CIWHA

CITY OF OXNARD

MANDALAY SEAWALL ASSESSMENT AND CAPITAL IMPROVEMENT PROGRAM

PHASE B – Strategic Investigation

Prepared for:
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City of Oxnard Agreement No. A-7390

TranSystems Project No. P50510040

FINAL REPORT August 20, 2012

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EXECUTIVE SUMMARY

OXNARD MANDALAY BAY SEAWALL INVESTIGATION

PHASE "B" – STRATEGIC INVESTIGATION

Phase "B" was a strategic investigation - An engineering approach to sampling that collects adequate sampling for the engineering assessment of all seawall exposure segments but does not include evaluation of each individual property. The Waterfront Engineering Team acquired as much information as possible by strategically selecting inspection locations relative to the changing seawall segment environmental exposure conditions and practicable points to start and stop construction repair phases. By Visual and Physical sampling each of these segments the team was able to rate their condition allowing the team to prioritize repairs within the 7 miles of seawalls. This phase also included a Geotechnical Engineering investigation to derive site specific soil loading criteria for use in a wall stability analysis that was used to evaluate the relative risk of collapse of the wider variation of concrete deterioration found occurring within the community. The Scope of Services and their results are described as follows:

A) Underwater Condition Survey:

TranSystems' Engineer/Divers performed a rapid "Level I Swim-By" inspection of the entire seawall below the mean tide line and a more detailed "Level II" evaluation at each of the 304 Above Water Inspection locations being concurrently evaluated by WDP & Associates' Field Engineers. Based upon the findings of the previous Phase A inspection work, the crew was focused on the following areas:

- Documenting damage to the seawall and foundation system below water which may allow soil loss or effect wall stability.

  Very few serious concrete foundation defects were observed. **A few pilasters and panels along West Hemlock Street were found broken by apparent overload. The resultant cracks now allow rapid deterioration of the reinforcing steel and are recommended for repair.**

- Identification of areas where existing slope protection is absent and appear critical to future performance. The adjacent seafloor elevation and slope are a key component of wall stability and protection of the timber support piling from marine borer attack. Seawall areas where more than 16" on the Boise wall footing was exposed and more than 24" of the Zurn cut-off wall was exposed were mapped.

  A few hundred feet of excessive exposure were mapped and are recommended for repair to prevent marine borer access.

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- Check and map undermined foundations which allow marine borer access to the timber support piling.

  Shallow undermining (less than 3" in height) was observed at a handful of locations, typically for short distances and are recommended for repair before marine borers destroy the support piling.

- Rate the concrete deterioration occurring below water at each seawall exposure segment for use in prioritizing repairs.

  The team rated all inspection locations to supplement and confirm the Above Water Inspection ratings. Typically above water ratings closely match the underwater ratings on the Zurn walls. On the Boise walls significant corrosion bleeding is occurring along the wider cracks (1/8" or greater) on the bottom few feet of the precast concrete panels. This deterioration cannot be consistently observed by the Above Water inspection team and is responsible for increasing the rating of a few dozen Boise panels.

- Measure the depth of the commonly occurring gap between the Zurn seawall footing and cut-off wall which has the potential to allow marine borers access to the timber piling.

  A few hundred feet of this gap were observed and mapped for a simple "sand-fill" repair to prevent marine borer access to the support piling.

B) Above Water Condition Survey:

WDP lead this inspection effort with the assistance of TranSystems in development of the above water wall rating system.

B.1 Rapid Visual Inspection

At 304 strategically selected wall locations, WDP sampled the worst condition wall segment occurring within the field of each city block of wall exposure and the wall ends, typically occurring at the corner properties, which are the probable start and stop points of construction repair phases. The field teams collected the following data:

- Visual rating of the structural condition of the wall faces on a relative scale of 1 to 5 for the above water portion of the wall. At a minimum, the wall above mean tide elevation was evaluated so it could be combined with the notes of the Underwater Inspection Team to formulate an overall rating.

