EXHIBIT E-5

EMC-Engineers/Scientists

Preliminary Dock Analysis

EMC

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- Engineers/Scientists, LLC

1/19/17

MEMO-11917-01

To: Gary Dehlinger
Manager, Port of Brookings
From: Jack Akin
EMC-Engineers/Scientists, LLC
RE: Landing to the Port Fuel Dock

Introduction

On Wednesday, January 18, 2017, Jack Akin of EMC-Engineers/Scientists, LLC (EMC), at the request of Gary Dehlinger, Port of Brookings Manager (Gary), inspected the concrete landing system that provides the access to the fuel dock. Gary had expressed concerns because it had been noticed that an increasing gap had been developing between the concrete pad landing and the approaching concrete stairway to the landing.

Design of System

Design drawings for this system were provided by MSS Inc. on 10/10/01, and these drawings reside in the Port of Brookings offices. The pad system as designed (concrete with railing, fuel and all other lines, compacted fill, etc.) is supported by the existing ground, compacted fill, driven 12W-53 H-beam piles and rip rap. The existing riprap can be described as approximately gradation equivalent to ODOT 2000, with an average weight of about 750 pounds, and the largest rocks weighing approximately 2000 pounds (as briefly observed by sight, but not measured). The pad is laid with a peripheral keying atop graded aggregate, and thence atop an average of 4.5 feet of compacted fill. The fill is supported by native soils and existing riprap. Five H-beams are driven into the underlying native soils and the pad is fixed to the beams. These beams have cross-sectional areas of 15.6 in.^{2}, are 12" deep and have a flange width of 10". They are of 36,000 lbs./in.^{2} (36 ksi) steel, and provide adequate lateral strength (M_x = 10 kips, M_y = 5 kips) for this structure[1]. The drawings show driven depths of at least 16 feet, but don't exactly specify the minimum depths to be driven for these columns. It is assumed that they were to be driven into the native soils to a point of fixity, or to refusal. All piping (for electrical, sewer, water, telecommunications, fuel service) was to be inserted through pre-installed chases that were located in the compacted fill beneath the pad and underlying aggregate base.

[1] Data from AISE Manual of Steel Construction

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Existing System

The landing system as observed was not constructed as designed. The pad is supported along its east and west edges by two concrete walls (oriented north-south), apparently meant to provide a crawl space through which some of the piping and the fuel lines fuel sump could be accessed. These walls sit on a supporting pad of about two feet thickness. The lower pad appears to be supported by riprap and native soils. Some compacted fill may have been placed between riprap, but it cannot easily be determined. There are some rebar pins that appear to have been bored into the riprap for lateral support. No H-beams were observed to have been used, and no alternative anchoring against lateral failure was provided.

Damage Assessment

Northward view of stairway/ landing system
Photo 1

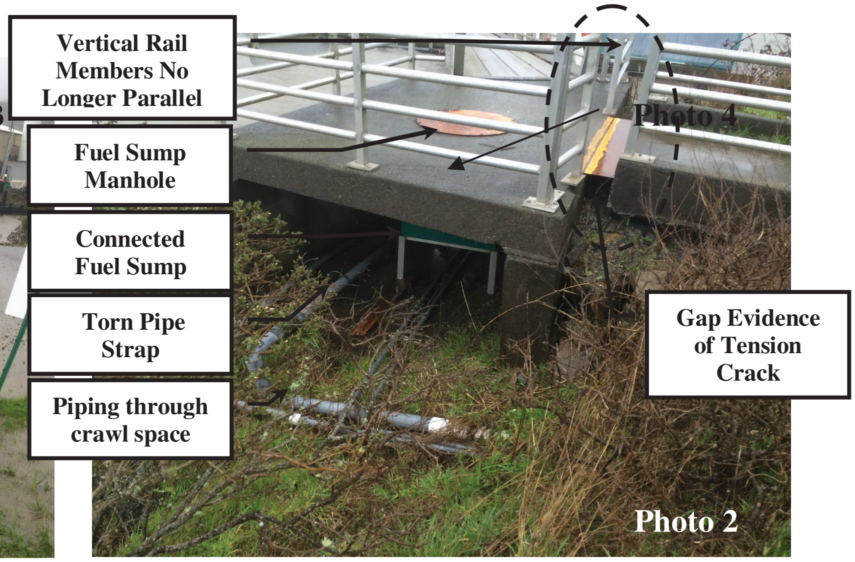

Photo 2


Photo 3
Cracks in Supporting Riprap at Toe of Slope (from Southwest Corner)

