

Slope Stabilisation and Landslide Management

The Halcrow landslide management team offers staff with international experience of landslide management and slope stabilisation.

Our specialists include several with over 30 years experience, and their contribution to the practice and science of landslide management is reflected by well over 100 papers on the subject in technical journals and conference proceedings. The team has conducted stability assessments of thousands of slopes and undertaken detailed design of stabilisation measures for many hundreds of man-made slopes, rock slopes and all types of landslides.

This document provides:

- Summaries of representative projects categorised as follows:
 - Emergency response
 - Regional landslide risk and hazard studies
 - Offshore geohazard risk assessments
 - Landslide investigation and remediation
 - Slope assessment and upgrading
 - Guidance and manuals
 - Research and development.
- Summaries of the experience of key staff and retained consultants
- Descriptions of some of the processes and systems used
- A selection of the papers published by present team members





Slope Stabilisation and Landslide Management Projects

Emergency response

Landslide Investigative Consultancies, Hong Kong

Period of services: 1997 -2003

Client: Hong Kong SAR Government

Halcrow was engaged under three separate consultancies to provide emergency call-out services for the inspection of landslide events during the wet seasons in 1997, 2000 and 2002. These inspections were followed by detailed assessments of over 70 landslides to investigate their causes and develop follow up actions. Emergency teams of specialists were continuously on standby during rainstorms to respond to landslide incidents ensuring early mobilisation to capture crucial transient data.

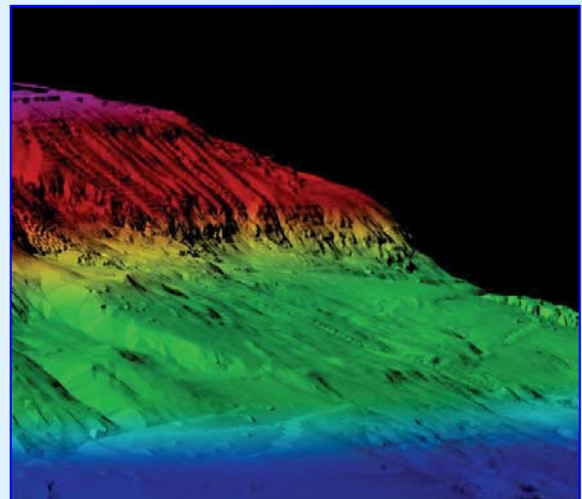


Blaencwm Landslide, Rhondda, UK

Period of services: 1990 – ongoing

Client: The Coal Authority

Following the initiation of the largest landslide to have occurred in the South Wales coalfield for thirty years, Halcrow was commissioned to provide emergency planners with an immediate response on the nature of the hazard, sources of risk and risk mitigation measures. Halcrow contributed to a contingency plan which was aimed at protecting lives and property in response to various failure scenarios and was responsible for monitoring, inspections, 24 hour watches and later corrective works. The illustration is taken from a laser scanning image obtained from an experimental installation for monitoring movements.



Dawlish Sea Cliffs, Devon, UK

Period of services: 2002 – ongoing

Client: CL Associates for Network Rail.

There has been a long history of cliff stability problems affecting the main railway line from Paddington to Penzance along the Dawlish Sea Cliffs and Teignmouth area of Devon. Since October 2002, Halcrow has provided a 24 hour call out service providing Network Rail with geotechnical specialists available within 1 hour. The service has been used for a number of railway sites in South West England.





Slope Stabilisation and Landslide Management Projects

Regional landslide risk and hazard studies

A4061 Rhigos Road, Rhondda, UK

Period of services: 1990 – 2004

Client: Rhondda Cynon Tâf County Borough Council

Halcrow has undertaken a series of commissions in connection with landslide activity along this road. These include a landslide hazard assessment for a 7km length of the road for which a series of large-scale geomorphological hazard maps were produced explaining ground movement in terms of the landslide and other slope processes. Other work included design and supervision of a ground anchor scheme at Foel Goch to stabilise a section of the road, remediation of a section at Hirwaun Common, and inspection and monitoring.



