Technical Memorandum

September 17, 2026

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From	Stephanie Gould, PE / Marc Percher, PE (GHD)	**Project No.**	12683907
Project Name	Crescent City Harbor District Marina H Dock Repair Concepts		
Subject	Marina H Dock Repair Concept Summary		

1. Introduction

At the request of the Crescent City Harbor District (CCHD), GHD performed a site visit to inspect existing damage at the CCHD Marina H Dock in order to develop concept repairs which can be selected for future development by CCHD. This memo summarizes the findings of the site inspection and provides concepts for repairs of the existing structure.

1.1 Purpose of this Memorandum

This Technical Memorandum is provided as an interim communication under our agreement with the CCHD. It is provided to foster discussion in relation to technical matters associated with the project.

1.2 Scope and limitations

This technical memorandum has been prepared by GHD for Crescent City Harbor District. It is not prepared as, and is not represented to be, a deliverable suitable for reliance by any person for any purpose. It is not intended for circulation or incorporation into other documents. The matters discussed in this memorandum are limited to those specifically detailed in the memorandum and are subject to any limitations or assumptions specially set out.

1.3 Background

The CCHD Marina was rebuilt following the 2011 tsunami damage with concrete floats and steel guide piles. The current configuration has 240 slips over eight docks named A Dock through H Dock, with H Dock highlighted in Figure 1.

H dock consists of concrete modular floats restrained by two to four piles per float, as shown in Figure 2. The H dock is designed to act as a wave attenuator for the harbor and reduce tsunami energy entering the remainder of the marina; therefore, the design varies from the remaining docks by including greater isolation between floats and a denser field of guide piles. Electrical power runs from a transformer at the western end MM08 float through internal conduits within each float. Between each float the electrical wires hang in a loop to provide additional flexibility. Firewater and potable water run in HDPE pipes attached to the outer faces of the floats via stainless steel brackets and unistruts post-installed and mechanical anchored to the concrete float, as shown in Figure 3.

At approximately 2:40 AM on July 30, 2025, Crescent City Harbor sustained significant tsunami-related damage due to a tsunami initiated in the Kamchatka peninsula of Russia. A surge of water of several feet in height caused the decking of the H Dock to lift along its pilings, but as water levels continued to rise, the structure was unable to adjust. The decking became lodged on the pilings and was eventually submerged. Electrical arcing and sparking were observed during the incident by individuals on site.

Following this event, the H Dock was taken out-of-service and an initial inspection was performed by Moffatt & Nichol (M&N) on September 9 through 11, 2025, with a summary report issued September 23, 2025. This report identified the following typical damage to H Dock:

- At one location near the east end of H Dock the potable water line is broken between the main line and the hose bibb
- The water line connections (Unistrut anchorage) to the floats are failing or missing in numerous locations.

The M&N report concluded that “The marina water lines should be repaired to restore potable water and fire services. Additionally, the missing, loose and broken pipe hanger attachments and hardware should be replaced and/or reinstalled throughout the marina.”

