# Appendix A: Responses to expert's letter dated 22nd November 2024

## Summary of responses

| Figure Reference (from 22nd November Letter) | Area | Summary of Experts Concern (from 22nd November Letter) | Response | Overlay Updates Proposed |
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| A2 | Bayview North | No evidence of geomorphic instability identified in the Beca inventory in the Tier III areas identified within Figure A2. | The Beca, 2021 report explains that slopes adjacent to those with features in the slope instability inventory and exhibiting consistent geomorphic and geologic conditions to the features in the inventory have been included in the overlay. From a technical perspective, this is appropriate when identifying areas that may potentially be susceptible to slope instability, because these areas exhibit similar characteristics to where instability has occurred nearby or in the past. Furthermore, considering that the intent of these slope overlays is to act as a tool to flag where further site-specific geotechnical assessment is required and to apply planning provisions to manage slope instability risks, I believe this criterion is appropriate and reasonable to align with this intent. These areas identified in dashed red lines in A2 are included because they exhibit these similar characteristics to areas that have failed nearby; therefore, the areas should remain within the overlay and no change is required. | No overlay update required |
| A3 + A4 | Bayview Central | Some shallow slope failures identified in the Beca inventory are interpreted as shallow debris flows >25m wide which therefore warrant Tier II classification. An additional deep-seated feature not identified in the Beca inventory is mapped within the Tier III area. | Based on the datasets used/available, this feature was not identified on the published geologic maps and the Beca staff did not observe a clearly defined headscarp feature in the datasets that clearly indicated a deep-seated feature being present. Therefore, they did not have sufficient evidence to define it as this type of feature, so it was identified as Area 3 rather than Area 2. To confirm if it was deeper seated would require field verification, intrusive investigations or site-specific knowledge which was not included or available as part of developing regional scale susceptibility maps in this area. This level of detail would be expected to be provided at the site-specific assessment stage that the susceptibility map would trigger.<br><br>With regards to the width of the instabilities, one instability feature identified within the mapping is identified as having a maximum width of <25m and therefore did not warrant inclusion. Other feature was interpreted as a shallow instability.<br><br>Note: The SI-TAG did not have specific comment of deep-seated instability in this area and the feature identified that Beca 'missed' was not mapped in the geology map (Johnston et al. 2021). Also, if the | No overlay update required. Combination of Tier 2 and 3 overlay extents into single overlay results in no change to overlay extents |

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| | | | recommendation to combine areas 2 and 3 is accepted, then the extents of the overlay will not change in this area in light of other expert's comments. | |
| A5 | Bayview Ledger | There is no geomorphic evidence of slope instability identified in the Beca inventory within the portion of Tier III land identified in Figure A5. | The slope instability inventory has been created in accordance with the AGS guidance and aligns with a 'basic' level inventory. The mapping of features is not considered to be an exhaustive record of all instability in the region but is sufficient to show the classification and distribution of slope instability on hillslopes in the region. The aim of the mapping was to capture a representation of slope failure locations and types in the region. Please note that there are features interpreted in the DEM that are not included in the slope instability inventory within this area (see snip and commentary in the Statement of Reply for why features not included). These features extend into the area identified by red dashed area in A5 which is why this red dashed area is included in the overlays. Also, as described in Beca, 2021 there is evidence of slope instability on nearby slopes. The suggested change areas exhibit consistent geomorphic and geologic conditions to these areas where previous failures have occurred. Therefore, this area should remain within the overlay and no change is required. | No overlay update required |
| A6 + A19 | Wakapuaka Cemetery | Parts of the Tier III area are noted as not containing mapped evidence of instability within the Beca inventory and appear to be at slopes of <35 degrees. The western hillslope within the cemetery is noted as being excluded from Tier III despite appearing to exhibit a similar slope profile as the eastern face of the slope within the cemetery.<br>The extents of Tier II north of the cemetery do not correspond with features mapped in the Beca inventory. | Tier II area is based on the Johnston et al. 2021 geologic map and refined based on the DEM. The toe area extent was based on initial assessment criteria considering slope angle which is why this is not included in the overlay (as described in reply document). No additional areas were added when this was refined into Tiers, therefore the extent reflects the initial mapping agreed with SI-TAG.<br><br>Tier III areas identified in the Beca map are >20 degrees and exhibit consistent slope morphology and underlain by same geologic unit as adjacent slopes that have evidence of previous shallow failures including post-August features (see snips). Slope identified in A19 on the west side of the cemetery is not included within the overlay as the overall slope angle across the area is largely less than 20 degrees. Therefore, the area was not included. Alternatively, the south and east slopes identified have overall slope angles of >20 degrees which is why they are included (showing consistent application of methodology). Although there is no geomorphic evidence of instability in these areas, there is in the adjacent gully in the same materials on similar slopes which is why they are included.<br><br>Note: Some of this area is outside of PC29 extents. Assuming because it is a cemetery | No overlay update required |

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| A7 | Atawhai Drive, Havenview, Young Way | The extent of Tier II mapped immediately south of the cemetery is identified as terminating within the debris field of instability and it is noted that there is no mapped feature within the lower portion of the slope in the Beca inventory that informs the Tier II designation. | Tier II area is based on the geologic map (Johnston et al. 2021) and refined/expanded to include the area upslope using the DEM as Beca were aware this area is earthflow deposits due to in-house knowledge in the area. The evidence of this earthflow has likely been obscured by the earthworks of the subdivision which is why it is not observable. It also shows the same morphology as the earthflows identified to the northeast in similar gullies and geology. The toe area extent was based on initial assessment criteria considering slope angle which is why this is not included in the overlay (as described in the Statement of Reply document). No additional areas were added when this was refined into Tiers, therefore the extent reflects the initial mapping agreed with SI-TAG. | No overlay update required |
| A8 + A24 | Whakatu/Bishopdale Overview | Tier II area extends into an area where Bishopdale conglomerate and Marsden Coal Measures are not differentiated in the QMap and no features are identified in the Beca inventory to justify assigning Tier II. | Beca have used the geological map information from Johnston et al. 2021 to define this area. It is identified in these maps as Bishopdale Conglomerate (Kb), therefore, Beca have included areas where the slope angle is greater than 15 degrees as per methodology. The areas outside of this geology unit (that are still Tier 2) are interpreted to be earthflow deposits and included because of this, not because of the underlying geology, as indicated on A24 by Mr Lines and Dr Hargraves. These earthflows were discussed with the SI-TAG following the August 2022 event as there were a number of these that activated in this event and started to encroach on the road. These earthflow features are not shown as such in the inventory as they were identified during the review process and following the SI-TAG discussions, but the inventory was not updated to reflect the change of landslide type. This is a well-known area of instability in Nelson. | No overlay update required. Combination of Tier 2 and 3 overlay extents into single overlay results in no change to overlay extents |
| A9 | Tasman Heights/ Coastal View | Evidence of previous slope failures observable in local datasets not considered in the assessment (Top of the South aerial imagery) are not identified in the Beca inventory. | The slope instability inventory has been created in accordance with the AGS guidance and aligns with a 'basic' level inventory. The mapping of features is not considered to be an exhaustive record of all instability in the region but is sufficient to show the classification and distribution of slope instability on hillslopes in the region. The aim of the mapping was to capture a representation of slope failure locations and types in the region. In my opinion, this type of inventory, in combination with the other evidence of slope instability (i.e. records provided by NCC and the Post-August 2022 landslide dataset provided by GNS) is sufficient to inform the creation of these slope overlays and aligns with the AGS guidance.<br><br>Areas identified by the experts are within the extents of the overlay, therefore no change is required. | No overlay update required |
| A10 | Austin Ward Heights | Parts of the hillslope assigned Tier III do not | Please note that there are records provided by NCC of failures across the suggested change areas and features identified in the DEM that are not included in | No overlay update required |

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| | | contain geomorphic evidence of instability within the Beca inventory and only localized areas of the hillslope are >35°. Additional slope failures not identified within the Beca inventory are noted on the remainder of the hillslope that is assigned to Tier III. | the slope instability inventory (see snip). Also, as described in Beca, 2021 there is evidence of slope instability on nearby slopes. The suggested change areas exhibit consistent geomorphic and geologic conditions to these areas where previous failures have occurred. Therefore, I believe this area should remain within the overlay and no change is required. | |
| A11 + A12 A23 | Kakenga Road | The deep-seated slope failure shown in the Beca inventory and assigned to Tier II does not appear to correspond to geomorphic evidence in aerial photographs from 1948 nor 1943. Additionally, a portion of the adjacent hillslope and ridge assigned as Tier III does not contain evidence of instability in the Beca inventory. | Tier 2: This feature was identified in the desktop datasets (DEM) as a deep-seated landslide because its morphology was similar to that of deep landslide features to the south west on adjacent hills. A headscarp feature was interpreted in the DEM and 'fingers' of what was inferred to be landslide debris lower down the slope. More site-specific knowledge may show this is not a deep seated landslide however, however, this is the intent of further investigation as warranted by the susceptibility map. Note that there is presence of shallow instability within this area obscured by landscaping works that are not included in the inventory. Considering a combined overlay, it will not affect the extent of the overlay.<br><br>Tier 3: Please note that there are features interpreted in the DEM that are not included in the slope instability inventory within this area (see snip). These extend into the area identified which is why it is included in the overlays. There are also records provided by NCC of failures in the south of this area. The ridge remains in the overlay because it is too narrow to be excluded as per the methodology. Also, as described in Beca, 2021 there is evidence of slope instability on nearby slopes. The suggested change areas exhibit consistent geomorphic and geologic conditions to these areas where previous failures have occurred. Therefore, I believe this area should remain within the overlay and no change is required. | No overlay update required |

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| A13 + A14 | Suffolk Heights | The headscarp of one deep seated failure shown in the Beca inventory does not directly correspond to the boundaries of Tier II and associated geomorphic evidence visible in the DEM and there is no mapped evidence for instability in the lower portion of the Tier II in the Beca inventory. Features are noted as being debris flows not deep-seated slope failures (both warrant Tier II). Additional deep-seated features are identified on the adjacent hillslope that are shown as shallow failures in the Beca inventory (Area is within Tier III). | Tier 2: These areas are mapped as landslide deposits in the Johnston et al. 2021 map and their extents were refined based on interpretation of the DEM, therefore, the areas were included as Tier 2. The scarp location was defined as presented in the overlay extents during the review process ,but not updated in the inventory. The 'hole' in tier 2 identified at Suffolk Heights is there because of the way the maps were developed and is a hangover of this. The original slope overlay maps were one map without any Tiers identified and was largely developed by the 20 degree slope angle/geomorph evidence criteria of the methodology tree. Based on the recommendation from the SI-TAG, the map was split out into the different tiers, but its extents were not changed. As this area was less than the 20 degrees criteria in the original overlay it was not included. When the map was differentiated into its tiers, the map extents were not changed therefore it was not included in the updated overlay with the tiers.<br><br>Tier 3: Based on the datasets used/available to the assessing person (and verifier), they assessed and made judgement that the feature was either shallow or deep because the way they interpreted the datasets/information. To make a decision on whether an area fell within Area 2 or Area 3 of the slope overlay, they needed confidence or possibly additional information that was not available to them to decide, therefore made an appropriate judgement with the information at hand. To confirm if it was deeper seated would require field verification, intrusive investigations or site-specific knowledge which was not included or available as part of developing regional scale susceptibility maps in this area.<br><br>Note: if the recommendation to combine areas 2 and 3 is accepted, then the extents of the overlay will not change in this area. Also, some of this area is outside of PC29 extents. | No overlay update required |
| A15 | Quail Rise to Marsden Valley Road | Specific evidence of slope instability (headscarps) visible in the DEM are not present in Beca inventory on a slope within Tier III and mapped on the wider hillslope. One feature within the inventory is identified as relating to a building platform, not slope failure. | The slope instability inventory has been created in accordance with the AGS guidance and aligns with a 'basic' level inventory. The mapping of features is not considered to be an exhaustive record of all instability in the region but is sufficient to show the classification and distribution of slope instability on hillslopes in the region. The aim of the mapping was to capture a representation of slope failure locations and types in the region. In my opinion, this type of inventory, in combination with the other evidence of slope instability (i.e. records provided by NCC and the Post-August 2022 landslide dataset provided by GNS) is sufficient to inform the creation of these slope overlays and aligns with the AGS guidance. | No overlay update required |

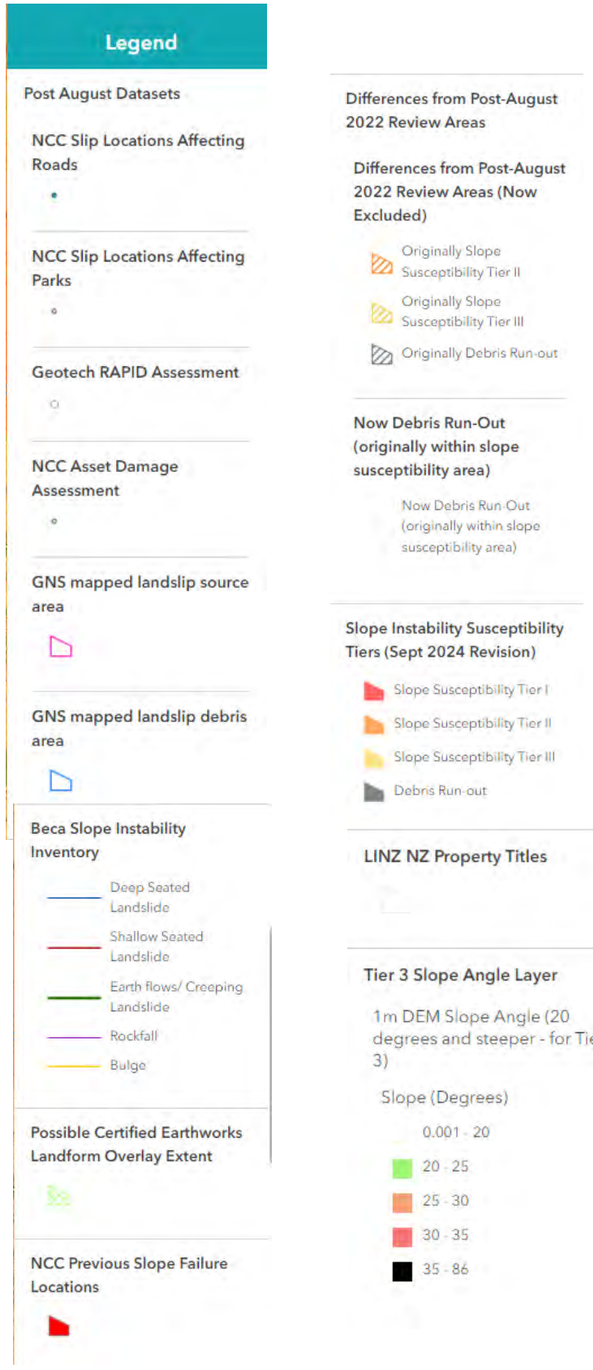
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| | | | Features/areas identified by the experts are within the extents of the overlay, therefore no change is required.<br><br>Note: Some of this area is outside of PC29 extents. | |
| A16 | Woodford / Sunningdale Drive | Evidence of debris inundating the rear of a house during the August 2022 event is noted by a white dot in an area outside of the Tier III and runout overlays. | I agree that this area should be included in the slope overlay (see snip) | Update Tier III boundary to incorporate area at rear of property that was inundated with debris. Revised area is not outside the original Beca (2023) overlay extents |
| A17 | Atawhai | Headscarp of instability mapped by GNS following the August 2022 event is identified on a ridgeline in an area excluded from the overlay. | I agree that this small area should be included in the overlay (see snip in PDF for proposed extents)<br><br>With respect to other areas of instability noted. The slope instability inventory has been created in accordance with the AGS guidance and aligns with a 'basic' level inventory. The mapping of features is not considered to be an exhaustive record of all instability in the region but is sufficient to show the classification and distribution of slope instability on hillslopes in the region. The aim of the mapping was to capture a representation of slope failure locations and types in the region. In my opinion, this type of inventory, in combination with the other evidence of slope instability (i.e. records provided by NCC and the Post-August 2022 landslide dataset provided by GNS) is sufficient to inform the creation of these slope overlays and aligns with the AGS guidance. This does not affect the extent of the overlays; therefore no change is required for these.<br><br>Note: area is outside of PC29 extents. | Update Tier III boundary to incorporate area with mapped headscarp. Revised area is not outside the original Beca (2023) overlay extents |

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| A18 | Above Brunner Street (Grampians) | Absence of detailed mapping of geomorphic features in Beca inventory in an area assigned as Tier III that exhibits widespread evidence for slope failures in the DEM. | In this particular area, due to the amount of instability present on the slope, each individual feature was not identified as it is clear this whole area has stability issues. The slope instability inventory has been created in accordance with the AGS guidance and aligns with a 'basic' level inventory. The mapping of features is not considered to be an exhaustive record of all instability in the region but is sufficient to show the classification and distribution of slope instability on hillslopes in the region. The aim of the mapping was to capture a representation of slope failure locations and types in the region. In my opinion, this type of inventory, in combination with the other evidence of slope instability (i.e. records provided by NCC and the Post-August 2022 landslide dataset provided by GNS) is sufficient to inform the creation of these slope overlays and aligns with the AGS guidance.<br><br>Features/areas identified by the experts are within the extents of the overlay, therefore no change is required.<br><br>Note: Some of this area is outside of PC29 extents. | Area already within overlay, no updates required. |
| A20 | Marie Place, Bishopdale | Area with geomorphic evidence of previously being impacted by a slope failure in the DEM and containing mapped inundation in the post-August 2022 mapping by GNS is excluded from Tier III along with adjacent slope. | I agree that this small area should be included in the overlay and a small area as run-out (see snip for proposed extents) | Update Tier III boundary to incorporate area and also run out below. Revised area is not outside the original Beca (2023) overlay extents |
| A21 | Brunner / Tukuka Streets, Nelson South | Beca inventory does not contain mapped features that inform/ justify the extents of Tier II shown. Noted that the extent of the Tier II area terminates within the debris field. | The overlay in this area was based on the original Grampians overlay with geomorphic mapping identifying that the landslide feature extends further downslope than the area within the Grampians Overlay. The downslope area exhibiting hummocky topography and >20 degrees was included in the original map resulting in the 'fingers'. The remaining area <20 degrees was excluded. This overlay was subsequently subdivided into the Tier II area and therefore inherited the morphology from the original overlay at the request of the SI-TAG. (See snip for interpretation). As this area was within the Grampians overlay already, geomorphic evidence of deep-seated features were not mapped.<br><br>The fault items will be addressed with the below A22 comments | No overlay update required |

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| A22 | Bishopdale - Fault mapping | Application of the '100m fault zone' trigger does not consider all active faults known to exist within the region including those informing the Fault Deformation and Fault Awareness overlays. | The faults included in the 100m downslope of a fault criteria in the methodology tree are the faults presented on the GNS Active Faults database. The AGS guidance identifies that sliding may be possible on steep natural slopes in regions affected by large earthquakes. The 100m downslope of active faults is to reflect this, as well as the consideration that the bedrock near active faults will typically be more fractured and likely to have water seepages. Therefore, these areas are likely to be potentially susceptible to instability.<br><br>The updates to the fault deformation/awareness areas postdated the original overlay creation and were therefore not included for consideration as part of these overlays. This criterion of the methodology tree was agreed and accepted by the SI-TAG and no change was suggested.<br><br>If these areas were to be incorporated for this plan change, it would result in some new areas of land (beyond those notified in the PC29 overlay) to be included into the overlay. Therefore, for a future plan change, it may be appropriate to develop this criterion of the methodology tree to incorporate the areas downslope of all the active faults identified in the fault deformation/awareness areas. | It may be appropriate to incorporate these areas into a future revision of the overlays |

This PDF document shows Beca replies (in blue) to the letter prepared by Mr Lines and Dr Hargraves dated 22nd November 2024. These responses should be read in conjunction with the text in the Statement of Reply of Dan Chamberose (27 November 2024) document under Section 5. SLOPE INSTABILITY SUSCEPTIBILITY OVERLAYS AND DEBRIS RUN-OUT OVERLAY – ACCURACY OF THE OVERLAYS.

