WATER RESOURCES AUTHORITY

FLOOD REPORT

AUGUST TOWN GULLY
NOVEMBER 6, 1998

1. INTRODUCTION

1.1 Overview of the Event

During the period October 24 to November 6, 1998, the Parish of St. Andrew experienced intermittent to heavy rainfall as a result of severe weather conditions. The impact of this rainfall was most severe on November 6, when surface runoff from the northern side of the Long Mountain (Figure1) combined with urban runoff from the Mona, University campus environs and the August Town areas severely eroded the August Town Gully also referred to as the Back Gully. On one bank of the gully, approximately 1 kilometer upstream of the confluence with the Hope River (Plate 7, Figure 1), a house collapsed and was partially washed away. Two children who were occupants at the time were swept away by the flood waters and drowned. The Water Resources Authority carried out field investigations into the cause and effect of the flooding in the August Town area on November 9, 1998.
This report present the results of that investigation.

1.2 Objective of the Report

The objective of this report is to present the findings of the field investigation and the assessment by the Water Resources Authority of the possible cause(s) of flooding; to make recommendations for action and remedial projects to be implemented to reduce the effects of any future flooding and the loss of lives and property.

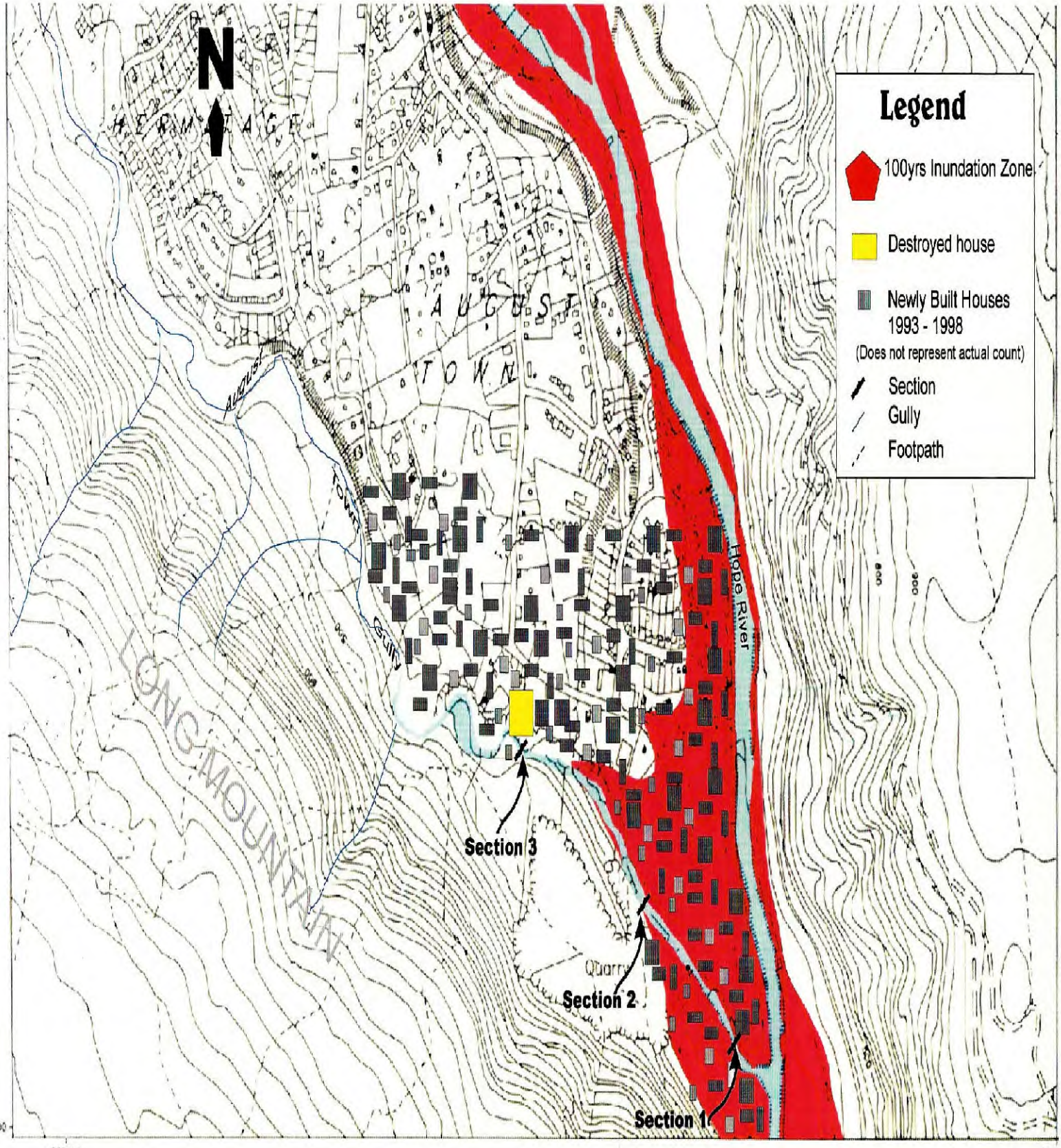
2. DESCRIPTION OF AUGUST TOWN GULLY DRAINAGE

