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Pantteg Landslide, Pantteg Executive Summary; Hazard and Risk Assessment

Prepared for:

Neath Port Talbot County Borough Council

The Quays, Baglan Energy Park, Brunel Way, Briton Ferry, SA11 2GG



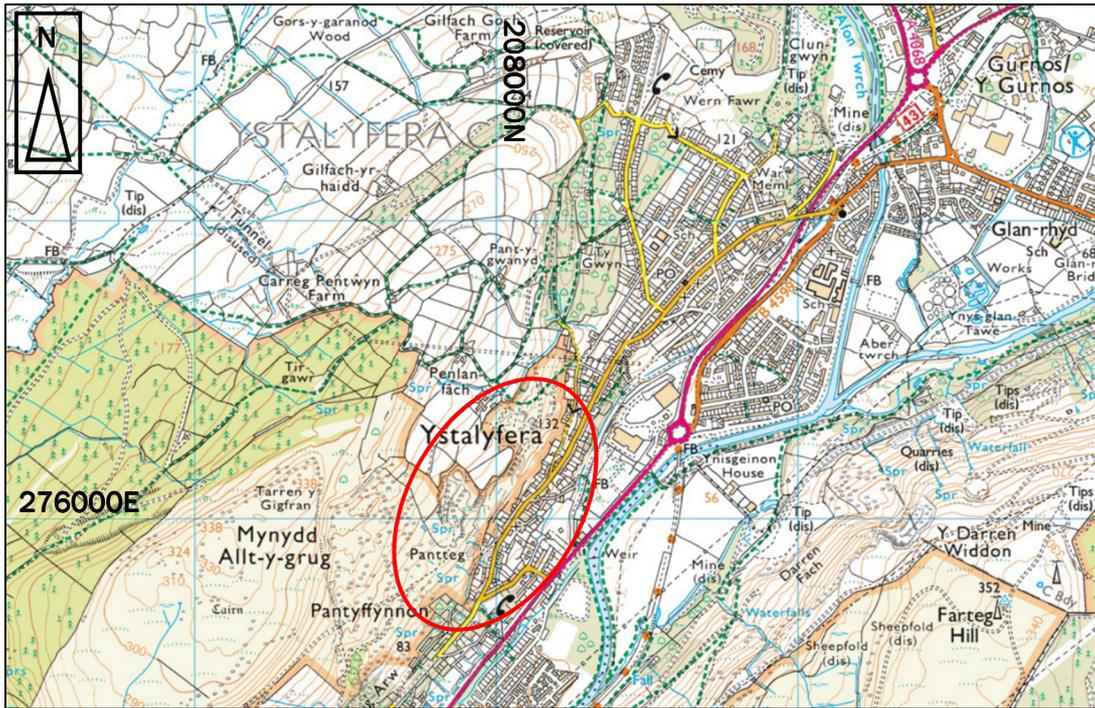
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1 Introduction

Neath Port Talbot County Borough Council (NPTCBC), hereafter known as the Client, have appointed Earth Science Partnership Ltd (ESP) to assess the hazards and risks associated with the Pantteg Landslide near Ystalyfera in the Lower Swansea Valley. The general site location is shown on Insert 1 below.

Insert 1: Site Location Plan 1:25,000 (Ordnance Survey License No.: AL100015788).



The aim of the assessment was to develop the understanding of the historical and current landslide conditions, hazards and risks, such that opinions for the future management of the landslide can be considered along with strategies for informing residents of the hazards and risks.

Information is also portrayed as a number of figures, which are detailed below and enclosed:

Figure 1 – Conceptual Ground Model

Figure 2 – Residential Property Risk

1.1 Investigation Information

All the factual site investigation information has been combined into a single report volume (Volume 1), which includes all the investigation and monitoring information from various parties to date. Volume 2 represents the interpretation and main assessment report, and Volume 3 (this volume) provides an Executive Summary of the assessment.

Whilst this report provides an overview of the assessment and its outcomes, it cannot provide all the information which and the reader is recommended to review the first two volumes to fully understand the justification for the assessment recommendations.

