May 9, 2017

State of Alaska DHS-EM EQ Workshop

Anchorage Port Modernization Concept for Seismic Resiliency

Presented by:

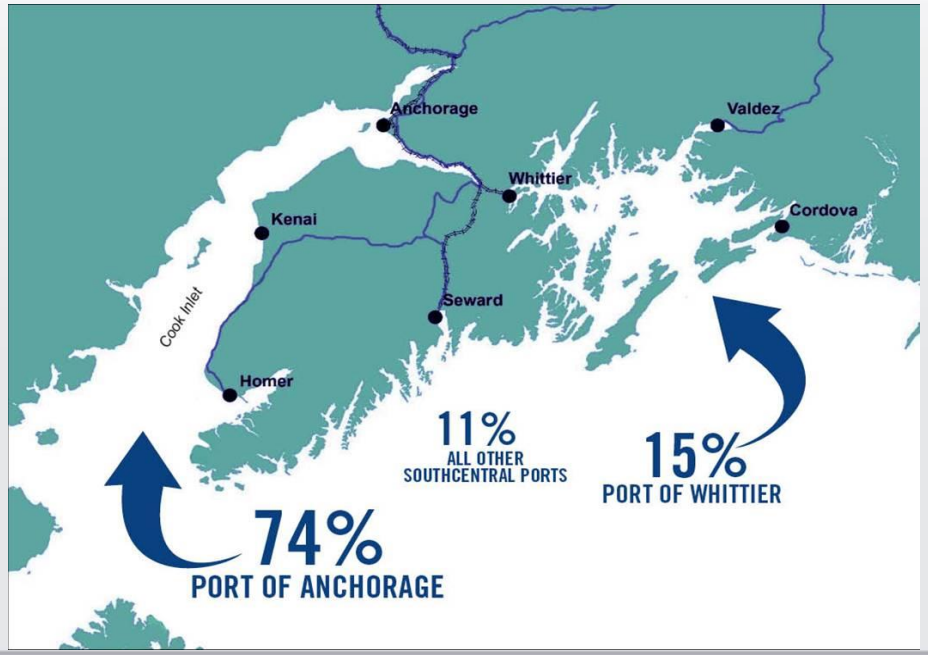
Todd Cowles, P.E.
Port Engineer

Presentation Overview

- Port of Anchorage Overview
- Modernization Program Phasing
- Seismic Performance Requirements
- Seismic Berth Concept Design Alternatives
- Questions

Port of Anchorage Overview

- Owned by the Municipality of Anchorage / Landlord Port
- Cargo: Petroleum, Cement, Container, Project Cargo
- Critical to Alaska *(~3.5M tons of cargo in 2016)*
  - 74% of all in-bound non-petroleum freight thru Southcentral ports
  - 95% of all refined petroleum products moving thru Southcentral ports
- Dept. of Defense Designated National Strategic Seaport



Port of Anchorage Facilities

Piling Condition

Terminal/POL	Age *(years)*	Min. Thickness Observed 2014	Percent Loss
Terminal 1	56	0.15”	67%
POL Terminal 1	52	0.15”	67%
Terminal 2	49	0.20”	55%
Terminal 3	44	0.18”	59%
POL Terminal 2	22	0.13”	71%