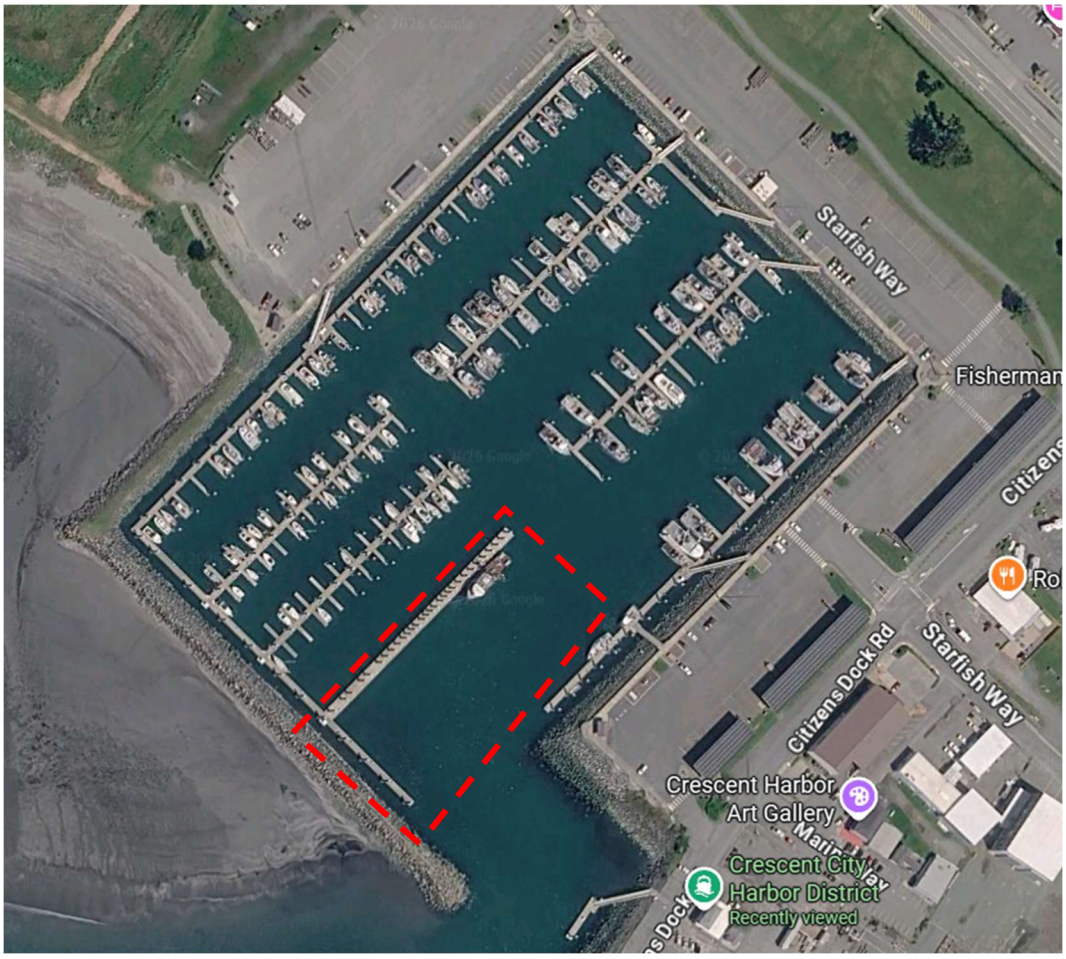

Figure 1: CCHD Marina H Dock

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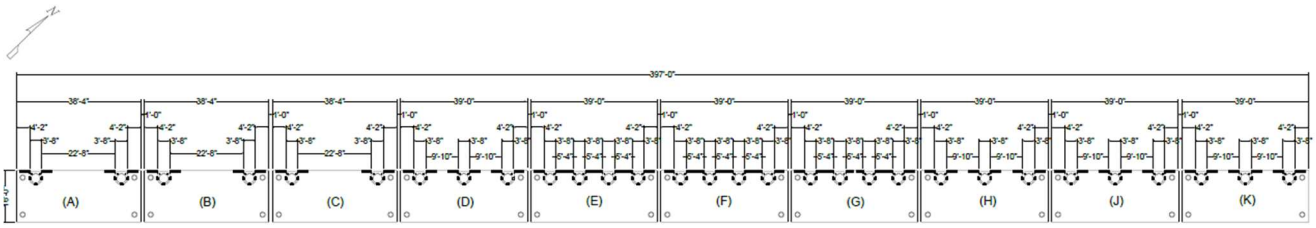
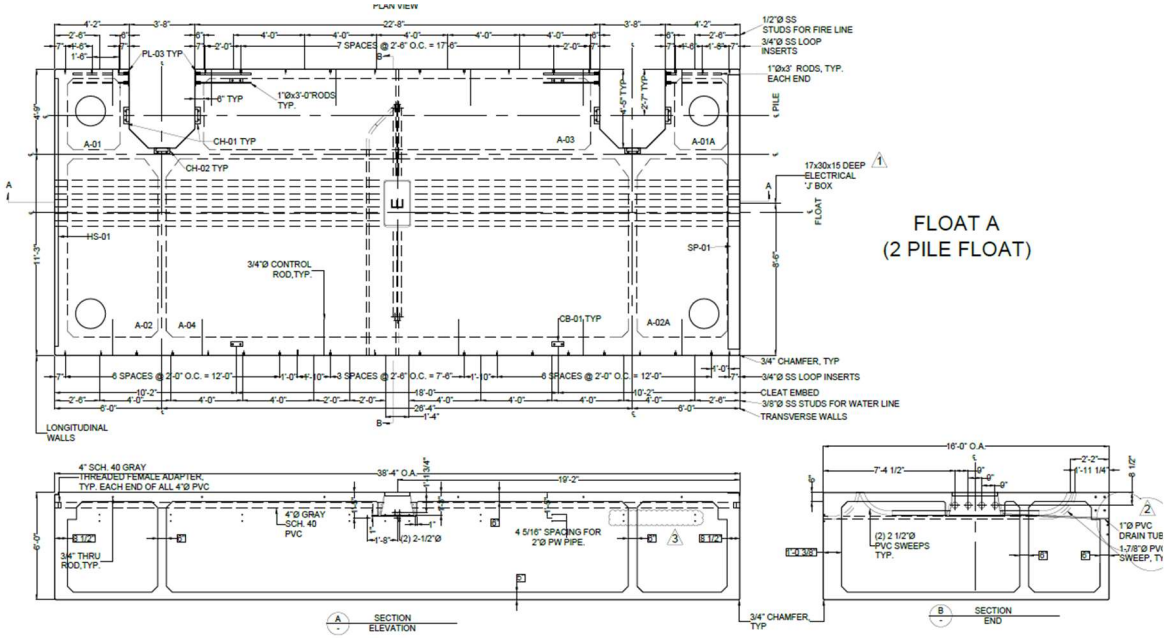
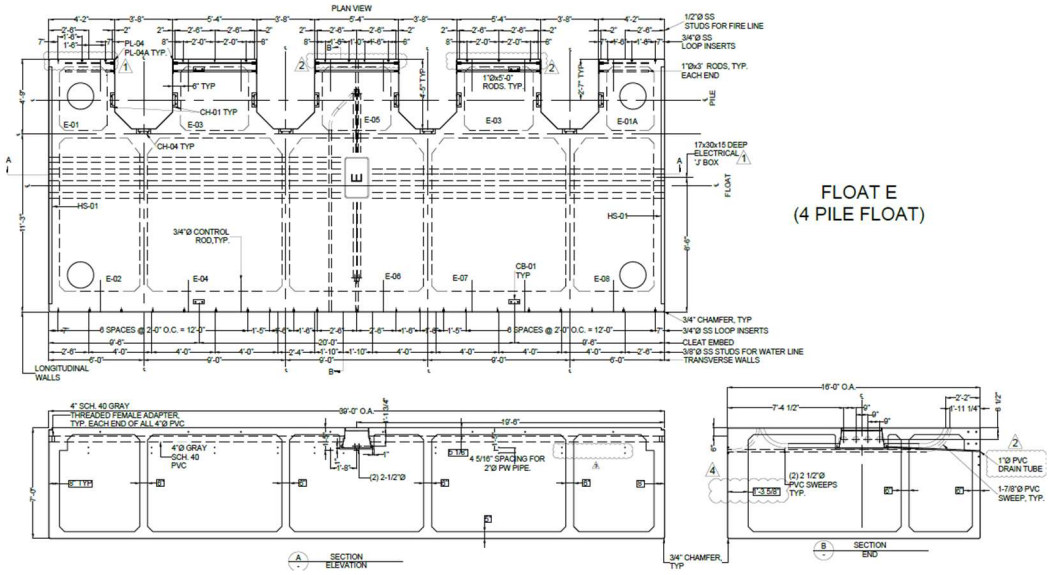


a) H Dock Layout



b) Typical Two Pile Float with Pull Box



c) Typical Four Pile Float with Pull Box

Figure 2: H Dock Plans and Typical Sections

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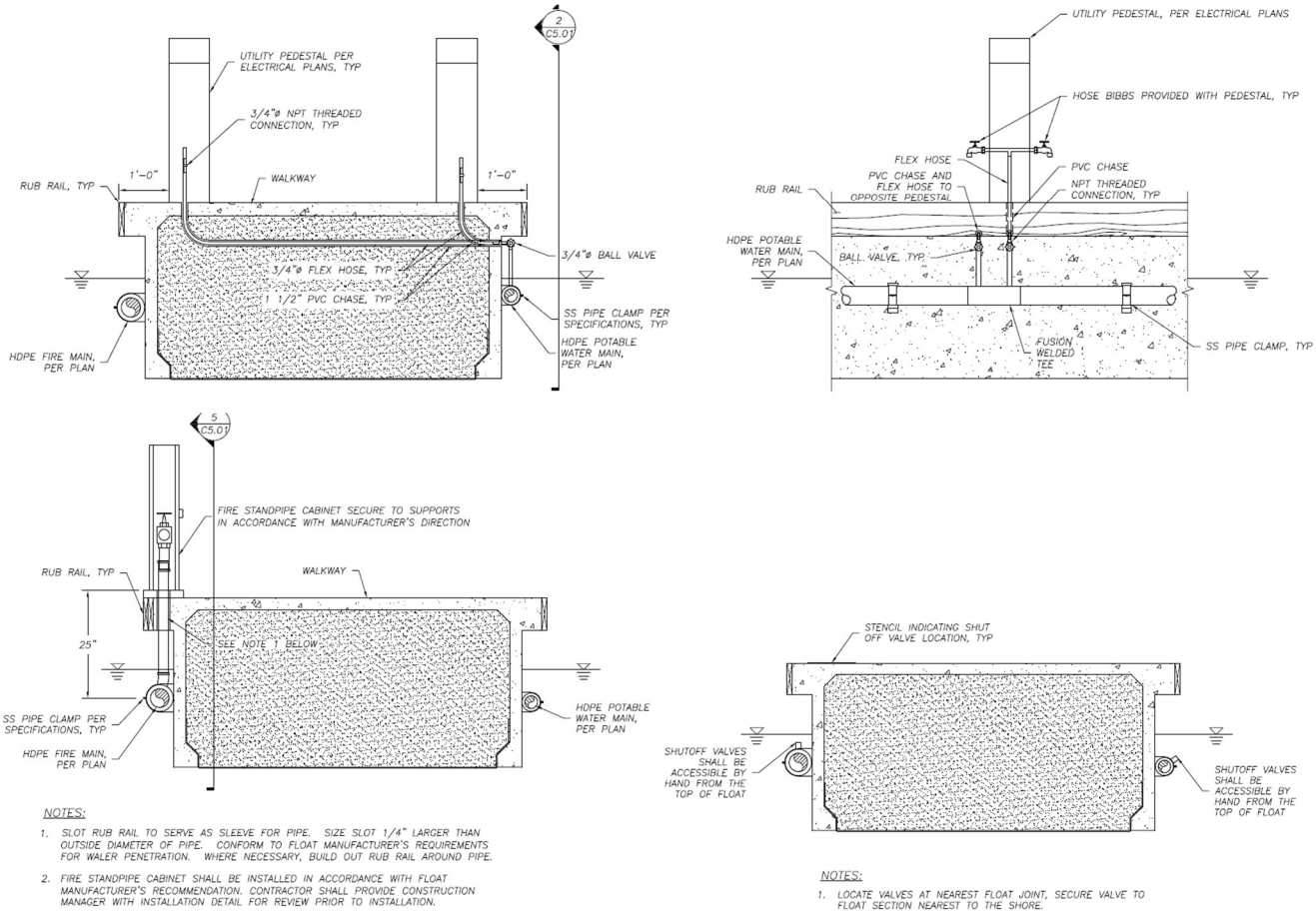