2 Brief Ground Model

2.1 Conceptual Ground Model Timeline

The instability at Pantteg and the wider landslide system is considered to have three main components. Two of these components are within the Upper Landslide System and are considered to be 'active'; the third is within the Lower Landslide system and is considered to be inactive and ancient.

Figure 1 shows a representative ground model taken from the Volume 2 report.

2.2 The Lower Landslide System

The Lower system generally represents the first failure to occur at Pantteg and evidence of this is the thick 10-20m of Colluvium in the valley base. Inclinometers and other evidence generally demonstrate little or no movement in this material and confirms the view that this is generally inactive.

2.3 The Upper Landslide System

It is considered likely that there are two areas of instability in the Upper Landslide System, the furthest uphill is below the Pen-y-Graig Plateau, the second is down slope, between a convex break in slope and a bench associated with a mudstone bed or the Upper Cwmgorse Marine Band.

Investigation has shown the instability in the Pen-y-Graig area can be attributed to a slip surface that is thought to be the lowest expression of the Lower Pinchin Coal Group. The slip surface comprised extremely weak weathered rock and a thin clayey silt layer, which is interpreted as being the base of the landslide materials. Inclinometer monitoring shows the material above the Lower Pinchin slip surface to be moving down slope.

Aerial photographic interpretation has shown a second area of instability which is broadly delineated by a convex break in slope in the west and a lower bench in the east. Numerous translational landslides have occurred along this bench and it is likely to receive material slowly moving from the plateau area, and periodically over-steepening the second area until failure reduces the slope angle.

In addition to the above, rock fall is occurring due to block release in tension cracks and blocks will also be falling from the sandstone back scarp.

3 Hazard Identification and Risk Assessment

A Hazard¹ Identification and Risk² Assessment has been carried out for Pantteg which, in accordance with good practice, has been peer reviewed.

A landslide inventory was generated using the previous reports and aerial photograph interpretation (API) and the following hazard types were identified:

Hazard Type 1: Slow ground displacement leading to vertical or lateral displacement or undermining of structures and infrastructure related to large-scale complex landslide.

Hazard Type 2: Debris impacts from shallow translational landslides – impact loading on structures, impact/burial of people, impact on vehicles, burial of people inside buildings (ground floor) if of sufficient volume.

Hazard Type 3: Regressing shallow translational landslides in Made Ground resulting in structural damage and potentially building collapse.

Hazard Type 4: More mobile debris avalanches impact loading on structures, impact/burial of people, impact on vehicles, burial of people inside buildings (ground floor) if of sufficient volume.

Hazard Type 5: Boulder Fall, possible structural damage, impact on people/vehicles.

Hazard Type 6: Rock Fall, possible structural damage, impact on people/vehicles.

The outcome of the assessment allowed an to update the Hazard and Risk Map for Pantteg based upon current engineering geology practice, to develop an understanding of where instability is likely to occur in the future and give us a better understanding of likely impacts on roads, land and properties in the area. The subsequent updated Hazard and Risk map, which amalgamated all the hazard types onto one plan, is provided as Figure 2.

Although there are uncertainties involved in the quantitative risk assessment the results indicate that the main risk to life is to people in buildings (and gardens).

The three houses and garages south of the Graig-y-Merched junction are linked to the very high-risk area are in the very high-risk polygon; the properties are denoted as 'very high risk' to explain the risk to the residential properties. Mitigation from upslope properties plays a role here; a conservative adopted position has been for landslides >500m³ volume that may engulf the upslope properties and continue downslope.

The high risk zone below Cyfyng Road encompasses the whole housing-terrace. The interconnectivity of the structures is an important factor here.

¹ Hazard: A condition with the potential for causing an undesirable consequence (e.g. location, volume/area, velocity of the potential landslides and any resultant detached material) and the probability of occurrence within the given period of time.

² Risk: A measure of the probability and severity of an adverse effect to health, property or the environment (risk = probability of a given magnitude x consequences). This can be quantitative or qualitative, depending on the availability of data. A series of risk assessments have been carried out for the study area using the AGS Guidelines for Landslide Susceptibility Hazard and Risk Zoning, 2007.