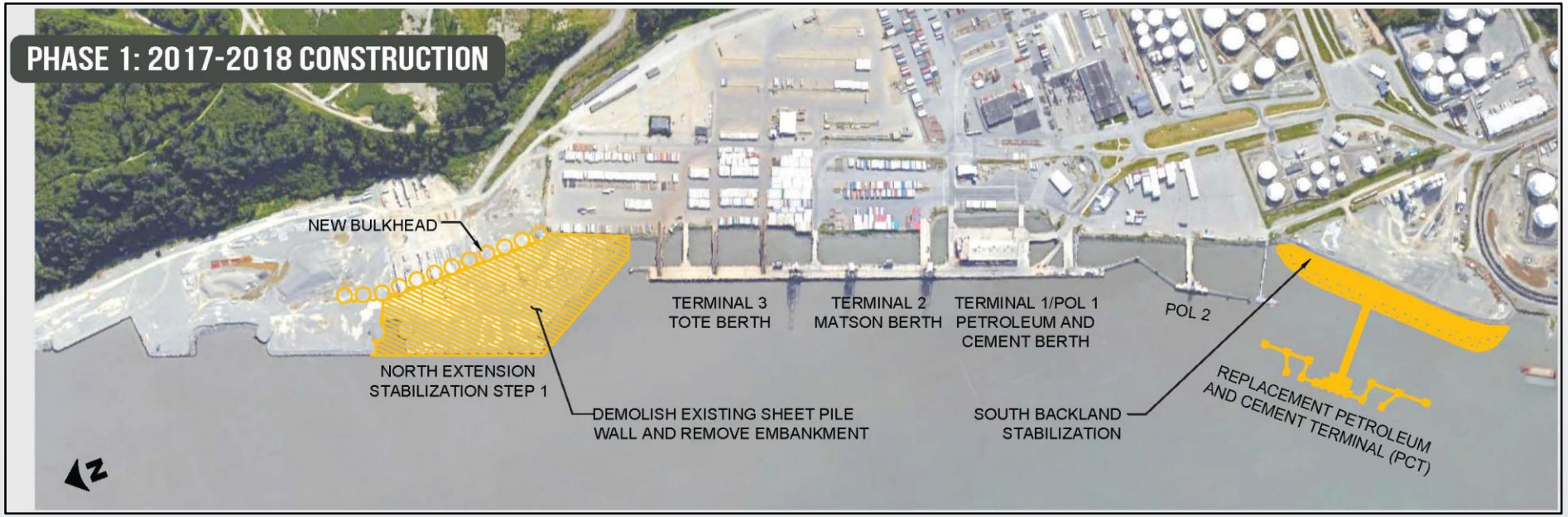
Jacket Repairs

- Primarily a vertical capacity enhancement
- Does not improve the seismic resilience of the Port
  - Simply “band-aids” a structure not designed to current codes
  - Continued risk of sediment liquefaction during EQ
- One-time fix

