GEOTECHNICAL STUDY AREA G2

LUCCOMBE LANDSLIDE, VENTNOR UNDERCLIFF, ISLE OF WIGHT, UK

Plate G2 ***View from Bonchurch towards Luccombe, Isle of Wight, UK***

1. BACKGROUND

In 1987/1988 landslide movements occurred seaward of Luccombe Village at the eastern end of the Isle of Wight Undercliff affecting a number of properties (see Plate G2 and Figure G2.1). These movements were not an isolated event in the area. Geomorphological mapping and analysis of historical documents, including newspapers and postcards indicate the village was built on an ancient landslide system and there has been intermittent movements several times this century. Over the last 50 years in particular the landslide movements have taken the form of periodic reactivations and upslope extension of earlier failures, and have thereby been progressively affecting a larger area of the village.

In addition to the obvious landslide damage there has been gradual subsidence, which has affected all the properties within the village. A study commission by the Department of the Environment in 1988 (DoE: Report on the Study of Landsliding in and around the village of Luccombe) identified a continuing potential for landslide activity involving seasonal movements below the coastal footpath, period movements along the rear scarp feature at the head of the landslide and slow and gradual subsidence upslope of the immediate landslide area. The risks associated with future movements ranged from likely building damage to the possibility of personal injury.

In the past there had been an 'ad hoc' response to specific landslide events, primarily relating to repairing building damage or condemning properties rather than preventing further movements. However, the nature and scale of the movements in 1987/88, accompanied by the continuing potential for further movements indicated that there was a clear need to identify the most appropriate strategy to reduce the problems and to identify who may be responsible for undertaking any further works.

The DoE report published in 1988 outlined a number of strategies which could be adopted including landslide monitoring and forecasting, planning controls, engineering measures and acceptance of risk.

The results of this study recommended that, with the aim of reducing risk to local residents, and to establish the viability of stabilization measures it was necessary to:

1. Develop an efficient monitoring and early warning system whereby rapid on-site assessment of the initial stages of slope failure could be used to predict major movements and instigate preventative measures, thereby reducing the risk of personal injury and damage to property.
2. The implementation of a detailed site investigation to determine the causes and mechanisms of ground movements together with variations in the ancient landslide systems, and a study of coastal retreat as a basis for defining engineering measures.
3. The execution of a detailed assessment of the financial implications of continued movements taking account of building damage, insurance and ongoing maintenance costs, etc.

The results of these investigations provided clear information to leading to the development of a cost-effective solution to the problems at Luccombe Village.

2. IMPACT OF THE INSTABILITY PROBLEM

The site at Luccombe Village was built as a private development on open grassland above Shanklin Cliff between 1927 and 1936. Prior to this a small fishing community existed on the foreshore at Luccombe Chine but was destroyed by the great landslip of 1910. Photographic and newspaper evidence of landslide activity in the vicinity of Luccombe Combe prior to 1950 is available and this clearly demonstrates that landslide movements have been recorded in the area for many years. Although there were no reported failures of the sea cliffs, there has been significant cliff retreat over this period, with an estimated rate of erosion of 0.3m per year (Plate G2a).

During the period 1950-1990 Luccombe Village experienced three major phases of landsliding in 1950/51, 1961/62 and 1987/88. The extent of the 1950 and 1961 movements, which resulted in the demolition of three homes, were recorded by the Local Authority at that time. Between 1952 and 1961 a further six properties were demolished. See Figure G2.3 and Plate G2b.

Each phase of landsliding was reported in local newspapers which gives an indication of the nature and extent of the resulting damage. The movements initially occurred seaward of the village and subsequently retrogressed inland exposing a number of pre-existing scarp slopes. Each period of landsliding was reported to have occurred after periods of prolonged and intense rainfall.

In January 1988 further ground movements resulted in four homes being damaged or demolished. The Council appealed for help and the Luccombe Residents Association was formed in February 1988. The impact of landslide movements over the years at Luccombe has resulted in damage to many properties. The whole community was affected and was anxious to support and to safeguard their livelihood. Anxiety had been promoted from day to day concern of grounds movements occurring to seeking help and compensation and fighting insurance claims.

