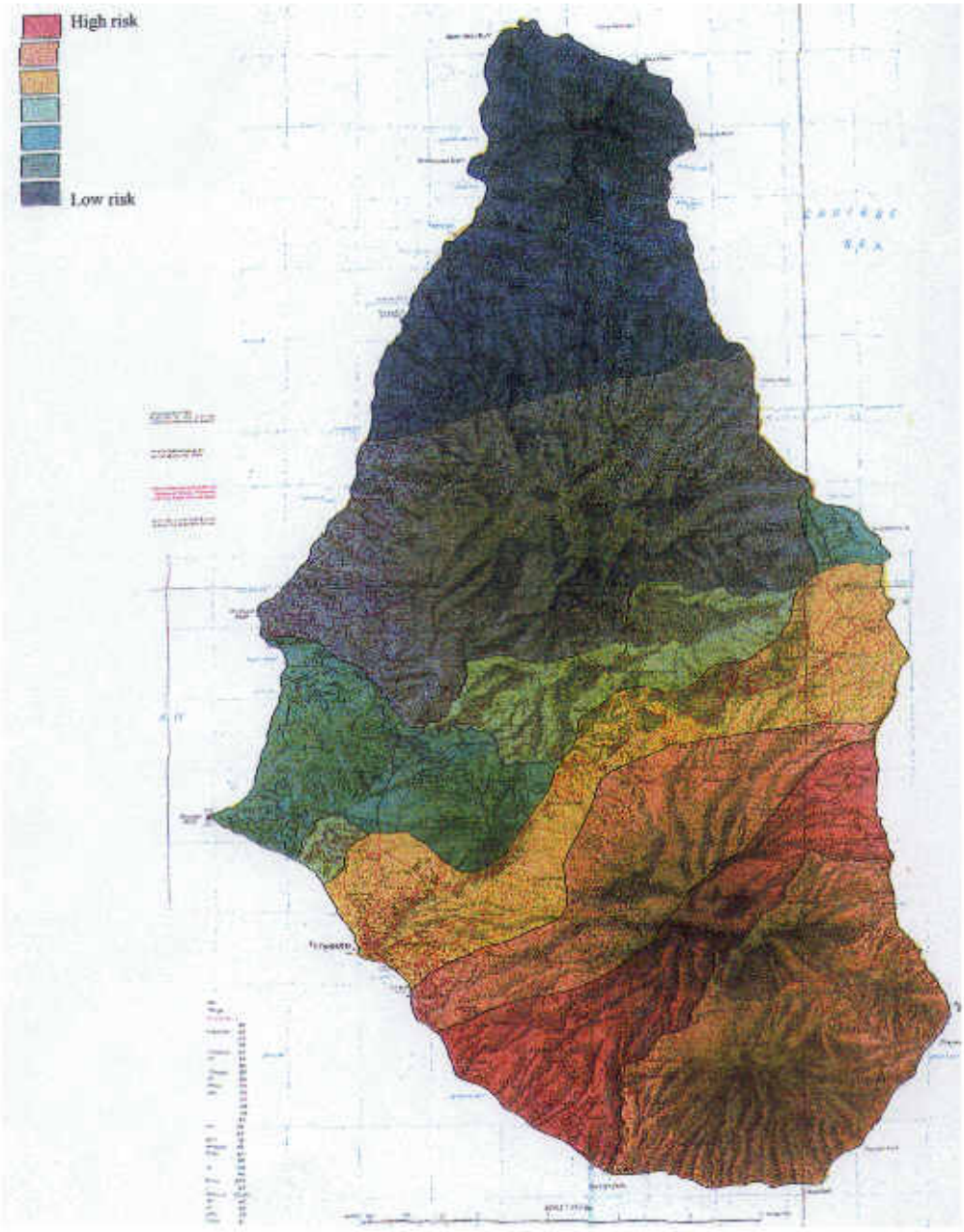

1. Colour chart indicates increasing risk zones based on an evaluation of the hazard.

2. The status of each of the zones is dependent on the alert level.

3. Potential hazards include: pyroclastic flows, surges, falling rocks and ash fall hazards.

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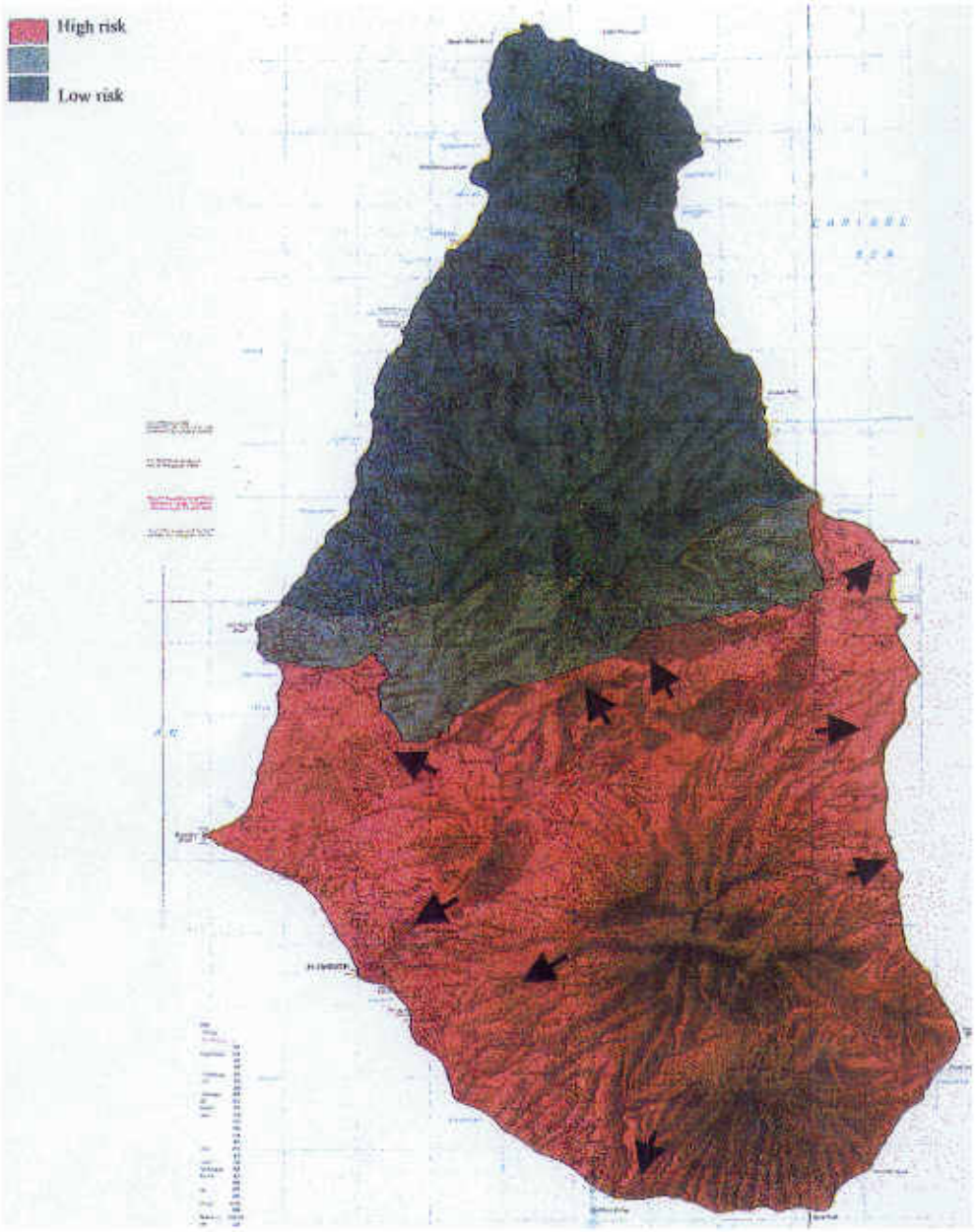
Figure 6- Volcanic Risk Map Updated February 1997



1. Colour chart indicates increasing risk zones based on an evaluation of the hazard.
2. The status of each of the zones is dependent on the alert level.
3. Potential hazards include: pyroclastic flows, surges, falling rocks and ash fall hazards.
4. Arrows mark extent of pyroclastic flow and surge.

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Figure 7- Volcanic Risk Map Updated 1st July 1997

and a booklet "A Resident's Guide to Evacuation Procedures in a Volcanic Emergency". The guides were at the time under review as a result of experiences and the organisational aspects were being refined. In the light of the changing circumstances and reduction in human resources such reviews are to be expected. However, no further documented information has been received and the guides have been used as references for this report.

1.2.2 The Second Visit

The second visit to Montserrat in mid-May 1997 focused primarily on inspections of the facilities and in particular the spring sources and the intake and supply mains therefrom. The visits included the two major sources at Killiecrankie and Monkey, which provide some 35% of the average daily capacity of the available resources. While these main sources are just outside of the Unsafe Zone (at 1/7/1997 - Figure 7), access to them is required through the Unsafe Zone.