- Visually estimated the deterioration (% of visual spalling across wall length, band elevation of damage, worst spall depth, largest spall size) as tangible confirmation of the visual rating.
- Occurrence of major structural damage such as open joints, broken panels, wide cracks, and large corrosion concrete spalls. Minor defects and damage, such as shrinkage cracks and impact nicks, which do not warrant repair, were not recorded.
- Wall rotation, where observed by an offset between two sides of a construction joints, was measured with a digital "Smart Level" and tape measure to record the wall position on each side of the joint.
- Each inspection location was photographed with an "overall" and "close-up" to document conditions

The results of the visual inspection confirm a significant amount of variation in conditions through the 7 miles of seawall. In general, more significant damage was observed in locations with western exposure that receive significant late-afternoon sun exposure. The last construction phase was generally in better condition than the balance of the community.

One segment of seawall along Kingsbridge Way was found leaning significantly towards the water, (7 degrees from vertical and over 1.75" of relative displacement to the adjacent panel) without movement of the foundation. The upper 7 feet of the wall appears at significant risk of failure. We recommend a program to investigate and repair this wall segment be implemented as soon as practicable.

B.2 Physical Testing (Drill Inspection)

The community was divided into 140 seawall exposure segments, typically one side of a city block. At each location, 3 drill test holes were made, approximately 3/4 inch diameter, at the elevation of worst visual deterioration and 1 foot above and below. Drilling was stopped when sound (hard) concrete is encountered. Testing locations coincided with Rapid Visual Inspection Locations. The field team recorded the following for each location:

- Elevation of test location above footing
- Depth to sound concrete
- Quantify or rate the drilling effort

The drill penetration resistance, particularly for the Zurn walls, suggests that a decrease in penetration resistance was more prevalent at the more visibly damaged walls sections. However, significant differences were not observed in the test data between panels with different visual ratings. Hidden areas of softer concrete were not observed in the tested locations. The lack of a significant trend in the drill test results is likely because of wave and wind action that acted over time to remove the softest (scaled) concrete from the tested wall sections.

B.3 Non-Destructive Testing (NDT)

At 140 Wall Exposure Segments the following NDT testing was performed:

Impact-Echo Testing: 15 data points at worst visual damage location per segment.

Resistivity Testing - 20 data points at worst visual damage location per segment

The impact-echo test results indicated that defects, primarily in the form of distributed cracking resulting from alkali-silica reactivity, were present in the vast majority of the tested panels. Defects, likely the result of internal cracking damage, were also documented in panels with lesser amounts of visible damage. The impact-echo results were used with the invasive probe results to estimate the depth of damaged concrete to be included in analytical models.

Resistivity testing results indicated that the concrete in the seawalls was largely saturated and therefore widespread macro-cell corrosion of the reinforcing steel was not likely. These results were consistent with the results obtained in Phase A.

B.4 Core Sampling and Petrography

At 10 locations, core samples were taken at inspection locations. These cores reflect the range, from Good to Poor, of observed deterioration conditions occurring in the community as a whole. Cores allowed the visual observation of the interior concrete. All of the cores were sent for petrographic analysis for insight into the concrete deterioration mechanisms, with a detailed petrographic analysis completed on six of the core samples.

The cores confirm that Alkali-Silica reactivity (ASR) is the major contributing factor to the deterioration of the seawalls. The deterioration is much more advanced in the Zurn walls than the Boise walls which may be attributed to the higher quality control and lower

permeability of the air entrained concrete used for production of the Boise Panels. Evidence of marine attack was observed in some areas as a secondary deterioration mechanism. The marine attack was limited to areas where cracking damage due to ASR had previously occurred.

B.5 Invasive Probing of Base of Zurn Walls

At 8 locations the engineering team instructed its Contractor Partner - MTM Builders, Inc. to make careful demolition exposures at base of the Zurn walls near construction joints to investigate the potential existence of microcell corrosion, which cannot be identified using non-destructive testing. The depth of deteriorated concrete was also documented at invasive probe locations. At each location at least one vertical reinforcing bar was exposed and often a footing dowel or horizontal bar. The bar conditions were documented and the walls repaired within 48 hours.

At 6 locations, the reinforcing steel was found in good condition with only limited surface corrosion and minimal evidence of pitting. The depth of observed concrete cracking damage was recorded in these areas. At two locations along Eastbourne Bay significant corrosion damage on the vertical reinforcing steel was observed. The probes were performed at an area with a deteriorated construction joint at the base of the wall. The vertical reinforcing steel in the probe openings had significant loss of cross section, likely the result of localized microcell corrosion.

