GREENWOOD BAY HOMEOWNER'S ASSOCIATION SEAWALL REPAIR

Engineering Criteria Review Board Meeting

BCDC Permit No. 1973.015.04

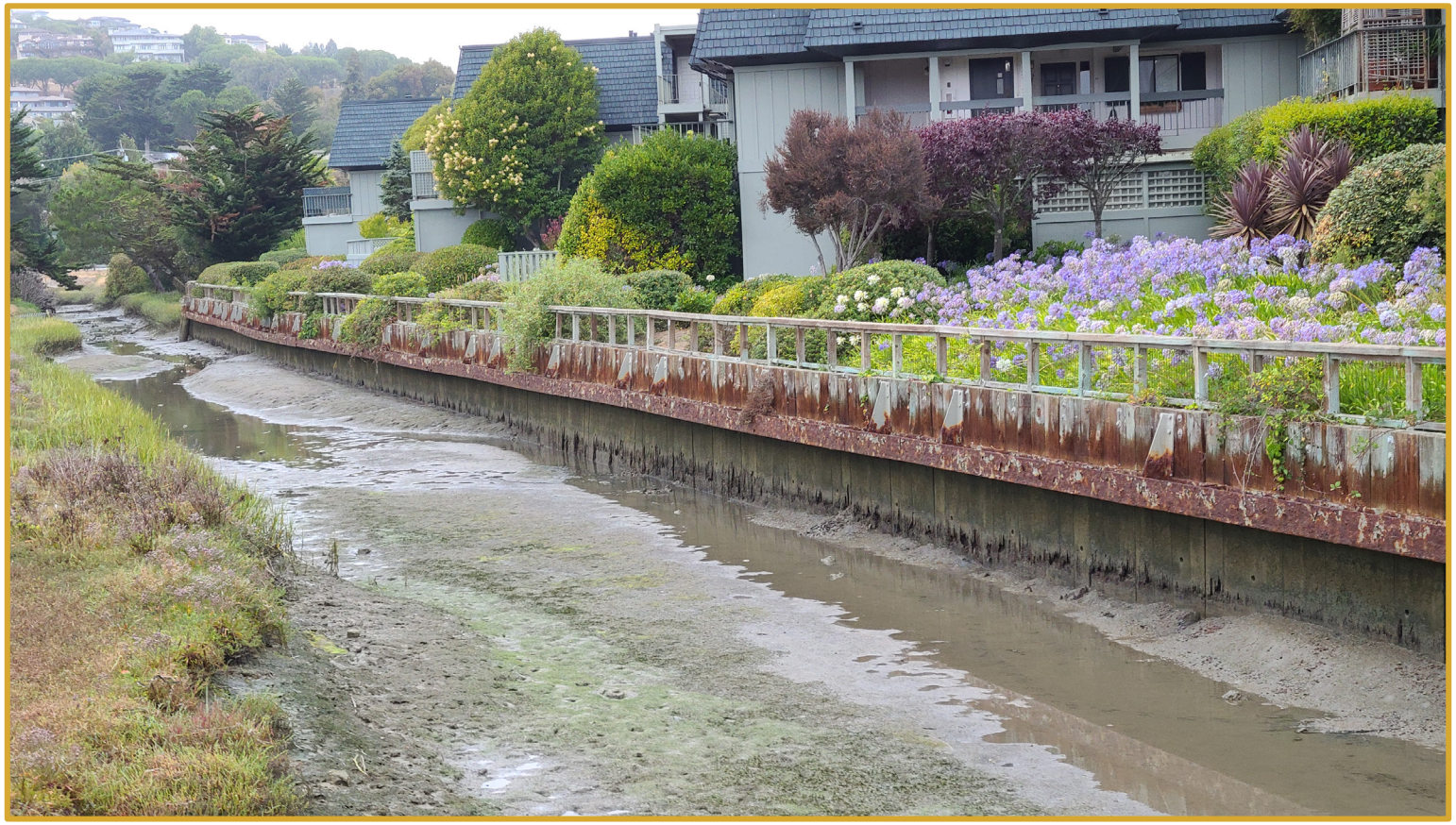
P.J. Cosgrove – Barnegat Group

Justin Pyun, P.E., S.E. – Simpson Gumpertz & Heger (SGH)

22 June 2023

Agenda

- Introductions
- Project Background
- Project Scope and Design Criteria
- Structural Design Details

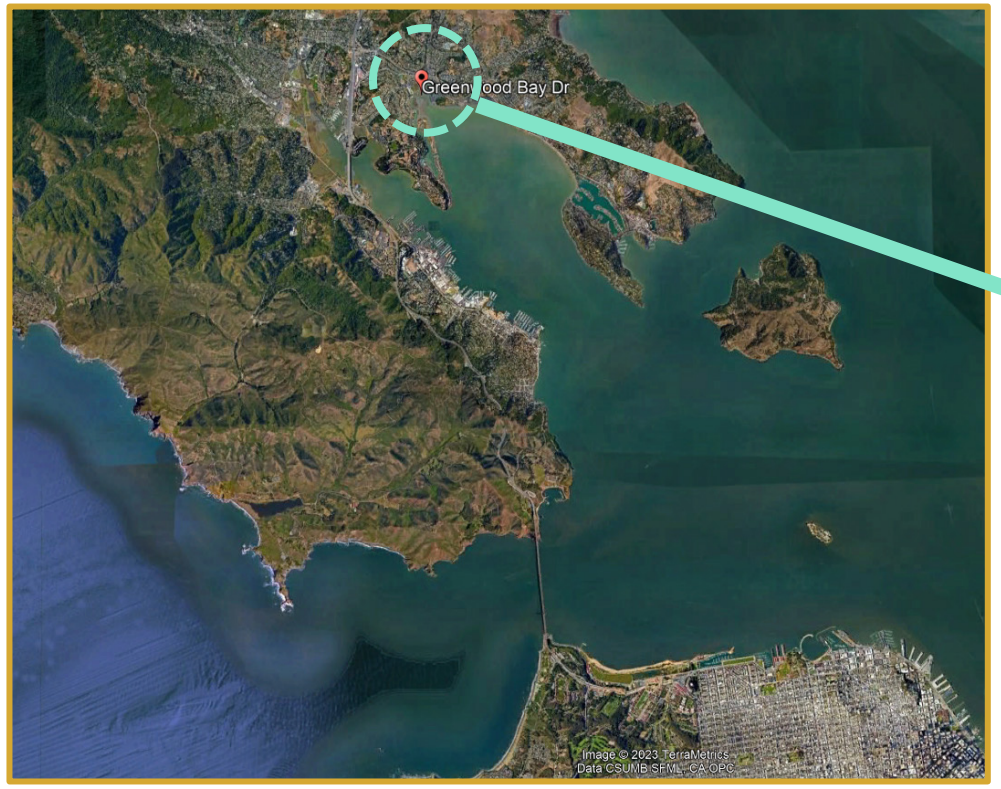


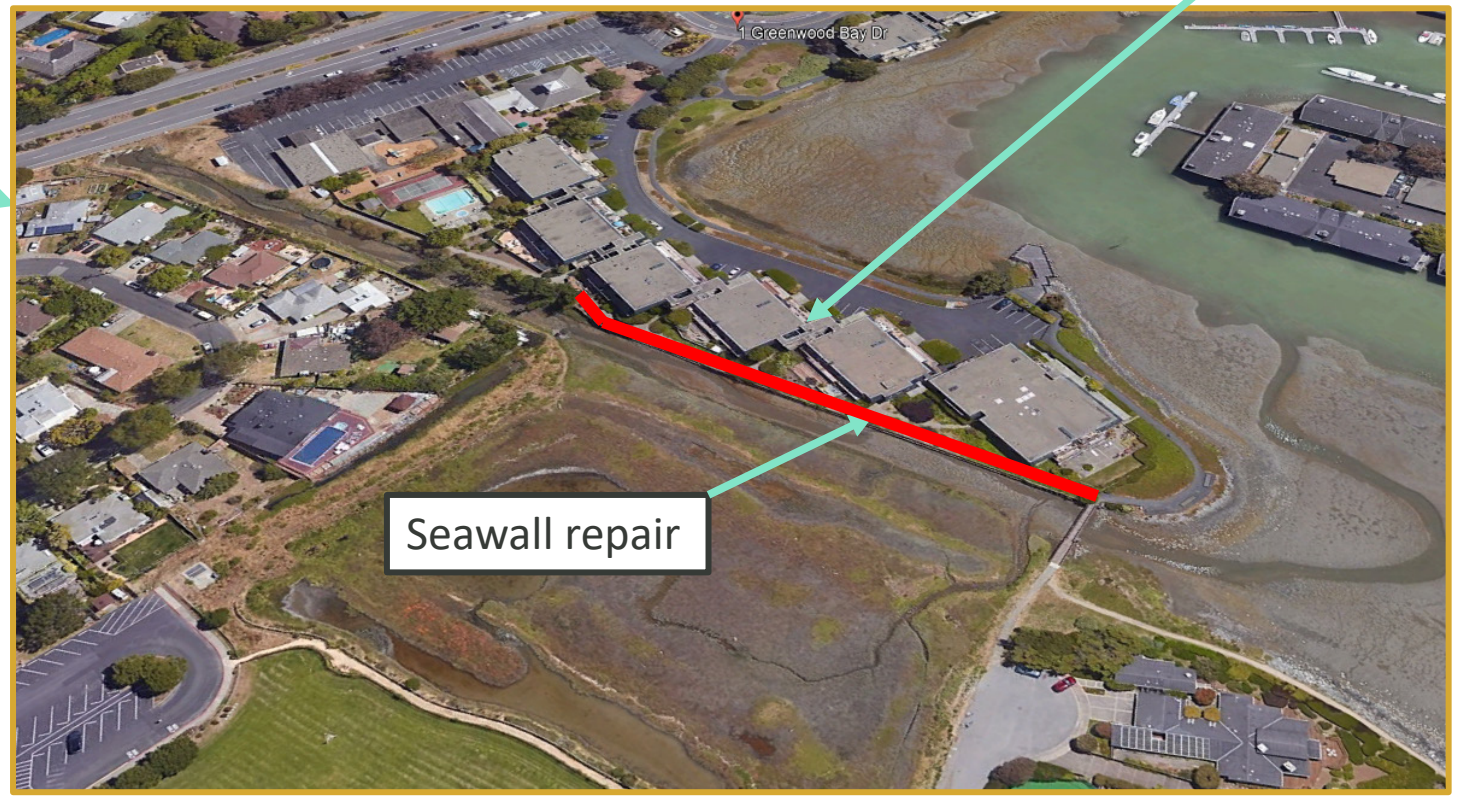
Design Team

- Owner's Representative – Barnegat Group
  - P.J. Cosgrove
- Structural Engineer of Record – Simpson Gumpertz & Heger (SGH)
  - Justin Pyun, P.E., S.E.
- Geotechnical Engineer of Record – RGH Consultants
  - Eric Chase, P.E., G.E.
  - Jared Pratt, Certified Engineering Geologist
- Independent Geotechnical Consultant
  - R. William ("Bill") Rudolph
- Permitting – AnchorQEA
  - Katie Chamberlin
  - Jordan Theyel