A preliminary investigation of the nature and cause of the slide was commissioned by the Department of the Environment. However, support was slow to come forward, mostly for fear of setting precedents and due to a shortage of funds, both locally and nationally. Yet, through the efforts of the Residents Association, action was taken by the former South Wight Borough Council and by the Water Authority (Southern Water Services Ltd) who subsequently implemented some landslide management measures, which are discussed below.

3. THE ROLE OF KEY AGENCIES

The key agencies involved with instability problems at Luccombe were (and still are) the Local Authority, now the Isle of Wight Council, and Southern Water Services Ltd. The Council is responsible for undertaking ground movement monitoring in the area as well as maintaining and keeping and clearing ditches and watercourses below the village, whilst the Water Company maintains the drainage system (sewerage) which was provided as part of the remedial solution in 1991, together with maintenance of water supply pipes.

The local residents, through their Residents Association, continue to play an important role in terms of maintaining their own drainage systems, assisting with monitoring in the Luccombe area and advising the Council of problems that may occur from time to time including discussion of any planning and building control matters.

4. THE STUDY AREA

4.1 Geology and Geomorphology

Luccombe is situated on the south coast of the Isle of Wight, 3km north-east of Ventnor. The village lies on the eastern margin of the Southern Downs outlier which is developed in Lower and Upper Cretaceous sedimentary rocks. The Lower Greensand units are well exposed at Luccombe cliff between Luccombe Chine and Shanklin Chine where they dip gently to the south at 1-2°. The base of the Gault Clay is exposed at the top of the cliff whilst the Upper Greensand and Lower Chalk form the inland slopes behind Luccombe Village (Figure G2.2).

The geomorphology of Luccombe Valley was mapped at a scale of 1 : 25,000 and indicated that the area can be divided into four main geomorphological units. These units and their characteristics are as shown in Table 1.

5. MANAGEMENT AND MONITORING

Luccombe Village is built on a pre-existing landslide underlain by shear surfaces forming an inherently unstable slope (Moore et al. 1991). Factors which have contributed in varying degrees to the reactivation of the Luccombe landslide can be separated into two broad groups: Preparatory factors, that reduce the stability of the slope without actually initiating movement, and triggering factors, which initiate movement.

Three main preparatory factors have been identified as being responsible for reactivating landslide movements at Luccombe. These include the recession of the coastal cliffs, the construction and development activities in Luccombe Village since 1927 and water supply and sewage leakage.

Geomorphological Unit	Description
Upper Greensand valley slopes	The Upper Greensand unit consists of a series of long linear, west-east orientated ridges and narrow dry valleys. The ridges are steep-sided with slopes of 17-22° where the valleys cut through the Chert Beds. As the ridges extend down slope through the Malm Rock and Passage Beds into the Gault Clay vale, the relief is more subdued and slope angles decline to around 6-9°. The slopes on the south-east flank of Cowleaze Hill are convex in form, ranging from 6-13°, but below 130-140m OD they have been affected by large scale landslide activity.
Gault Clay vale	The Gault Clay forms a gentle sloping (5-6°) vale consisting of soft unconsolidated layers of alluvial material and possibly peats. Two streams flow across the vale, both of which are fed by springs issuing from the overlying Passage Beds.
Landslide systems	These slides represent the degraded remnants of a series of major rotational failures of Upper Greensand strata on a shear surface probably seated within the Gault Clay. The landslides in Luccombe Valley may be sub-divided into four inter-related zones : 1. Landslide backscars. 2. Zone of landslide blocks. 3. Debris aprons. 4. Contemporary degradation zone. The contemporary degradation zone represents the upslope extent of recent landslide activity, and is characterised by a series of part translational, part successive rotational failures in both landslide debris and the underlying in-situ Gault Clay, in response to continuing sea cliff retreat caused by marine erosion.
Sea cliffs	The sea cliffs are developed in the alternating sequence of sandstones and clays of the Lower Greensand. However, over much of the section between Luccombe Chine and Luccombe Village the clifftop is developed in the lower, silty units of the Gault Clay, the cliffs varying in height from around 60m at Luccombe Chine to 85m east of Luccombe Village. The cliffs towards Shanklin are characterised by a series of lithologically-controlled benches or “undercliffs” which are covered by spreads of landslide debris that have spilled over the cliffs above.

Table 1 Geomorphological Units at Luccombe, Isle of Wight, UK.

