MEMORANDUM

PND Engineers, Inc.

To:	City of Depoe Bay	Date:	April 4, 2022
From:	Rian Johnson, P.E.	File:	224017.01
	John Olson, P.E.		
Subject:	Depoe Bay Harbor – Concept Assessment Report		

INTRODUCTION

The City of Depoe Bay's Boat Harbor serves as a unique, naturally protected safe harbor on the central Oregon coast. The harbor hosts a U.S. Coast Guard station as well as a regular fleet of fishing charters, whale watching vessels, commercial fishing boats and recreational boaters. The floating docks have been in place for many decades, where age and wear and tear are taking a toll. The City had a conceptual engineering report developed in 2015 by Mott MacDonald, exploring replacement options for the harbor's docks 2, 3 and 4. PND has been tasked with assessing the substance and findings of the 2015 report, and provide recommendations for the City's consideration. The analysis and recommendations in this memorandum are based on review of the concept report, site observations, discussions with stakeholders and engineering experience and judgement.

REVIEW AND RECOMMENDATIONS

Dock Layout:

PND understands that the City does not want to dramatically change the layout of the boat basin. The docks are evenly spaced from one another (main walks spaced approximately 130 feet apart). The existing three 28-foot long access ramps are permanently attached to the seawall, and the dock utility feeders match this spacing, making adjustments to the layout more difficult. We also understand the City desires to maintain the same existing vessel mix in the harbor.

The main walk widths measured 10 feet which is a sufficient width for float stability and provides usable width for passing individuals, larger tour and charter groups, and carts. Finger floats are a bit narrow for the larger slips however. It is recommended to provide floats at least 6 feet wide if vessels will be taking on passengers from the finger float. Currently, it appears that all charters and tours board along the main walks as a side tie. There may be some benefit to exploring layout alternatives using pull in slips. See **Floats** section for more on this.

There is also a desire to provide ADA access to at least one of the boat harbor docks. A reconfiguration of the dock layout to accommodate an 80-foot long ADA ramp could be advantageous for moorage slip optimization also. The 'Limited ADA Float Layout' option presented in the 2015 report serves as a good basis for further development. Similar alternatives could maintain the desired slip mix while providing the added benefits of ADA access and should be considered. There may also be grant funding opportunities through the state of Oregon to provide ADA access to the docks.

The seawall is showing signs of instability and the U.S. Army Corps of Engineers is working to evaluate and address repairs as needed. Any new access points will need to account for USACE plans as all the ramps are connected to the existing seawall *(see Photo 1)*.

Environmental Considerations:

The Depoe Bay Harbor has unique environmental conditions that need to be accounted for during design of the docks, piles, and gangways. Storm surge and tsunami forces are significant environmental design criteria for this site that need to be fully explored and addressed. These will likely be the controlling design conditions, dictating float pile and float design, including connections, hoops, cleats, floatation details, etc. Significant currents within the harbor because of storm surge is a regular occurrence and tsunami events are expected to be a rare, but significant event. We understand, from talking to the Harbor Commission, that the surge initiates from the harbor mouth and proceeds in a counterclockwise direction: crossing docks 2, 3, and 4 from north to south.

Preliminarily, analysis will be based on review of video taken during the 2011 tsunami that struck and damaged many of the ports along the West coast *(see Photo 2)*. Analysis and visual approximations will be made of the delivered forces from this event and used for design assumptions. Additional resources will be explored, such as any Oregon State University, U.S. Army Corps of Engineers, and other research studies to verify assumptions. Initially, it is anticipated that loading will be modeled as a sustained, high velocity, static water flow.

Corrosion along the Oregon coast is a significant factor for all structures constructed of metal, whether it be mild steel, aluminum, stainless or cathodic components. One key to minimizing the severity of corrosion concerns is to reduce the surface area exposed to corrosive activity. This can be done by selecting material shapes that maximize strength while minimizing exposed surface area (i.e. pipe pile rather than H-pile). An attempt has been made to try to preserve the H-piles by application of a FRP sleeve filled with epoxy *(see Photo 3)*, though this solution has not performed well. Another key is to either provide protective coatings to keep the corrosive surface from exposure and oxidation, or provide an initial cathodic protection system (galvanizing) and addition of anodes when needed. Finally, wherever possible, try to keep corrosive materials from coming into contact with corrosive elements (salt water). Effective float design can minimize the effects of corrosion in floating dock structures.

