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Willamette Falls Canal and Locks

Independent Condition Assessment and Recommendations for Recommissioning, Escalated for 2026 Construction Costs

Prepared for:
Willamette Falls Locks Authority

Prepared by:
KPFF Consulting Engineers
1601 Fifth Avenue, Suite 1300
Seattle, WA 98101
(206) 382-0600

Clackamas County
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EXECUTIVE SUMMARY

An independent condition assessment of the Willamette Falls Canal and Locks was completed by KPFF in 2018 in support of the Willamette Falls Locks Commission (WFLC). The Willamette Falls Locks Commission was superseded by Willamette Falls Locks Authority in 2021. This updated report reflects the Transition from the Commission to the Willamette Falls Locks Authority and escalates the opinion of cost for constructing improvements recommended in the 2018 report to reflect construction in 2026.

The 2018 independent condition assessment used field observations from a May 30th, 2018 site visit along with a detailed review of existing technical documents. Documents included condition assessment reports for the facility done in 2007 and 2011 (updated in 2013) as well as the USACE Draft Disposition Study (DDS) on the facility. This report assumes that site conditions have not substantively changed from KPFF's 2018 site visit and retains the overall Capital Improvement and Maintence plan outlined in the 2018 report.

In 2018, we found that the lock facility was in remarkably good condition for a civil works project nearing 150 years old. While the design and construction details were outdated, the facility had been very well maintained, and all critical systems appeared to be operable. Previous engineering assessments had identified seismic safety concerns with the lock chamber walls and gate monoliths, uncertainty as to the remaining strength of the miter gate gudgeon anchors, and localized erosion of backfill behind the lock wall structure. At the time we concluded that, once these specific safety issues were addressed, the lock facility could be placed back into regular service with few additional capital improvements. Once back in service, additional capital improvements along with a well implemented continuous maintenance program will support economical and reliable operation of the facility into the foreseeable future.

Given these observations, we developed a recommended program of capital improvements and maintenance activities for recommissioning and operating the locks. Our recommendations were classified by priority of completion as follows:

- Critical Need: Complete prior to lock start up
- Moderate Need: Complete within the next five years
- Long Term Need: Complete within the next 10 years
- Future Capital Costs: Gate inspection/refurbishment and other costs anticipated beyond the 10 year time frame
- Maintenance Need: Complete on a repetitive basis (1 or 5 year cycle)

This plan addressed the critical lock safety issues (Critical Need) prior to reopening while making use of the existing mechanical and electrical/control systems to get the lock back into full operation.

We also identified recommended routine maintenance (Maintenance Need) and additional capital improvements aimed at modernizing the lock system once it was operational. Additional capital improvements were targeted for completion within 5 years (Moderate Need) or 10 years (Long Term Need) and were designed to improve the lock system's reliability and to minimize operation and maintenance costs.

Finally, we identified significant future costs beyond the 10 year time frame (Future Capital Costs) that the new owner would need to plan for.

Future Capital Costs and 5-year cycle Maintenance Needs were annualized to represent a recommended annual capital set aside and then added to the estimated annual maintenance costs.

Overall, this plan of action was consistent with the recommendations contained in the 2007 and 2011/2013 reports. Our proposed seismic retrofit for the lock wall structures and gate monoliths was essentially identical to the solutions proposed in the earlier reports. It should be noted that the USACE Draft Disposition Study (DDS) included an additional seismic retrofit to the PGE/Ship Canal Wall that was not included in the earlier reports. See our discussion in the Cost Summary section titled “COMPARISON TO PREVIOUS REPORTS” for additional information. Our approach to the gudgeon anchorage was slightly different but accomplished the same overall goal. Finally, our approach to stabilizing the backfill erosion behind the lock wall was more substantial than that proposed in the earlier reports but reflected the extensive additional damage that had occurred since the 2011 site investigation.

We estimate that our plan, in 2026 dollar values, requires approximately $16.8M in new capital improvements over the next ten years with $12.5M to be completed prior to reopening the lock. This compares to approximately $30.6M in recommended capital improvements that were proposed in the 2011/2013 report over the same time horizon. The seismic and structural repair costs contained in these two proposals were similar, but the control system and mechanical upgrades we recommended were less costly.

Note that our recommended capital improvements only addressed the functionality of the locks. Other enhancements to the facility will be required to address public safety, state and local building code requirements, federal ADA requirements, and recreational/historical enhancements, including the historic museum on site. These enhancements will require additional capital improvement expenditures.

In addition to the estimated capital costs, we recommended an ongoing routine maintenance program and future capital set aside for maintaining reliability and efficient operation of the facility. We estimate that this program, in 2026 dollar values, will cost approximately $650K annually.

The plan presented in our 2018 report and retained for this report update reflects the site conditions during our 2018 site visit as well as the vision for the facility set forth by the WFLC. Any comprehensive restoration plan should be guided by an updated technical assessment of the facility, including a comprehensive site investigation, and should address the Authority’s current vision for the facility. This plan will most likely differ from that which KPFF put forward in 2018.

BACKGROUND

PURPOSE

Willamette Falls Locks is owned and operated by the United States Army Corps of Engineers (USACE). The facility is currently not available for use to the public due to safety concerns outlined in previous engineering evaluations. The Willamette Falls Locks Commission, later superseded by Willamette Falls Locks Authority, was charged with determining the feasibility for potentially acquiring ownership of the Lock and envisioned reopening the Willamette Falls Locks to the public to support industrial, tourism and recreational users. In 2018, Summit Strategies hired KPFF Consulting Engineers to provide an independent evaluation of the facility’s infrastructure needs and to advise the Willamette Falls Locks Commission on how best to reopen and operate the Willamette Falls Locks.

KPFF has now been retained by the Willamette Falls Locks Authority to update our previous report to reflect capital expenditures in the 2026 time frame. This effort assumes that site conditions remain largely as observed during KPFF’s 2018 site visit and that recommendations made in the 2018 report remain valid. Much of the original report has been repeated in this document to provide context for the escalated

cost estimates. This does not reflect KPFF's present view of the facility's condition, but only as a repetition of our view at the time of the 2018 report.

Basis of Assessment

KPFF's 2018 engineering assessment was based on a brief site visit and more extensive review of historic documents provided by USACE, as described in detail below.

Site Visit

A site visit to Willamette Falls Locks was conducted on May 30, 2018 by Bob Riley, PE, SE and Dan Hartford, PE. Both engineers spent approximately 3 hours at the locks. All gates, lock chambers, and visible gate anchors were visually observed. Gates 1, 2, 3 and 4 were operated and observed. Gates 5, 6, and 7 were not operated during the site visit. A copy of our site observation report is included as Appendix B.

Document Review

Documents reviewed for this engineering evaluation are as follows:

A. *Willamette Falls Locks, Engineering Study, Large Scale Capital Costs*, July 2007. Prepared by INCA Engineers, Inc. for the Clackamas Heritage Partners.
B. *Willamette Falls Locks- Evaluation Report*, August 2011. Prepared by INCA Engineers/CH2MHill Joint Venture for USACE.
C. *Willamette Falls Locks, Interim Engineering Design Report,* March 2013, Prepared by Tetra Tech for USACE.
D. Section 216 Preliminary Draft Disposition Study with Integrated Environmental Assessment, Prepared by USACE, May of 2017.
E. *As-Built 1968.pdf*, Drawing package transferred from USACE.
F. WFL Calebs Folio.pdf, Drawing package transferred from USACE.

Facility Assessment

Condition Assessment

In the 2018 assessment, we found the facility in remarkably good condition for a civil works project constructed in the late 19th century. While the Lock's design and construction was based on outdated practices, the facility had been very well maintained by the USACE since they took ownership in 1915.

Structural Condition

The condition of the facility's lock wall and gate monolith structures has been well documented by previous reports. Our 2018 site observations confirmed the general condition of these structures as previously reported. The size and extent of soil erosion behind the Corps side monolith and wall structure near Gate 4 had significantly increased over what was reported in the 2011 evaluation report. Our review of previous structural calculations confirmed the USACE's concerns over seismic stability of the stacked ashlar masonry structure. The remediation measures recommended in 2013 included installation of new vertically installed rock anchors drilled into the soils below the masonry walls. KPFF concurred with these recommendations and included them in our repair recommendations.

Previous reports suggested a seismic retrofit scheme for the chamber walls and gate monolith structures with the assumption that the structures were classified as “normal” structures. We understood that the Commission wanted to investigate the use of the Locks as a mode of transportation in an emergency situation where many of the nearby bridges may be out of service due to a large seismic event. If the Commission or another agency wishes to use the Locks in this type of emergency situation, then the structures should be classified as “critical” structures, rather than as “normal” structures. Designing a seismic retrofit with a critical classification would reduce the risk of these structures being damaged in a seismic event.

The impact of a “critical’’ designation is that the required design Factor of Safety (FS) for wall or monolith sliding increases by 33% under normal loading conditions (FS of 2.0 vs 1.5), increases by 15% under the Operational Basis Earthquake (OBE) (FS of 1.5 vs 1.3), and stays the same under the Maximum Design Earthquake (MDE) (FS of 1.1). The Maximum Design Earthquake is the same design earthquake that would be required by local building codes and has a 950 year return period (10% chance of being exceeded in a 100 year period). The Factor of Safety is simply the ratio of the required structural capacity to actual demand. In this case, the actual demand is the same whether the structure is considered normal or critical; the difference is in the structure’s required capacity. In order to increase the structural capacity under a “critical” designation, additional rock anchors over and above those already included in this report may be required. Given that performing this seismic stability analysis is fairly time-consuming and beyond the scope of this report, KPFF was not able to assess how many additional anchors may be required to classify this as a critical facility. Additional analysis would be required to adequately address this question.

The condition of the Lock’s miter gates were also well documented in the previous reports. These gates were removed, inspected, rehabilitated, and then reinstalled in 2009. The rehabilitation addressed the primary gate structures, quoin blocks, miter blocks, gate seals, and pintle bearings only. The gate gudgeon anchorage system was not refurbished. Our 2018 site observation confirmed that the primary gate structures were in good condition and consistent with what we would expect from a lightly used miter gate refurbished within the previous 10 years.

The gudgeon anchorage system for the miter gates was observed to be in poor condition and to be consistent with conditions described by previous inspection reports. The gudgeon anchorage system consisted of anchor rods either buried in the lock wall structure, for the rods parallel with the lock, or buried a significant distance below grade, for the rods perpendicular to the lock. The exposed linkage components connected these anchor rods to the gudgeon pin. The true condition of the buried anchor rods could not be assessed without substantial excavation. Based on the anchorage movements observed at Gate 3 and on corrosion issues noted in previous reports, we concluded that these anchor rods should be replaced to support reliable and safe operation of the miter gates in the future. Portions of the exposed linkage components appeared to be in relatively good condition and could have been refurbished to provide safe and reliable operation.

Mechanical and Electrical Condition

Lock mechanical equipment consisted of miter gate operating cylinders, hydraulically operated lock fill/empty valves, a packaged hydraulic power unit adjacent to each miter gate, hydraulic piping/hoses, and an air bubbler system just upstream of each miter gate. With the exception of the bubbler system, all mechanical features were found to be functional and in relatively good condition. This was consistent with observations from previous inspection reports. Based on our assessment, we believed in 2018 that the lock mechanical equipment could be put back into operation with minimal refurbishment and would have supported near term operation of the lock system.

Hydraulic power units for each gate were located adjacent to each lock gate monolith, on the Corps side for Gates 1 through 5 and on the Mill side for Gates 6 and 7. Hydraulic piping from the power units was routed directly to the near side gate leaf operator and to the fill/empty valves mounted on the near side gate leaf. Piping for the far side gate was routed from the HPU through a concrete encased trench down the near side lock wall, along the sill of the lock chamber and then up the far side lock wall. Each HPU included two solenoid-operated directional control valves, one operating near side gate cylinders and the second operating far side cylinders. With only one valve operating both the miter gate and the fill/empty valve cylinders, sequencing of the various control functions was accomplished via a specialized hydraulic sequence valve. This design had a significant operational limitation in that adjustments to lock chamber water level could cause unwanted miter gate operation. Lock operators reported that they routinely isolated miter gate cylinders from the HPU via manual ball valves when they were making lock chamber water level adjustments. This was time consuming and required the significant expertise of a seasoned lock operator.

In 2018, the hydraulic piping appeared to be in relatively good condition, however much of it was fabricated using threaded pipe fittings and was prone to corrosion and leakage. This piping would eventually become a maintenance problem for the facility and presented a substantial risk of spilling hydraulic fluid into the river. According to the operational staff, the hydraulic fluid in use was a biodegradable product, however any spill would have triggered the need for environmental reporting and cleanup.

