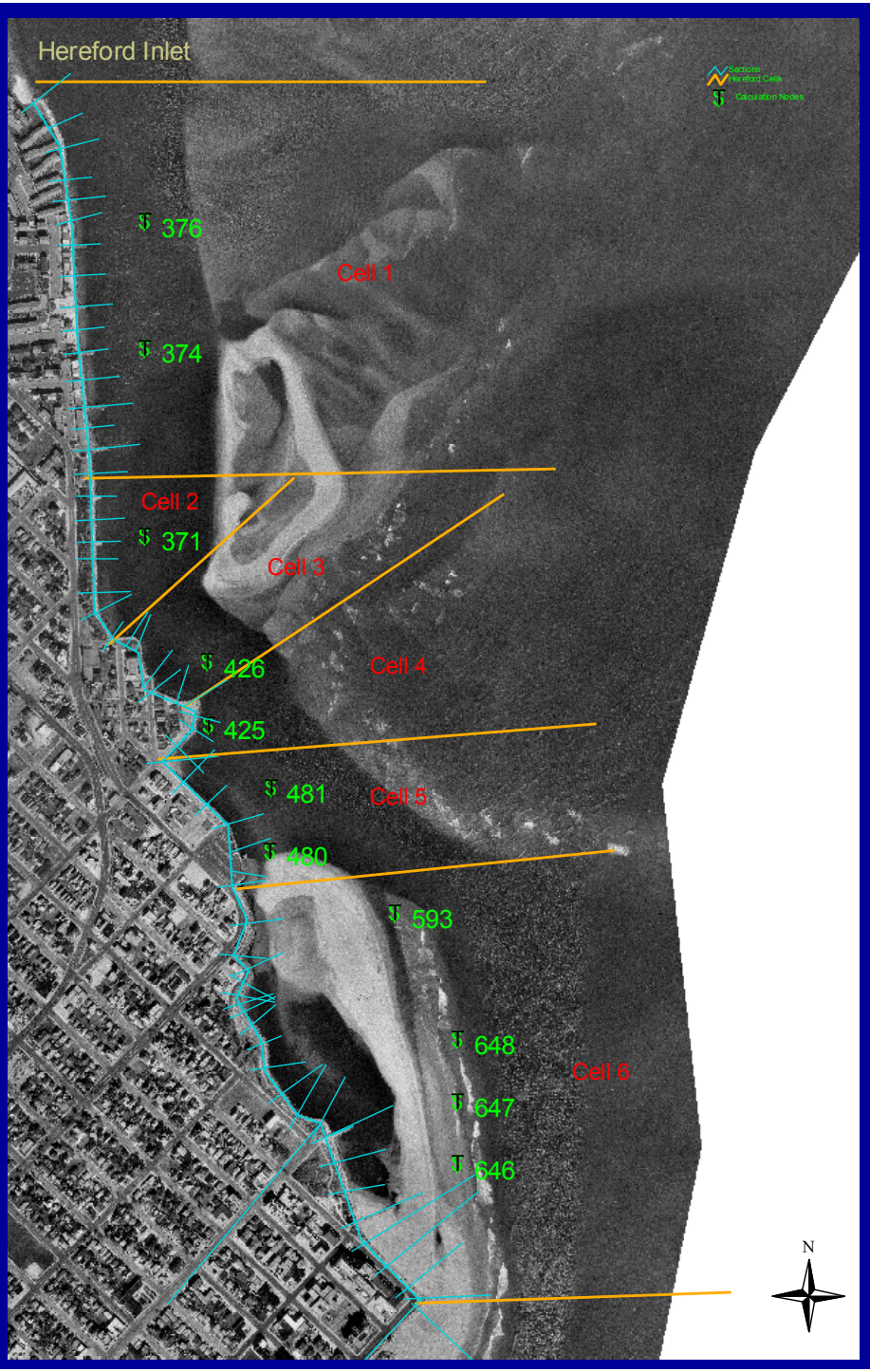
TYPICAL SECTION–STA. 3+28 TO STA. 9+30

Avalon VE: $13M



TYPICAL SECTION – STA. 2+81.5 TO STA. 9+75
STA. 9+75 TO STA. 10+55

Hereford Seawall



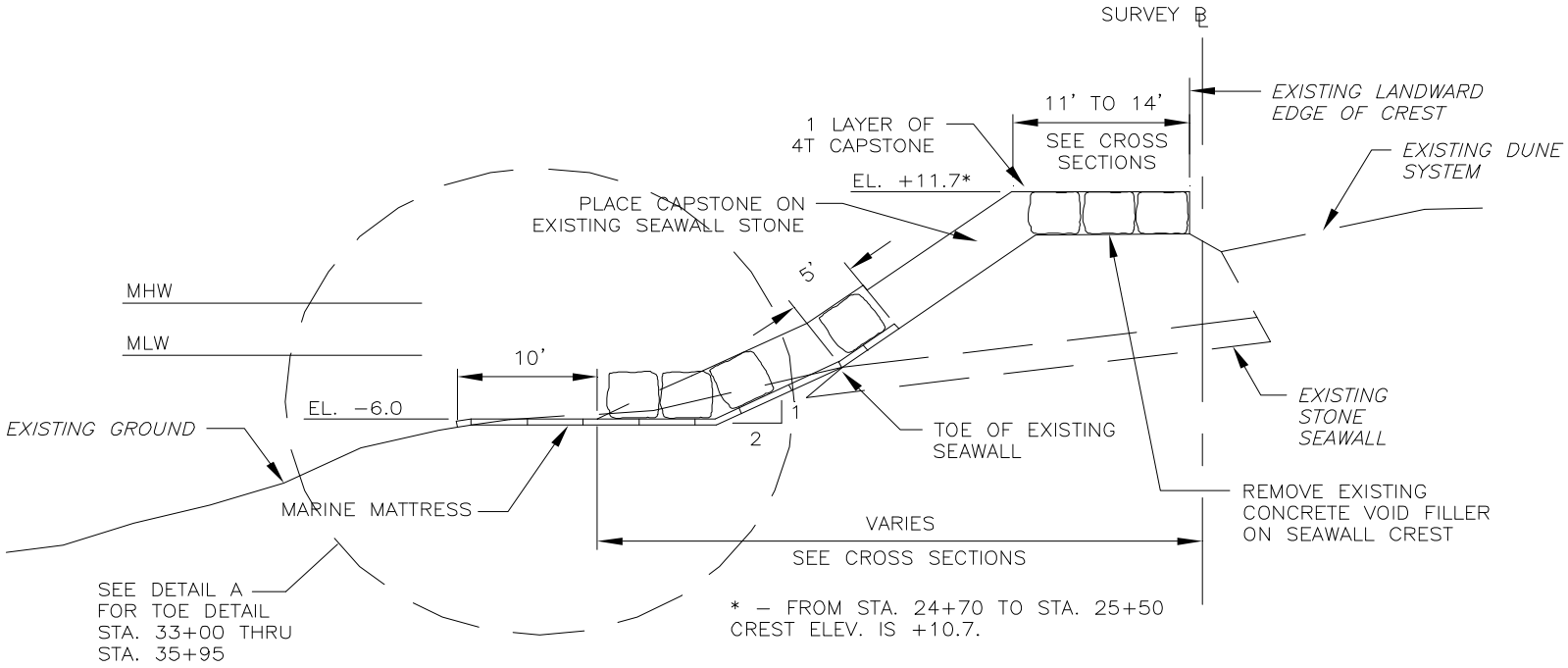
Hereford Seawall Structure

- Consists of three schemes
