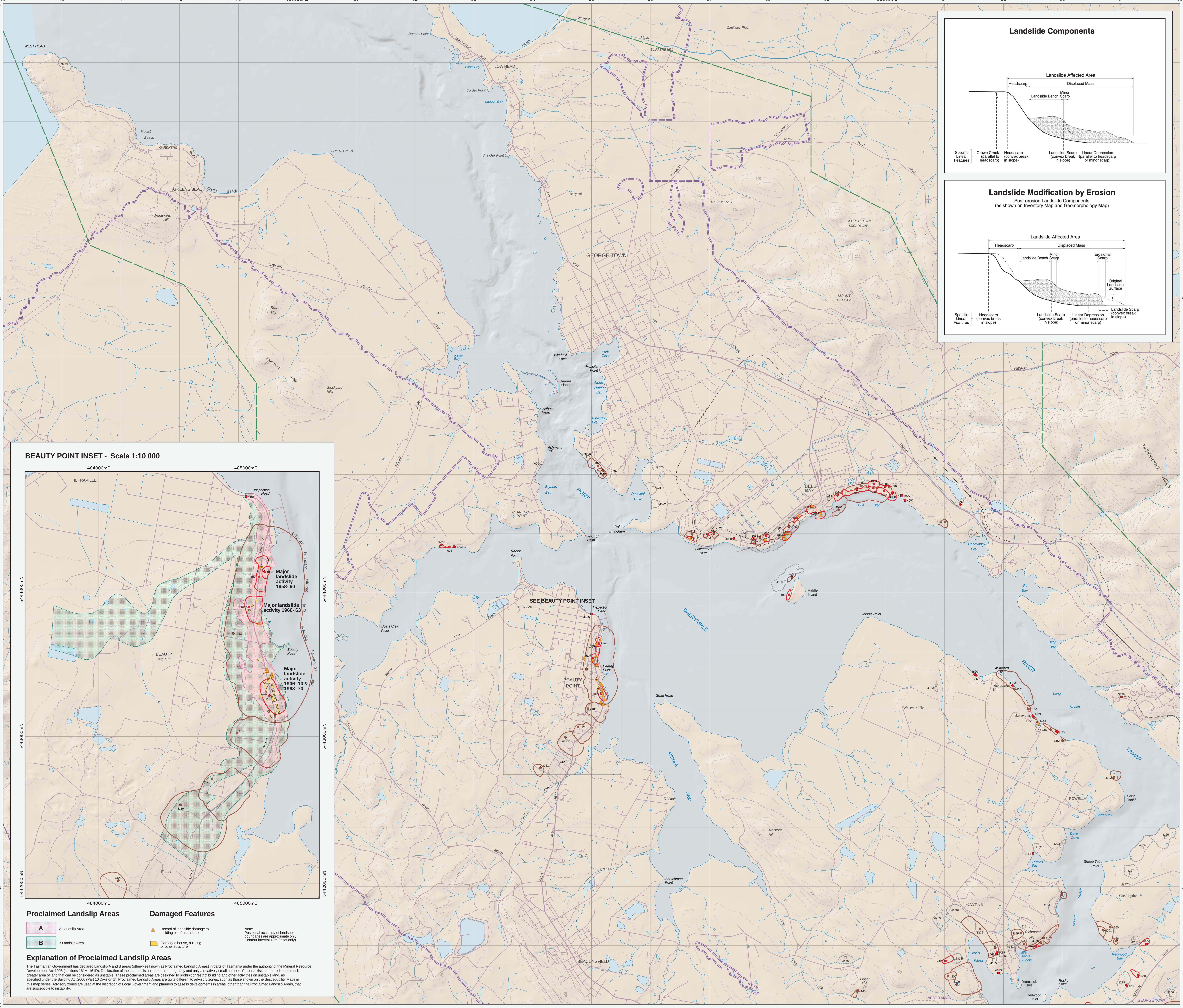
Department of Infrastructure Energy and Resources
MINERAL RESOURCES TASMANIA

TASMANIAN LANDSLIDE MAP SERIES

BELL BAY - LANDSLIDE INVENTORY

MAP 1



Explanation of Proclaimed Landslip Areas

The Tasmanian Government has declared Landslip A and B areas (otherwise known as Proclaimed Landslip Areas) in parts of Tasmania under the authority of the Mineral Resources Development Act 1995 (sections 161A- 161D). Declaration of these areas is not undertaken regularly and only a relatively small number of areas exist, compared to the much greater area of land that can be considered as unstable. These proclaimed areas are designed to prohibit or restrict building and other activitites on unstable land, as specified under the Building Act 2000 (Part 10 Division 1). Proclaimed Landslip Areas are quite different to advisory zones, such as those shown on the Susceptibility Maps in this map series. Advisory zones are used at the discretion of Local Government and planners to assess developments in areas, other than the Proclaimed Landslip Areas, that are susceptible to instability.