PROJECT BACKGROUND

Project Site





PROJECT SCOPE - PHASES

Phase 1

- Pile repairs for fishing pier and pedestrian bridge
- Completed in 2021
- Expedited because of closure of structures due to safety concerns

Phase 2

- Repair of damaged lagging on timber seawall west side of property
- Expected to be amendment to current permit

Not in Scope

- Adjacent shoreline on west side of property with no existing seawall
- Shoreline on south and east side of property with no existing seawall

PROJECT SCOPE - SHORELINE

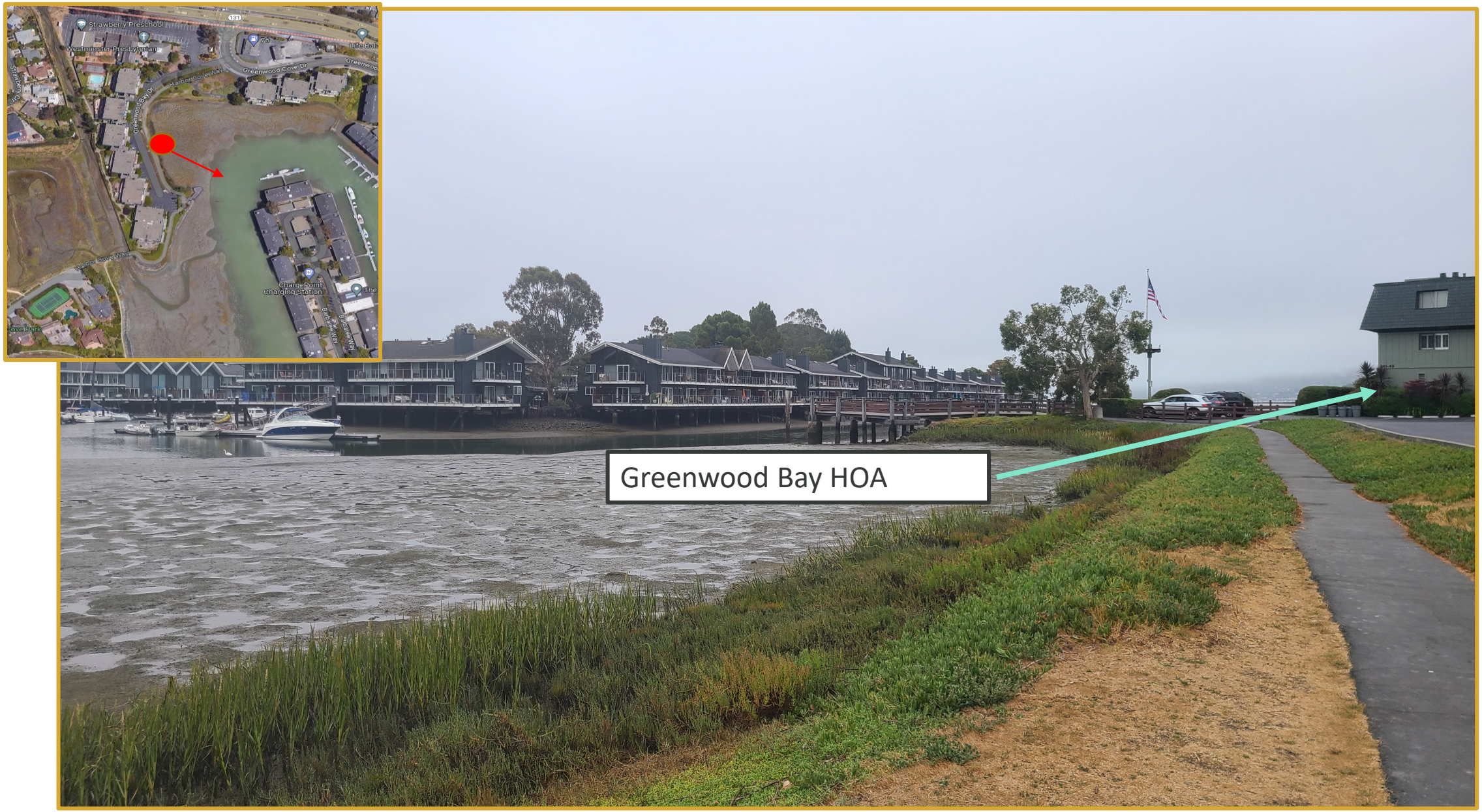
Seismic

- Repair designed to satisfy the requirements of the California Building Code for new design
- Seismic parameters consistent with ASCE 7-16 (2019/2022 CBC)

Sea Level Rise

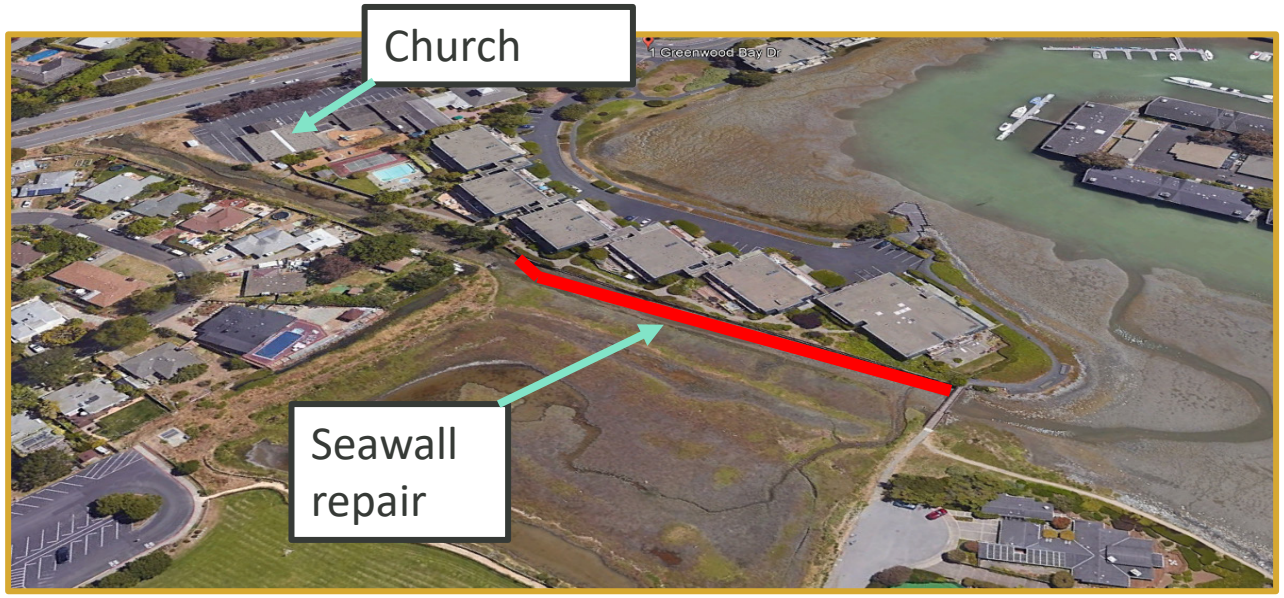
- Not considered in repair design
  - Not considered in Phase 1 for bridge and fishing pier
  - Phase 2 intent is only repair of existing seawall
    - Not associated with new development or other upgrades to complex
  - Only addresses part of shoreline of property
    - No plans to address SLR on remainder of property shoreline
    - Requirements to do so would require large engineering, construction, and development effort
    - Would likely kill entire repair project

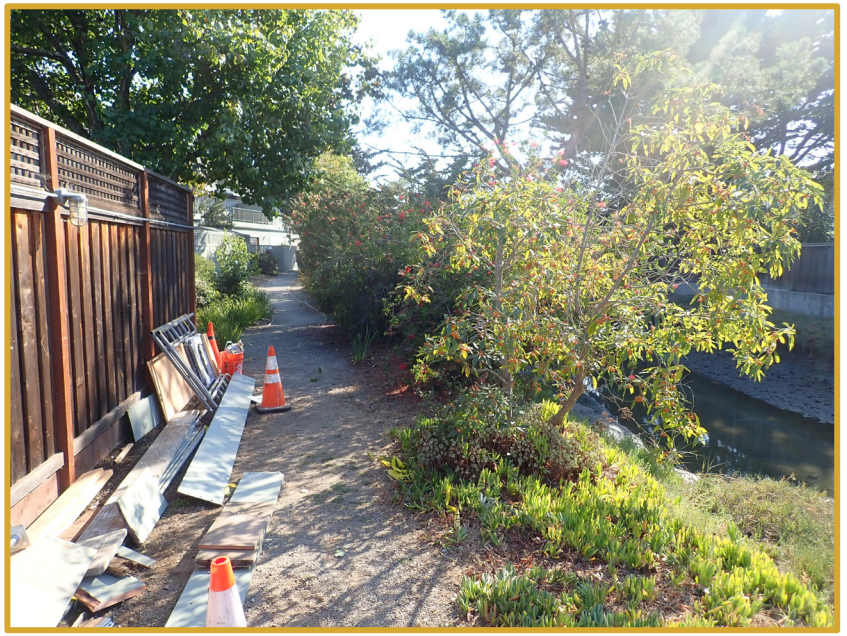
PROPERTY SHORELINE OUT OF SCOPE



SITE ACCESS CONSTRAINTS – BY LAND

- No access for large land-based equipment (cranes, pile driving rig, etc.)
- Private property with no public access. Wall is located behind locked pedestrian gates
- One access point at north end of the channel near the church
- Narrow access path and space





