# Quesnel Lake Cloudiness at Lake Overturn

November 14, 2014

The tailings breach on August 4th resulted in a debris flow along the Hazeltine Creek channel. In addition to tailings that were released, a large amount of natural glacial sediments, including very fine glacio-lacustrine (ancient glacial lake) sediments underneath the former channel were scoured out and displaced into Quesnel Lake.

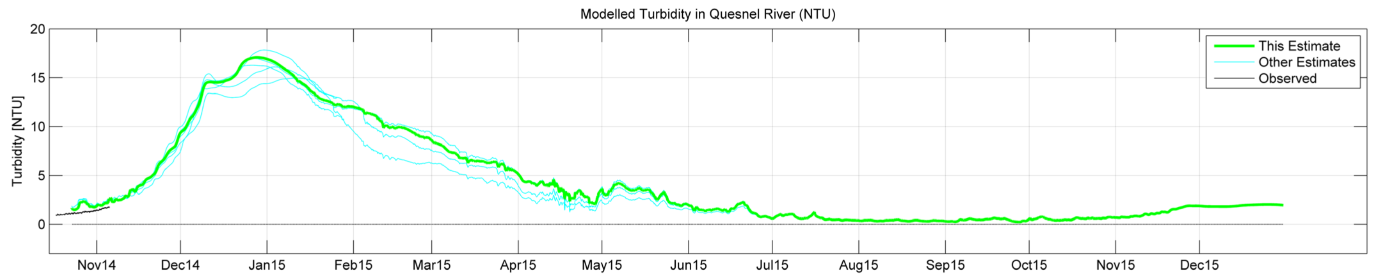
MPMC has had an ongoing and extensive program of studying Quesnel Lake since the event. We have identified that near the bottom of Quesnel Lake, most of the material has settled; however, there is a layer of cloudy water that, because of its very fine particle size, is slow to settle and remains in suspension in the bottom waters as would be expected for such small particles.

In September, we brought two advanced research vessels onto the lake to study the lake bathymetry (shape and depth) and water circulation patterns of, in particular, the West Arm of Quesnel Lake. These studies have allowed our specialists to develop a computer simulation model of the conditions that might be expected to develop over time in Quesnel Lake. We continue to work on refinements of the model but now have initial findings that we would like to share with the community to let them know what can be expected in the lake.

## Temperature Stratification

Naturally, during the summer, the lake is layered with warm water on top and cold water down deep. As temperature is measured starting at the surface, there is an abrupt temperature change that happens at a depth that varies from 20 to 40 meters depth. This abrupt temperature change layer is called the thermocline and this is a natural condition in Quesnel Lake. Because water temperature affects the density of water, and because water of differing densities resist mixing, the thermocline keeps the colder, and in this case, cloudy water at depth. This density barrier is not a hard and fast barrier and some incomplete mixing can occasionally occur.

As winter approaches, the warmer surface waters begin to cool and the thermocline begins to break down and so too does the barrier to mixing. Once the temperature of the lake is constant from the surface to bottom, mixing will occur with the action of winds, which move the water mass. This movement results in mixing of the cooled surface waters with the deeper cloudy water which is then observed at the lake surface. When and how quickly this will occur will depend on the temperatures and wind conditions that happen.




**Plot A:** Modelled turbidity in Quesnel River (NTU)

The figures below show the simulation model predictions. The figures are presented as a long centreline section of the lake extending from Likely (on the left of the chart) to Plato Island (on the right). Depth is shown on the left of the chart and the colours correspond to the predicted levels of turbidity. The amount of turbidity expected is shown using a colour scheme that can be read against the strip chart to the right of the graphic.