Below shows a legend of what different icons/colours are in the below maps to aid the Panel.



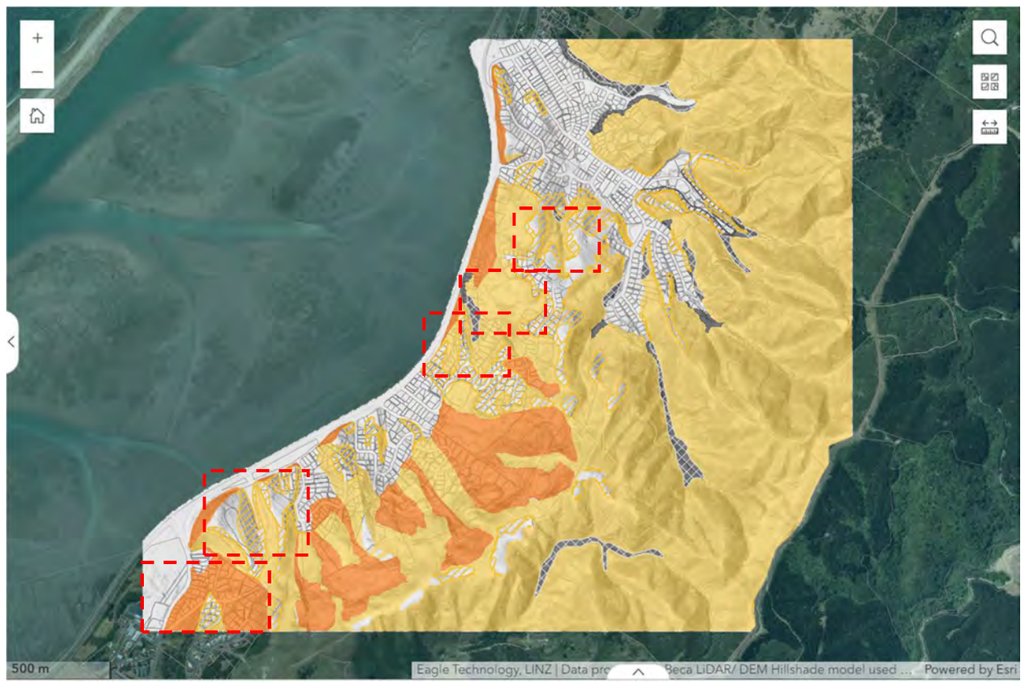



Figure A 1 - Overview of Atawhai Area




Figure A 2 - Bayview North

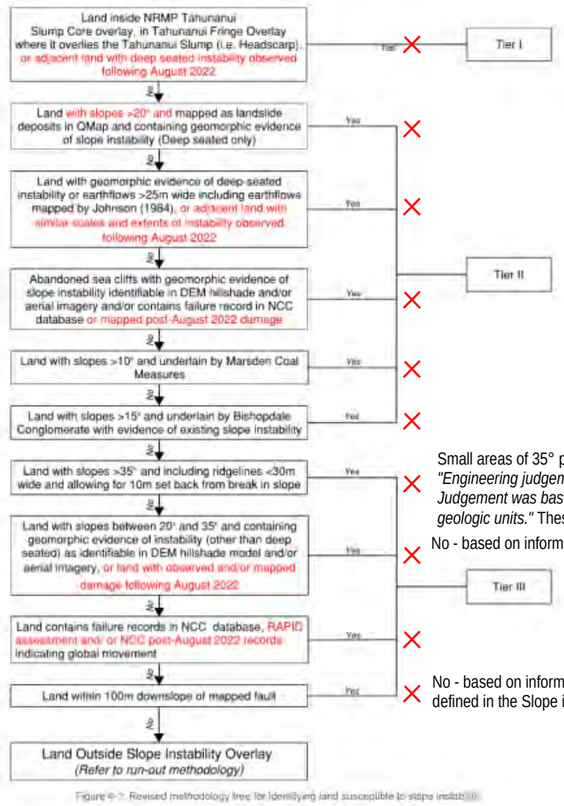



Figure 6-2: Revised methodology tree for identifying land susceptible to slope instability

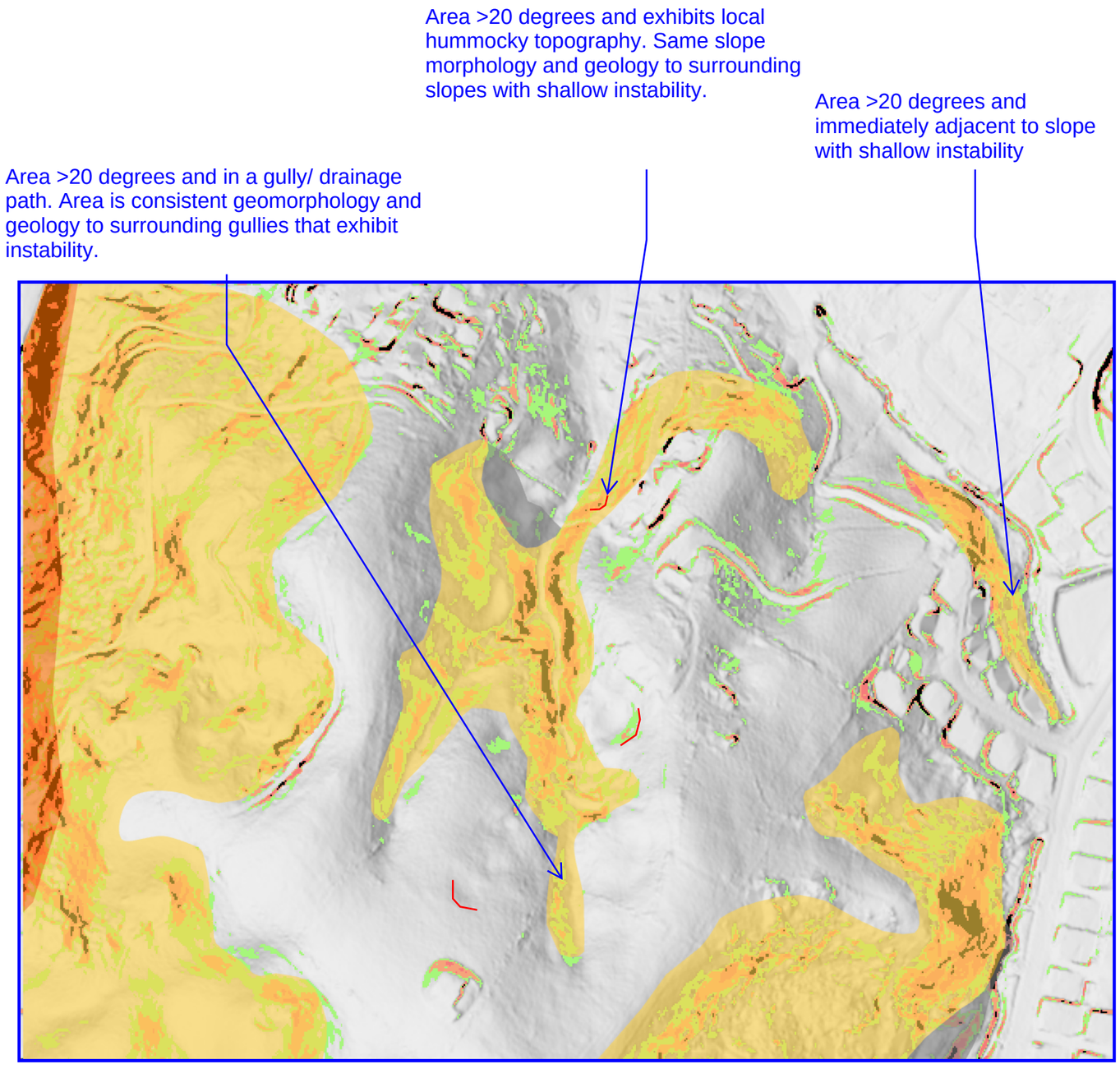
Small areas of 35° plus illustrated from automated slope angle determination from the DEM. However, Becas 2021 document allows: *"Engineering judgement has been used to determine whether slope profiles partially greater than 35 degrees have been included in the overlay. Judgement was based on the overall steepness of the slope profile using the 2 m elevation contours, overall topography, and underlying geologic units."* These areas on average well below 35°.

No - based on information provided by Beca in GIS. Which does not present any geomorphic evidence of instability.

No - based on information provided by Beca in GIS. This only adopts 1:250,000 active faults. Flaxmore fault located upslope of lots but not defined in the Slope instability susceptibility GIS.

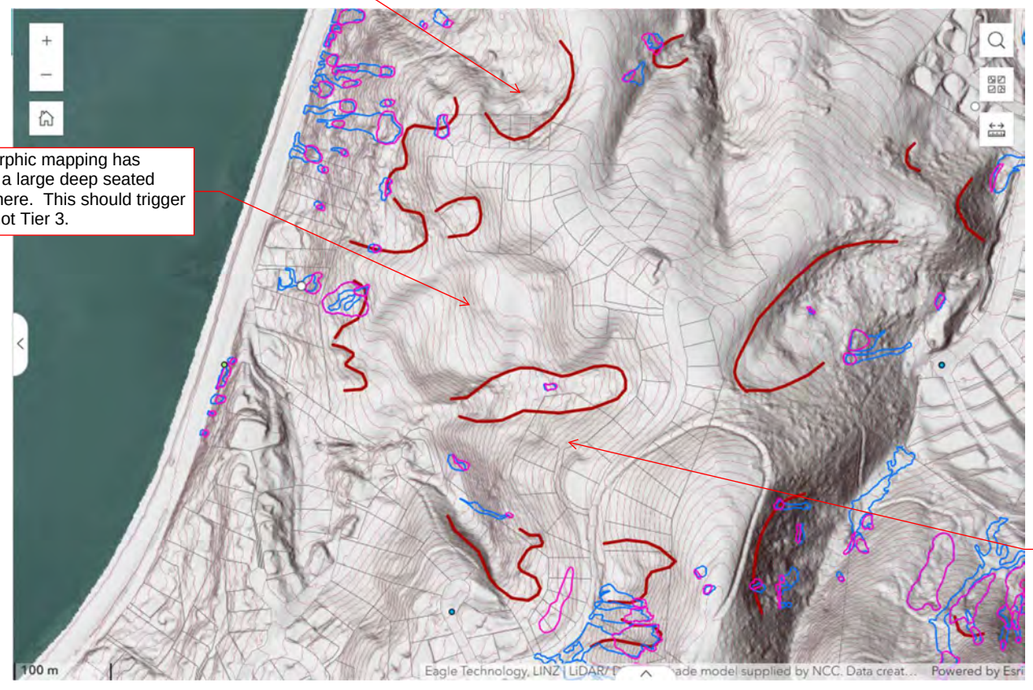
**A2 Response**

The Beca, 2021 report explains that slopes adjacent to those with features in the slope instability inventory and exhibiting consistent geomorphic and geologic conditions to the features in the inventory have been included in the overlay. From a technical perspective, this is appropriate when identifying areas that may potentially be susceptible to slope instability, because these areas exhibit similar characteristics to where instability has occurred nearby or in the past. Furthermore, considering that the intent of these slope overlays is to act as a tool to flag where further site-specific geotechnical assessment is required and to apply planning provisions to manage slope instability risks, I believe this criterion is appropriate and reasonable to align with this intent. These areas identified in dashed red lines in A2 are included because they exhibit these similar characteristics to areas that have failed nearby; therefore, the areas should remain within the overlay and no change is required.



This shallow debris flow is wider than 25 m as drawn. This should trigger Tier 2 not Tier 3.

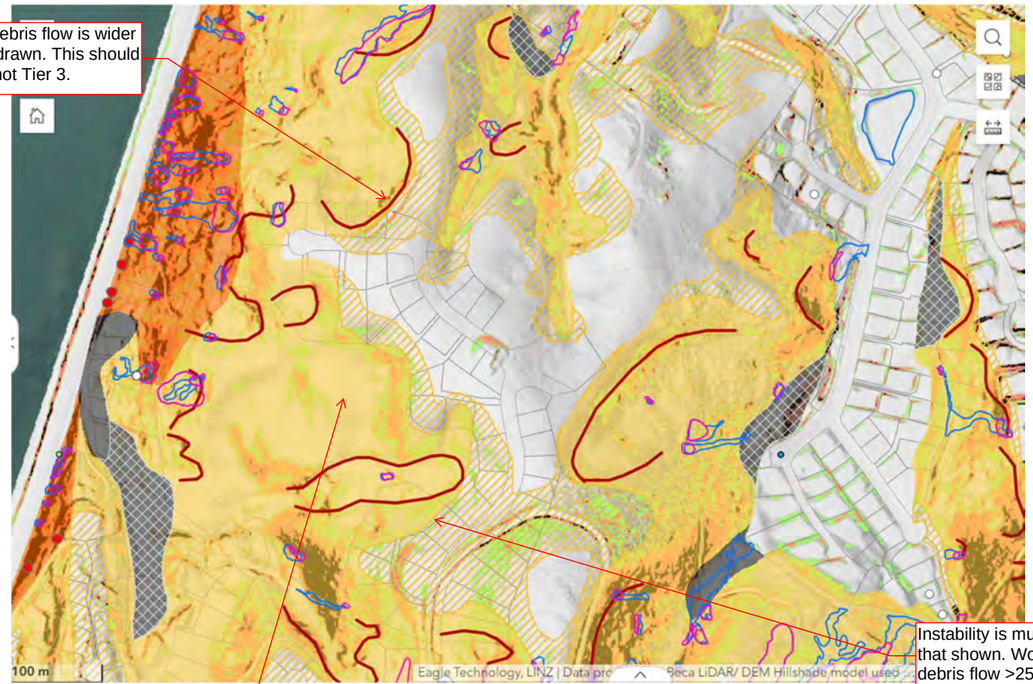
Geomorphic mapping has missed a large deep seated failure here. This should trigger Tier 2 not Tier 3.




Instability is much wider than that shown. Would classify as debris flow >25 m wide i.e Tier 2

Figure A 3 - Bayview Central (hillshade)

This shallow debris flow is wider than 25 m as drawn. This should trigger Tier 2 not Tier 3.




Instability is much wider than that shown. Would classify as debris flow >25 m wide i.e Tier 2

Geomorphic mapping has missed a large deep seated failure here. This should trigger Tier 2 not Tier 3.

Figure A 4 - Bayview Central

**A3 + A4 Response**

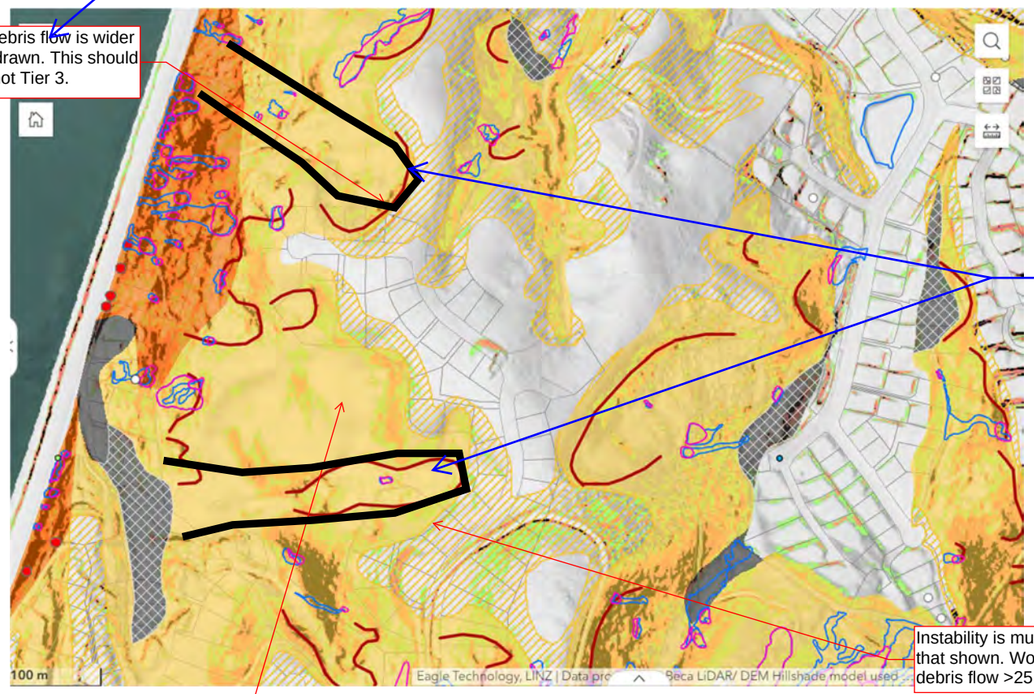
Based on the datasets used/available, this feature was not identified on the published geologic maps and the Beca staff did not observe a clearly defined headscarp feature in the datasets that clearly indicated a deep seated feature being present. Therefore, they did not have sufficient evidence to define it as this type of feature so it was identified as Area 3 rather than Area 2. To confirm if it was deeper seated would require field verification, intrusive investigations or site specific knowledge which was not included or available as part of developing regional scale susceptibility maps in this area. This level of detail would be expected to be provided at the site specific assessment stage that the susceptibility map would trigger.

With regards to the width of the instabilities, one instability feature identified within the mapping is identified as having a maximum width of <25m and therefore did not warrant inclusion. Other feature was interpreted as a shallow instability.

Note: The SI-TAG did not have specific comment of deep seated instability in this area and the feature identified that Beca 'missed' was not mapped in the geology map (Johnston et al. 2021). Also, if the recommendation to combine areas 2 and 3 is accepted, then the extents of the overlay will not change in this area in light of other experts comments.

Inconsistent terminology used by other experts. Says shallow debris flow. Earthflows were criteria for Tier II, not shallow debris flow. Interpretted as a shallow feature by Beca, therefore width does not affect this.

This shallow debris flow is wider than 25 m as drawn. This should trigger Tier 2 not Tier 3.




Features mapped in geologic map as landslide deposits

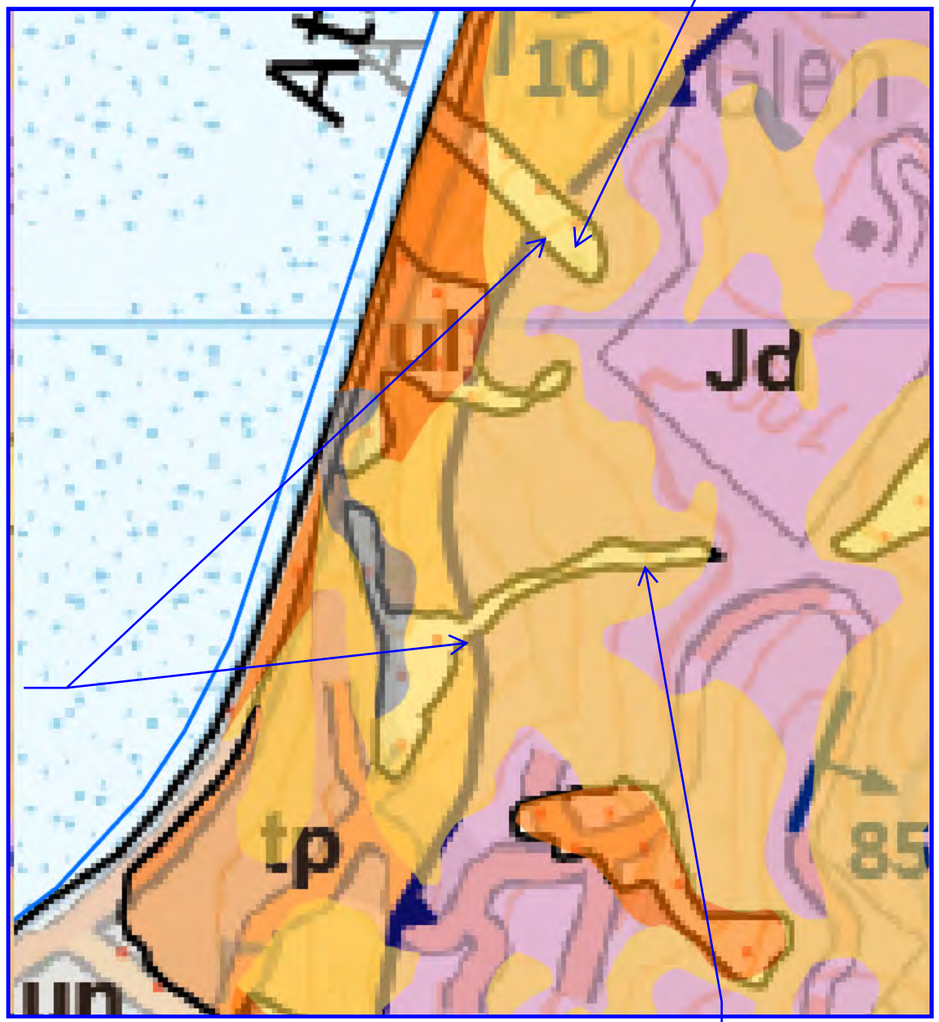
Instability is much wider than that shown. Would classify as debris flow >25 m wide i.e Tier 2

Geomorphic mapping has missed a large deep seated failure here. This should trigger Tier 2 not Tier 3.