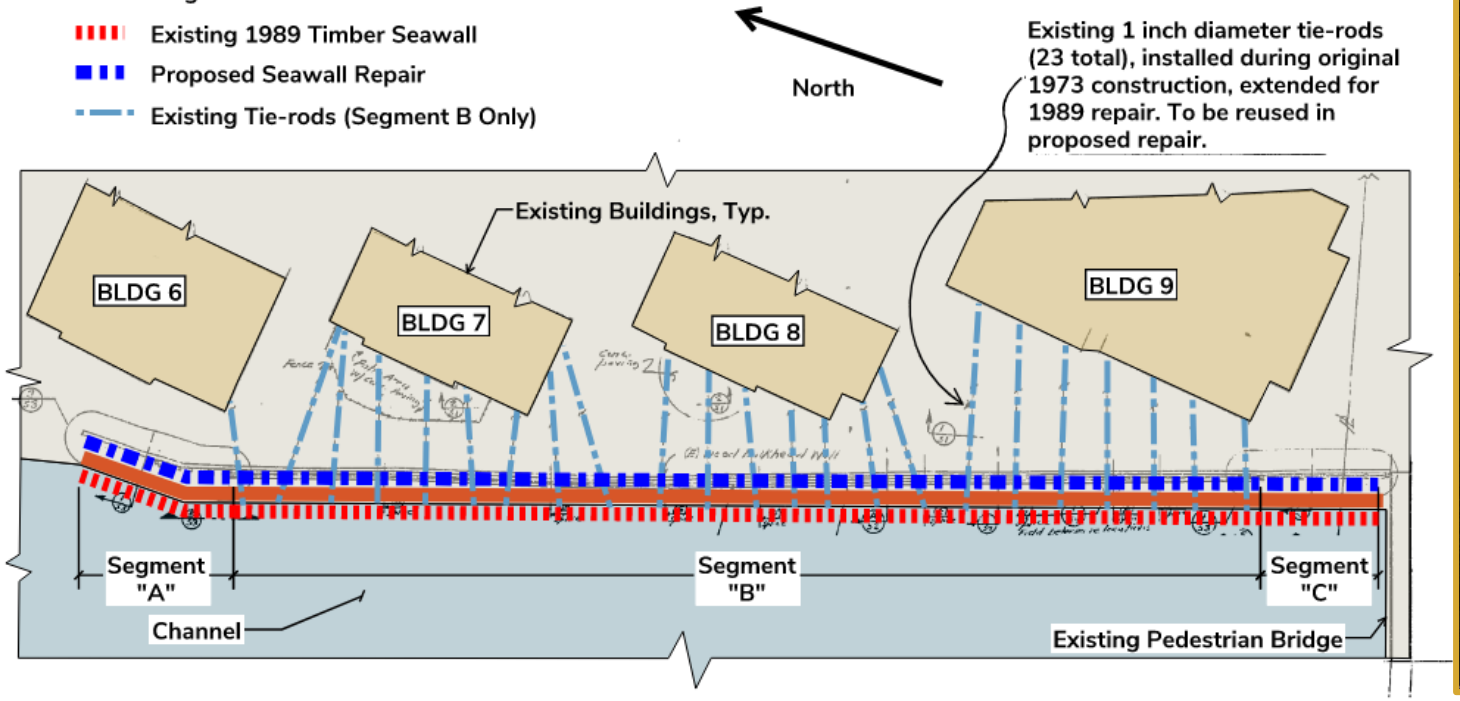
SITE ACCESS CONSTRAINTS – BY WATER

- Bottom of channel mudline elevation is approximately at mean sea level
- Tide timing and soft mud prohibitive for stationary equipment (barges, etc.)
- Pedestrian bridge with low clearance height prohibits access for most water-based construction vessels
- No marine contractor interested in this project

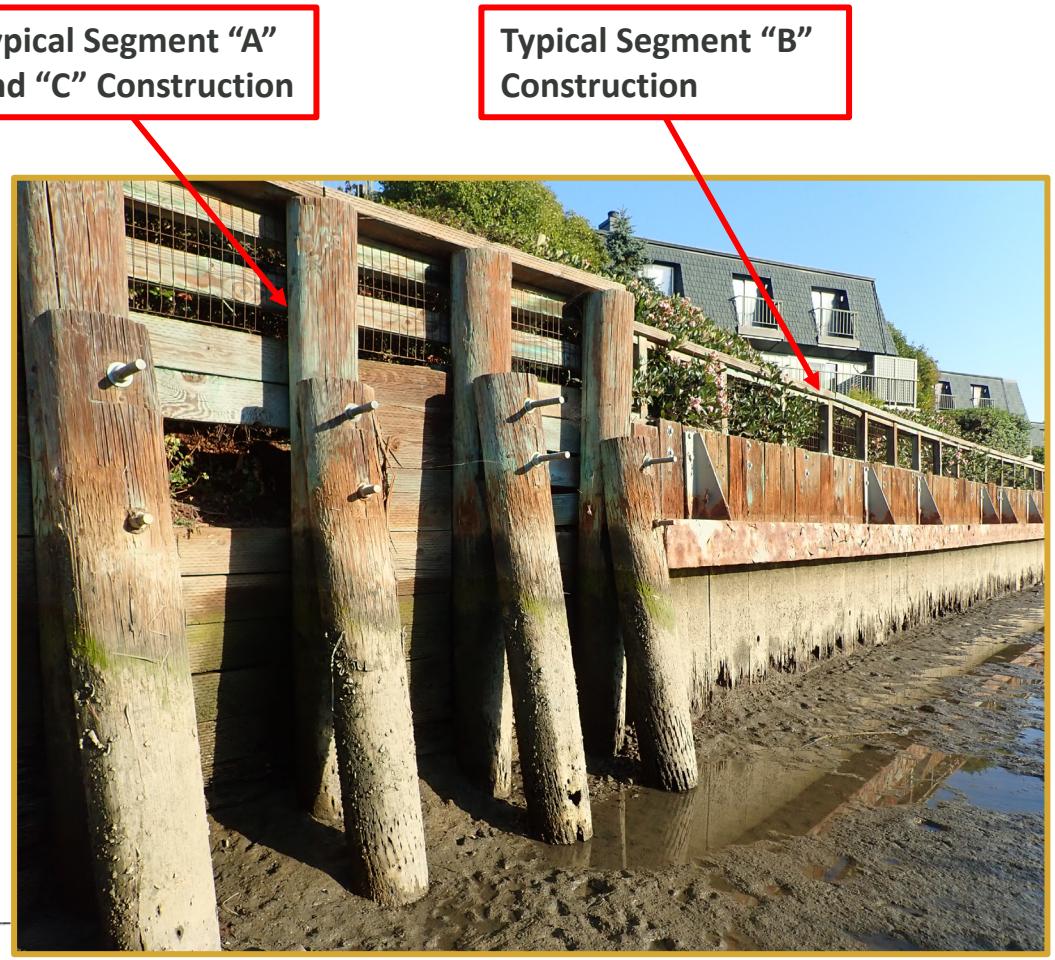
STRUCTURAL DESIGN DETAILS

DESCRIPTION OF SYSTEMS - OVERVIEW

Relation to Existing Seawall



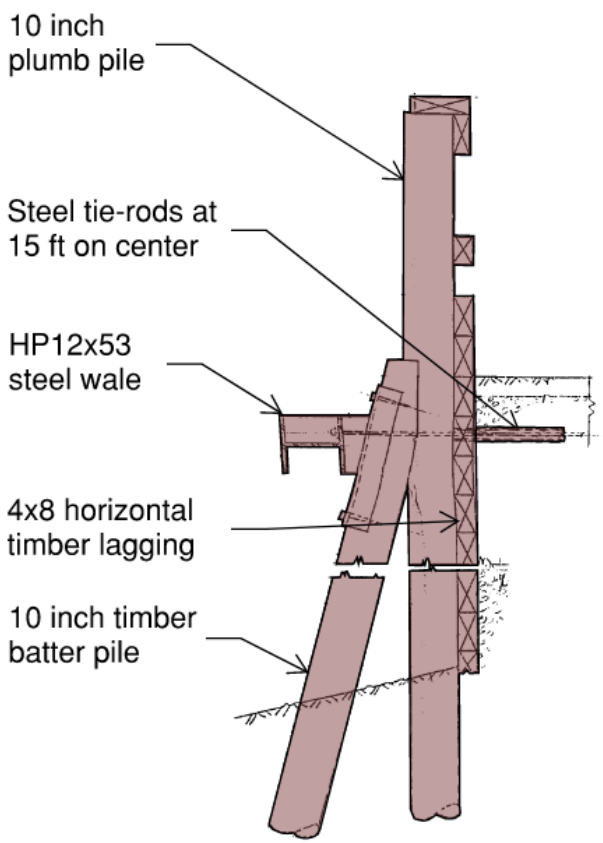
Plan - 1973 Original Seawall and 1989 Seawall Repair