3.1 Quantitative Risk Assessment: Central Village

A Quantitative Risk Assessment has been undertaken for the central Pantteg area for risk to life. This is considered to be the zone with the highest hazard associated with Hazard Type 2 for which there is sufficient data to allow a quantitative assessment. Risk is reported using annual probability of loss of life. Risk to pedestrians, people in vehicles and residents were all evaluated and reflect the annual individual risk for the persons most at risk.

Table 1: Annual Probability Classifications

Very High Risk	Annual probability of >1 in 1,000 ($>10^{-3}$ /annum) that the persons at risk will lose their life.
High Risk	Annual probability of 1 in 10,000 to 1 in 1,000 (10^{-4} to 10^{-3} /annum) that the persons at risk will lose their life.
Moderate Risk	Annual probability of 1 in 100,000 to 1 in 10,000 (10^{-5} to 10^{-4} /annum) that the persons at risk will lose their life.
Low Risk	Annual probability of 1 in 1,000,000 to 1 in 100,000 (10^{-6} to 10^{-5} /annum) that the persons at risk will lose their life.
Very Low Risk	Annual probability of <1 in 1,000,000 ($<10^{-6}$ /annum) that the persons at risk will lose their life.

With respect to UK individual risk to life, AGS 2007 quotes UK HSE (2001) which notes that 10^{-6} /annum is broadly acceptable, and 10^{-4} /annum is tolerable (very low to moderate risk).

3.2 Qualitative Risk Assessment: Remainder of Village

The approach to the remainder of the village is qualitative using estimates of likelihood and consequences (AGS, 2007) and is based on risk to property rather than risk to life. The terminology is qualitative i.e. it uses words.

The below is an example risk level implications (AGS Practice Note Guidelines for Landslide Risk Management, 2007).

Table 2: Risk Level Implications

Very High Risk	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work likely to cost more than value of the property.
High Risk	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low. Work would cost a substantial sum in relation to the value of the property.
Moderate Risk	May be tolerated in certain circumstances (subject to regulator’s approval) but requires investigation, planning and implementation of treatment options to reduce the risk to Low. Treatment options to reduce to Low risk should be implemented as soon as practicable.
Low Risk	Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required.
Very Low Risk	Acceptable. Manage by normal slope maintenance procedures.

The risk zonings for Pantteg and their extent is shown in Figure 2.

4 Landslide Management

The assessment has found no evidence of a large scale, deeper seated, movement (Hazard Type 1).

Previous reports concluded that the overall landslide system could not be economically stabilised, and we concur with this opinion. We understand that wholesale abandonment of the private residences and infrastructure in Pantteg is not feasible due to various factors including ground movement in other areas, compensation costs and other socio-economic impacts, however this should be reviewed.

It is noted that the solution at Pantyfynnon was to abandon the village (although different landslide processes are active there). We draw attention to some of the very earliest conclusions for Pantteg:

'no further building development should take place in the affected areas and as and when opportunity offered, the existing buildings should be abandoned or cleared to ground level'
(Ref: Dillwyn and Jones, Mining Engineers, November 1957).

Hazard Awareness Notices have been issued by NPTCBC to residents within the 'very high risk' and 'high risk' areas as defined on the Residential Property Risk plan presented as Figure 2.

Occupation of houses within the highest risk zones is not preferable due to the unacceptable risks presented. Residents should consider moving themselves out or be encouraged to move out of the very high and high risk zones at the earliest point (despite that they are privately owned for the majority of cases). This approach is in addition to 'warning and informing' in terms of a 'Hierarchy of Controls' approach (e.g. Management of Health and Safety at Work Regulations, 1999).

The concepts of '*managed retreat*' or '*gradual vacation*' should be reviewed and explored further to be incorporated into specific planning policy by NPTCBC for the Pantteg area. Mechanisms for capturing individual properties that have become unoccupied or reoccupied need to be considered and formalised.