Sources in the Unsafe Zone on the western side of the Soufriere Hills Volcano at Amersham and Brodericks were not visited. These sources are not in operation at present as they have been affected by discharges from the volcano, being down wind on the western flank.

Further visits focused on the area north of the Unsafe Zone, along the western side of the island, where the major portion of the remainder of the springs exists and where the major portion of the present population resides.

Enquiries were made into the effects of Hurricanes Hugo in 1989 and Luis in 1995 and a request was made for a literature search for records on the hurricanes in relation to the water system, as well as any other pertinent past and current records on items such as water analysis results.

The Planning Office provided some background to their work on the National Physical Development Plan, prepared in July 1995, and subsequent Development Strategy for north Montserrat, prepared in September 1996, as well as copies of the reports after a range of discussions.

The department with responsibility for forestries provided background information on conditions and the effects from hurricane Hugo and supplied notes on the vulnerability of the water catchments.

1.3 Brief History of Recent Volcanic Activity

Prior to the foregoing visits there were periodic eruptions of the volcano with pyroclastic flows primarily to the east. Subsequent to the Contractor's visits and recently since the latter part of June, the volcano has become more active and there have been substantial pyroclastic flows to the north, east and west causing loss of life and damage to property.

The volcanic activity commenced on 18th July 1995 with a small eruption The activity continued until mid-November when a growth of the lava dome in the crater revealed that magma was reaching the surface.

In the interim, there had been three heavy ash falls on the 21st August, 4th and 30th October 1995 These falls allowed for substantial ash to be blown into the town of Plymouth. It suffered a similar type fall on 4th November 1995.

Following the 21st August 1995 event, more than six thousand (6,000) residents were evacuated from the southern part of the island to north of the Belham River Valley Evacuation orders were lifted on 6th September, but as a result of subsequent activity and growth of the dome, by late November, as a precaution, the Long Ground area was evacuated on 29th November

Ash fumes continued to be discharged and as the dome extrusion escalated, pyroclastic flows commenced in late March 1996.

Four main dome collapses occurred between July and August 1996 By mid-September, volcanic activities produced a significant ash fall which affected Plymouth, the results of which are shown on Figure 8

At this time the pyroclastic flow activity dropped and the eruption entered its explosive phase.

Periodic activity along similar lines continued through to late June 1997, with major eruptions, with the largest occurring on 30th June 1997. During this period there was loss of life and significant loss of property as a result of fire

1.4 Recent Concerns

During this period, pyroclastic flows took place to the north towards the Belham Valley area as well as the east, with ash drifting west as well as north over the Safe Zone. Measured ash fall thicknesses on the ground have not been received for falls that have occurred in the Safe Zone subsequent to the late June / early July 1997 eruptions A scenario based on the mid-