The retreat of the Lower Greensand sea cliffs has removed support from the ancient landslide system. As a result the debris aprons in front of the landslide blocks have been gradually eroded through a series of retrogressive failures. The erosion of the debris aprons has led to the unloading of the toe areas of the main landslide blocks upslope, and has progressively reduced the stability of the whole landslide system.

Luccombe Village has been extensively developed since 1927. Level plots for houses have been formed by means of cutting and filling the slopes. Similar works would have been carried out to lay roads. Water, drainage and service pipes were laid, ponds have been built and gardens terraced. All these operations have interfered with the natural drainage of the site. Additionally, many hardstandings, paths and landscape features have concentrated drainage artificially into a limited number of points in the ground. There has been little maintenance of the surface water drainage in the village; rubble drains are infilled with debris, ponds formed in the landslide area remain undrained and, in some places, drainage outlet pipes appear to discharge directly onto the landslide.

The leakage of supply water and sewage within Luccombe was undoubtedly promoting instability since the construction of the village. Water leakage from the supply network within Luccombe was estimated prior to remedial works being undertaken at 4,350 litres per day or 29% of the total supplied. It is not clear whether this leakage was caused by the 1987/88 movements or whether significant leakage occurred prior to the landslide.

Luccombe Village had only a very poor sewerage system, the majority of water supplied each day (about 15,000 litres) ultimately entered the landslide system by a leakage or septic tank drainage. The domestic wastes were firstly discharged into septic tanks or directly into the ground. Irrespective of the efficiency of the methods, all water discharged was finding its was into the landslide system eventually.

In summary, there has been considerable human interference with the natural drainage of the site both through the concentration of run-off into a few locations and the artificial groundwater recharge of around 15,000 litres per day through leakage and septic tank drainage. As a result, it is likely that since the development of the village the artificially raised groundwater levels have resulted in a gradual reduction in slope stability. In combination with the retreat of the coastal cliffs, human activity has clearly produced a situation whereby the ancient landslide systems within Luccombe Village have become increasingly susceptible to reactivation.

The primary factor initiating movement had been reported to be prolonged and intense rainfall. This is certainly true of the movements which occurred in 1987/88. The mean annual rainfall recorded at nearby Shanklin is 888.4mm. The long term annual rainfall trend is indicated by the five year running mean which highlights 1950-52, 1958-62 and 1965-68 as significant wet periods. It is important to note that this trend shows a general reduction in annual rainfall since 1969, with mean totals as low as 800mm and there has accordingly been less rainfall between 1969 and 1987 than in previous periods.

Landslide activity in 1987/88 was undoubtedly triggered by prolonged and intense rainfall; the wet phase totalled 638.2mm in 1987/88 and was the fourth largest total since 1947, while the monthly rainfall in October 1987 (259.3mm) was the highest monthly total recorded since 1947. This was followed in 1988 by the highest recorded January total (183.1mm) since 1947. As a result of these events, groundwater levels, measured in a borehole near Luccombe, rose from about 103m OD in mid-September 1987 to about 111m OD by late January 1988. Within the landslide area groundwater levels were close to the surface during the phase of active movement.

Whilst there is an overall association between periods of high rainfall with correspondingly high groundwater levels and landslide activity, not all rainfall events resulted in ground movements. Events surrounding the activity in 1988 illustrate that point. No reports of landsliding activity were made in October, despite the highest monthly rainfall total since 1947. The first reports of movement were made on 11 November 1987 following over 60mm of rain in four days. No movements were reported between 11 November 1987 and 5 January 1988, corresponding to

a relatively rain-free period with only 117.4mm of rainfall occurring. The main phase of movement occurred between 5 and 29 January 1988, although there appears to be little correspondence with daily rainfall events. These findings suggest that antecedent conditions are more significant than single rainfall events.

Following the execution of various engineering works to reduce the impact of instability in Luccombe Village, the Council decided to install in 1994 monitoring instrumentation at Luccombe itself. This comprised provision of two tiltmeters and one piezometer. Prior to that time there was a period of manual monitoring undertaken by the Building Control Section of the Council. However, the value of automatic systems linked by telemetry was then being recognised by the Council and as a result the system subsequently became connected through a telemetric link to the Isle of Wight Council offices in Newport. Movements are recorded alongside weather data which is continuously recorded at the Council's automatic weather station located in nearby Ventnor.