Sea level rise is another environmental condition that should be considered. Estimate of anticipated sea level rise over the design life of the docks will be outlined in the basis of design for the docks. This will affect the height of float piles, the details of the gangway hangers, in addition to accounting for ramp landings on the docks.

Floats:

A variety of float materials were discussed in the concept report including timber frame (*see Photo 4)*, concrete *(see Photo 5)*, aluminum frame *(see Photo 6)*, steel frame, and High-density polyethylene (HDPE) pipe systems *(see Photo 7)*. Deck options include grating (fiberglass, aluminum), concrete, timber, and plastic lumber. Floatation materials include enclosed steel pipe *(see Photo 8)* or HDPE, filled with EPS (expanded polystyrene), EPS filled polytub billets, and concrete encapsulated EPS. The choice of materials requires a thorough analysis of design conditions, desired performance, operational life, level of maintenance, agency restrictions (environmental permitting), and initial cost. Each material construction type has its advantages and difficulties, including effects on anchoring systems and ease of construction and utility installation.

A timber framing system may still be permittable. However, the timber will need to be treated and the product must be sealed to prevent leaching into the surrounding bay. The regulatory restrictions will also prohibit timber for use as float rubstrips as this contact may result in treated timber in the water. Solid dock surfaces will require mitigation. Permitting agencies prefer docks wider than 6 feet to have at least 50% of the surface composed of grating containing at least 60% open space *(see Photo 9)*. Floating dock wider than 6 feet without grating will require mitigation to offset the large, covered area. PND recommends grating over a portion of the 10-foot wide docks to limit the limit the amount of mitigation required for the project and streamline the permitting process.

The width of the float system is major consideration. Stability is maximized by using wider float units. For the main walks, wider floats also better accommodate two-way traffic, particularly with larger groups associated with tours and charters. Dock carts and harvesting gear stored on the docks also takes up significant space, necessitating a wider main walk float. The existing dock finger floats are a very narrow 30 inches and adding some width to new fingers would have a significant positive impact on dock stability and strength as a structural component of the system. Wider finger floats on the larger docks could also have a great benefit to the commercial tenants by allowing queuing and embarking from dedicated finger floats. However, the additional width will need to be incorporated in the overwater coverage which will impact the environmental permitting of the work.

A comment was received by the Harbor Commission during the site walk, that berthing vessels perpendicular to the predominant currents and storm surge acting in the basin (from north to south) was very difficult. It was noted that most of the commercial operators (tours and charters) currently operate parallel to the main walk of the docks, in a side tie position. Dock configurations that provide fingers, and thus pull-in mooring slips for all users would improve the difficult berthing conditions expressed. In addition, finger floats will also improve the stability of the main walk floats, like outriggers. Orienting all vessels bow/stern to the current as opposed to broadside, may also reduce some of the loading to the dock system and anchor piles. However, may be infeasible for some of the large charter, tour, and fishing vessels.

One criterion that was mentioned in the concept report, and further discussed on site, was the need to remove the finger floats for the winter. While any new dock design could incorporate the ability to disassemble and remove finger floats, it does not mean that they must be removed regularly. It may be a great benefit to the City to remove this maintenance burden from the harbor staff and free up required storage space in the boat launch parking lot by constructing a dock system that can function year-round while remaining fully assembled. Most modern float systems incorporate hinged connections for disassembly of portions of the dock, if needed, but are reinforced to carry vessel and current forces. All utilities will be contained in the main walk float, but the fingers should be standalone pieces to facilitate removal if needed.

