Memorandum

To	Nathan Geard
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From	Adele Amos
Reference	GER 2025-01
Date	21 January 2025
Subject	HCC Landslide Study - Development of Slope Hazard GIS Layer

Background

The Hutt City District Plan is the primary document used for overseeing land use and development, and identifies resource management issues, objectives, policies, and rules around managing development within the Hutt City District. The current district plan has been in use since 2004. Recently the Council completed a comprehensive review and revision of the plan. As part of their review and update of the Hutt City District Plan, Hutt City Council have recognised the need for improved understanding of landslide risks to inform land use management. The Council commissioned WSP to carry out and deliver an assessment of landslide susceptibility, run out from slope failures, followed by the development of a slope hazard GIS overlay.

The slope failure susceptibility was assessed for the entire district, with more refined information in the priority developed areas of the district. The run-out assessment was carried out only for the priority areas, as defined by the Council.

These reports were:

- WSP (2021). Hutt City Council District Plan Review - Slope Failure Susceptibility Assessment. Report No. GER 2021-36. September 2021.
- WSP (2024). Hutt City Council District Plan Review - Slope Failure Runout Assessment. Report No. GER 2024 – 48. July 2024.

Slope Hazard Overlay

The 2021 slope failure susceptibility and 2024 slope failure runout maps were combined to encompass areas susceptible to both slope failure and runout hazards.

This combined GIS susceptibility layer was used as the basis for developing a simple Slope Hazard Overlay for use in the District Plan.

This memo summarises the methodology used to develop the slope hazard overlay and provides the basis for the slope hazard overlay.

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Inputs

Several layers of information were used to develop the final GIS slope hazard overlay.

Slope Failure Susceptibility

The first dataset was the slope failure susceptibility model developed in 2021 (Figure 1). Specific focus was given to the Moderate, High, and Very High categories.

To develop this model, the factors influencing slope failure susceptibility listed below were given weighted ratings and analysed in GIS software to calculate slope failure susceptibility ratings across the region.

- Slope angle
- Slope aspect
- Lithology
- Land cover
- Distance to active fault
- Distance to stream
- Soil drainage
- Soil hardness
- Slope curvature

The GIS model was validated and refined before a layer with the following categories was compiled: Very High, High, Moderate, Low, and Very Low. Refer to Slope Failure Susceptibility Study (WSP, 2021) for further information.