Anchorage Port Modernization Program

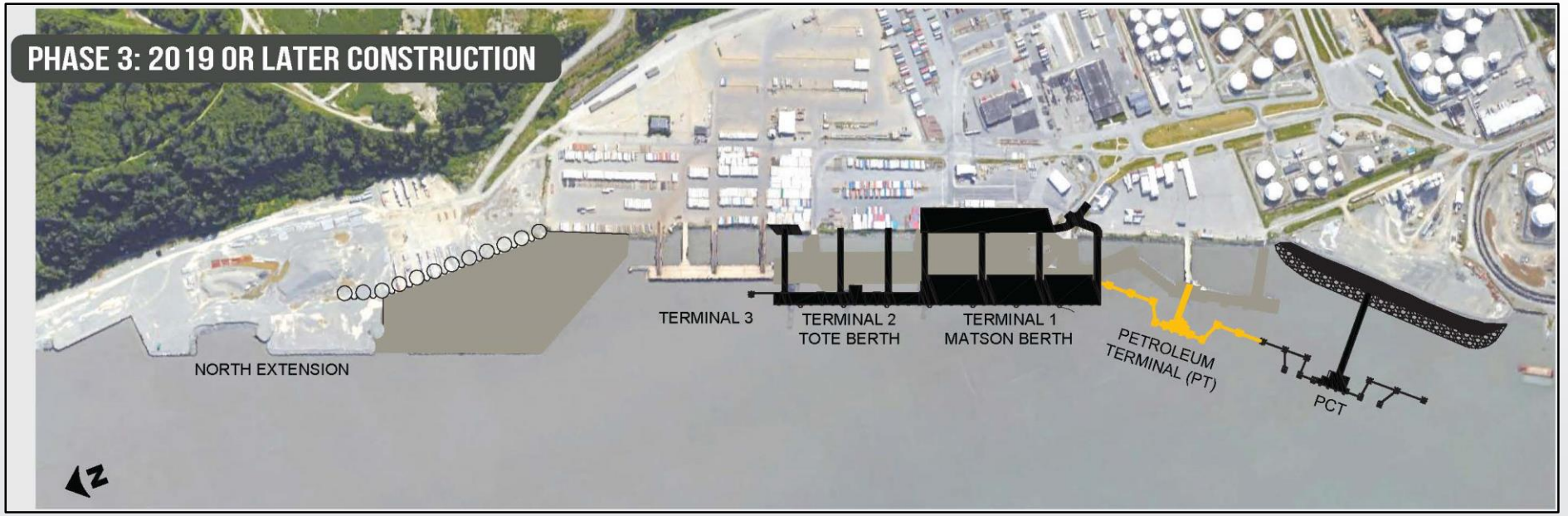
PHASING

APMP PHASE 1: NORTH EXTENSION STABILIZATION STEP 1 + PETROLEUM/CEMENT TERMINAL



APMP PHASE 2: TERMINAL 1 + TERMINAL 2

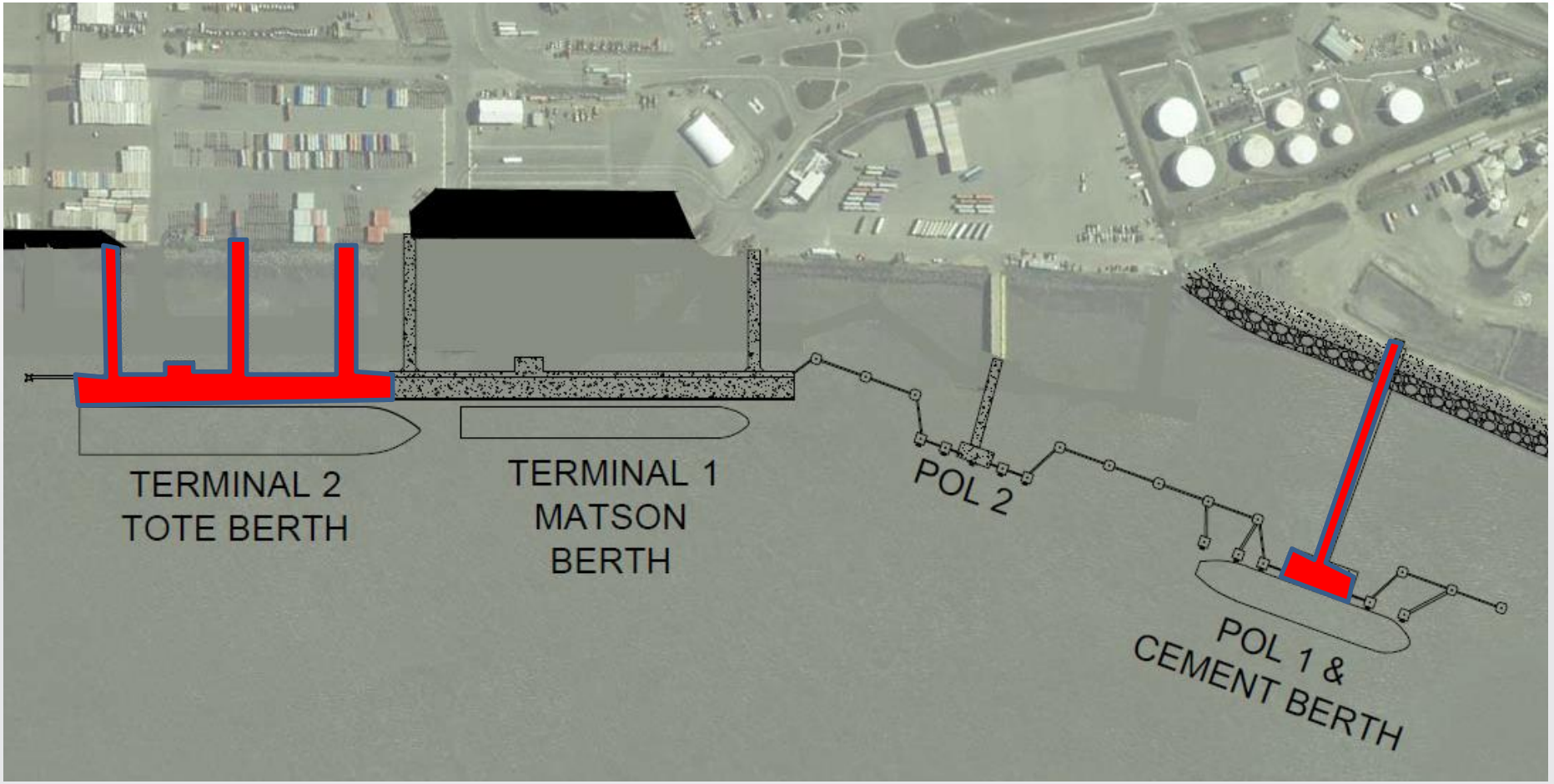
APMP PHASE 3: PETROLEUM TERMINAL



Anchorage Port Modernization Program

SEISMIC PERFORMANCE REQUIREMENTS

Seismic Berths (T2 and PCT)



Seismic Hazard Levels

Table 1-1. Peak Ground Acceleration – APMP			
Location	Seismic Hazard Level	Return Period	Peak Ground Acceleration (g)
Trestles	OLE	72 year	0.14
	CLE	475 year	0.31 (+29%)
	DE	1,000 year [a]	0.39 (+63%)
Wharves	OLE	72 year	0.23 (approx. equal)
	CLE	475 year	0.38 (+58%)
	DE	1,000 year [a]	0.45 (+88%)
1964 Alaska Earthquake (areas around Anchorage)			0.18-0.24[b]

[a] DE corresponds to 2/3 of the MCE, and corresponds to a ground motion of approximately 1,000-year return period.

[b] Recorded peak ground acceleration around Anchorage area. (USGS, 2008)

Seismic Performance Levels

Minimal Damage OLE	Controlled and Repairable Damage CLE	Life Safety Protection DE
		