2.1 The Drainage Network

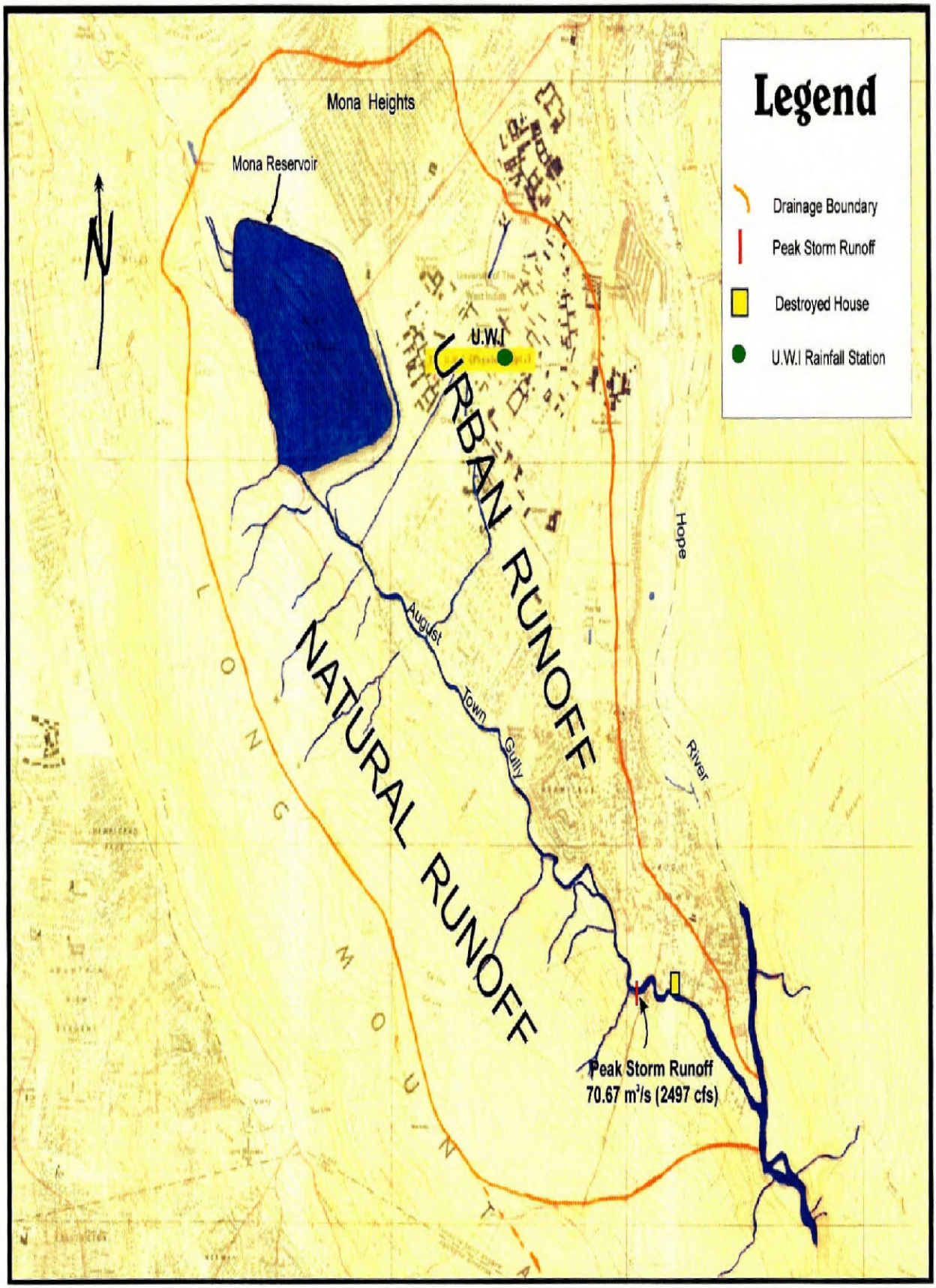
The August Town Gully drains an area of 6.8 km^2 which includes the forested limestone area of the Long Mountain, sections of the urban areas of Mona, the University Campus, Hermitage and August Town. (Figure.2). Several other channels in the Long Mountain contribute to surface runoff into the August Town Gully.