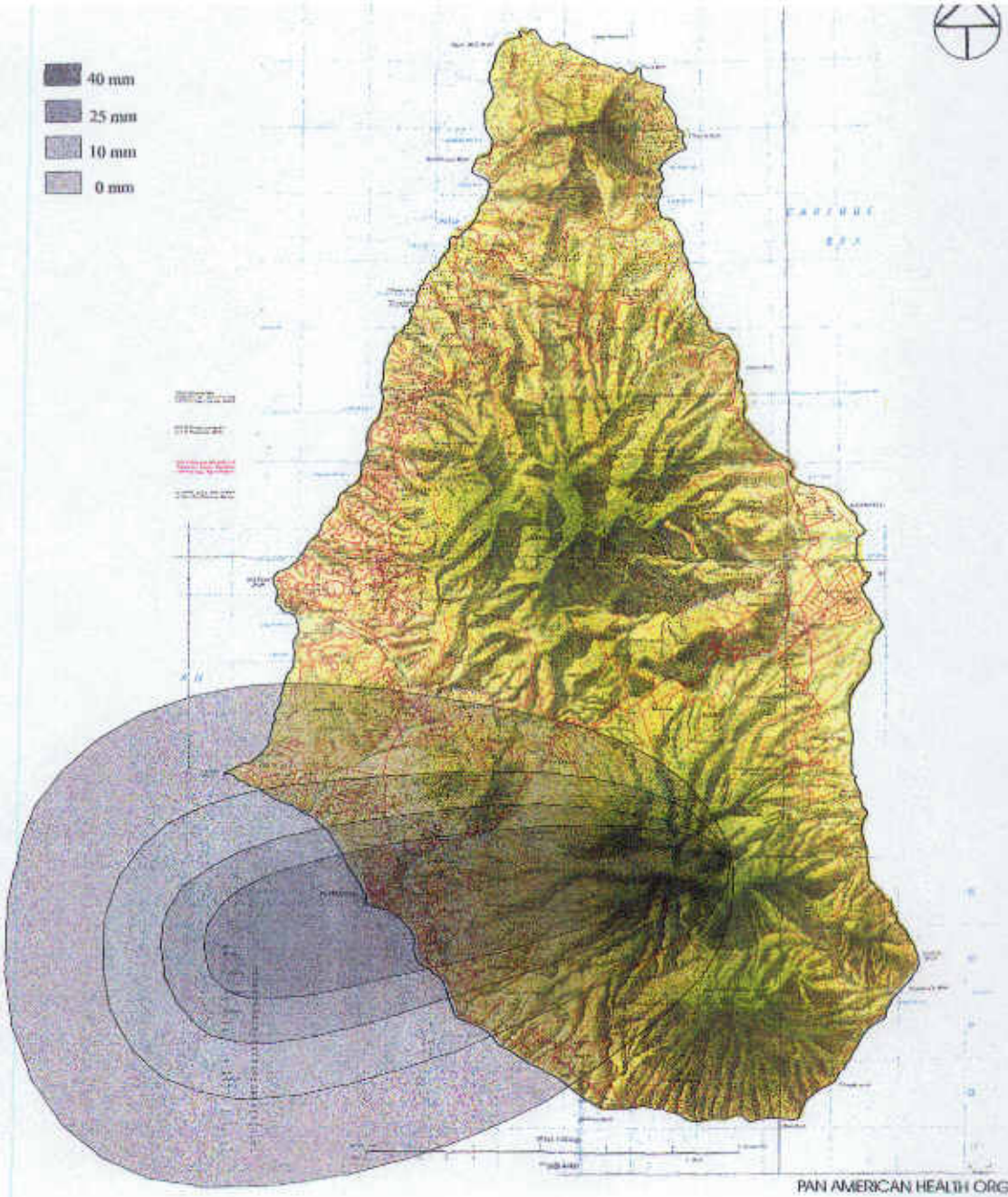

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Figure 8- Ash Thickness Contours for eruption September 1996