6. CURRENT STATUS AND APPROACH TO THE PROBLEM

The study of landsliding at Luccombe Village initiated by the Department of the Environment identified a continuing potential for landslide activity involving :

1. Seasonal movements below the coastal footpath.
2. Periodic movements along the rear scarp feature at the head of the landslide. Such movements being likely to occur after prolonged periods of heavy rain.
3. Slow gradual subsidence affecting the whole village upslope of the active landslide area.
4. The future risk associated with further movements ranging from building damage to the possibility of personal injury. To alleviate the future impact of continued landsliding within Luccombe village, a number of management strategies were adopted jointly by the Council, Southern Water and the local residents.

Apart from the monitoring programme described above, an important aspect of the strategy was related to development control. Planning controls have had a dual affect in Luccombe. First by protecting areas of potential hazard from inappropriate development by minimising the adverse effects of landsliding through avoidance, the adoption of buffer zones and compulsory purchase of threatened sites; second by controlling the methods of development. Building control codes require the use of particular types of foundation, structural design and construction methods which are able to accommodate slight or moderate movements. The appropriateness of either or both of these approaches is carefully considered by the Local Authority.

7. EXPERIENCE, SUCCESSES AND PROBLEMS WITH THE CURRENT APPROACH

In response to the ground movements and through continued dialogue between the key parties and agencies involved a series of measures were put in place to try and reduce the instability problems at Luccombe. These included abandonment and removal of the existing sewerage drainage system and replacement with a new mains drainage system provided by Southern Water, which collected all sewerage flows, together with roof water and much surface water from properties, and the transfer of these flows out of the Luccombe area to the nearby town of Shanklin. Second, the water company also renewed all the water supply pipes, thereby eliminating the problem of leakage described above.

The Local Authority, which owns some of the land seaward of the village arranged for ditches and watercourses to be thoroughly cleaned out and to be maintained on a regular basis in order that water could run freely across the landslide system and down to the sea cliff. This eliminated the problem of ponding and seepage into the landslide system which had been occurring prior to the movements in 1988.

Further measures included an extensive programme of tree planting on the coastal slope seaward of the village. This measure appears to have been very successful with many trees growing to maturity, thereby helping to stabilize the ground but also to draw moisture from it. Highway drainage systems comprising surface water pits were also connected up as part of the drainage system and efforts are made to maintain these adequately, to prevent overflowing and ponding. The combination of these measures has been to enable an effective reduction in the artificially raised groundwater levels so that if major rainfall events do occur there is greater capacity in the ground enabling rainfall to be absorbed to a greater degree prior to triggering movements.

Since the engineering works were completed, there have been two wet winters, 1994 being the most significant situation. During that winter period the drainage systems worked well and no serious instability problems were encountered in the village. There were some minor movements along the coastal path seaward of the village but these were to be expected bearing in mind the extremity of the rainfall conditions during that winter period. The Council continues to monitor the system at Luccombe but is pleased that the collaborative efforts of the water company, the local residents and the Council appear to be working satisfactorily. The success of these measures relies on ongoing support from the various parties and progress at this and other locations is reviewed regularly at the Ventnor Undercliff Landslip Management Committee. Meetings are held approximately twice a year and bring together professionals involved with all aspects of development, planning and engineering relating to unstable ground in the Isle of Wight Undercliff.

The Council recognised that coastal protection to further reduce instability at Luccombe was not an option. The site in question was designated as a Site of Special Scientific Interest (and more recently a candidate Special Area of Conservation under the European Habitats Directive) and natural erosion of the sea cliffs is a major contributor towards the sediment budget for Sandown Bay, one of the main tourism areas with fine sandy beaches. In addition, a considerable amount of cliff face weathering would still occur and this could not be controlled by coast protection at the base of the cliff. Therefore, the success of coast protection measures in terms of reducing instability would be doubtful. A further requirement for coast protection works in order to trigger grant aid from the Government would be a positive benefit-cost and it is doubtful whether there would be sufficient benefit-cost at Luccombe to enable grant aid to be forthcoming, bearing in mind the value of the properties and the distance that they are situated back from the clifftop.