Filey and Cayton Bay Cliff Behaviour Assessment and Coastal Strategy, Yorkshire, UK

Period of services: 2000 – 2005

Client: Scarborough Borough Council

Detailed geomorphological field mapping and aerial photograph interpretation of cliff instability mechanisms and processes were used to derive semi-quantitative estimates of cliff recession potential and sediment supply from cliffs to the shoreline and beaches. The work formed the basis of a strategy for the future management of the coastline.

Natural Terrain Hazard Studies, Lei Pui Street, Kwai Chung, Hong Kong

Period of services: 2002 – 2004

Client: Hong Kong SAR Government

Halcrow undertook a quantified risk assessment (QRA) of natural terrain hazards arising from this 128 ha site adjacent to a heavily populated residential area. A multi-variant susceptibility analysis was formulated to assess event frequency and an innovative mobility model was devised, in collaboration with the HK Government, to model channellised debris flows. Based on the ALARP principle and cost-benefit analyses, an outline mitigation scheme was developed to reduce the risk to acceptable levels.



Christchurch Bay Coastal Defence Strategy, Hampshire, UK

Period of services: 2001 – 2004

Client: New Forest District Council

Geomorphological investigations were carried out to evaluate coastal cliff instability risk and recession potential for the next 100 years to inform the coastal defence strategy for Christchurch Bay. The approach involved the analysis of historical cliff behaviour from ortho-rectified aerial photographs. Using GIS tools, 3D measurements of change were made from digital elevation models of various epochs to a high degree of confidence.

Comparisons of historical and present day behaviour of natural and engineered cliff sections were used as an analogue for making projections of the likely outcome of a 'do-nothing' policy, taking account of factors such as climate change. Projections of future cliff behaviour and recession were input to the cost benefit analysis of various management options identified by the coastal defence strategy.





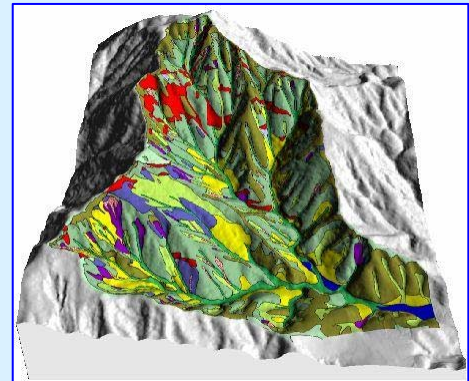
Slope Stabilisation and Landslide Management Projects

Cloudy Hill Natural Terrain Study, Hong Kong

Period of services: 2000 – 2002

Client: Hong Kong SAR Government

Halcrow carried out a detailed study of about 50 natural terrain landslides that occurred after intense rainstorms in the vicinity of Cloudy Hill, Tai Po. Following systematic collection of data, the study involved assessing the landslide characteristics, failure mechanisms, and debris mobility. This required aerial photograph interpretation, engineering geological and regolith mapping and detailed inspections. Data interpretation with reference to topographical and geotechnical factors was then used to develop landslide models of the natural terrain.

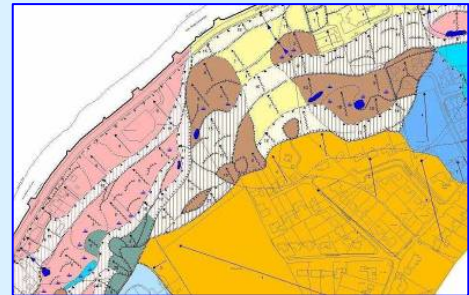


Cowes to Gurnard Coastal Slope Stability Study, Isle of Wight, UK

Period of services: 2000 – 2001

Client: Isle of Wight Council.

Halcrow carried out a ground stability assessment of the coastal slopes from Cowes to Gurnard on the north coast of the Isle of Wight. The study involved the preparation of detailed geomorphological, ground behaviour and planning guidance maps to assist the Council's planning and building control functions.



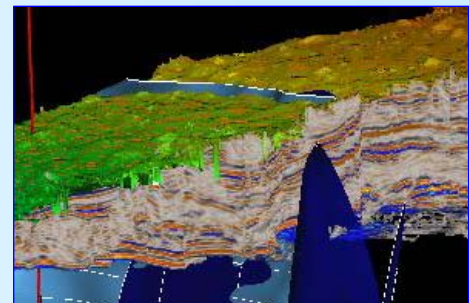
Offshore geohazard risk assessments

Nile Delta and Angola

Period of services: 2003 – ongoing

Client: BP

Halcrow is participating in multi-disciplinary studies that integrate geological, geomorphological, geophysical and geotechnical expertise to evaluate 2D and 3D seismic data and model seabed morphology, landforms and processes. The approach has been used at a number of development sites to conduct geohazard risk assessments, including that of sub-sea landslides, for sea bed oil and gas installations.