  - 1,200 ft Deepwater stabilization
  - 2,400 ft New rubble seawall 3 – 5 T capstone
  - 5000 ft Rehab of existing seawall 2 T capstone
- 600 – 1000 lb corestone
- Marine mattress

Hereford Seawall
Multiple Projects

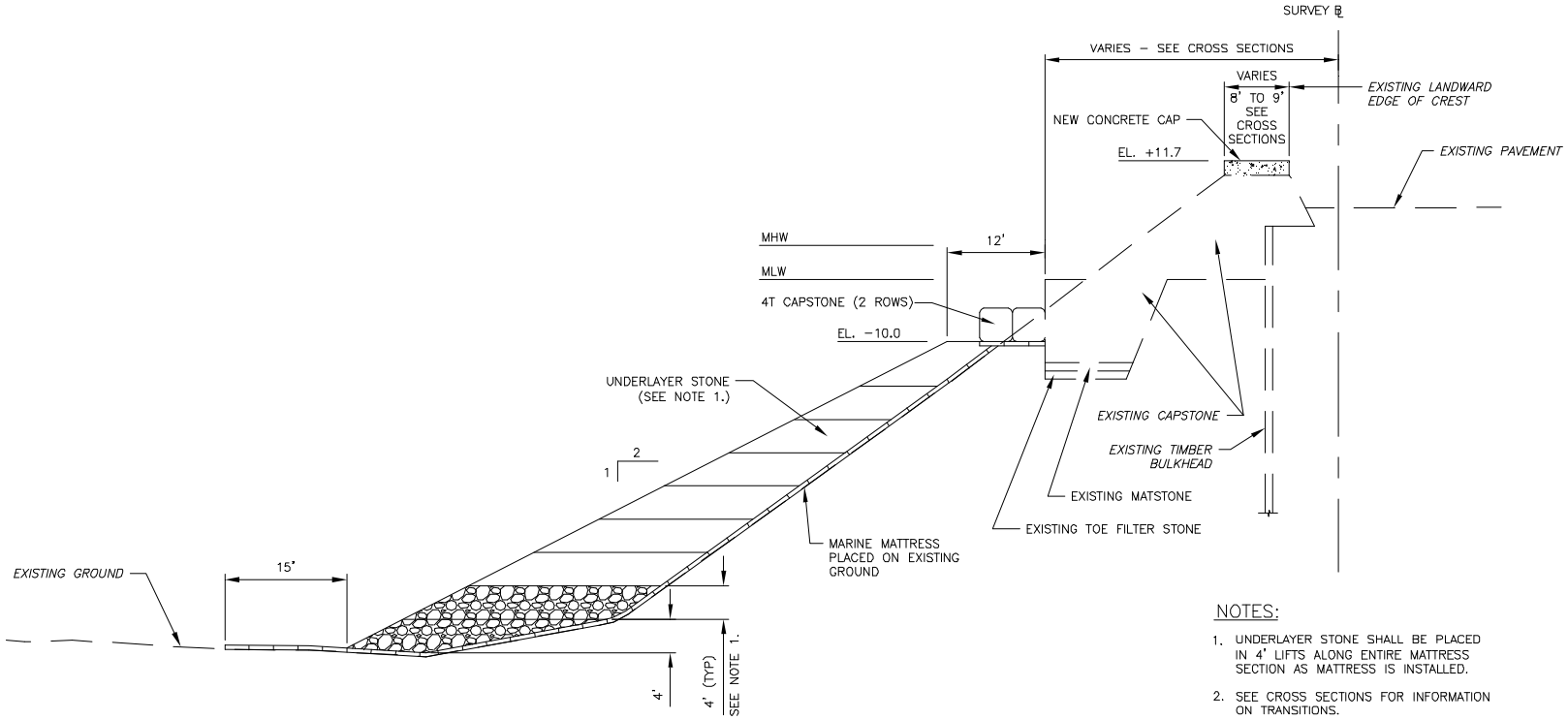
- Rehabilitation
- Deepwater stabilization
- New Section