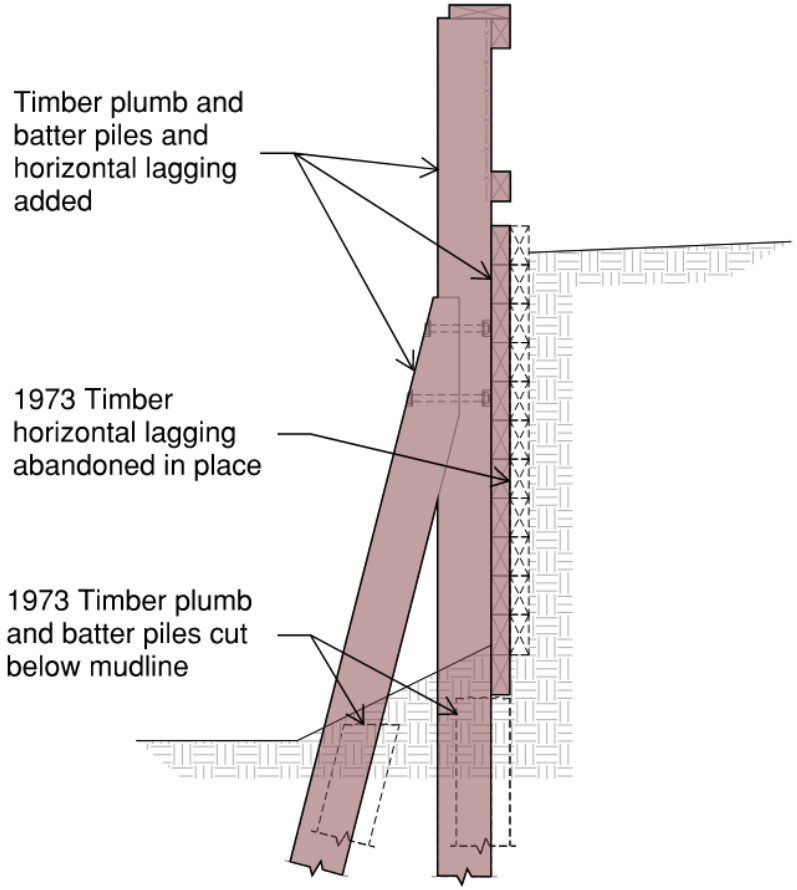
1989 Seawall Repair (Existing Condition)

DESCRIPTION OF SYSTEMS - SECTIONS

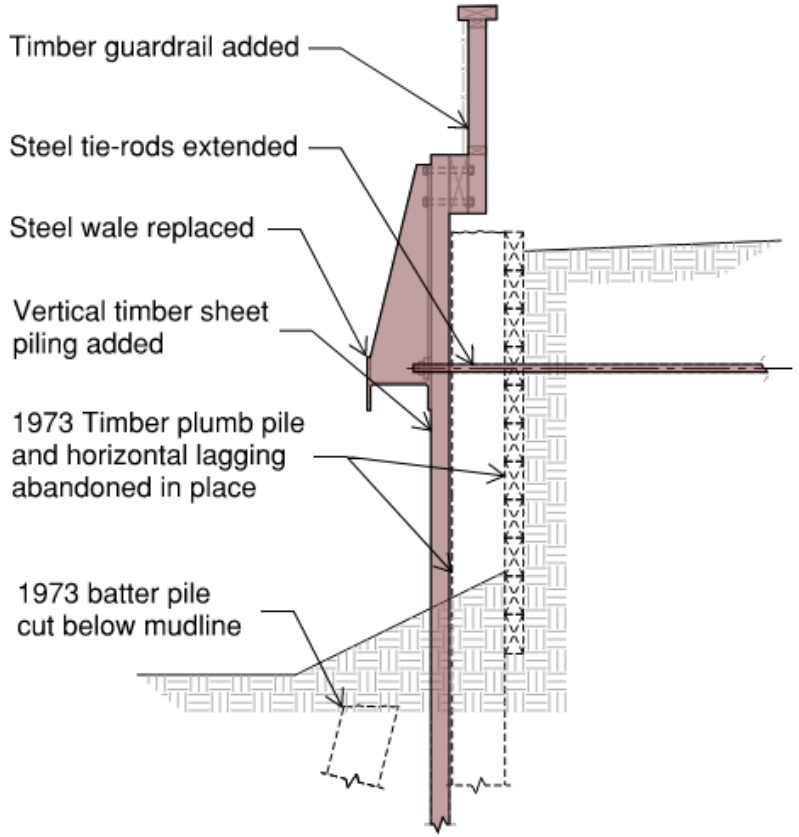
Sections



1973 Original Seawall



1989 Seawall Repair
Segment "A" and "C"



1989 Seawall Repair
Segment "B"

EXISTING CONDITIONS AT WALL

Typical Condition at Segment “A” and “C”

Typical Condition at Segment “B”

EXISTING CONDITIONS AT WALE AND GRADE

Typical Condition of Steel Wale

Typical View of Existing Grade at Top

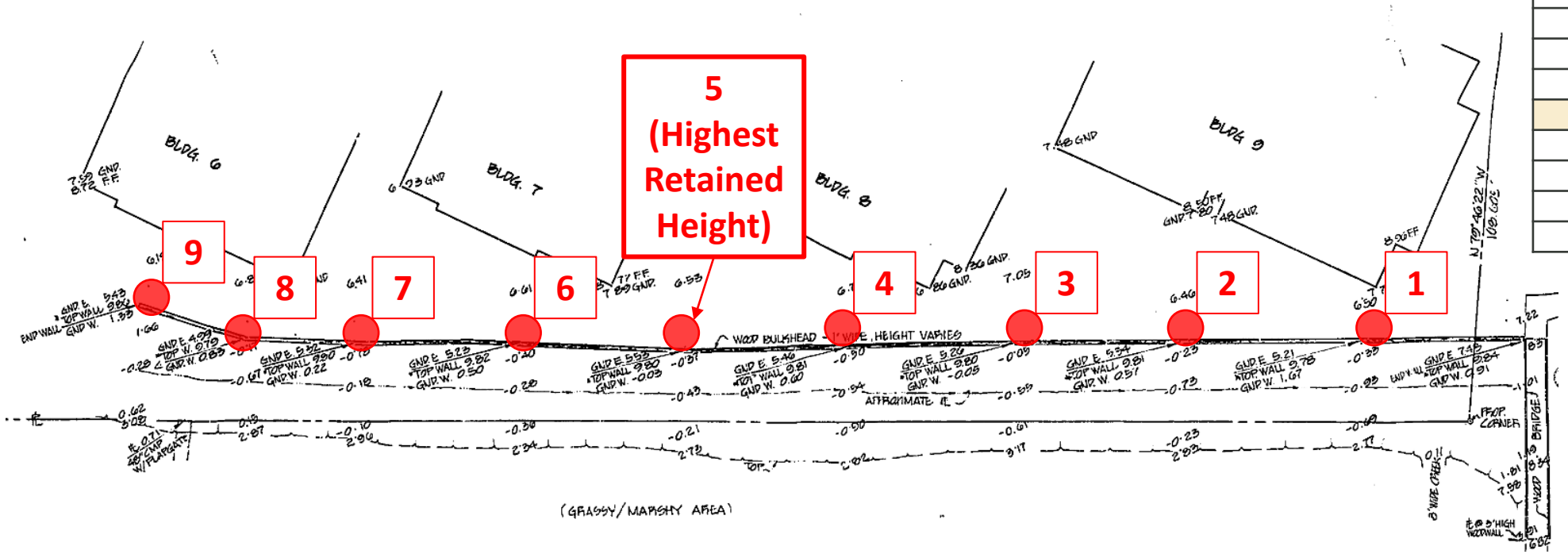
DESCRIPTION OF SYSTEMS - TOPOGRAPHY

Wall Height

Note:

1. Highest retained height is approximately 5.5 ft. That height is used in the calculations.
2. Survey datum shown in plan is NGVD29. Elevations shown in the table are converted to NAVD88.

Summary of Retained Heights			
Plan ID	T.O. Grade Landside (ft.)	T.O. Grade Waterside (ft.)	Retained Height (ft.)
1	7.88	4.34	3.54
2	8.01	3.24	4.77
3	7.93	2.62	5.31
4	8.13	3.27	4.86
5	**8.20**	**2.64**	**5.56**
6	7.90	3.17	4.73
7	7.99	2.89	5.10
8	7.66	3.50	4.16
9	8.10	4.00	4.10