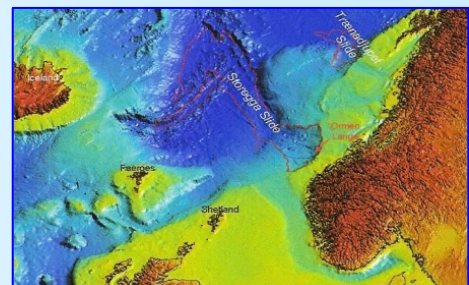


Storegga Undersea Landslide, Norway

Period of services: 2002

Client: Norsk Hydro and Statoil

Halcrow carried out a geomorphological assessment of the Storegga undersea landslide, in connection with risk evaluation for prospective gas field development. Detailed mapping of high-resolution bathymetry was conducted to identify key landforms, probable landslide mechanisms and causes, and the sequence of past events. The mapping was integrated with deep seismic stratigraphy and other data to construct a generalised model of the landslide.





Slope Stabilisation and Landslide Management Projects

Landslide investigation and remediation

Channerwick Peat Slides and Debris Flows, UK

Period of services: 2003 – ongoing

Client: Shetland Islands Council

Halcrow was called in to investigate and identify management solutions for an area severely affected by peat slides and debris flows in September 2003. A specialist investigation programme was implemented to establish the causes and failure mechanisms, install monitoring systems, and identify engineering and management options to mitigate the risks of repeat events.

Landslide Investigation and Risk Assessment, Ventnor Undercliff, Isle of Wight, UK

Period of services: 2002 – ongoing

Client: Isle of Wight Council

Halcrow was appointed to derive robust ground models for use in a stability risk assessment for an area of ancient deep-seated landsliding. Using information from geomorphological studies and boreholes up to 140m deep, ground models were derived to reconstruct past episodes of landsliding and to develop potential failure scenarios and their relative probabilities. The assessment of potential consequences and vulnerability of assets was used as a basis for cost benefit appraisal of coastal slope stabilisation options.

Dibba Road Rockslide, UAE

Period of services: 2006 - ongoing

Client: Ministry of Public Works

In early 2006, a major rockfall occurred on the newly opened Tawaian to Dibba Highway, closing the road for over 6 months. Halcrow was appointed to undertake an independent investigation into the causes of the landslide. The study involved detailed site reconnaissance including geological mapping and a review of the original design. Results of the investigation were presented in a report identifying the causes of the landslide.

Yuvacik Dam, Turkey

Period of services: 2006

Client: Thames Water

Rockfalls have occurred periodically from a cut slope above one abutment of this earthfill dam. Halcrow undertook a desk study and site visit to assess the risk to the dam control structures and adjacent public road from the rock slope. A report was prepared quantifying the risks and recommending mitigation measures.





Slope Stabilisation and Landslide Management Projects

St Dogmaels Landslide, Pembrokeshire, UK

Period of services: 1994 – 2005

Client: Pembrokeshire County Council

Halcrow was commissioned to investigate the mechanism and controlling processes of a deep-seated landslide in glacial lake clays occupying an area of some 30ha. An award-winning stabilisation scheme was subsequently designed and implemented involving groundwater lowering together with rural and urban drainage improvements. Following completion of the works, Halcrow has undertaken inspections and monitoring work.

Slope assessment and upgrading

Landslide Preventative Maintenance Consultancies, Hong Kong

Period of services: 1995 – ongoing

Clients: Hong Kong SAR Government and others in the private sector

Under a number of commissions covering a period of over 10 years, Halcrow has carried out detailed studies comprising field inspections, desk studies, ground investigations, stability analyses, design of upgrading works, contract preparation and supervision of construction for almost 400 slopes and retaining walls.