AUGUST TOWN GULLY FLOODING NOVEMBER 6, 1998
(Map Showing Flood Plane Encroachment)

Figure 1.0



AUGUST TOWN GULLY DRAINAGE AREA (6.8 km) Figure 2.0



2.2 Geology

The August Town area is underlain by rocks of the August Town and Liguanea Formations (Figure3). The Liguanea Formation consist of alternating sequences of sand and gravels with occasional bands of clay. This formation is associated with deposition of sediments from the Hope River. It lies at the top of the present lithologic sequence. Permeabilities in the sandy sections are high, but the occurrence of clays serves to reduce infiltration in many areas.

Underlying the Liguanea Formation is a sequence of limestones. This limestone becomes exposed close to the Long Mountain area. The August Town Formation, consists of sandy marls and white limestones. The rock formation is not generally pure and it is expected that permeabilities in this rock will be very low.

The low permeability of the geologic formations and the extensive urbanization will reduce infiltration rates and increase runoff and lead to flooding during extreme rainfall events.

2.3 The Mona Reservoir Overflow

The Mona Reservoir has an overflow canal (Plate 9) which joins the August Town Gully at College Common near University of the West Indies. The overflow canal has a cross-sectional area near the reservoir of $3.35m^2$, and an estimated discharge capacity of approximately 8.49 m^3/sec. (161.5 migd.).