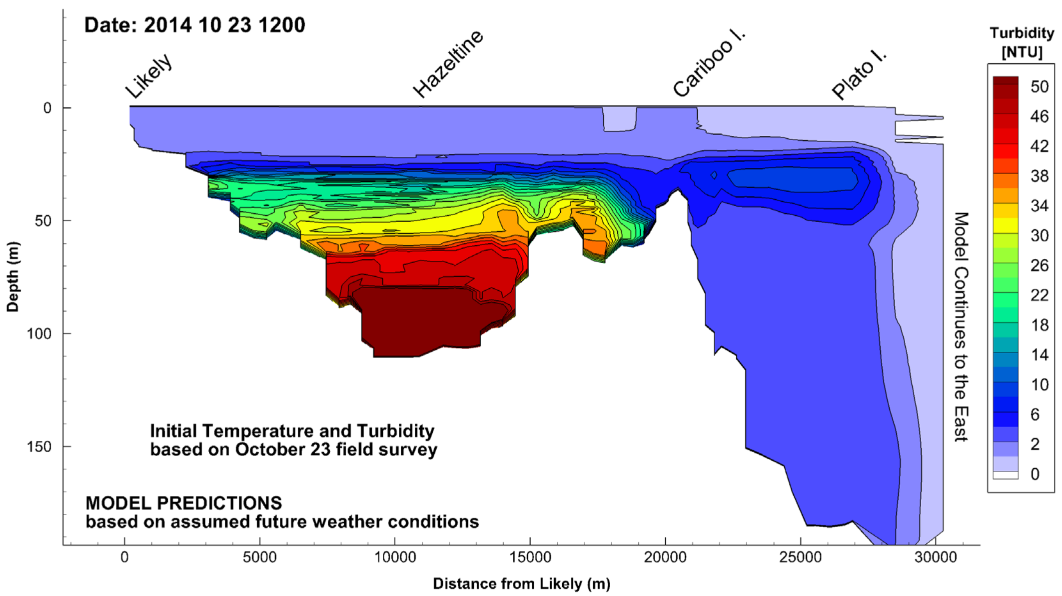



**Figure 1.** Actual conditions as observed on Quesnel Lake (October 23, 2014)

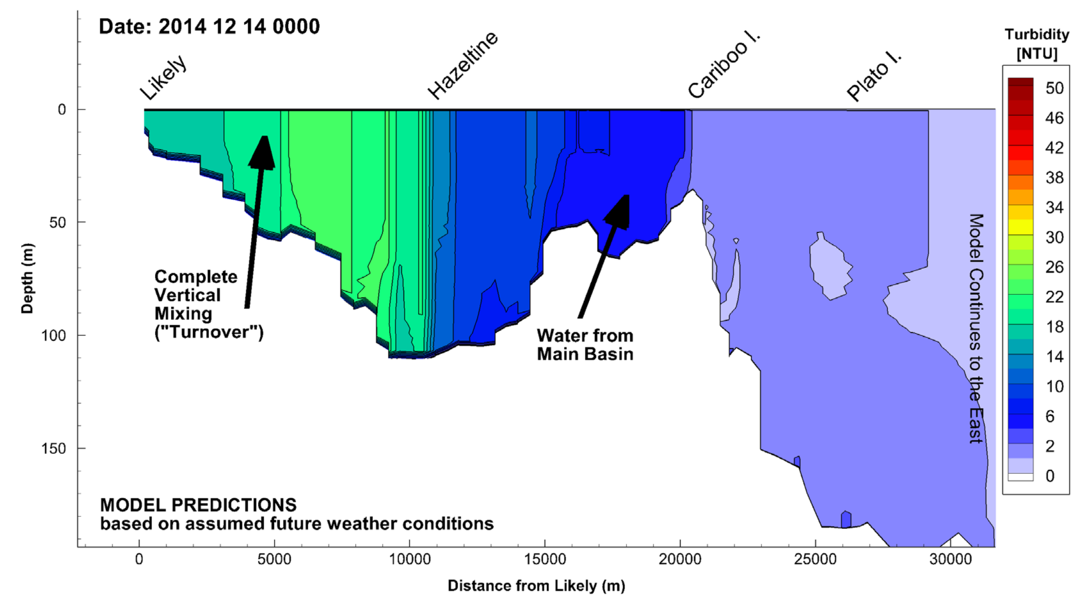



**Figure 3.** Simulated conditions on December 14, 2014. Water is mixed across the depth of the West Arm, especially between Likely and Hazeltine Creek