A drainage and vegetation management strategy should be developed and agreed for the landslide area to consider individual landowner and key stakeholder responsibilities, e.g. NPTCBCs and private landowners roles in managing the highway infrastructure.

Continued downslope movement of material is likely during the next wet periods. This may comprise tens of tonnes, or more, of material. The rock berm constructed at the toe of the slope (opposite Pantteg Chapel) has been designed and constructed by NPTCBC to arrest landslide material and maintain the function of the road carriageway during/after the frequent and smaller landslide types.

We recommend that a formal Management Strategy be developed for the Pantteg landslip to enable decisions on actions to protect human life and property to be taken with an underlying set of triggers, actions and responses. This should be an integral part of NPTCBC planning and policy decisions for Pantteg. In addition:

- Relatively simple physical improvements to, and maintenance of existing drainage should be continued for optimum effectiveness of subsequent actions;

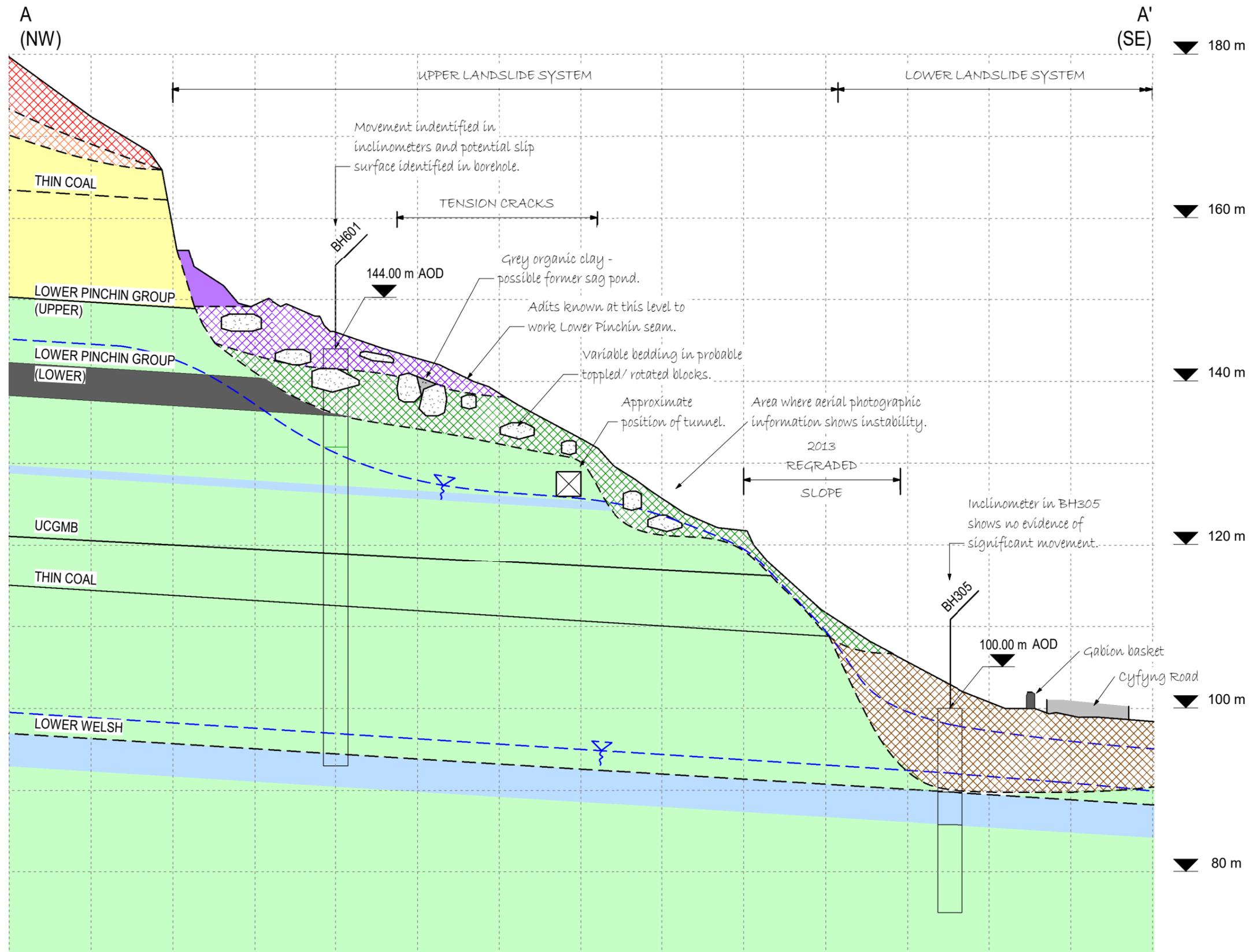
- Ongoing assessment of the condition and effectiveness of drains, conduits, gullies and streams should be carried out on land NPTCBC are responsible for and on private land. This includes the possible link between the Mount Hill and the lower landslide area (Lower Pantteg) via the possible mine tunnel. Definition of responsibilities of each party/stakeholder should be confirmed (e.g. The Coal Authority, NPTCBC, Dwr Cymru Welsh Water, private landowners etc.);
- Discussions should be held with the Coal Authority to confirm their responsibilities in relation to maintaining drainage pathways through mine workings, including consideration to the mine tunnel;
- Review the benefits of investigation and instrumentation of key locations across the Pantteg landslide. Agreement on the resolution within the Ground Model and slope stability models, relating to topography, geology, hydrology and hydrogeology should be confirmed. Access, health and safety and cost will need to be considered as part of this review;
- Review the topographical information from LiDAR data in relation to modified technical aims and objectives for Pantteg. The requirement for repeat LiDAR surveys should be reviewed periodically considering changes to the slope system or findings of future investigation and assessment;
- Create a risk register based on emerging conditions and findings. The Risk Register for the site should be updated regularly based on emerging conditions and new information. A Trigger Action Response Plan (TARP) should be formulated to confirm responsibilities and actions to be taken when certain criteria or conditions are met;
- Use the various elements to integrate into a formal Management Plan to enable reliable protection of human life, property and infrastructure (where possible). This will become more accurate, reliable and useful over time; and
- Repair of vandalised logger boxes is being carried out.