Landslide Map Series

Background, Aim and Purpose

This map is one of a set of thematic maps addressing regional landslide susceptibility and hazard for urban areas and surrounds in Tasmania. The project is undertaken by Mineral Resources Tasmania, in partnership with Local Government and sponsored by the Natural Disaster Mitigation Programme (involving Federal and State contributions).

Large tracts of land throughout Tasmania are subject to slope instability and over 75 houses have been destroyed by landslides since the 1950s with many more significantly damaged. While only minimal loss of life has occurred such events are highly traumatic to those directly affected and the financial cost to individuals, organisations and the State runs into many millions of dollars. Recent disasters such as the Thredbo Landslide in New South Wales, serve to remind society of the potential for loss of life even from relatively small landslides. Fortunately, landslide damage can be avoided when ground conditions are properly understood before construction proceeds and, in already developed areas, this understanding can be used to mitigate the hazard through various measures.

Method

A methodology has been specially developed for this map series and is used for other areas of Tasmania. Refer to the document "Tasmanian Landslide Map Series: User Guide and Technical Methodology" (see Further Information). The methodology has evolved since the earlier maps were published, in part due to the Australian Geomechanics Society publishing guidelines for landslide zoning (AGS 2007a,b) - changes have been made to conform to these as much as possible.

The methodology used is based on:

- Recording observations of land instability in- and surrounding- the study area (the landslide inventory).
- Analysis of the processes that control each landslide type.
- Computer assisted modelling that simulates each of the landslide processes to predict areas that could be affected by future landslides.

Caveats for Use

The information provided is in the public domain and anyone is free to use it provided they read and understand the purpose and limitations.

The following caveats shall apply to the maps.

- The hazards identified are based on imperfect knowledge of ground conditions and models to represent our current understanding of the landslide process. As this knowledge improves our perception of the hazard and the depiction on the map may also change.
- These maps can be used as a guide (or flag) to the need for specific assessment in potential hazard areas.
- Planning decisions should not be made solely on the basis of the zones delineated on the map.
- The scale limitations of the data should be considered at all times as exceeding this limit could lead to inaccurate decisions about the hazard.
- Site specific assessment of landslide hazard and risk should be undertaken by suitably qualified and experienced practitioners in the fields of engineering geology and geotechnical engineering.
- Practitioners undertaking site specific assessments should read the map text and associated documents to obtain a thorough understanding of the methodology and limitations of the maps.
- Areas where no susceptibility or hazard is shown can still have issues with slope instability.
- Anthropogenic influence on slopes cannot be predicted and the occurrence of slope instability resulting from the influence of human actions is specifically excluded from these maps.
- The identification and performance of cut and filled slopes have not been specifically considered in map production and their scale is such that they often cannot be resolved on the maps. The presence of such slopes should always be considered in site specific assessments.

Landslide Inventory

Landslide data shown on this and associated maps is included in a state- wide landslide database administered by Mineral Resources Tasmania (MRT). Summary information from the database, as well as map images from this map series, can be viewed with the MRT online web map viewer (choose Map: Landslides).
Data stored within the database is sourced from both MRT records and external sources. Local Government Councils and other organisations have provided information to contribute to the knowledge base. However, MRT cannot guarantee that all historic data on landslides held by other parties is in our possession. Further, it is likely that there are a number of unrecognised landslides or human modified forms in the landscape that may be revealed after these maps are published.

This landslide inventory is regarded as a fundamental underpinning layer for the development of susceptibility and hazard maps. As part of the compilation process, all data shown on the map has been checked by MRT geologists to ensure that it meets the necessary minimum standards for landslide description. Landslide data that have not passed MRT quality standards are not shown on the map but are kept in the database as a closed file. All reasonable effort has been made to ensure the landslides are accurately located and attributed.

