



Earthquakes and Tailings Dams

The tailings storage facilities in Waihi are designed to withstand a magnitude 7 earthquake. With the September 2010 earthquake in Christchurch registering at 7.1 some people are naturally asking whether we should be worried about the risk of huge damage here. The answer is 'no'. There are other factors that must also be taken into account. Seismology and geotechnics are complicated sciences and here we attempt to provide some simplistic explanations.

We asked our specialist consultant from Engineering Geology Ltd to provide some information about the design of our tailings dams:

Dams, including tailings dams, come under the provisions of the Building Act. Design criteria are based on national and international guidelines. Earthquake design levels for large dams are related to the potential consequences of failure. This is international practice.

The intensity of earthquake shaking (ground motion) at a site is the main interest to designers of dams and the value adopted for design is primarily affected by three factors. These are earthquake magnitude, distance and depth of earthquake from the site and the frequency of occurrence (return period) of different magnitude earthquakes. In 2007 the Institute of Geological and Nuclear Sciences provided updated estimates of ground motion for design of the tailings dams at Waihi. Estimates were provided for return periods up to 10,000 years. These estimates included the possibility of up to magnitude 7 earthquakes occurring in close proximity to the site.

The tailings dams at Waihi have been assessed as being capable of withstanding earthquake ground motion with an average return period of 10,000 years and would be capable of withstanding even higher ground motion.

In comparison normal buildings are designed for earthquake ground motions with an average return period of 500 years, structures that may contain large numbers of people including schools are designed for 1000 years and structures with special post-disaster functions (e.g., hospitals, fire and police stations) and vital infrastructure (e.g., state highway bridges) are designed for 2,500 years. It is noted that structures designed to these levels would generally be expected to withstand higher levels of ground motion due to inherent conservatism in the design process.

Some people believe that Christchurch was of low seismicity. However, the potential for large earthquakes up to magnitude M7 within the Canterbury region has been recognised and allowed for in estimates of earthquake ground motion that are the basis for modern building design. Seismic design loads for Christchurch were adjusted upwards in the 2004 Loadings Standard to allow for some newly recognised faults west of Christchurch and are likely to be adjusted up further as a result of the recent earthquakes. The current seismic design load in Christchurch is 55% of that required in Wellington and 22% greater than that required in Waihi. The actual performance of buildings that were designed and built over the last 30 years was very good. It was the older unreinforced masonry structures that performed poorly and there was also considerable damage to infrastructure (buried services and roads) and houses due to liquefaction of the ground.

What if an earthquake happens here?

The risk of an earthquake breaching the Waihi tailings dams is considered to be very low. In designing the project, the risks have been identified and, where possible, have been minimised or 'engineered out'. The Martha Mine open pit slopes and the tailings storage facilities have been designed to achieve long-term stability; the risk that remains is minimal.

Risk can be defined as the potential for an activity to have an undesirable outcome. Risk assessment procedures consider the hazards and identify actions required to lessen the risk. As an example, recent reports suggest that there is the likelihood of a very large earthquake happening off the coast of Chile

every 50 to 100 years. It is predicted that such an earthquake would create tsunami waves travelling thousands of kilometres across the Pacific Ocean, hitting New Zealand's east coast and inundating coastal land. Do we decide to evacuate all inhabited areas on the east coast of New Zealand because of this risk? No, but we do make preparations such as installing tsunami warning sirens, having Civil Defence practices or knowing the best route to take to higher ground. We lessen the risk by taking appropriate action.



Above: The tailings dams at Waihi. Storage 2 is to the left, Storage 1A is behind it. Photo taken February 2011

The risk of a breach of the tailings dams at Waihi is extremely low for several reasons:

- The embankment slopes are gentler than necessary due to the availability of large quantities of rock from the Martha Mine open pit
- The foundations are solid, based on bedrock present at shallow depth
- The tailings themselves consolidate with time to be essentially soil that is not prone to liquefaction, unlike many other types of tailings.

Recent tests on Tailings Storage 2, where tailings discharge finished several years ago, indicate the tailings have consolidated to be equivalent to a firm to stiff soil and even in the highly unlikely scenario that the dam was breached the tailings would not flow anywhere, but would stand alone.

Within the embankments storage capacity is provided for a 1,200mm rain storm (the Probable Maximum Precipitation) plus an additional 1.0 metre minimum freeboard. The downstream shoulder of the embankment is considerably flatter than would normally be the case for water retaining embankments. The slope of Storage 1A is typically 3.2:1.

This compares to about 2.2:1 for the Benmore Dam, the highest hydro dam in New Zealand.