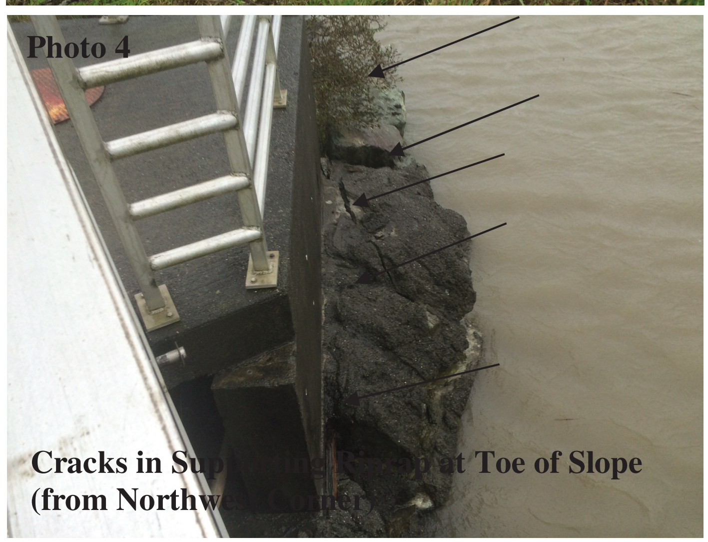
Photo 4
Cracks in Supporting Riprap at Toe of Slope (from Northwest Corner)

The pad, underlying support soils and rip rap are failing along a slip surface estimated to be located as shown in the attached **Exhibit A**. This slip surface is estimated to be a sector of about 26 feet from the theoretical center of moment, which provides a surface resisting force of about 30 feet in length. It is noted that the lowest elevation of the slip is several feet higher than the designed H-beam support. Resisting force was designed to have been provided by the cohesion of soils and rock beneath the structure, rip rap at the toe and the five W12 x 53 piles. The unsaturated load is roughly estimated to be about 76 tons, which is the primary disturbing force. Indications of the failure of the supporting soils and rip rap can be seen in **Photo 3** (cracking as viewed from the southwest pad corner) and **Photo 4** (cracking as viewed from the northwest pad corner).

The resulting slipping of the entire pad system (concrete pad, underlying fill, riprap and native soils) is shown in **Photos 1** and **2**. **Photos 1** and **2** are northward views of the pad and stairway approach, and **Photo 2** provides a closer look at the pad and its connection to the stairway. As is noted on this photo, a tension crack on the east side of the pad has developed, creating a gap between the stairway approach and the pad (note the metal plate temporarily placed to prevent trip hazard). The separation is also indicated by the fact that the rails bolted to the stairway approach and to the pad are no longer parallel as shown in **Exhibit A**. The sliding of the entire pad system, including the concrete support, is also noted by the pull-away of the piping from its brackets. It appears that soil saturation from pour water and seepage has adequately reduced the soil cohesion factor, and increased the weight of the normally unsaturated soils by as much as 12 lbs./cubic foot (over 300 lbs/cy).

Conclusion

This preliminary structural analysis concludes that the identified disturbing forces are greater than the available resisting forces of this system. Therefore the safety factor is less than one and the total failure of this slope is eminent. Excessive soil saturation and resulting soil weight and loss of cohesion appear to be at the root of the failure. The resistance against lateral slipping is limited to the cohesiveness of the soils, strength of the toe and pinning to supporting riprap. Since a considerable loss in cohesion and cracking in the toe riprap has occurred, only the weight of the pinned riprap remains to hold the pad in place. Since the slip surface is below this pinned riprap, it provides little resistive force against failure. It must be noted that if the H-beams had been placed according to the original design, the lateral support provided by the beams would have been adequate to prevent this failure. The beam design, as can be seen in **Exhibit A**, shows these columns driven to an elevation below extreme low water and well below the estimated slip surface.

The existing slip of the system westward will continue. When full failure occurs the attached lines and conduit are likely to be severed. Additionally, the gangway approach to the fuel dock from the pad would be damaged and possibly lost. It appears that the potential loss of fuels (spillage into the waterways) is limited by fuel tank dispenser controls and the piping configuration from the tanks. Properly working anti-siphon valves are assumed to be located in the piping beneath the fuel pumps at the tanks.

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Recommendation

It is recommended that:

1) The fuel lines attached to the failing system be drained and blinded (or disconnected);
2) public access to the system be prohibited, and appropriate signage be placed, employees should minimize the use of the landing access to the fuel dock, when use is deemed necessary employees must use this access with extreme caution, and the potential safety hazards must be communicated in writing to all employees permitted to use the access;
3) failure of this system is likely to occur along the slip surface identified on **Exhibit A**, and consequently such options as tieback, helical supports, etc. are not recommended without removal of the existing concrete landing and loosened underlying soils and riprap, and slope stabilization;
4) tieback/deadman system, correctly designed, could then be placed in lieu of H-beam pile, if underlying soils/rock cannot be penetrated;
5) if piles are used, penetration should be designed and should be driven to several feet below the theoretical slip surface, noting that the slip surface shown in **Exhibit A** is a preliminary estimation, and a more thorough analysis would be required if H-beam support is elected and
6) during this analysis the existing Spill Prevention, Countermeasures and Control Plan (SPCC) was reviewed by EMC, and was found to be inadequate, not compliant with pursuant law (CFR 112), which can be a high liability item, and so it is recommended that the SPCC be brought into compliance.

Sincerely

Jack (John) Akin, MS, PE, IC, HMS, CAI
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