Landslide Mapping Methodology

It should be appreciated that most landslide boundaries are approximate only and largely based on the interpretation of aerial photos or airborne laser scanning (LiDAR) with limited field mapping. The mapping has utilised aerial photography dating back to the 1940s, which has allowed for more accurate mapping of landslides within areas that have since been modified by human activity. Many small scale landslide features may not have been captured in this mapping, however landslides in the MRT database that are too small to depict at this map scale are shown as a point feature.

The depiction of individual landslides and internal landslide features, on the Inventory Map (Map 1) and the Geomorphology Map (Map 2), is a representation of the morphological features that currently exist in the landscape - rather than an estimation of the original, uneroded morphology. As landslide morphological features are eroded over time their shape will change. For example, with erosion landslide headscarps will tend to become broader and slopes will reduce, while landslide toes may become flatter and less apparent or may be trimmed by more active erosion (by the ocean or a stream) and so become steeper.

The outlines on the Inventory Map (red on Geomorphology Map) show the total affected area of each landslide, or landslide zone. The internal features within these affected areas are depicted on the Geomorphology Map, i.e. headscarp (or main scarp) and features within the displaced mass - landslide bench, internal minor scarps, erosional scarp at toe - and linear depressions. Linear depressions are the probable representation of the former head/heel of back- tilted blocks, transverse cracks, or crown cracks above the headscarp - they are often defined in the landscape by internal drainage. These internal landslide features have been depicted on the Geomorphology Map where scale allows, however the MRT landslide database contains all of the internal features where they have been mapped.

During this mapping programme it was found that many landslides were well disguised within the eroded landscape that has formed on the Paleogene sediments. Some landslides are disguised by their formation in a position that has exposed their toes to significant erosion at some point (e.g. by the past higher sea levels) and often have some of their displaced mass removed.

Past movements of large blocks of rock (block slides) have been identified, but it is often difficult to prove their origin. A recent study of magnetic remanence (Calver 2011) has shown that many large blocks of Paleogene basalt outcropping along the Tamar Valley have been significantly rotated - and therefore have moved by mass failure processes.

It was found that some of the features previously mapped as landslides were in fact differential erosion features, and many of the ‘possible’ landslides on these maps are those where it was not certain that differential erosion could be ruled out. It should be noted that small scale hummocky ground caused by shallow soil creep has not been included in this mapping programme.

Landslide Classification

A landslide is defined as a downslope movement of a mass of rock, debris or earth. This broad definition includes a variety of failure modes and is not only limited to slide- type failures. However, ground subsidence and collapse are excluded. The material involved may be either ‘rock’ (a hard or firm mass that was intact and in its natural place before initiation of movement), or engineering ‘soil’ (an aggregate of solid particles either sediment/transported or formed by weathering of bedrock). ‘Soil’ is further divided into ‘debris’ (more than 20% of material coarser than 2mm) and ‘earth’ (more than 80% of material finer than 2mm).

There are five kinematically distinct types of landslide movement: fall, topple, slide, flow and spread (Cruden & Varnes 1996). Based on available data, the most common types of landslide in the study area are:

- Falls and Topples - Falls refer to detachment and very rapid movement (falling, bouncing and rolling) of material from a steep slope. Toppling failures are distinguished by forward rotation about a point below the centre of gravity of the displaced mass. Landslides of these types occur on steep slopes or cliffs. They are also shown on a separate map that represents areas determined from modelling techniques to have a potential for rock fall (Map 4).

- Slides - (in a more restrictive sense of the term ‘landslides’) are movements of material along recognisable shear surfaces or zones. The shear surface may be curved and concave (rotational slides) or roughly planar (translational slides). Within the study area both of these slide types are common as well as transitional types, including slides that develop into flows. These are commonly developed in soft or weathered Paleogene sediments and basalts. Slides, along with flows, are also shown on a separate map (Map 5). These other maps represent areas determined from modelling techniques to have a potential for slides and flows.

- Flows - Flows refer to a spatially continuous movement of material where inter- granular movement predominates over shear surface movement. Within the study area there are both debris flows and earth flows. Flows can develop as secondary movements in the toe area of slide- type movements within Paleogene basalts and sediments. Flows are also shown on a separate map that represents areas determined from modelling techniques to have a potential for slides and flows (Map 5).