The Council believes that the works undertaken at Luccombe, adopting a partnership approach, form a good example of how mitigation against modest landslide activity can take place with collaboration and support of all parties. It is important for dialogue to be maintained between local residents and the Local Authority and to ensure that sufficient budgets are available for maintenance to be undertaken regularly and for trends in ground movement and rainfall to be monitored.

8. REFERENCES

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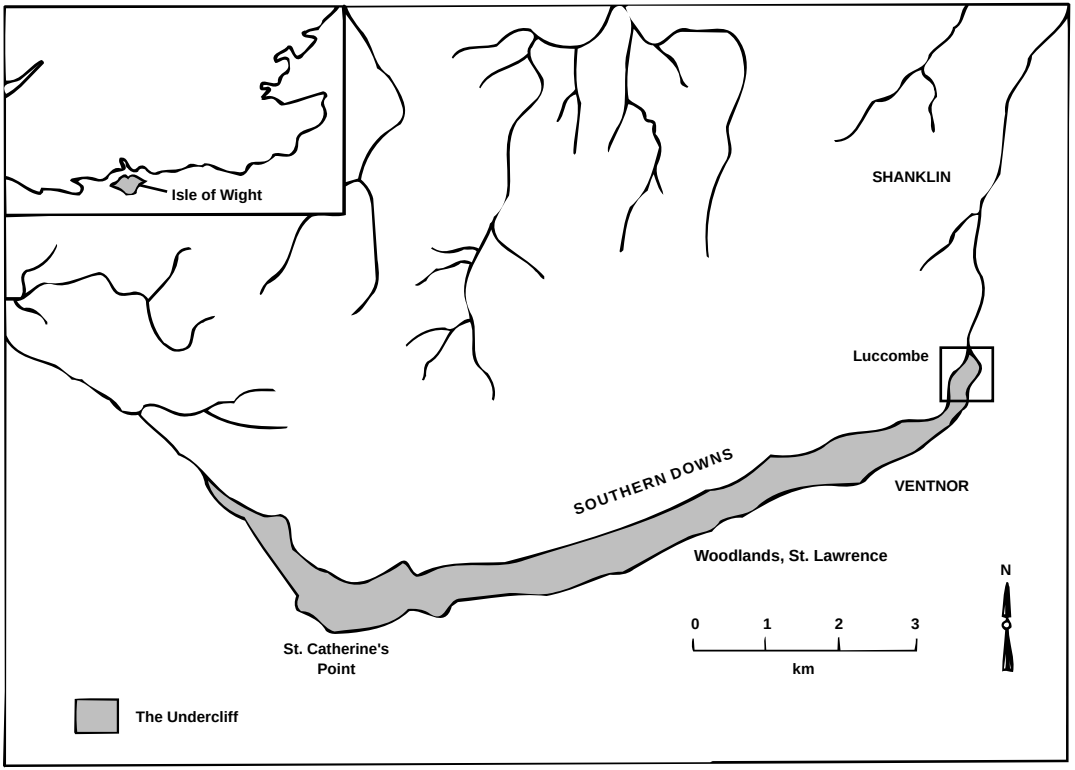