Hereford Seawall Rehabilitation Detail



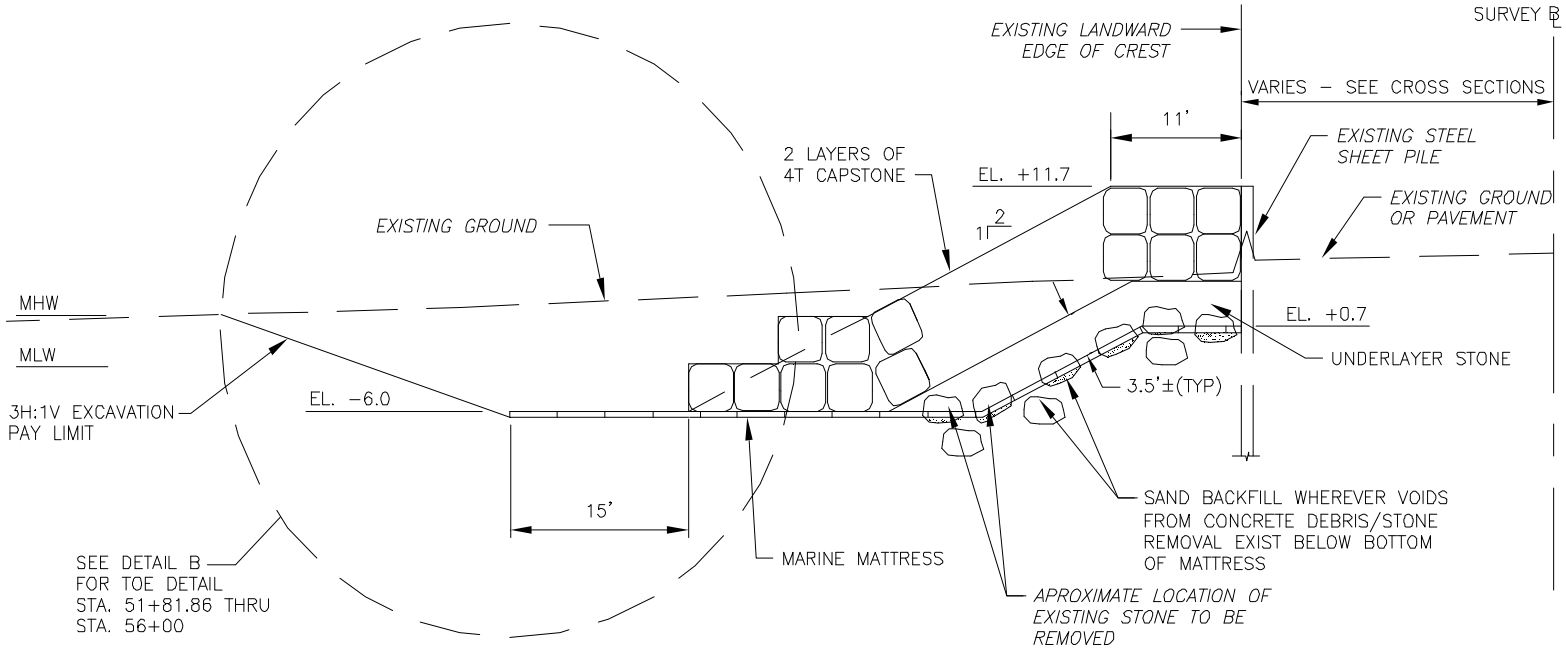
TYPICAL SECTION
STA. 24+70 TO STA. 35+03.47