August 1988 Topographic Survey

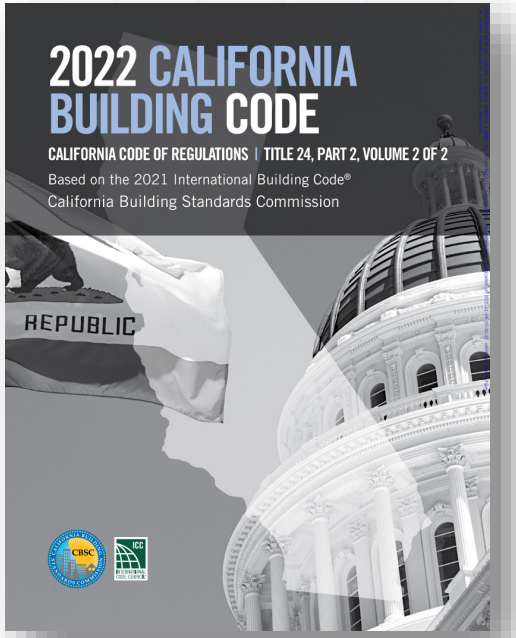
STRUCTURAL DESIGN BASIS

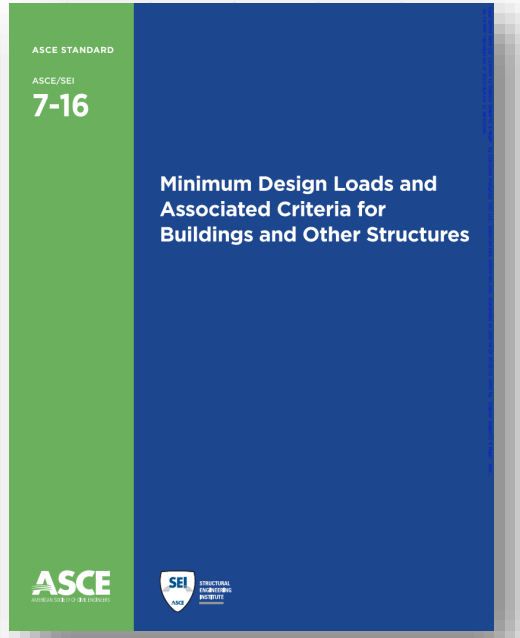
Codes and Standards

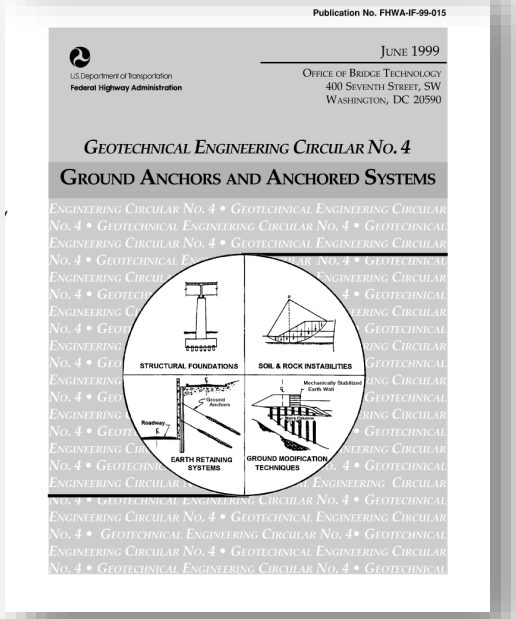
- 2022 California Building Code
- American Society of Civil Engineers, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, ASCE 7-16
- Geotechnical Engineering Circular No. 4, *Ground Anchors and Anchored Systems*, FHWA-IF-99-015
- U.S. Army Corp of Engineers, *Design of Sheet Pile Walls*, EM 1110-2-2504

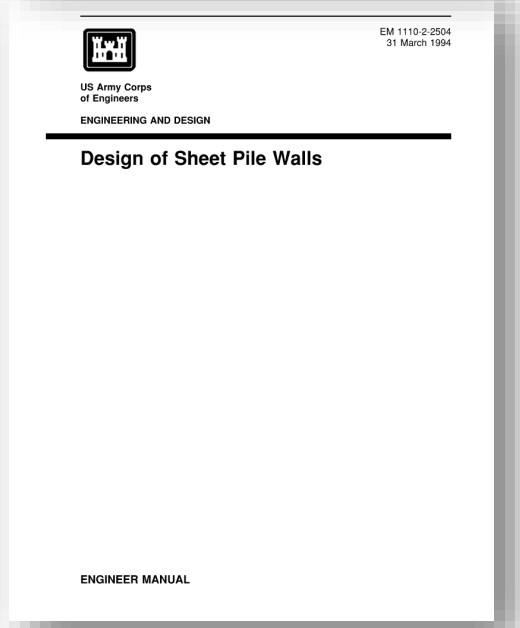
Loads Considered

- Gravity (dead and live surcharge)
- Earth pressures (static and seismic)
- Hydrostatic (tidal lag)





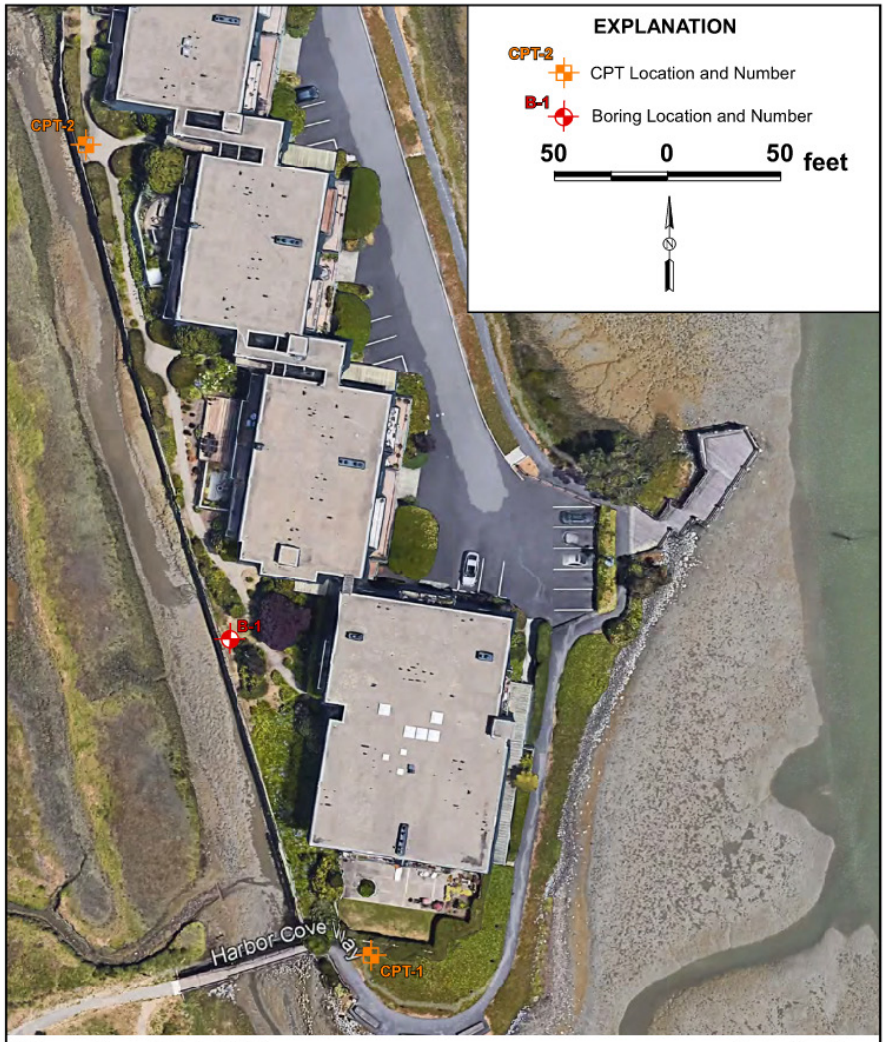




GEOTECHNICAL RECOMMENDATIONS – SITE INVESTIGATION

Boring B-1

- Heterogeneous fill within the existing backfill underlain by Bay Mud to a depth of 33 feet below the channel. Alluvial soils below that.

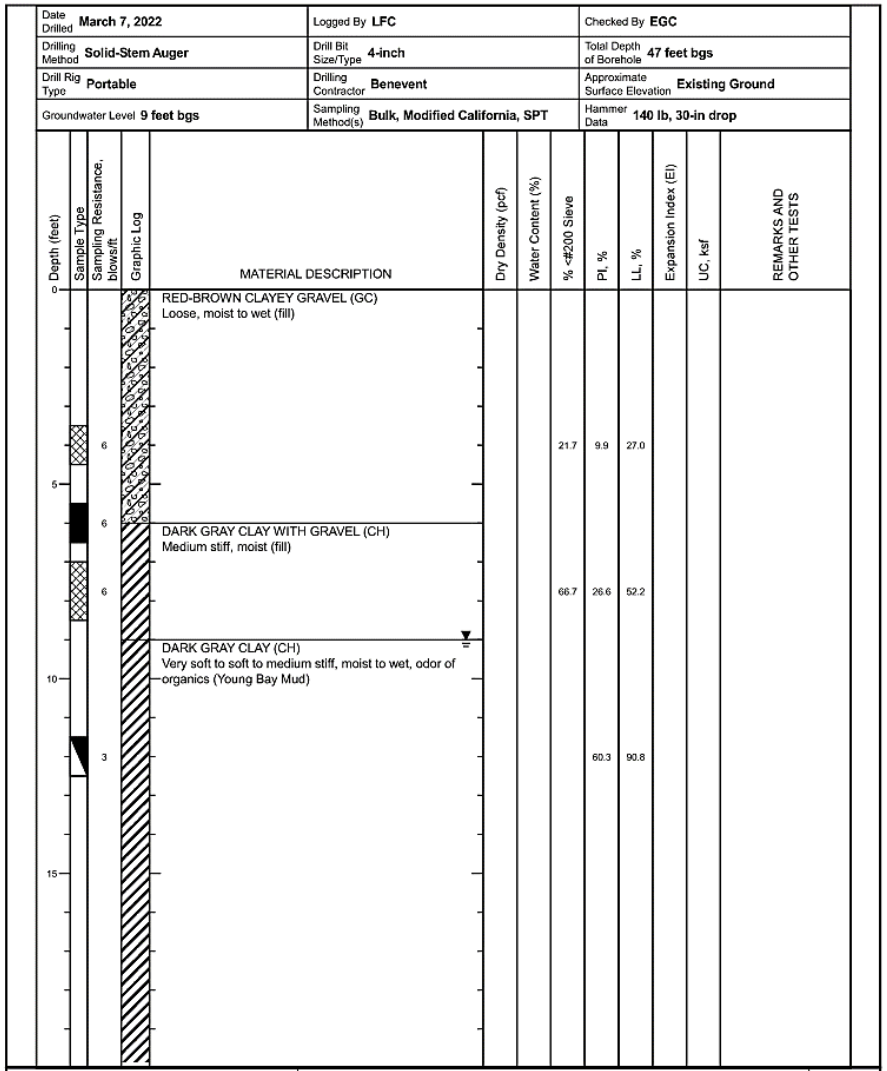


RGH CONSULTANTS

Job No: 7441.01.04.1 | Date: MAY 2022

EXPLORATION PLAN
Greenwood Bay Condominium Complex Timber Seawall
Greenwood Bay Drive
Tiburon, California

