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Dear Mark Ivamy,

Interim results on active faults around the Pukehangi Road development site, Rotorua

1.0 ACTIVE FAULTS AROUND THE PUKEHANGI ROAD DEVELOPMENT SITE

To assess the potential presence, or absence, of active fault(s) at the Pukehangi Rd site, we have analysed the Digital Elevation Model (DEM) derived from Light Detecting and Ranging (LIDAR) and 1940s aerial photographs (NZ Aerial Mapping run 710, photos 50 to 70), and assessed the ages of lake terrace surfaces.

We cannot identify any geomorphic features (fault scarps) that can be classified as an active fault across the Pukehangi Rd site. There is also no evidence that the active faults mapped in the surrounding area (red lines in Figure 1) do extend into the Pukehangi Rd site or nearby areas.

We cannot however, discount the possibility of a buried fault under the old lake sediments and surfaces. If such a fault existed, it would have not ruptured in at least the last 12,000 years, possibly the last 25,000 years, in the low elevation areas, and to the last 60,000 years in the high elevation areas. Below we summarise the evidence for the ages of the surfaces that comprise the Pukehangi Rd site as these have relevance to how we have assessed the presence and rates of activity of active faults.

The Pukehangi Rd site is located within the Rotorua volcanic caldera. The caldera formed around 240,000 years ago by collapse of the ground the after the eruption of the voluminous Mamaku Formation (Milner et al. 2002; age of Mamaku Formation from Gravely et al. 2007). A large lake occupied this subsided area after the caldera formed (Marx et al. 2009). Since its formation, Lake Rotorua has reached different topographic levels as a consequence of blockage and establishment of lake outlets responding to the tectonic and volcanic activity around the lake. The modern lake shoreline is at 280 m above sea level (asl). Marx et al.

(2009) determined the age of the geomorphic surfaces and sediments exposed around the current lake; they identified and dated three main lake shore levels:

- **Highest terrace at ~415 m asl** was the highstand (i.e. highest water level) associated with the lake that formed **<240,000 years ago.**
- **Shoreline and littoral terraces at up to ~380 m asl** correspond to the lake that formed after two coeval volcanic eruptions, the Rototiti and Earthquake Flat eruptions, around **60,000 years** ago (age from Wilson et al. 2007). The products from these eruptions blocked both the north and south outlets of the lake.
- **Shoreline terrace at 349 m asl** was the highstand caused by blockage of the northwestern lake outlet by volcanic sediments from Hauparu eruption (**~36,000 years ago;** age from Jurado-Chichay and Walker, 2000). The highstand was short lived and the lake dropped to near current levels. It is possible that other short duration high stands occurred in the period between 36 and 25,000 years ago.
- After 25,000 years ago, some highstands occurred (e.g. with the 25,000 year old Te Rere eruption the lake rose to 260 m asl and with the 9500-year-old Rotoma eruption the lake rose to 277 m asl). However, those were formed below the current 280 m asl level (formed as a consequence of the Mamaku eruption at 8000 years ago).

In Figure 1 we have display a hill-shaded DEM from the LiDAR data (provided by BoP Regional Council) overlain with the:

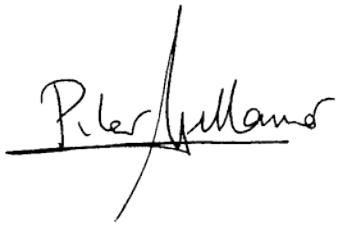
- previously mapped active faults in the surrounding area in red solid lines (Leonard et al. 2010, Villamor et al. 2010; Langridge et al 2016; this study);
- three topographic contour lines defining the highstand of the three lakes mentioned above; and
- location of the Pukehangi site in black solid lines.

We have used the geomorphic surfaces established by Marx et al. (2009), together with the ages they assigned to these surfaces, and geological mapping (Leonard et al., 2010), to assess the age of the surfaces at the Pukehangi Rd site. The site partially occupies a sub-horizontal (slightly sloping towards the lake) surface (380—367 m asl) that corresponds to the 60,000-year-old lake shoreline. The rest of the Pukehangi site east of the sub-horizontal area is a steeper sloping surface. This sloping surface corresponds to the erosional surface left behind as the 60,000 years-old lake drew down, as well as the erosional surface left by the ~36,000-year-old lake draw down (for elevations <349 m asl). The shoreline and littoral surfaces associated with ~36,000 years old lake are not represented at the site; they are likely to have been eroded. Therefore, for the sections of the Pukehangi site above 367 m asl we assigned a ~60,000 years surface age, and for those between 367 and 349 m asl we assign an age of 60,000 to 36,000 years. Areas located below 349 m asl are assigned a surface age of < 36,000 years (from Marx et al. 2009) and >12,000 years (from geological mapping Leonard et al. 2010). The lower age bound is likely to be at least > 25,000 years as none of the younger highstands seem to have reached the lowest elevations of the Pukehangi site.