The bubbler system described above was non-functional during our 2018 site visit and was determined to be unnecessary for the future intended purpose of the facility. We concurred with the USACE's conclusions regarding this system and recommended that it be abandoned.

The control and electrical system for the lock facility was also found to be functional and in roughly the same condition as described in the 2011 inspection report. Subsequent to the 2011 report, the elevated control house structure located at Gate 6 (Control House 3) was condemned and the lock gate controls located in the structure were no longer accessible. The loss of this control location had minimal impact on lock operations as Gates 6 and 7 could still be operated from Control House 2 adjacent to Gate 4. Based on our observations and the previous reports, we believed that the lock system could be returned to operation with minimal refurbishment and repair of the electrical and control equipment.

While the mechanical and electrical systems could be brought back to full functionality with minimal refurbishment, many of the components were nearing the end of their useful life. In addition, the existing control scheme relied almost completely on individual operator expertise to ensure safe operation of the locks. This level of expertise was likely not consistent with anticipated future operations. Recognizing these issues, we recommended significant capital improvements to the hydraulic and control systems. Generally, these improvements were consistent with the measures proposed by previous evaluation reports but were tailored to the assumed future operational scenario. See the Needs Assessment section below for additional details. Note that full operation of the lock facility as assumed for this report should not begin until the proposed mechanical and control systems capital improvements are completed.

NEEDS ASSESSMENT

Based on our 2018 site visit and review of existing documentation, we recommended a set of repairs and refurbishments supporting future operation of the locks. Our recommendations were classified by priority of completion as follows:

- Critical Need: To be completed prior to lock start up

- Moderate Need: To be completed within the next five years
- Long Term Need: To be completed within the next 10 years
- Future Capital Costs: In addition to the 10 year outlook, there will be asset depreciation that will need to be planned for, the primary item being gate inspection and refurbishment.
- Maintenance Need: To be completed on a repetitive basis (1 or 5 year cycle).

Our assessment was restricted to repairs and improvements required to make the lock system operable and to maintain reliable operation. Cost for capital improvements to address public safety, state and local building code requirements, federal ADA requirements, and recreational/historical enhancements, including the historic museum on site, were not included in our estimates. Note that there may be significant financial advantages to combining these "facility enhancements" with the capital improvements and repairs recommended in 2018. One typical example is the area lighting for the facility. Our recommendations restored the lighting system to support operations of the locks but did not provide area lighting that was appropriate for a public space. Combining our recommended repairs with any proposed site enhancements could result in substantial cost savings for the project. Our cost estimates also did not include costs of operation on an annual basis but did include costs of maintenance on an ongoing basis.

Needs are briefly discussed in the below sections. More details of cost and scope are defined in Appendix A.

Note that capital improvement buckets used by KPFF in our 2018 report were driven by the WLFC's vision and objectives at the time and may not represent the most cost-effective approach for the Authority moving forward. KPFF recommends that any new assessment of the facility consider potential capital cost savings that might be realized by making multiple improvements under a single project regardless of criticality.

Critical Need

Critical Needs were repairs identified to be completed before startup of the locks. The following tasks were identified as needs required for the near term. **Items in bold** were higher cost items and further described below:

1. Erosion Repair and Ground Improvements at Lock Chamber 3
2. **Erosion Repair and Ground Improvements at Gate 4 Monolith (Corps Side)**
3. Control Running Water via Drainage Trench at Gate 4 (Corps Side)
4. Hydrographic Survey
5. Reinstall Timber Brace for Wall Lagging, Lock 1 Mill Side
6. Replace Walkway and Walkway Framing Supports
7. **Stabilize Chamber Walls in Select Locations**
8. **Stabilize Monolith Walls in Select Locations**
9. **Replace Corroded Gudgeon Anchorages**
10. Operator Anchorage Repair
11. Replace Pedestrian Draw Bridge over Lock 4
12. Replace Gangway Float at Downstream Approach
13. Install new Piles in Concrete Foundation at Downstream Approach
14. Replace Timber Lining in Chamber 3
15. Replace all Hydraulic Hoses
16. Sample Hydraulic Fluid
17. Detailed Inspection/Documentation of All Fill/Empty Valves
18. Repairs to Valves (Projected)
19. Lubricate all Systems
20. Install New Gate & Valve Operating Cylinders at Gate #1
21. Salvage, Rebuild and Store Cylinders from Gate 1
22. Remove Debris

23. **Install Fire Protection Equipment**
24. Inspect / Repair Generator, Install Packaged Load Bank
25. Repair Broken Luminaires
26. Inspection/Documentation of Electrical Distribution System
27. Repair of Electrical Distribution System
28. Maintenance Activities

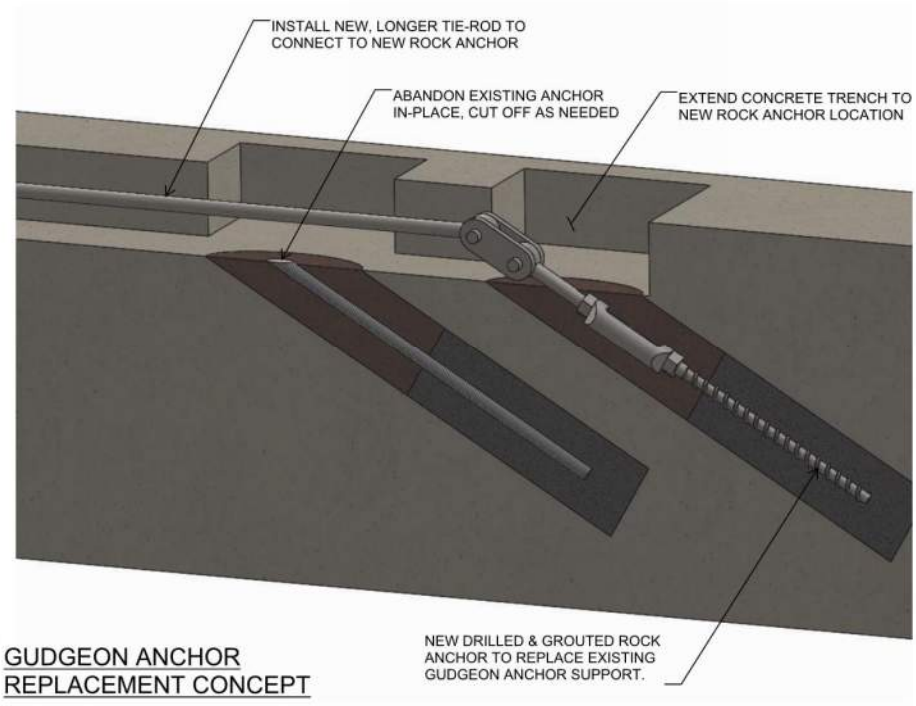
2. Erosion Repair and Ground Improvements at Gate 4 Monolith - Corps Side ($1.15M): It was our understanding that when Lock Chamber 4 was full, a significant amount of water seeped out of the chamber between the timber facing boards on the Corps side. This water had caused erosion behind the wall adjacent to the ashlar stone monolith that supported Gate 4. The water then traveled downhill around the monolith and had caused significant erosion behind the lock chamber wall at Chamber 3 directly adjacent to the monolith. Costs for repairing this area of erosion at Lock 3 were identified in Item 1. KPFF was not able to observe this seepage taking place in person, and relied on video footage from 2010 provided by USACE for an understanding of this phenomenon. The 2011 INCA report identified a waterproofing repair to the Gate 4 monolith as an option for repair, which is the cost identified in this report. This repair, in conjunction with a new drainage trench identified in Item 3, would help to reduce the risk of future erosion. However, these measures did not stop the water from seeping out of Lock Chamber 4—they simply provided a means for conveying the water in a less destructive way. KPFF recommended further investigation at this area to better understand the problem and to identify more holistic solutions for stopping the source of the problem, if it could be accomplished for equal or less cost than those proposed in KPFF's 2018 report.

7. Stabilize Chamber Walls in Select Locations ($2.77M): Install vertical rock anchors at Chamber 2 (three anchors along a 20 ft long portion on Mill side), Chamber 3 (two anchors along a 10 ft long portion on both the Mill side and Corps side), Chamber 4 (the entire length with anchors spaced at 7'-6"), and the Guard Lock (the entire length with anchors spaced at 7'-6"). These anchor locations were based on the 2011 Corps Evaluation Report. Costs for this work took into account the difficulty in accessing the various anchor locations, as well as that in drilling vertically down through the center of the large masonry blocks and installing steel rod anchors that would be grouted into the underlying soils (or rock) below the wall. The rock anchors would increase stability of the gate monoliths during the design level earthquake. This recommendation for repair and scope of work aligned with the 2011 USACE evaluation.

8. Stabilize Gate Monoliths in Select Locations ($1.69M): Install vertical rock anchors at Gate 4 (Corps and Mill side), Gate 5 (Corps and Mill side), Gate 6 (Mill side only), and Gate 7 (Mill side only) to address seismic stability concerns of the ashlar masonry walls. These anchor locations were based on the 2011 Corps Evaluation Report. The scope of KPFF's work did not allow sufficient time to perform an independent seismic stability analysis of these walls. However, we were able to review the original wall stability calculations and generally agreed with their approach. Costs for this work took into account the difficulty in accessing the various anchor locations, and the costs for drilling vertically down through the center of the large masonry blocks and installing steel rod anchors that would bee grouted into the underlying soils (or rock, depending upon subsurface conditions) below the wall. These rods would then be post-tensioned to place a vertical load on the walls. This would improve the stability of the walls by increasing the downward force on the masonry layers to increase the inter-layer friction. This recommendation for repair and scope of work aligned with the 2011 USACE evaluation.

9. Replace Corroded Gudgeon Anchorages ($780K): This wasn't one of the highest cost items, however it was heavily discussed in previous reports. This estimate assumed all gudgeon anchorages needed to be replaced for Gates 2, 3, 4, 5, 6, and 7 to mitigate any concerns regarding the safety of these anchorages. For the anchor rods parallel to the lock, these rods were assumed to be replaced in kind. For the anchor

rods perpendicular to the lock, the approach was to abandon the existing anchor rod in place and install new drilled in and grouted rock anchors a few feet further back from the gate and then install longer tie rods to connect to the gate. This was true for all perpendicular gudgeon anchors except at Gates 4 & 5 Mill side, where they were replaced in kind. This recommendation for repair and scope of work was different from the 2011 USACE evaluation, which recommended abatement of existing corrosion and replacing only a handful of pieces of hardware, which did not address the potential for corroded and buried anchorages which were not accessible for inspection. See the figure below for a conceptual sketch of the replacement gudgeon anchor.



23. Install Fire Protection Equipment ($1.10M): In 2018 there was no fire protection equipment along the locks to protect the lock users. There was minimal hydrant access along the lock system for firefighters to connect to, the closest documented hydrant being up on Willamette Falls Drive, approximately 250’ from the locks. Installing a firewater system with multiple hose reels along the locks would increase fire protection coverage. This recommendation aligned with the 2011 USACE evaluation.

Moderate Need

Moderate Needs were repairs recommended to be completed within five years of operation but not critical for startup of the locks. The following tasks were identified as moderate needs. Items in bold were higher cost items and further described below:

29. Replace Chamber Ladders
30. Replace Damaged Guardrails
31. **Install new Hydraulic Power Units**
32. Replace Bottom Seals
33. **Replace Lighting System**
34. **Replace/Refurbish Control System**

These items could be done earlier if budget allowed for it, and some items would be less expensive to execute if completed at the same time. An example is combining tasks that require dewatering within the locks.

31. Install new Hydraulic Power Units ($890K):

As discussed above, the existing hydraulic power units, control valves, and piping were operable and would have supported routine operation of the lock facility by personnel of equivalent expertise and training as those employed by the USACE to operate the system in 2018. While operable, the hydraulic and controls installed at that time were nearing or past their recommended service life, had significant operational limitations, and would not have allowed operation of the facility under a more diverse and less highly-trained group of operators. For these reasons, we recommended that the existing HPUs be replaced with new package commercial units.

Our recommendation was to replace the 7 existing HPUs with 14 smaller commercial packaged HPUs, one unit for each gate leaf. With this configuration, hydraulic piping under the lock chamber could be abandoned, and risks of a hydraulic oil spill would be substantially reduced. We further recommended that each HPU be equipped with multiple modular directional control valves, one to control the miter gate cylinder and one for each of the four fill-empty valve cylinders. This arrangement allowed for independent control of all operations and eliminated the limitations created by the sequence valves in the existing hydraulic circuit.

We further recommended that all hydraulic piping from the HPU to the gate, as well as piping on the gate leaf, be replaced by high quality stainless steel tubing.