Figure A 4 - Bayview Central

Not identified in geologic map, or a clearly defined headscarp feature observable in the datasets that clearly indicated a deep seated feature.

Widest point = >25m




Widest point =23m

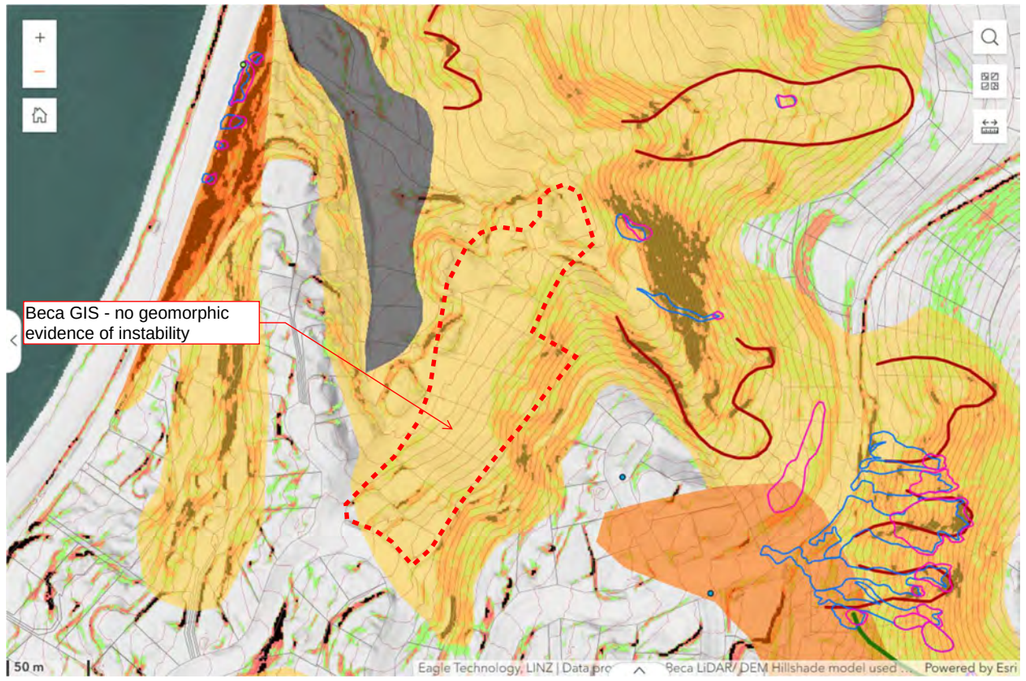



Figure A 5 - Bayview Ledger

Why does Tier 2 stop, when it is still well within the debris field of major instability mapped by Johnson et al 2022?

Based on shape of Tier 2 orange this is based on landslide mapped in Johnson 2022, despite it not being shown as such.

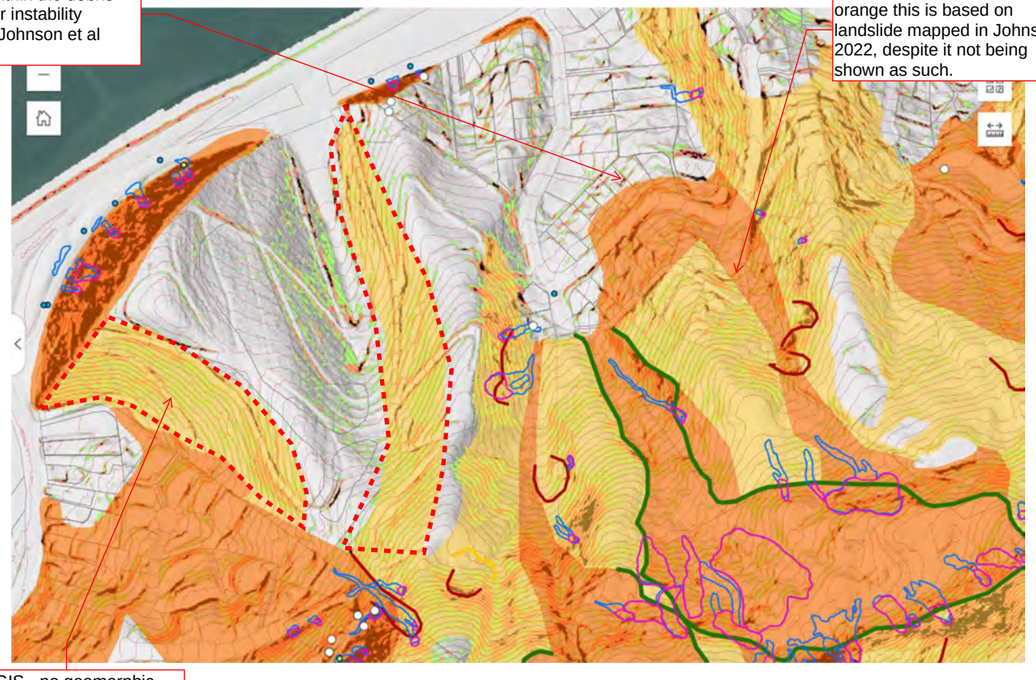



Figure A 6 - Wakapuaka Cemetery

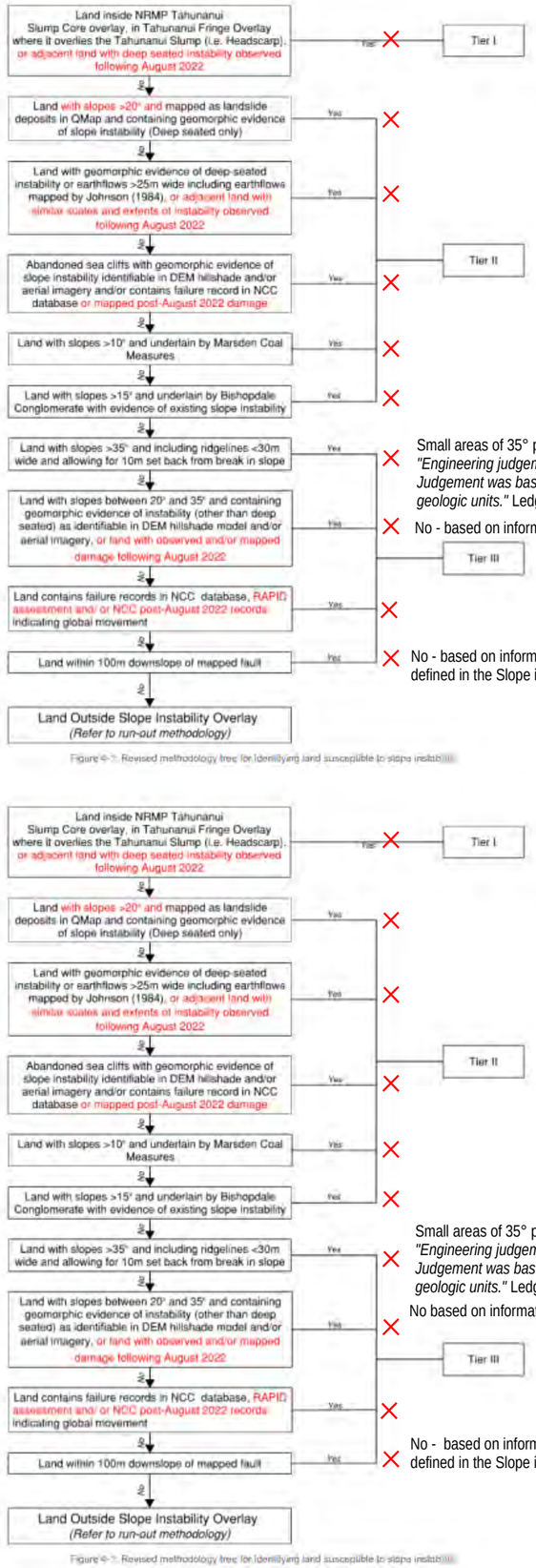



Figure 4-2: Revised methodology tree for identifying land susceptible to slope instability

Small areas of 35° plus illustrated from automated slope angle determination from the DEM. However, Becas 2021 document allows: *"Engineering judgement has been used to determine whether slope profiles partially greater than 35 degrees have been included in the overlay. Judgement was based on the overall steepness of the slope profile using the 2 m elevation contours, overall topography, and underlying geologic units."* Ledger Road sites can clearly be considered to be on average <35°.

No - based on information provided by Beca in GIS. Which does not present any geomorphic evidence of instability.

No - based on information provided by Beca in GIS. This only adopts 1:250,000 active faults. Flaxmore fault located upslope of lots but not defined in the Slope instability susceptibility GIS.

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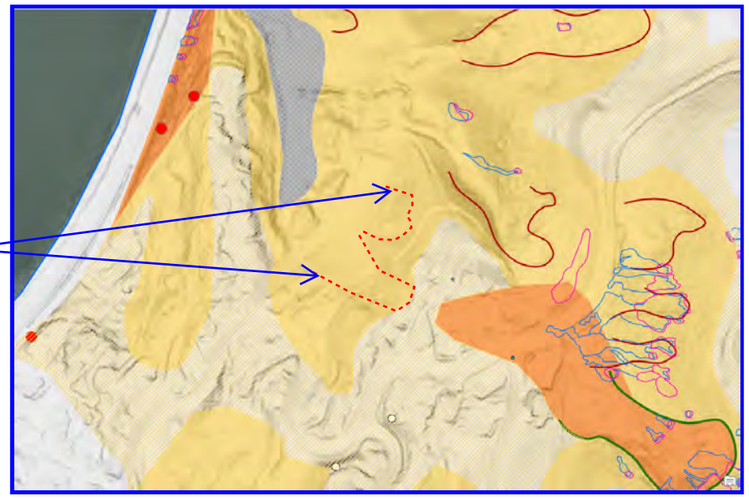
No based on information provided by Beca in GIS. Which does not present any geomorphic evidence of instability.

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**A5 Response**

The slope instability inventory has been created in accordance with the AGS guidance and aligns with a 'basic' level inventory. The mapping of features is not considered to be an exhaustive record of all instability in the region but is sufficient to show the classification and distribution of slope instability on hillslopes in the region. The aim of the mapping was to capture a representation of slope failure locations and types in the region. Please note that there are features interpreted in the DEM that are not included in the slope instability inventory within this area (see snip and commentary in the Statement of Reply for why features not included). These features extend into the area identified by red dashed area in A5 which is why this red dashed area is included in the overlays. Also, as described in Beca, 2021 there is evidence of slope instability on nearby slopes. The suggested change areas exhibit consistent geomorphic and geologic conditions to these areas where previous failures have occurred. Therefore, this area should remain within the overlay and no change is required.

Inferred scarps not shown in inventory that extend down into area below.

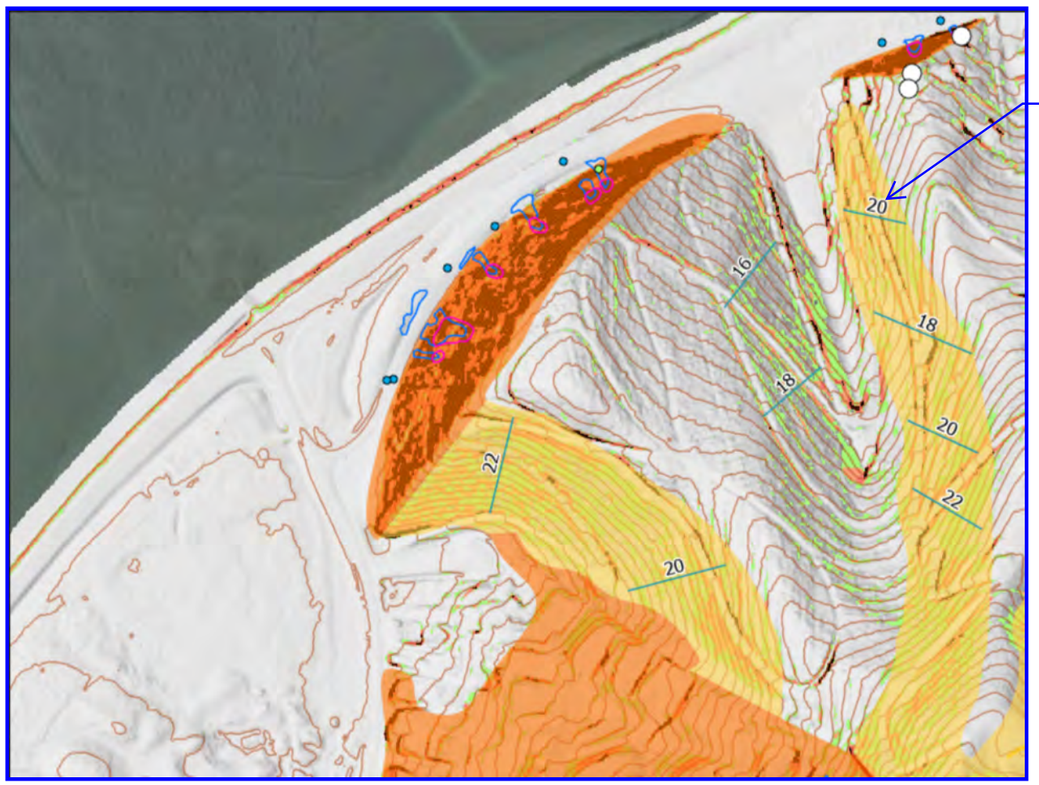


**A6 + A19 Response**

Tier II area is based on the Johnston et al. 2021 geologic map and refined based on the DEM. The toe area extent was based on initial assessment criteria considering slope angle which is why this is not included in the overlay (as described in reply document). No additional areas were added when this was refined into Tiers, therefore the extent reflects the initial mapping agreed with SI-TAG.

Tier III areas identified in the Beca map are >20 degrees and exhibit consistent slope morphology and underlain by same geologic unit as adjacent slopes that have evidence of previous shallow failures including post-August features (see snips). Slope identified in A19 on the west side of the cemetery is not included within the overlay as the overall slope angle across the area is largely less than 20 degrees. Therefore the area was not included. Alternatively, the south and east slopes identified have overall slope angles of >20 degrees which is why they are included (showing consistent application of methodology). Although there is no geomorphic evidence of instability in these areas, there is in the adjacent gully in the same materials on similar slopes which is why they are included.

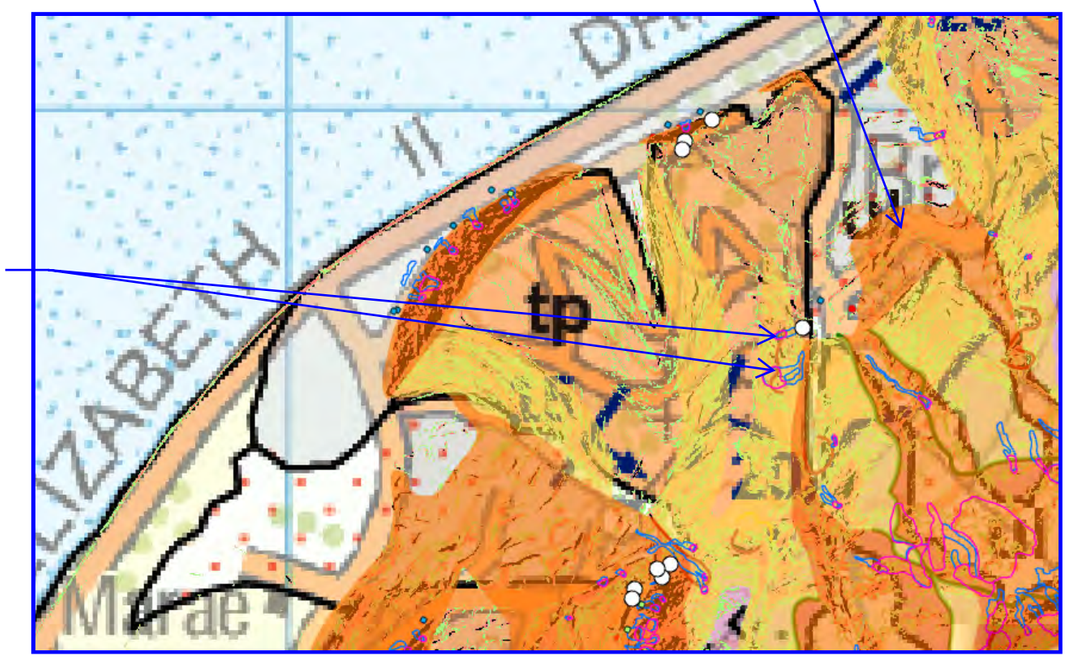
Note: Some of this area is outside of PC29 extents. Assuming because it is a cemetery




Slope angles taken from contours to show consistency of methodology application in terms of slope angles in this area

Note instability on adjacent hill area in the same geology and similar slope angles

Mapped landslide deposits and lower area excluded due to slope angle



Why does the tier 2 area stop in a mapped area of landslide debris?

No geomorphic evidence of instability shown. Johnson et al 2022 map a failure. But it has different extents. What is the basis for this Tier 2 area?

