US Army Corps of Engineers ®
Portland District

Technical Assistance Memo

Date: June 12, 2017
Project: Long Tom River Channel Modifications
Subject: Monroe Drop Structure
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Purpose

On April 28, 2017 the City of Monroe sent a letter to the Portland District requesting information on the Monroe drop structure through the Technical Assistance FPMS program. The City of Monroe specifically requested assistance in determining the flood risk and consequences of a possible failure of a constructed feature appurtenant to the Corps-owned Monroe drop structure located on the Long Tom River in Benton County, Oregon. The April letter requested information to the five following concerns:

1. Unregulated flow <from a mill race failure> could result in downstream flooding as a pool above the Monroe Drop Structure de-waters.
2. The unregulated flow event could increase the risk for serious bank erosion downstream.
3. Changes in permanent water level (backwatering effect) could liberate upstream sediment resulting in significant shoaling that could lead to the river changing course or damage to Corps constructed embankments.
4. Changes in permanent water level upstream could result in the intake for the City of Monroe's water intake being perched.
5. Changes in sediment transport could create water quality concerns for Monroe drinking water and fish and wildlife in the area.

Background

As noted in the letter from the City of Monroe, the Corps modified the Long Tom River in the 1940s as part of the Fern Ridge Reservoir Project to achieve flood reduction of riverside properties. In addition to significant channel straightening and armoring, the Corps built three grade control structures to stabilize the river. The downstream structure in the City of Monroe was enlarged from its original function serving as a millrace intake in the 1940s improvements. The Corps currently owns the weir structure on the east side of the channel; the fish ladder and headrace are privately owned.

Methods

The Corps has an existing hydraulic model of the Long Tom River developed in 2014 in an effort to investigate the channel capacity of the Long Tom River. Using the 2014 model, the Corps investigated the potential failure of the Monroe Drop Structure. The failure analysis used two hydraulic events in the evaluation, January 2006 and July 2015. The first hydraulic event on January 2006 represented high flows, resulting in flood levels peaking at about 8,000 cubic feet per second (cfs) at Monroe, OR. The second event on July 2015 was a drought year and represented low flows with releases from Fern Ridge

Dam between 45 and 60 cfs and the minimum flow at Monroe falling to about 25 cfs. Irrigation rights pulling from the river between Fern Ridge and Monroe reduced the flow rate between the two points.

In the hydraulic models, two scenarios were evaluated, one with the existing conditions of the drop structure and one representing flashboard failure. The analysis used only readily available information and models. No additional survey was acquired for this study. As-built drawings and recent photographs were used to estimate the hydraulic structures' geometries.

Results

In general, the largest differences between the existing conditions and failure scenarios exist in the July 2015 model runs. This is due to the large difference in flow area between the weir and the headrace. The headrace is only about 8 feet wide while the weir is 134 feet wide. The failed flashboards would absorb a much larger percentage of the total flow area during lower flow (up to the total flow of the river) than it does during the flood. Much more water is flowing through the river during high water and most of it goes over the weir.

Below are specific discussions to address concerns from the City of Monroe letter:

1. Unregulated flow could result in downstream flooding as the pool above the Monroe Drop Structure de-waters.

Outside of some truly unique circumstances, flooding downstream of the structure due to a flashboard failure is unlikely. For the 2015 simulation the computed water surface downstream of the drop structure is 2.5 feet greater for the failure of the flash board compared to the exiting configuration. A difference in WSEL is apparent for about 24 hours, when the pool is sufficiently drained for the area downstream of the weir to return to its previous conditions.

The flow during January 2006 is much higher, with most of the water going over the weir during and after the flashboard failure. The water depths upstream and downstream of the structure are much higher (10 to 12 feet) than the 2015 simulations and changes in WSEL are less than 0.2 feet (2 in.). Failure of the millrace has minimal effect in the downstream hydraulics during high flow conditions.

In summary, the lower the level, the greater the change from the flashboard failure. However, even this large change will never approach a typical flood already observed going over the weir.

2. The unregulated flow event could increase the risk for serious bank erosion downstream.

Higher flow events would still be regulated by the weir. The gap left by the flashboards failure would still have limited capacity and create a pool behind the structure for moderate to high flows (estimated at about 250 cfs).

The velocity through the structure would increase as compared to the same conditions with the weir. However, like WSEL, the greatest changes in velocity are during the lowest water conditions. Even these largest velocity changes from rapid dewatering – from 1 foot per second (fps) to 3 fps – are less than velocity during higher flows (about 5 to 6 fps). The velocity changes during high flow are minimal – a difference of 0.2 fps. The possible failure of the flashboards will have limited effect on average velocity.