Most of the existing pile are driven through internal frame hoops, running down the centerline of the main walks. None of the fingers have pile hoops. Internal pile hoops make it difficult to modify and/or remove docks. Additionally, piles down the middle also consume valuable dock surface. Moving the piles to the edge helps reduce deck obstructions, while also facilitating install, etc. If dock fingers remain on the main walk permanently (see above paragraph) the pile hoops could be attached to the outside of edge, midway between finger floats without being a vessel berthing obstruction. If side tie spaces remain a priority, the pile hoops could be placed on the opposite side of the main walk from the side tie side. The type of float system employed will help inform the best type of pile hoop to use. Structurally, pile hoops are designed for appropriate design loading using steel or aluminum. Using UHMW-PE rubstrips that provide a low friction sliding surface for the pile to slide tends to perform better and with less maintence than rollers. The rubstrips should be placed in the hoop to mimic the shape of the pile with consistent spacing to avoid binding and uneven rubbing *(see Photos 10 and 11)*.

Piles:

Most of the existing float anchor piles are H-piles that have suffered extreme corrosion and mechanical damage over time. H-piles are inherently susceptible to this kind of damage because they have far more exposed surface area than an equivalently sized pipe pile. Additionally, H-piles have two axes of bending (a strong direction and a weak direction), which is not ideal in a float anchor system, where loads may act from any direction. A similarly sized pipe pile, with similar weight and section modulus equivalent to the strong bending direction on the existing H-pile would be a 12.75” diameter x 0.5” wall pipe pile. The pipe pile has 33 percent less surface area exposed to corrosion and has more bending strength in any direction than the H-pile in its strongest axis. In short, it is strongly recommended that any new piles be galvanized steel pipe pile, appropriately sized for the design forces.

Steel pipe pile are available in a variety of diameter and wall thickness. Typical sizes include 12.75”, 16”, 18”, 20”, 24”, 30” diameter, etc. Wall thickness starts at about 0.5” and, for larger diameter piles, are manufactured in increasing thickness as needed.

Cursory consideration of geotechnical information (primarily verbal descriptions at this point) suggests that the basin consists of a rather shallow layer of sediment, overlaying a very dense layer of mudstone and sandstone. This will need to be verified and analyzed in detail for pile design to commence. USACE has historic borelogs associated with the seawall and is scheduled to perform additional geotechnical borings in the parking lot in April. PND has made contact with USACE to coordinate this information. Given the anticipated large current forces at the site, pile socketing into the dense layer may be needed *(see Photo 12)* though impact driving may be adequate to achieve embedment *(see Photo 13)*.

There are two galvanized steel pipe piles near the head of each dock 2, 3 and 4, that straddle the existing gangways. The piles appear to be in good condition and should be integrated into the new project. They may be a good option for bearing piles to support a new ADA access ramp approach platform. See **Access** section for more on this.

Utilities:

Harbor staff requested that all utilities be accessible from the deck surface for easy access. Thoughtful float design, using removable deck panels to access utility chases, should be part of any dock design *(see Photo 14)*. Also, providing frequent isolation valves to reduce service interruptions during repairs should be included.

The City would like to have potable water integrated into the electrical utility pedestals *(see Photo 15)*. According to the concept report, no fire suppression system is required on the docks. This should be verified to ensure the fire department is not going to require this as part of the new dock system.

Electrical pedestals currently use 30 Amp 120 Volt service. However, upgrading to 50 Amp 120 Volt/240 Volt service for larger vessels will likely require additional trenching and electrical disconnects within 50 feet of the top of the gangway. We recommend pedestals on each side of the float rather than in the middle of the float to keep the dock surface clear of electrical cords. These electrical pedestals can be integrated with water and lighting to limit additional utility stands on the floating docks.

Access:

Currently, docks 2, 3 and 4 are each accessed by their own 28-foot long aluminum gangway ramp *(see Photo 16)*. The ramps are attached to steel hangers attached to the seawall. The top of the seawall is at an elevation of about +13' Mean Lower Low Water (MLLW). The water elevation varies from about -4.5' to as high at +13' placing the dock surface anywhere from -3' to +14.5'. At low tide, the 28-foot long ramp has an extremely steep slope (Slope Grade ~70%). At high tide (exacerbated by frequent surge events) the lower end of the ramp high centers on the end of the floats and lifts off the deck. Both of these conditions are problematic.