This HPU and control valve scheme was contingent upon simultaneous installation of a modern digital control system and updated power distribution system as described in the work under items 33 and 34 below. Interconnecting these HPUs and the control valves via a networked control scheme would allow control valves to be mounted in a manner that would minimize the required hydraulic piping.

33. Replace Lighting System ($1.13M): While the existing lighting system was functional, it was obsolete and should have been replaced. In addition, our proposed scheme for the hydraulic power units required electrical power at each gate monolith (Corps. and Mill Side of the locks). We recommended that a new power distribution and lighting system be installed simultaneously with the new HPU and control system. Our cost for this item reflected a lighting system similar in performance to the existing system but using current state-of-the-art luminaries. We also recommended that this work be coordinated with any public access improvements to the site, as the end use of the facility may have dictated a lighting system better suited for a public use facility.

34. Replace / Refurbish Control System ($1.75M): In 2018, the control system was an older analog system. It functioned, however much of the equipment was obsolete, would be difficult to maintain/repair over time, and eventually should have been upgraded. Upgrading the control system would allow for better overall control of the facility as well as automation of the system that would allow use by a more diverse and less highly-trained group of operators.

We proposed replacing the existing analog control system with a digital programmable logic controller (PLC) based control system using distributed network controls. The PLC and key control system functions would have been installed in one of the existing control houses. All lock control would have been handled through touch screen human machine interfaces (HMIs) distributed throughout the lock facility. HMIs

would have been installed adjacent to each lock gate monolith to allow for local operator control, and in the two lock control houses.

Control devices, including limit switches and hydraulic control valves, would have been connected to the control system via a control network, eliminating the need for individual hard wiring from the PLC to each device. To automate the system, we recommended monitoring water surface elevations in all lock chambers via redundant ultrasonic liquid level sensors. These devices would also have communicated with the PLC via the control network.

With this type of control scheme in place, the PLC could provide operational oversight of the facility, insuring that the lock was operated in a safe manner regardless of the expertise of the operator.

This system was contingent on implementation of the new HPU as well as the power distribution and lighting upgrades proposed in items 32 and 33 above.

Long Term Need

Long Term Needs were repairs identified to be completed within 10 years of operation. There were no relatively high costs identified for long term needs. The following task was identified as needs to happen within 10 years:

35. Repair Loss of Masonry at Lowest Course at the Downstream Approach, Mill Side

Estimated Maintenance + Future Capital Improvement Set-Asides

Our cost estimate accounts for annual maintenance costs as well as long term maintenance and anticipated future capital costs under a single line item. In this cost line item, all costs are annualized and are presented as total annual cost.

Future Capital Costs

Future capital needs were forecasted high cost items that would be required after 10 years and needed to be anticipated and planned. The major item here was the inspection and refurbishment of gate leaves. This work would likely be required after 2030. The following tasks were identified as future capital costs. Items in bold were higher cost items and further described below:

36. Inspect / Refurbish Gate Leaves
37. Flood Repair Contingency

36. Inspect / Refurbish Gate Leaves ($1.76M): This line item was added to anticipate this large expenditure in the future. Gate Leaves typically have a 25-50 year life and need to be inspected and refurbished. All gate leaves were inspected and refurbished in 2009, thus likely the gates will need to be refurbished between 2034-2059. This work aligned with the line item identified in the 2011 USACE evaluation report to install new miter blocks, since that activity would require removal of the gate leaves, however KPFF did not anticipate the need to replace the miter blocks within a 10 year period. Scope of work included removing the gates via a barge + crane and transferring to a shop, stripping the planks off the gates, sand blasting the structure, detailed inspection, weld repair as needed, repainting, installing new bottom seals and valve seals, installing new bearings, installing new quoin block/miter block, transferring the gates back to the site and reinstalling the gate leaves via a barge and crane, and adjusting the retention diagonals so the gates hung level. Note that it was recommended to keep either Gates 6 & 7, 6 & 5 or 5 & 7 installed at the same time to maintain pool integrity for the hydroelectric plant.

37. Flood Repair Contingency ($1.02MK): This line item was added to allow a contingency fund for repairs needed for a future flooding event.

Routine Maintenance Need

Routine Maintenance Needs are preventative maintenance items to be completed on a routine basis. The following tasks were identified as needs required annually:

1. Inspect Timber Lining and Replace Rotting Pieces as Needed
2. Inspect Lock Walls and Region behind Lock Walls for Movement
3. Inspect Masonry for Structural Integrity
4. Remove Debris as Needed
5. Hydraulic Fluid Sampling
6. Replace One Set of Gate and Valve Hydraulic Cylinder Operators
7. Lubricate Systems
8. Run Generator on Load Bank Monthly
9. Limit Switch Inspection / Repair / Replacement

The following tasks were identified as needs required every 5 years:

10. Hydrographic Survey and Dredging
11. Adjust Retention Diagonals on Miter Gate Leaf
12. Testing and Correction of Grounding System
13. Replace Hydraulic Hoses
14. Slide Gate Inspection / J seal & J clamp PM

Comparison with Previous USACE Needs Assessment

In general, our recommendations and needs assessments for the facility were consistent with those recommended in the 2007, 2011, and 2013 reports. All deficiencies that we identified were discussed by the previous reports, and we were able to identify any significant additional deficiencies in the system. In some cases, we identified slightly different solutions or we proposed to phase capital improvements differently than previous reports. Overall our estimated costs for capital improvements were less than those listed in the 2011 report, but were substantially higher than those contained in the 2007 report. The discrepancy between engineering estimates is discussed in more detail under the Cost Summary section below.

Several specific capital improvements recommended by the 2007 and 2011 reports were not included in our recommendations. Some of these recommendations were eliminated because of the anticipated operating methodology for the lock listed below. Other specific items were eliminated because repairs had been made or because site conditions had changed subsequent to the report being issued. Please see below for a discussion on why each line item was not included. Some line items included on old reports that were not directly copied onto our report or shown below were incorporated into other line items.

Analyze Lock Control Stand at Gate 6 (Mill Side): The structure of the lock control stand was condemned. There was no need to analyze the structure since it had already been deemed unsafe structurally. If the control stand was needed, the structure would need to be replaced. This activity would have added complexity with all of the utilities routed around, underneath, and into the control stand. With the recommended operational methodology, the control stand was no longer needed.

Miter Block Repair: The USACE anticipated having to replace the miter blocks within a 10 year period. KPFF recommended deferring this work until the gates were inspected and refurbished in the future. The miter block repairs had been recommended after noticing a miter block had cracking towards the top on

at least one gate. The 2011 USACE evaluation report suggests that these cracks occur when the gates close, due to first contact being made at the top of the gate. KPFF added a 5 year cycle maintenance task to adjust the retention diagonals so the gates sat square, as this would reduce the likelihood of damage to the miter blocks and enable the deferral of this item.

Gate limit switches (2nd set): The USACE recommended changing the operator methodology of the locks to decrease overall wear on the system. The addition of these limit switches would allow the future control system to slow gate travel as the gate neared its open or closed limit. This would reduce impact loading on the structure and the operators and would increase the service life of the components. We assumed that the total number of annual lockages would remain relatively low when compared to the locks' historical use, and the cost for this additional control complexity was not justified.

CCTV Repair / Upgrade: With the recommended way of operating, it was determined that CCTV was not required for operation of the lock. Both the 2011 and 2013 Corps Evaluation Reports recommend CCTV repairs/upgrades for remote operation, however under new ownership we assumed that the lock would not be operated remotely and thus these improvements would not be required in the future.

Remote monitoring / operating system: This line item was added to enable USACE to operate the Willamette locks from Bonneville dam, however under different ownership and recommended operation methodology an operator would be onsite. With an operator onsite, this line item was no longer required.

Our proposed upgrades were substantially more extensive than the final recommendations presented by the Draft Disposition Study (DDS) prepared by the USACE. That study considered 8 alternatives for transferring the facility to a new owner. Eleven (11) measures were identified that could be implemented by the Corps to facilitate the transfer of the asset. Costs for each measure were assigned based on the 2011 report. Eight (8) different alternatives were then identified, with each alternative accomplishing some subset of the eleven measures. The eight alternatives were reduced to three based on a defined screening criteria and then a preferred alternative was selected based on minimizing the associated costs to the Federal Government. The preferred alternative presented by the DDS was alternative number 3, which would transfer a non-functional Lock to a new owner after addressing only seismic safety of structures retaining the upper pool. Given the limited scope of capital improvements proposed by the USACE in the DDS, the costs presented were substantially less than those identified in KPFF's report. See the Cost Summary section for additional details of the comparative costs.

Note that the proposed capital improvements to the facility were similar in scope to the following measures identified by the DDS:

1. Seismic Partial
2. Safety Functional
3. Safety Minimal
4. Seepage

If the costs of the above measures were combined, they would be similar to the capital expenditures included within this report.

COST SUMMARY

ESTIMATED ROM COSTS

The costs shown in the table below represent our ROM estimate for completing the improvements we proposed for this facility. Costs given are Rough Order of Magnitude (ROM) costs. The 2018 ROM cost estimates are provided here for reference and have also been escalated to reflect the 2026 timeframe. A 30% contingency was added to each line item since this was a high level engineering evaluation. Estimated engineering & permitting costs are also included in this estimate using an additional 20% markup added to the construction and contingency costs. Table 1 gives an overall cost estimate for each Need. Note that line item 4 includes the cost of annual routine maintenance as well as annual funding set-asides to finance major systems, anticipated major capital improvements, and periodic emergency repairs and maintenance (not accounting for earned interest or future inflation). See Appendix A for further scope detail and cost of each Need Type.

Need Type	Amount ($2018)	Amount ($2026)
Critical Need (Prior to Locks Reopening)	$8,610,000	$12,530,000
Moderate Need (Within 5 years)	$2,940,000	$4,250,000
Long Term Need (Within 10 years)	$240,000	$350,000
Estimated Maintenance + Future Capital Improvement Set-Asides	$450,000	$650,000

TABLE 1: SUMMARY OF OVERALL COSTS

Cost escalation was determined using the USACE's engineering manual EM-1110-1304, Civil Works Construction Cost Index System (CWCCIS). Along with the March 31, 2024 published Indices. including historical data and predicted future costs. The quarterly cost indices for locks in Q2 2018 and Q2 2026 were used to find an effective inflation rate of 44.8% over the time in question.

COMPARISON TO PREVIOUS REPORTS

The Table below compares our cost estimates to those developed by other consultants for the 2011 report. This table presents an apples-to-apples comparison of our estimated costs to the previous estimate based on our proposed planning horizon.

As for USACE's Disposition Study, it is difficult for us to make direct cost comparisons to this study, primarily due to the fact that this study includes costs to seismically stabilize the shared PGE/Ship Canal wall, which is currently not included in our recommendations for repair. None of the previous 2007, 2011 or 2013 reports indicate that this wall requires seismic stabilization. KPFF has heard recent anecdotal concern from the Corps regarding this wall's stability. However, we have not had the opportunity to independently evaluate the need for stabilization of this wall.

The USACE's preferred solution in the Disposition Study is Alternative 3, which transfers a non-functioning lock and limits the scope of seismic improvements at the facility to structural elements needed to maintain the upper pool at the site. USACE reports the cost for this alternative at $1.963M ($3.140M in 2026-Dollars), which includes $1.847M ($2,96M in 2026 Dollars) in seismic retrofit costs. The scope of these retrofits includes stabilization of the PGE/Ship Canal wall, the guard lock wall and guard lock gate 6 & 7 monoliths on the River side. KPFF's study presented herein includes costs for seismic retrofit of the guard lock wall and gate 6 & 7 monoliths for a cost of approximately $1.3M in 2018-dollars ($1.88M in

2026-dollars), but this cost does not include retrofit of the PGE/Ship Canal wall. Further study would be required for KPFF to validate the need and cost for retrofit of the Ship Canal wall.

Planning Horizon	KPFF Estimate ($2018)	KPFF Estimate ($2026)	2011 Report ($2011/2013) Escalated to 2026-Dollers
Critical Need (Prior to Locks Reopening)	$8.61M	$12.53M	$12.54M*
Moderate Need (Within 5 years)	$2.94M	$4.25M	$9.00M* to $7.89M*
Long Term Need (Within 10 years)	$240K	$350K	$9.06M*

* 2011/2013 report values escalated using USACE EM 1110-1-1304 Table 2 Yearly Cost Indices, CWWBS Code 05, Locks, FY2013 – FY2026 (March 31, 2024 Table)

TABLE 3: COMPARISON TO 2011/2013 REPORT

Note that our total ROM estimated costs for the project are somewhat less than those presented in the 2011 engineering report prepared by the joint venture INCA/CH2M team. This discrepancy is primarily related to the following issues:

1. Portions of our cost estimates are based on a more detailed take-off than was used to prepare the 2011 report.
2. For some scope items we are proposing slightly different design details.
3. For many items such as the electrical/control system and the gate mechanical systems, we are proposing systems that are more appropriate for the assumed future operation of this facility. As an example, the control system that we are proposing is appropriate for a lock operated locally. The 2011 report envisioned a lock control system that allowed USACE staff to fully operate the lock remotely.