PLATE 2



RGH CONSULTANTS

Job No: 7441.01.04.1 | Date: MAY 2022

LOG OF BORING B-1
Greenwood Bay Condominium Complex Timber Seawall
Greenwood Bay Drive
Tiburon, California

PLATE 3

PGA and Liquefaction

Excerpt 1 from RGH Geotech Report Page 5 Regarding PGA

and Associated Criteria for Buildings and Other Structures" (2017). Using the site-specific seismic criteria developed in accordance with Chapter 21 of ASCE 7-16, the site's latitude and longitude of 37.8970°N and 122.5025°W, respectively, and a site soil Class of E, the PGA for the site is 0.6g. The San Andreas fault is

Excerpt 2 from RGH Geotech Report Page 6 Regarding Liquefaction Induced Lateral Spreading

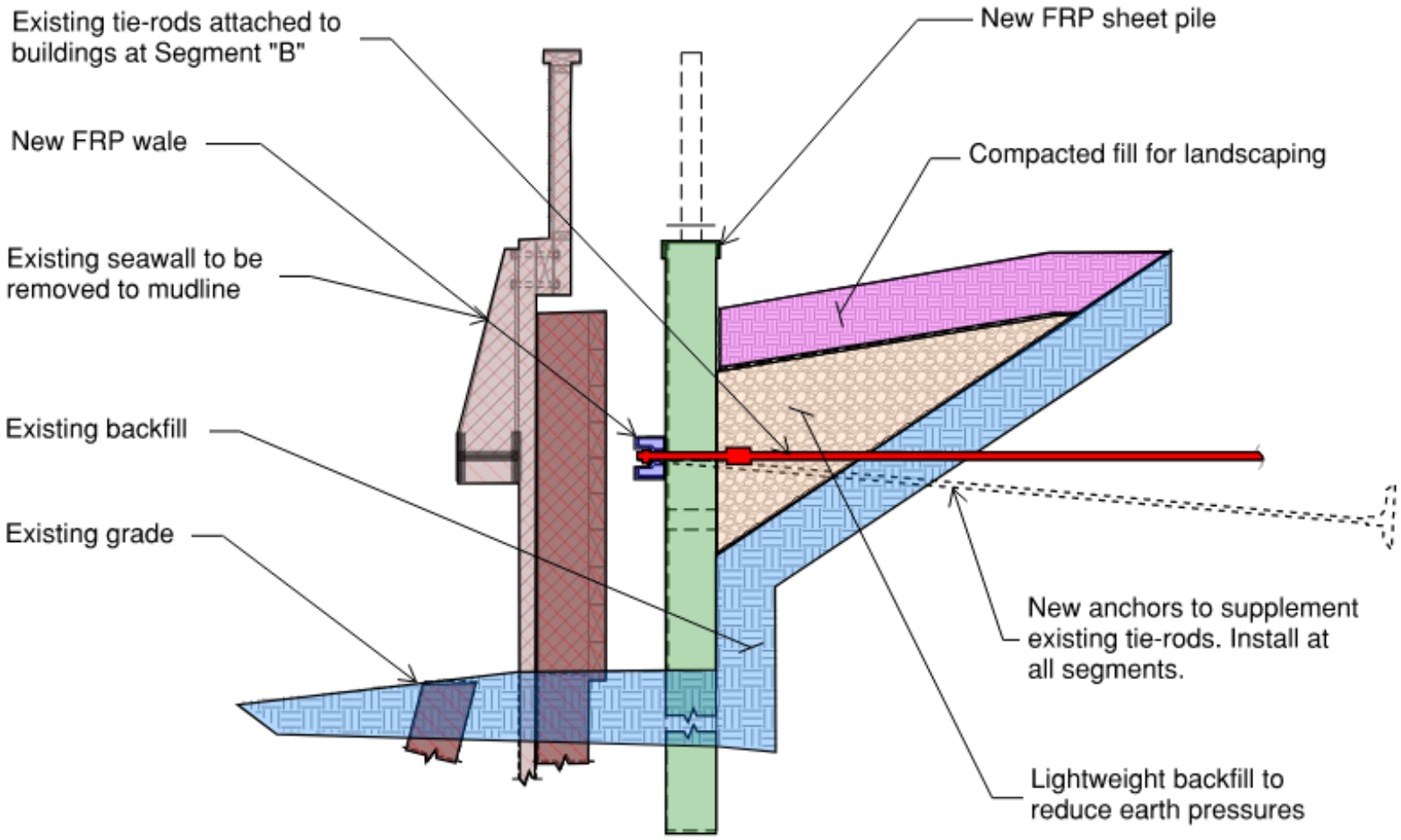
Lateral spreading can occur where continuous layers of liquefiable soil extend to a free face, such as a creek bank. The potentially liquefiable layers are located just below the channel mudline to the west of the condominium complex. Therefore, we judge the potential for liquefaction-induced lateral spreading at the site is low.

Excerpt 3 from RGH Geotech Report Page 6 Regarding Liquefaction Induced Settlements

As discussed previously, there are layers of the subsurface soil that are susceptible to liquefaction. Potentially liquefiable soils present at the site are susceptible to settlement due to the densification of the liquefied soils. Our analysis found that the total settlements could be in the range of ¾ inch. The sheet piles will extend below these soils, so the impact to the seawall from liquefiable soils will be minimal.

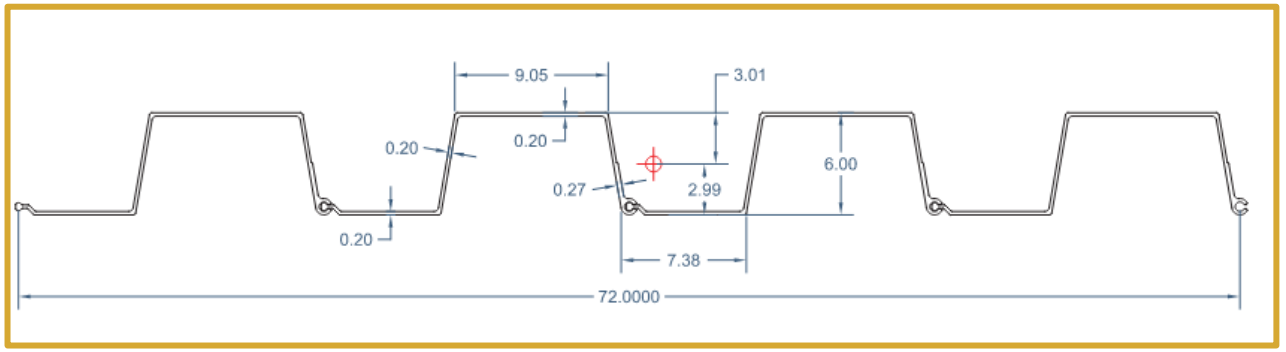
PROPOSED REPAIR - OVERVIEW

Typical Section



PROPOSED REPAIR – SHEET PILE

FRP Sheet Piling



SuperLoc Sheet Piles - Series 1560 (SS806)

Part drawings and physical property sheets can be viewed at **CreativeCompositesGroup.com**

Physical & Mechanical Properties

Series 1560 (SS806) 18" (457.2mm) W x 6" (152.4mm) H Physical Properties	Imperial Value	Units	Metric Value	Units
Section Modulus	8.02	in^3/ft	431.18	cm^3/m
Moment of Inertia	24.13	in^4/ft	3295.16	cm^4/m
Typical Thickness	0.2	in	5.08	mm
Depth of Sheet	6	in	152.4	mm
Width of Sheet	18	in	457.2	mm
Weight (single pile)	4.82	lb/ft of sheet	7.17	kg/m of sheet
Angle of the web	10	°	10	°
Cross Sectional Area of Sheet	6.17	in^2	39.81	cm^2
Standard Color	Graphite Gray			

PROPOSED REPAIR – WALE

FRP Wale and Splice

Mechanical Properties Of Wale Section Bent About The Minor Axis	Test Method	Units	Polyester Resin Average Values	Vinyl Ester Resin Average Values
Modulus of Elasticity	Lab	Msi (GPa)	3.16 (21.8)	3.56 (24.5)
Shear Modulus	Lab	Msi (GPa)	0.45 (3.1)	0.45 (3.1)
Shear Capacity	Lab/Calculated	lb (kg)	31,600 (14,300)	44,100 (20,200)
Moment Capacity	Lab/Calculated	ft-lb (N-m)	41,600 (56,400)	42,400 (57,400)
Bending Stiffness EI Value	Calculated	lb-in^2 (N-m^2)	1.56E8 (4.46E5)	1.75E8 (5.03E5)
In-Plane Shear Strength	ASTM D5379	ksi (MPa)	9.6 (66.2)	13.4 (92.4)

*Note: All values listed in the above table are characteristic values determined in accordance with ASTM D7290-06.

W-Splice

SuperWale W-Splice

Part Number	Material	Dimension	Weight
FAB383	50 ksi structural steel galvanized per ASTM A123	12L x 8.4W (305x213) in(mm) Hole diameter 1.125 (28.58) in(mm)	11 lbs. (5 kg)

Engineering Notes:

1. Tie-rod must be backed with a 3x3x.25 (83x83x6) in(mm) galvanized per ASTM A123 steel washer.
2. A tie rod should be utilized with each splice.
3. The working load capacity of the wale splice is 20,000 lbs., which includes a service factor.

PROPOSED REPAIR – MANTA RAY ANCHOR INSTALLATION

Manta Ray Anchor Installation

1. Thread a standard anchor rod into the threaded shackle of the Manta Ray® anchor.

2. Insert drive steel into the anchor. Position and angle.

3. Pull the drive steel out of the ground.

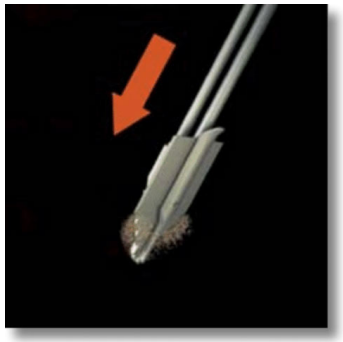
4. The end of the anchor rod should be at ground level. (In looser soils, may be countersunk up to 12" below the surface for greater holding capacity.)