None of the ramps provide ADA access to the docks. It is recommended that at least one of the docks be upgraded to meet ADA accessible standards. This will include replacing one of the 28-foot ramps with an 80-foot ramp and new fixed approach pier *(see Photo 17)*. Rather than lay the new, longer gangway down the middle of the main walk, and consuming deck space and reducing access to part of the dock, a new landing float could be added. The gangway ramp would run parallel to the seawall from the new approach pier. As mentioned earlier, in the **Dock Layout** section, this would allow for some freedom to adjust the spacing of one of the docks and optimize layout options, while also providing and ADA facility.

Costs:

The cost data furnished in the 2015 concept report appears to be underestimated fairly significantly, as a result of current market forces, scarcity and lingering supply chain issues. The costs for prefabricated floating docks, for instance have increased to closer to $160 to $200 per square foot in recent years. Steel, aluminum, fiberglass grating, and even lumber have seen steady increases in price over the last couple of years. It was noted that minimal utility upgrades were anticipated in the concept report, however, it is typical to provide utility pedestals that serve two adjacent slips, rather than four, which will increase the cost of this item. Additionally, the float piles may require socketing to achieve the required design capacities, which will increase the cost of pile installation. As a result of these items, it is recommended that the project budgeting be adjusted approximately 150% from the costs presented in 2015, to ensure project success.

To address anticipated higher construction costs, the design team will consider project costs balancing the robust structural demands with an eye on efficient use of materials. It may be advantageous to also consider a phased approach to construction, as well as exploring all potential funding sources and revenue adjustments.

Photo 1 – Existing Seawall

Photo 2 – Screenshot from [Depoe Bay Tsunami, 3/11/11 - Bing video]

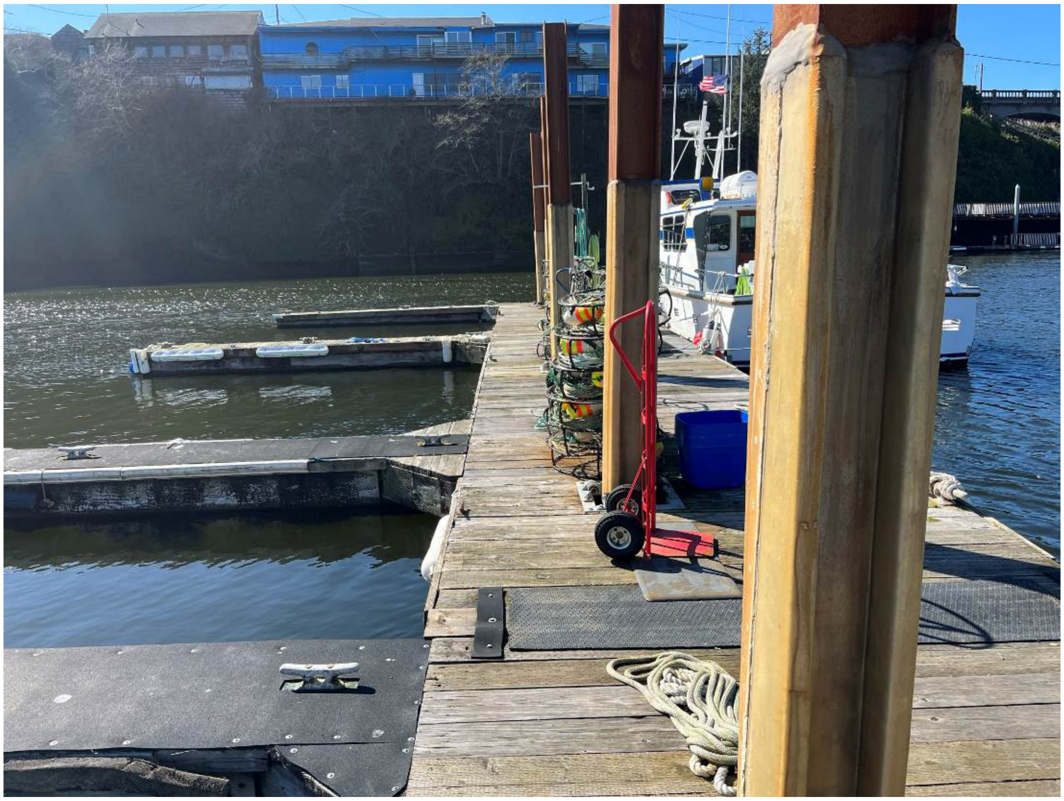

Photo 3 – Steel H-Piles (attempt at corrosion protection)