The planning regime should be utilised as a method of controlling new development, or changes to existing development that could have an adverse effect on the stability of the slope. This would include areas to the east and west of the main road.

We also recommend a specific policy be developed for Pantteg village; this should include guidance on what actions are possible/appropriate when individual properties become vacant/abandoned.

In addition, confirmation of how the above information links into the multi-agency response plan for Pantteg should be obtained.

End of Executive Summary



KEY

	MUDSTONE
	SILTSTONE
	SANDSTONE
	ROCK FALL DEBRIS
	GROUND WATER
	INFERRED COAL
	COAL
	PROBABLE LANDSLIDE MATERIAL
	WEATHERED ROCK (SOIL)
	QUARRY SPOIL
	COLLUVIUM
	COLLIERY SPOIL - PREDOMINANTLY COARSE DISCARD
	POSSIBLE FORMER SAG POND

- NOTES**
1. DASHED LINES DENOTE UNCERTAINTY.
 2. BOREHOLES MOVED ALONG STRIKE OR DOWN/UP DIP TO HELP POPULATE GROUND MODEL.
 3. GROUND WATER MONITORING ONGOING.
 4. ROCK HEAD PROFILE INFORMED BY INVESTIGATION WHERE POSSIBLE. ASSUMED IN OTHER AREAS.
 5. LOWER PINCHIN GROUP DETAILS FROM BH301, BH1 USED IN SECTION. NOTE SEAT EARTHS GROUPED WITH COAL IN LOWER PORTION.
 6. POSITION AND SIZE OF BOULDERS DIAGRAMATICALLY SKETCHED ONLY.
 7. GROUND LEVEL BASED UPON LIDAR SURVEY.