Figure G2.1 Luccombe location map

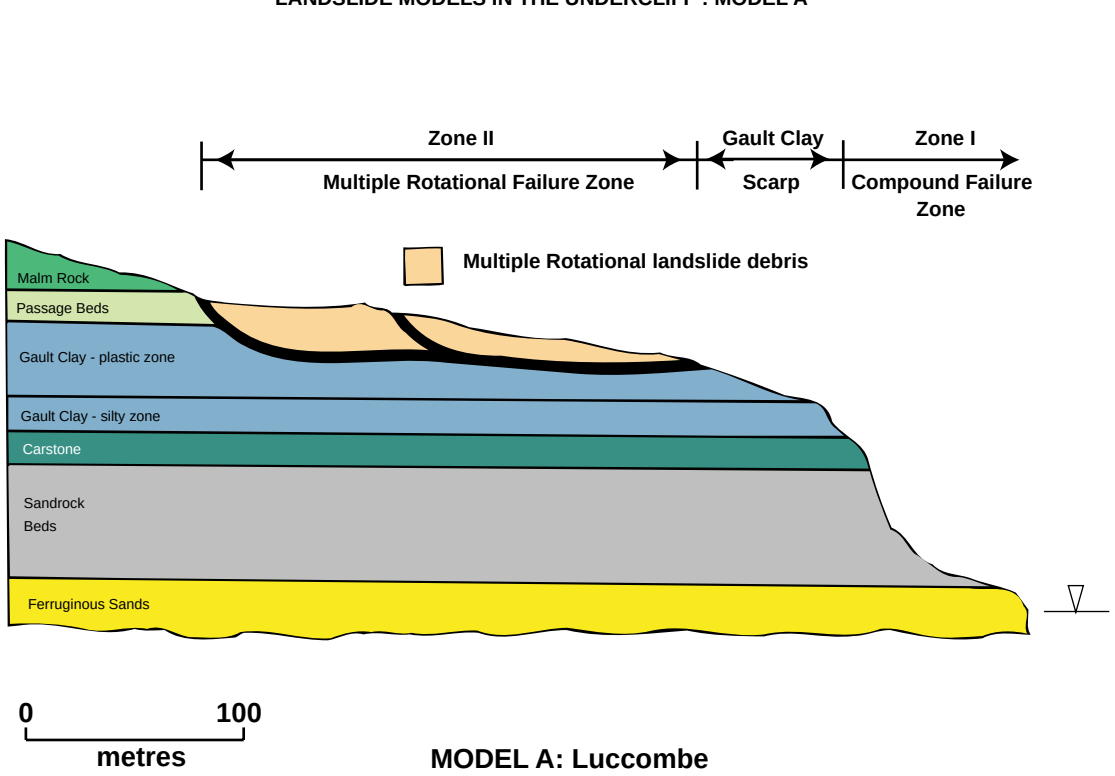

Figure G2.2 Luccombe landslip model.