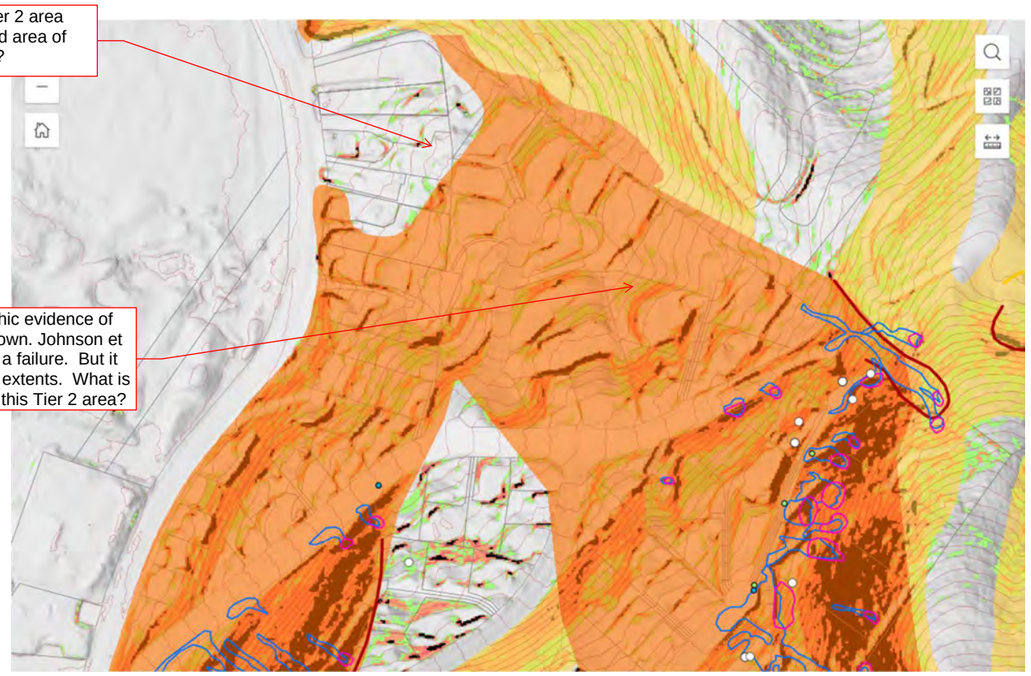
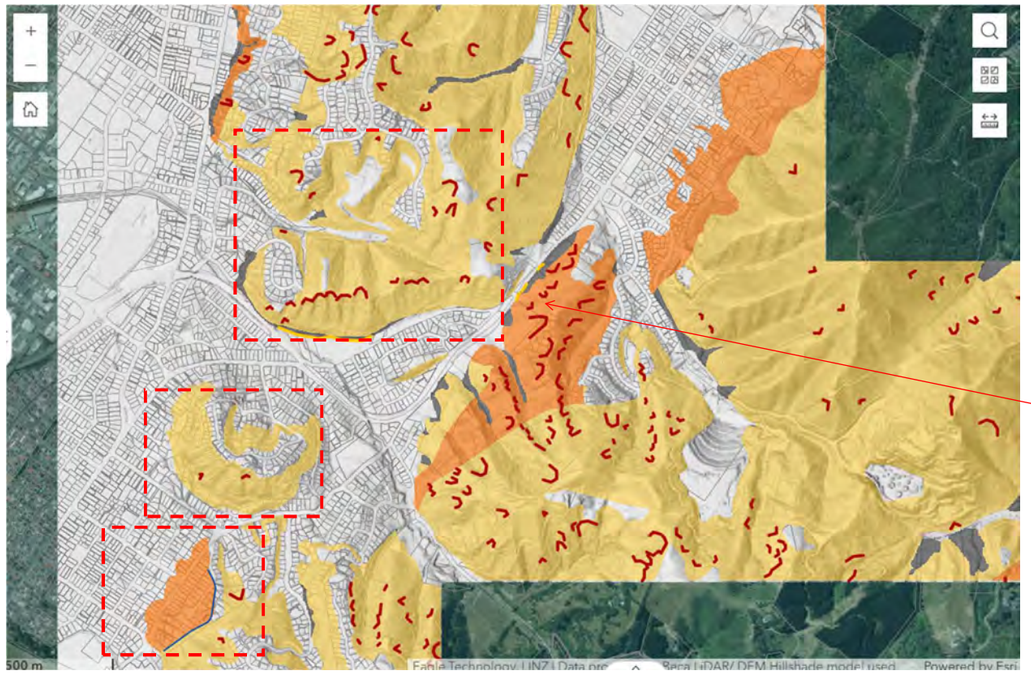


Figure A 7 - Atawhai Drive, Havenview, Young Way

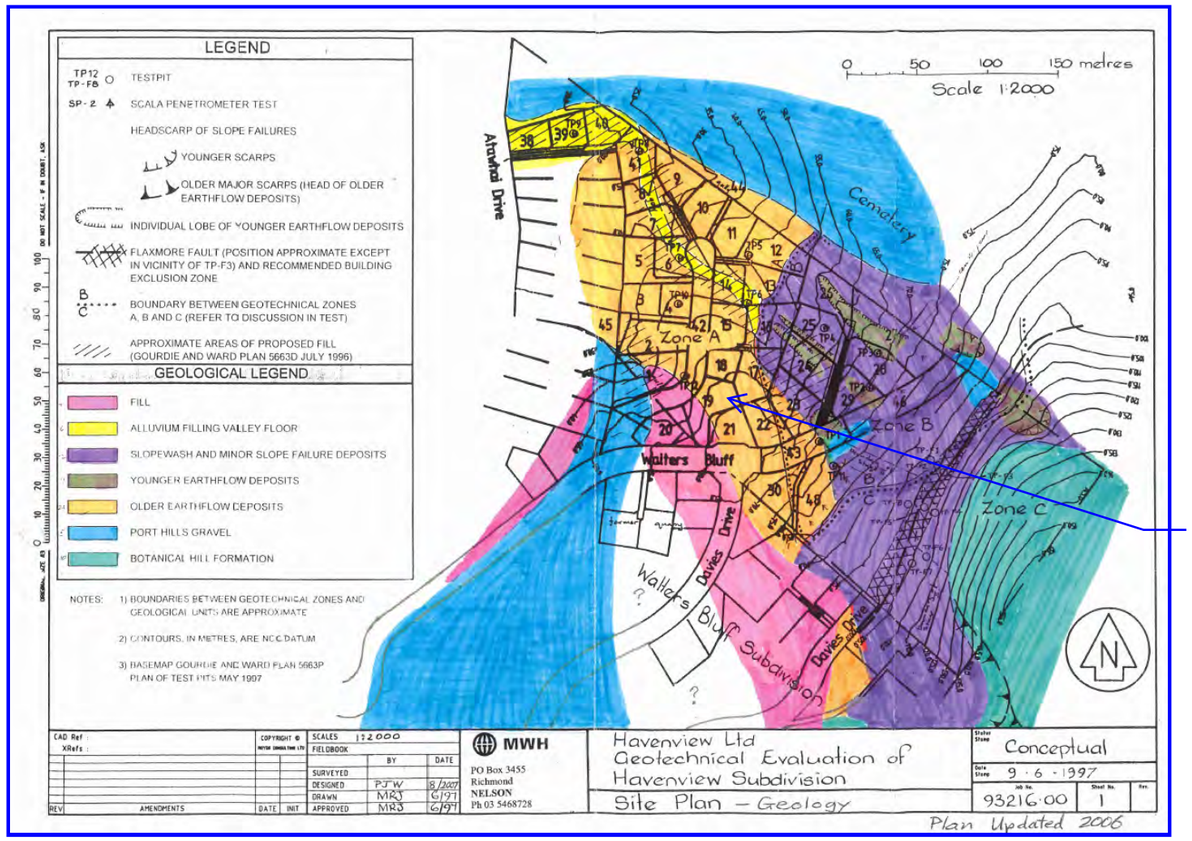


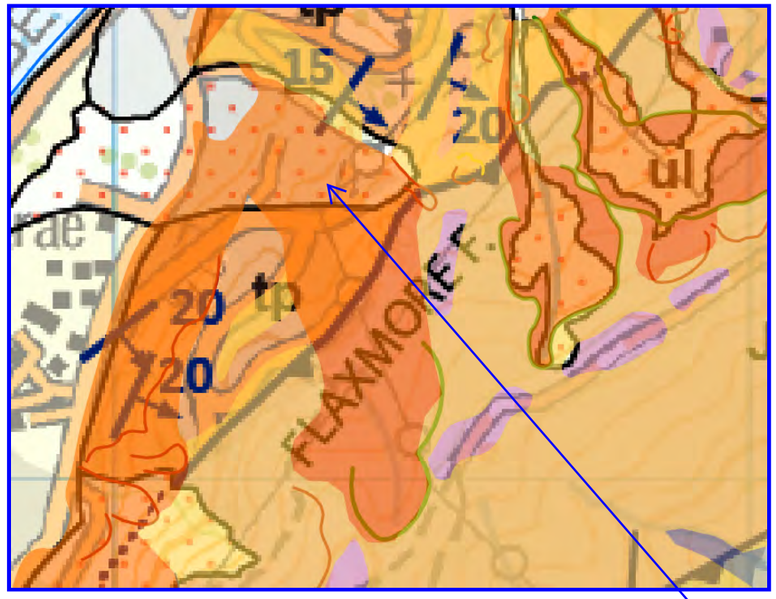
I'm not sure about this Tier 2 zone. The geological they have given us is QMap where Marsden coal measures are not differentiated.

Figure A 8 - Whakatu/Bishopdale Overview

## A7 Response

Tier II area is based on the geologic map (Johnston et al. 2021) and refined/expanded to include the area upslope using the DEM as Beca were aware this area is earthflow deposits due to in-house knowledge in the area. The evidence of this earthflow has likely been obscured by the earthworks of the subdivision which is why it is not observable. It also shows the same morphology as the earthflows identified to the north east in similar gullies and geology. The toe area extent was based on initial assessment criteria considering slope angle which is why this is not included in the overlay (as described in the Statement of Reply document). No additional areas were added when this was refined into Tiers, therefore the extent reflects the initial mapping agreed with SI-TAG.






Tier II based information Beca are aware of, that includes earthflow deposits present (see adjacent map). This was included into the overlay post creation of inventory map, therefore full extent was not shown

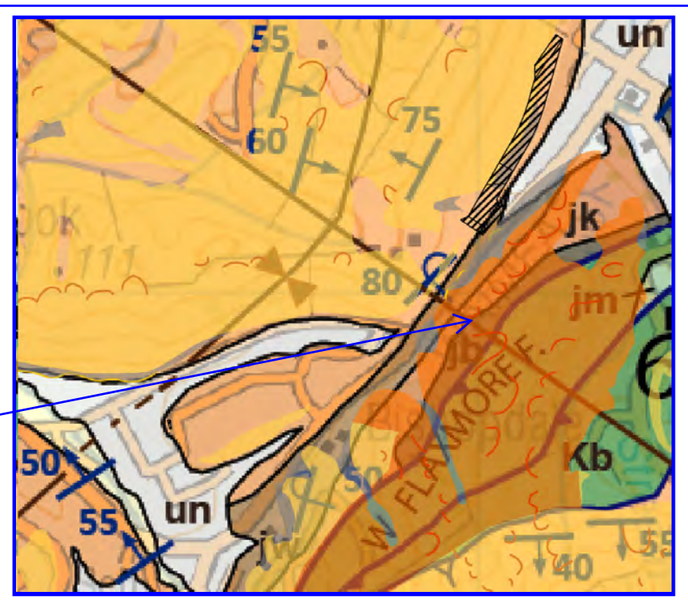
Partially identified as landslide in geologic map, boundaries refined using topography visible in DEM. Area within eartthflow feature identified in geomorphic map which exhibits similar morphology to earthflows formed in surrounding Jd (Drumduan) unit.

## A8 + A24 Response

Beca have used the geological map information from Johnston et al. 2021 to define this area. It is identified in these maps as Bishopdale Conglomerate (Kb), therefore, Beca have included areas where the slope angle is greater than 15 degrees as per methodology. The areas outside of this geology unit (that are still Tier 2) are interpreted to be earthflow deposits and included because of this, not because of the underlying geology, as indicated on A24 by Mr Lines and Dr Hargraves. These earthflows were discussed with the SI-TAG following the August 2022 event as there were a number of these that activated in this event and started to encroach on the road. These earthflow features are not shown as such in the inventory as they were identified during the review process and following the SI-TAG discussions, but the inventory was not updated to reflect the change of landslide type. This is a well known area of instability in Nelson.

Kb = Bishopdale Conglomerate downslope area is Braemar (Jb), Kawai Fmt (Jk), and Wakatu Fmt (Jw) - all Jenkins group.

Areas outside of this geology are earthflow deposits as identified in review process and following SI-TAG involvement.






I'm not sure what aerials have been used. But the top of the south maps show failures in this area, which haven't been picked up.

Figure A 9 - Tasman Heights/Coastal View




No geomorphic evidence of instability. Some localised areas of >35° terrain, but these seem to correspond to property boundaries and road verges (local retaining?). On balance tier 3 not appropriate for the red areas.

Very little geomorphic evidence of instability mapped. However, there is plenty of it in this area, which also has >35° terrain. On balance tier 3.

Figure A 10 - Austin Ward Heights

**A9 Response**

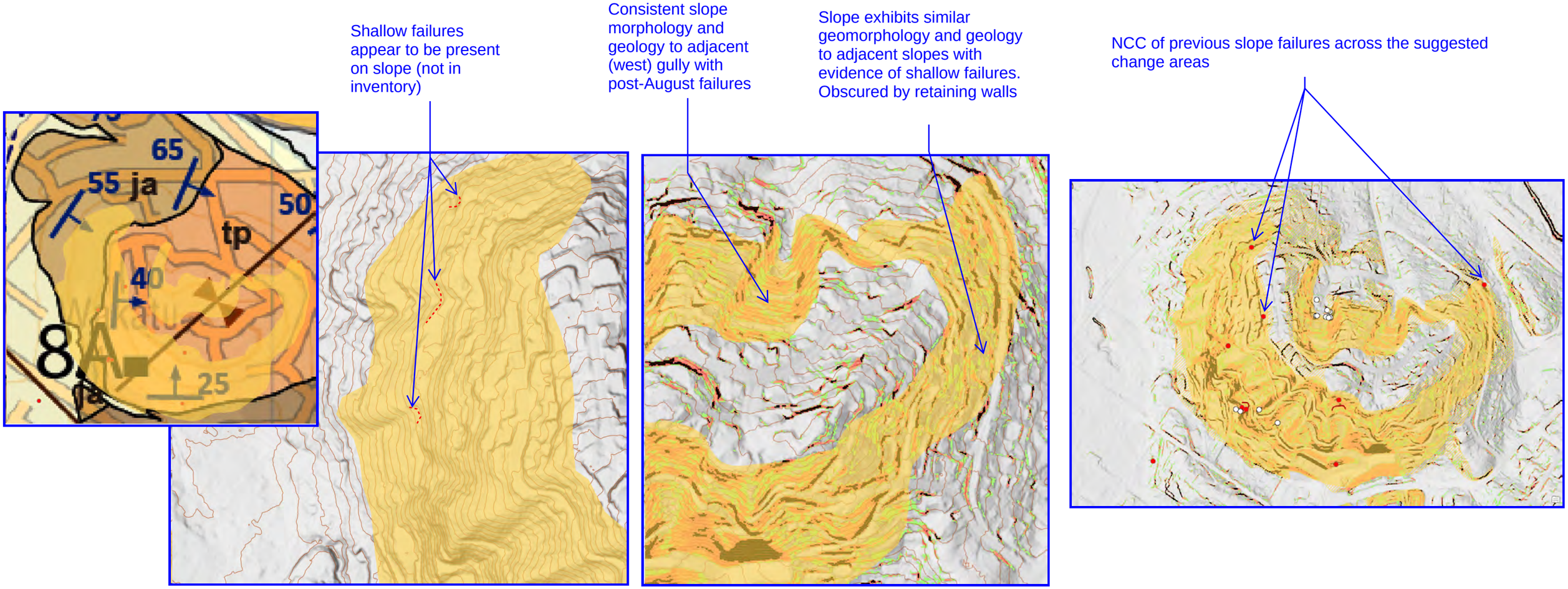
The slope instability inventory has been created in accordance with the AGS guidance and aligns with a ‘basic’ level inventory. The mapping of features is not considered to be an exhaustive record of all instability in the region but is sufficient to show the classification and distribution of slope instability on hillslopes in the region. The aim of the mapping was to capture a representation of slope failure locations and types in the region. In my opinion, this type of inventory, in combination with the other evidence of slope instability (i.e. records provided by NCC and the Post-August 2022 landslide dataset provided by GNS) is sufficient to inform the creation of these slope overlays and aligns with the AGS guidance.

Features/areas identified by the experts are within the extents of the overlay, therefore no change is required.

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**A10 Response**

The slope instability inventory has been created in accordance with the AGS guidance and aligns with a ‘basic’ level inventory. The mapping of features is not considered to be an exhaustive record of all instability in the region but is sufficient to show the classification and distribution of slope instability on hillslopes in the region. The aim of the mapping was to capture a representation of slope failure locations and types in the region. Please note that there are records provided by NCC of failures across the suggested change areas and features identified in the DEM that are not included in the slope instability inventory (see snip). Also, as described in Beca, 2021 there is evidence of slope instability on nearby slopes. The suggested change areas exhibit consistent geomorphic and geologic conditions to these areas where previous failures have occurred. Therefore, I believe this area should remain within the overlay and no change is required.