Overall we believe that our estimate ROM costs are reasonable for the Commission's planning purposes and that they are in-line with the costs that were presented in the 2011 report, once the differences in proposed scope of work are accounted for.

Potential Issues

Some additional risks were identified in the 2018 report due to unknowns associated with the site, such as:

- Erosion at Gate 4: The costs included in this report are based on the solutions presented in the 2011 report. KPFF recommends further investigation be conducted to determine if there is a solution to mitigate future erosion from occurring at Lock 3 due to seepage out of Lock Chamber 4 and the Gate 4 monolith. Upon discussion with the Corps, mitigating the seepage itself may not be realistic; however there may be better options for mitigating future erosion due to this seepage.

- Dredging: Upon discussion with the Corps, it appears that minimal sediment accumulates within the lock chambers. Therefore, for the purposes of estimating a dredging maintenance cost, we

have assumed 2' of sediment accumulates and needs to be dredged out from two of the standard 210' long chambers every 5 years.

- Seismic stabilization of the PGE/Ship Canal wall: Costs for stabilizing this wall are currently not included in this report. Further investigations are required to determine if this activity needs to be undertaken and to determine the costs for these improvements.

- Operations: Repairs were assessed based on an assumed method of operations, which assumed the owner will pursue an onsite/manual approach. If the owner decides to operate the Locks differently, other repairs or improvements should be considered. Examples would be the need for a remote control stand at Gate 6, CCTV requirements, etc.

- Environmental assessment - no environmental assessments were performed as part of this scope of services. The USACE has prepared a comprehensive section 216 Preliminary Draft Disposition Study with Integrated Environmental Assessment. The Locks Commission should consider having this assessment reviewed by a qualified Environmental Consultant prior to assuming Ownership of the Locks.

- The project site has been damaged by extreme flood events in the past. The new owner should be aware of the flood hazard risk and should have a plan for operating the facility under flood hazard conditions.

- The Guard Lock walls, along with miter gates 6 and 7, retain the upper pool for the dam. Since this dam facility includes generating assets, it is governed by FERC licensing requirements. These requirements dictate dam safety inspections on a routine basis. Project re-licensing is also typically contingent on capital improvements aimed at environmental mitigation. We recommend that the Commission work with PG&E to define how these potential costly items will be handled.

KPFF assumes that these conditions remain, and the recommendations made in 2018 are still valid.

Additional Items to be Considered in the Future:

Through wall leakage in the Mill Monolith and side walls – This was an item identified in the 2007 report. This did not appear to be a safety or operational issue in 2018. KPFF recommends reassessing this issue as part of any new comprehensive condition assessment of the facility. Cost for mitigating this issue is not included in the 2018 proposed plan and is not included in the updated cost estimate provided in this document.

Operational Assumptions

KPFF assumes the lock will be operated as a mixed commercial, tourist and recreational facility as described in our 2018 assessment report. Key assumptions included:

- Operational year-round for commercial and major tourist operations. Lockages by these users may occur while the facility is or is not staffed.
- The facility will be staffed to support light recreational use either seasonally or year round.
- When dedicated operating staff is not on site, the lock would be operated by employees of commercial/tourist operations. These independent operators would travel with the commercial/tourist vessel, would access the facility via the floating docks, and would be specifically trained in proper lock operation.

Overall, we anticipated that the total number of lockages will be on the order of 1700-2500 annually.

RECOMMISSIONING APPROACH

Per the 2018 needs assessment, we recommended capital improvements to the facility as well as a program of ongoing routine maintenance. These recommendations are adopted as-is for this report. report. Recommendations were aimed at returning the facility to reliable operation as a mixed commercial and recreational facility and then improving and maintaining that operation moving forward. KPFF's recommendations were consistent with those contained in the 2007, 2011 and 2013 reports compiled by the USACE, but were more extensive than the recommendations presented by the Corps in the 2017 Draft Disposition Study.

- Negotiate and oversee transfer of the Locks from the ACOE by 2027
- Further broaden Locks' partnerships
- Secure the rest of the funding needed to match already committed resources ($7.2M) to complete capital upgrades required for modern operation and seismic redundancy
- Manage capital improvements
- Oversee environmental conditions
- Negotiate operating agreements
- Develop a permanent funding plan for operation
- Protect and maintain core National Historic Register values through perpetual preservation agreements and partnerships
- Promote commercial use of the locks through collaboration with economic development entities, tourism and private industry
- Return operational Locks to the community

Willamette Falls Lock Authority is committed to negotiating the transfer of the Locks from the USACE by 2027. This transfer will most likely entail some combination of federal funds along with other state and local funding sources.

Where federal funds are being contributed, the Authority may be faced with choices on how best to proceed. The Authority could require all improvements made with federal funds be completed prior to taking ownership. Alternately the Authority could take ownership as-is, and then make needed improvements using Federal Funds negotiated as part of the transfer agreement.

There are advantages and disadvantages to each approach. Having capital improvements completed prior taking ownership minimizes the Authorities' risk, but will delay ownership transfer. Additionally, this approach likely limits the Authorities' ability to combine state and locally funded improvements with the federally funded capital improvements.

By taking early ownership of the Lock as-is, the Authority has more control over the capital improvement projects and can proceed with all capital improvements simultaneously regardless of funding sources. This has the potential to make more efficient use of the available capital improvement funds.

Performing construction in a facility as old as the Locks is bound to encounter unforeseen conditions, which typically lead to substantial change orders in a public bid environment. The Authority should take this fact into account when negotiating a turn-over strategy with the Corps. The original bid from a

Contractor will not likely be the final contract amount. Managing the unknowns can be challenging and should be planned for with contingency or escrow accounts to manage these costs.

The construction work to be performed is specialized, and should be performed by a qualified Contractor. A phased bidding approach should be considered. KPFF recommends going through a pre-qualification phase where qualified bidders are short listed and then asked to prepare pricing for the actual work in a subsequent phase of bidding. In a Design-Bid-Build type of contract, the bid could be structured so that items that are at greater risk of encountering unknown conditions could ask for additional pricing based on a per quantity basis (such as excavation, drilling of rock anchors, or removal and replacement of structure in kind to provide access to certain areas).

The Authority could investigate contracting the work using a Design-Build approach. The advantage of these types of contracts is that they typically allow the Owner to take on less risk, but usually this is only true if the scope of the work is well defined. Given the fact that the scope of work for this facility is likely to encounter some unknowns, a Design-Build approach may not be the best contracting option for this work.

A third option that could be explored is the use of a GC/CM type of approach. In this case, qualified bidders provide high level bids for a given scope of work that is at a 15-20% level of definition. The winning Contractor is then brought on board during design to help assist the team to define the scope of work given their preferred approach to the Construction. This may be the least risky approach to the Owner in defining and pricing the work at this type of facility.

APPENDIX A – COST ESTIMATE

Willamette Falls Locks
Rough Order of Magnitude Engineer's Estimate to Operate and Maintain the Locks Infrastructure

July 1, 2024

Capital Improvements (Estimated Costs in $2018 - Escalated to 2026-Dollars July 2024(

	Item	Critical Need (Prior to Re-opening of Locks)	Critical Need (2026 $)	Moderate Need (Within Next 5 Years)	Moderate Need (2026 $)	Long-Term Need (Within Next 10 Years)	Long-Term Need (2026 $)	Scope of Work
1	Erosion Repair and Ground Improvements at Lock Chamber 3	$ 249,000	$ 359,000					Repair a 85' long by 6' wide by 10' deep area and a 35' long by 10' wide by 10' deep area based on KPFF's 5/30/18 site visit and 2011 Corps Evaluation Report. This includes removing steel plates and asphalt pavement at the sinkhole locations, excavating the sinkholes to expose the deteriorated timber lagging and lay back the temporary excavation slopes, removing and replacing the deteriorated timber lagging, place a non-woven drainage geotextile fabric, place new backfill, and place new asphalt pavement on the repaired areas.
2	Erosion Repair and Ground Improvements at Gate 4 Monolith (Corps Side)	$ 793,000	$ 1,147,000					Repair a 20' long by 6' wide by 10' deep area based on KPFF's 5/30/18 site visit. This includes removing timber decking at the sinkhole locations, excavating the sinkholes to expose the deteriorated timber lagging and lay back the temporary excavation slopes, removing and replacing the deteriorated timber lagging, place a non-woven drainage geotextile fabric, place new backfill, and place new timber decking on the repaired areas.
3	Control Running Water Via Drainage Trench at Gate 4 (Corps Side)	$ 24,000	$ 35,000					Construct a drainage trench from behind the Miter Gate 4 monolith to the timber faced wall downstream of the miter gate monolith per the 2011 Corps Evaluation Report
4	Hydrographic Survey	$ 94,000	$ 136,000					Recommend a hydrographic survey be conducted to determine level of sedimentation within the locks and whether dredging may be required at this time
5	Reinstall Timber Brace for Wall Lagging, Lock 1 Mill Side	$ 4,000	$ 5,000					Re-install the 12x12 horizontal timber brace on the Mill side of Lock 1. The work necessary is to loosen the anchor rod, lift the timber brace into place, and retighten the anchor rod per the 2011 Corps Evaluation Report
6	Replace Walkway and Walkway Framing Supports	$ 283,000	$ 409,000					Remove and replace the walking surface, replace the missing posts, and recoating the deck at Corps side of Guard Lock and at Gate 2 per the 2011 Corps Evaluation Report.
7	Stabilize Chamber Walls in Select Locations	$ 1,915,000	$ 2,773,000					Install vertical rock anchors at Gate 4 (Corps and Mill side), Gate 5 (Corps and Mill side), Gate 6 (Mill side only), and Gate 7 (Mill side only) per 2011 Corps Evaluation Report, taking into account costs for rig access.
8	Stabilize Gate Monoliths in Select Locations	$ 1,163,000	$ 1,685,000					Install vertical rock anchors at Chamber 2 (three anchors along a 20 ft long portion on Mill side), Chamber 3 (two anchors along a 10 ft long portion on both the Mill side and Corps side), Chamber 4 (the entire length with anchors spaced at 7'-6"), and the Guard Lock (the entire length with anchors spaced at 7'-6"), per the 2011 Corps Evaluation Report, taking into account costs for rig access.
9	Replace Corroded Gudgeon Anchorages	$ 539,000	$ 779,000					Replace all Gudgeon anchors from Gates 2-7. For the anchors that are parallel to the lock, replace in kind. For the anchor rods that are perpendicular to the lock, abandon the existing anchor rod in place, install new rock anchors further back from the gate and install longer tie rods.
10	Operator Anchorage Repair	$ 529,000	$ 765,000					Replace the concrete foundation and anchor rods that hold the operating anchors down at various locations where needed. Two locations were reported in the 2011 Corps Evaluation Report.
11	Replace Pedestrian Draw Bridge over Lock 4	$ 528,000	$ 763,000					Replace draw bridge in kind per KPFF site visit on May 30, 2018
12	Replace Gangway Float at Downstream Approach	$ 195,000	$ 284,000					Replace in kind existing float supporting end of gangway
13	Install new Piles in Concrete Foundation at Downstream Approach	$ 78,000	$ 114,000					Add new drilled in piles into existing concrete foundation that has been undermined by scour
14	Replace Timber Lining in Chamber #3	$ 202,000	$ 361,000					Replace all of existing timber facing lining in lock chamber #3 as it is deteriorated and likely contributing to the erosion seen at the Corps side of this lock
15	Replace all Hydraulic Hoses	$ 57,000	$ 83,000					Replace approximately 200 existing hydraulic hoses with new hydraulic hoses per KPFF site visit and 2011 Corps Evaluation Report. Hydraulic hoses typically have a 5 year expiration date and need to be periodically replaced.
16	Sample Hydraulic Fluid	$ 11,000	$ 18,000					Sample existing hydraulic fluid to confirm fluid quality per KPFF site visit. Verify hydraulic fluid is environmentally safe.
17	Detailed Inspection/Documentation of all Fill/Empty Valves	$ 50,000	$ 74,000					Inspect each gate valve for proper operation per KPFF site visit. Inspection list includes: actuator seals, actuator function, limit switch function, valve seals, control buttons, indicators, wiring, etc.
18	Repairs to Valves (Projected)	$ 553,000	$ 801,000					Potential valve repair work includes: replace broken limit switches, replace valve actuator seals, replace/repair valve perimeter seals, replace/repair valve controllers. This cost includes installation of a coffer dam if needed. Projected repair work is based on 2011 Corps Evaluation Report. Scope includes replacing valve perimeter seals, valve limit switches, & potentially replace whole valves.
19	Lubricate all Systems	$ 29,000	$ 43,000					Relubricate all systems per vendor recommendations per KPFF site visit.
20	Install New Gate & Valve Operating Cylinders at Gate #1	$ 59,000	$ 85,000					Purchase and install two new gate hydraulic operators and eight hydraulic valve actuators per KPFF site visit. Salvage the existing hydraulic cylinders and have them refurbished per KPFF site visit. The design recommendation is replace in kind.
21	Salvage, Rebuild and Store Cylinders from Gate #1	$ 32,000	$ 47,000					Send salvaged hydraulic cylinders, the gate operators as well as the valve operators, from Gate #1 to be rebuilt / refurbished per KPFF site visit. Store these cylinders on site as spares.
22	Remove Debris	$ 36,000	$ 52,000					Clear debris from lock chambers to reduce damage on equipment per 2011 Corps Evaluation Report. Estimate is based on hiring an operator, renting a barge with a backhoe to remove debris, and transporting/disposing of debris.