As the possibility for bank erosion is closely associated with river velocity, the primary driver of embankment erosion in the failed conditions would still be floods and high flow. The failure of the headrace would have almost no effect on the larger river's erosive capacity – most water would continue to go over the weir.

The most serious concern is the immediate downstream of the headrace outlet. The area would be subject to a much higher flow concentration and could erode rapidly. Available photographs appear to show significant bedrock or concrete shore protection in this area, which would lessen this concern somewhat.

3. Changes in permanent water level (backwatering effect) could liberate upstream sediment resulting in significant shoaling that could lead to the river changing course or damage to Corps constructed embankments.

During high flows, the current and failed conditions' WSELs, velocities and water surface slopes are essentially unchanged due to the headrace flow being relatively minor part of the total flow over the complete structure. There is less of a pool behind the drop structure during high water and the flow behind over the weir appears to take a more 'river and riffle' look than a 'pool and dam' look.

The amount of re-suspended sediments specifically due to a failure is likely to be low. Most physical changes to the Long Tom occur during high water. The relatively limited capacity of the headrace will mean that the total flow through the structure won't change significantly during high water.

The length of the pool during summer months is about 1.5 miles. In the event of a failure, this would be reduced to about 3,000 to 3,500 feet. The newly free-flowing area would see a velocity increase from about 0.1 fps to 1.3 fps. Even this increased water velocity does not increase the transport capacity of fine sand. Any entrained silts and clays would continue to move downstream like before a failure. More detailed findings on this topic would a longer study.

4. Changes in permanent water level upstream could result in the intake for the City of Monroe's water intake being perched.

The greatest concern here is with drought-level flows. Due to the limited capacity of failed flashboard condition flow outlet, the pool would not dewater to the level of failure. The Corps estimates that low summer flow would equalize about 1 to 3 feet above the lowest failure elevation. There would be more variability in the pool elevation as the capacity of the small outlet changes more based on upstream WSEL than it does with the weir.

Although it is heavily dependent on the actual nature of the potential failure, water levels could drop up to 5 feet below their current summer levels (the top of the weir). A more typical difference is probably 3 to 4 feet below current levels. For the drought conditions of the July 2015 run, the pool elevation at the water intake decreases from 277.6 feet to 273.0 feet (both NAVD88). These values are based on failure estimates and could be refined with further study.

As the Long Tom River at Monroe is generally higher than 250 cfs in the winter and spring, the pool elevation would appear very nearly normal under the failed conditions during these seasons. As the weir is engaged, the river would appear to be closer to its current operation.

5. Changes in sediment transport could create water quality concerns for Monroe drinking water and fish and wildlife in the area.

As mentioned above, the pool length would be reduced to between 3,000 and 3,500 feet from 1.5 miles with a flashboard failure. The location that any entrained sediment drops out of the river would change accordingly. Other than the precise shoal location, Total Dissolved Solids measurements are unlikely to change in the vicinity of the City's water intake.

Typically, ponded water warms during the summer months. A lower pool would likely lead to somewhat lower river water temperatures. However, other factors (Fern Ridge Dam, the upstream drop structures, Amazon Creek inflow) likely affect temperature more than the pool length at Monroe, so this difference is probably small.

The fish ladder would dewater with the flashboard failure. As the City's letter states, its present state does not meet current fish passage standards. Even so, the lower pool would mean that there would be no fish passage at the Monroe structure instead of the limited passage currently available.

Conclusions & Recommendations

The flashboard's failure greatest impact appears to be on the City's drinking water intake. The Corps estimated the dimensions of the headrace and probable failure of the flashboard. As such, the results in item #4 above (a 3- to 5-foot drop at the intake) are tentative. A comprehensive survey, with measurements, of the current state of the headrace and fish ladder would yield more certainty in the findings.

Even with the potential failure of the flashboards, the primary control of the river's hydraulic grade will remain the Corps-owned weir drop structure. During summer months the pool upstream of the structure would drop and reduce its length. The pool is unlikely to fall to the level of the failure – the opening in the headrace is much smaller than the length of the weir.

This memorandum is intended as a brief investigation of issues that the City of Monroe brought to the Corps attention. This investigation has focused on addressing questions raised by the City of Monroe in their April 28, 2017 letter. Effects to the hydraulic conditions as a result from anything other than the stop log failure described in this letter would require additional analysis. Possible follow-up investigation could include additional structure survey, soil surveys, temperature modeling and sediment transport modeling.