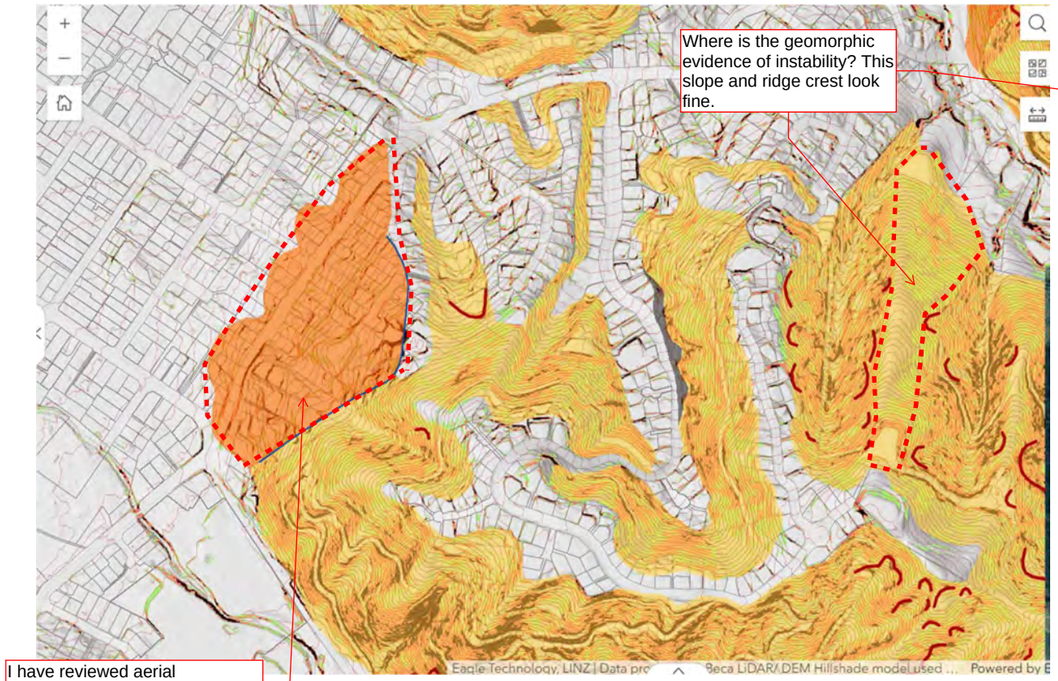



Figure A 11 - Kakenga Road




Figure A 12 - Kakenga Road

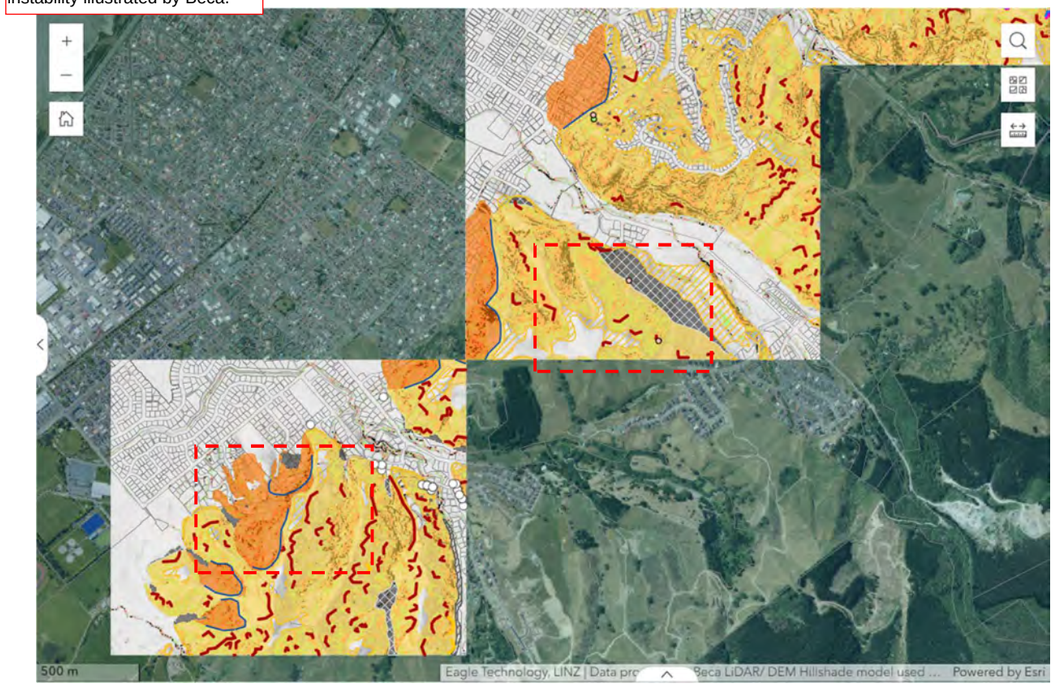
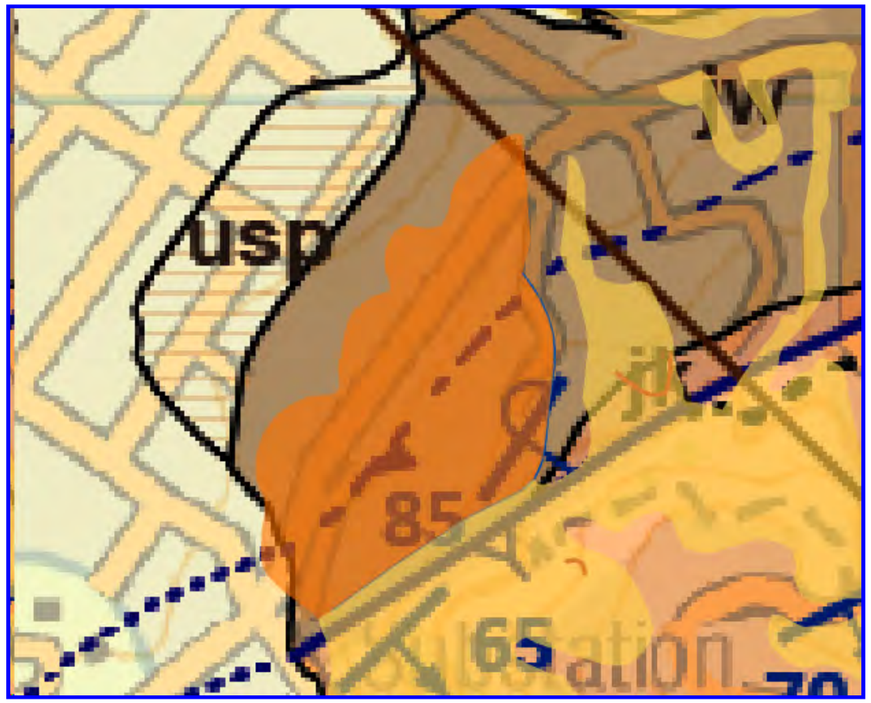


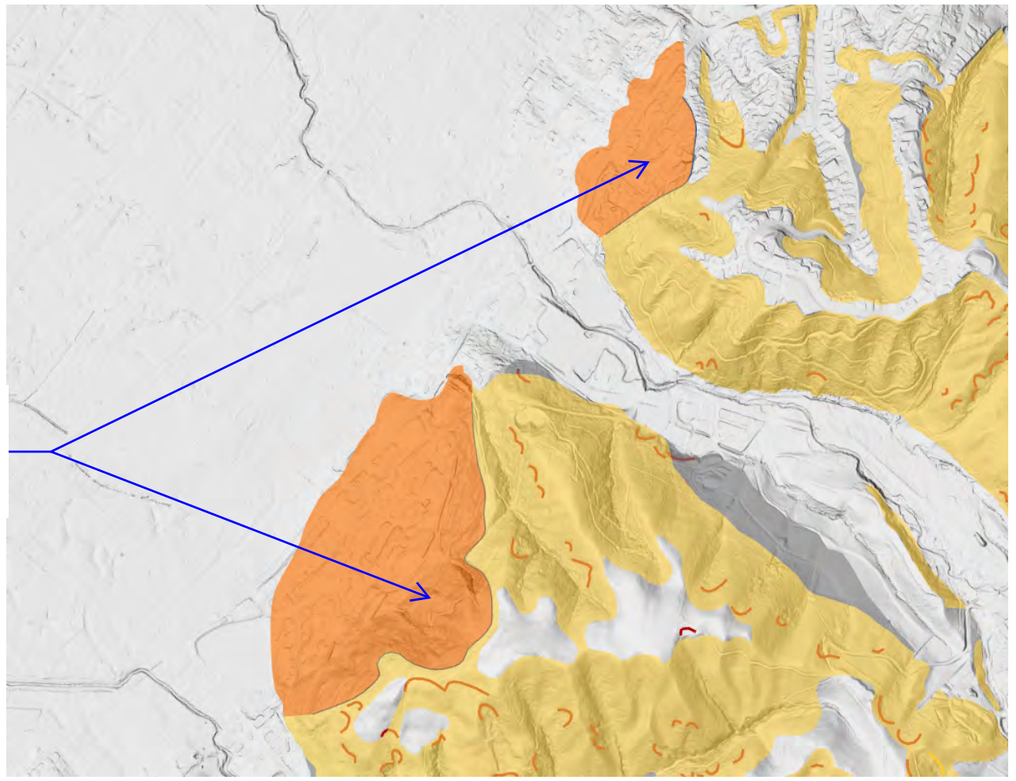

Figure A 13 - Suffolk Overview

**A11 + A12 + A23 Response**

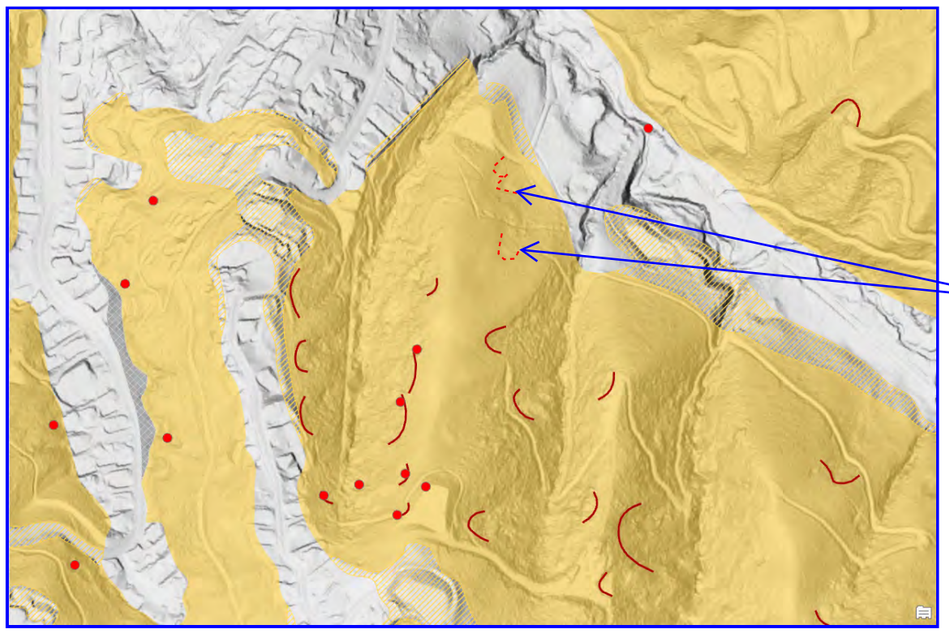
Tier 2: This feature was identified in the desktop datasets (DEM) as a deep seated landslide because its morphology was similar to that of deep landslide features to the south west on adjacent hills. A headscarp feature was interpreted in the DEM and 'fingers' of what was inferred to be landslide debris lower down the slope. More site specific knowledge may show this is not a deep seated landslide however, however, this is the intent of further investigation as warranted by the susceptibility map. Note that there is presence of shallow instability within this area obscured by landscaping works that are not included in the inventory. Considering a combined overlay, it will not affect the extent of the overlay.

Tier 3: Please note that there are features interpreted in the DEM that are not included in the slope instability inventory within this area (see snip). These extend into the area identified which is why it is included in the overlays. There is also records provided by NCC of failures in the south of this area. The ridge remains in the overlay because it is too narrow to be excluded as per the methodology. Also, as described in Beca, 2021 there is evidence of slope instability on nearby slopes. The suggested change areas exhibit consistent geomorphic and geologic conditions to these areas where previous failures have occurred. Therefore, I believe this area should remain within the overlay and no change is required.



Exhibits similar morphology to other deep seated instability to south west



Shallow failures appear to be present on slope (not in inventory map)

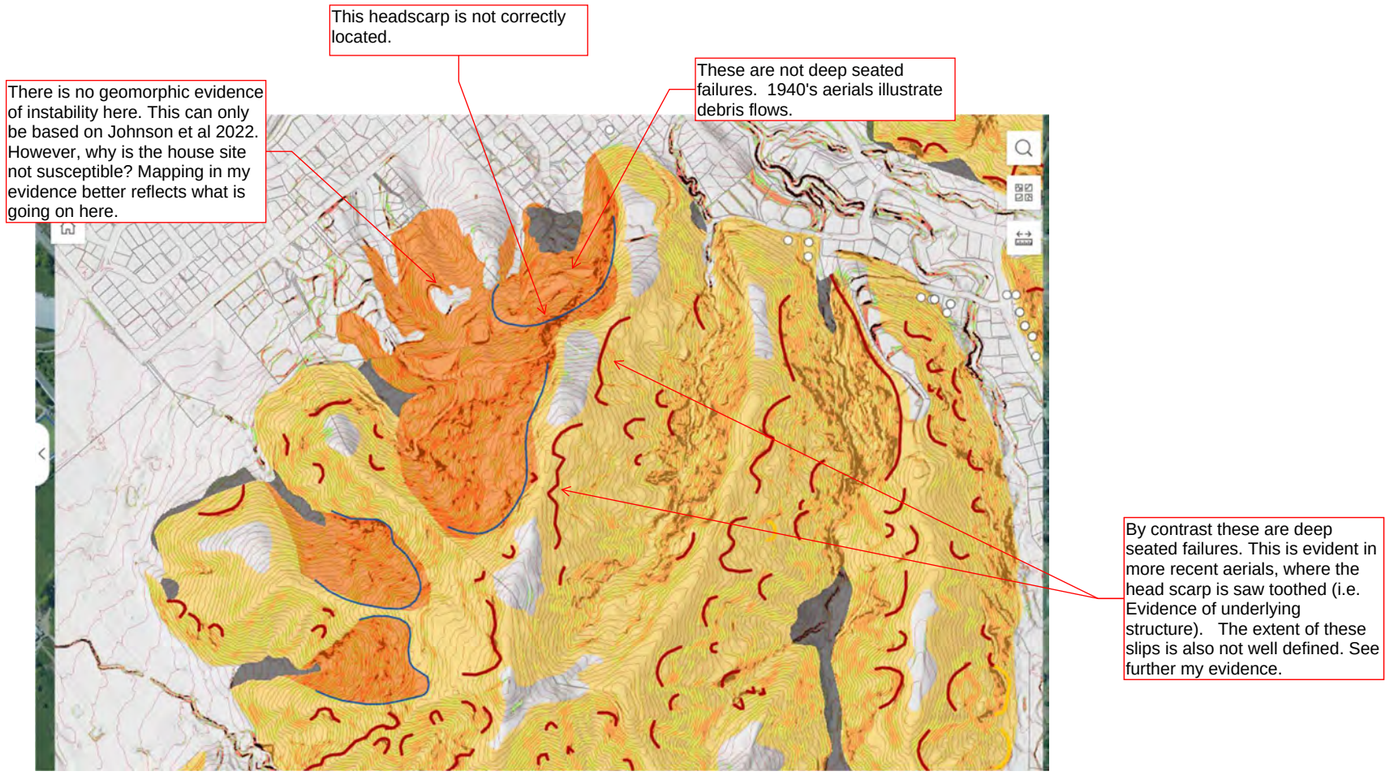



Figure A 14 - Suffolk Heights

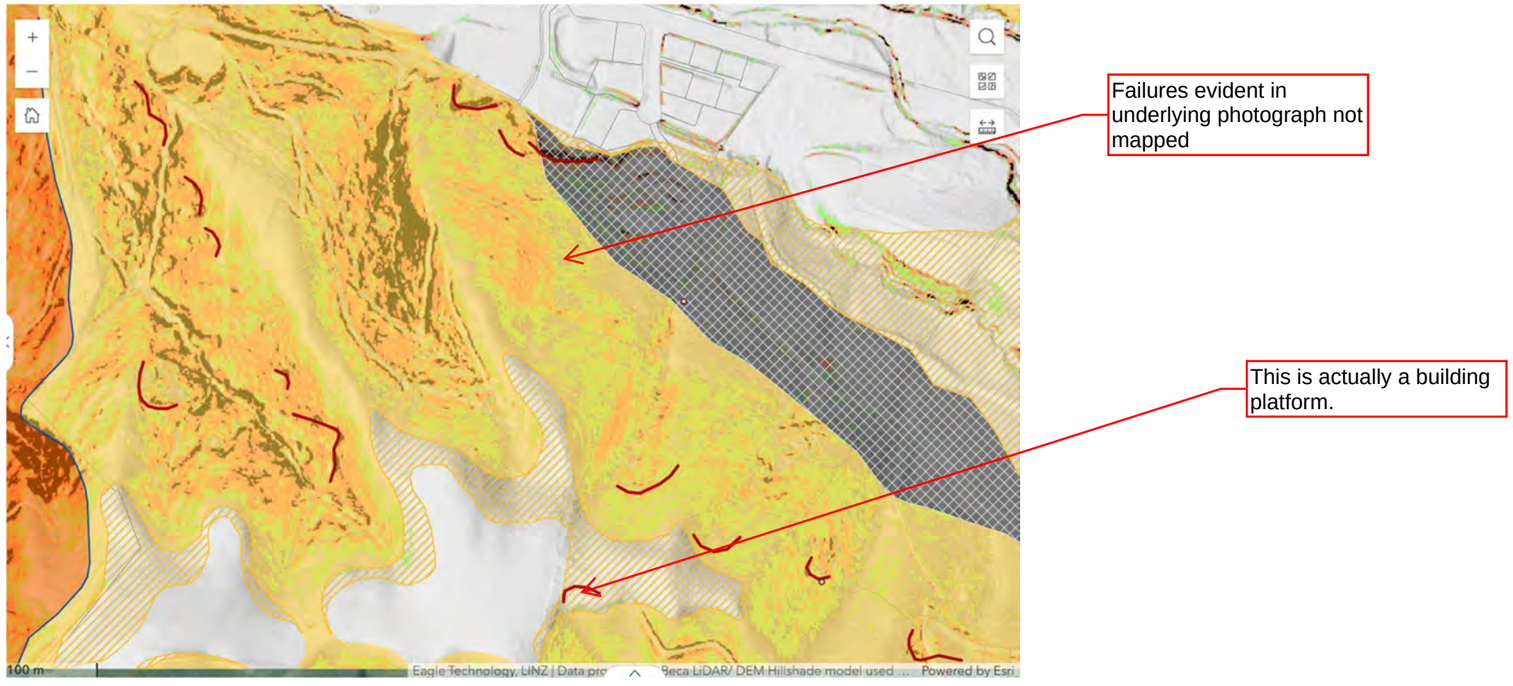



Figure A 15 - Quail Rise to Marsden Valley Road

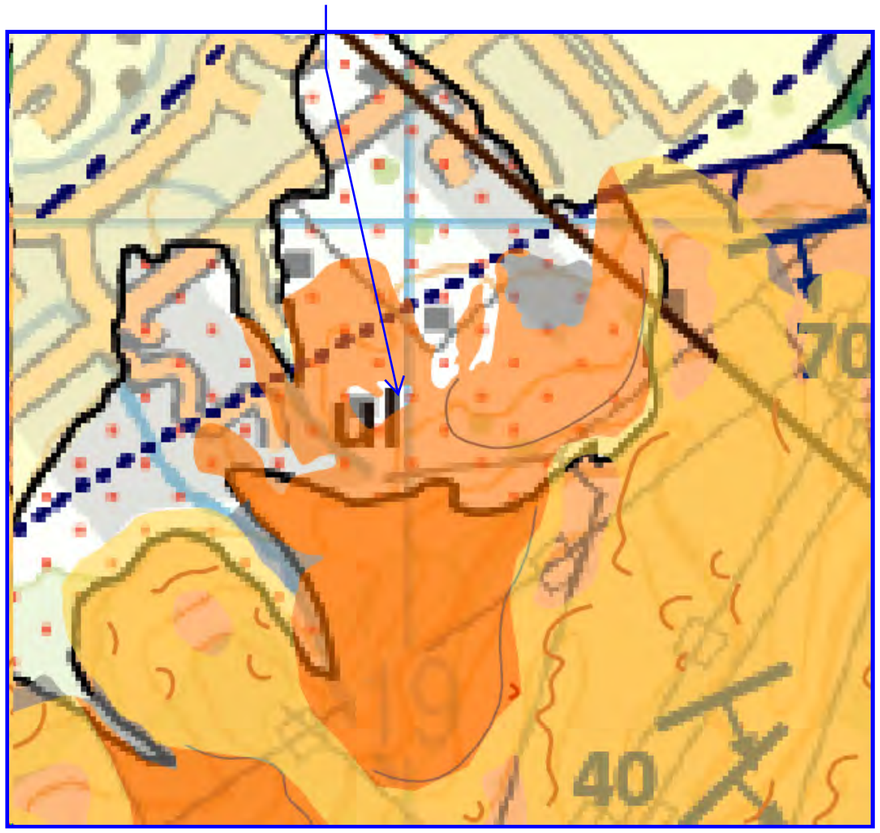
**A13 + A14 Response**

Tier 2: These areas are mapped as landslide deposits in the Johnston et al. 2021 map and their extents were refined based on interpretation of the DEM, therefore, the areas were included as Tier 2. The scarp location was defined as presented in the overlay extents during the review process ,but not updated in the inventory. The 'hole' in tier 2 identified at Suffolk Heights is there because of the way the maps were developed and is a hangover of this. The original slope overlay maps were one map without any Tiers identified and was largely developed by the 20 degree slope angle/geomorph evidence criteria of the methodology tree. Based on the recommendation from the SI-TAG, the map was split out into the different tiers, but its extents were not changed. As this area was less than the 20 degrees criteria in the original overlay it was not included. When the map was differentiated into its tiers, the map extents were not changed therefore it was not included in the updated overlay with the tiers.