Initial cracking and spalling of the pile and/or deck	Substantial spalling of the pile and the deck in the vicinity of the pile thereby exposing reinforcement in the pile and the deck	Broken connection from either spalling into the core, fractured dowel bars or buckled strand.

Proposed Seismic Design Criteria – APMP

Seismic Design Criteria – APMP			
Structure	Design Classification	Seismic Hazard Level	Seismic Performance Level
New Terminal 2 and approach trestles	Seismic Berth	OLE	Minimal damage
	Seismic Berth	CLE	Minimal damage*
	Seismic Berth	DE	Life safety protection
New Terminal 1 and approach trestles	High	OLE	Minimal damage
	High	CLE	Controlled and repairable damage
	High	DE	Life safety protection
New POL 2 and approach trestle	Moderate	OLE	Minimal damage
	Moderate	CLE	Controlled and repairable damage
	Moderate	DE	Life safety protection
New POL 1 and approach trestle	Seismic Berth	OLE	Minimal damage
	Seismic Berth	CLE	Minimal damage*
	Seismic Berth	DE	Life Safety Protection

Notes:

DE (Design Earthquake) level is equivalent to 2/3 of MCE per ASCE 7-10. Ground motions from ASCE 7-10 exceed those from ASCE 7-05 specified in ASCE/COPRI 61-14.

