4 CONCLUSIONS & RECOMMENDATIONS

4.1 General

The core hospital building is generally in fair condition, but there are concerns about the SB Slab flooring system and cracking in walls. A number of the peripheral structures providing specific services are showing varied signs of distress, principally to masonry walls.

The results of the assessment for vulnerability to hurricanes indicate that all buildings require some mitigative measures. In their current condition, it is likely that damage to the buildings would be moderate. Also, the buildings in which the primary activities of the hospital are held need to be analytically assessed to determine their vulnerabilities to seismic events.

It is therefore necessary to undertake mitigative actions if the QEH is to provide, with confidence, efficient and adequate service in the event of natural hazard impacts.

4.2 Hurricanes and Torrential Rains

4.2.1 Short Term Measures

The following items should be addressed immediately, or as soon as practically possible.

- All deteriorated roof sheeting should be replaced. 24-gauge steel sheeting should be used as a minimum. Fixings for roof sheeting should be spaced at every other corrugation generally, and at every corrugation at eaves, ridges, hips and gable ends. Ridge fixings, where used, should be fitted with washers matching the profile of, and wide enough to cover, the ridge of the sheeting. (See reference sketches #3 and #4, provided in Appendix E.)

- Plywood sheets should be stored in an easily retrievable location to be used as window shutters for use in the short term. Each sheet should be cut to size and marked to identify its proposed window location for installation in the event of a hurricane warning. (See reference sketch #10, provided in Appendix E.)

- Hurricane straps should be fitted to all trusses and rafters wherever it appears that the holding-down detail is suspect or where the detail is not visible (eg where it is encased in concrete or masonry). (See reference sketches #6 and #7, provided in Appendix E.)

- Additional cable stays should be provided for all chimneys.

- All external doors should be checked and made secure by installing barrel bolts to the top and bottom inside faces at the corners remote from the hinged edges.

- All large trees in the vicinity of buildings and utility poles and overhead wires should be kept trimmed.

4.2.2 Medium and Long Term Measures

The following items are measures which should be scheduled for implementation during the coming five years.

- A thorough investigation into the structural integrity of all buildings using timber frames, and all buildings using steel trusses and portal frames in their construction, should be carried out by way of an analytical assessment.

- Permanently installed hurricane shutters should be provided for all windows and other openings. They should be of such a design as can allow them to remain open under normal conditions but be easy to close in advance of a hurricane. (See reference sketches #8 and #9, provided in Appendix E.)

- Alternatively, all glazed windows should be replaced with laminated glass panels. These panels should be bonded into sturdy frames with structural silicon and well fixed in place. The window assemblies should be carefully specified to meet the desired standards when they are being procured.

- A comprehensive system of stormwater drainage should be designed and constructed in order to prevent flooding on the hospital compound and on the adjacent access roads.

4.3 Earthquakes

4.3.1 Short Term Measures

The following items should be addressed immediately, or as soon as practically possible.

- A survey should be carried out by officers of the hospital's

Maintenance Department in order to establish the overall level of non-structural vulnerability of the various Departments in the hospital to earthquake effects. This vulnerability survey would identify areas needing attention and provide an estimate of the extent of required remedial works. A number of Check Lists to be used in conducting non-structural vulnerability surveys for earthquake damage, and an accompanying catalogue of visual reference material, are provided in Appendix D.

- All free-standing cupboards and shelves, particularly those containing medicines or other potentially hazardous materials, should be properly fixed to walls or floors. Open shelves and cupboards should be retrofitted to prevent toppling of their contents. (See reference sketch A, provided at the end of Appendix D.)

- The soffits of the SB Slabs in the main building should be fitted with a fine wire mesh or similar system to prevent fragments of clay block from falling and causing injury to persons or equipment. Alternatively, the existing suspended ceiling should be assessed to establish its ability to prevent being breached by falling clay blocks.

- All mechanical equipment, light and heavy, should be firmly and adequately bolted down to their bases.

4.3.2 Medium and Long Term Measures

The following items are measures which should be scheduled for implementation during the coming five years.