Therefore, we conclude that no active faults have been identified at the Pukehangi Rd development site. We cannot however, discount the possibility of a buried fault at the site. If such fault existed, it would have not ruptured in at least the last 12,000 years, possibly the last 25,000 years in the low elevation areas and to the last 60,000 years in the high elevation areas.

Please let me now if you need further clarification.

Yours sincerely



Pilar Villamor
Senior Scientist

This report was undertaken by Pilar Villamor, Julie Lee and Kate Clark. It was internally reviewed by Nicola Litchfield.

2.0 REFERENCES

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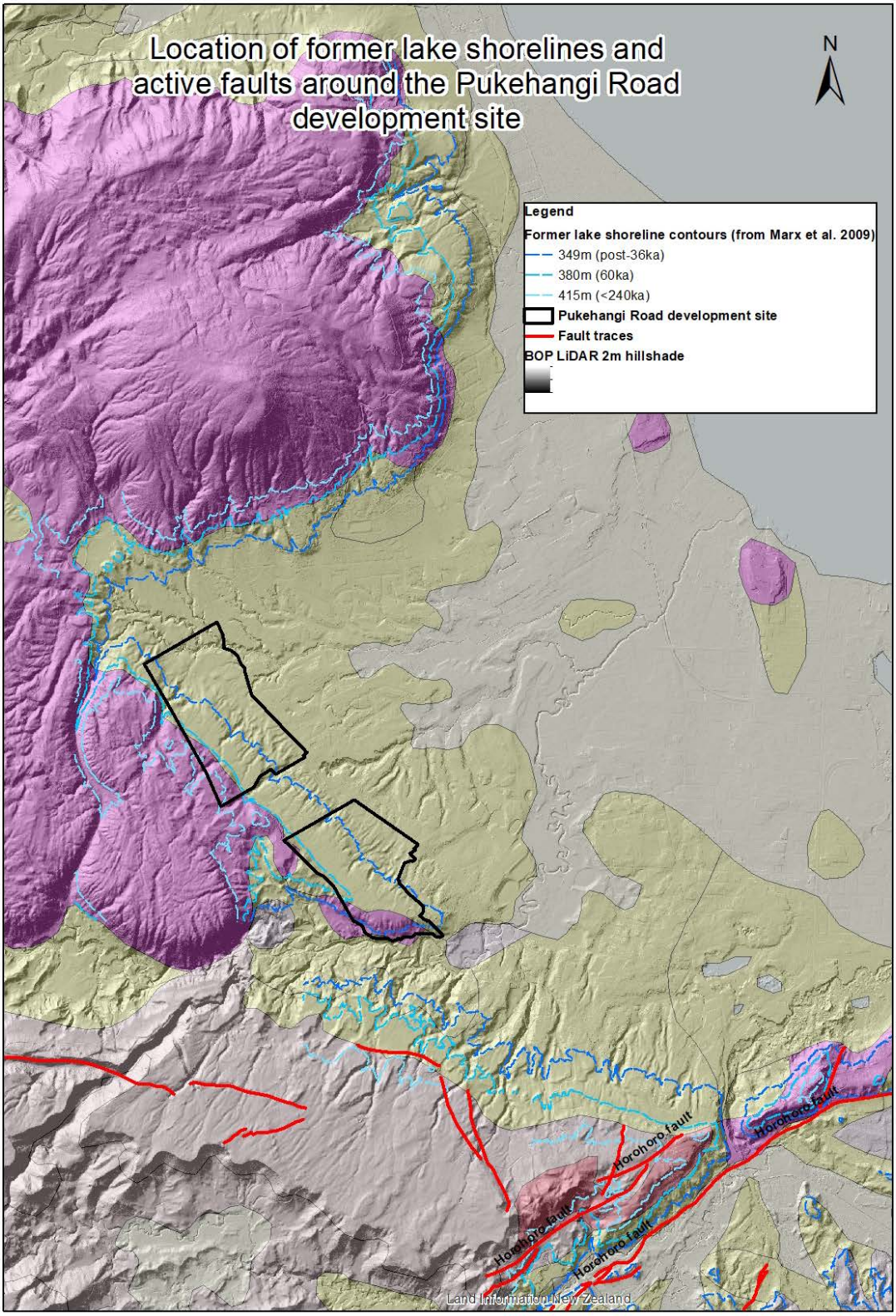

Figure 1 Location of the Pukehangi Rd development site (black solid lines) with respect to active faults (red solid lines: Leonard et al. 2010, Villamor et al. 2010; Langridge et al 2016; this study). Main coloured polygons are: purple= post -Mamaku eruption domes including Ngongotaha lavas (<240,000 years old); dark yellow= Late Pleistocene lake deposits (190,000-125,000 years old); and light yellow= Holocene river deposits (< 12,000 years old).