*** Seismic performance level above that required by ASCE/COPRI 61-14**

MOA Geotechnical Advisory Commission Recommendations

- At a minimum, one container dock and one petroleum, oil and lubricants (POL) dock should be designed for "minimal damage" at the Contingency Level (CLE) ground motions, and "controlled and repairable damage" at the Design Earthquake (DE) ground motions. These structures are referred to as the "seismic berths".

MOA Geotechnical Advisory Commission Recommendations

- The GAC advises that the definition of "controlled and repairable damage" should be adjusted to mean damage which is feasibly repairable within several days to one week of the seismic event, and contingencies, plans and materials for the repair are to be included in the design to reduce response time. The GAC also recommends that the performance of the new port elements should consider the effects on repair and/or reconstruction schedules if a major earthquake occurs during the winter.

Seismic Design Criteria – Comparison

Seismic Design Criteria – APMP vs GAC				
Structure	Design Class	Seismic Hazard Level	Seismic Performance (APMP)	Seismic Performance (GAC)
New T2	Seismic	OLE	Minimal damage	Minimal damage
	Seismic	CLE	Minimal damage*	Minimal damage*
	Seismic	DE	Life safety protection	Controlled and repairable damage**
New T1	High	OLE	Minimal damage	Minimal damage
	High	CLE	Controlled and repairable damage	Controlled and repairable damage
	High	DE	Life safety protection	Life safety protection
New POL 2	Moderate	OLE	Minimal damage	Minimal damage
	Moderate	CLE	Controlled and repairable damage	Controlled and repairable damage
	Moderate	DE	Life safety protection	Life safety protection
New POL 1	Seismic	OLE	Minimal damage	Minimal damage
	Seismic	CLE	Minimal damage*	Minimal damage*
	Seismic	DE	Life Safety Protection	Controlled and repairable damage**

Notes:

DE (Design Earthquake) level is equivalent to 2/3 of MCE per ASCE 7-10. Ground motions from ASCE 7-10 exceed those from ASCE 7-05 specified in ASCE/COPRI 61-14.

- *** Seismic performance level above that required by ASCE/COPRI 61-14**
- **** Controlled and Repairable defined as functional within 1 week of EQ**

Anchorage Port Modernization Program

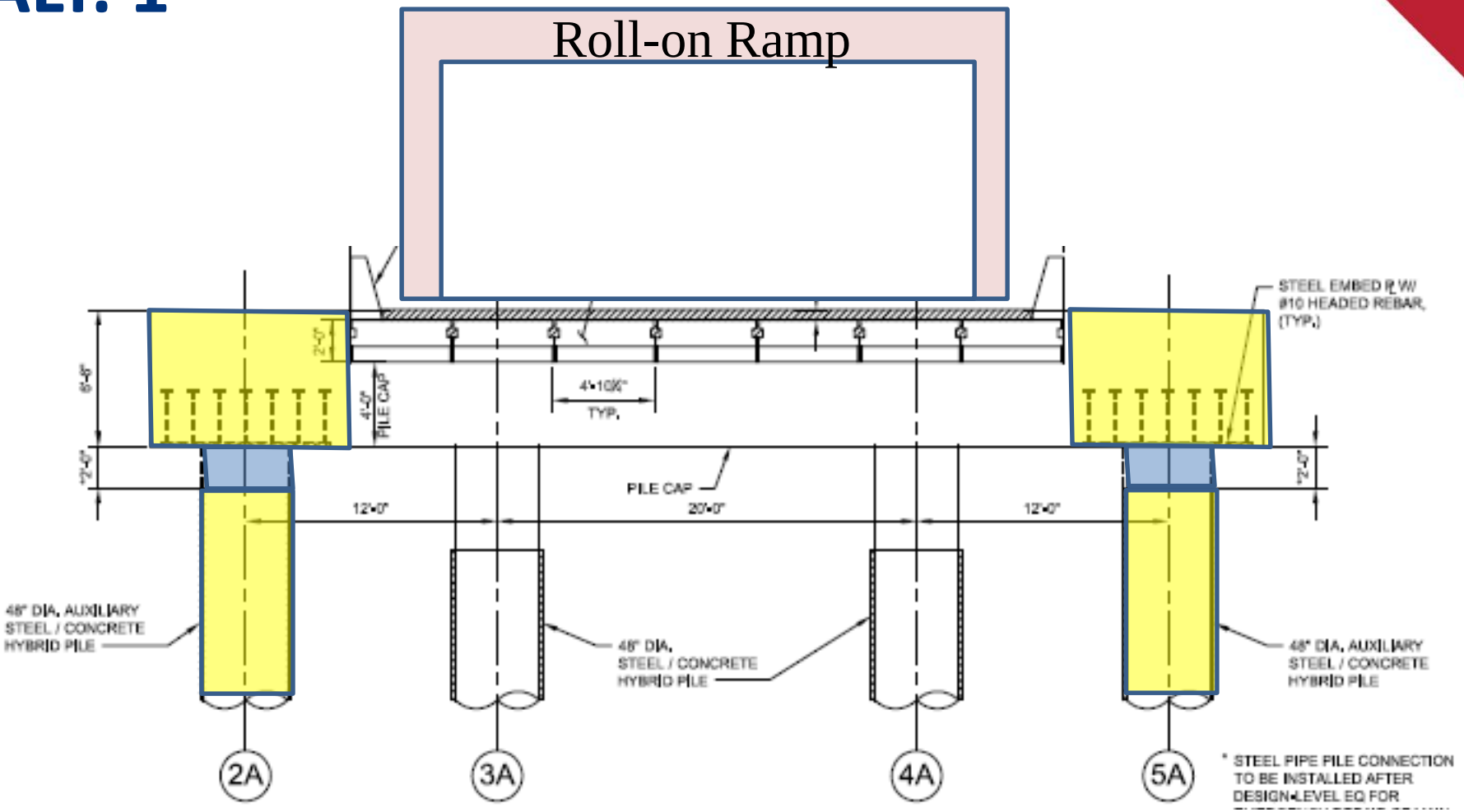
SEISMIC BERTH CONCEPT DESIGN ALTERNATIVES