Photo 4 – Timber Floats

Photo 5 – Concrete Floats

Photo 6 – Aluminum Floats

Photo 7 – HDPE Pipe Floats

Photo 8 – Steel Pipe Floats

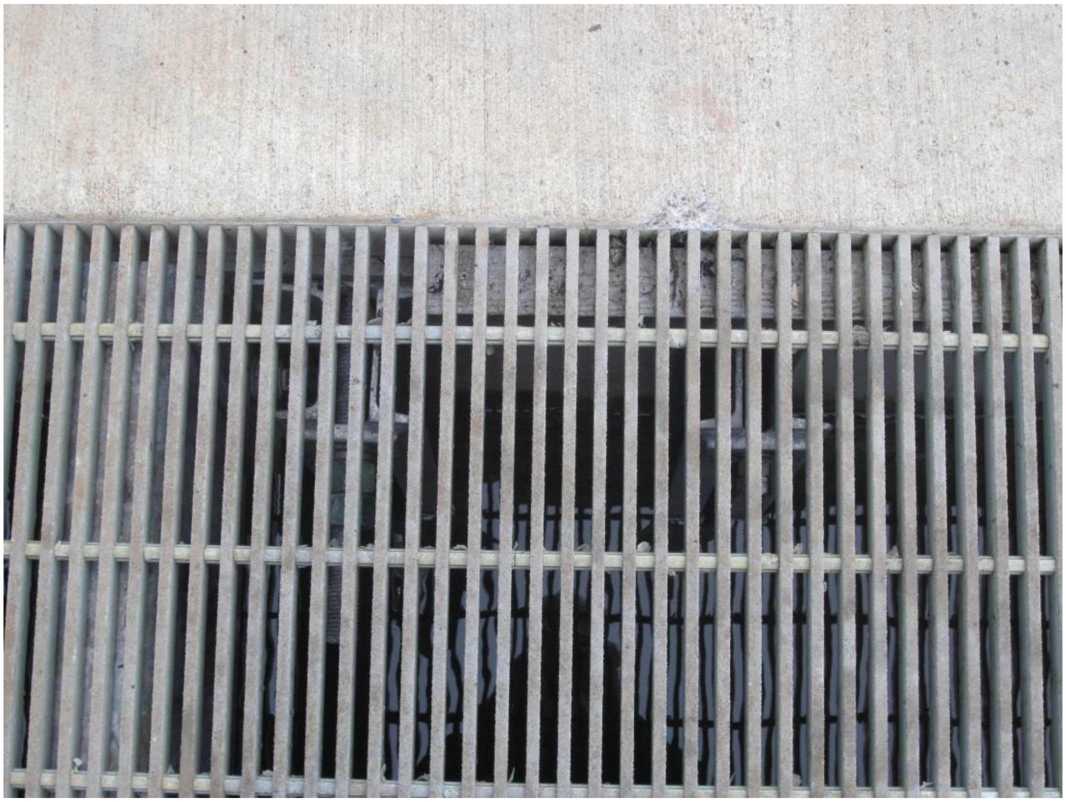
Photo 9 – 60% Open Area and ADA Grating

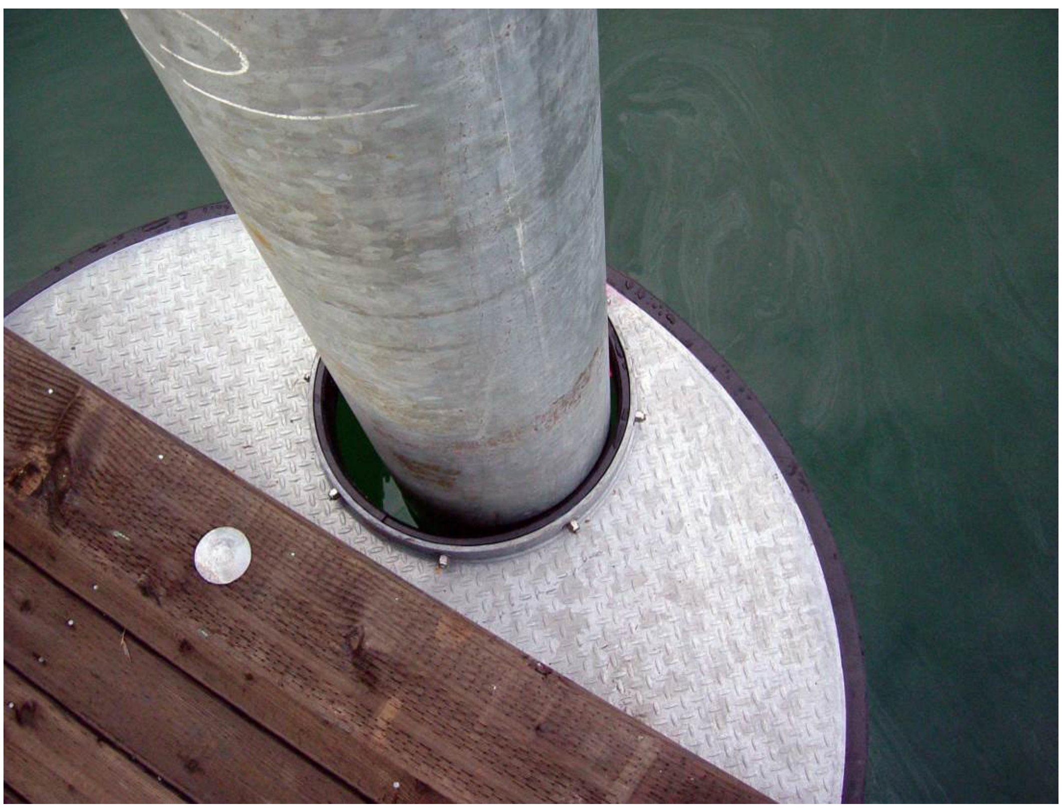
Photo 10 – Pile Hoop at End of Finger Float