- A thorough analytical assessment of the structural integrity of all buildings which received low scores in the earthquake vulnerability assessment should be performed. This may lead to the need for retrofitting.

- Protection should be provided for all services passing across any separation joints in the buildings.

4.4 Cost Estimates

The estimates of cost for retrofitting provided hereunder are made with reference to the short-term measures prescribed above for the mitigation of damage due to hurricanes.

The items shown in the following table are listed in the same order as they are presented in section 4.2.1 above. The figures quoted are preliminary global estimates, and are based on rates related to the floor areas of buildings.

Item	Description of the Work	Cost (est) (BDS$)
1	**Roof Sheeting:** Remove existing deteriorated roof sheeting and replace with 24-gauge steel sheeting. Fixings to be spaced at every other corrugation generally, and every corrugation at eaves, ridges, hips and gable ends Ridge fixings (where used) to be fitted with washers matching the profile of, and wide enough to cover, the ridge of the sheeting.	88,000.00
2	**Temporary Window Shutters:** Cut ¼" thick plywood sheets to size to suit window openings; mark each cut sheet to identify its building and window. Store in dry, ventilated and easily retrievable location.	587,000.00
3	**Hurricane Straps:** Twisted metal straps to be fitted to all trusses and rafters wherever it appears that the holding-down detail is suspect or where the detail is not visible (eg where encased in concrete or masonry).	240,000.00
4	**Cable Stays:** Provide additional cable stays for all chimneys.	6,000.00
5	**External Doors:** Barrel bolts to be installed at the top and bottom inside faces of all external doors, at the corners remote from the hinged edges.	49,000.00
6	**Trees:** Trim overhanging branches of all trees in close proximity to buildings, utility poles and overhead wires.	14,000.00
	TOTAL	**984,000.00**

Appendix A

Terms of Reference

Vulnerability Assessment of the Queen Elisabeth Hospital, Barbados 1998

Terms of Reference

The Contractor shall conduct a Vulnerability Survey of the Queen Elisabeth Hospital (QEH) The services shall include the following:

1 Review any readily-available reports which may have been prepared on the design and/or vulnerability of the Queen Elisabeth Hospital (QEH) with particular reference to natural hazards, review readily-available plans, specifications and other documents describing the construction of the hospital and supplement existing documents through interviews with the hospital officers responsible for the buildings and equipment.

2 Carry out on-site inspections of the hospital in consultation with the QEH maintenance department.

3 Estimate the level of resistance of the QEH to the natural hazards of hurricane, torrential rain and earthquake.

4 Recommend cost-effective measures to increase the level of resistance of the QEH to the above-listed natural hazards. These recommendations should take into account the financial constraints of the hospital and the Ministry of Health:

- The first objective is to ensure that the structure will not cause deaths to its occupants in major events.
- The second objective is to ensure that the hospital, or at least the critical parts of it, will be in a position to remain functioning during the subject events or to resume functioning immediately after the impact of the events.
- The third objective is to improve the auto-sufficiency of the QEH with respect to utility services.

5 In addition to the medium and long-term measures in 4 above, provide sufficient information to permit implementation of such mitigation measures with respect to hurricanes which can reasonably be implemented in the short-term.