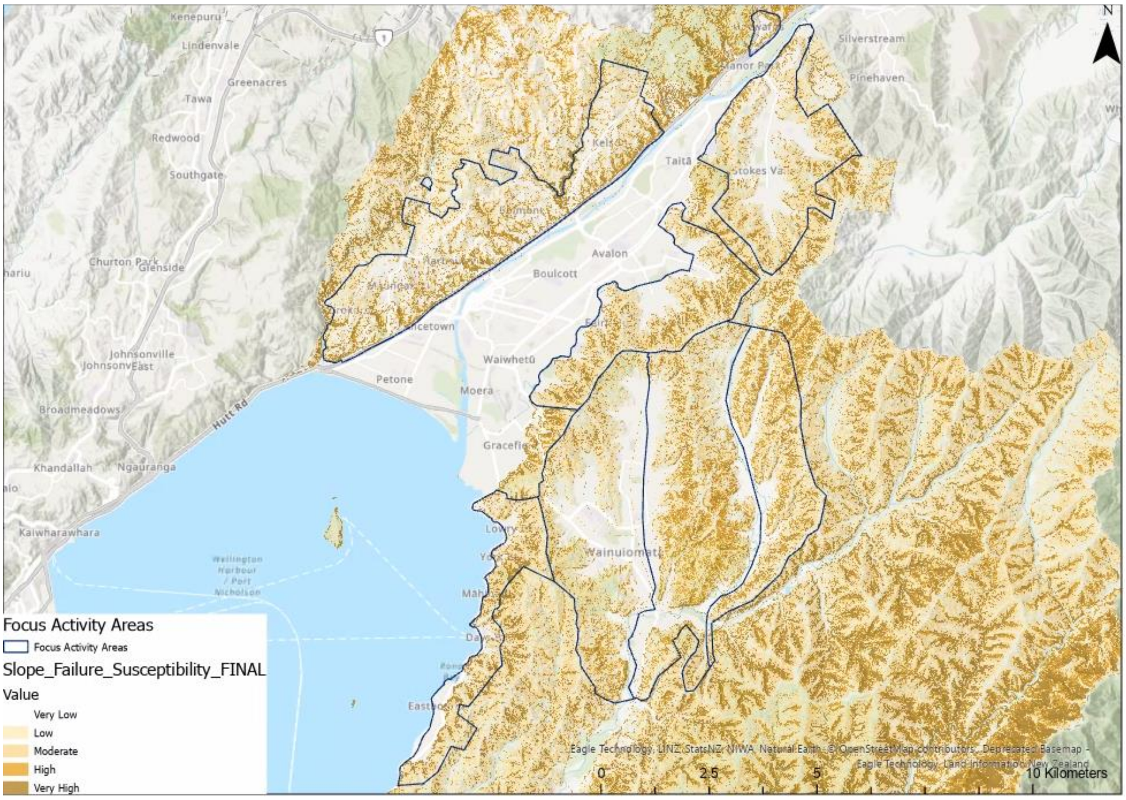

Figure 1: 2021 Slope Failure Susceptibility Layer

Runout

The second dataset was the GIS landslide runout assessment developed in 2024 (Figure 2). This dataset was developed using the Moderate, High, and Very High slope failure susceptibility areas from the 2021 susceptibility maps. Identification of areas susceptible to inundation by landslide debris from upslope instability were assessed using the empirical Fahrboeschung method, undertaken using the visibility tool in ArcGIS Pro. Refer to Slope

Failure Runout assessment, Hutt City Council District Plan Review (WSP, 2024) for further information.

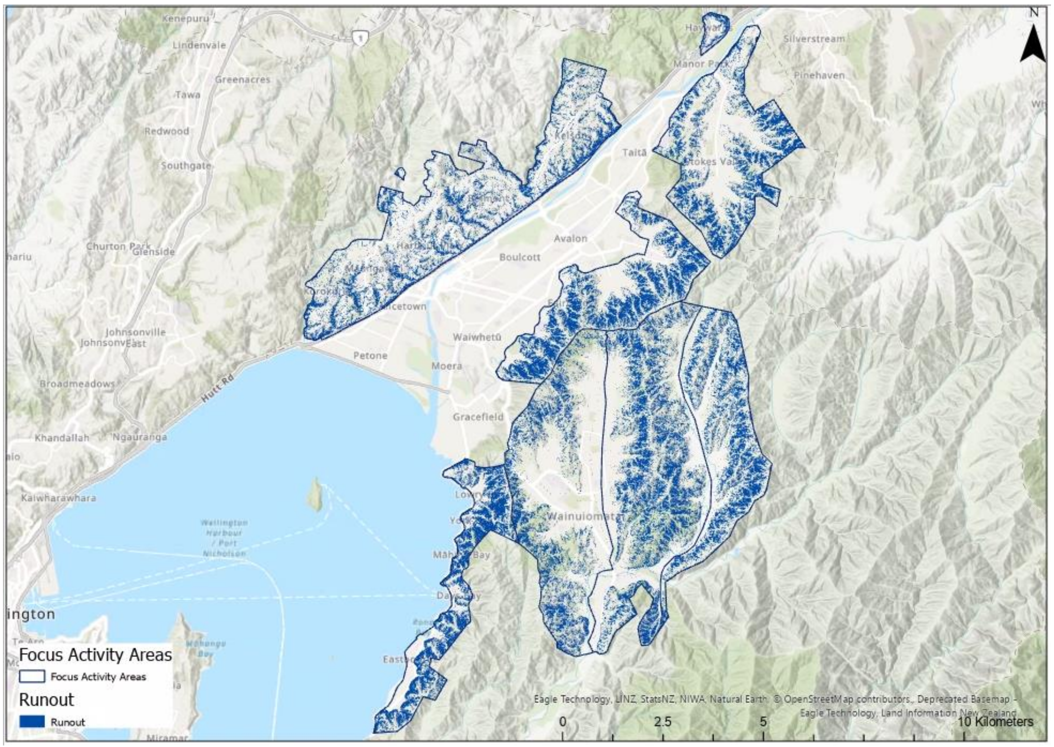

Figure 2: 2024 Runout Layer

Slope Angle

A slope angle layer was derived from the most up to date Land Information New Zealand (LINZ) 1 m Digital Elevation Model (DEM)using the Slope tool in GIS. This represents the rate of change in elevation for each DEM cell in degrees. The output was split into areas of slope angle >35°, 25 - 35°, and <25° (Figure 3).