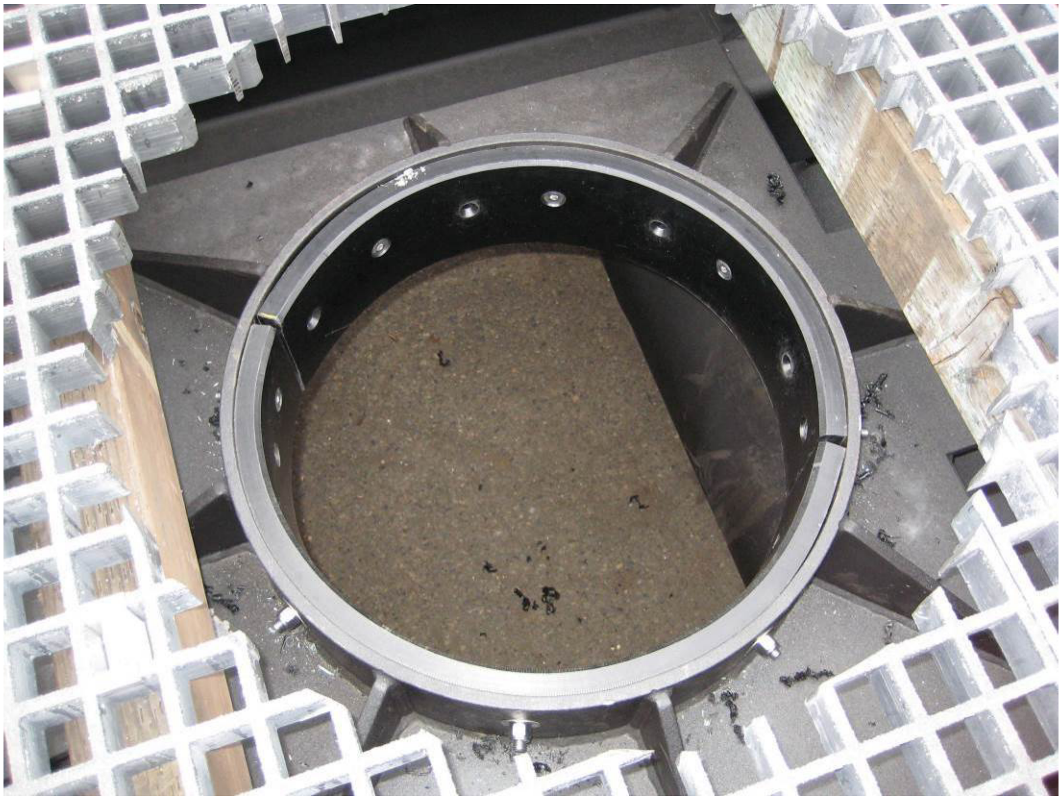

Photo 11 – Pile Hoop Internal Frame (prior to final deck fit up)

Photo 12 – Drilling Equipment for Socketing Piles

Photo 13 – Impact Driving

