2.3 Torrential Rains

Although hurricanes are often accompanied by heavy rains, severe rainfall events resulting in flooding in St Lucia are also, and frequently, associated with troughs and tropical depressions. The risk of flooding is therefore not restricted to, nor more likely to occur during hurricane events.

Drainage systems and structures in St Lucia are generally designed for rainfall events having return periods of 20 years. This means that such systems are likely to become overloaded and cause some degree of flooding when rainstorms are experienced with return periods greater than 20 years. Figure 8 and 9 (at the end of this sub-section) show the rainfall intensity-duration-frequency curves for two locations in St Lucia.

Generally, lower lying areas will be more susceptible to flooding than higher and sloping ground.

The damage caused by flooding depends on the type and elevation of facilities in the location. The results of flooding may range from the inconvenience of temporarily submerged driveways to the loss of equipment and finishes inside flooded buildings and consequential disruption of the functions.

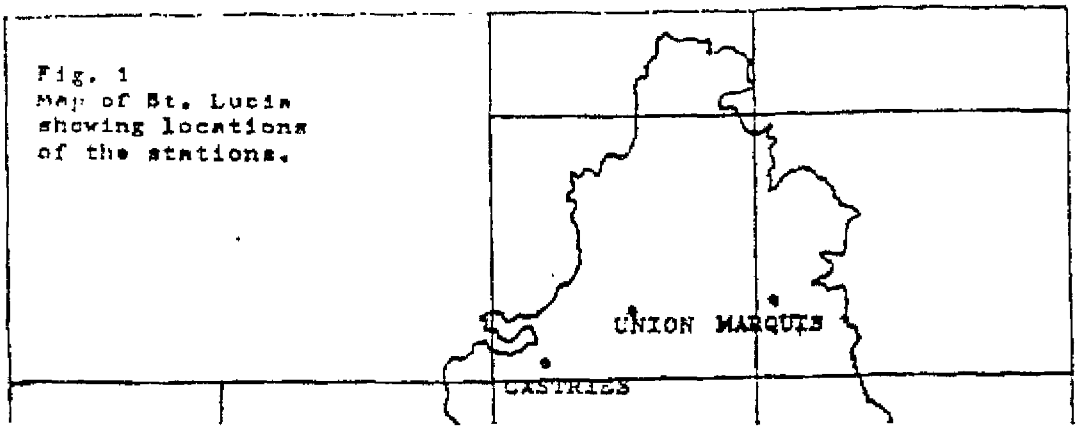

Fig. 1
Map of St. Lucia
showing locations
of the stations.