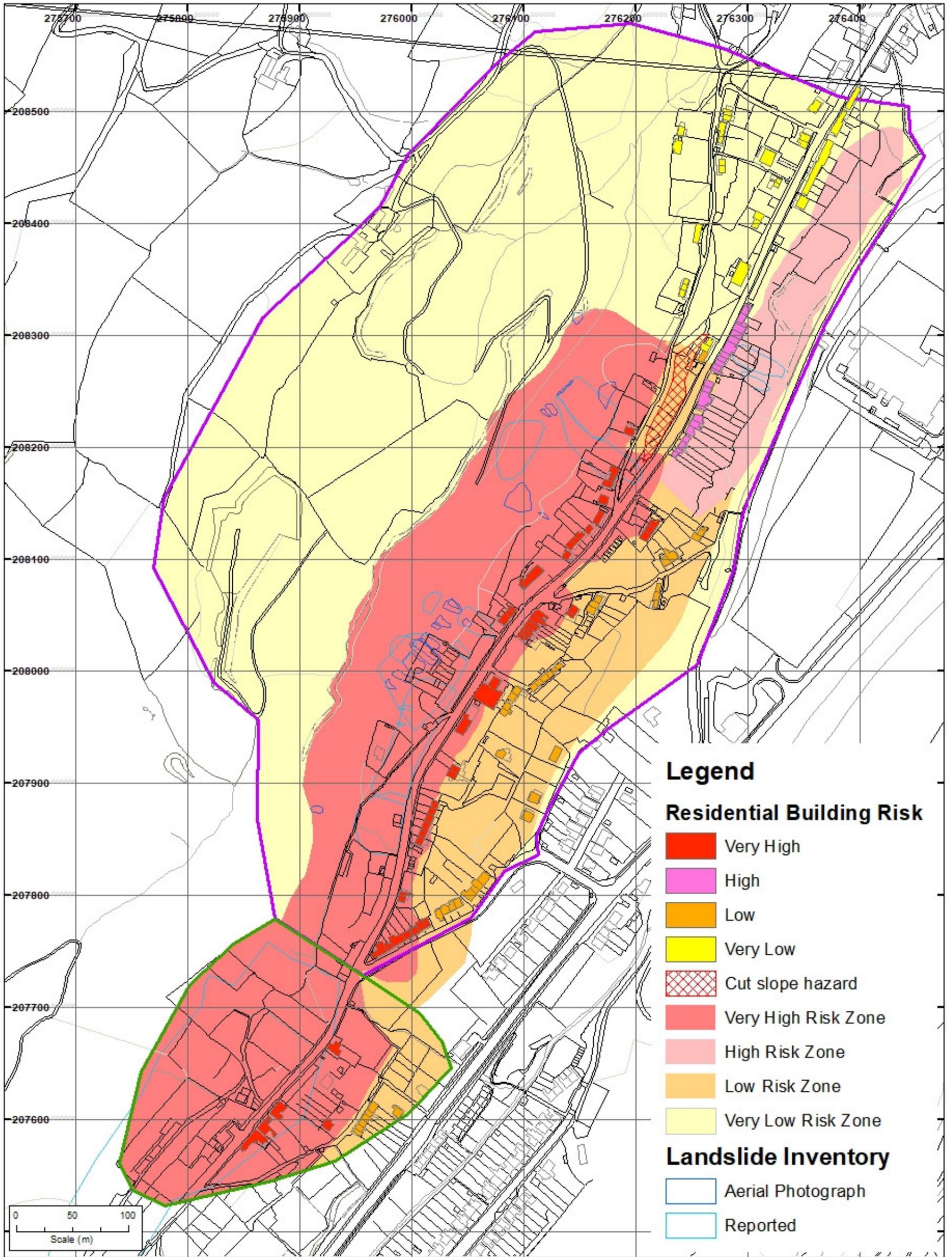
PROJECT: PANTTEG LANDSLIDE

SCALE: 1:500

FIGURE 1: CONCEPTUAL GROUND MODEL



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PROJECT: PANTTEG LANDSLIDE

Scale: 1:3,000 (at A3)

FIGURE 2 - RESIDENTIAL PROPERTY RISK



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