C) Geotechnical Investigation & Wall Stability Analysis:

C.1. Subsurface Evaluations. Terra Costa Consulting performed the Geotechnical investigation effort. They provided a series of (9) CPT soundings and (4) test pits to investigate the subsurface soil conditions. This testing was able to generalize the subsurface conditions allowing TranSystems to model the wall for various loading conditions. TerraCosta provided passive, active, seismic, and surcharge earth pressures for use in the seawall stability calculations. Eight CPT soundings were taken at representative locations spread throughout the site, typically in vacant lots and street ends to minimize disruption.

C.2 Evaluate Wall Stability, TranSystems, with the assistance of TerraCosta, evaluated the static and seismic stability of the existing seawalls using the earth, surcharge, and seismic pressures. The various levels of deterioration were modeled, based upon the findings from the field work. The findings from this analysis indicate:

The Class 4 rated (Tract 1) 10" thick Zurn walls are within 5 years failure under static (non-seismic) conditions. It is also estimated that within 2 years they will require shoring during repair work causing the repair cost to escalate significantly.

The Class 4 rated (Tract 1) 10" thick Zurn walls with a "deck surcharge" may be as short as 2 -3 years.

The Class 4 rated (Tracts 2 & 3) 12" thick Zurn walls have 5-10 years until failures are expected under static (non-seismic) conditions but repairs are recommended to start in 5 years to avoid the need for costly shoring during repair work.

The Class 4 rated Boise panels with significant vertical or diagonal cracking are expected to fail within 3-10 years. The remaining reinforcement cross section of the Boise Panel is recommended for investigation in Phase C to refine the life expectancy.

C.3 Liquefaction Potential. This site is prone to liquefaction damage, as are all similar developments using hydraulically placed fills within close proximity to ground water.

The Geotechnical Report indicates that the vast majority of walls are expected to fail during a "Design Level" seismic event which has a return period of 390 years. The Boise walls will fail sooner than the Zurn walls as the deadman anchorage securing the tie-back rods will lose all capacity when the soil liquefies. The study further indicates that the soils are just on the verge of liquefaction and a few failures are expected at a lesser seismic event with a return period of 72 years.

D) Prioritization and Budgetary Cost Estimates:

Find a list of the top "near-term" repair priorities and a cost estimate of the estimated repairs to maintain the seawalls for the next 25 years in the attached Executive Cost Estimate. Site Plans are included in the report indicating the wall ratings and locations of recommended repairs

Cost Estimate

1. Costs are in 2012 Dollars
2. Repairs are listed in order of priority in each category
3. Costs are fully burdened including OH & P, Design, Construction Admin, Permits & Dock Moves

Expedited Repairs (Program ASAP)

1) Stabilization of 150 LF minimum of seawall along Kingsbridge Way.............................$319,000

2) Repair (4) pilasters & (4) panels minimum on West Hemlock Street..............................$103,000

3) Repair the estimated (42) Class 4 and Class 5 Boise pilasters......................................$200,000

4) Provide 125 LF of slope protection at 6 undermined locations......................................$175,000

5) Fill 240 LF of cut-off wall gaps with sand & grout...$30,000

High Priority Repairs (Years 2 – 6)

6) Provide 232 LF of slope repairs at 7 locations w/ high undermining potential.................$325,000

7) Repair 4,027 LF of Class 4 Zurn walls in Tract 1 (10")...$6,240,000

8) Repair (120) Class 3.5 Pilasters...$540,000

9) Repair 204 LF Class 4 Boise seawall segment...$395,000

10) Repair the (23) isolated Class 4 Boise panels...$535,000

Medium Priority Repairs (Years 7 – 12)

11) Repair 182 LF of seawalls foundations w/ steep slope...$254,800

12) Repair the (259) Class 3 Pilasters..$1,101,000

13) Repair the 2070 LF of Class 3.5 Zurn walls in Tract 1 (10")...$3,208,000

14) Repair the 773 LF of Class 4 Zurn walls in Tract 2 (12")..$1,198,000

15) Repair the 2,890 LF of Class 3.5 Boise seawall segments..$4,479,000

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Low Priority Repairs (Years 13 – 18)