Figure 3: Potable Water and Fire Water HDPE Piping Attached to Side of Docks

2. Site Inspection

GHD performed a site inspection by two marine structures engineers (Marc Percher, PE, and Stephanie Gould, PE) and one electrical engineer (Becca Keating, PE) on August 27, 2026. The GHD personnel met with CCHD personnel and performed an above water review from the topside of the floating docks, with special focus on H Dock. While on site GHD noted general damage and took photos of noted conditions, including the following:

- The existing transformer and load panel at float MM08 (see Figure 4) and CCHD noted that it was previously tested by an electrician and found to be in acceptable condition. The transformer is currently shut off due to damage to the electrical wiring on Dock H.
- Wiring between floats was severed in many locations, as shown in Figure 6. Wiring within the conduits within the float is expected to be undamaged and remain in place, but will need to be replaced due to the severed connections between floats. Based on the observed conditions in the pull box on HM01, as shown in Figure 5, the wiring appears consistent with that shown in the construction drawings.
- While on site, CCHD personnel noted that there is ongoing regular abrasion of the electrical lines between floats due to rubbing with the concrete as well as with barnacles and other biological growth, as shown in Figure 6.

- While on site, CCHD personnel noted that as the current water (potable and fire) lines are fusion welded HDPE they are difficult to maintain as damage cannot be fusion welded underwater, therefore the fusion welding must be performed by lifting the water pipeline clear of the water. CCHD personnel expressed an interest in improving the system for easier regular maintenance and repair
    - It was noted that the existing location of the potable water valve at the waterline exposes the valve to damage from berthed vessels. Due to the above fusion welding constraint, this damage is challenging to repair.
- While on site, CCHD personnel and a local vessel operator noted that there may be stray currents in the marina resulting in reduced lifespan for vessel cathodic protection.
- While on site, CCHD personnel noted that the pedestal at H9 was knocked over and submerged during the 2025 tsunami event. Other pedestals were exposed to water above the deck but likely below the elevation which could influence electrical components within the pedestal.
- Loss of the firewater and potable water support brackets due to failure of the bracket anchorage was noted at several locations throughout the marina as a systematic failure, similar to those shown in Figure 7 and Figure 8. As turbidity was high, GHD was not able to visually observe all locations of the bracketed connections at H Dock. CCHD will request all available inspection notes from M&N for review in order to better map damage locations for repair.
    - GHD observed that the flexible connectors for the firewater line and potable water line used in final construction consist of a plastic or rubber bellow material which appear to be under constant compression in locations (not at H dock), as shown in Figure 9. It is believed that the bellows connector does not provide sufficient flexibility for the connected HDPE piping and that compressive forces are resulting in the piping, causing it to buckle and break the anchorage locations. GHD recommends that when a wider repair program is implemented, these bellows are replaced with a more flexible connection which does not result in axial loading of the HDPE piping.
- CCHD personnel expressed a strong interest in performing repairs to restore operations by the next crab season (Q4 2026), but recognized a full system repair and mitigation of observed damage root causes may require a longer duration.

Figure 4: Combined Transformer and Load Panel at float MM08

Figure 5: Wiring at Pull Box on HM01

a) Wiring at HM01 to 02

b) Wiring at HM03 to 04

c) Wiring at HM05 to 06

d) Wiring at HM09 to 10

Figure 6: Wiring Between Floats

Figure 7: Example Loss of Firewater Pipe Support (Not at Dock H)

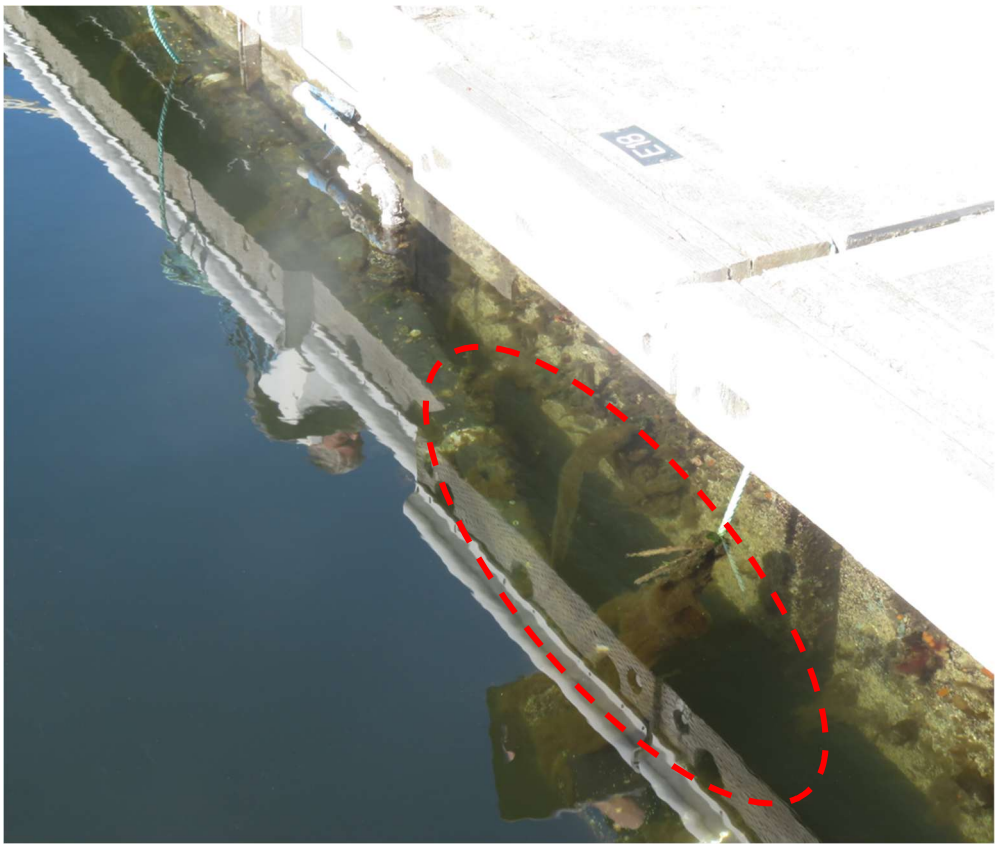

Figure 8: Example Loss of Firewater Pipe Support (Not at Dock H)

Figure 9: Typical Flexible Bellow Connection

3. Concept Repairs

Recognizing that the CCHD is interested in rapid return to operations for the facility within a short timeframe (prior to the end of Q4 2026), GHD recommends a phased approach using a temporary repair allowing for return to operations for the 2026/2027 crab season and then a longer-term full-system repair which incorporates either localized repairs or a more systematic replacement.