RAINFALL INTENSITY-DURATION FREQUENCY CURVES

UNION

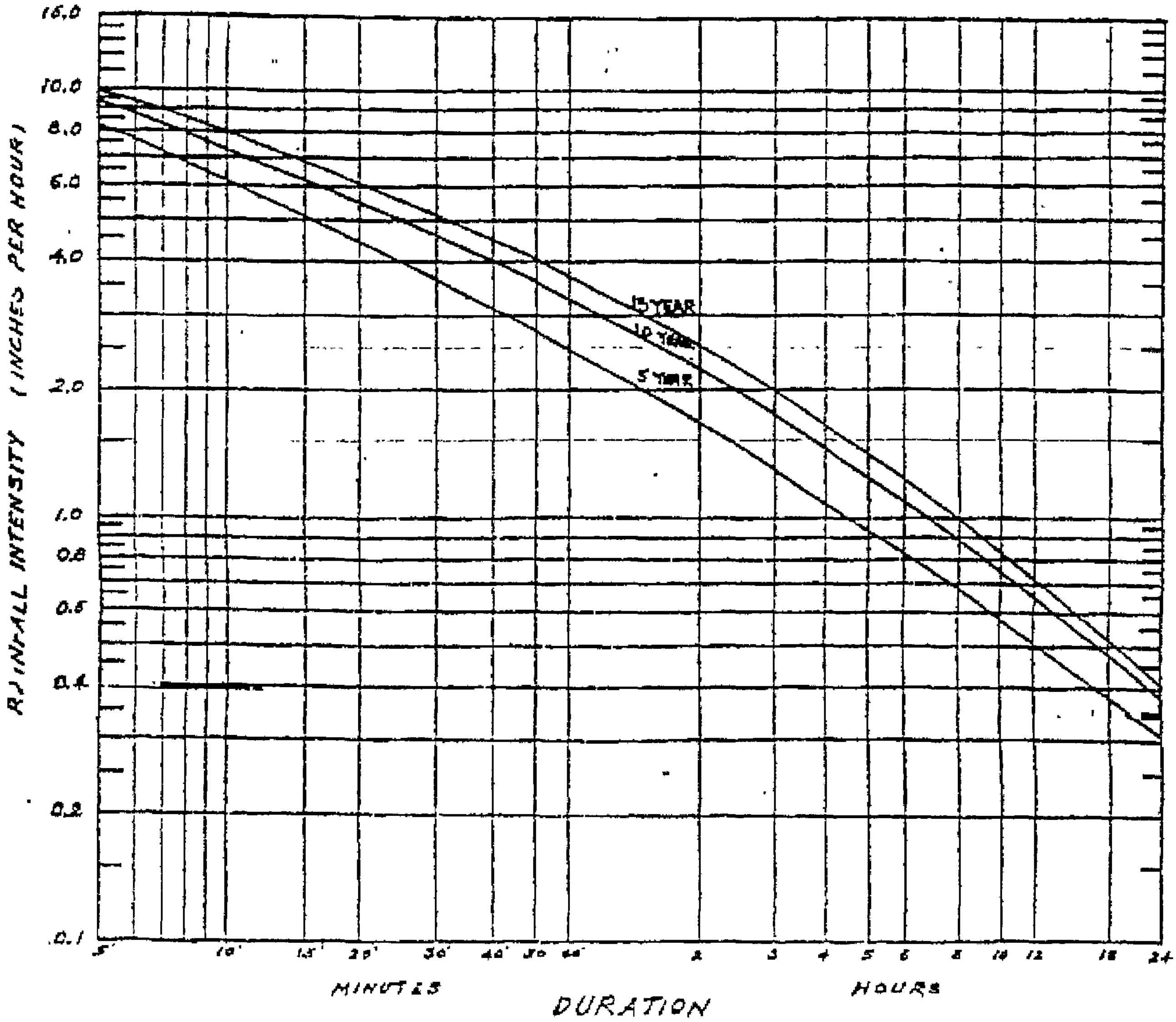

Figure 8

RAINFALL INTENSITY-DURATION FREQUENCY CURVES

LA PERLE, SOUFRIERE,
ST. LUCIA

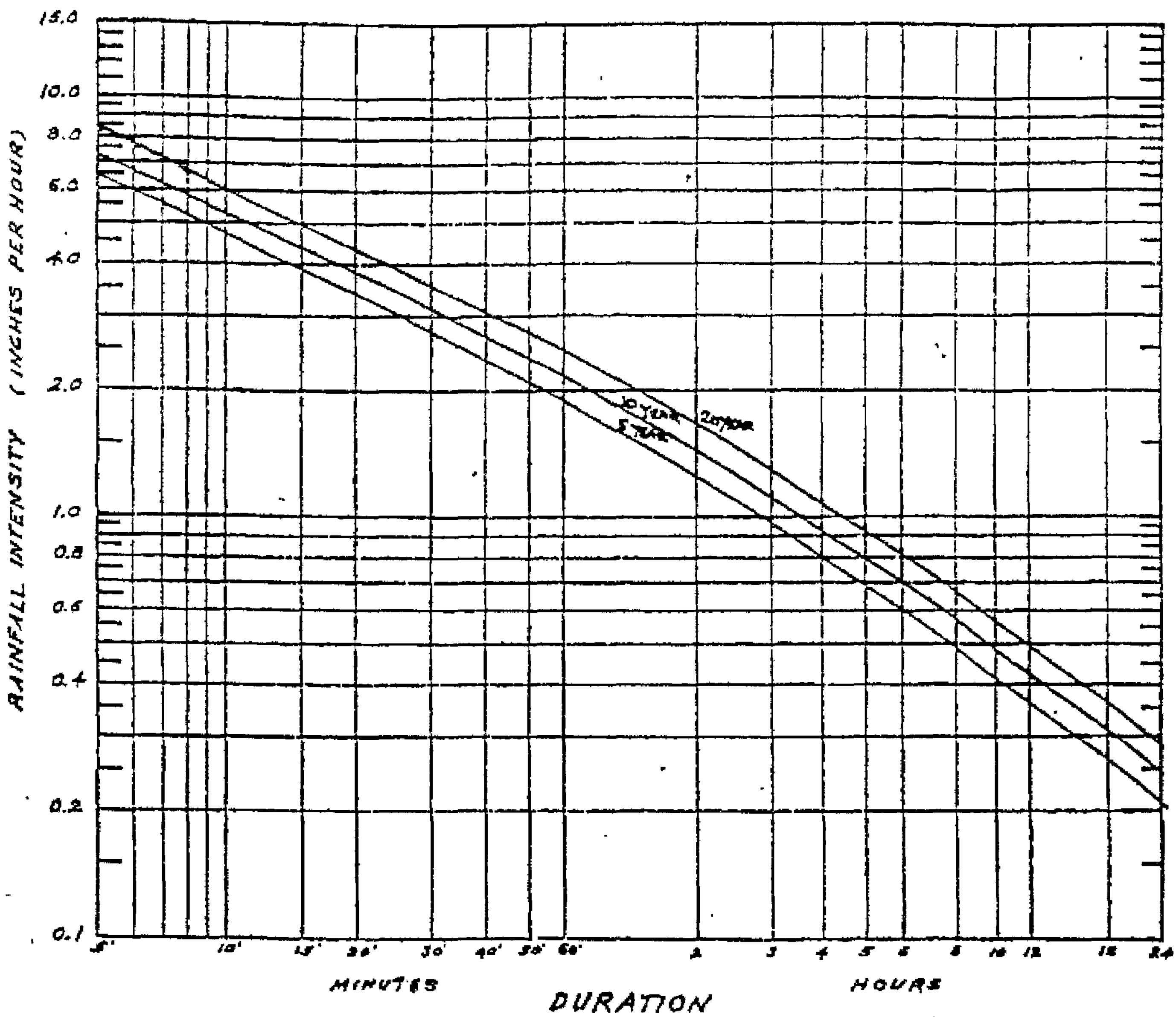

Figure 9

3.0 STUDY PROCEDURE

3.1 Site Visit

A site visit was made on 20th May 1993 in the company of Mr Phil Leon, Senior Draughtsman of the Architectural Section of the Central Planning Unit of the Government of St Lucia. Photographs taken at that time by Tony Gibbs are reproduced at Appendix A (Plates 1 to 14).

The general principles of design were discussed and the implications for hurricane and earthquake vulnerabilities were reviewed. Suggestions were made at that time for improvements in geometry and details to achieve greater security in hurricanes and earthquakes. These suggestions were readily understood and accepted.

3.2 Survey of the Existing Premises

The buildings are all single-storey and raised above the ground on short "pilotis". The purpose for raising the buildings is to reduce the risk of flooding. The unfavourable effect of this, however, is to increase the vulnerability to earthquake damage, since it does not appear that the structures below the ground floor are proportioned for the higher-than-normal earthquake-resistant demands of a soft-storey situation. A soft storey occurs when a relatively stiff upper structure sits on a relatively flexible lower structure. This situation can be seen in Plates 5, 6 and 7 at Appendix A. This problem can be addressed by cross bracing the rectangular spaces between the columns under the ground floor. The cross bracing would be in the vertical planes of adjacent columns and extend from the column-beam junctions to the column bases.