Hereford Seawall
Deepwater Stabilization Detail



TYPICAL SECTION – DEEPWATER STABILIZATION OF EXISTING SEAWALL
STA. 36+10.75 TO STA. 42+20

Hereford Seawall
New Seawall Detail

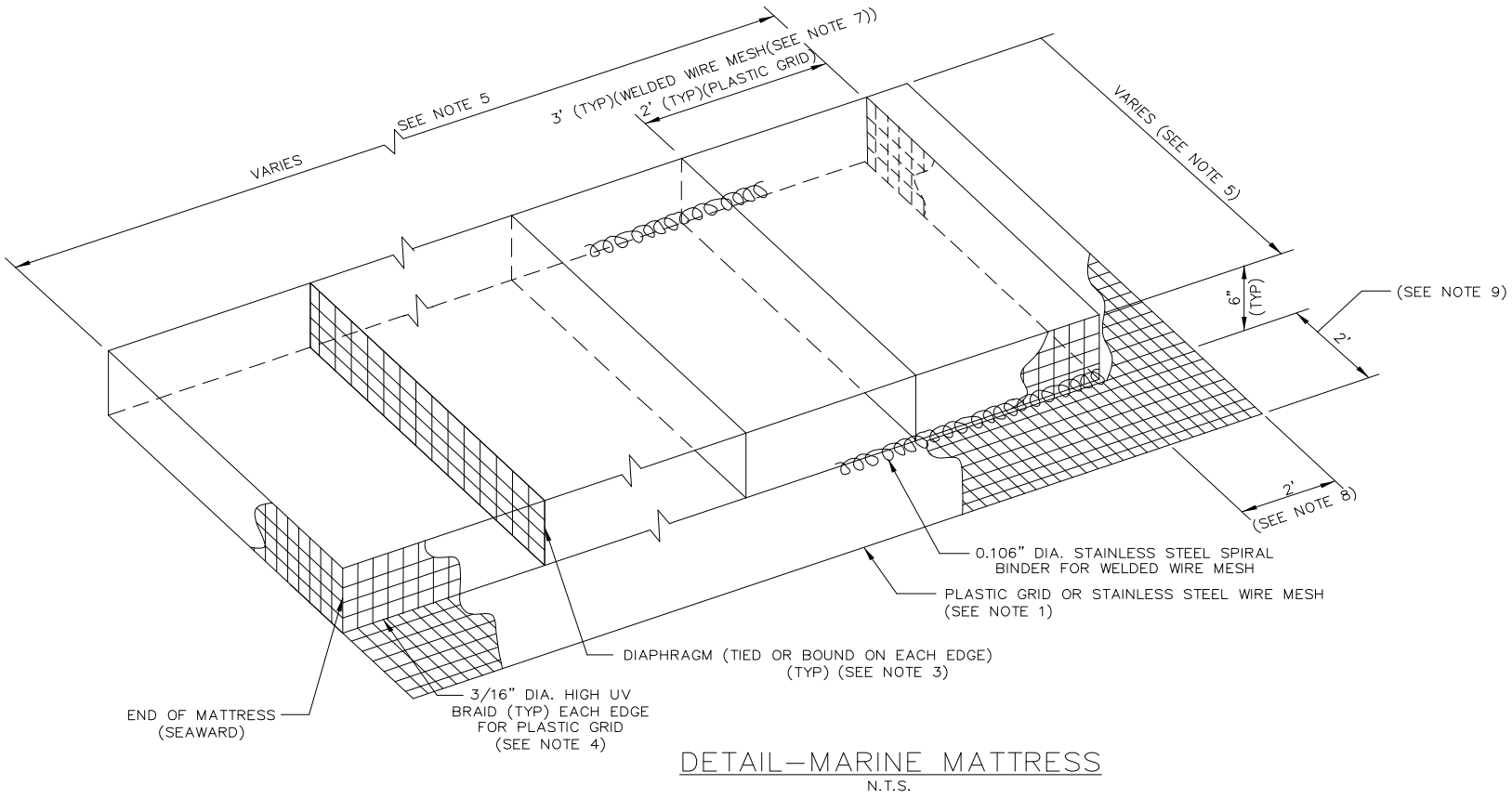


TYPICAL SECTION
STA. 44+82.89 TO STA. 56+00 @ 318° TO SURVEY BASELINE

Marine Mattress Description

- Polyethylene geogrid basket
- Lined with geotextile
- Approximately 6-ft by 20-ft
- Overlap flap

Marine Mattress Detail



DETAIL—MARINE MATTRESS

N.T.S.

Marine Mattress

Marine Mattress Construction

Marine Mattress Construction

Marine Mattress Placement

Marine Mattress Advantages

- Instant Filter: Eliminate material quantity
- Flexible: conforms to under shape
- Stable placement in moving water
- Serves as scour apron
- Provides stable work area
- Provides cushion to work on