23	Install Fire Protection Equipment	$ 760,000	$ 1,102,000					Install a firewater system for fire protection of boaters in the locks per 2011 Corps Evaluation Report. The firewater system includes fire pumps, piping, hose stations and hydrants.
24	Inspect / Repair Generator, Install Packaged Load Bank	$ 64,000	$ 93,000					Hire a Cummins representative to do an inspection on the generator and repair as need per 2007 report findings. Install a packaged load cell and coupler for monthly testing of generator.
25	Repair Broken Luminaires	$ 15,000	$ 22,000					Replace two luminaires identified as broken and unrepairable in the 2011 Corps Evaluation Report. Added two luminaires and associated wiring to be replaced as contingency.
26	Inspect / Document of Electrical Distribution System	$ 117,000	$ 169,000					As Built electrical, instrumentation and controls system to have adequate drawings for future trouble shooting of locks per 2007 report findings. Inspect electrical, instrumentation and controls equipment and document deficiencies for repair
27	Repair of Electrical Distribution System	$ 78,000	$ 114,000					Repair/Replace broken conduit, conductors, enclosures and supports as determined during inspection. This estimate was generated based on reviews of photos of electrical equipment and repair recommendations from the 2011 Corps Evaluation Report
28	Maintenance Activities	$ 145,000	$ 212,000					This line item is to account for the maintenance activities to be done before start up that aren't already included in other near term costs
29	Replace Chamber Ladders			$ 43,000	$ 61,000			Remove existing ladders at lock chambers 1 through 4 and the ladder on the Mill. Furnish and install replacement ladders. Per 2011 Corps Evaluation Report
30	Replace Damaged Guardrails (Railing on Mill Side from Gate 1 to Gate 5, and Guard Lock)			$ 96,000	$ 139,000			Replace the wood and metal guardrails near the oil storage building and the Guard Lock. Assume a majority of the railing on the Mill side from Gates 1 to 5 needs to be replaced. Per the 2011 Corps Evaluation Report
31	Install New Hydraulic Power Units			$ 616,000	$ 893,000			Install 14 new hydraulic power units (HPU), 1 for each gate leaf. This scope of work includes demolishing the existing units, demolishing/abandoning both conduit & piping, disposing of oily waste, installing new piping to the gate leaves, installing new HPU's.
32	Replace Bottom Seals			$ 185,000	$ 269,000			Replace in kind bottom seals as needed per 2011 Corps Evaluation Report
33	Replace Lighting System			$ 782,000	$ 1,133,000			Scope of Work includes replacing all exterior luminaires, light poles, switches, junction boxes and rewiring entire lighting system per 2011 Corps Evaluation Report.
34	Replace/Refurbish Control System			$ 1,209,000	$ 1,752,000			Replace control system with upgraded digital controls to allow for future automation if desired per 2011 Corps Evaluation Report.
35	Repair Loss of Masonry at Lowest Course at the Downstream Approach, Mill Side					$ 234,000	$ 341,000	A portion of the downstream approach masonry wall is missing along the bottom length of the wall. Per the 2011 Corps Evaluation Report, mitigation would include replacing the missing portions with reinforced concrete.
	Total Cost Summary	***$ 8,610,000***	***$ 12,530,000***	***$ 2,940,000***	***$ 4,250,000***	***$ 240,000***	***$ 350,000***	

Future Capital Costs (Estimated Costs in $2018)

36	Inspect/Refurbish Gate Leaves					$ 1,215,000	$ 1,760,000	Lock Doors typically have a 25-50 year life and need to be inspected and refurbished. All of the doors were inspected and refurbished in 2009, thus likely the doors will need to be refurbished between 2034-2059. Scope of work includes removing the gates via a barge + crane and transferred to a shop, strip the planks off the gates, sand blast the structure, detailed inspection, weld repair as needed, repaint, install new bottom seals and valve seals, install new bearings, install new quoin block/miter block, transfer the gates back to the site and reinstall the gate leaves via a barge and crane, and adjust the retention diagonals so the gates hang level. Note that it is recommended to keep either Gates #6 & #7, #6 & #5 or #5 & #7 installed at the same time to maintain pool integrity for the hydroelectric plant.
37	Flood Repair Contingency					$ 710,000	$ 1,020,000	After the 1996 flood, repairs were needed to the electrical system. It is referenced in the historical report that it is recommended to have a contingency fund in case another flood event occurs for potential repairs
						$ 1,930,000	***$ 2,780,000***	

Routine Maintenance (Estimated Costs in $2018)

	Item	Annual Maint Costs	Annual Maint Costs (2026 $)	Five Year Maint Costs	Five Year Maint Costs (2026 $)	Scope of Work
1	Inspect Timber Lining and Replace Rotting Pieces as Needed	$ 75,000	$ 108,000			Physically inspect all of the timber lining for any rotten timber boards. Assume that 10% of lining will need to be replaced per year.
2	Inspect Lock Walls and Region behind Lock Walls for Movement	$ 4,000	$ 7,000			
3	Inspect Masonry for Structural Integrity	$ 4,000	$ 7,000			Visually inspect masonry for structural integrity. It is structurally acceptable to have 1 missing block sporadically. Repair is required if two blocks are missing adjacent to each other
4	Remove Debris as Needed	$ 17,000	$ 25,000			As needed; it is estimated this activity will be needed post storms, approximately three times per year. This activity involves hiring a team to utilize a barge and backhoe and float through the lock system to remove debris.
5	Hydraulic Fluid Sampling	$ 16,000	$ 24,000			Environmentally friendly Panalin hydraulic fluid is recommended to be sampled annually per vendor. This means establishing a baseline sample, and sampling each year for fluid for water content, viscosity, particulates and filtering and adding hydraulic fluid as needed. Estimate is based on a lump sum of testing and adding hydraulic fluid.
6	Replace One (1) Set of Gate and Valve Hydraulic Cylinder Operators	$ 60,000	$ 88,000			The intent is to replace a set of hydraulic cylinder operators (Both gate and valve) for a gate each year. For year two of operation, install gate #1's refurbished hydraulic cylinders for Gate #2. Salvage Gate #2's hydraulic cylinder operators and refurbish and store as spares. For year three of operation, install gate #2's refurbished hydraulic cylinders on Gate #3, and so on. Once all of the gates have been done, start the cycle over for Gate #1.
7	Lubricate Systems	$ 29,000	$ 43,000			Relubricate systems annually for increased equipment longevity and performance.
8	Run Generator on Load Bank Monthly	$ 5,000	$ 7,000			This activity will reoccur monthly and run for a minimum of 30 minutes per manufacturer recommendations; Cost reflected is the projected annual cost for this activity
9	Limit Switch Inspection / Repair / Replacement	$ 57,000	$ 83,000			Inspect / repair / and replace limit switches as need for control functionality
10	Hydrographic Survey and Dredging			$ 188,000	$ 255,000	As needed, assume removal of 2 feet of sedimentation in 2 lock chambers every 5 years.
11	Adjust Retention Diagonals on Miter Gate Leaf			$ 30,000	$ 44,000	This activity would allow the gates to level and not attempt to swing open or closed due to gravity. Over time of settling, the gates can get out of level and cause damage on other equipment such as the miter blocks
12	Testing and Correction of Grounding System			$ 32,000	$ 46,000	Test grounding system on a routine basis to verify the electrical system is grounded correctly; repair as needed.
13	Replace all Hydraulic Hoses			$ 48,000	$ 71,000	Hydraulic hoses typically have a 5 year life, replacing hoses every 5 years reduces the potential for leaks of hydraulic fluid.
14	Slide Gate Inspection / J seal & J clamp PM			$ 246,000	$ 358,000	Valve seals have a low design life and will need to be replaced as needed. This estimate assumed half of the valve seals need to be replaced every 5 years to be conservative.
	Total Cost Summary	***$ 270,000***	***$ 400,000***	***$ 550,000***	***$ 780,000***	

Notes:

- A 30% contingency + a 20% engineering, design and permitting contingency is included in each value

kpff 1601 5th Avenue, Suite 1300 Seattle, Washington 98101 p (206) 382-0600	project: Willamette Falls Locks	by: KMB/CMK	sheet no.
	location: West Linn, OR	10/10/2018	
	client: Willamette Falls Locks Authority	Updated:: KF/DWH	job no.
	Critical Need Requirements	7/8/2024	

Opinion of Probable Construction Costs

#	Item	Quantity	Unit	Unit Cost (2018 $)	Cost (2018 $)	Unit Cost (2026 $)	Cost (2026 $)
	Erosion Repair and Ground Improvements at Lock Chamber 3						
1.00	Remove Steel Plates and Asphalt Pavement at Sinkhole Locations (2 Sinkholes)	825	SF	$ 6.00	$ 4,950	$ 9	$ 7,170
1.01	Excavate Sinkholes to Timber Lagging	5	DA	$ 2,500	$ 12,500	$ 3,620	$ 18,110
1.02	Remove and Replace Deteriorated Timber Lagging	1,205	LF	$ 32	$ 37,960	$ 46	$ 54,970
1.03	Furnish & Install Propex Geotextile 401	4,360	SF	$ 1.00	$ 4,360	$ 1	$ 6,320
1.04	Furnish & Install Controlled Density Fill	305	CY	$ 250	$ 76,350	$ 362	$ 110,550
1.05	Furnish & Install Base Course	8	CY	$ 75	$ 580	$ 109	$ 830
1.06	Furnish & Install New Asphalt Paving	10	TON	$ 144	$ 1,440	$ 208	$ 2,090
1.07	Utility repair allowance	1	LS	$ 20,000	$ 20,000	$ 28,961	$ 28,970
	Erosion Repair and Ground Improvements at Lock Chamber 3 Subtotal				***$ 159,000***		***$ 230,000***
	Erosion Repair and Ground Improvements at Gate 4 Monolith (Corps Side)						
2.00	Gate 4 Monolith Repair	1	LS	$ 500,000	$ 500,000	$ 724,020	$ 724,030
2.01	Utility repair allowance	1	LS	$ 7,500	$ 7,500	$ 10,860	$ 10,870
	Erosion Repair and Ground Improvements at Lock Chamber 4 Subtotal				***$ 508,000***		***$ 735,000***
	Control Running Water Via Drainage Trench at Gate 4 (Corps Side)						
3.00	Furnish and Install drainage trench at Gate 4 (Corps side)	1	LS	$ 14,700	$ 14,700	$ 21,286	$ 21,290
	Control Running Water Via Drainage Trench at Gate 4 (Corps Side) Subtotal				***$ 15,000***		***$ 22,000***
	Hydrographic survey						
4.00	Hydrographic survey	1	LS	$ 60,000	$ 60,000	$ 86,882	$ 86,890
	Hydrographic SurveySubtotal				***$ 60,000***		***$ 87,000***
	Reinstall Timber Brace for Wall Lagging, Lock 1 Mill Side						
5.00	Reinstall Timber Brace for Wall Lagging (Lock 1 Mill Side)	1	LS	$ 1,750	$ 1,750	$ 2,534	$ 2,540
	Reinstall Timber Brace for Wall Lagging (Lock 1 Mill Side) Subtotal				***$ 2,000***		***$ 3,000***

kpff
1601 5th Avenue, Suite 1300
Seattle, Washington 98101
p (206) 382-0600

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location: West Linn, OR | 10/10/2018
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Replace Walkway and Walkway Framing Supports

