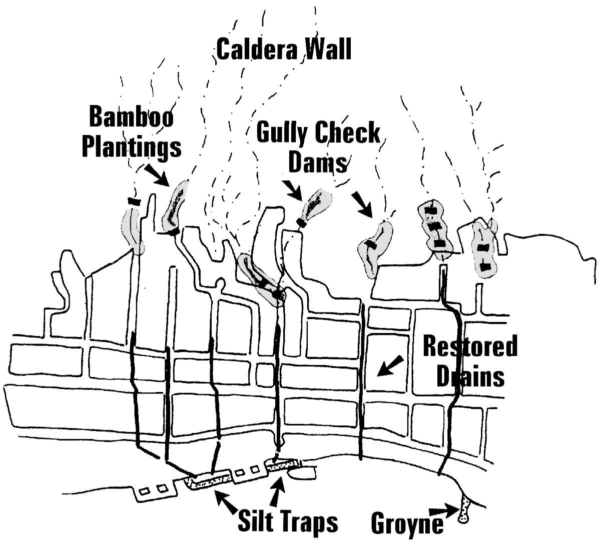

Figure 4 Portion of the Drainage Design

Drainage, erosion and siltation controls were identified as critical aspects for restoration.

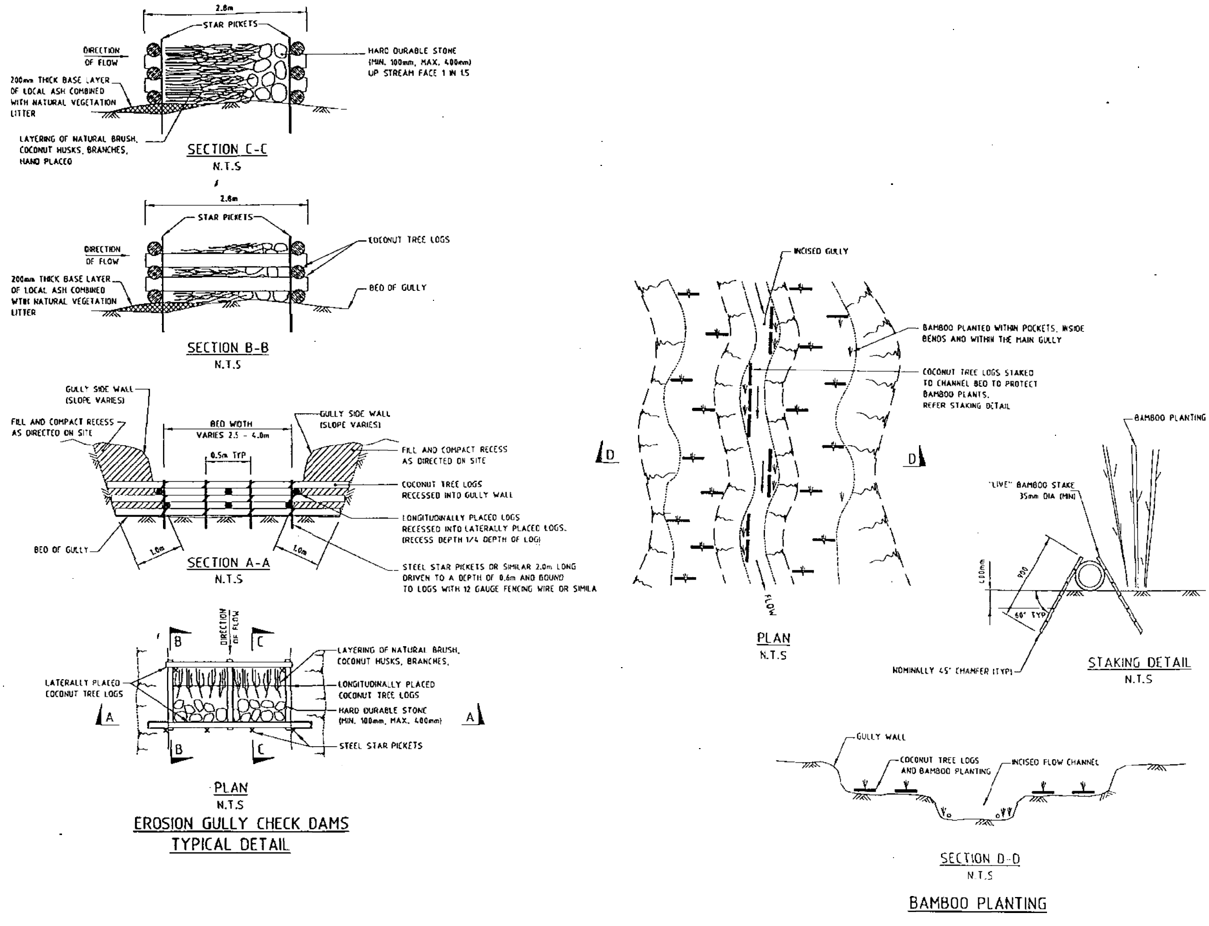

Figure 5 Erosion Control Structures

Coconut log structures and bamboo plantings restrict sediment movement from the steep caldera wall entering the town.