Slope Remediation, Forestry Land, South Wales, UK

Period of services: 1996 – ongoing

Client: Forestry Commission

Halcrow was appointed to prepare an inventory of all spoil heaps and natural landslides in the Forestry Commission's South Wales Estate with the object of prioritising the sites for management and, where needed, implementation of remediation works. Investigations were subsequently carried out at six sites for which a rolling programme of major stabilisation works involving earthworks, subsurface and surface drainage has been designed and supervised by Halcrow.



Porth Relief Road, South Wales, UK

Period of services: 2000 – ongoing

Client: Glamorgan Engineering Consultancy for Rhondda Cynon Tâf County Borough Council

The ancient Wattstown landslide impacts upon the proposed Porth Relief Road, the proposed route of which crosses the toe of the landslide. Halcrow's role includes assessing the results of geomorphological and ground investigations together with movement and groundwater monitoring, and developing the design of a stable platform for the proposed road whilst maintaining the overall stability of the landslide. A Halcrow landslide expert supported the client at a Public Inquiry.



Maintenance Inspection of Slopes, Hong Kong

Period of services: 1998 – ongoing

Client: Hong Kong SAR Government

Halcrow inspected over 12000 slopes and retaining walls throughout Hong Kong to determine maintenance measures to prevent their deterioration, and developed slope inventory databases for client's staff to manage their slopes more effectively.



Slope Stabilisation and Landslide Management Projects

Guidance and Manuals

Many Halcrow landslide projects including some of those described above have included the preparation of guidance or manuals covering issues such as monitoring and instrumentation, contingency plans and emergency procedures. Some examples are given below.

Peat Slide Hazard and Risk Assessment - Best Practice Guide

Period of services: 2006 – ongoing

Client: Scottish Executive Energy Consents Unit.

Halcrow has been commissioned to produce best practice guidance to ensure that accurate and realistic peat slide hazard and risk assessments can be undertaken during the planning of upland electricity generation developments in Scotland, such as wind farms. The geotechnical controls of peat slide failures are distinct to organic soils and the standard approaches to slope investigation and analysis are not necessarily appropriate for this type of failure. The document will provide guidance on the best methods for identifying, mitigating and managing peat slide hazards and their associated risks.

Integrating Man-made Slopes into their Surroundings

Period of services: 1998 – 2000

Client: Hong Kong SAR Government

Halcrow, working with a specialist landscape sub-consultant, was author of the award-winning Technical Guidelines on Landscape Treatment and Bioengineering for Man-made Slopes and Retaining Walls which was issued as a Hong Kong Government Publication GEO 1/2000 and has become an industry standard manual.

Inspection and Monitoring Procedures for Forestry Commission Sites

Period of services: (1996 – ongoing)

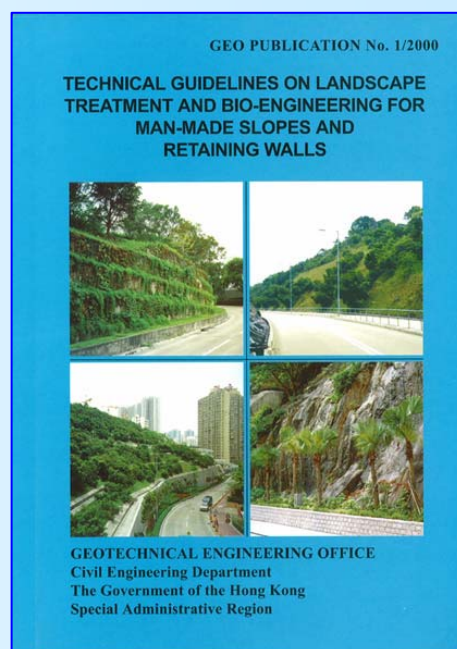
Client: Forestry Commission

Halcrow has prepared for the Forestry Commission a three tier risk-based register, which is up-dated on six-monthly basis, which includes spoil heaps, natural landslides and geo-hazard sites on its land in the South Wales coalfield to facilitate their inspection and management. For each site in the highest risk category Halcrow has prepared site specific inspection and monitoring procedures to facilitate their management. For remediated sites, Halcrow has also prepared manuals covering the operation and maintenance of the engineering stabilisation measures together with guidance on future site inspection and landslide management requirements.