6.00	Replace Walkway Framing Supports (Corps Side of Guard Lock and one at Gate 2)	1	LS	$	26,421	$	26,430	$	38,258	$	38,260
6.01	Remove and Dispose of Existing Timber Waolkways on Corps Side	5,930	LF	$	5	$	29,650	$	7	$	42,940
6.02	Furnish and Install New 3x12 Treated Timber	5,930	LF	$	21	$	124,530	$	30	$	180,330
	Replace Walkway and Walkway Framing Supports (Corps Side of Guard Lock) Subtotal					***$***	***181,000***			***$***	***262,000***

Stabilize Chamber Walls in Select Locations

7.00	Chamber 2 - Mill Side: Rock Anchors	3	EA	$	15,000	$	45,000	$	21,721	$	65,170
7.01	Chamber 2 - Mill Side: Access Contingency	1	LS	$	16,500	$	16,500	$	23,893	$	23,900
7.02	Chamber 3 - Corps and Mill Side: Rock Anchors	4	EA	$	15,000	$	60,000	$	21,721	$	86,890
7.03	Chamber 3 - Corps and Mill Side: Access Contingency	1	LS	$	2,000	$	2,000	$	2,896	$	2,900
7.04	Chamber 4 - Corps Side: Rock Anchors	25	EA	$	15,000	$	375,000	$	21,721	$	543,020
7.05	Chamber 4 - Corps Side: Access Contingency	1	LS	$	40,500	$	40,500	$	58,646	$	58,650
7.06	Guard Lock - Mill Side: Rock Anchors	25	EA	$	15,000	$	375,000	$	21,721	$	543,020
7.07	Guard Lock - Mill Side: Access Contingency	1	LS	$	137,500	$	137,500	$	199,106	$	199,110
	Stabilize Chamber Walls in Select Locations Subtotal					***$***	***1,052,000***			***$***	***1,523,000***
	Additional contingency to account for potential increased quantity of anchors (assume 10 add'l anchors @ $17.5K ea)					***$***	***175,000***			***$***	***254,000***
	Stabilize Chamber Walls in Select Locations Subtotal					***$***	***1,227,000***			***$***	***1,777,000***

Stabilize Gate Monoliths in Select Locations

8.00	Gate 4 - Corps and Mill Side: Rock Anchors	10	EA	$	15,000	$	150,000	$	21,721	$	217,210
8.01	Gate 4 - Corps and Mill Side: Access Contingency	1	LS	$	65,000	$	65,000	$	94,123	$	94,130
8.02	Gate 5 - Corps and Mill Side: Rock Anchors	10	EA	$	15,000	$	150,000	$	21,721	$	217,210
8.03	Gate 5 - Corps and Mill Side: Access Contingency	1	LS	$	55,000	$	55,000	$	79,642	$	79,650
8.04	Gate 6 - Mill Side: Rock Anchors	5	EA	$	15,000	$	75,000	$	21,721	$	108,610
8.05	Gate 6 - Mill Side: Access Contingency	1	LS	$	27,500	$	27,500	$	39,821	$	39,830
8.06	Gate 7 - Mill Side: Rock Anchors	5	EA	$	15,000	$	75,000	$	21,721	$	108,610
8.07	Gate 7 - Mill Side: Access Contingency	1	LS	$	27,500	$	27,500	$	39,821	$	39,830
	Stabilize Gate Monoliths in Select Locations Subtotal					***$***	***625,000***			***$***	***906,000***
	Additional contingency to account for potential increased quantity of anchors (assume 6 add'l anchors @ $20K ea)					***$***	***120,000***			***$***	***174,000***
	Stabilize Gate Monoliths in Select Locations Subtotal					***$***	***745,000***			***$***	***1,080,000***

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Replace Gudgeon Anchors

9.00	(12) Gudgeon Anchors Parallel to Lock: Remove Existing Gudgeon Anchors & Assoc Hardware	3,381	LB	$	1.00	$	3,390	$	1	$	4,900
9.01	Gudgeon Anchors Parallel to Lock: Furnish and Install 8'-9.5" Long 1.75" Dia. Tie Rods (2/Gate for 6 Gates)	865	LB	$	10.00	$	8,650	$	14	$	12,530
9.02	Gudgeon Anchors Parallel to Lock: Furnish and Install Link Plates (4x1x10") (4/Gate For 6 Gates)	273	LB	$	10.00	$	2,730	$	14	$	3,950
9.03	Gudgeon Anchors Parallel to Lock: Furnish & Install Support Plates (4x1.75x12") (4/Gate For 6 Gates)	573	LB	$	10.00	$	5,730	$	14	$	8,300
9.04	Gudgeon Anchors Parallel to Lock: Furnish & Install Bearing Plates (8x1.25x10") (2/Gate For 6 Gates)	341	LB	$	10.00	$	3,410	$	14	$	4,940
9.05	Gudgeon Anchors Parallel to Lock: Furnish & Install Eccen. Support Plates (7x1x9.5") (4/Gate For 6 Gates)	453	LB	$	10.00	$	4,540	$	14	$	6,570
9.06	Gudgeon Anchors Parallel to Lock: Furnish and Install 8'-9.5" Long 1.75" Dia. Anchor Rods (2/Gate for 6 Gates)	865	LB	$	10.00	$	8,650	$	14	$	12,530
9.07	Gudgeon Anchors Parallel to Lock: Furnish and Install 1.75" Dia. Turnbuckle Hex(2/Gate for 6 Gates)	12	EA	$	150	$	1,800	$	217	$	2,610
9.08	(2) Gudgeon Anchors Perpendicular to Lock: Remove Existing Gudgeon Anchors (Gate 4 & 5 on Mill Side)	421	LB	$	1.00	$	430	$	1	$	610
9.09	(2) Gudgeon Anchors Perpendicular to Lock: Furnish & Install 8'-9.5" Long 1.75" Dia Tie Rods (Gate 4 & 5 on Mill Side)	144	LB	$	10.00	$	1,440	$	14	$	2,090
9.10	Gudgeon Anchors Perpendicular to Lock: Furnish & Install Link Plate (4x1x10") (4 Total)	45	LB	$	10.00	$	450	$	14	$	660
9.11	Gudgeon Anchors Perpendicular to Lock: Furnish and Install Support Plate (4x1.75x12") (4 Total)	95	LB	$	10.00	$	950	$	14	$	1,380
9.12	Gudgeon Anchors Perpendicular to Lock: Furnish & Install Bearing Plates (8x1.25x10") (2 Total)	57	LB	$	10.00	$	570	$	14	$	830
9.13	Gudgeon Anchors Perpendicular to Lock: Furnish and Install Eccen. Support Plate (7x1x9.5") (4 Total)	76	LB	$	10.00	$	760	$	14	$	1,110
9.14	Gudgeon Anchors Perpendicular to Lock: Furnish and Install DWYIDAG Anchor Rod (2 Total)	2	EA	$	15,000.00	$	30,000	$	21,721	$	43,450
9.15	Gudgeon Anchors Perpendicular to Lock: Furnish & Install 1.75" Dia Turnbuckle Hex (2 Total)	2	EA	$	150.00	$	300	$	217	$	440
9.16	(10) Gudgeon Anchors Perpendicular to Lock: Abandon Existing Anchor Rods: Remove Rest of Connection	2,169	LB	$	1.00	$	2,170	$	1	$	3,150
9.17	Gudgeon Anchors Perpendicular to Lock: Furnish and Install 9'-9.5" Long 1.75" Dia. Tie Rod (2/Gate for 5 Gates)	803	LB	$	10.00	$	8,030	$	14	$	11,630
9.18	Gudgeon Anchors Perpendicular to Lock: Furnish and Install Link Plate (4x1x10") (4/Gate For 5 Gates)	227	LB	$	10	$	2,270	$	14	$	3,290
9.19	Gudgeon Anchors Perpendicular to Lock: Furnish & Install Support Plate (4x1.75x12") (4/Gate For 5 Gates)	477	LB	$	10	$	4,770	$	14	$	6,910
9.20	Gudgeon Anchors Perpendicular to Lock: Furnish & Install Bearing Plate (8x1.25x10") (2/Gate For 5 Gates)	284	LB	$	10	$	2,840	$	14	$	4,120
9.21	Gudgeon Anchors Perpendicular to Lock: Furnish & Install Eccen. Support Plate (7x1x9.5") (4/Gate For 5 Gates)	378	LB	$	10	$	3,780	$	14	$	5,480
9.22	Gudgeon Anchors Perpendicular to Lock: Furnish & Install DWYIDAG Anchor Rod (2/Gate for 5 Gates)	10	EA	$	15,000	$	150,000	$	21,721	$	217,210
9.23	Gudgeon Anchors Perpendicular to Lock: Funish and Install 1.75" Dia. Turnbuckle Hex(2/Gate for 5 Gates)	10	EA	$	150	$	1,500	$	217	$	2,180
9.24	Remove existg and Form and Pour new concrete trenches at (12) locations (anchors perpendicular to lock)	9	CY	$	2,000	$	18,000	$	2,896	$	26,070
9.25	Trench plates over new concrete trenches at (12) locations	10	EA	$	500	$	5,000	$	724	$	7,250
9.26	Access Contingency: Gate 2	1	LS	$	13,000	$	13,000	$	18,825	$	18,830
9.27	Access Contingency: Gate 3	1	LS	$	6,000	$	6,000	$	8,688	$	8,690
9.28	Access Contingency: Gate 4	1	LS	$	13,000	$	13,000	$	18,825	$	18,830
9.29	Access Contingency: Gate 5	1	LS	$	11,000	$	11,000	$	15,928	$	15,930
9.30	Access Contingency: Gate 6	1	LS	$	18,000	$	18,000	$	26,065	$	26,070
9.31	Access Contingency: Gate 7	1	LS	$	11,000	$	11,000	$	15,928	$	15,930
	Replace Gudgeon Anchors Subtotal					***$***	***345,000***			***$***	***499,000***

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Operator Anchorage Repair

10.00	Demolish and Remove Existing Concrete Base (3.5'x2'x3.5' Triangular Pyramid + 3.5' Cube) for 6 Locations	13	CY	$	500	$ 6,500	$ 724	$ 9,420
10.01	Remove Existing Anchors	92	LB	$	1	$ 100	$ 1	$ 140
10.02	Pour Concrete Base (3.5'x2'x3.5' Triangular Pyramid + 3.5' Cube)	13	CY	$	1,250	$ 16,250	$ 1,810	$ 23,540
10.03	Furnish 3/4" dia anchor rods (60' long ea)	360	LF	$	5	$ 1,800	$ 7	$ 2,610
10.04	Drill (4) 13' long 4" Dia. Holes at 6 Different Locations	312	LF	$	150	$ 46,800	$ 217	$ 67,770
10.05	Primary Grout	12	CY	$	1,000	$ 11,560	$ 1,448	$ 16,740
10.06	Access Contingency	6	LS	$	12,500	$ 75,000	$ 18,101	$ 108,610
10.07	Proof Testing of Anchor	24	EA	$	7,500	$ 180,000	$ 10,860	$ 260,650
	Operator Anchorage Repair Subtotal					***$ 339,000***		***$ 490,000***

Replace Pedestrian Draw Bridge over Lock 4

11.00	Replace Pedestrian Draw Bridge Over Lock 4 (Assume 10' Width x 45' Length)	450	SF	$	750	$ 337,500	$ 1,086	$ 488,720
	Pedestrian Draw Bridge Over Lock 4 Subtotal					***$ 338,000***		***$ 489,000***

Replace Gangway Float at Downstream Approach

12.00	Replace Gangway Float at Downstream Approach	250	SF	$	500	$ 125,000	$ 724	$ 181,010
	Replace Gangway Float at Downstream Approach Subtotal					***$ 125,000***		***$ 182,000***

Install new Piles in Concrete Foundation at Downstream Approach

13.00	Install (2) New Piles in Existing Undermined Concrete Foundation	2	EA	$	25,000	$ 50,000	$ 36,201	$ 72,410
	Install new Piles in Concrete Foundation at Downstream Approach Subtotal					***$ 50,000***		***$ 73,000***

Replace Timber Lining in Chamber #3

14.00	Remove and Dispose of Existing Timber Lining in Chamber #3	6,114	LF	$	5	$ 30,570	$ 7	$ 44,270
14.01	Furnish and Install new 3x12 Treated Timber	6,114	LF	$	21	$ 128,400	$ 30	$ 185,920
	Replace Timber Lining in Chamber #3 Subtotal					***$ 129,000***		***$ 231,000***

Replace all Hydraulic Hoses

15.00	Inspect & document hoses, collect proper size and data for ordering	40	HR	$	150	$ 6,000	$ 217	$ 8,690
15.01	Replace 1/2" valve operator hoses, 1/2" ID, 3'L, 1000# rated - 3000# rated	56	EA	$	100	$ 5,600	$ 145	$ 8,110
15.02	Replace 144 hoses with 3/4" ID, 3'L, 1000# rated - 3000# rated	144	EA	$	130	$ 18,720	$ 188	$ 27,110
15.03	man hours to replace hoses	56	HR	$	110	$ 6,160	$ 159	$ 8,920
	Replace Hydraulic Hoses Subtotal					***$ 36,500***		***$ 53,000***