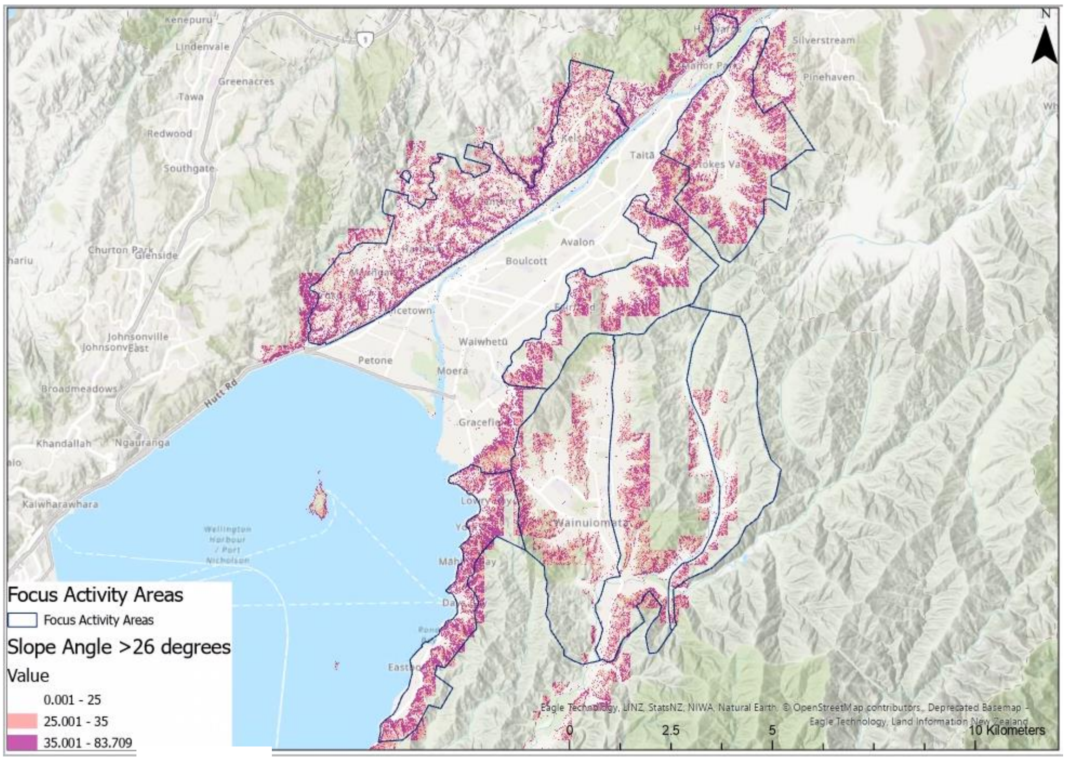

Figure 3: Slope Angle derived from most recent LINZ 1 m DEM

Where gaps were present in the coverage, slopes derived from the older 1 m DEM were used (Figure 4). It should be noted that this model is not derived from the most up to date data and therefore will not reflect any changes to topography since the date of capture due to development activities etc.