Rhondda Valleys Landslide Potential Mapping and Planning Guidance

Client: The original Client's successor organisation is Rhondda Cynon Tâf County Borough Council

Although this project was undertaken in the 1980s, it resulted in the preparation by Halcrow of planning guidance for the local authority which is still in use today. This guidance zones the local authority's area such that for any proposed new development, it can determine the need for and scope of any special investigations into slope stability by the developer.





Slope Stabilisation and Landslide Management Projects

Coastal Slopes, Anguilla

Period of services: 2000

Client: Department for International Development (for Government of Anguilla)

In November 1999, the Caribbean island of Anguilla was badly affected by Hurricane Lenny causing extensive coastal landslide activity. Halcrow was appointed to study the hazards posed by the widespread slope instability and provide guidelines for future development planning.



Research and Development

Halcrow's landslide team is actively involved in a number of research and development projects, and maintains strong links with academic specialists and expert consultants to ensure that up-to-date knowledge and methodologies are available to clients. Some of this work is funded by clients, and some is funded by Halcrow.

EU Life RESPONSE

Period of services: 2003 – ongoing

Client: Isle of Wight Council

The RESPONSE project aims to develop sustainable strategies for local authorities and stakeholders to manage natural hazards in the coastal zone. Halcrow's contribution relates to coastal landslides. The project will develop innovative regional scale methodologies for coastal evolution studies and risk mapping taking account of the predicted impacts of climate change.

CRANIUM (Climate change risk assessment: new impact and uncertainty methods)

Period of services: 2003-2006

This EPSRC/UKCIP funded project is being undertaken by the University of Bristol in association with others. The work seeks to analyse the potential impacts of climate change on the built environment, transport and utilities. It focuses on new methods of handling uncertainty (particularly with respect to climate change scenarios), system simulation, risk analysis and decision-making. Halcrow is an Industrial Sponsor, working with the University of Bristol, contributing expertise on the impact of climate change on landslide risk.

Review of the Use of Horizontal Drainage Systems

Period of services: 2005 - ongoing

Client: Highways Agency

Halcrow is undertaking research on behalf of the Highways Agency, on the use of horizontal bored drains to control groundwater in infrastructure earthworks slopes. It is a desk study and involves collating information from researchers and practitioners on design and construction techniques used in different parts of the world.

Landslide behaviour

Period of services: 2004 - ongoing

Halcrow is supporting a PhD research project at the University of Durham into methods of determining catastrophic deep-seated landslide behaviour through the combined understanding of groundwater, surface movement and basal deformation characteristics. The student is employed by Halcrow and, with the co-operation of the client (Isle of Wight Council), has benefited from investigations and data obtained in the course of Halcrow's work on landslides at Ventnor.

Slope Stabilisation and Landslide Management

Key staff and retained consultants

Halcrow employs specialists in geotechnical engineering, geology, and geomorphology, many of whom have in excess of 30 years experience of slope and landslide work.

H J Siddle

Howard Siddle (BSc CGeol FGS) heads Halcrow's landslide management team. He has over 30 years experience of the investigation and remediation of slopes and landslides, as well as mining, geological, geomorphological and hydrogeological investigations. He has been responsible for the investigation of many large landslides and has published over 20 papers on aspects of landslide and landslide hazard. He has acted as an Expert Witness in landslide and slope stability cases.



G Daughton

Gerry Daughton (BSc FHKIE RPE(G) CGeol FGS) has over 30 years experience in geotechnical and geological aspects of civil engineering works. He has particularly extensive experience in landslides and both rock and soil slope stability. For several years, he was engaged on the investigation and design of remedial measures to hillsides and spoil heaps in South Wales. He has based in Hong Kong for over 20 years, where he has been Project Director for many slope and landslide projects for Government and private clients.



Dr S R Hencher

Steve Hencher (PhD DIC CEng CGeol MIMM FHKIE RPE(G) FGS) has over 30 years experience in geotechnical engineering much of it related to slopes and landslides. For 12 years he taught engineering geology at MSc and PhD level at Leeds University in the UK. He has published more than 60 papers on fundamental aspects of geotechnical design and practice, with a strong emphasis on slope engineering.



Dr D B Jones

Barrie Jones (PhD MSc CEng MICE) is a member of the Academy of Experts and has over 30 years of wide ranging geotechnical experience including major slope and landslide projects. He is experienced in finite element and finite difference modelling of soils, rocks and soil – structure interaction. He has acted as Expert Witness for several litigation proceedings, and has provided advice and support at a Parliamentary Committee Hearing.