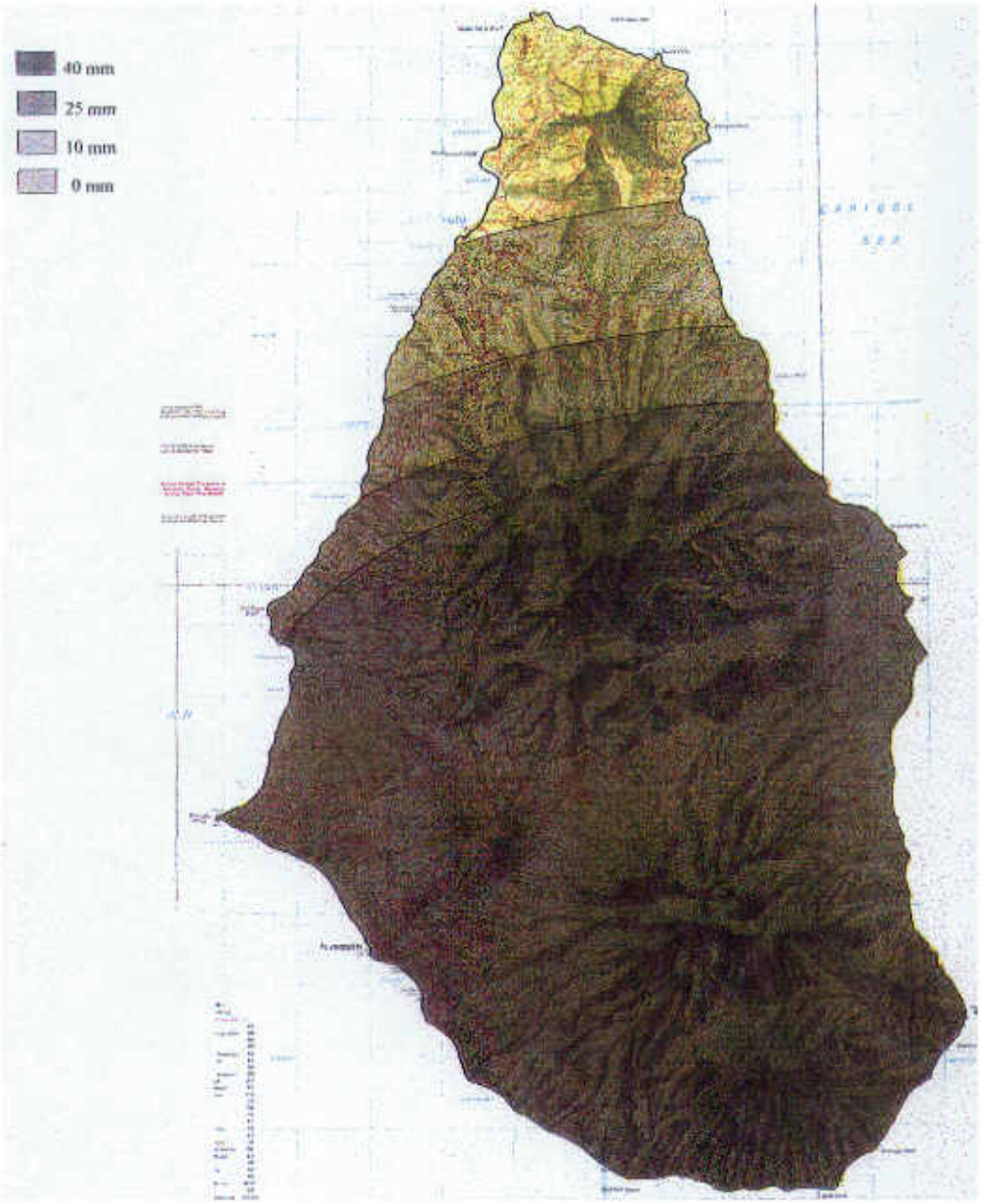

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Figure 9- Ash thickness estimates based on measurements from eruption on 17th September 1996 assuming a full spectrum of wind conditions

September 1996 ash fall on Plymouth, assuming winds from the south and north, is shown in Figure 9 to give some indication of a possible range of ash distribution.

Subsequent to the aforementioned activities there has been some concern over water quality and the Contractor has provided advice with respect to sampling, in order that some guidance may be given with respect to an approach to the problems At the time of drafting this report, the indications were that there was a problem of high acidity in the water. Subsequent enquiries indicate that the analysis whose results caused concern was on rainwater with pH in the vicinity of 3 being taken as a spring source analysis Later results indicated spring source water pH was in the range of 6.5 to 7 7. Later reports with respect to levels of chlorides and sulphates and in particular fluorides have been acceptable for the spring sources However, indications from results of rainwater analysis are that high acidity is being maintained and fluorides are at levels in excess of 1.5 mg/l

The immediate concern is the effect on animals drinking rainwater Traditionally Montserrat has not depended on rainwater storage for water supply but nonetheless all residents should be regularly reminded not to consume rainwater Further samples of ash and air tested did not indicate levels of major concern to water supply Recent samples of overflow water at Trials reservoir, receiving water from the springs on the western flanks of the volcano since commencement of its activity, indicate an acceptable quality of potable water. A full chemical and bacterial analysis should however be carried out as a baseline indicator A significant effort however is now essential to ensure that water quality is monitored on a regular basis, although the period since commencement of volcanic activity and discharges over the western flank is in excess of the estimated spring lag times between rainfall and discharge at the spring and basic water quality still appears acceptable The mitigation measures proposed should take immediate effect in a phased approach as outlined later in this report.

1.5 Brief History of Recent Hurricanes

The woes of Montserrat within the last decade have included, in addition to the volcano activity, Hurricane Hugo in 1989 and Hurricane Luis in 1995 and the 1997 hurricane season has recently commenced

1.6 The Vulnerability Assessment Report

The Vulnerability Assessment Report is based on information referred to in the aforementioned and as stated in the references in Appendix A, along with information and knowledge from local public and private sector personnel and the Contractor's own information and knowledge.

Included in the following sections is an interpretation of the status on:

- Emergency Planning and Preparedness
- Existing Water Systems and Their Vulnerability

and Proposals for

- Mitigation Measures

Each of the foregoing is addressed with respect to the disasters of volcano, seismic activity and hurricanes

Since vulnerability of the physical plant is common in many respects to each of the disasters, their vulnerability and the mitigation measures are often addressed jointly within the main heads listed above