Seawall Construction Sequence

Seawall Construction Sequence

Seawall Construction Sequence

Seawall Construction Sequence

Seawall Construction Sequence

Seawall Construction Sequence

Seawall Construction Sequence

Seawall Construction Sequence

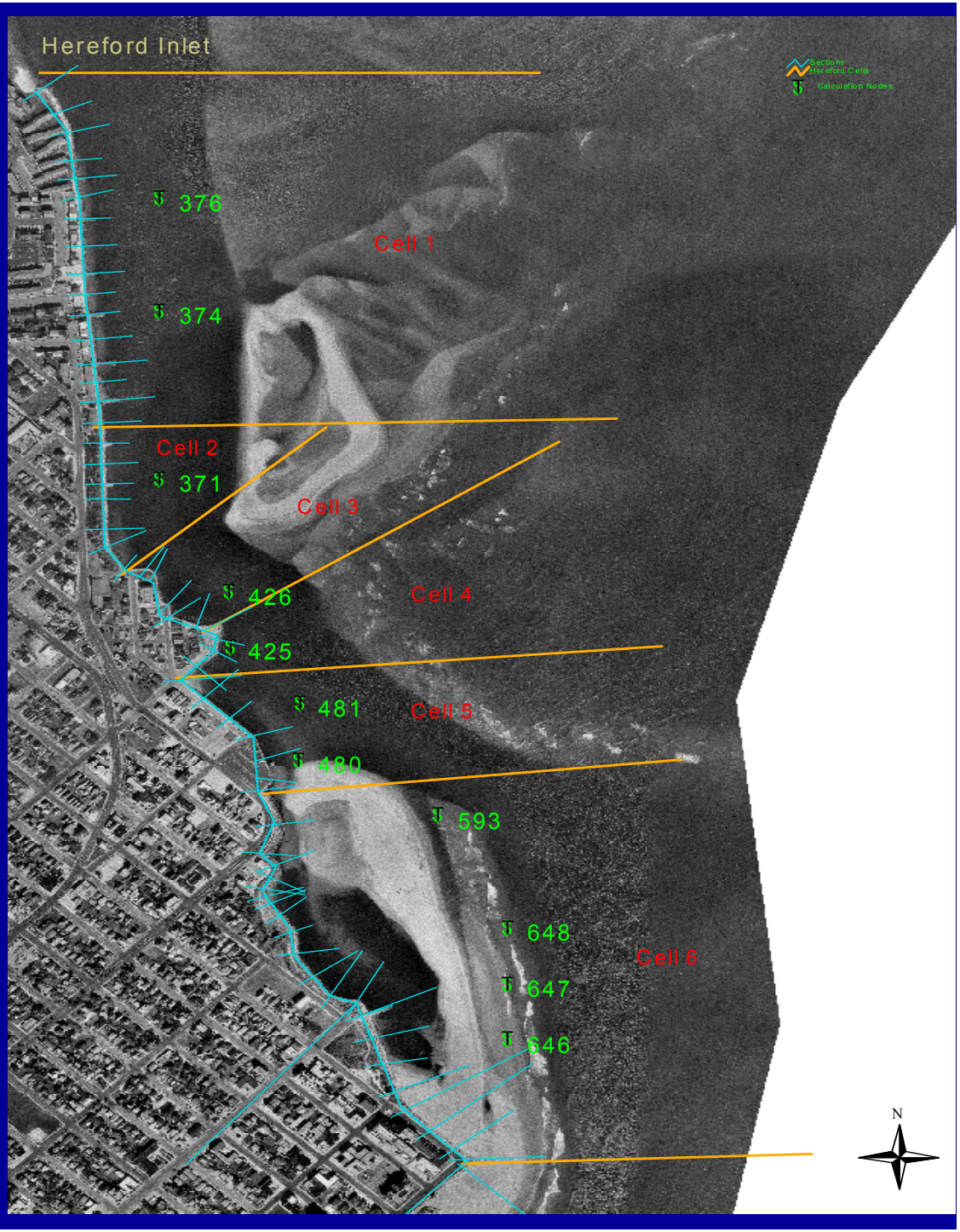
Seawall Construction Sequence

Seawall Finished Product

Avalon Seawall Action