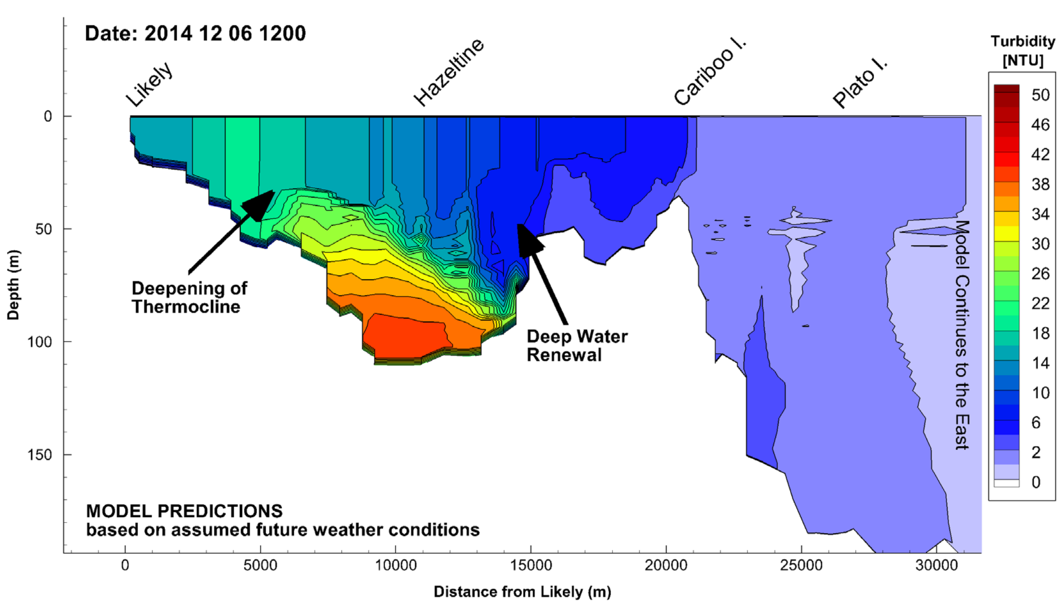



**Figure 2.** Simulated conditions on December 6, 2014. Turbid water from depth begins mixing towards the surface. Cloudy water is seen at Likely, BC