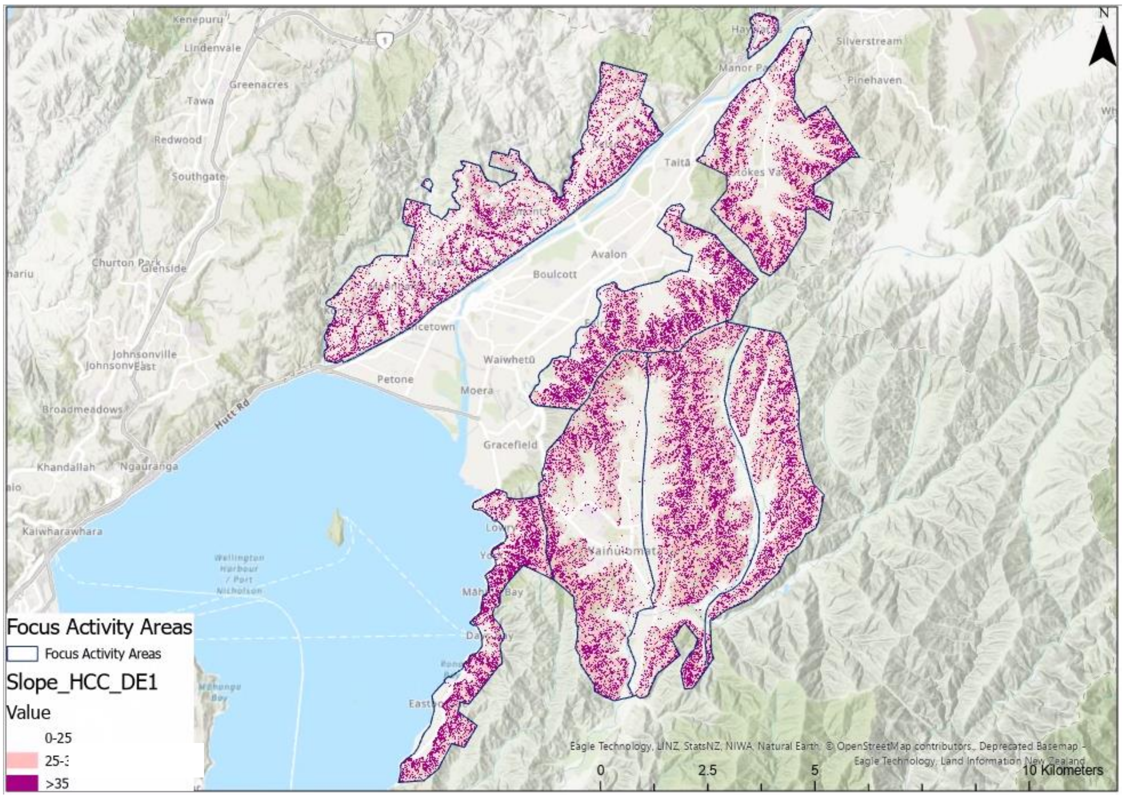

Figure 4: Slope Angle derived from prior LINZ 1 m DEM

Methodology

To develop the slope hazard overlay, the 2021 slope failure susceptibility (Moderate, High, and Very High categories), 2024 runout areas, and slope angle layers were overlaid in a GIS platform.

At a scale of 1:2,000, areas where there are low slope-related hazards were delineated with polygons. Slope angle and hillshade relief maps were used to make informed judgements as to whether to include or exclude fragmented areas of the slope failure susceptibility and/or runout layers (Figure 5).

This was reviewed at a 1:500 scale, and adjustments made. This revision used aerial imagery and building footprints to guide adjustments of the slope hazard areas and improve the final layer output. Note, this revision was not done on a property-by-property basis and the outputs should not be used for site specific assessments.

The Erase and Clip geoprocessing tools were used to invert the polygon feature class. This created a layer illustrating the combined slope hazard (Figure 6).