3.1 Temporary Repair

In order to implement a temporary repair that returns H Dock to operations, GHD recommends that the following be performed, as shown in Figure 10 and Figure 11:

1) The existing transformer at float MM08 is provided with new penetrations on the side of the box that allow for access to the transformer.
2) New temporary lines are installed from the transformer to the pedestals, run in conduits on the surface of the deck with flexible connections at each float to float connection
3) Potable water is rerouted to new hose lines also run above the deck to the pedestals as necessary
4) A plywood walking surface is then built around the temporary line runs to protect the runs from vessel operations. This walking surface will be wide enough and have sufficient vertical capacity to support vessel operations.

As an alternate to running new temporary wiring conduit along the surface of the existing concrete floats, it is also possible to install overhead strung cables on temporary posts, as shown in Figure 12 and Figure 13. The cables could be fed to outlet boxes at the top of the float on the post. The pedestals would remain out-of-service for electrical power during this temporary operation. The existing transformer would remain unchanged, though new penetrations on the transformer may be necessary to accommodate running overhead lines.

It is recognized that a temporary line run above the existing concrete deck will result in tripping hazards; however, given the short duration to implement repairs, this hazard is considered acceptable to return H dock to operations. The intent is that following the crab season, the temporary construction would be removed and a final repair design would be implemented.

GHD also considered the use of diesel generator(s) either located on the floats or on a barge adjacent to the float. Generators create a new problem of requiring refueling over water, which could become an environmental hazard. Additionally, the generators would still require running additional lines across or over the deck. As the existing transformer is undamaged, use of diesel generators is not recommended.

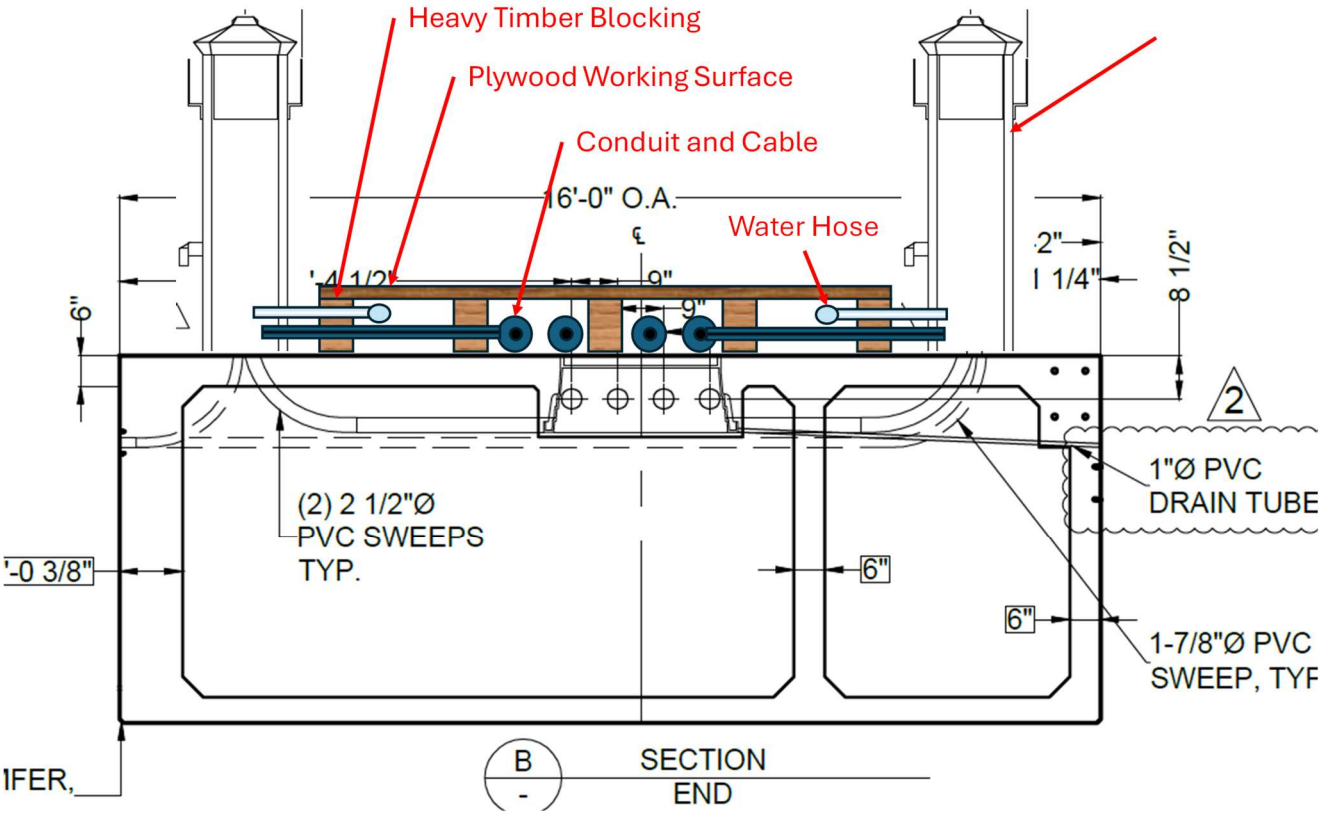

Figure 10: Temporary Repair Concept with Temporary Conduit Transverse Section through Float

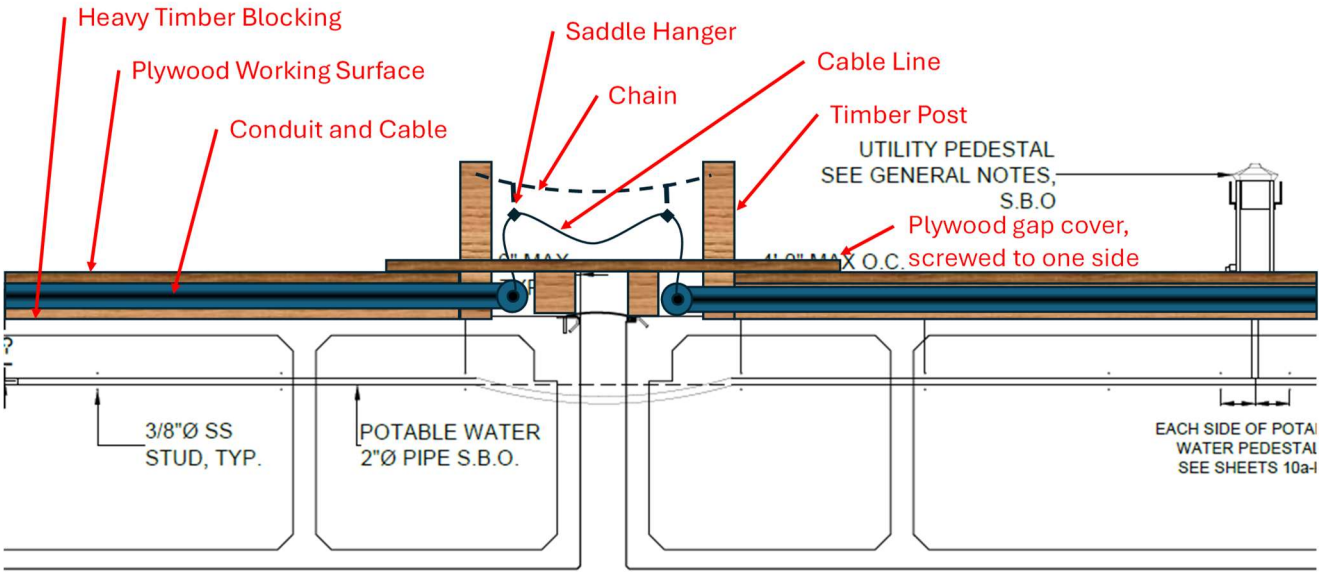

Figure 11: Temporary Repair Concept with Temporary Conduit Longitudinal Section through Float