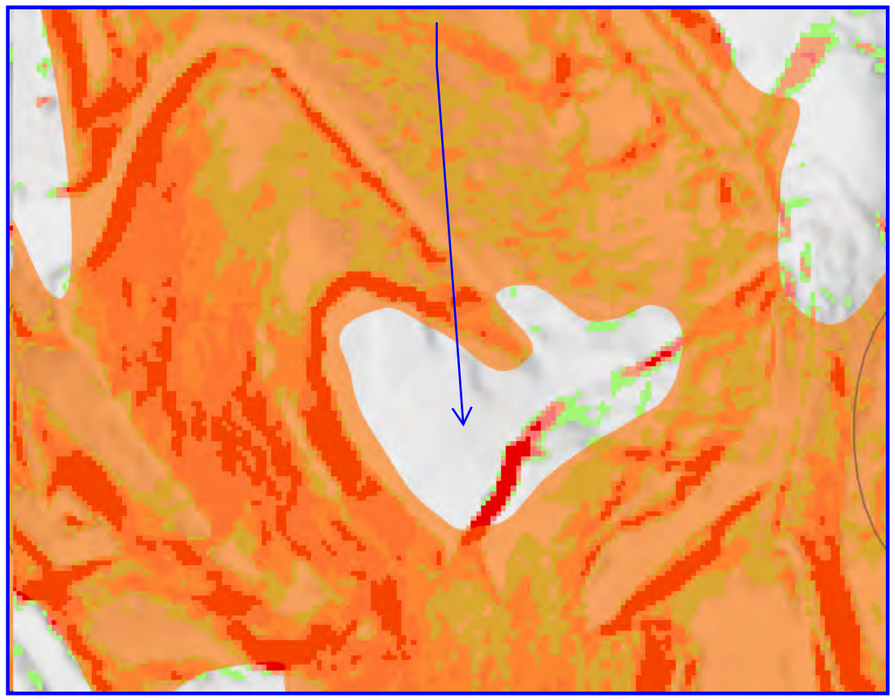
Tier 3: Based on the datasets used/available to the assessing person (and verifier), they assessed and made judgement that the feature was either shallow or deep because the way they interpreted the datasets/information. To make a decision on whether an area fell within Area 2 or Area 3 of the slope overlay, they needed confidence or possibly additional information that was not available to them to decide, therefore made an appropriate judgement with the information at hand. To confirm if it was deeper seated would require field verification, intrusive investigations or site specific knowledge which was not included or available as part of developing regional scale susceptibility maps in this area.

Note: if the recommendation to combine areas 2 and 3 is accepted, then the extents of the overlay will not change in this area. Also, some of this area is outside of PC29 extents.

Mapped as landslide deposits in Johnston et al. 2021




Area <20 degrees therefore did not meet slope angle criteria to be included in original overlay



**A15 Response**

The slope instability inventory has been created in accordance with the AGS guidance and aligns with a ‘basic’ level inventory. The mapping of features is not considered to be an exhaustive record of all instability in the region but is sufficient to show the classification and distribution of slope instability on hillslopes in the region. The aim of the mapping was to capture a representation of slope failure locations and types in the region. In my opinion, this type of inventory, in combination with the other evidence of slope instability (i.e. records provided by NCC and the Post-August 2022 landslide dataset provided by GNS) is sufficient to inform the creation of these slope overlays and aligns with the AGS guidance.

Features/areas identified by the experts are within the extents of the overlay, therefore no change is required.

Note: Some of this area is outside of PC29 extents.

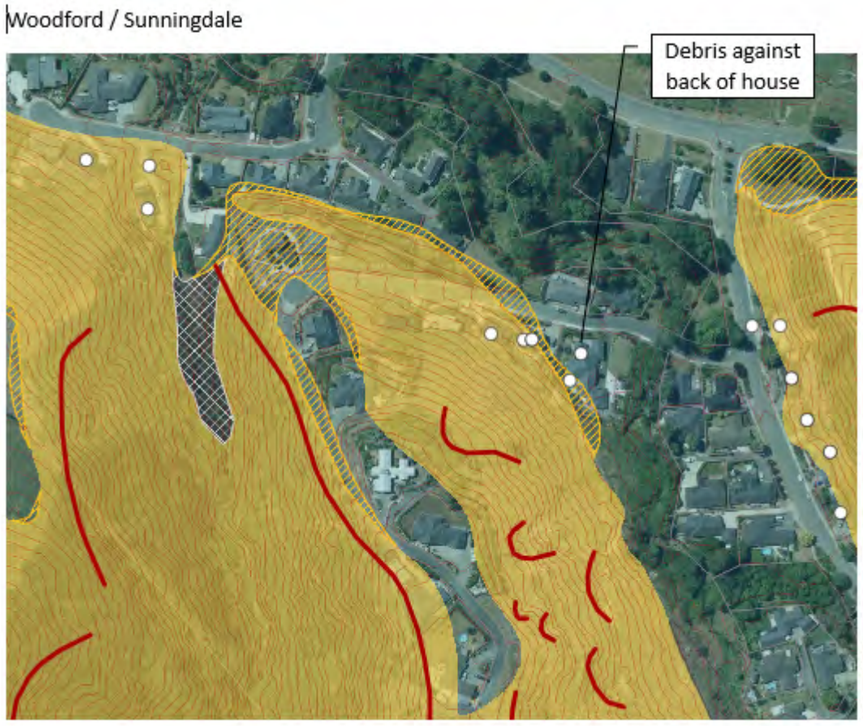



Figure A-16 Woodford / Sunningdale Drive

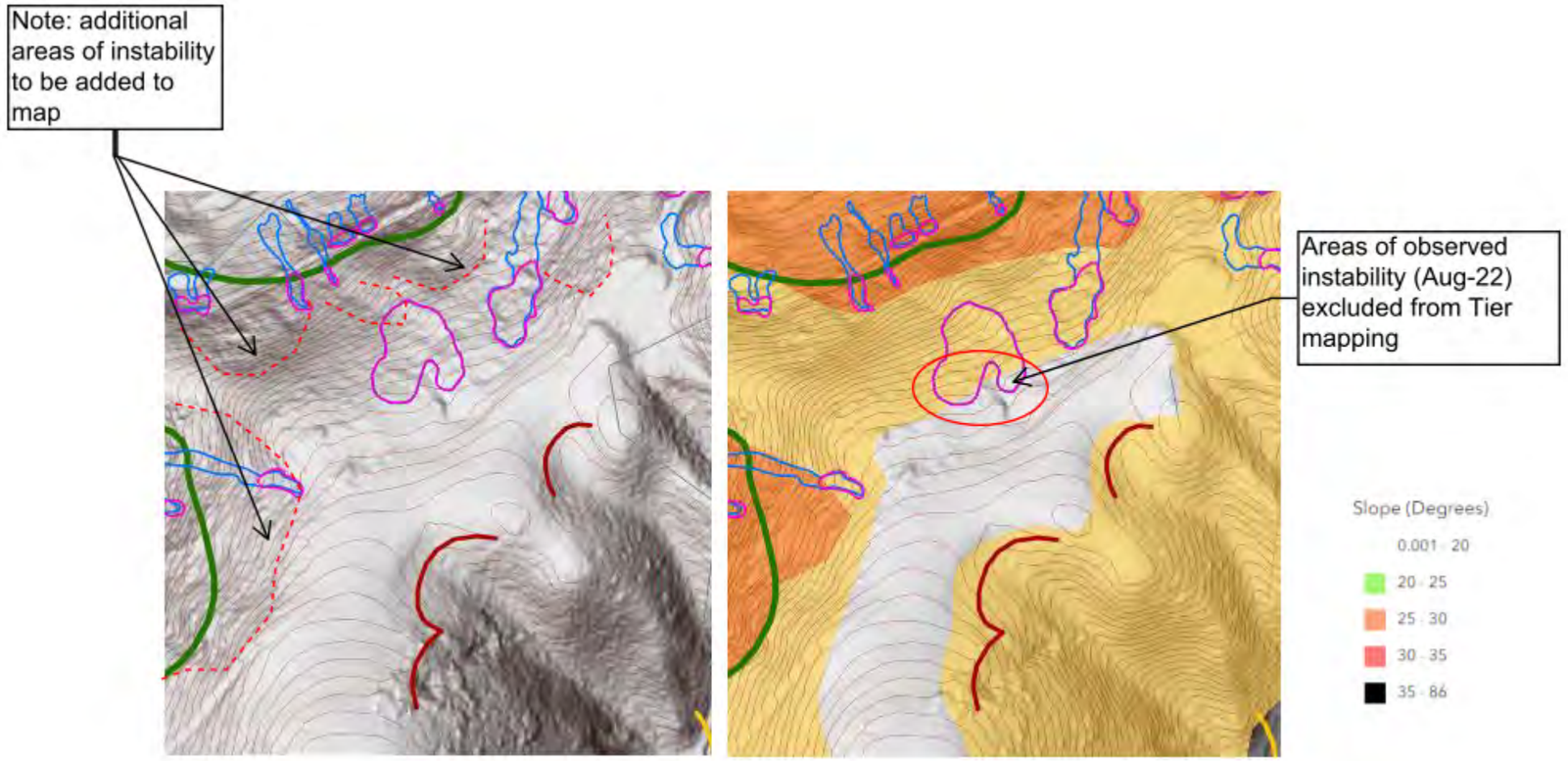



Figure A-17 Atawhai

**A16 Response**

I agree that this area should be included in the slope overlay (see snip)



Proposed extent of addition to overlay. Area is not outside the notified PC29 overlay extents

**A17 Response**

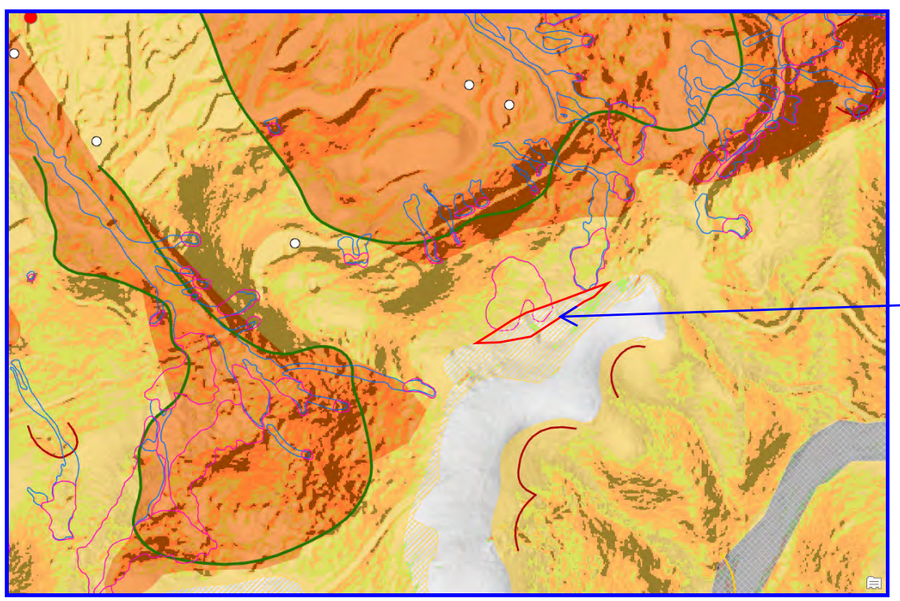
I agree that this small area should be included in the overlay (see snip in PDF for proposed extents)

With respect to other areas of instability noted. The slope instability inventory has been created in accordance with the AGS guidance and aligns with a ‘basic’ level inventory. The mapping of features is not considered to be an exhaustive record of all instability in the region but is sufficient to show the classification and distribution of slope instability on hillslopes in the region. The aim of the mapping was to capture a representation of slope failure locations and types in the region. In my opinion, this type of inventory, in combination with the other evidence of slope instability (i.e. records provided by NCC and the Post-August 2022 landslide dataset provided by GNS) is sufficient to inform the creation of these slope overlays and aligns with the AGS guidance. This does not affect the extent of the overlays, therefore no change is required for these.

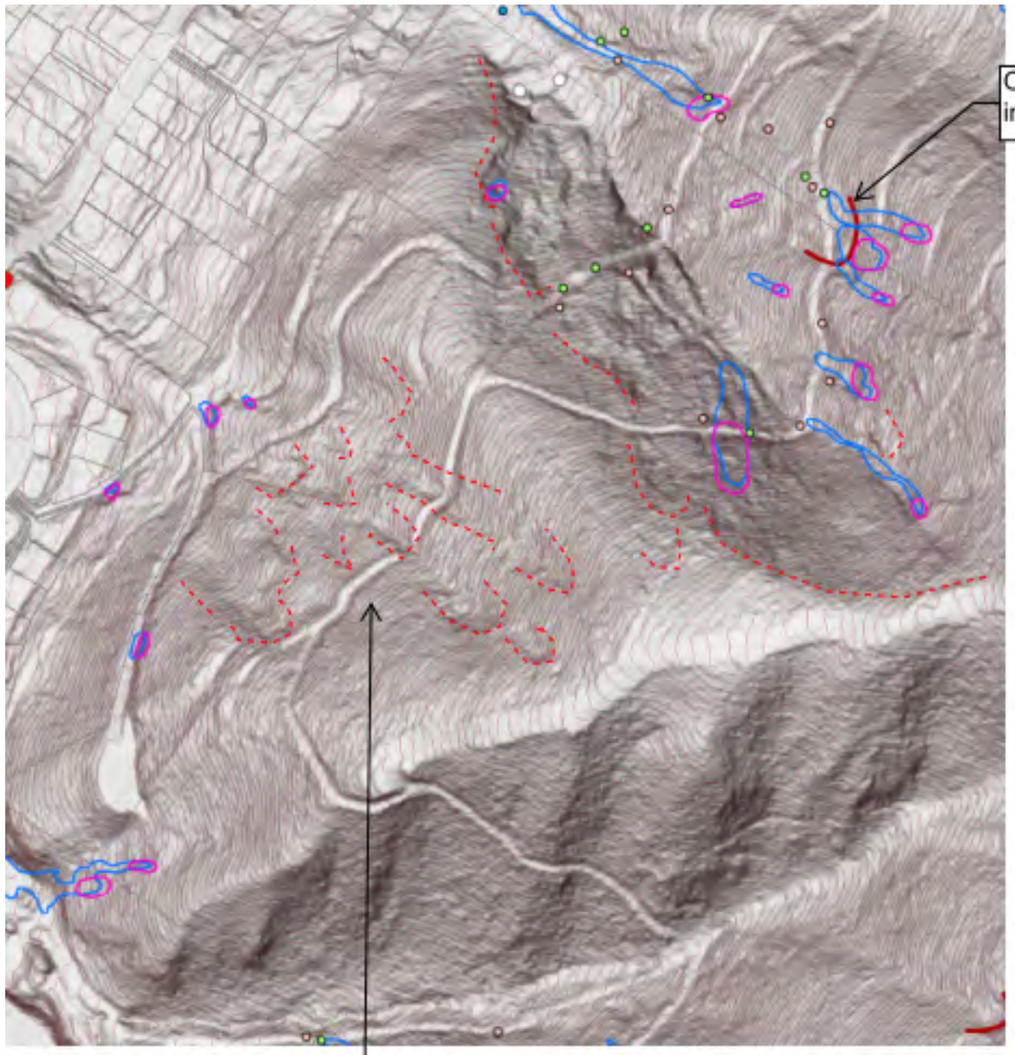
Note: area is outside of PC29 extents.

Distance = 8m; note scale of mapping. This was snipped at 1:5000



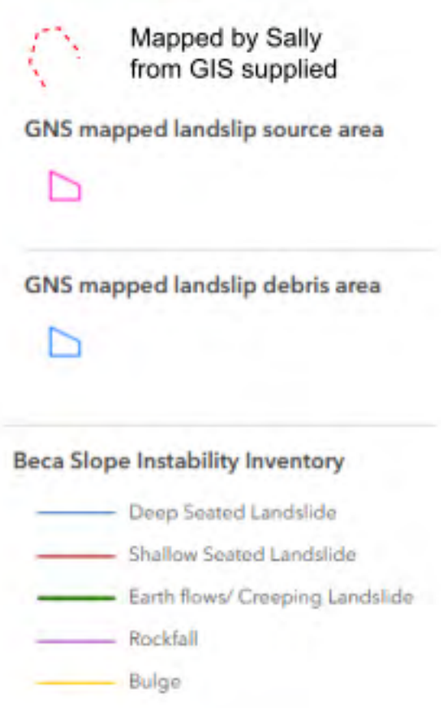


Proposed extent of addition to overlay. Area is not outside the notified PC29 overlay extents




This snip shows how very basic the Beca georphological mapping was and how many obvious landslip features are missing. Instead of just mapping landslip scarps, Beca might also have considered mapping whole areas as either being subject to shallow or deep-seated instability.

Figure A-18 Above Brunner Street (Grampians)

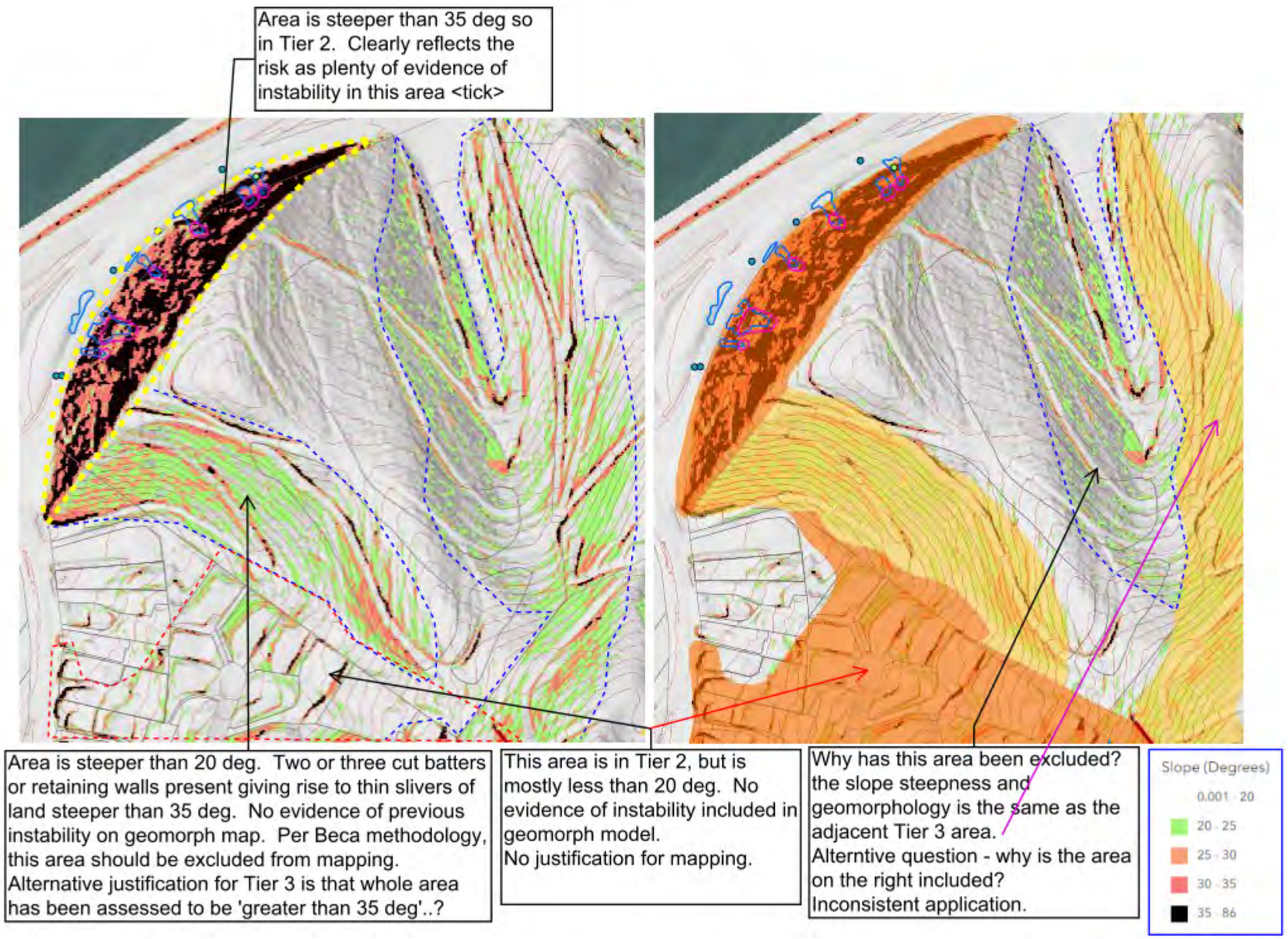


**A18 Response**

In this particular area, due to the amount of instability present on the slope, each individual feature was not identified as it is clear this whole area has stability issues. The slope instability inventory has been created in accordance with the AGS guidance and aligns with a ‘basic’ level inventory. The mapping of features is not considered to be an exhaustive record of all instability in the region but is sufficient to show the classification and distribution of slope instability on hillslopes in the region. The aim of the mapping was to capture a representation of slope failure locations and types in the region. In my opinion, this type of inventory, in combination with the other evidence of slope instability (i.e. records provided by NCC and the Post-August 2022 landslide dataset provided by GNS) is sufficient to inform the creation of these slope overlays and aligns with the AGS guidance.