The general shapes of the roofs are favourable for hurricane resistance. The relatively steep slopes and the hipped ends can be seen in Plates 4, 5, 6 and 9 at Appendix A. The overhanging roofs of the balconies in Plates 4 and 11 and the shallow mono-pitch roof in Plate 13 are very vulnerable to wind damage. The problem of the balcony roofs can be alleviated by installing ceilings to relieve the roofs of the high wind pressures at the undersides of the roofs. The fasteners for the roof sheeting are installed at fairly even spacings throughout the roofs. This is inconsistent with the known aerodynamic effect of higher wind suctions in the vicinity of eaves and ridges. Additional fasteners should be installed in these regions. The roof over the Standby Generator Room (Plate 13) should be changed completely to a new one with a hipped shape.

The access corridor (Plate 8) is open at the sides. This makes it hazardous for use during hurricanes. There is no easy and satisfactory solution to this. The open-sided corridors are desirable for everyday use. However, they would hamper movement from one part of the Hospital to another during wind and rain storms. Consideration should be given to having large adjustable louvres (vertical or horizontal) along the sides of corridors which could be kept open most of the time and closed in the event of storms.

Plate 9 shows the arrangement of fenestration in the critical areas of the Laboratory, the Medicine & Dietary Stores and the Operating Theatre. These glass windows would need to be protected from impact damage in times of hurricanes by purpose-made shutters. Fold-down, awning-type, metal shutters would be suitable. They would remain in an open position in normal times, thus performing a sun-shading function as well. Plate 10 shows high-level louvres for ventilation. Removable shutters would need to be provided to prevent the ingress of rain during hurricanes. The door seen in this Plate has an insubstantial latch. As added protection for hurricane winds (which produce suctions as well as pressures) bolts at the top and bottom free corners are recommended.