Hereford Deepwater Stabilization

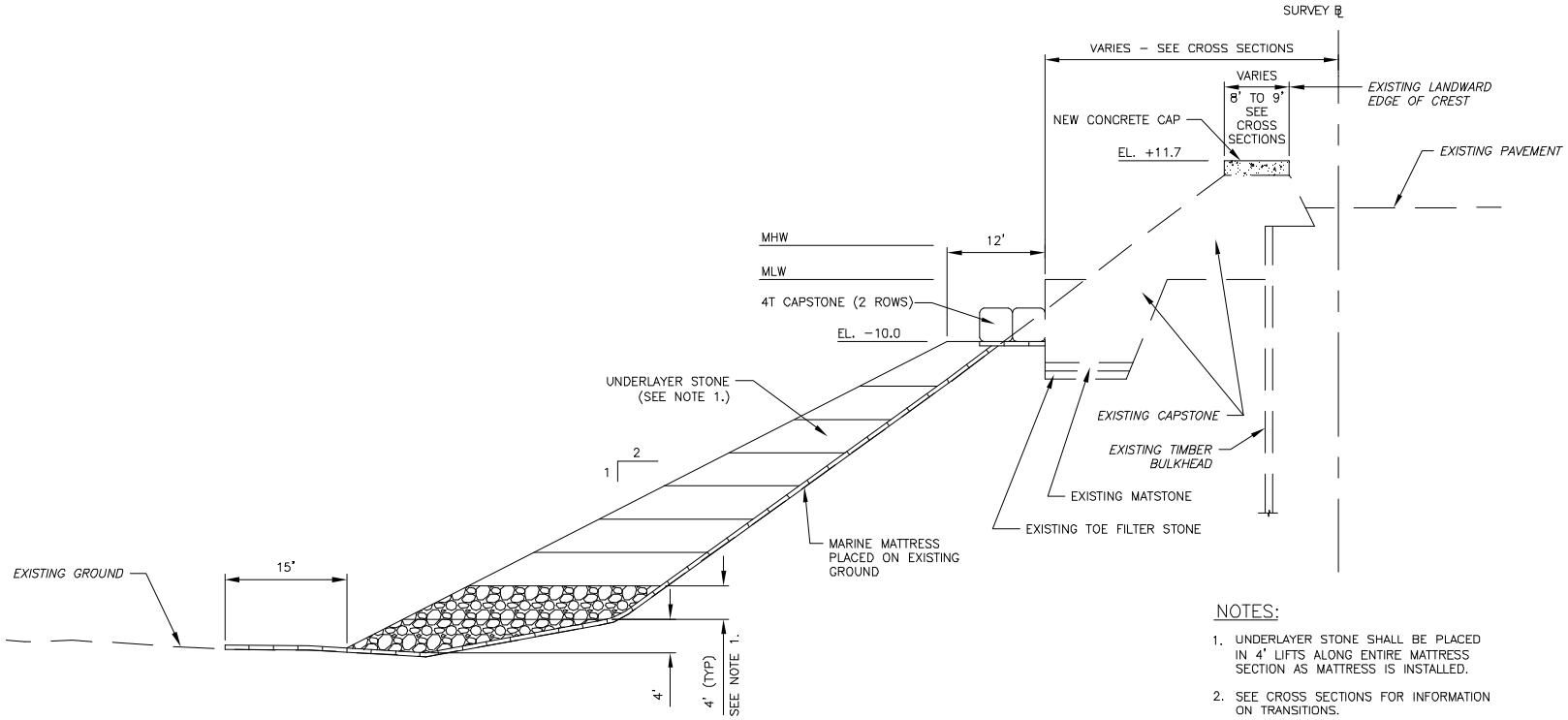
Deepwater Stabilization



Design Basis
Deepwater Stabilization

- Geotechnical slope stability
- Current erosion

Deepwater Stabilization



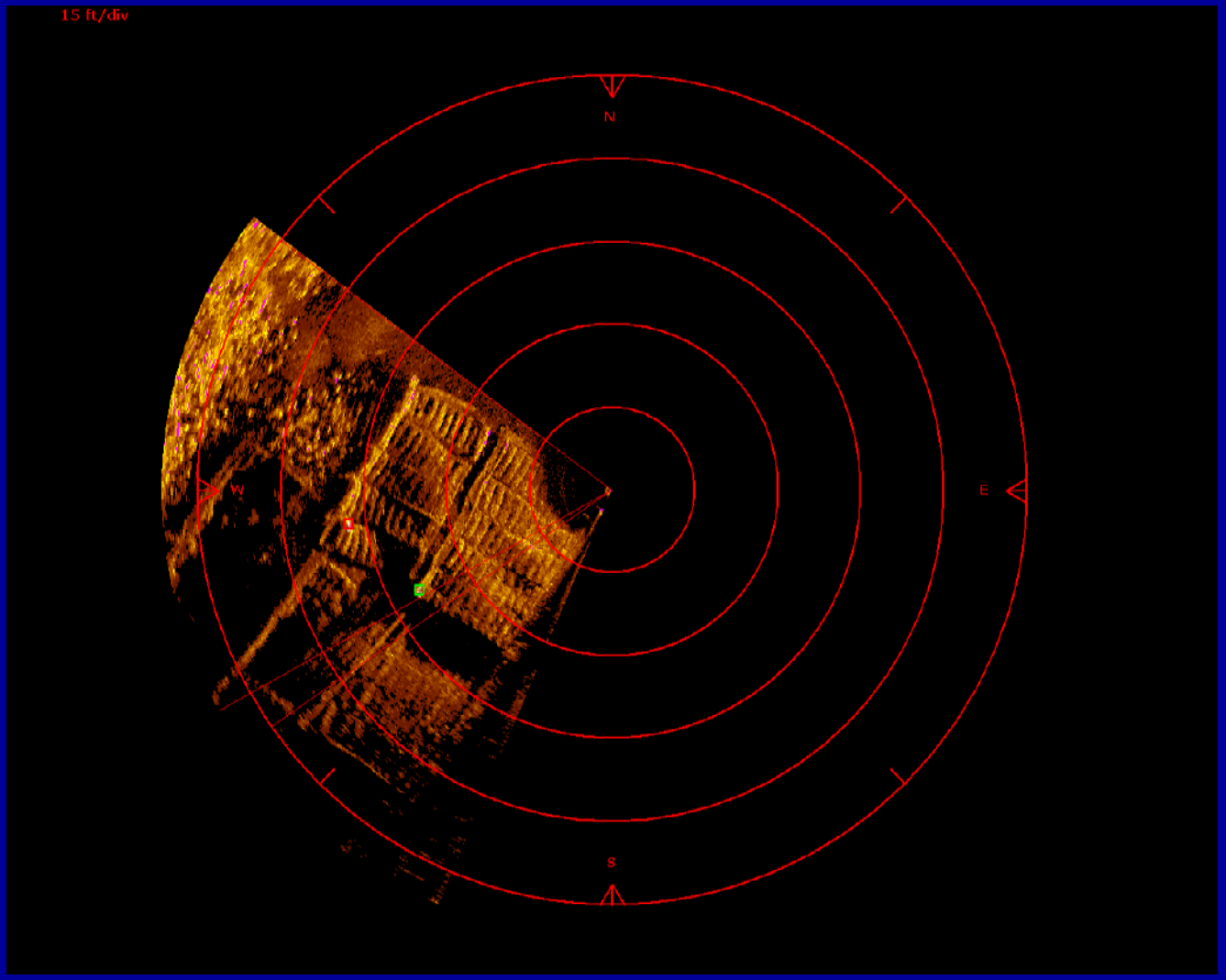
TYPICAL SECTION – DEEPWATER STABILIZATION OF EXISTING SEAWALL
STA. 36+10.75 TO STA. 42+20