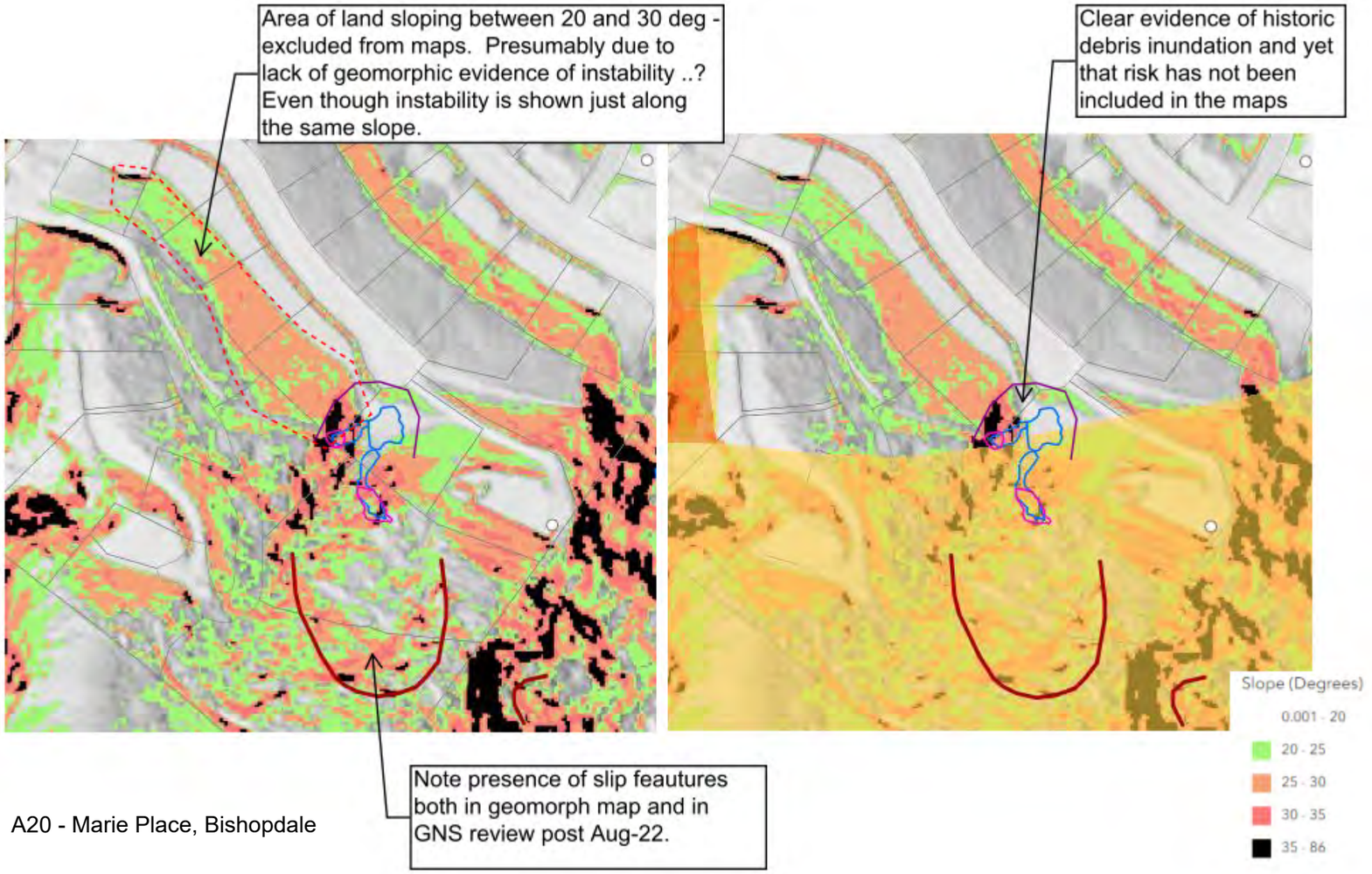
Features/areas identified by the experts are within the extents of the overlay, therefore no change is required.

Note: Some of this area is outside of PC29 extents.



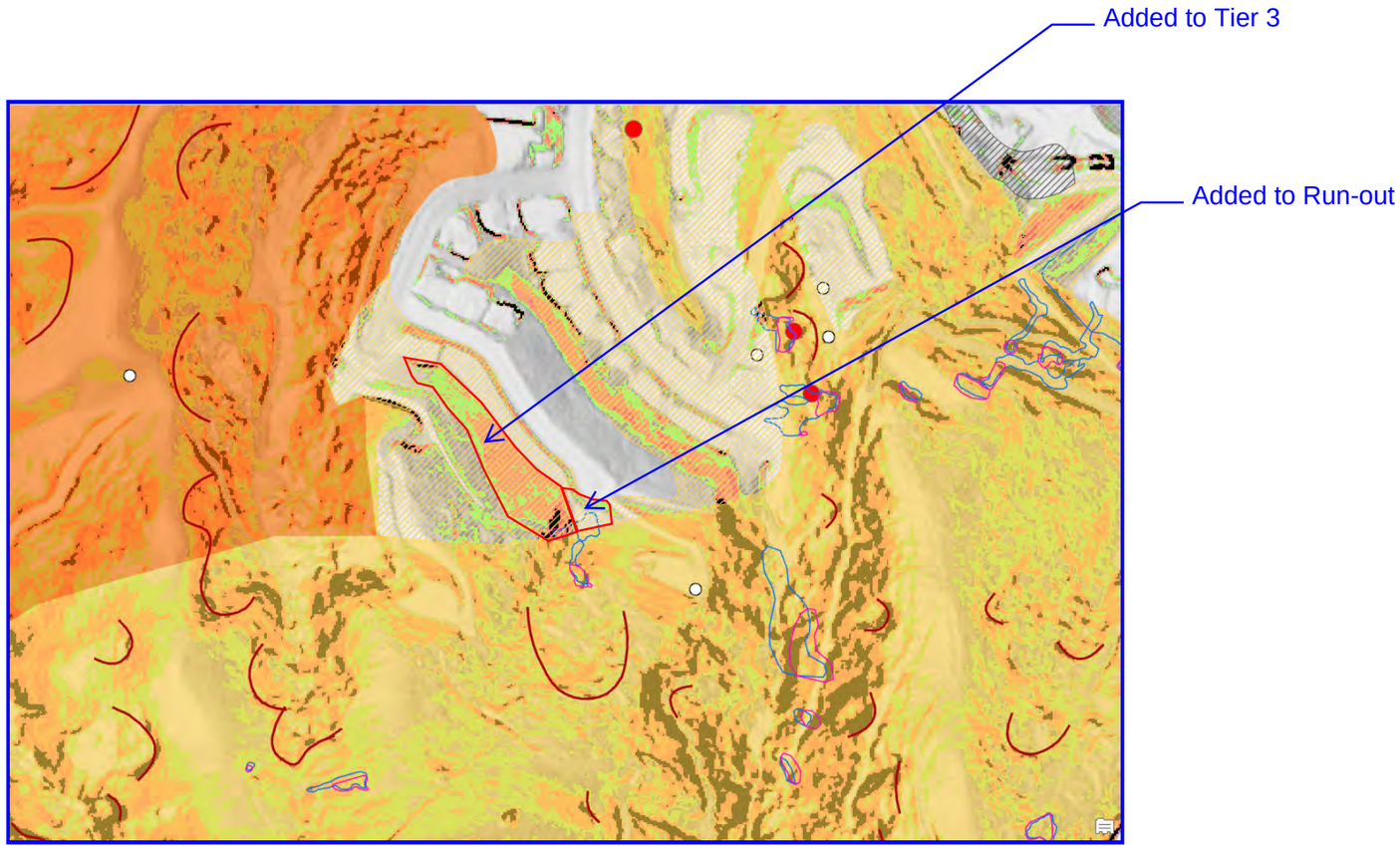

**A19 Response**

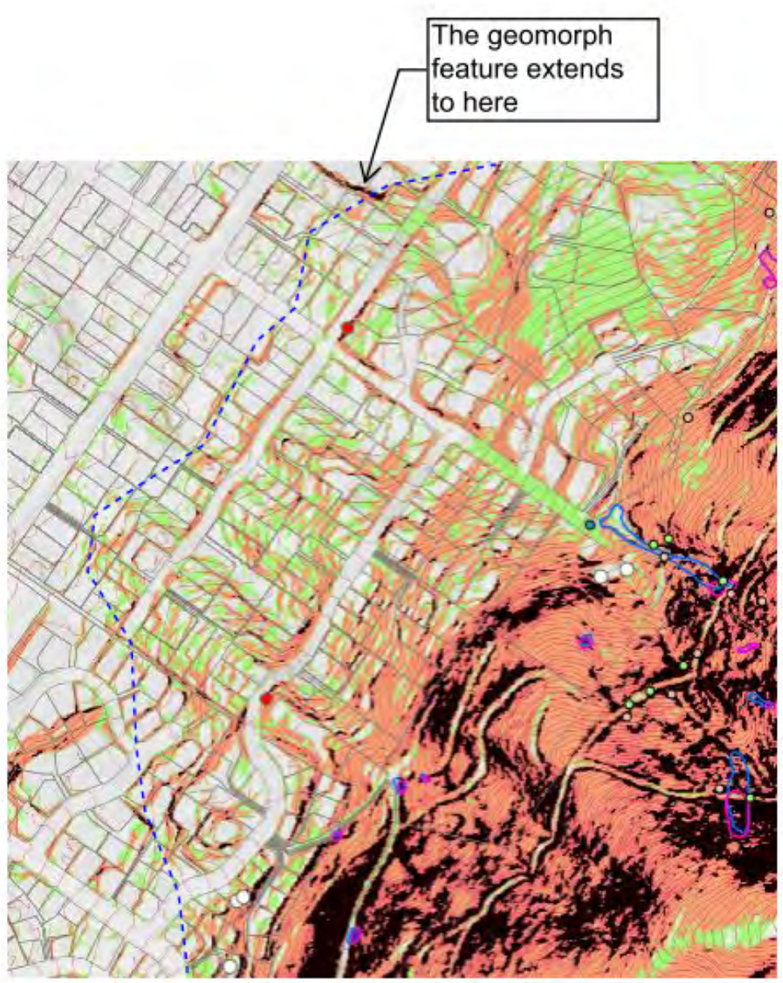
Addressed as part of A6

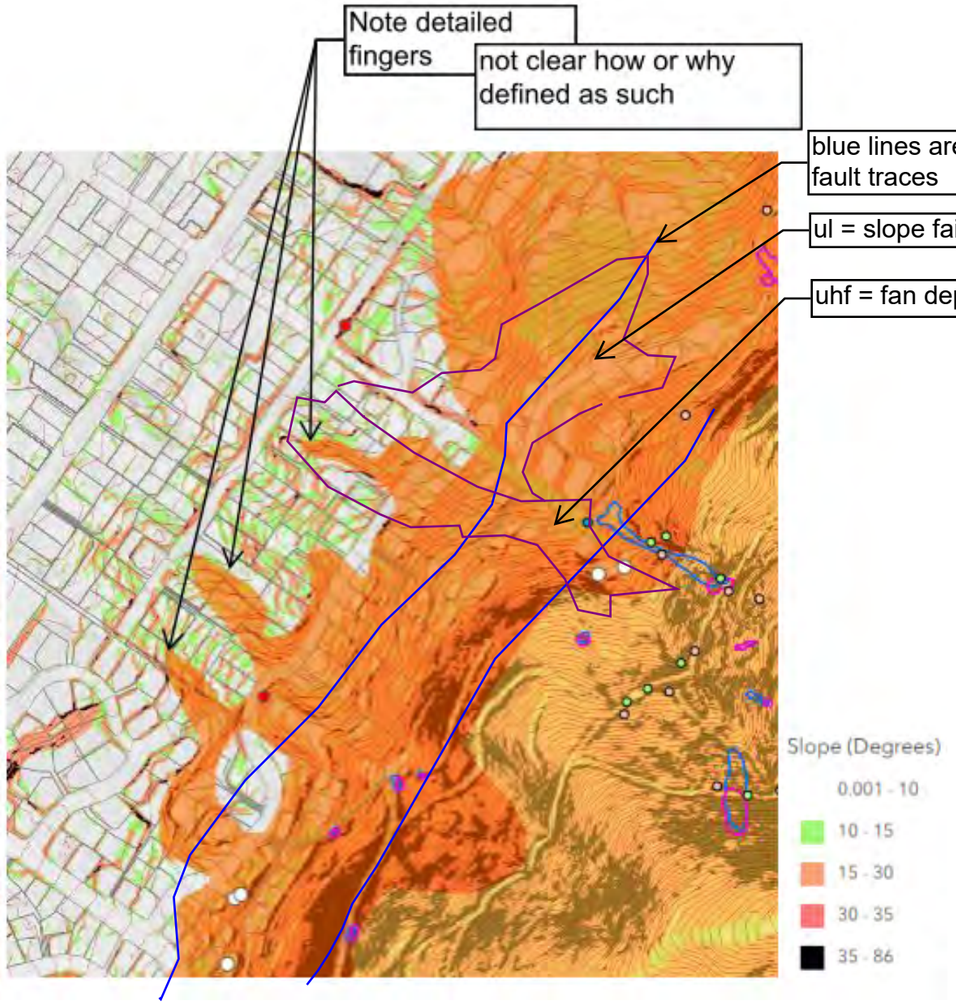



A20 - Marie Place, Bishopdale

**A20 Response**
I agree that this small area should be included in the overlay and a small area as run-out (see snip for proposed extents)









Extract from Johnston et al Geology Map (2024)

A21 - Brunner / Tukuka Streets, Nelson South

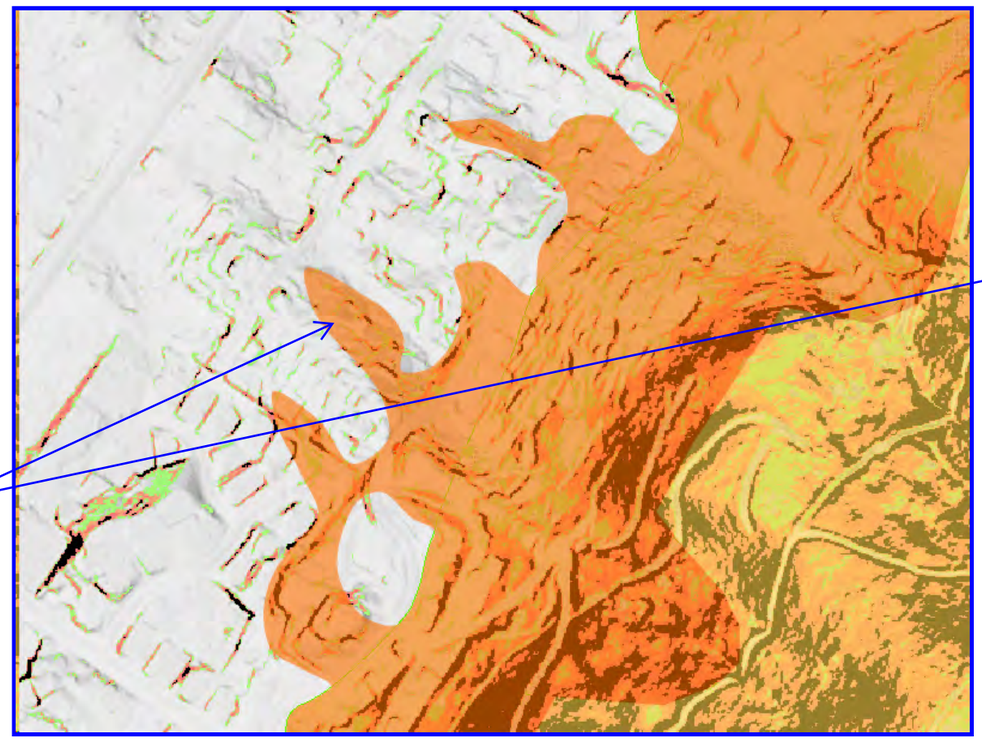
No geomorphic features have been identified so it's not clear why this area has been designated as Tier 2, nor is it clear why the edge is defined as it is. The same 20 to 35 degrees slopes extend out to the blue dashed line, but the edge of the Tier 2 zone is interfingered out into this area. The geology maps seem to indicate there may be old slope failure deposits in this area, but the areas don't match those used in the mapping.

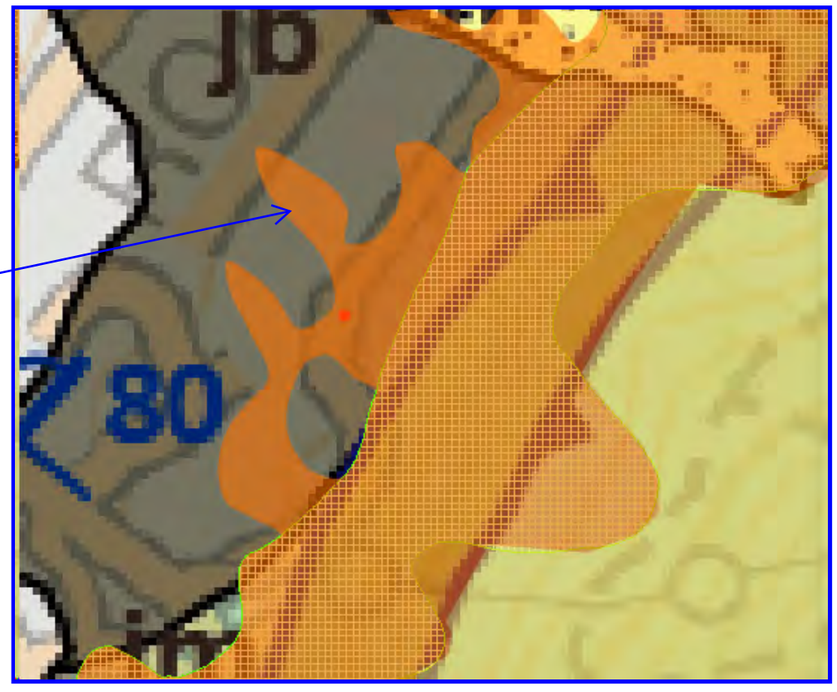
**A21 Response**

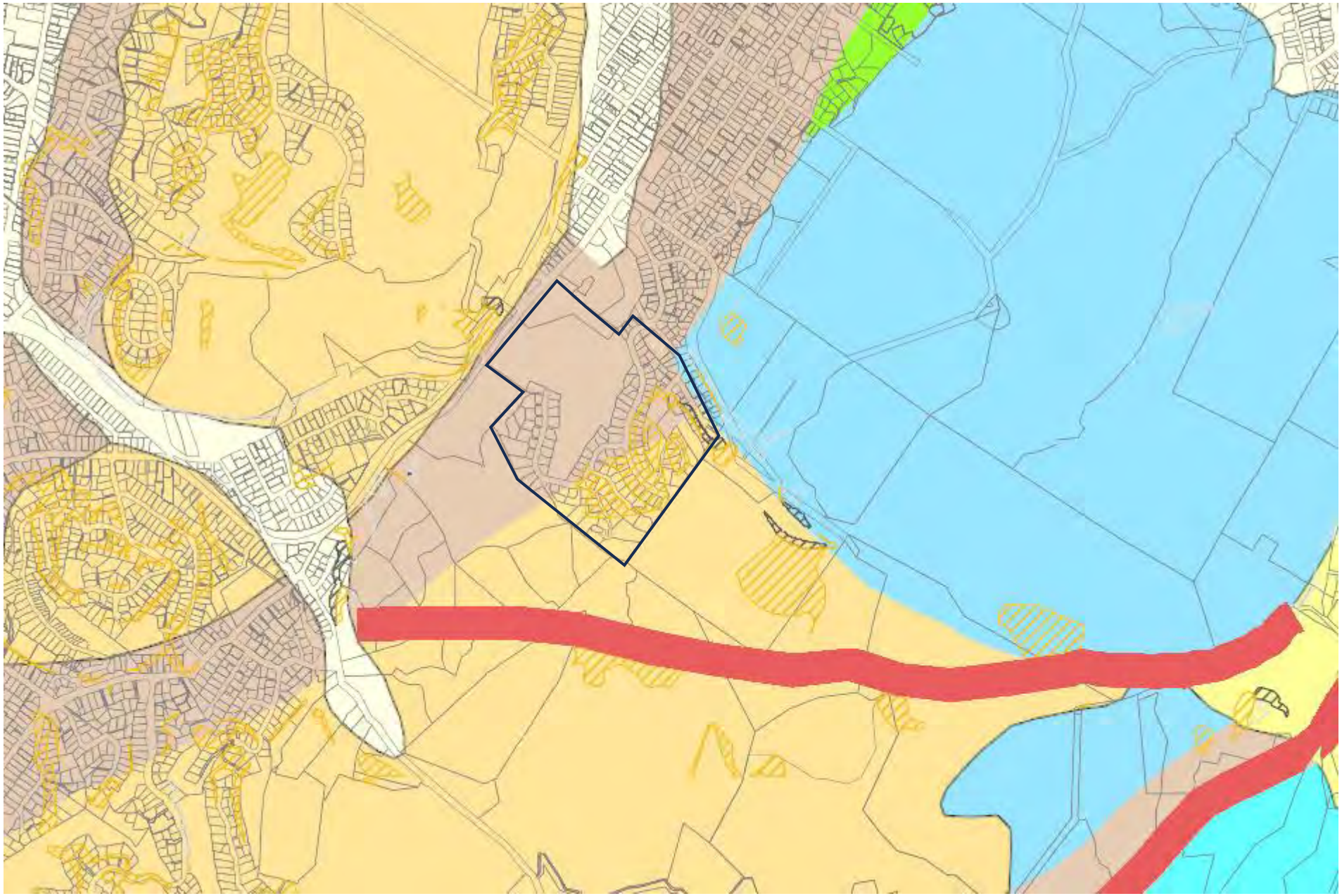
The overlay in this area was based on the original Grampians overlay with geomorphic mapping identifying that the landslide feature extends further downslope than the area within the Grampians Overlay. The downslope area exhibiting hummocky topography and >20 degrees was included in the original map resulting in the 'fingers'. The remaining area <20 degrees was excluded. This overlay was subsequently subdivided into the Tier II area and therefore inherited the morphology from the original overlay at the request of the SI-TAG. (See snip for interpretation). As this area was within the Grampians overlay already, geomorphic evidence of deep seated features were not mapped.