Dr R Moore

Roger Moore (PhD CGeol FGS FICE) has over 20 years experience in landslide hazard, impact and risk studies. He has specialist skills in remote sensing, the interpretation of aerial photography and geomorphological mapping, geohazard and quantitative risk assessment (QRA). His experience includes the investigation and mitigation of landslides and coastal cliff recession, and offshore geohazard assessments. Dr Moore has acted as an Expert Witness on geomorphological issues.



Professor D Brunsdon OBE

Denys Brunsdon (DSc) is Emeritus Professor and Fellow of King's College London. With over 40 years of experience, he is a retained consultant to Halcrow. He has a worldwide and distinguished reputation as an engineering geomorphologist specialising in hillslope processes, landslides and coastal studies. He has published over 15 books and 100 technical papers and was awarded the William Smith and Glossop Medals by the Geological Society of London for his contribution to engineering geomorphology.





Slope Stabilisation and Landslide Management

Key staff and retained consultants

J D Maddison

Dean Maddison (MSc CEng MICE) has over 20 years experience of landslide investigation and remedial works design, slope stabilisation works, stability assessment of colliery spoil heaps and slopes associated with highway and motorway schemes. He was the project manager of the multi-disciplinary team which designed the award winning remediation scheme at the St Dogmaels landslide and has managed several large slope stabilisation schemes for the Forestry Commission.



K L Tang

Leonard Tang (MES, MHKIE, MIEAust, MIPENZ) is a Director of Halcrow China Limited, with 17 years experience in both consulting and contracting, much of it related to slope stabilisation and landslip investigation studies. He has acted as Project Manager for landslip investigation studies and also for one of the biggest Natural Terrain Hazard Studies for the Hong Kong Government using a Quantified Risk Assessment (QRA) approach. He is currently Project Director and Project Manager of numerous of slope stabilisation projects for both government and private sectors.



A T Watkins

Allan Watkins (CEng FICE FIPENZ Reg Eng FHKIE RPE(C) RPE(G)) has extensive practical experience of landslide preventive measures and associated management systems through more than 20 years works with the Geotechnical Engineering Office of the Hong Kong Government. Since joining Halcrow in 2001, he has acted as Project Director for several contracts for design and construction to improve the safety of slopes in Hong Kong.



J P Tyson

Julian Tyson (BSc MSc CGeol FGS MHKIE) has over 20 years experience in engineering geology. He has been involved in a wide range of slope projects including geotechnical design, landslide risk assessment studies and engineering geological field mapping. He has significant international experience, and is based in Dubai, having previously worked in Hong Kong, the Philippines, and the UK.



Dr Mark Lee

Mark Lee (PhD CGeol FGS) is a retained consultant to Halcrow with a distinguished reputation in the application of engineering geomorphology to civil engineering projects. He is a leading expert on probabilistic landslide hazard risk assessments and economic appraisal. He was the principal team leader for the MAFF-commissioned research on Soft Rock Cliffs published in 2002 and is co-author of the book on Landslide Risk Assessment published in 2004. In addition, Mark Lee has published over 50 technical papers on applied geomorphology and coastal cliff studies.



G Davis

Geoff Davis (MSc BSc CEng MICE MIMMM CGeol FGS) is an engineering geologist with 17 years experience. He has particular expertise in the assessment and management of coastal slope stability issues, and was West Dorset District Council's team leader for the Lyme Regis coast protection project. More recently, Geoff Davis has been a member of the Halcrow team for projects such as the investigation and risk assessment for the large urban landslides at Ventnor, Isle of Wight, and the assessment of offshore geohazards on the Nile Delta. He has 12 published papers on aspects of landslide management, site investigation and public relations.



Slope Stabilisation and Landslide Management

Key staff and retained consultants

C D Warren

Colin Warren (MSc DIC BSc C Eng MIMM CGeol FGS) has over 30 years experience in engineering geology and hydrogeology, with specialist knowledge of the Chalk and Gault strata of southern England having worked extensively on the major landslides at Folkestone Warren and Castle Hill through which the Channel Tunnel was built. Current research interests include mechanisms of landslide movement and progressive failure. He is the author of over 40 papers and has been an invited speaker at national and international conferences.