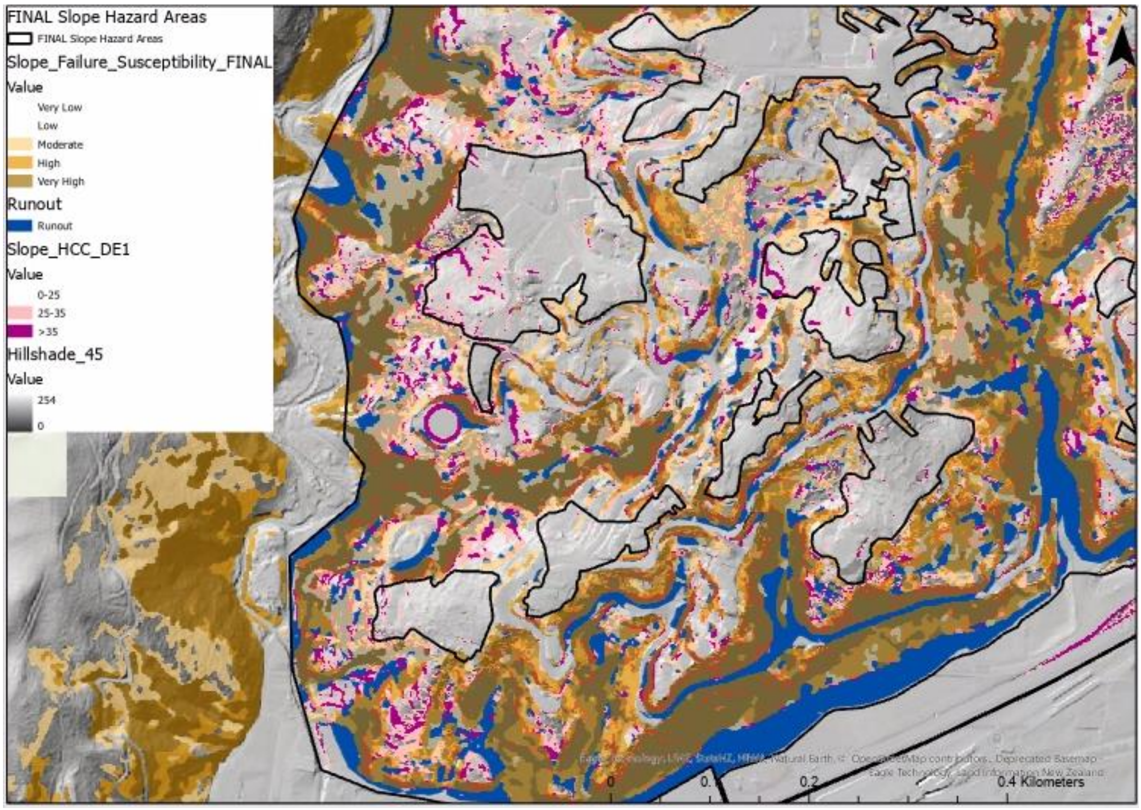

Figure 5: Slope Failure, Runout, and Slope Angle layers overlaid in GIS. Black polygons identify areas of low slope-related hazards.