- Block Slides - These are a special case of transitional slides that are likely to include other styles of movement and have a complex history. In several places in the Tamar Valley large blocks of Paleogene basalt have seperated from the main mass and moved downslope by sliding on the underlying soft Paleogene sediment. There are examples of a ’train’ of such blocks progressing down the slope (e.g. Craigburn Rocks). The blocks tend to reduce in size and preservation of form with distance from the basalt mass, indicating a breakdown, and possible rotation, of the blocks as they proceed downslope. The mechanism of movement is probably partly block spread, as defined by Cruden & Varnes (1996), in the early stages and transitions into block slide and block topple as it moves downslope. Block spreads are typically extremely slow moving and the slide toe is not usually obvious. Where identified these features are shown on the Inventory Map (Map 1) and Geomorphology Map (Map 2) as slides, but no attempt has been made to model areas susceptible to this type of large scale landslide as their controlling factors are poorly understood.

Many landslide features shown on this Landslide Inventory map are in fact complex Landslide Zones that involve a number of separate landslide movements (refer to the Geomorphology Map), and have been classified on their dominant landslide movement type.

Based on the state of activity, landslides are classified into the following groups:

- Recent or Active - Landslides that are currently moving or have moved recently (i.e. since European settlement). Landslide features (head scarp, flanks, toe and related cracks) are commonly fresh and easily recognisable. Damage to infrastructure and property is usually visible.

- Activity Unknown - This category includes landslides that have no evidence of historical (European era) movement and in some instances have been significantly modified through erosional processes. In accordance with Cruden and Varnes (1996) this category will include a range of inactive features, such as dormant, abandoned, stabilised and relict. Previously these landslides were referred to as ancient or fossil by MRT geologists but this classification is obsolete and perhaps incorrect. Importantly it implied that ancient landslides were necessarily formed under different conditions (which has not been established) and that they are stable features (which in some instances has been proved otherwise). The potential for reactivation should be assessed on a case by case basis especially as it is possible that some of these features could have moved since European settlement where knowledge of this is not in the possession of MRT.

- Possible - Mapped landscape features that have several of the characteristics of a landslide but due to significant weathering, or modification by urban development, it is difficult to be confident that they are indeed landslides. Therefore the activity of these features is unknown.

Damage

Damage from landslide movement to buildings, roads and railways and other urban infrastructure is well documented throughout the area. Localities where damage has occurred due to landslide movement are indicated on the Inventory map. However, the damage localities shown on this map are only those where MRT has records in its possession, and there are likely to be many more damage localities that have not been reported.

Geology

The majority of known landslides have been recorded in Paleogene sediments and associated Paleogene basalts, as well as younger slope deposits derived from these, and to a lesser extent in deeply weathered Jurassic dolerite and Parmeener Supergroup sediments. The complete geology of the area is shown on Map 3 (Geology).

Geomorphology

The relationship of the landslides to the geomorphology and slopes is shown on Map 2 (Geomorphology).

References

AGS 2007a. Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning. Australian Geomechanics, 42: 13- 36.

AGS 2007b. Commentary on Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning. Australian Geomechanics, 42: 37- 58.

Calver, C.R. 2011. Landslide mapping and magnetic remanence of Paleogene Basalt, Tamar Valley. Record Tasmanian Geological Survey 2011/03.

Cruden, D. M., and Varnes, D. J. 1996. Landslides Types and Processes, In: A. K. Turner and R. L. Schuster (eds.), Landslides: Investigation and Mitigation. National Research Council, Transportation Research Board, Special Report 247, p36 - 75. National Academy Press, Washington, D.C.

Further Information

IMPORTANT: This map should be used in conjunction with an understanding of the information contained within the document "Tasmanian Landslide Map Series: User Guide and Technical Methodology" (Mazengarb, C. and Stevenson, M.D. 2010. Tasmanian Geological Survey Record 2010/01).

This document, and other information on this map series or Tasmanian landslides in general can be obtained from the MRT web site at www.mrt.tas.gov.au or by contacting the agency directly. Copies of the map images (PDF format) are freely available from the MRT website. GIS layers developed by MRT and shown on the map are supplied to each Council in the area and are available for purchase at a minimal cost of supply.
Summary information from the MRT landslide database and map images from the Tasmanian Landslide Map Series can be viewed with the MRT online web map viewer (choose Map: Landslide).