The fault items will be addressed with the below A22 comments

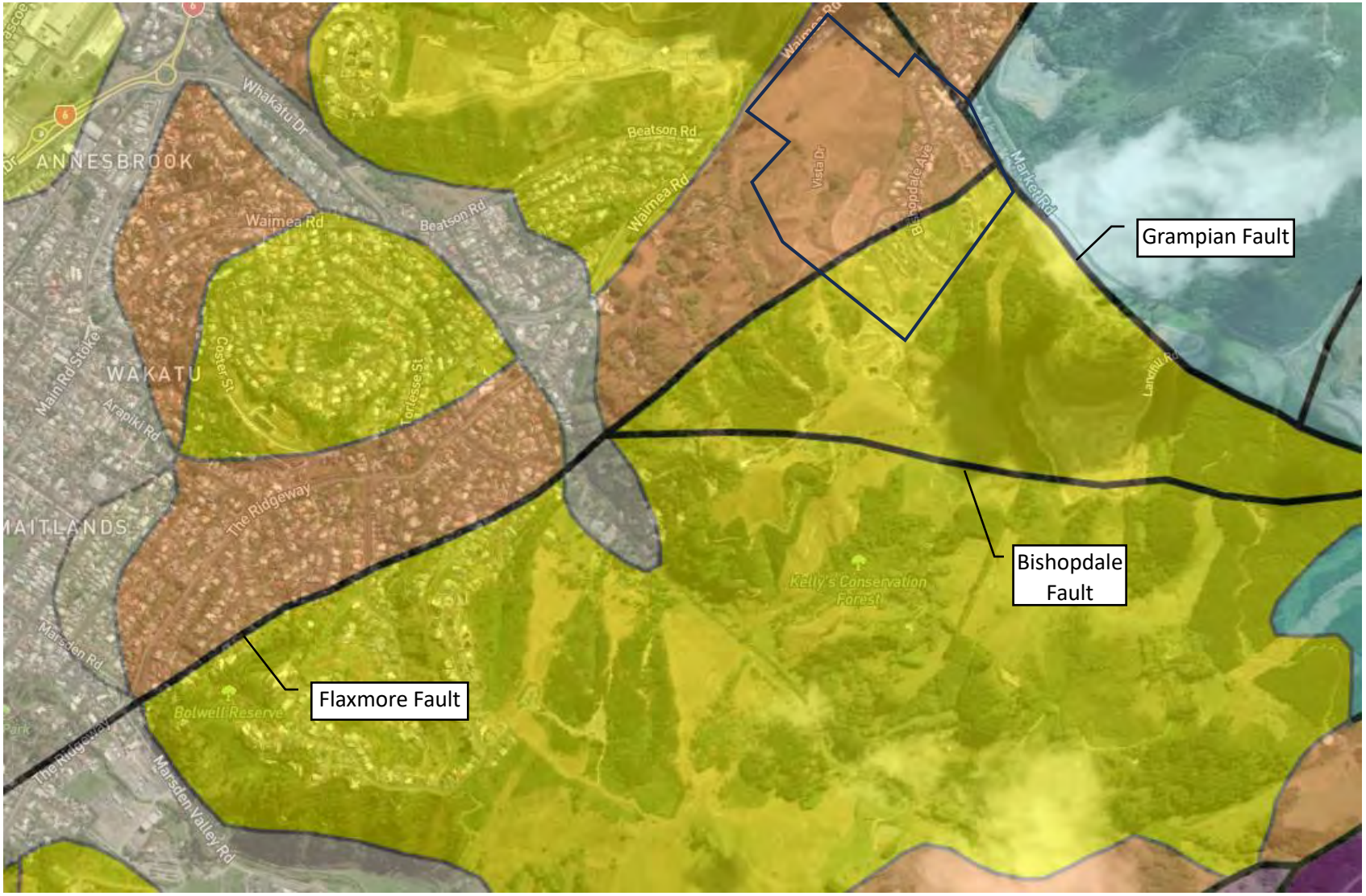
The geomorphology of the slope indicates the feature extends downslope further than identified in the original Grampians overlay, as represented by blue dashed line in figure provided by experts. The original assessment identified the downslope extents of the feature that were <20 degrees, resulting in the 'fingers' with downslope area excluded. These extents subsequently informed where Tier II was identified as the overlay was subdivided.



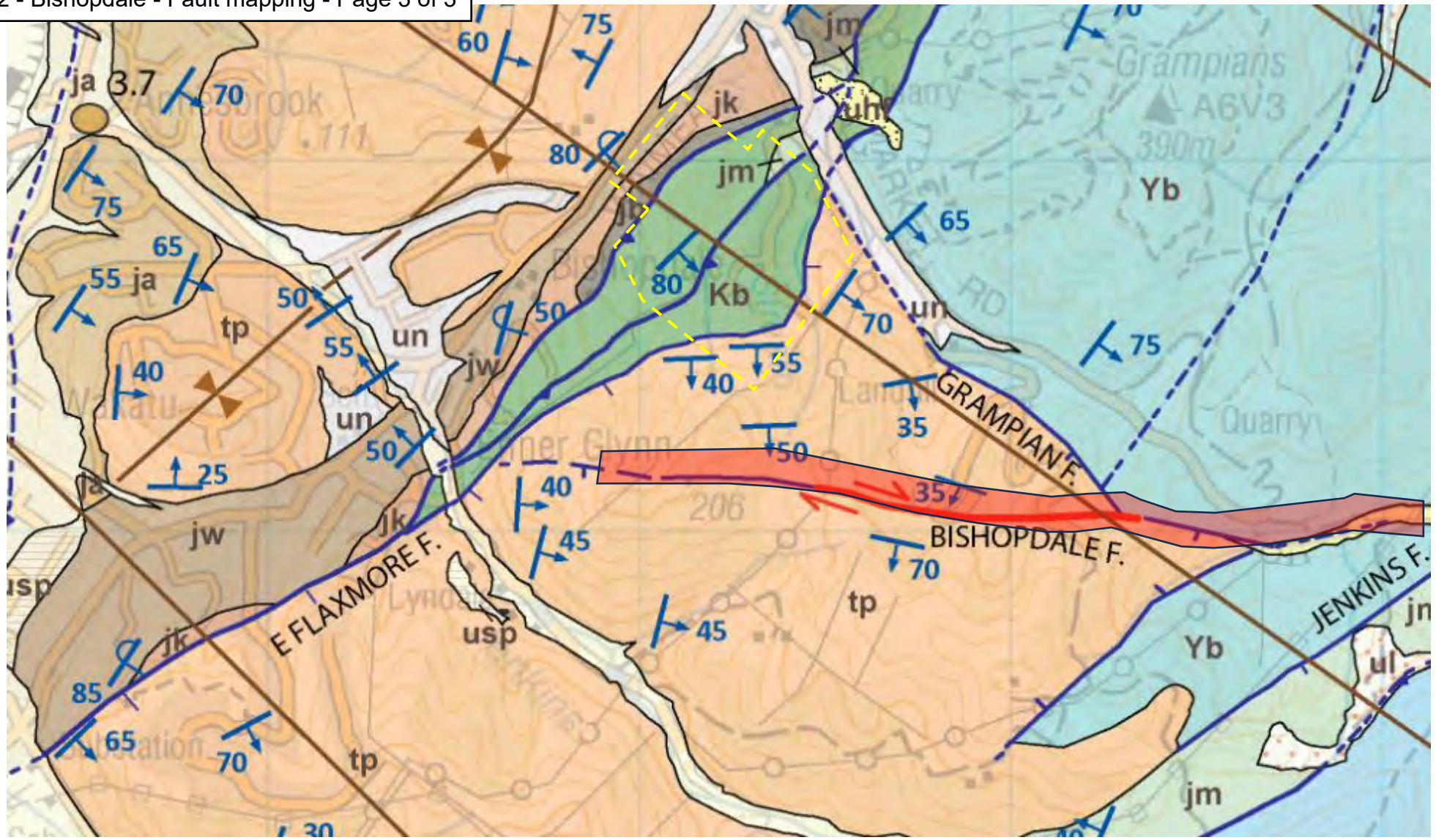




Extract from QMAP layer in Beca GIS showing geology and 100 m fault zone (red) below the **Bishopdale Fault**. The other '100 m fault zone' shown far right corner is the **Waimea Fault**. Polygon is the original Bishopdale Subdivision Area.




QMAP – 1:250,000 Scala geological map. Browny colour denotes 'Undifferentiated Jenkins Group sandstone'; yellow is Port Hills Gravel. Faults shown are as labelled. Marsden Coal Measures and Bishopdale Conglomerate are not shown on this map at this scale.




Most recent Geology Map (Johnston, Ghisetti & Wopereis, 2022) – this is a LIVE map and is updated annually or as needed to reflect new data.

Note how many more faults exist, with three strands of the Flaxmore fault passing through the Bishopdale Subdivision site, none of which have had any offsets included in the Stability mapping. Dark blue lines are faults, with location uncertain if dashed. Thick red lines are 'late Quaternary' fault scarps i.e. active within the Holocene period (11,700 years). The application of the red "100 m offset" is inconsistently (and incorrectly) applied to only some portions of some faults.

**A22 Response**

The faults included in the 100m downslope of a fault criteria in the methodology tree are the faults presented on the GNS Active Faults database. The AGS guidance identifies that sliding may be possible on steep natural slopes in regions affected by large earthquakes. The 100m downslope of active faults is to reflect this, as well as the consideration that the bedrock near active faults will typically be more fractured and likely to have water seepages. Therefore, these areas are likely to be potentially susceptible to instability.

The updates to the fault deformation/awareness areas postdated the original overlay creation and were therefore not included for consideration as part of these overlays. This criterion of the methodology tree was agreed and accepted by the SI-TAG and no change was suggested.

If these areas were to be incorporated for this plan change, it would result in some new areas of land (beyond those notified in the PC29 overlay) to be included into the overlay. Therefore, for a future plan change, it may be appropriate to develop this criterion of the methodology tree to incorporate the areas downslope of all the active faults identified in the fault deformation/awareness areas.

## A23 Response

Addressed as part of A11 + A12



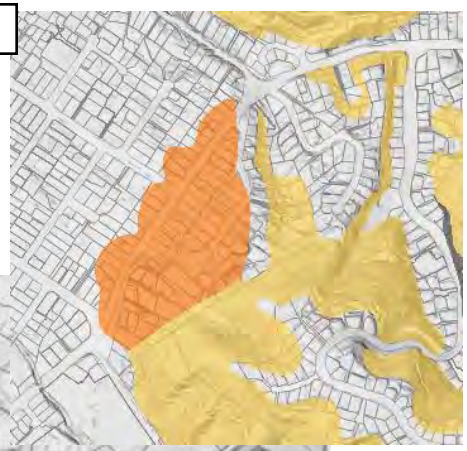



1943 aerial photo – no signs of deep-seated slip or any other instability in dashed area




**A23 Response**

Addressed as part of A11 + A12





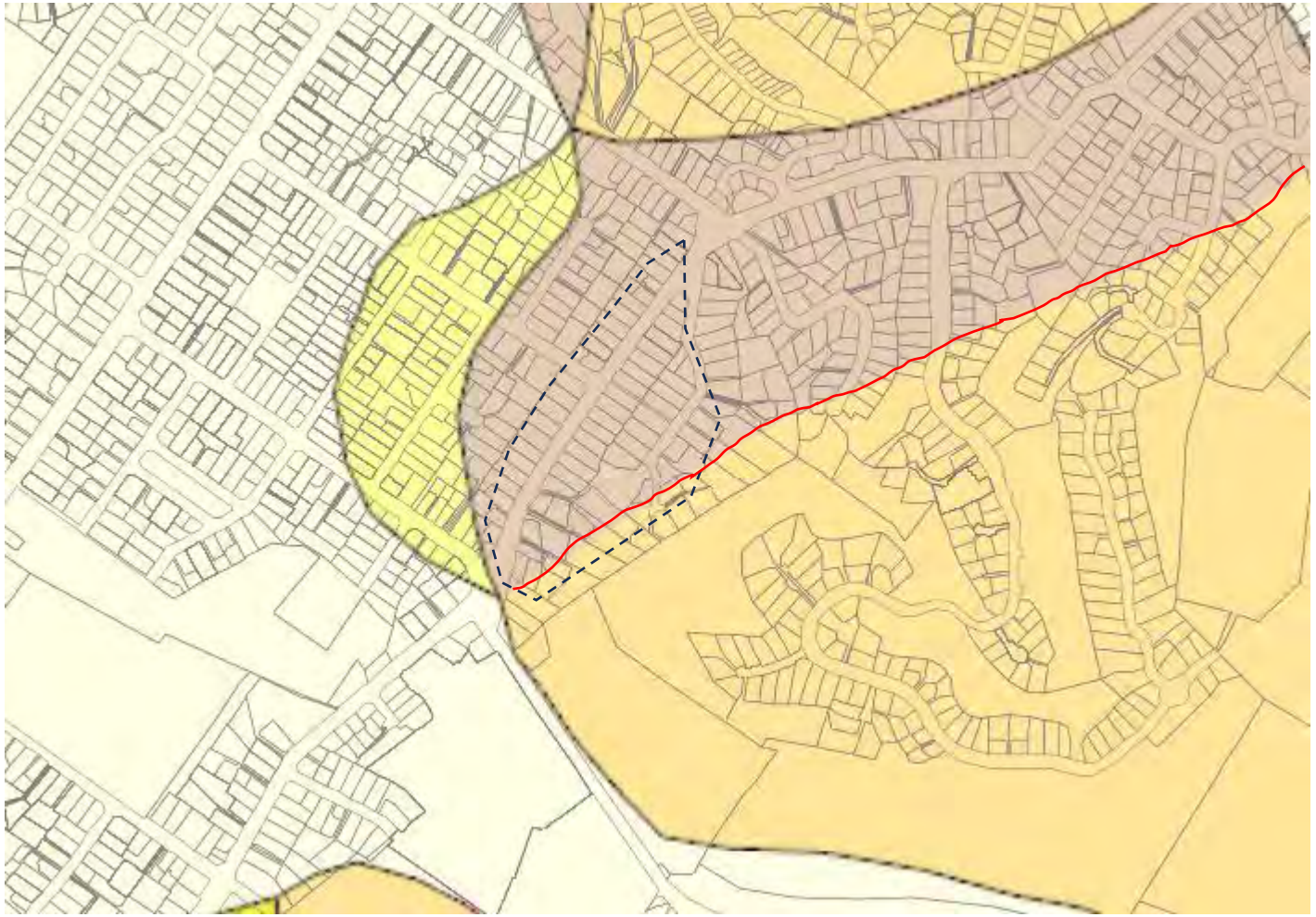
DEM – no signs of deep-seated landslip or other ground movement

## A23 Response



Addressed as part of A11 + A12

QMAP: No reason for Tier 3 for geology purposes & no mapped evidence of deep-seated landslip; no 100 m from fault zone shown.



*Note. Red line is an older, inactive fault separating the two geological units. This is not included in the GIS database provided.*

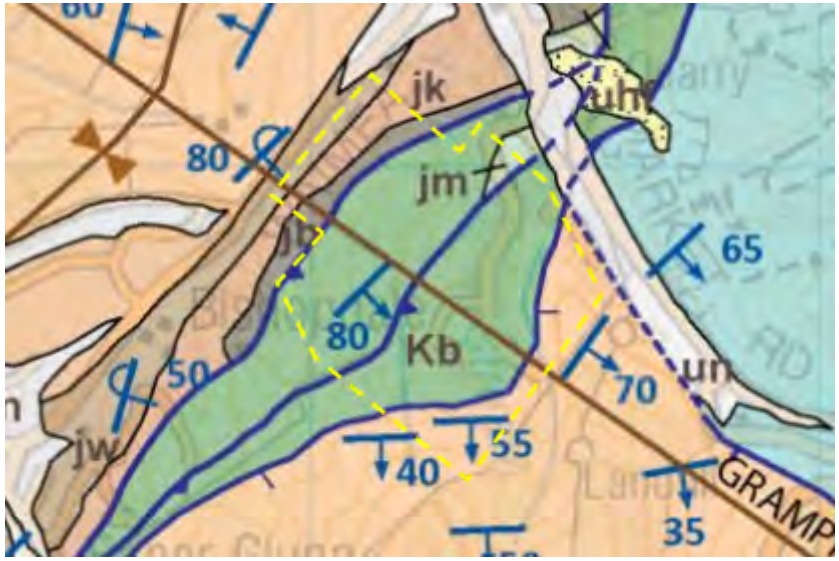
*The area dashed is not included as a landslide or as landslide debris in any of the local geological maps; Johnson 1979 "Nelson Urban Area"; Johnson 1981 "Dun Mountain; Johnson et al (2021-2022) "Revised Geological Map of the Nelson-Richmond Urban Area.*

Tier 3 slope angles – insufficient to justify bump up to Tier 2

**A23 Response**

Addressed as part of A11 + A12






Tier 2 but mapped to be underlain by geology other than Bishopdale Conglomerate or Marsden Coal Measures



A24. Bishopdale - Application of methodology

**A24 Response**

Addressed as part of A8