5. The portable power source operates the Load Locker which grips the adapter setting bar and rotates the anchor underground into position. The desired holding capacity is set with the Load Locker gauge.

6. After removing the Load Locker, the eye is threaded to the end of the anchor rod. Now it's ready for guying.

PROPOSED REPAIR – MANTA RAY ANCHORS

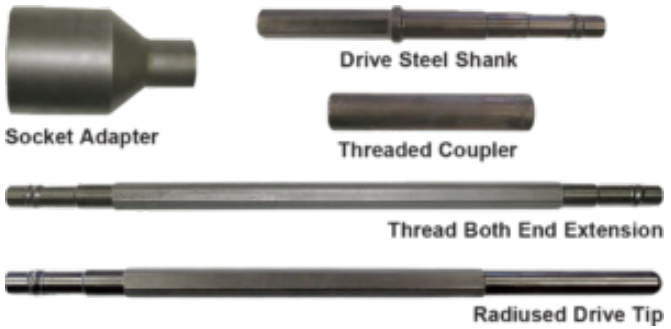
Manta Ray Anchor Capacities



Drive Anchor

Remove Drive Steel

Pull Anchor



COMMON SOIL TYPE DESCRIPTION	TYPICAL BLOW COUNT "N" PER ASTM D1586	MR-68	MR-88	MR-3	MR-2	MR-1	MR-SR
Very dense/cemented sands; coarse gravel and cobbles	60 – 100+	2.5 kips (1, 3)	5 kips (1, 3)	10 kips (1, 3)	20 kips (1, 3)	(5)	(5)
Dense fine sand; very hard silts and clays	45 – 60	1.5-2 kips (2, 3, 4)	4-5 kips (2, 3, 4)	8.5-10 kips (2, 3, 4)	10.5-14 kips (2, 4)	18-20 kips (1, 3, 4)	20 kips (1, 3)
Dense clays, sands and gravel; hard slits and clays	35 – 50	1.1-1.5 kips (4)	2-3 kips (4)	6-9 kips (2, 4)	7.5-11 kips (2, 4)	12-18 kips (2, 4)	16-20 kips (2, 3, 4)
Medium dense sandy gravel; very stiff to hard silts and clays	24 – 40	0.75-1 kips (4)	1.5-2 kips (4)	4.5-7 kips (4)	6-9 kips (4)	9-10 kips (2, 4)	12-17 kips (2, 4)
Medium dense coarse sand and sandy gravel; stiff to very stiff silts and clays	14 – 25	0.55-0.75 kips (4)	1-1.5 kips (4)	3.5-4.5 kips (4)	4.5-6 kips (4)	7.5-10 kips (4)	9-12 kips (4)
Loose to medium dense fine to coarse sand; firm to stiff clays and silts	7 – 14	0.45-0.6 kips (4)	0.75-1.25 kips (4)	2.5-4 kips (4)	3.5-5 kips (4)	5-7.5 kips (4)	7-9 kips (4)
Loose fine sand; alluvium; soft-firm clays; varied clays; fills	4 – 8	0.3-0.5 kips (4, 6)	0.45-0.75 kips (4, 6)	1.5-2.5 kips (4, 6)	2.5-4 kips (4, 6)	4-6 kips (4, 6)	4.5-7 kips (4, 6)
Peat, organic silts; inundates silts fly ash	0 – 5	(5)	0.1-0.45 kips (4, 6)	0.4-1.5 kips (4, 6)	1-2.5 kips (4, 6)	1.5-4 kips (4, 6)	2-6 kips (4, 6)

PROPOSED REPAIR – ANCHOR TESTING

Performance and Proof Testing of Anchors per Sheet S03

- Two anchors to be performance tested:

Table 1. Performance Test Schedule						
Cyclical Load Increments (%DL/100)						
Cycle 1	AL	0.25DL				
Cycle 2	AL	0.25DL	0.25DL			
Cycle 3	AL	0.25DL	0.5DL	0.75DL		
Cycle 4	AL	0.25DL	0.5DL	0.75DL	1.00DL	
Cycle 5	AL	0.25DL	0.5DL	0.75DL	1.00DL	1.25DL

AL = Alignment Load (0.10DL)
DL = Design (Working) Load

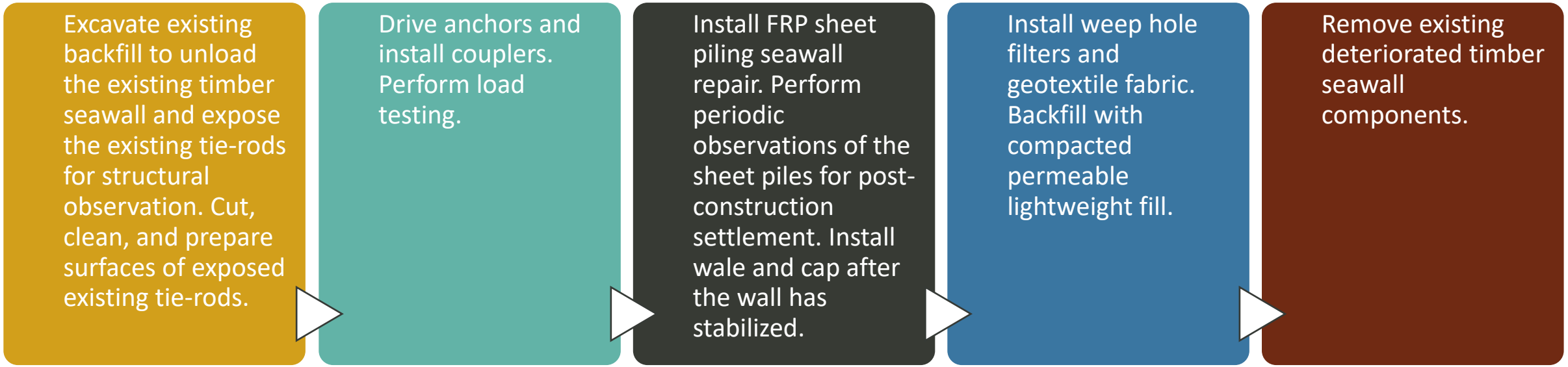
- Remaining anchors to be proof tested:

Table 2. Proof Test Schedule						
Load Test (%DL/100)	AL	0.25DL	0.5DL	0.75DL	1.00DL	1.25DL
Observation Period (Min.)	AL	2	2	2	2	5

AL = Alignment Load (0.10DL)
DL = Design (Working) Load

PROPOSED REPAIR – EXAMPLE SEQUENCE

Example Sequence of Work



Above figure shown on Sheet G-02 as **example** sequence. **Contractor** is responsible for means and methods.

Approach

- Use force-equilibrium analysis approach
- Determine required penetration depth of sheet piling to satisfy factor of safety (FOS) against overturning > 1.5 (static) and 1.1 (seismic) per USACE and CBC
- Design and select sheet pile, wale, and anchor size/layout based on analysis results and correspondence with components manufacturers
- Additional verifications analysis using PYWall
- “Informal” review by independent geotechnical engineer (Bill Rudolph)

ANALYSIS AND DESIGN – WALL LOADING

Wall Loading Profile

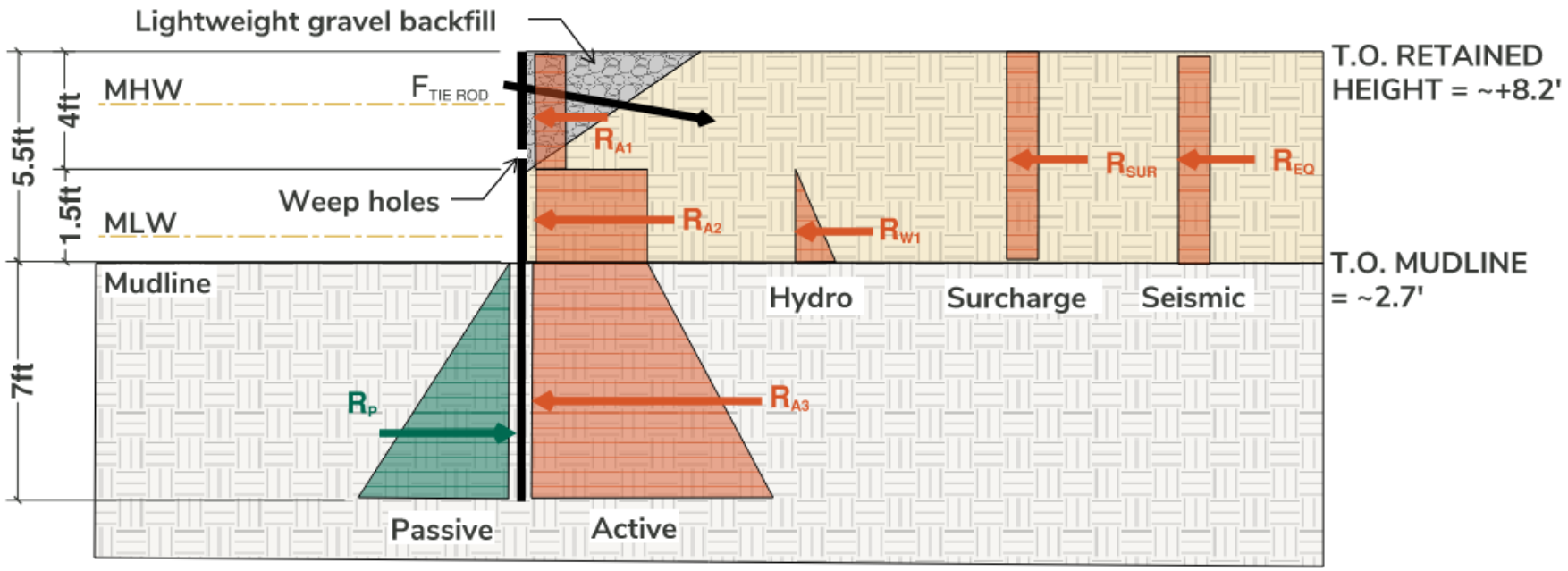


Table 3-1 – Active Static Soil Properties

Soil Layer	Equivalent Fluid Pressure *F*, pcf	Unit Weight γ, pcf	Friction Angle $\varnothing$, deg
New Lightweight Fill[1]	22	80	35
Native Fill, Above Mudline[2]	12	120	30
Native Fill, Below Mudline[2]	20	95	15

1. Soil properties are based on Clearlake Lava permeable drain rock.
2. Soil properties are taken from the RGH Geotechnical Report.