Landslide Features

(red outline)	Recent or active landslide.	1061	Recent or active earth or debris flow.	1066	Earth or debris flow, activity unknown.
(brown outline)	Activity unknown.	1062	Recent or active rock or soil slide.	1067	Rock or soil slide, activity unknown.
		1063	Recent or active rock fall.	1068	Rock fall, activity unkown.
(dashed outline)	Possible landslide.	1064	Possible landslide, activity not specified.		

Note: Not all landslide points have an associated polygon. Some polygons not shown if too small for map scale. Landslide point with landslide ID from GEOHAZARD (landslide) database. Further details of landslides may be obtained from MRT.

Damaged Points

Record of damage to houses, buildings or infrastructure (roads & rail) known to be caused by a landslide.

Note: Damage due to other causes (eg. reactive soil) are also recorded in the GEOHAZARD (landslide) database.

Miscellaneous

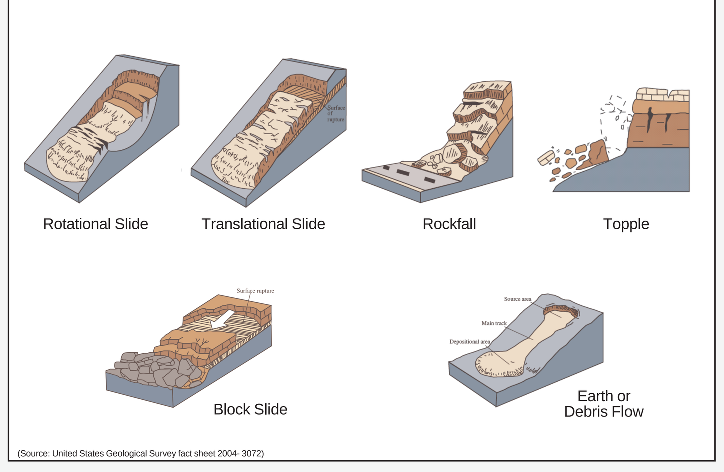
Municipality boundary.

Limit of Geomorphological mapping.

Boundary between Airborne Laser Scanning (survey centred on the Tamar Valley) and 1:5 000 / 1:25 000 topographic contours - for DEM derivatives.

Note: Landslides outside the limit of geomorphological mapping have not been reviewed or refined in this map series.

Principal Landslide Types in the Study Area



Scale: 1:25 000

0 500 1000 1500 2000 2500m

GDA94 - MGA Zone 55. Contour Interval 20 metres.

Citation:

Stevenson, M.D. 2013. Bell Bay, map 1 - Landslide Inventory. Tasmanian Landslide Map Series. Mineral Resources Tasmania, Department of Infrastructure Energy and Resources, Hobart.

Acknowledgements:

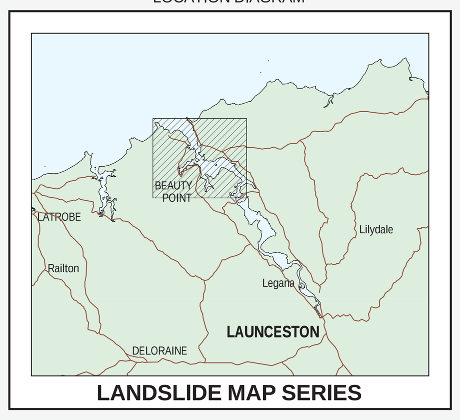
Contributions to the map from C. Mazengarb, D. Shearer, R. Blake, J. Bowerman and A. Mayne.

Base data from the Land Information System of Tasmania (LIST), Copyright State of Tasmania.

Sources for digital terrain model: airborne laser data derived from Climate Futures for Tasmania LiDAR dataset (2008), available from the LIST. Bathymetry derived from data supplied by SeaMap Tasmania (Institute of Marine and Antarctic Studies, 2009), and TasPorts Corporation, including the Tamar River Hydrographic Survey (2009).

Map produced by the Geoscience Information Branch of Mineral Resources Tasmania using GIS software.

LOCATION DIAGRAM



LANDSLIDE MAP SERIES

WARNING: INKS ARE LIGHT SENSITIVE

Data correct & plotfile generated: 13-MAR-2014