Photo 14 – Utility Chase with Removable Deck Panels

Photo 15 – Utility Pedestals with Potable Water

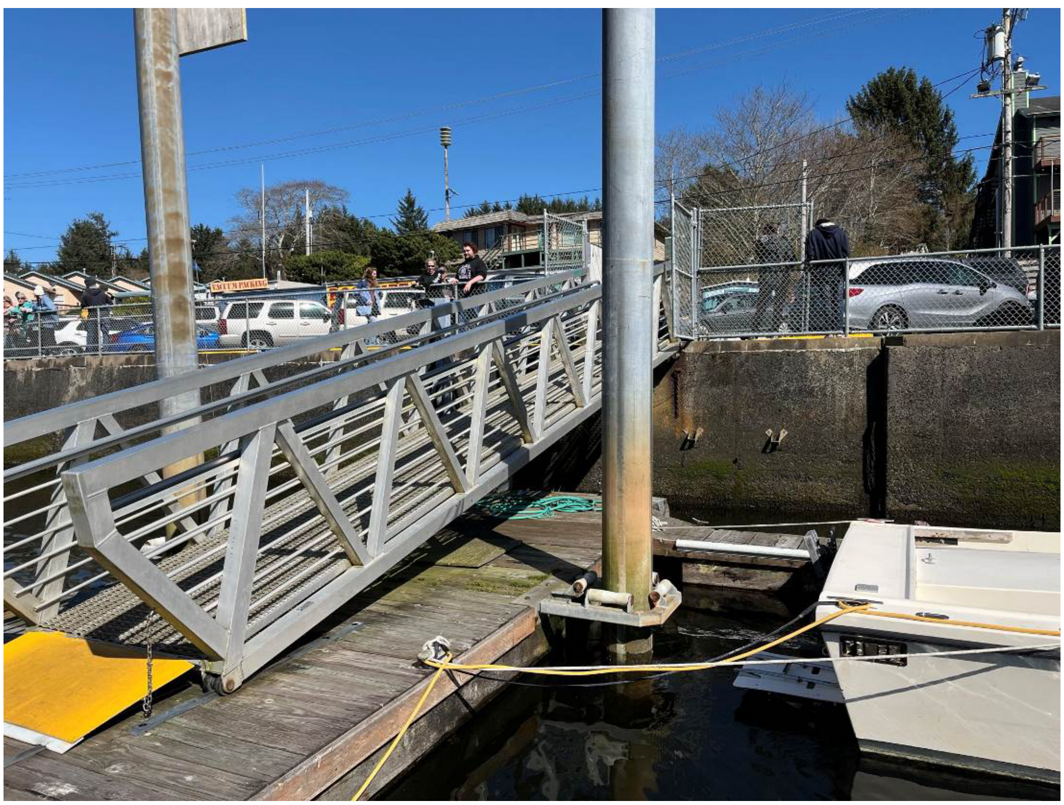
Photo 16 – Existing Gangway Ramp

Photo 17 – 80-foot Long ADA Gangway Ramp (Port of Kalama)