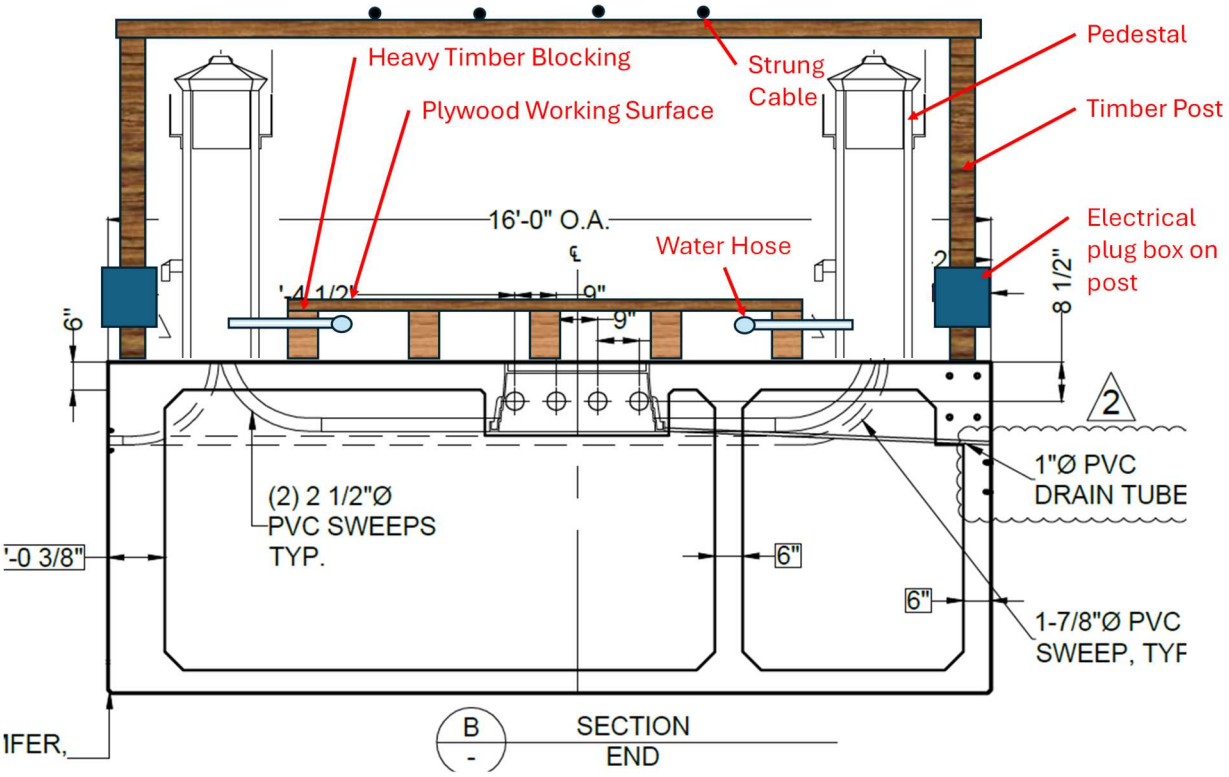

Figure 12: Temporary Repair Concept with Strung Cable Transverse Section through Float

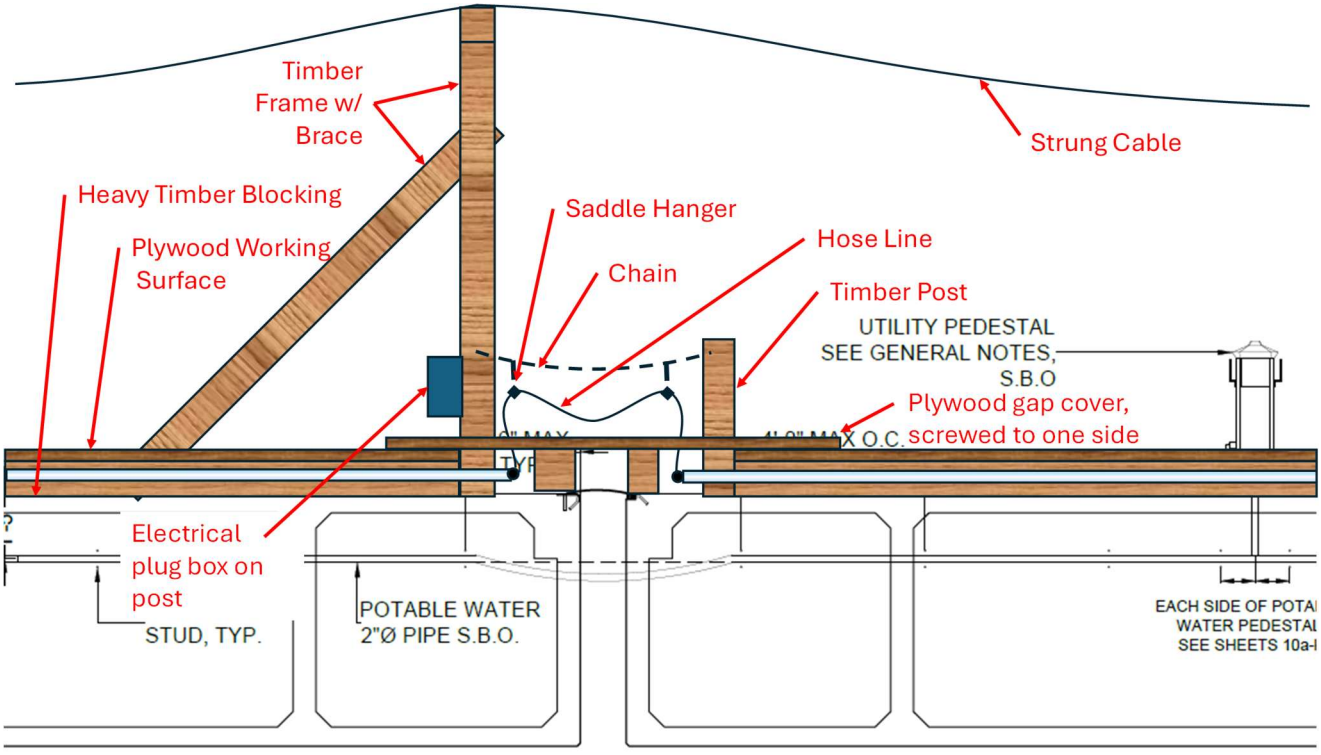

Figure 13: Temporary Repair Concept with Strung Cable Longitudinal Section through Float

3.2 Full System - Localized Repair

A longer lead time repair of the full system based on localized relocation and replacement of elements can be performed based on the following, as shown in Figure 14 and Figure 15:

1) All electrical lines are removed from their existing conduits and replaced along the full length from the transformer to the pedestal as currently installed. This installation may require removal or intentional sinking of each float in order to clear the existing wire and install new wire along the runs. The final condition would be the same as the pre-2025 damage condition, with the exception that braided stainless steel wire sheathing would be installed over the new run of line at the float isolation to reduce abrasion on the lines from biologicals and concrete corners.
2) The existing stainless steel brackets would be supplemented with new Unistrut and brackets of 316 stainless steel material. The new Unistrut brackets would be installed above the waterline adjacent to the timber waler.
3) The existing HDPE line would be shifted upwards to be out of the water and just below and inside the timber rub rail. If additional protection is desired, the 4x10 or 6x10 rub rail can be replaced with a thicker timber member, such as a 10x10 timber as shown in Figure 17. A wider rub rail could also accommodate fasteners from the Unistrut below which would reduce load on concrete anchors.
4) New posts are installed at the intersection of the floats for hanging a new flexible stainless steel braided line. The line will provide sufficient flexibility for all normal service movements and will be readily replaceable in the event of future tsunami induced excessive movements. A flanged connection will be added to the end of the HDPE lines to allow for future repairs.
5) Spigot valve and pedestal feeder lines will be altered as necessary to accommodate the relocation of the HDPE line. A threaded tee hardware will be installed on the main pipe to accommodate future maintenance of the feeder lines and valves. It may be necessary to add additional elbows to the feeder lines at the face of the concrete float to mitigate interference with the main potable water supply line.