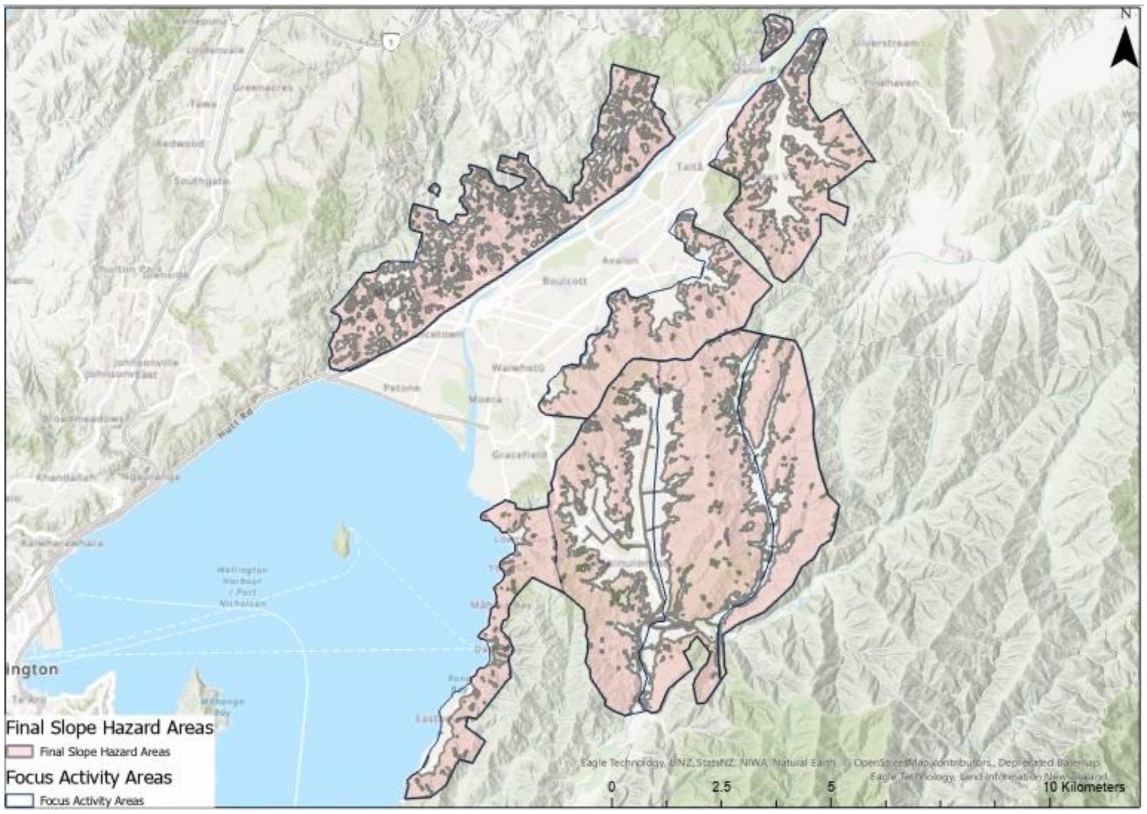

Figure 6: Final Slope Hazard Overlay

Limitations

Scale

The mapping has been completed as part of a city-wide study using remotely sensed data including LiDAR and the maps should not be used at a scale greater than 1:2,000 or for site specific assessments. No site-specific data or analysis has been incorporated into the development of the Slope Hazard overlay or into the development of any of the GIS input layers. Ideally, the maps should not be able to be viewed at larger scales, but if the zones are able to be visualised at larger scales, such as for individual properties, then a disclaimer should be included.

Given the 1:2,000 scale of mapping and the district level data that was used, the slope hazard overlay is an indicator of where higher levels of slope hazards are present and does not indicate that there are no slope hazards outside the slope hazard overlay.

Property owners and developers should seek independent advice on land stability at their particular property.

Data Resolution

Assessment and mapping of the zones will have inherent uncertainties, but these were mitigated by the use of high-resolution LiDAR terrain data.

Data Quality and Currency

The overlay produced should not be considered as a static layer. Updated or higher quality datasets and improved mapping of known landslips can improve landslide susceptibility and runout knowledge and refine the layer.

Slope Hazard Type

The runout areas exclude any runout as a result of debris flows. Overland flow path and flood data was not available within the period of this study, and it was decided in discussion with the Council to exclude this type of hazard from the runout assessment and therefore it is explicitly excluded from the slope hazard overlay.

Low Height Slopes

Low height slopes (up to ~4 m) were not captured in the runout assessment for practicality reasons, and therefore runout from low height slopes will not have been captured in the slope hazard overlay.

Engineered or Modified Slopes

There are engineered and treated slopes in Hutt City, including cuttings, fills, and retaining structures built during residential, road and rail developments. The terrain information used to develop the overlay, and its inputs does not differentiate engineered slopes from unsupported slopes.

Slope modification within individual properties is not captured beyond that which is captured in the LiDAR and aerial imagery. This is limited by the quality and age of the datasets. Any modifications following the acquisition of the LiDAR and aerial imagery will not have been captured. The slope hazard within individual properties may differ from what is captured in the overlay and confirmation of slope hazard would require more detailed, site-specific information on the subsurface conditions and efficacy of any existing mitigation measures.

Conclusions and Recommendations

Slope failure susceptibility areas were combined with slope runout zones to create a GIS overlay delineating areas of combined slope hazard that can be used in the district plan. The combined slope hazard overlay has been mapped at a 1:2,000 scale.

Recommendations

Based on the results of the study, we make the following recommendations for consideration.

- The slope hazard overlay maps are included in the District Plan and used by the Council for resource and building consenting processes.
- The slope hazard overlay maps are used with reference to this memo and the earlier reports that describe the assessment of landslide susceptibility and runout.
- The slope hazard overlay maps are used at a scale no greater than 1:2,000, and ideally not be able to be displayed at larger scales. A disclaimer should be included with the maps to state this.
- The slope hazard overlay maps are reviewed periodically as new data is collected. The maps should be updated in areas where new data differs from the data used in the development of the maps, or where there is a need for the hazard overlay in areas not currently mapped.
- The slope hazard overlay maps are used for emergency response planning by lifeline utility owners and Council's civil defence and emergency management groups to plan their response.
- Ongoing data collection and geotechnical investigations are implemented, to improve understanding of the distribution, impacts and controlling factors of landsliding across Hutt City.