Restoring Roads and Stormwater Drains. Once large areas of the caldera wall and coastal plain have been revegetated and stabilised, roads and drains in ash-covered areas could then be restored. The Engineering Plan stipulated that unused road and drainage networks in the unoccupied regions of the town should remain covered in ash until there is a genuine need for their use. This was considered important for a number of reasons:

- Sufficient time is required for the stabilisation or revegetation of the ash beds. The premature clearance of the roads and drains in the ash-covered areas will prevent these networks becoming an unnecessary maintenance burden to continually clear the ash.
- Ash-covered roads are in a sense preserved. It had been determined through Mobil Australia that the constituents of the ash and its leachate, in particular sulphuric acid, would have little or no effect upon the bitumen binder. Provided the bitumen seal remains covered it will stay protected from erosion and ultraviolet light deterioration. Therefore, covered sealed roads can be expected to have a markedly reduced rate of deterioration.
- Covered drains will not be exposed to the severe erosion problems and would not require ongoing maintenance.

Reoccupation of Stages. The restoration of the ash-covered roads and stormwater drains would facilitate the reoccupation of these areas. This would be a progressive or 'staged' development that would follow a coordinated and controlled program cognisant of the Town Plan.

Reconnection of Services. The clearance of successive roads and drains and the reoccupation of these areas would allow the service departments to provide electricity, telecommunications, and water and wastewater services. The service departments indicated that they would respond to future demand but did not intend to undertake detailed future planning until the demand is realised.

Mitigation Measures. The Engineering Plan had to embrace mitigation measures to deal with the effects of natural hazards. SMEC established a number of measures to reduce the impacts of all hazards including the obvious effects from another eruption. This task was not easy, as huge forces of nature are involved such as volcanic eruptions, tsunamis and earthquakes. Some of the measures identified by the Team are discussed below:

Drainage. The eruption of 1994 demonstrated the need for proper stormwater drainage. Flash floods and mudflows caused significant damage because of the indiscriminate direction of the flow paths. It was determined that the road system in Rabaul would function as ideal secondary drains provided that the flows could be contained within the road reserves. Most of the roads running north-south and east-west have a constant grade between 2-5% from the caldera wall to the harbour. To contain the flows within road reserves it was recommended that ash on adjacent allotment should be left in situ, therefore providing a clearly delineated flow path. In this way the risk of building damage from mudflow and flash floods is diminished.

Building Regulations and Standards. Special consideration was required for building regulations to protect property and provide safety to the general community. Regulations recommended complimented existing Standards, or in their absence, provided short-term guidance. It was determined that regulations or indeed Standards cannot provide design recipes which remove the designer's flexibility to achieve their desired solution, but instead must provide adequate design information and parameters. A balance will have to be achieved incorporating anticipated construction costs, risk of natural hazards, and the risk to life.

For example, during the last eruption parts of the town received 3m of ash. If these loadings are considered indicative over a 50-year life span, then newly designed buildings would possibly be unaffordable concrete boxes. After careful consideration of a number of factors it was determined that a design ash load of 300mm was the best compromise and would be adopted as an interim building regulation until a formalized Standard was produced.

Other building restrictions raised during the feasibility, town planning and design phases included:

- To provide protection from mudflows, flash floods and landslides, buildings should not be reconstructed on the slopes of the caldera wall or within major flow paths close to the caldera wall.
- Effects of tsunamis should be considered for buildings close to the shoreline.
- Allotments should be raised to assist in channelling mudflows and flash floods along the road reserves.
- Steep pitched roofs are recommended as they provide a naturally stronger roof construction and some ash shedding capabilities.
- A combination of ash and seismic loads should be considered a possible worst case scenario during structural design.

Utilities. SMEC recommended numerous measures to reduce the impacts of another eruption to the utilities, such as:

- Underground power distribution despite the cost being twice the cost of. an aerial network. Aerial Bundled Conduits (ABC) were recommended as the preferred cable for aerial distribution. These cables are covered in a sheath of plastic and therefore less susceptible to corrosion and a simple pole without cross members is required which is easier to repair.
- Special water reservoirs were recommended constructed to be earthquake and ash load resistant.
- The water distribution system should be redesigned to incorporate redundancy, such as loop mains, strategically placed reservoirs, and re-establishing more than one bore.