While the above scheme addresses many of the flexibility issues and maintenance challenges for the existing system, it does not address the ongoing damage experienced using Unistrut. The systematic failure of the brackets does not have a clear root cause and may be due to corrosion, overloading from the HDPE piping due to lack of flexibility, out of spec materials (such as use of 304 stainless versus 316 stainless), or some combination thereof. The localized repair scheme runs the risk of continued challenges following implementation of these repairs, therefore a more resilient repair scheme was also developed.

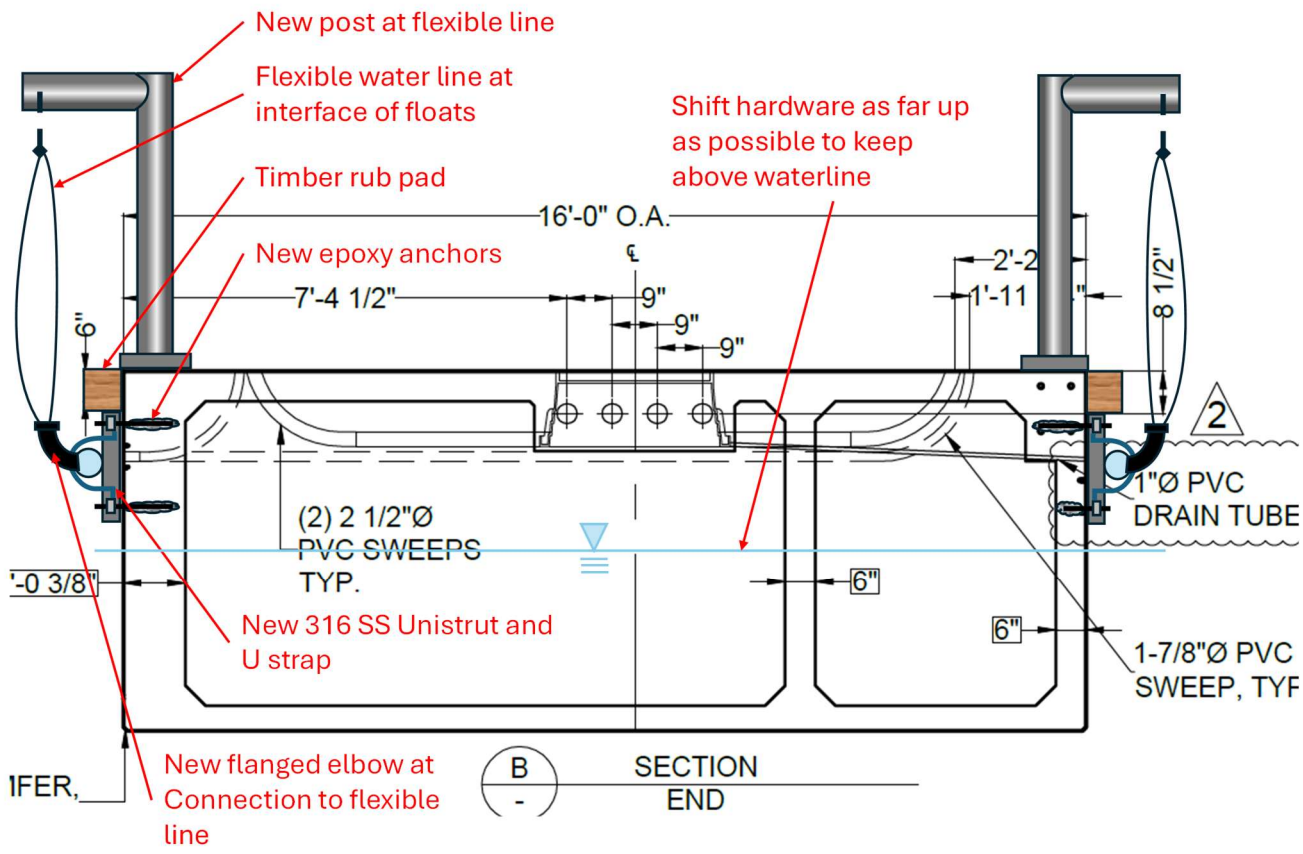

Figure 14: Full System Localized Repair Concept Transverse Section through Float

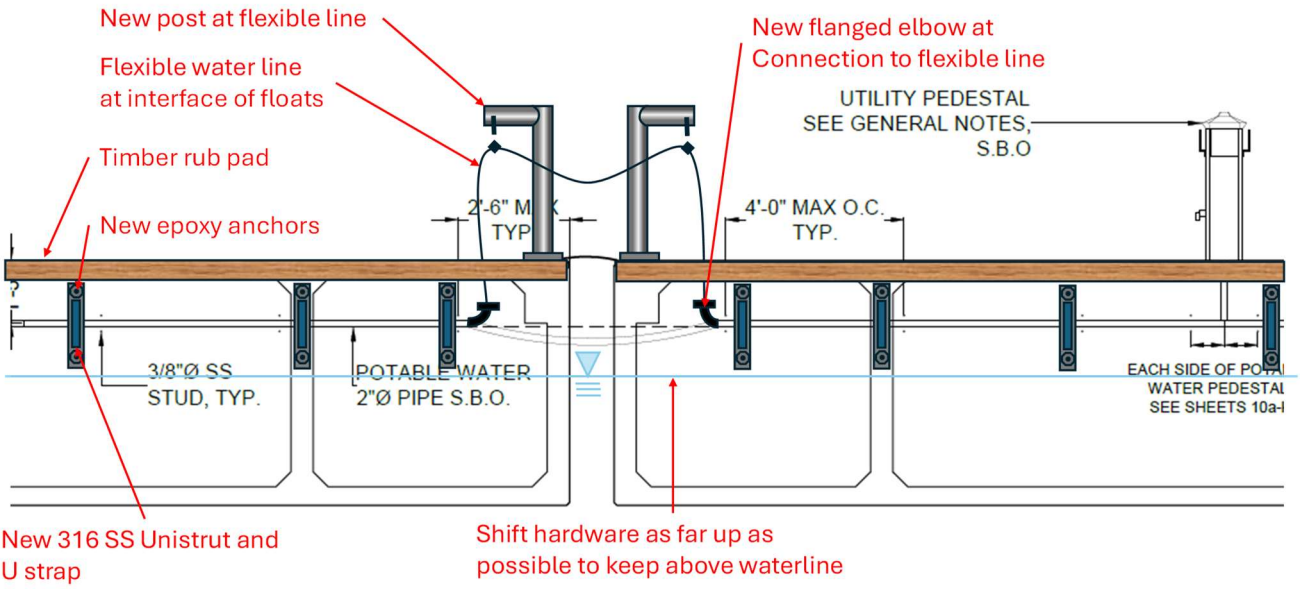

Figure 15: Full System Localized Repair Concept Longitudinal Section through Float