W S Martin

Stewart Martin (BSc CEng MICE FGS) has over 30 years experience in most fields of geotechnical engineering. His experience includes stability evaluation of several 200 year old embankment dams and preparation of a risk management strategy for an ancient landslide in Scotland. Recent responsibilities include advising Shetland Islands Council and the Scottish Executive on the management of landslides affecting trunk roads induced by high intensity rainfall.



Michael Palmer

Mike Palmer (MSc DIC BSc EurGeol CGeol FGS) has 20 years experience as an engineering geologist with wide experience of major projects in the UK and overseas including a number of large landslides. These include the Ventnor coastal instability risk assessment and investigation where he has been responsible for detailed stratigraphic interpretation of the borehole sequences and the development of ground and landslide models. Other UK landslide projects include Bonchurch, Encombe, Fairlight Cove, Filey Bay and Folkestone Warren. These projects have contributed to his considerable experience of the interpretation, modelling, stability and risk analysis of landslides, and the design of remedial measures. He has also extensive experience of developing and using relational databases for geotechnical data.



G S Green

Guy Green (MSc DIC BSc CEng MICE FGS) has over 20 years experience, much of it involving the investigation, design and reporting on a wide range of slope and landslide projects. In Hong Kong he was Project Manager for contracts awarded under the HK Government Landslip Preventive Measures Programme. More recently he spent two years managing a framework contract for British Waterways which included extensive maintenance and renewal works for their large asset of earthworks structures.



Dr L J Donnelly

Laurance Donnelly (PhD BSc CGeol FGS EurGeol CSci) has over 15 years experience in engineering geology, with specialist expertise in geological hazards. This includes the investigation, zonation, risk assessment, mitigation and stabilisation of landslides, and engineered rock and soil slopes. His experience covers the investigation of landslides induced by volcanic eruptions, earthquakes, mining activities and engineering works in Asia, the Americas, Europe and Australasia.





Slope Stabilisation and Landslide Management

Processes and systems

Geotechnical analysis and data management

It is essential that the geotechnical analytical methods used are appropriate and supported by a thorough understanding of fundamental soil and rock mechanics principles. The systems used include a range of in-house and commercial stability analysis programs such as SLIP5, STABLE, ENB and SLOPE/W, and numerical modelling software such as PLAXIS, FLAC and UDEC. Ground investigation information is generally handled digitally in AGS format using database software such as Holebase.

Geographical Information Systems (GIS)

Halcrow maintains a highly resourced GIS facility. GIS technologies have particular application to the investigation and management of landslides, through handling and analysis of 3D site mapping, survey, ground investigation and monitoring data. Increasingly, GIS is used by clients for asset management, decision support and strategic planning in landslide prone areas and Halcrow is able to customise deliverables to meet Client requirements.

Hazard and risk assessment methods

Halcrow has particular expertise in the development and application of qualitative and quantitative geohazard and risk assessment methods. Such methods aim to identify areas where landslides are likely, to represent hazard locations on maps, and to disseminate geohazard and risk information to planners, engineers, and decision-makers. Qualitative hazard and risk maps are typically based on geomorphological mapping, ground behaviour assessment and geotechnical analysis.

Instrumentation and monitoring systems

Instrumentation and monitoring systems are essential to landslide investigations, landslide management and to the verification of the effectiveness of remedial works. Halcrow has extensive experience of planning and specifying systems ranging from basic systems involving perhaps only site inspections and periodic surveying of surface movement markers, to extensive and sophisticated systems involving remote monitoring of data via automated telemetry from piezometers, rainfall gauges, movement gauges and laser scanning systems.

Field data management

Halcrow has been pioneering the application of new technologies to the acquisition of field data. These include use of orthorectified aerial photographs for aerial photographic interpretation, which in conjunction with use of a mobile GIS system and a handheld GPS, can be used as base maps for field mapping. Data gathered in the field can be transferred directly into a GIS for subsequent analysis.

Digital photographic and LIDAR aerial surveys

Interpretation of remote sensing data such as satellite imagery and aerial photography has wide application in the investigation of natural terrain and landslides. These technologies offer significant advantages for landslide investigations that require real-time accurate spatial data for mapping and monitoring purposes. Techniques in use include digital photographic and LIDAR aerial survey, integrated with real-time 3D position and height data.