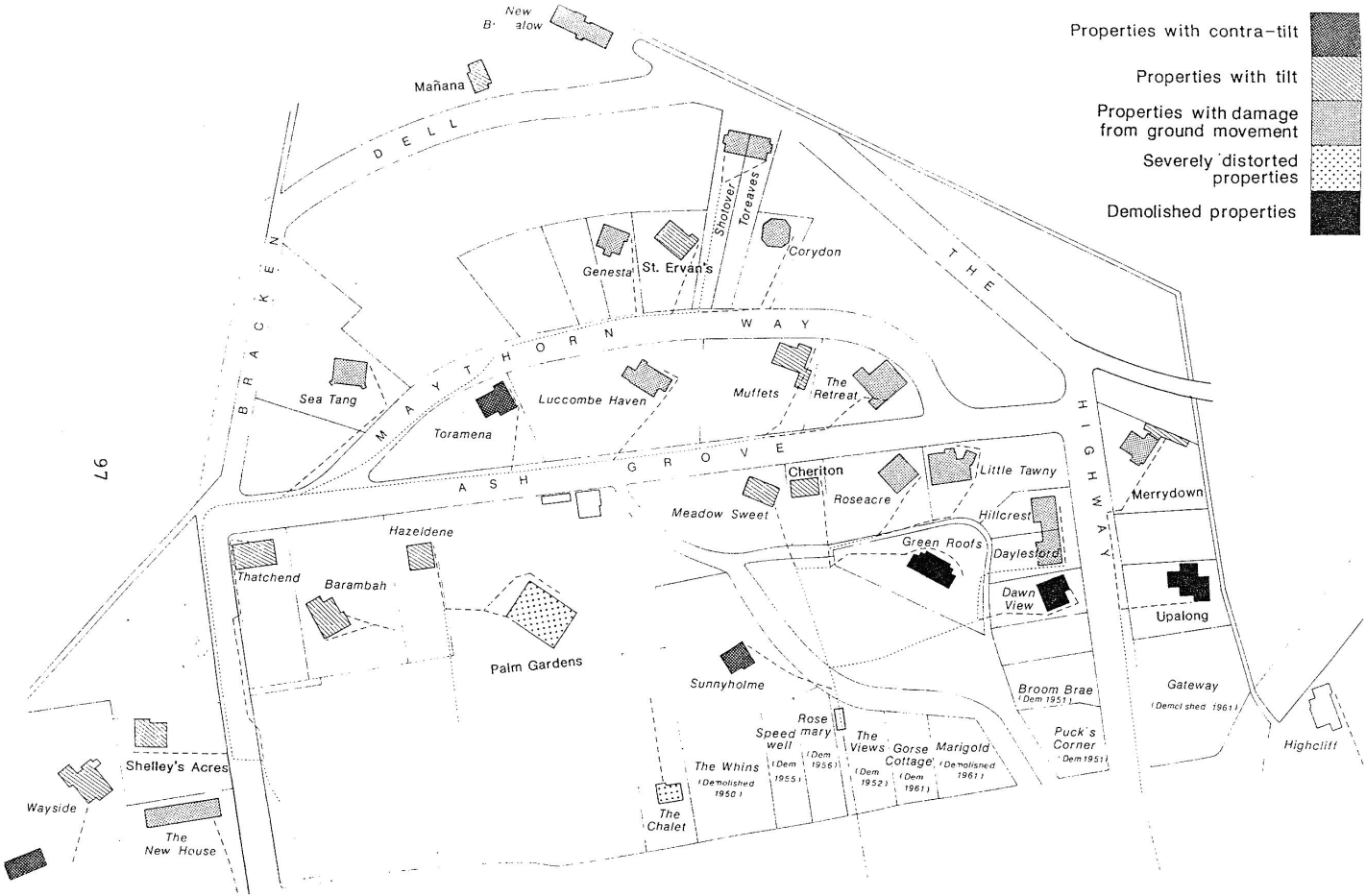

Figure G2.3 Building damage in Luccombe village, 1988.

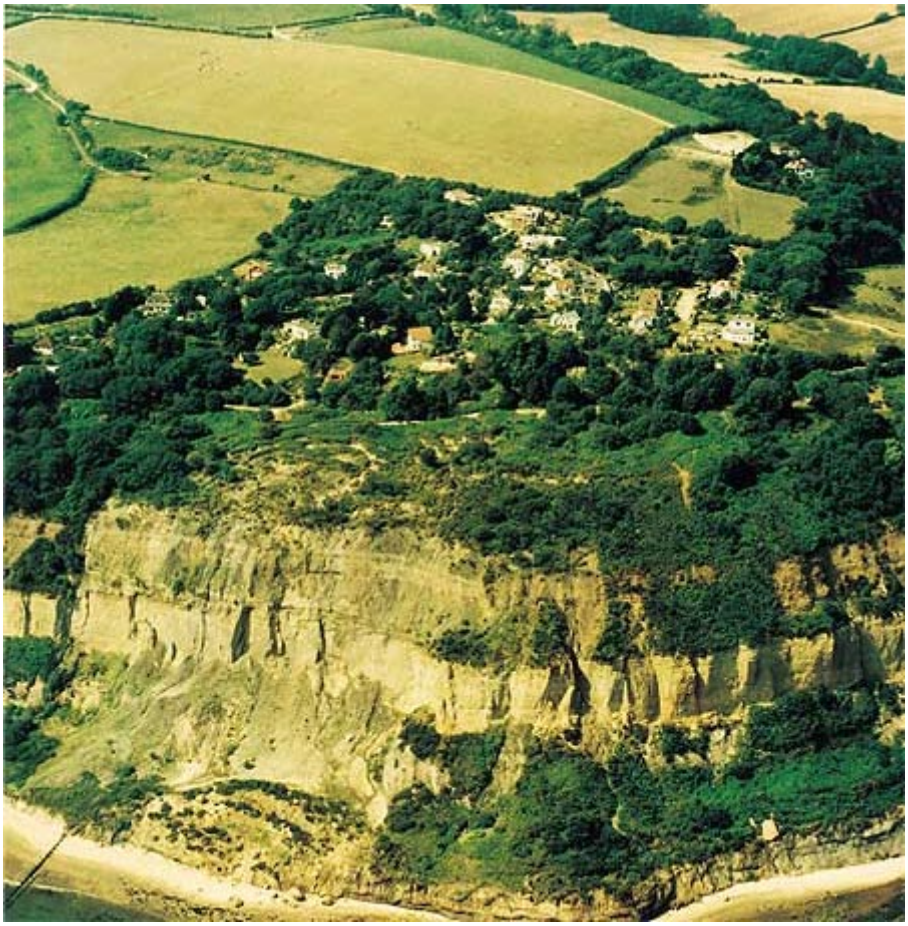

Plate G2a ***Aerial view of Luccombe Village***

Plate G2b P*roperty damage - Green Rooves, Luccombe (demolished (1988)*