Figure 16: Example of retrofit Unistrut above the waterline

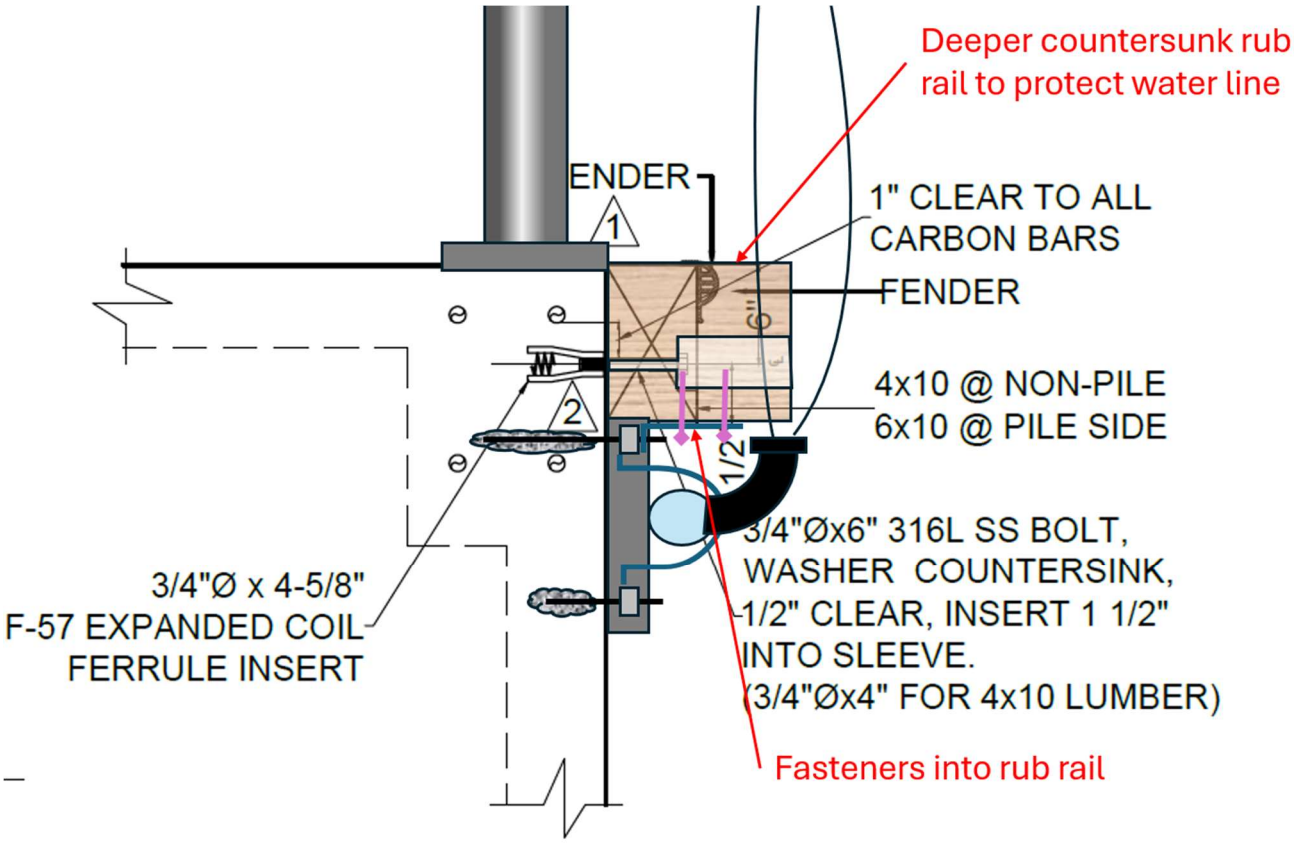

Figure 17: Concept for Deeper Rub Rail to Protect Water Line

3.3 Full System – Replacement

A longer lead time replacement of the full system based on a new rub rail / pipeline enclosure run can be performed based on the following, as shown in Figure 18 and Figure 19.

1) All electrical lines are removed from their existing conduits and replaced along the full length from the transformer to the pedestal as currently installed. This installation may require removal or intentional sinking of each float in order to clear the existing wire and install new wire along the runs. The final condition would be the same as the pre-2025 damage condition, with the exception that braided stainless steel wire sheathing would be installed over the new run of line at the float isolation to reduce abrasion on the lines from biologicals and concrete corners.
2) The existing water supply system piping and brackets would be removed and existing anchors would be cut or ground to the concrete surface and coated for corrosion protection to mitigate future spalling of the concrete floats.
3) The existing rub rail would be removed and replaced with an HP12x89 steel section which is anchored to the concrete float via the existing ferrule inserts and new epoxy anchors, as shown in Figure 20. The HP12 would be installed on its weak axis to act as a run for the water piping and would have a cap plate above to allow for vessel access without a tripping hazard. The HP12 would stop at existing pedestal feeders. The main pipe would be fitted with threaded tees and valves below the HP12 web. A new timber rub rail will be installed offshore of the HP12 and anchored to the flanges. Stiffeners can also be incorporated on the HP12 to protect against vessel impact.
4) New post are installed at the intersection of the floats for hanging a new flexible stainless steel braided line. The line will provide sufficient flexibility for all normal service movements and will be readily replaceable in the event of future tsunami induced excessive movements. A flanged connection will be added to the end of the lines to allow for future repairs.
5) Consideration can be given to the replacement lines being constructed of coated or galvanized steel, which is expected to be more resilient and easier to maintain than the current HDPE lines.

It is expected that this system will add cost to the overall repair, but will provide for better future maintenance and resiliency.