Sample Hydraulic Fluid

16.00	Sample Hydraulic Fluid / Replace Hydraulic Fluid	7	EA	$	1,000	$ 7,000	$ 1,448	$ 10,140
	Hydraulic Fluid Subtotal					***$ 7,000***		***$ 11,000***

Detailed Inspection/Documentation of all Fill/Empty Valves

17.00	Manhours for inspection and operation of each valve	200	HR	$	110	$ 22,000	$ 159	$ 31,860
17.01	Inspection of Gate 1 & Gate 7 slide gate valves	2	DY	$	5,000	$ 10,000	$ 7,240	$ 14,490
	Detailed inspection/documentation of all fill/empty valves & valve operators Subtotal					***$ 32,000***		***$ 47,000***

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Repairs to Valves (Projected)

18.00	Valve actuator cylinder refurbish	10	EA	$ 1,850	$ 18,500	$ 2,679	$ 26,790
18.01	man hours to fix valves	640	HR	$ 110	$ 70,400	$ 159	$ 101,950
18.02	Total Valve Replacement	7	EA	$ 10,000	$ 70,000	$ 14,480	$ 101,370
18.03	Total Valve Replacement labor - diver	2	DY	$ 5,000	$ 10,000	$ 7,240	$ 14,490
18.04	Dewatering	2	LS	$ 35,000	$ 70,000	$ 50,681	$ 101,370
18.05	man hours to replace valves	320	HR	$ 110	$ 35,200	$ 159	$ 50,980
	gate 7 valve seal and perimeter seal				$ -	$ -	$ -
18.06	gate 7 perimeter seal material	8	EA	$ 1,000	$ 8,000	$ 1,448	$ 11,590
18.07	gate 7 valve seal repair - diver	4	DY	$ 5,000	$ 20,000	$ 7,240	$ 28,970
18.08	Limit switch Repair	2	LS	$ 26,000	$ 52,000	$ 37,649	$ 75,300
	Repairs to valves (estimated) Subtotal				***$ 354,100***		***$ 513,000***

Lubricate all Systems

19.00	Lubricant	1	LS	$ 500	$ 500	$ 724	$ 730
19.01	Manhours to complete lubrication	160	HR	$ 110	$ 17,600	$ 159	$ 25,490
	Lubricate all systems Subtotal				***$ 18,100***		***$ 27,000***

Install New Gate & Valve Operating Cylinders at Gate #1

20.00	Valve actuator cylinders	8	EA	$ 2,000	$ 16,000	$ 2,896	$ 23,170
20.01	gate operator cylinder	2	EA	$ 4,000	$ 8,000	$ 5,792	$ 11,590
20.02	Manhours to uninstall / install	120	HR	$ 110	$ 13,200	$ 159	$ 19,120
	Install Gate & Valve Operating Cylinders at Gate #1 Subtotal				***$ 37,200***		***$ 54,000***

Salvage, Rebuild and Store Cylinders from Gate #1

21.00	Gate operator cylinder rebuild + transportation	2	EA	$ 1,850	$ 3,700	$ 2,679	$ 5,360
21.01	Slide gate operator cylinder rebuild + transportation	8	EA	$ 2,100	$ 16,800	$ 3,041	$ 24,330
	Salvage, Rebuild and Store Cylinders from Gate #1 Subtotal				***$ 20,500***		***$ 30,000***

Remove Debris

22.00	Mobilize/Demobilize	1	LS	$ 5,214	$ 5,220	$ 7,550	$ 7,560
22.01	barge rental	10	DA	$ 1,034	$ 10,340	$ 1,497	$ 14,970
22.02	backhoe rental + operator	10	DA	$ 514	$ 5,140	$ 744	$ 7,440
22.03	Waste disposal/delivery	2,000	EA	$ 0.95	$ 1,900	$ 1	$ 2,760
	debris removal Subtotal				***$ 22,600***		***$ 33,000***

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Install Fire Protection Equipment

23.00	Install 6" pipe with supports	3,105	LF	$ 100	$ 310,500	$ 145	$ 449,620
23.01	Install branch, valve and hose reel every 100'	20	EA	$ 2,000	$ 40,000	$ 2,896	$ 57,930
23.02	Pump Contingency - in case city water is not enough pressure	2	EA	$ 68,250	$ 136,500	$ 98,829	$ 197,660
	Fire protection equipment Subtotal				***$ 487,000***		***$ 706,000***

Inspect / Repair Generator, Install Packaged Load Bank

24.00	Generator inspection and full service	5	HR	$ 150	$ 950	$ 217	$ 1,090
24.01	New Generator	1	EA	$ 39,910	$ 39,910	$ 57,791	$ 57,800
	Inspect Generator, repair as needed and install a packaged load cell Subtotal				***$ 40,900***		***$ 59,000***

Repair Broken Luminaires

25.00	LED Luminaires	4	EA	$ 1,723	$ 6,890	$ 2,494	$ 9,980
25.01	Demolition Wiring - within poles only	110	LF	$ 3	$ 290	$ 4	$ 410
25.02	Installation Wiring - within poles only	110	LF	$ 8	$ 830	$ 11	$ 1,210
25.03	Switch Estimation	4	EA	$ 286	$ 1,150	$ 414	$ 1,660
25.04	Junction Box Estimation	4	EA	$ 48	$ 200	$ 70	$ 280
	Lighting System Subtotal				***$ 9,400***		***$ 14,000***

Inspect / Document of Electrical Distribution System

26.00	Inspection - electrician, electrical engineer	240	HR	$ 150	$ 36,000	$ 217	$ 52,130
26.01	drafting hours	320	HR	$ 120	$ 38,400	$ 174	$ 55,610
	Inspection/Documentation of Electrical/Power System Subtotal				***$ 74,400***		***$ 108,000***

Repair of Electrical Distribution System

27.00	Contingency Estimate	1	LS	$ 50,000	$ 50,000	$ 72,402	$ 72,410
	Electrical distribution system- conduit, conductors, enclosures, and supports Subtotal				***$ 50,000***		***$ 73,000***

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Assumptions:

1.02 Assume 3x12 treated timber members
1.07 Assumes existing cabling can be reused and is pulled through new conduit
7.00 Price includes materials and installation (typical for all of task)
7.01 Access contingency costs account for how difficult it will be to get to the location and install the anchors
9.00 Remove and Replace in Kind on Gates 2 -7 (6 total), assume removing same weight as New Anchor Components
9.02 Assume 0.284 lb/ft^3 steel density to find total weight of steel (for all LB Quantities in task)
9.06 Assume length of embedded anchor rod is same as tie rod
10.00 Assumed amount of concrete based on As Builts of 1968

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	Moderate Need - 5 Year Requirements	7/8/2024	

Opinion of Probable Construction Costs

#	Item	Quantity	Unit	Unit Cost (2018 $)	Cost (2018 $)	Unit Cost (2026 $)	Cost (2026 $)
	Replace Chamber Ladders						
29.00	Replace Chamber Ladders	1	LS	$ 26,400	$ 26,400	$ 38,228	$ 38,230
	Replace Chamber Ladders Subtotal				***$ 27,000***		***$ 39,000***
	Replace Damaged Guardrails (Railing on Mill Side from Gate 1 to Gate 5, and Guard Lock)						
30.00	Removal of Existing Guardrail (Railing on on Mill Side from Gate 1 to Gate 5, and Guard Lock)	1,051	LF	$ 8.00	$ 8,410	$ 12	$ 12,180
30.01	Chamber 1 (Chamber Length: 210' on One Side of Channel)	210	LF	$ 50	$ 10,500	$ 72	$ 15,210
30.02	Chamber 2 (Chamber Length: 210' on One Side of Channel)	210	LF	$ 50	$ 10,500	$ 72	$ 15,210
30.03	Chamber 3 (Chamber Length: 210' on One Side of Channel)	210	LF	$ 50	$ 10,500	$ 72	$ 15,210
30.04	Chamber 4 (Chamber Length: 210' on One Side of Channel)	210	LF	$ 50	$ 10,500	$ 72	$ 15,210
30.05	Guard Lock (Chamber Length: 211' on One Side of Channel)	211	LF	$ 50	$ 10,550	$ 72	$ 15,280
	Guard Rails Subtotal				***$ 61,000***		***$ 89,000***
	Install New Hydraulic Power Units						
31.00	New HPU Cost	14	EA	$ 14,500	$ 203,000	$ 20,997	$ 293,960
31.01	Install/Demo Costs	14	LS	$ 5,000	$ 70,000	$ 7,240	$ 101,370
31.02	Pipe Replacement - 1"	2,646	LF	$ 26	$ 67,940	$ 37	$ 98,380
31.03	pipe demolition - 1"	2,646	LF	$ 3	$ 8,470	$ 5	$ 12,270
31.04	valves - globe- 1"	140	EA	$ 322	$ 45,050	$ 466	$ 65,230
	Install new Hydraulic Power Units Subtotal				***$ 394,500***		***$ 572,000***
	Replace Bottom Seals						
32.00	Seal material cost	14	EA	$ 750	$ 10,500	$ 1,086	$ 15,210
32.01	Install manhour costs - Diver gate 1 & 7	4	DY	$ 5,000	$ 20,000	$ 7,240	$ 28,970
32.02	Dewatering - lock chamber 2, 3, 4, canal, guard lock	2	LS	$ 35,000	$ 70,000	$ 50,681	$ 101,370
32.03	Manhours for seal install - gate 2, 3, 4, 5, 6	160	HR	$ 110	$ 17,600	$ 159	$ 25,490
	Bottom Seals Subtotal				***$ 118,100***		***$ 172,000***

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Replace Lighting System

33.00	Replace Light Poles - 30' Aluminium	21	EA	$ 3,575	$ 75,080	$ 5,177	$ 108,720
33.01	Bracket Arms - 30' high	21	EA	$ 2,990	$ 62,790	$ 4,330	$ 90,930
33.02	LED Luminaires	19	EA	$ 1,723	$ 32,730	$ 2,494	$ 47,400
33.03	1000W flood lights replacement with LED's	4	EA	$ 2,795	$ 11,180	$ 4,047	$ 16,190
33.04	Demolition Wiring - within poles only	1,275	LF	$ 3	$ 3,290	$ 4	$ 4,760
33.05	Demolition poles	21	EA	$ 73	$ 1,550	$ 106	$ 2,240
33.06	Installation Wiring - within poles only	1,275	LF	$ 8	$ 9,620	$ 11	$ 13,930
33.07	Switch Estimation	120	EA	$ 286	$ 34,320	$ 414	$ 49,700
33.08	Junction Box Estimation	46	EA	$ 48	$ 2,220	$ 70	$ 3,210
33.09	20% Contingency for associated work & congested area work	1	LS	$ 42,736.00	$ 42,740	$ 61,883	$ 61,890
33.10	Guardlock wiring Replacement				$ -	$ -	$ -
33.11	Wiring installed overhead; #8 + overhead multiplier - corp side	1,236	LF	$ 11	$ 13,050	$ 15	$ 18,900
33.12	New conduit - mill side	67	LF	$ 16	$ 1,080	$ 23	$ 1,560
33.13	New wiring - mill side	379	LF	$ 6	$ 2,250	$ 9	$ 3,250
33.14	Wiring Demolition	1,615	LF	$ 3	$ 4,160	$ 4	$ 6,020
33.15	Conduit Demolition	100	LF	$ 3	$ 280	$ 4	$ 400
33.20	Wiring Replacement - Gate 1-5				$ -	$ -	$ -
33.21	Demolition wiring	19,815	LF	$ 3	$ 51,010	$ 4	$ 73,860
33.22	Demolition conduit	994	LF	$ 3	$ 2,690	$ 4	$ 3,900
33.23	Install 3/4" Conduit - 20% contingency for repair	419	LF	$ 13	$ 5,640	$ 19	$ 8,170
33.24	Install 1" Conduit - 20% contingency for repair	207	LF	$ 16	$ 3,330	$ 23	$ 4,820
33.25	Install 1.25" Conduit - 20% contingency for repair	368	LF	$ 19	$ 6,890	$ 27	$ 9,980
33.26	Install #8 wiring	11,845	LF	$ 8	$ 89,320	$ 11	$ 129,330
33.27	Install #10 wiring	5,680	LF	$ 6	$ 33,600	$ 9	$ 48,660
33.28	Install #12 wiring	2,290	LF	$ 5	$ 12,360	$ 8	$ 17,890
	Lighting System Subtotal				***$ 501,200***		***$ 726,000***