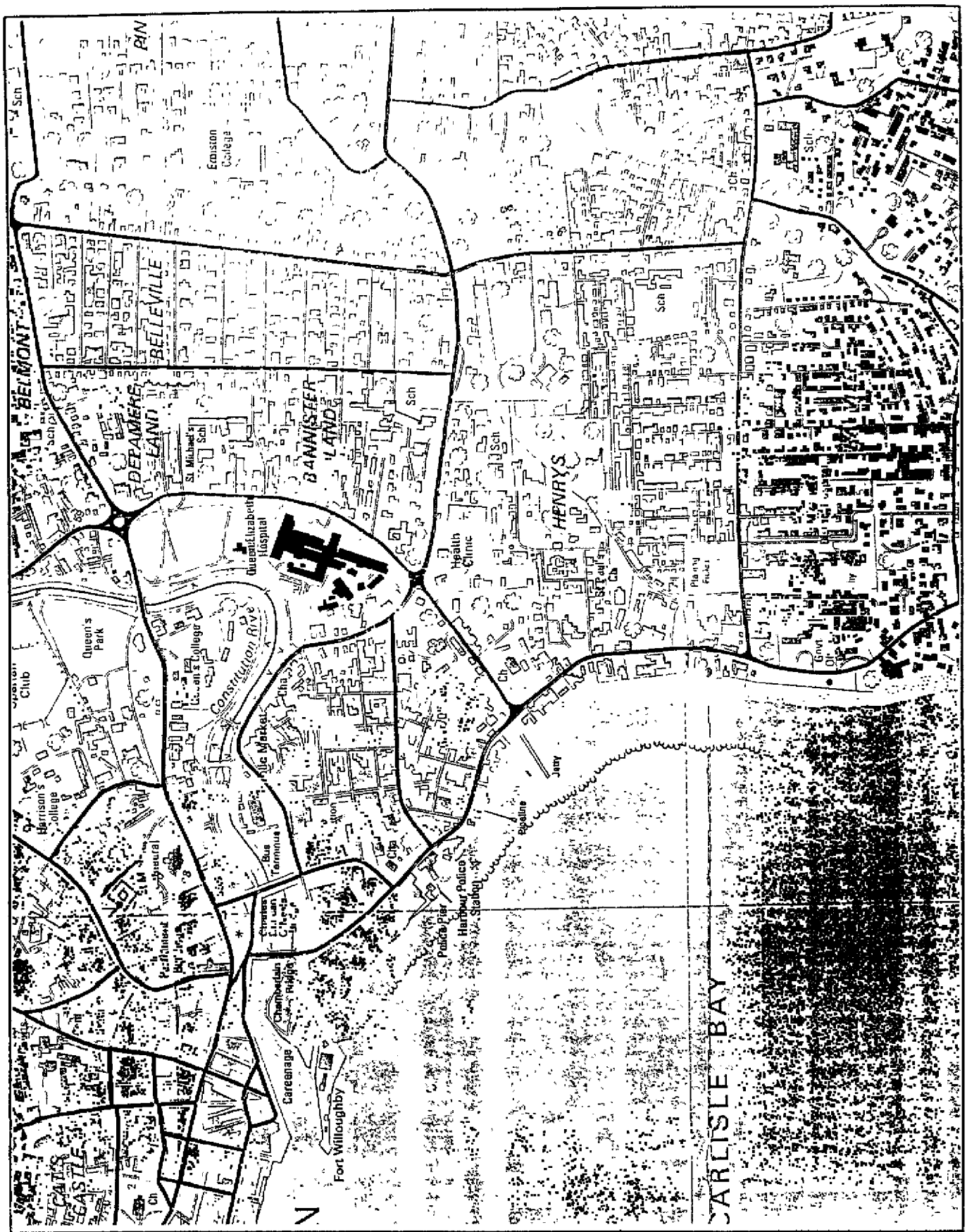
6 Provide a report of the survey (including cost estimates for each objective) for the Pan American Health Organisation describing the recommended measures. The report of the survey should be in a format that will assist with the planning of the measures to be implemented.

7 Transfer knowledge on the process of natural hazard damage mitigation to QEH officers responsible for the buildings and equipment.

8 Attend debriefing meeting at the end of the exercise to present the report to the Permanent Secretary, the Hospital Director and the QEH Chief Engineer. This meeting will be arranged by PAHO.

Appendix B

Location Plan
and
Site Plan



NOTES	The Queen Elisabeth Hospital Bridgetown, Barbados	SCALE: 1:10 000
–		DATE: Aug 98
	Location Plan	JOB No: CEP/20432
	CONSULTING ENGINEERS PARTNERSHIP LTD	SKETCH No: 1

NOTES	The Queen Elisabeth Hospital Bridgetown, Barbados	SCALE: Not To Scale
-		DATE: Aug 98
	Site Plan	JOB No: CEP/20432
	CONSULTING ENGINEERS PARTNERSHIP LTD	SKETCH No: 2