Design Alternatives

- **Alternative 1**: Restore lateral and vertical stability in the structure post-earthquake.
- **Alternative 2**: Rapidly deploy interim structures to provide contingency operations for post-earthquake essential cargo offloading.
- **Alternative 3**: Achieve minimum damage performance at the DE level so the two seismic berths are operational post-earthquake.

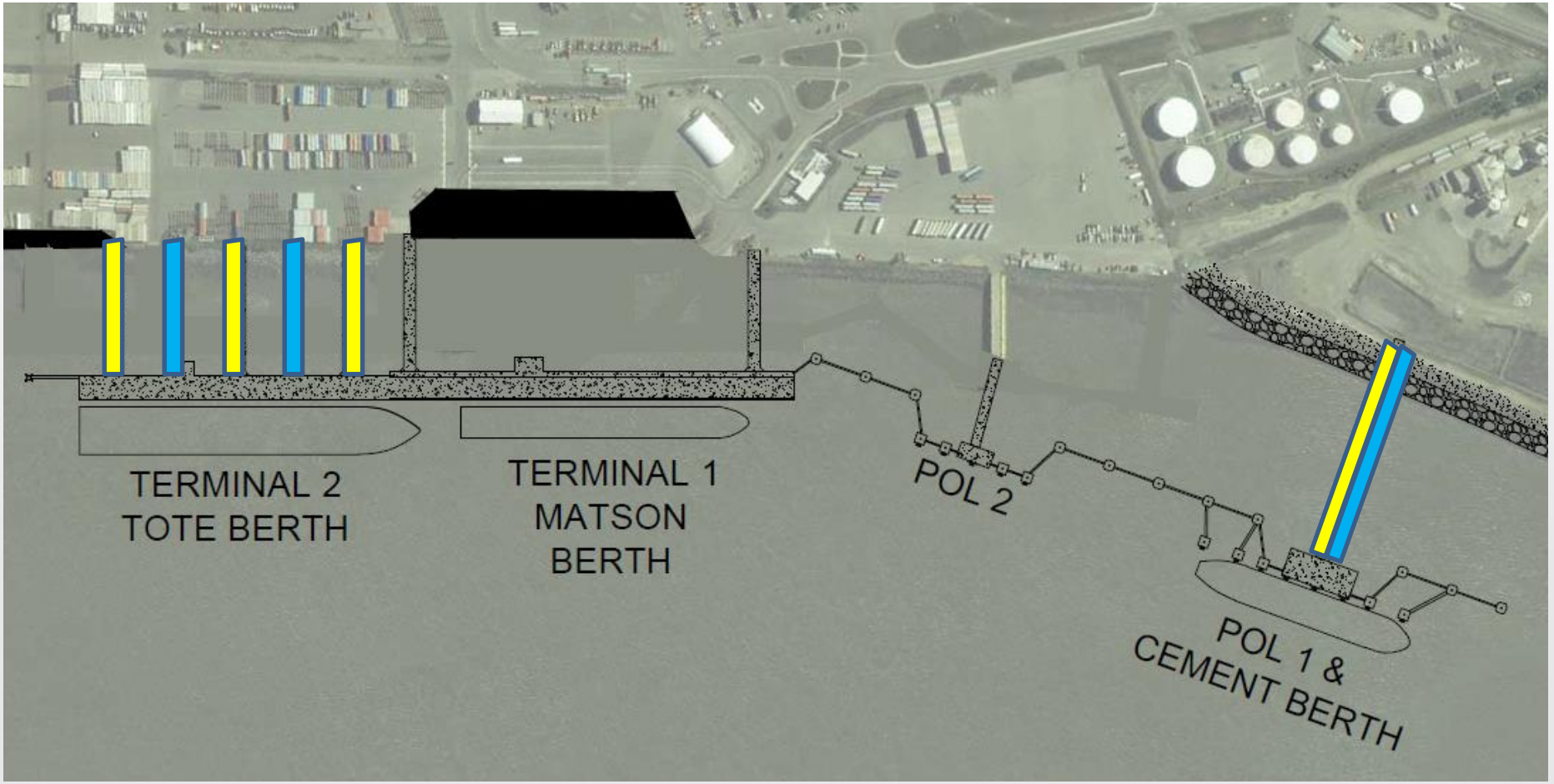
Seismic Container Berth Components

ALT. 1

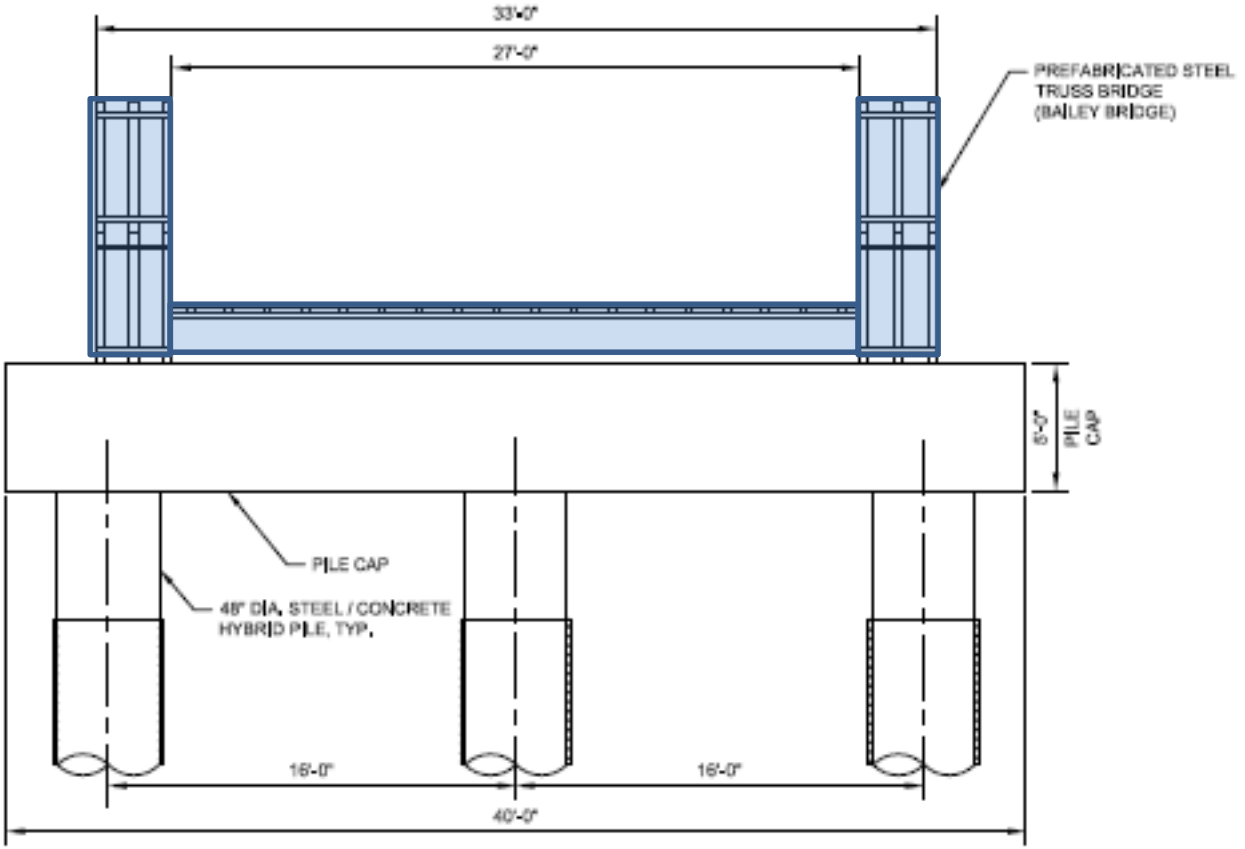


TRANSVERSE TRESTLE SECTION

Seismic Berths (T2 and PCT)