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project: Willamette Falls Locks		by: KMB/CMK	sheet no.
location: West Linn, OR		10/10/2018	
client: Willamette Falls Locks Authority		Updated:: KF/DWH	job no.
Moderate Need - 5 Year Requirements		7/8/2024	

Replace/Refurbish Control System

34.00	Install new 2" conduit	5,500	LF	$	26	$	141,570	$	37	$	205,000
34.01	Install new 3/4" conduit	5,500	LF	$	13	$	74,010	$	19	$	107,160
34.02	Install new fiber optic cable - 4x 3/4" conduit run	22,000	LF	$	1	$	24,510	$	2	$	35,490
34.03	Install new wire #8, 3 conduit - 5x 2" run	33,000	LF	$	8	$	248,820	$	11	$	360,310
	Install of conduit through 2 lock chambers:					$	-	$	-	$	-
34.04	Dewatering	2	LS	$	35,000	$	70,000	$	50,681	$	101,370
34.05	Concrete - saw cut	240	LF	$	8	$	1,920	$	12	$	2,790
34.06	Waste Management - Concrete / oily waste	6	TN	$	100	$	610	$	145	$	880
34.07	install new concrete/re-enforced	3	CY	$	850	$	2,550	$	1,231	$	3,700
34.08	20x20 Enclosure NEMA 4X + install	4	EA	$	1,000	$	4,000	$	1,448	$	5,800
34.09	10x10 control/power Enclosure NEMA 4x + install	28	EA	$	500	$	14,000	$	724	$	20,280
34.10	HMI enclosure NEMA 4x + install	7	EA	$	250	$	1,750	$	362	$	2,540
34.11	Consoles for control houses + install	2	EA	$	2,500	$	5,000	$	3,620	$	7,250
34.12	Remote I/O's	15	EA	$	400	$	6,000	$	579	$	8,690
34.13	HMI screens + install	9	EA	$	900	$	8,100	$	1,303	$	11,730
34.14	PLC + install	1	EA	$	10,000	$	10,000	$	14,480	$	14,490
34.15	PLC programming	1	LS	$	75,000	$	75,000	$	108,603	$	108,610
34.16	Commissioning / start up	1	LS	$	75,000	$	75,000	$	108,603	$	108,610
34.17	Lock Chamber ultrasonic level sensors + backup, Lock chambers 1, 2, 3, 4, canal, guard lock	12	EA	$	1,000	$	12,000	$	1,448	$	17,380
34.18						$	-	$	-	$	-
34.19						$	-	$	-	$	-
	Control System Replacement Subtotal					***$***	***774,840***			***$***	***1,123,000***

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project: Willamette Falls Locks	by: KMB/CMK	sheet no.
location: West Linn, OR	10/10/2018	
client: Willamette Falls Locks Authority	Updated:: KF/DWH	job no.
Long Term Requirements	7/8/2024	

Opinion of Probable Construction Costs

#	Item	Quantity	Unit	Unit Cost (2018 $)	Cost (2018 $)	Unit Cost (2026 $)	Cost (2026 $)
	Repair Loss of Masonry at Lowest Course at the Downstream Approach, Mill Side						
35.00	Replace Masonry at Lowest Course with Reinforced Concrete	1	LS	$ 150,000	$ 150,000	$ 217,206	$ 217,210
	Loss of Masonry at Lowest Course at Downstream Approach, Mill Side Subtotal				***$ 150,000***		***$ 218,000***

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client: Willamette Falls Locks Authority		Updated:: KF/DWH	job no.
Future Capital Costs		7/8/2024	

Opinion of Probable Construction Costs

#	Item	Quantity	Unit	Unit Cost (2018 $)	Cost (2018 $)	Unit Cost (2026 $)	Cost (2026 $)
	Inspect/Refurbish Gate Leaves						
36.00	Cost from 2009 Inspection and repair work in $2018	1	LS	$ 778,438	$ 778,440	$ 1,127,209	$ 1,127,210
	Refurbish Doors Subtotal				***$ 778,500***		***$ 1,128,000***
	Flood Repair Contingency						
37.00	Repair contingency from 1996 flood repair work in $2018	1	LS	$ 449,960	$ 449,960	$ 651,560	$ 651,570
	Flood Contingency Subtotal				***$ 450,000***		***$ 652,000***

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	location: West Linn, OR	10/10/2018	
	client: Willamette Falls Locks Authority	Updated:: KF/DWH	job no.
	Routine Maintenance	7/8/2024	

Opinion of Probable Construction Costs

#	Item	Quantity	Unit	Unit Cost (2018 $)	Cost (2018 $)	Unit Cost (2026 $)	Cost (2026 $)
	Inspect Timber Lining and Replace Rotting Pieces as Needed						
1.00	2 Inspectors for 40 Hours (1 Week for all Chambers)	80	HR	$ 75	$ 6,000	$ 109	$ 8,690
1.01	Boat for 5 days	5	DY	$ 300	$ 1,500	$ 434	$ 2,180
1.02	Replacement of 5% of Timber Lining Per Year	1,885	LF	$ 21	$ 39,580	$ 30	$ 57,320
	Inspect Timber Lining and Replace Rotting Pieces as Needed Subtotal				***$ 48,000***		***$ 69,000***
	Inspect Lock Walls and Region behind Lock Walls for Movement						
2.00	Inspect lock walls and region behind lock walls for movement	1	LS	$ 2,100	$ 2,100	$ 3,041	$ 3,050
	Inspection Subtotal				***$ 2,100***		***$ 4,000***
	Inspect Masonry for Structural Integrity						
3.00	Inspect masonry for 2 missing rocks adjacent to each other to maintain structural integrity	1	LS	$ 2,100	$ 2,100	$ 3,041	$ 3,050
	Inspection Subtotal				***$ 2,100***		***$ 4,000***
	Remove Debris as Needed						
4.00	barge rental	5	DA	$ 795	$ 3,980	$ 1,151	$ 5,760
4.01	backhoe rental + operator	5	DA	$ 395	$ 1,980	$ 572	$ 2,860
4.02	Waste disposal/delivery	1	EA	$ 2,000	$ 2,000	$ 2,896	$ 2,900
4.03	mobe/demobe	1	EA	$ 2,500	$ 2,500	$ 3,620	$ 3,630
	Remove debris as needed Subtotal				***$ 10,500***		***$ 16,000***
	Hydraulic Fluid Sampling						
5.00	Fluid Sampling and Filtering	1	LS	$ 10,000	$ 10,000	$ 14,480	$ 14,490
	Replace Hydraulic Hoses Subtotal				***$ 10,000***		***$ 15,000***

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Routine Maintenance	7/8/2024

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Replace One (1) Set of Gate and Valve Hydraulic Cylinder Operators

6.00	Valve actuator cylinders	8	EA	$ 2,000	$ 16,000	$ 2,896	$ 23,170
6.01	gate operator cylinder	2	EA	$ 2,250	$ 4,500	$ 3,258	$ 6,520
6.02	Manhours to uninstall / install	160	HT	$ 110	$ 17,600	$ 159	$ 25,490
	Replace one (1) set of gate and valve hydraulic cylinder operators				***$ 38,100***		***$ 56,000***

Lubricate Systems

7.00	Lubricant	1	LS	$ 500	$ 500	$ 724	$ 730
7.01	Manhours to complete lubrication	160	HR	$ 110	$ 17,600	$ 159	$ 25,490
	Lubricate all systems Subtotal				***$ 18,100***		***$ 27,000***

Run Generator on Load Bank Monthly

8.00	Operator Time	24	HR	$ 110	$ 2,640	$ 159	$ 3,830
8.01	Diesel fuel	24	GA	$ 4	$ 100	$ 6	$ 140
	Run generator on load cell for at least 30 minutes Subtotal				***$ 2,800***		***$ 4,000***

Limit Switch Inspection / Repair / Replacement

9.00	Limit Switch Inspection	40	HR	$ 110	$ 4,400	$ 159	$ 6,380
9.01	Replace gate limit switches	14	EA	$ 1,000	$ 14,000	$ 1,448	$ 20,280
9.02	Manhours to complete repairs/replacements	160	HR	$ 110	$ 17,600	$ 159	$ 25,490
	Limit Switch Subtotal				***$ 36,000***		***$ 53,000***

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	Routine Maintenance	7/8/2024	

Hydrographic Survey and Dredging

10.00	Mobilization and Demobilization for Dredging Only	1	LS	$	10,000	$	10,000	$	14,480	$	14,490
10.01	Hydrographic Survey (every 5 years)	1	LS	$	60,000	$	60,000	$	86,882	$	86,890
10.02	Downstream Approach (Chamber Size: 130' x 45', Dredge Depth: 4')	-	CY	$	30	$	-	$	43	$	-
10.03	Chamber 1 (Chamber Size: 210' x 45', Dredge Depth: 4')	700	CY	$	30	$	21,000	$	43	$	30,410
10.04	Chamber 2 (Chamber Size: 210' x 45', Dredge Depth: 4')	700	CY	$	30	$	21,000	$	43	$	30,410
10.05	Chamber 3 (Chamber Size: 210' x 45', Dredge Depth: 4')	-	CY	$	30	$	-	$	43	$	-
10.06	Chamber 4 (Chamber Size: 210' x 45', Dredge Depth: 4')	-	CY	$	30	$	-	$	43	$	-
10.07	Canal Basin (Chamber Size: 1272' x 45', Dredge Size: 4')	-	CY	$	30	$	-	$	43	$	-
10.08	Guard Lock (Chamber Size: 211' x 42'-5 7/16", Dredge Depth: 4')	-	CY	$	30	$	-	$	43	$	-
	Hydrographic Survey / Dredging Subtotal	-				***$***	***120,000***			***$***	***163,000***

Adjust Retention Diagonals on Miter Gate Leaf

11.00	barge rental	5	DA	$	795	$	3,980	$	1,151	$	5,760
11.01	backhoe rental + operator	5	DA	$	395	$	1,980	$	572	$	2,860
11.02	Manhours to complete task	120	HR	$	110	$	13,200	$	159	$	19,120
11.03						$	-	$	-	$	-
	Adjust retention diagonals Subtotal					***$***	***19,200***			***$***	***28,000***

Testing and Correction of Grounding System

12.00	Electrician time and Materials	1	LS	$	20,000	$	20,000	$	28,961	$	28,970
	Testing and Correction of grounding system Subtotal					***$***	***20,000***			***$***	***29,000***

Replace all Hydraulic Hoses

13.00	Replace 1/2" valve operator hoses, 1/2" ID, 3'L, 3000# rated	56	EA	$	100	$	5,600	$	145	$	8,110
13.01	Replace 144 hoses with 3/4" ID, 3'L, 3000# rated	144	EA	$	130	$	18,720	$	188	$	27,110
13.02	man hours to replace hoses	56	HR	$	110	$	6,160	$	159	$	8,920
	Replace all hydraulic hoses Subtotal					***$***	***30,500***			***$***	***45,000***

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Slide Gate Inspection / J seal & J clamp PM

14.00	J seal and J clamp material costs	28	EA	$	1,000	$	28,000	$	1,448	$	40,550
14.01	Demolition / Installation costs - diver gate 1/7	4	DY	$	5,000	$	20,000	$	7,240	$	28,970
14.02	Dewatering - for repairs for valves on gates 2/3/4/5/6	2	LS	$	35,000	$	70,000	$	50,681	$	101,370
14.03	Manhours for repairs on gates 2/3/4/5/6	320	HR	$	110	$	35,200	$	159	$	50,980
14.04	Inspection Costs	40	HR	$	110	$	4,400	$	159	$	6,380
	J seal & J clamp PM Subtotal					***$***	***157,600***			***$***	***229,000***

Assumptions:

1.02 Total price is 3x the cost of a 3"x12" to account for installation and delivery

	Cost Accrued	Raw Estimated Costs ($2018)	Annualized Costs ($2018)	Annualized Costs with Contengancy ($2018)	Raw Estimated Costs ($2026)	Annualized Costs ($2026)	Annualized Costs with Contingency ($2026)
Annual Maintenance Costs	1	$ 168,000.00	$ 168,000.00	$ 262,080.00	$ 248,000	$ 248,000	$ 386,880
Five Year Maintence Items	5	$ 348,000.00	$ 69,600.00	$ 108,576.00	$ 494,000	$ 98,800	$ 154,128
Gate Inspection/Repair	25	$ 778,500.00	$ 31,140.00	$ 48,578.40	$ 1,128,000	$ 45,120	$ 70,387
Flood Repairs	30	$ 450,000.00	$ 15,000.00	$ 23,400.00	$ 652,000	$ 21,733	$ 33,904
				$ 443,000.00			***$ 646,000***