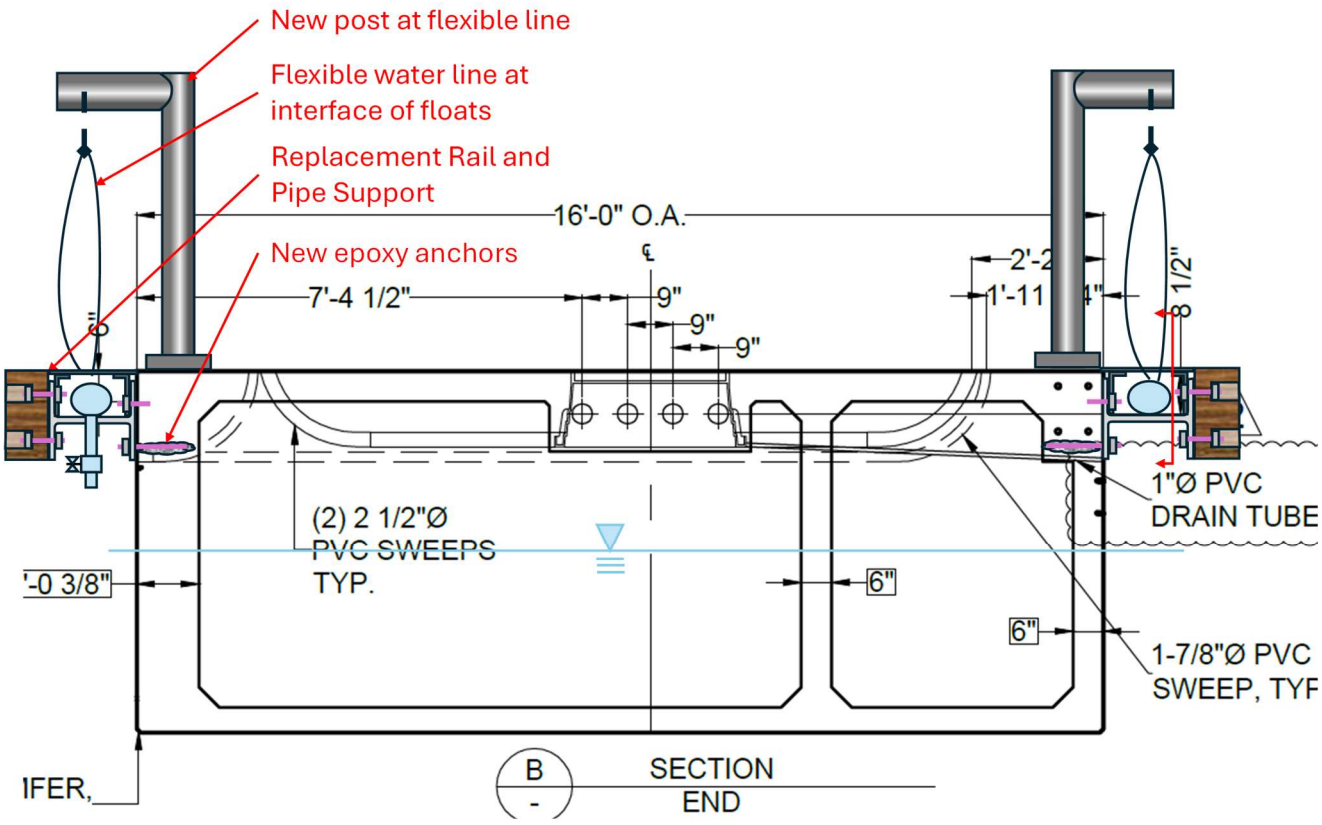

Figure 18: Full System Replacement Concept Transverse Section through Float

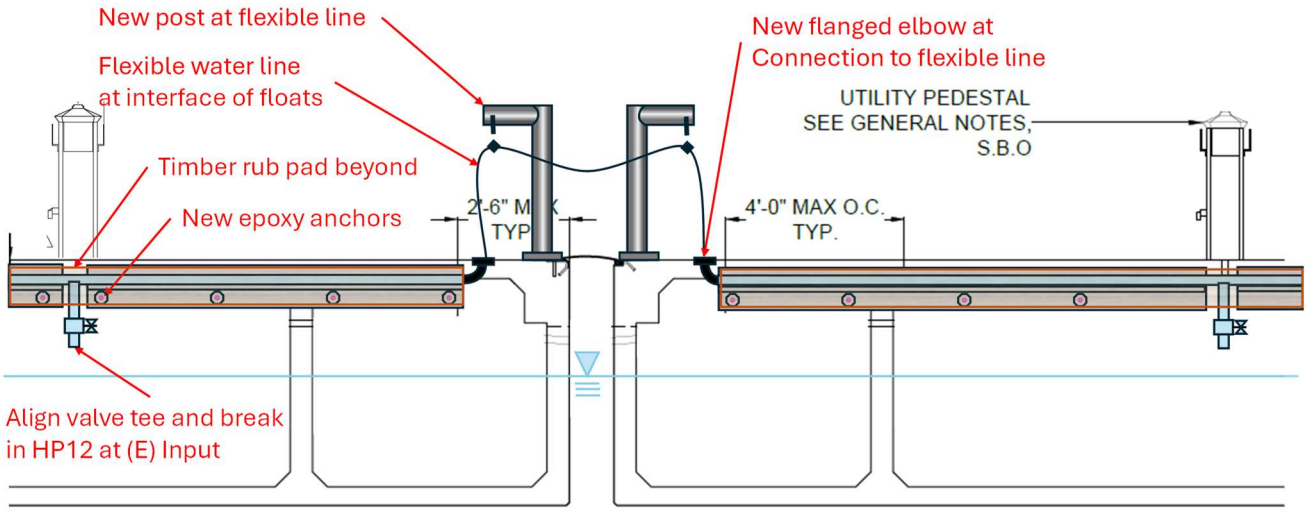

Figure 19: Full System Replacement Concept Longitudinal Section through Float

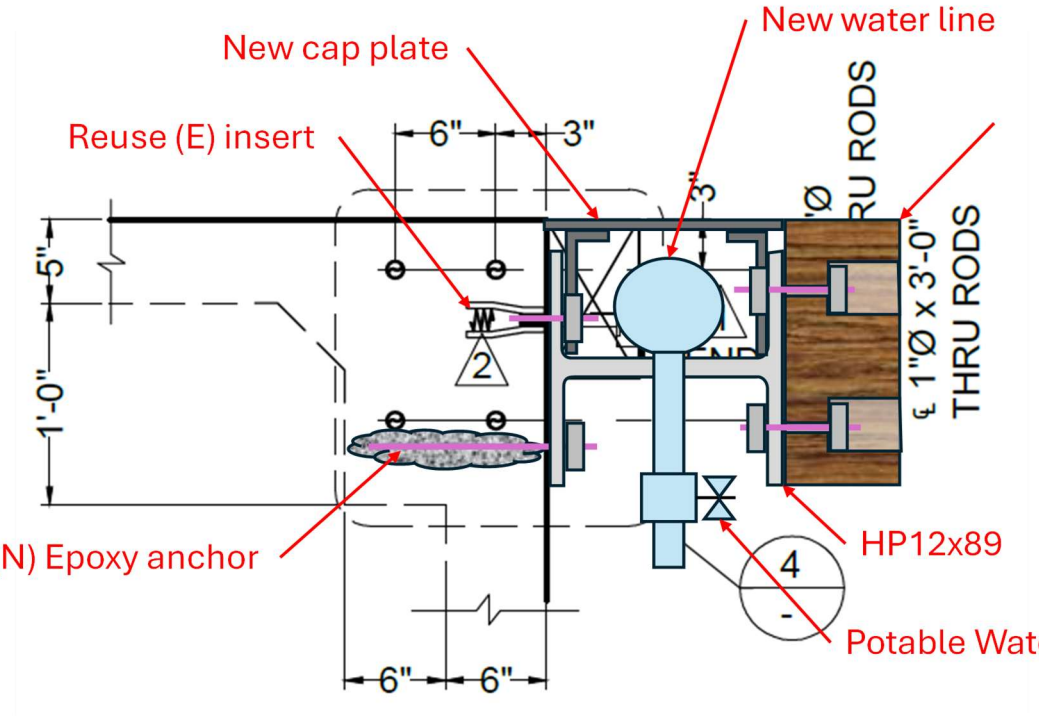

Figure 20: Concept for Replacement Rub Rail with Water Line Enclosure

4. Next Steps

Based on the above findings and concepts, GHD recommends the following:

- CCHD reviews the above concepts and provides direction on developing one or more concepts to a 30% design level appropriate for environmental permitting. GHD can assist CCHD with the permitting of the temporary solution based on a rapid schedule, while development of a long-term solution can be implemented following return to operations under the temporary solution
- Following selection of the desired approach, GHD recommends that engagement with local stakeholders is initiated to ensure that they are aware of the project. Engagement with the California Coastal Commission to introduce the project is also recommended.
    - For the temporary solution, engagement should focus on determining the required permits necessary when the project is treated as an emergency repair on a short-term basis.

We look forward to working with the CCHD on this project and expect that the facility can be returned to successful use for this and future years.

Regards

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