3.3.3 Seismic Lateral Pressures

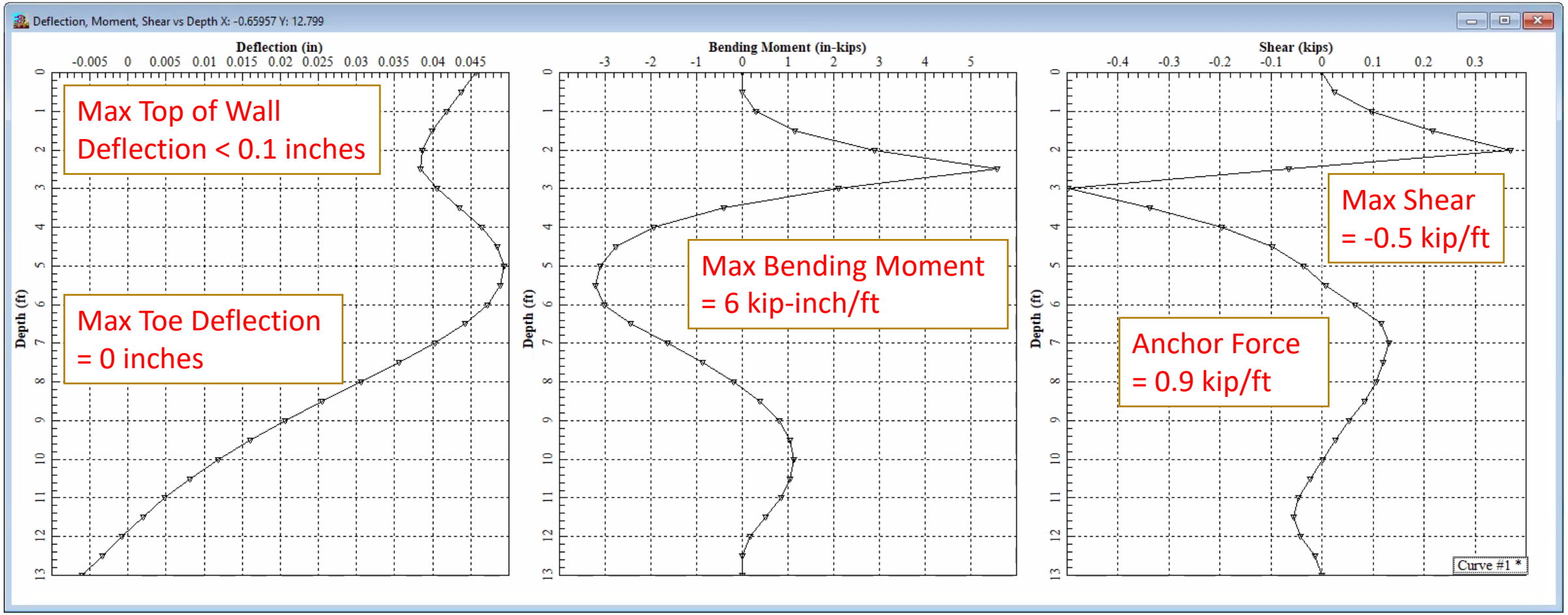
We applied an additional rectangular pressure of 9H over the retained height to account for the seismic increment based on recommendations included in RGH's Geotechnical report.

3.3.4 Passive Pressures

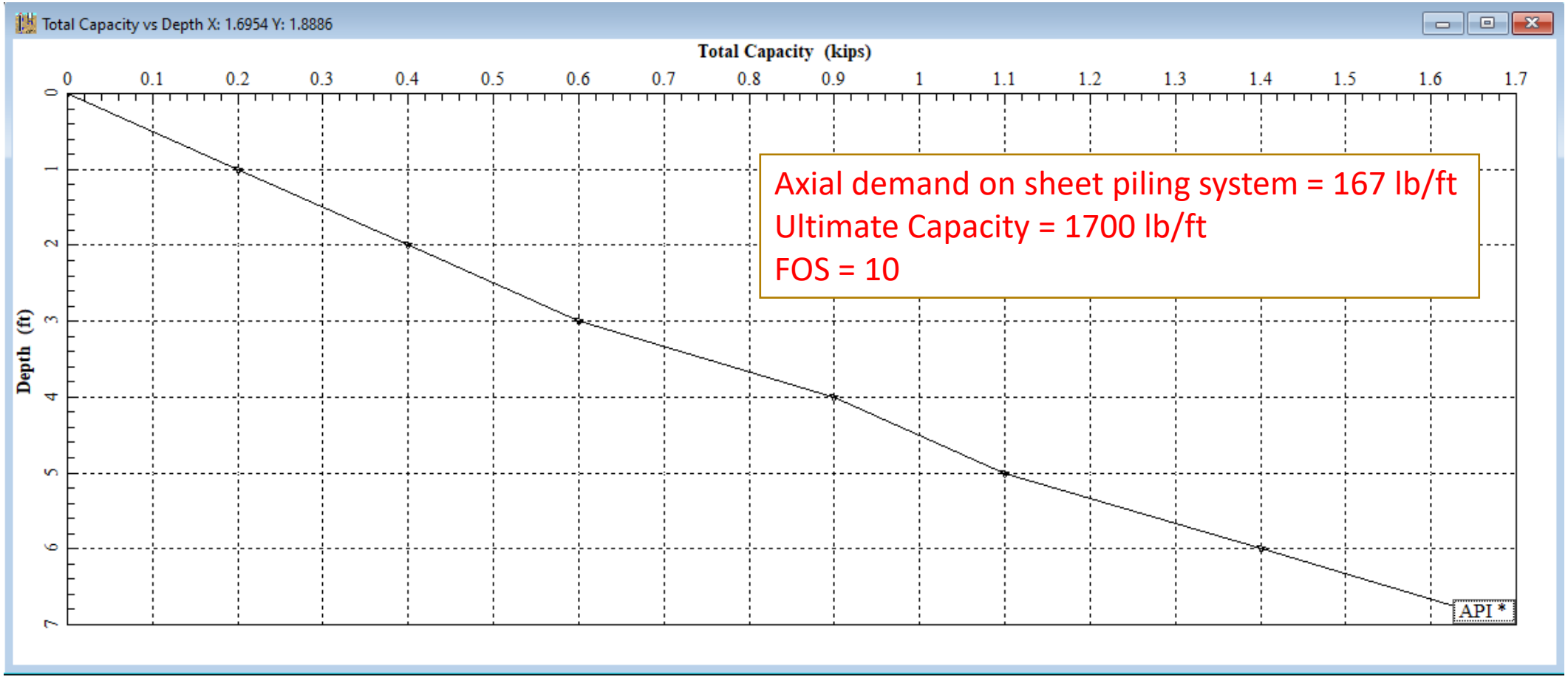
We applied a variable pressure of 107 pcf (not to exceed 750 psf) over the embedded length of the wall to account for the passive pressure on the wall based on recommendations included in RGH's Geotechnical report.

ANALYSIS AND DESIGN – PYWALL VERIFICATION

PYWall Results – Deflections, Shears, and Moments



PYWall Results – Skin Friction



Axial demand on sheet piling system = 167 lb/ft
Ultimate Capacity = 1700 lb/ft
FOS = 10

Design Summary

- We calculated a global overturning FOS of **2.86** using a force-based approach
- We calculated the following demand-to-capacity ratios:

	Demand	Capacity	DCR
Existing Tie-rod, Axial	14.97 kips	21.16 kips	0.71
Soil Anchor, Geotechnical	4.70 kips	7 kips*	0.67
Soil Anchor, Structural	4.70 kips	20 kips*	0.24
Sheet pile, Flexure	0.5 kip-ft/ft	3.02 kip-ft/ft*	0.17
Sheet pile, Concentrated Load	0.94 kips/ft	1.97 kips/ft*	0.48
Sheet pile, Shear	0.5 kips/ft	7.14 kips/ft*	0.07
Polyester Wale, Flexure	0.94 kips/ft	1.92 kips/ft*	0.49
Polyester Wale, Concentrated Load	7.00 kips	12.00 kips*	0.58
Wale, Splice	7.00 kips	20 kips*	0.35

*Capacity includes a factor of safety

SUMMARY

- Site access constraints
  - Water access impractical due to channel elevation and pedestrian bridge
  - Land access through church property
  - Limited to hand operated tools and small backhoe/excavator
- Sea level rise not considered
- Seismic
  - Potential for lateral spreading is low and liquefaction induced settlements are minimal per Geotechnical Report
  - Code-level seismic active earth pressures included in the analysis per Geotechnical Report
- System
  - 5.5 ft retained height and 7 ft minimum piling penetration
  - FRP sheet piling, wale, and cap
  - Reuse existing tie-rods and install supplemental anchors
  - Overturning stability FOS is satisfactory
  - Component DCRs are satisfactory
  - Minimal sheet pile deflections expected
  - Anchors to be performance and proof tested
- Design satisfies the requirements of the Building Code
- Net reduction in Bay Fill due to construction behind existing seawall