The Laboratory was formed by removing a masonry wall which separated two smaller rooms at the north-east corner of the building. Only a small pier remains at the west extremity of the removed wall to support the roof. The pier has cracked (Plate 12) and is in need of strenthening.

In Plate 13 can be seen the distribution power cables running overhead from the wall of the Standby Generator Room to the Hospital. This makes them vulnerable to damage in hurricanes. It is recommended that all power and telecommunications cables within the compound of the Hospital be placed underground for added security in hurricanes. This would enhance greatly the self-sufficiency of the Hospital during, and immediately after, hurricanes.

It was not possible to establish past flood levels for the site. The river to the north of the site can be seen in Plate 14, which also shows the river wall substantially higher than the river bed. As added protection against flooding of the buildings, they are all raised well above adjacent ground levels.

3.3 Construction Details

The following architect's drawings for the proposed Private Ward were received:

Drwg No. 51 - Site Plan
Drwg No. 52 - Floor Plan
Drwg No. 53 - Sections / Section Details
Drwg No. 54 - Elevations
Drwg No. 55 - Roof Framing Plan
Drwg No. 56 - Toilet and Kitchen Details
Drwg No. 57 - Details
Drwg No. 58 - Floor Plan
Drwg No. 59 - Floor Plan
Drwg No. 100 - Foundation Plan, Column and Column Footing Details
Drwg No. 101 - Floor Slab & Beam Details
Drwg No. 102 - Drain and Ring Beam Details to Ward
Drwg No. 103 - Covered Walkway Details

These are reproduced at a reduced scale at Appendix B.

3.4 Review of the Drawings

The drawings listed in sub-section 3.3 provide a very comprehensive set of instructions for the builder. The comments on these drawings, itemised below, stem from a general review of the drawings, which did not include any checking by calculation of the various member sizes and connection details.

Drwg No. 52 -	The 6" and 4" blockwalls are not reinforced. This should be done both vertically and horizontally throughout the building to provide resistance to earthquake forces. The external walls would, in any case, require reinforcement for hurricane winds. Reinforcing 4" walls can be difficult. Consideration should therefore be given to changing these to 6" walls.
Drwg No. 53 -	The fixing details of rafters-to-rafters at ridges; purlins-to-rafters and rafters-to-concrete-beams are clearly shown. This is good. The gauge of steel sheeting should be specified. The type and frequencies of fasteners for the roof sheeting should also be specified. The size of purlins (2"x 2") should be checked. It seems small in view of the probability that the real size is only 1.75"x 1.75".
Drwg No. 54 -	The form of the building is a rigid box-type structure supported by a relatively flexible column-and-beam system between the floor and foundations. This is an unfavourable system for earthquake resistance. The lateral forces on the column-and-beam system would be higher than normal so that the design of these elements must be carefully considered.
Drwg No.100 -	No information was readily available on the soils conditions. In the event that the bearing capacity of the soil is less than about 2 tons per sq ft, the individual footings should be tied together. This is advisable for safety in earthquakes. The columns are 10"x 10". This size does not facilitate detailing for the ductility that would be required from these elements in earthquakes. The size should be increased.
Drwg No.101 -	Some of the beams (eg section 4) have top rebars at such close spacing as to preclude mechanical poker vibration. The detailing should be rearranged to eliminate this problem.

4.0 CONCLUSIONS

4.1 The existing buildings and the designs for the new ward provide a good basis for developing a facility which would perform reasonably well in hurricanes, torrential rains and earthquakes.

4.1 The Existing Buildings

The main areas for retrofitting the existing buildings are:

(a) cross bracing the under-floor structure;

(b) installing ceilings under the overhanging balcony roofs;

(c) installing additional fasteners for the roof sheeting adjacent to eaves and ridges;

(d) changing the roof over the Standby Generator Room to a hipped shape;

(e) providing hurricane shutters for all fixed louvres and glass windows;

(f) installing bolts at the free corners of external doors;

(g) reinforcing the cracked pier in the Laboratory;

(h) placing all power and telecommunications cables within the Hospital compound underground;

(i) checking the historic and projected flood levels at the site to determine whether any additional drainage action is required.

4.3 The proposed Private Ward

The main items to be addressed on the designs and details for the proposed Private Ward are:

(a) checking the soils bearing capacity to establish whether foundation stays are needed;

(b) increasing the sizes of under-floor columns;

(c) checking the analysis and detailing of the under-floor structures to account for the soft-storey situation;

(d) specifying reinforcement for all walls;

(e) specifying the gauge of roof sheeting and the spacing of the fasteners.