Deepwater Stabilization Mattress Placement

Deepwater Stabilization Mattress Placement

Deepwater Stabilization Mattress Placement

Deepwater Stabilization Mattress Placement

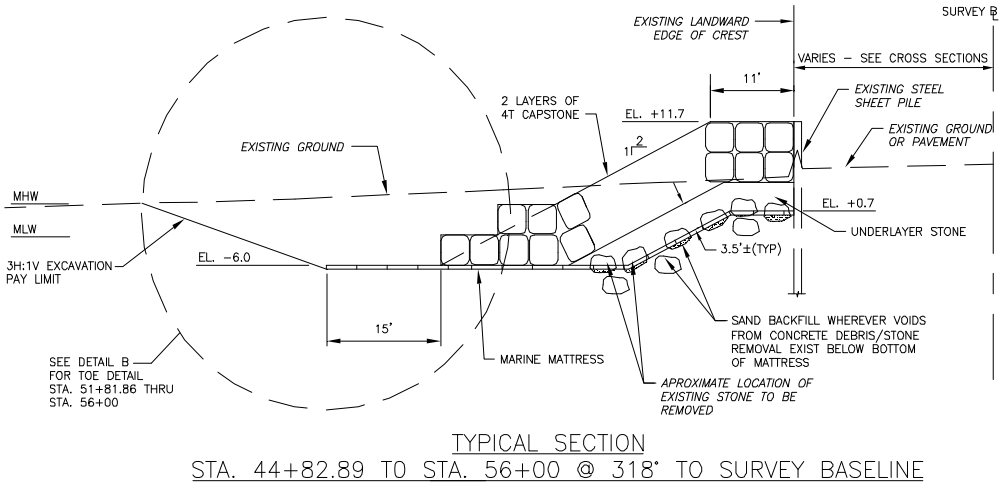


Lessons Learned

- VE can lead to significant savings
- Consider practical site characteristics
  - Toe scour history
  - Existing groins withstood ’62 storm
  - VE attributed existing failures to poor filter gradation, not scour

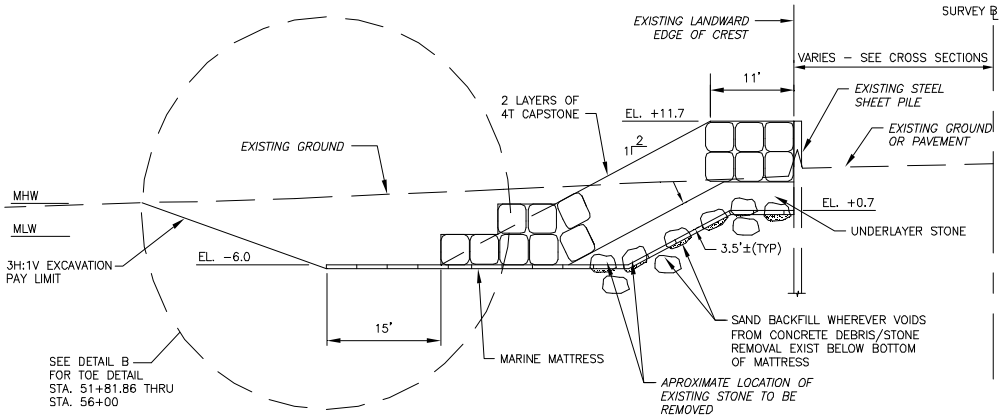
Lessons Learned

- Drawing representation
  - Square stones – not available in large quantity
  - Proximity to bulkhead