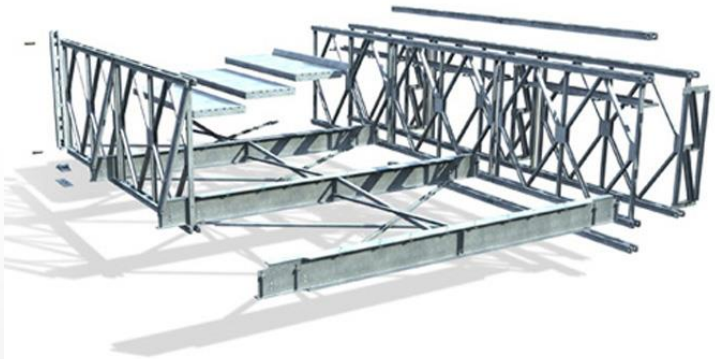


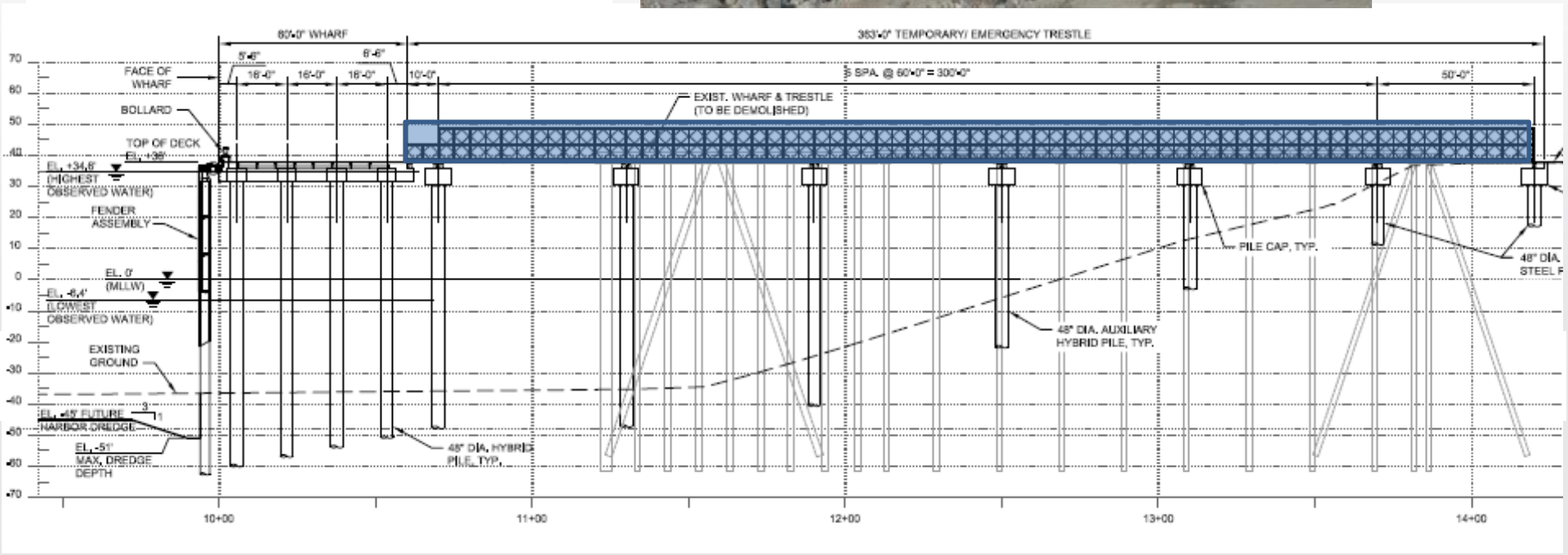
ALT. 2



TEMPORARY/EMERGENCY TRANSVERSE TRESTLE SECTION

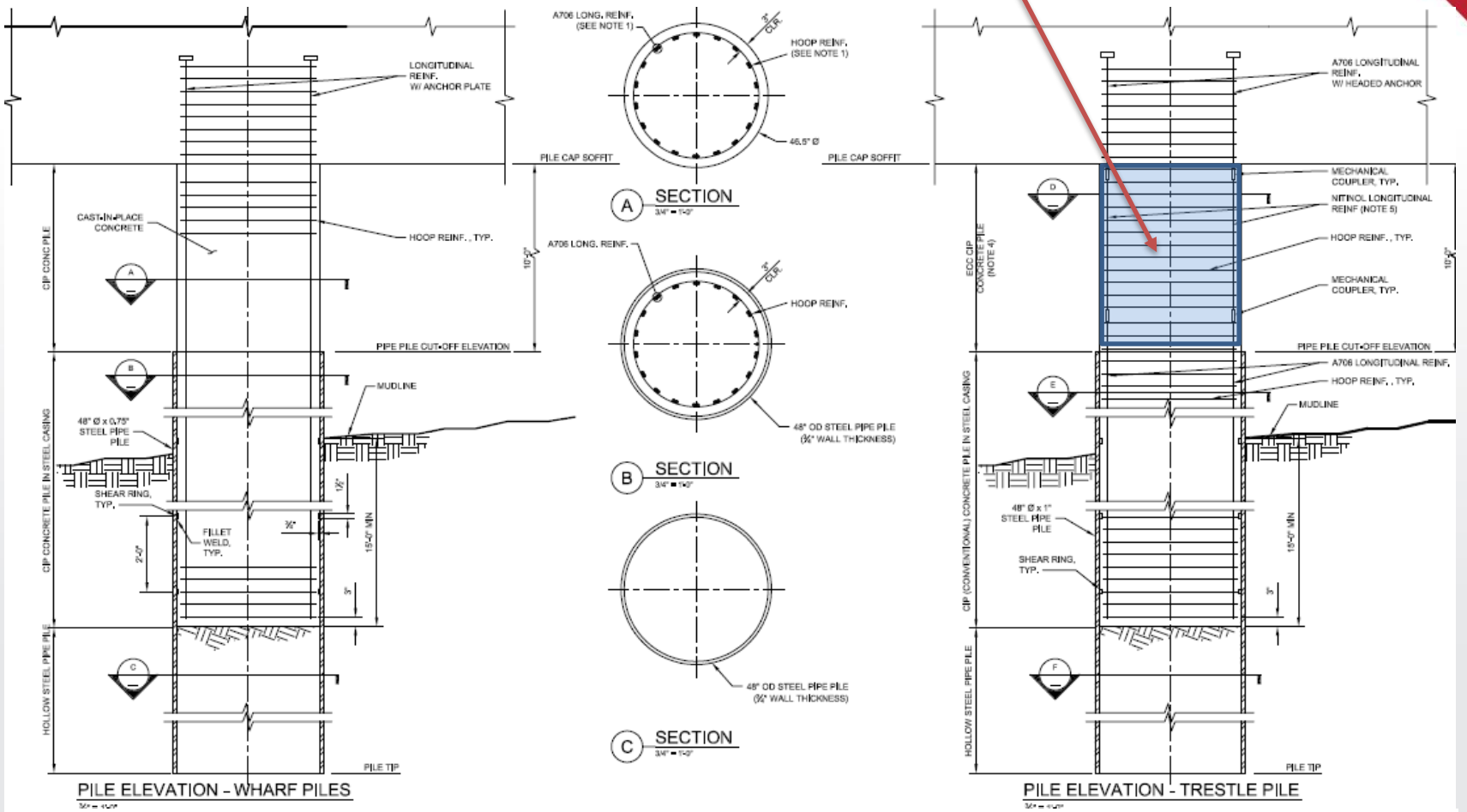
ALT. 2




80'-0" WHARF
353'-0" TEMPORARY/ EMERGENCY TRESTLE
FACE OF WHARF
5'-6"
16'-0"
16'-0"
16'-0"
6'-6"
10'-0"
5 SPA. @ 60'-0" = 300'-0"
50'-0"
BOLLARD
TOP OF DECK
EL. +35'
EXIST. WHARF & TRESTLE (TO BE DEMOLISHED)
EL. +34.6' (HIGHEST OBSERVED WATER)
FENDER ASSEMBLY
EL. 0' (MLLW)
EL. -8.4' (LOWEST OBSERVED WATER)
EXISTING GROUND
EL. -45' FUTURE HARBOR DREDGE
EL. -51' MAX. DREDGE DEPTH
48" DIA. HYBRID PILE, TYP.
PILE CAP, TYP.
48" DIA. AUXILIARY HYBRID PILE, TYP.
48" DIA. STEEL P
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
10+00
11+00
12+00
13+00
14+00

ALT. 3

Nickel Titanium rebar and Engineered Cementituous Composite



PILE ELEVATIONS

Alternative Scoring Matrix

Table 5-6. Final Weighted Scoring Matrix

No.	Objective	Measure	Weight	Alternative 1		Alternative 2		Alternative 3	
				Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Upfront Cost									
1	Minimize upfront cost	Lowest upfront cost	35	0.6	21	0.8	28	0.2	7
Initial Repair Cost									
2	Minimize repair cost	Lowest repair cost	10	0.6	6	0.4	4	1.0	10
Reconstruction Cost									
3	Minimize reconstruction cost	Lowest reconstruction cost	10	0.6	6	0.4	4	0.8	8
Speed of Initial Repair									
4	Minimize downtime	Lowest downtime	25	0.8	20	0.8	20	1.0	25
Performance Confidence									
5	Confidence of Effectiveness	Most confident	20	0.6	12	1	20	0.2	4
		Total Weighted Score	100		**65**		**76**		**54**

Note:

Weights and scores are only guides to assist in the evaluation of alternatives; they do not mandate automatic selection of any particular alternative.

APMP Concept for Seismic Resiliency is Alternative 2 – Temporary Modular Bridge

- Satisfies the GAC's recommended seismic performance requirements
- Lowest additional cost because the Terminal 2 temporary trestles are already included in the baseline program budget for construction phasing
- Highest confidence that it will work as planned
- Can be implemented within 7 days assuming that the handling equipment is available

QUESTIONS?

Thank You!

Todd Cowles, P.E.
cowlestc@muni.org