Slope condition databases

Halcrow has developed state-of-the-art databases for clients to store and manipulate slope attributes for the effective management of their earthworks assets. These databases include over 7000 slopes and retaining walls, and are structured to meet the individual clients' specific maintenance requirements. They allow statistical analysis and sorting of data to enable the clients' staff to prioritise works.



Slope Stabilisation and Landslide Management

Selected Publications by Halcrow Staff

(current staff shown in **bold font**)

Landslide investigations and monitoring

Clark A R, **Moore R** and Palmer J S: "Slope monitoring and early warning systems: application to coastal landslides on the south and east coast of England, UK", Proceedings of the 7th International Symposium on Landslides p1531 - 1538, Trondheim, Norway, June 1996

Daughton G, Noake J S and **Siddle H J**: "Some hydrogeological aspects of hillsides in South Wales," Proceedings of Conference on Rock Engineering, Newcastle-upon-Tyne, 423-437, 1977

Donnelly L J and Culshaw M G: "Engineering geological and geophysical investigations of a slope failure at Edinburgh Castle, Scotland", Bulletin of the International Association of Engineering Geology and the Environment, 2005 (to be published).

Donnelly L J: "Catastrophic Landslides in Colombia with Emphasis on Medellin and Sante Fe De Bogota", British Geological Survey, WN/97/35C, 1997.

Donnelly L J: "The 12 May 1996 Tar River Pyroclastic Flows, Soufriere Hills Volcano, Montserrat, West Indies: Helicopter Observations", British Geological Survey, WN/96/26, 1996.

Hencher S R: "Limitations of stereographic projections for rock slope stability analysis", Hong Kong Engineer, 13, 7, pp 37-41, 1985

Jones D B, Reddish D J, **Siddle H J** and Whittaker B N: "Landslides and undermining: Slope stability interaction with mining", 7th ISRM Congress, Aachen, 893-898, 1991

Liao Q H and **Hencher S R**: "The effect of discontinuity orientation and spacing on failure mechanisms in rock slopes – results from systematic numerical modelling", in Proceedings of CIM97, Paper No. WPM1-E2, Vancouver, 27-30 April, 1997

Martin P L and **Warren C D**: "The design and performance of drainage measures installed for the stabilisation of Taren Landslide, South Wales, UK", Proceedings 6th International Symposium 'Landslides', Christchurch, New Zealand, 10-14 Feb 1992, ed. Bell

Leggo P J, **Warren C D** and Blakeway D B: "Application of isotope hydrology to groundwater problems in engineering geology", Geological Society Engineering Group Special Publication No 3, 1986

Siddle H J: "Groundwater tracing in a South Wales Landslide," WRC Environment Workshop ER 1167-M, Tracers for Water Industry, 133-137, 1986

Siddle H J and Hutchinson J N: "A sliding and multiple topping failure in South Wales, UK," Proceedings of 6th International Symposium on Landslides, Christchurch, New Zealand, 213-218, 1992

Siddle H J, Ansell P and Oliver M J: "The effect of mining subsidence on spoil heap stability, a case history," Proceedings of 3rd International Conference on Ground Movements and Structures, Cardiff, July 1984, 264-278, Pentech Press, 1984

Siddle H J, Wright, M D and Hutchinson, J N. "Rapid failures of spoil heaps in the South Wales Coalfield", Quarterly Journal of Engineering Geology, 29, 103-132. 1996

Siddle H J: "Technical response to emergency planning following a landslide", Proc Instn Civ Engr Mun Engr, 133, 65-69

Varley P M, **Warren C D** and Avgherinos P J: "Castle Hill West Slip". In "Engineering Geology of the Channel Tunnel" editors Harris C S, Hart M B, Varley P M and **Warren C D**. Chapter 20, 295 – 309.

Coastal landslides

Brunsdon D and **Moore R**: "Engineering geomorphology on the coast: lessons from West Dorset", Geomorphology No. 834;1-19, 1999

Brunsdon D, Lee E M, **Burt N J** and **Moore R**: "Strategies for managing the landslide complex at Ventnor, Isle of Wight", International Conference on Slope Stability Engineering, Isle of Wight, 1991

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