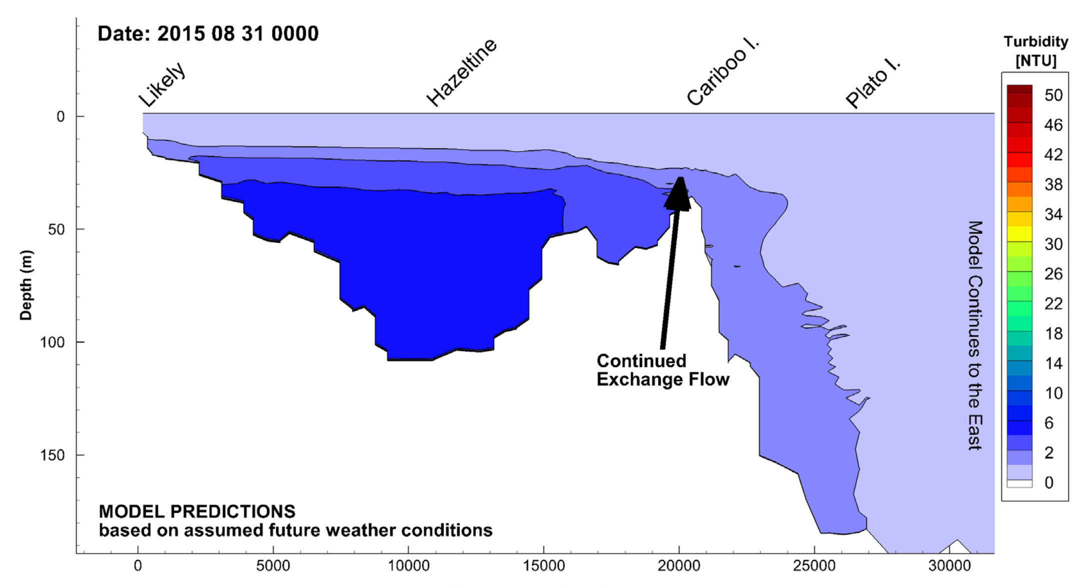



**Figure 4.** Computer Simulation for August 31, 2015. The surface waters of the lake are at or near background, with some turbidity at depth

## Computer Simulation Modelling Results

Computer modelling of the lake helps to understand the future behavior of the turbid water and to predict future water quality in Quesnel Lake and the Quesnel River. The observed conditions (Figure 1) were used as a starting point for the computer model. The computer then calculates the movement of water and dispersion processes that occur in the lake, based on actual lake conditions and the shape of the lake basin.

Once surface waters cool and wind storms occur, the thermocline in the West Arm is predicted to move deeper and some of the turbid water will mix to the surface (Figure 2). Initially, we expect this to be more prevalent in the area near Likely and then involving a greater portion of the West Arm. There will also be exchanges of water within the main body of the lake: clearer water will move from the eastern basin into the West Arm and a corresponding amount of turbid water will move east, although at very low turbidity levels. Since the water in the main body of the lake appears to be colder and therefore more dense, inflowing water from the eastern basin will likely sink and either displace, or mix with, the existing water near the bottom of the West Arm.

As the winter weather acts to further cool the lake, the cloudy material at the bottom of the lake will mix with surface waters. This will give the lake an increasingly cloudy appearance later into winter. The precise turbidity will depend on the actual conditions, however, our predictions indicate that waters in the range of 10 to 20 turbidity units can be expected, particularly near Likely. Figure 3 shows the progression of winter conditions as the cloudier material is mixed vertically through the water column. This cloudy water will also move into the Quesnel River (Plot A). However, within the Quesnel River, the water will be in continuous movement and these small particle sizes are too small to settle out under these conditions —they did not settle out under relatively still waters at the bottom of the lake over the summer months. The model-predicted turbidity values in the Quesnel River will continue to rise in late November and December and are expected to subside in mid-January. The exact dates and intensity of cloudiness will depend on the specific weather conditions that are encountered during this time as these will influence the intensity of the mixing process. By the middle of 2015, the cloudiness of the surface water is expected to begin to subside and by the summer of 2015 conditions at the lake surface are expected to have returned to normal (Figure 4).

## Drinking Water Sourced from Quesnel Lake

MPMC has continued to monitor the chemistry of Quesnel Lake water since the tailings breach and debris flow. Based on direct measurements, we expect that the concentrations of metals will continue to meet health protection requirements and we will continue to monitor the lake water chemistry to confirm our expectation. However, for those who take their drinking water from Quesnel Lake, the water will be cloudy and Interior Health advises that people should not drink cloudy water. This water remains suitable for other uses.

MPMC has recently been testing the filters supplied by Highland Irrigation and, because the cloudy water is caused by particles of very small particle size, the existing filters may not effectively remove the cloudiness of water. For those who drink from the lake, MPMC will maintain a source of drinking water from Spanish Mountain camp. We have looked at sources of replacement filter cartridges and have an active program of testing these cartridges. Should they be found to be more effective, MPMC will be providing these replacement cartridges to residents who wish to have them installed.

Other water sources such as well water or those who have been drawing from streams that drain into Quesnel Lake are not affected by the cloudy water conditions of Quesnel Lake.