Lessons Learned

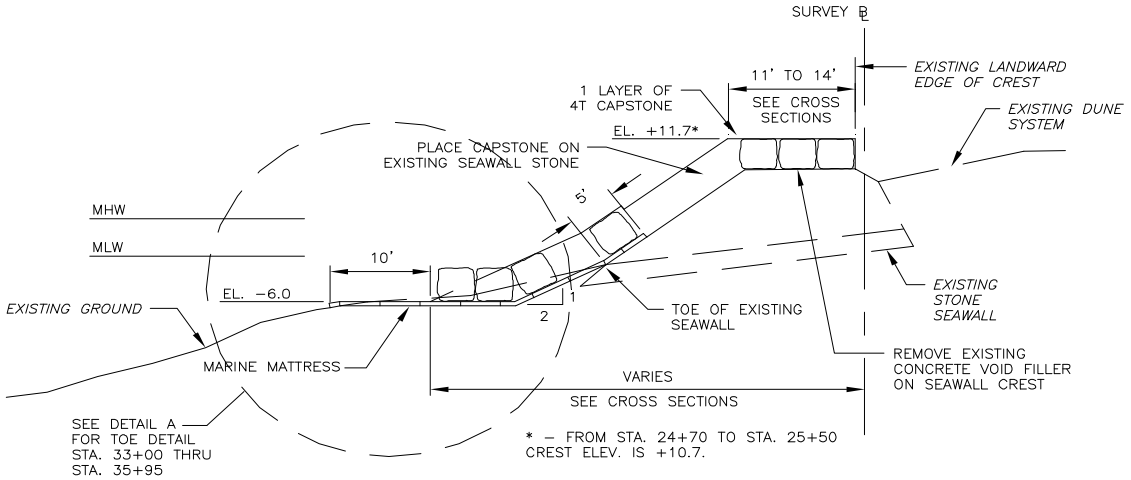
- Use “Anchor” Toe Stone or Key-in Toe
  - Difficult to build with low resistance of outer stones
  - Marine mattress prohibits “embedding toe in sand”



TYPICAL SECTION
STA. 44+82.89 TO STA. 56+00 @ 318° TO SURVEY BASELINE

Lessons Learned

- Evaluate single layer on existing flat surface
  - Difficult to achieve required interlock to ensure stable layer
  - Use concrete for raising existing cap



TYPICAL SECTION
STA. 24+70 TO STA. 35+03.47

Lessons Learned
Tolerance / Interlock

- Vary under-layer thickness
- Provide Contractor clear explanation
- Spec language: "The stones shall be closely fitted and interlocked…….. All stone will be in close contact to assure no independent movement or sliding"
- Require test sections
  - Complete FIRST
  - Instill team approach

Lack of Interlock / Tolerance

Lack of Interlock / Tolerance

Lack of Interlock / Tolerance

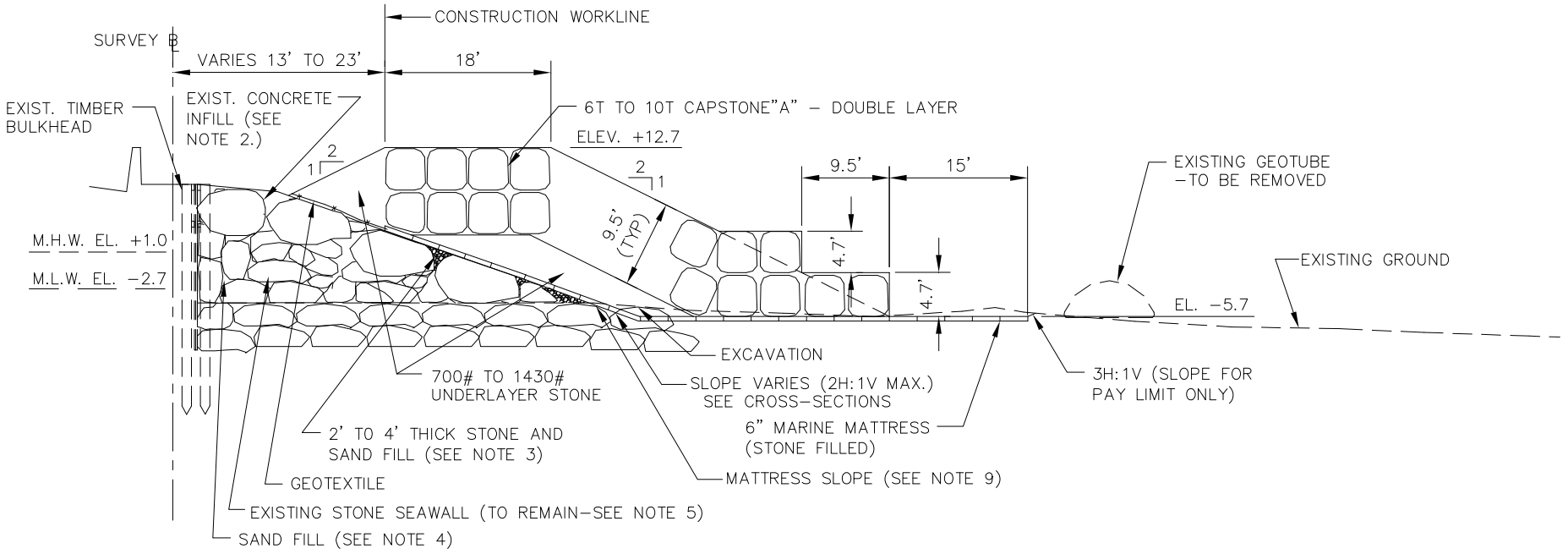
Lessons Learned

- Consider Best Value Procurement: Stone setter is key in product
- Stone shape / availability
  - “Inter-layer” interlock
  - “Intra-layer” interlock
  - Tolerance

High Points

- Avalon Overall Quality
- Contractor innovation – sonar imaging
- Design Involvement in Construction

Proposed Cross Section



TYPICAL SECTION – STA. 2+81.5 TO STA. 9+75
STA. 9+75 TO STA. 10+55

Actual Cross Section

Seawall Finished Product