16) Install slope protection to 1,249 LF of seawall with substandard slope.......................... $1,165,000

17) Repair (207) Class 2.5 Pilasters.. $880,000

18) Repair 4,500 LF of Class 3 Zurn walls in Tract 1 (10")... $6,975,000

19) Repair the 830 LF of Class 3.5 Zurn walls in Tract 2 (12")... $1,290,000

20) Repair the 4,900 LF of Class 3 Boise seawall segments.. $7,595,000

Non-Critical Repairs (Years 19 – 25)

21) Repair (220) Class 2 Pilasters.. $935,000

22) Repair 2,900 LF of Class 2.5 Zurn walls in Tract 1 (10")... $4,495,000

23) Repair 1,100 LF of Class 3 Zurn walls in Tracts 2 & 3 (12").. $1,705,000

Repairs Beyond 25 years

24) Repair 2,450 LF of Class 2.5 Boise seawall segments

25) Repair 670 LF of Class 2 Zurn walls in Tract 1 (10")

26) Repair 2,490 LF of Class 2 Boise seawall segments

27) Repair 1,900 LF of Class 2.5 Zurn walls in Tracts 2 & 3 (12")

28) Repair 6,100 LF of Class 2 Zurn walls in Tracts 2 & 3 (12")

Tie-back repair for 200 LF of failing wall on Kingsbridge Way	COST ESTIMATE			DATE PREPARED: August 20, 2012				SHEET:	
ACTIVITY AND LOCATION: Add tiebacks to reduce the bending moments and Freeze the seawall in its current position			A/E CONTRACT NUMBER: Agreement No. A-7390					IDENTIFICATION NUMBER	
			ESTIMATED BY: TRANSYSTEMS CORPORATION					CATEGORY CODE NUMBER	
PROJECT TITLE: Mandalay Seawall Emergent Repairs from - Phase B - Strategic Investigation			STATUS OF DESIGN: BUDGETARY LEVEL ESTIMATE					DELIVERY ORDER NUMBER	
	QUANTITY		MATERIAL COST		LABOR COST		ENGINEERING ESTIMATE		
ITEM DESCRIPTION	NUMBER	UNIT	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	
Mobilization	1	LS			40000.00	40,000	40,000.00	40,000	
Silt Curtain (Reuse 368' Curtain) & Maint	368	LF	40.00	14,720	50.00	18,400	90.00	33,120	
Two Barge Rentals	2	MO	15000.00	30,000			15,000.00	30,000	
Drill Rental	2	MO	8000.00	16,000			8,000.00	16,000	
Patch Decks after Geotech Borings	1	LS	1000.00	1,000	3000.00	3,000	4,000.00	4,000	
A) Docks									
Remove existing docks	5	EA			1200.00	6,000	1,200.00	6,000	
Reinstall docks w/ new guides	5	EA	2400.00	12,000	1500.00	7,500	3,900.00	19,500	
R & R Gangways & Platforms	5	EA	400.00	2,000	1000.00	5,000	1,400.00	7,000	
B) Tieback Installation									
Drill & Grout tieback rods (5.5' o.c.)	36	EA	1250.00	45,000	2750.00	99,000	4,000.00	144,000	
includes core drill, PT strand & grout.									
C) Concrete Wale									
Construct new 20x20 Concrete Wale	200	LF	45.00	9,000	100.00	20,000	145.00	29,000	
Raw Cost SUBTOTAL								328,620	
General Requirements	10%							32,900	
Contractor Overhead and Profit	10%							32,900	
Burdened Cost SUBTOTAL								394,420	
Selective Demo & Geotech investigation	10.0%							39,400	
Design Contingency (Drain Retrofit)	10.0%							39,400	
Design Engineering (8%)	8.0%							31,600	
Design & Geotech Constr. Support (2%)	2.0%							7,900	
Construction Administration (5%)	5.0%							19,700	
TOTAL PROGRAM COST								$532,420	
					UNIT PRICE $2662 / LF				

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