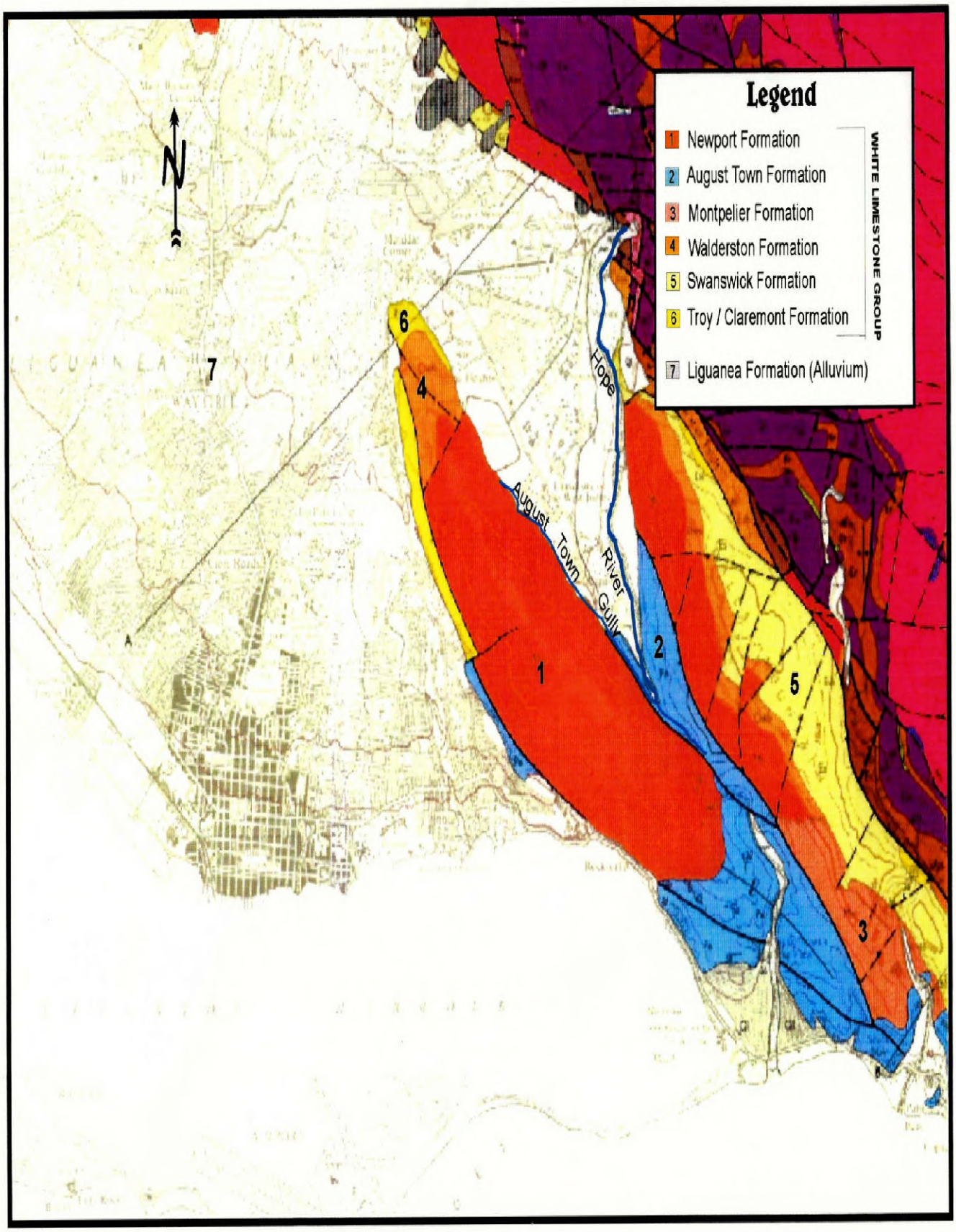
On November 6, the day of the flooding, records from the National Water Commission show that 18,176 cubic metres (4 million gallons) of water overflowed into the canal. This volume of water represents a very small outflow and did not contribute to the August Town Gully flooding as the estimated discharge capacity of the August Town gully in its lower reaches is approximately 25 times that of the Mona Reservoir overflow canal.

2.4 Flood Plain Encroachment

The lower section of the Hope River Watershed is bordered on the eastern side by Constitution Hill, through to Dallas Mountain and on the western side by Long Mountain, August Town and Mona Heights (Figure1). The area in and around the flood plain in this region is highly urbanized with a population estimated at 30,000 in 1991.
(Source: Hope River Flood Mapping project - Kinytyre to August Town Reach (UNDP, GOJ, UWA, February 1995). Figure 1 shows newly built houses that have been constructed between 1993 - 1998 within the 100 year flood inundation zone. These houses have further contributed to the already high volume of urban runoff, posing additional danger for the residents.
The August Town Gully at the confluence with the Hope River (Figure1) may pose a threat to residents as the Hope River at high flood stage may create a back water effect restricting the gully outflow and causing more houses to be inundated.

GEOLOGY OF THE AUGUST TOWN GULLY DRAINAGE AREA

Figure 3.0



More than 60% of the August Town Gully drainage area is urbanized. (Figure 2). This means that in this area there is low infiltration and high surface runoff from rainfall. The additional houses that have been built in and around the flood plain over the past 5 years have contributed to increased surface runoff in the lower section of August Town, making that area more vulnerable to flooding.

3. FIELD INVESTIGATION AND OBSERVATION

A team from the Water Resources Authority visited the areas of Grove, Hope river from Kintyre to August Town, Mona Reservoir, Hope Treatment Plant and the University of the West Indies and August Town on November 9, 1998 to carry out investigations into the flooding of the Hope River valley.

3.1 Hope River Flows

The Water Resources Authority streamflow recording station on the Hope River at Grove recorded a rise in the river level of 1.2 metres in 1 hour between 2.00 a.m. and 3.00 a.m. on November 6, 1998 which suggest that the highest intensity of rainfall occurred during this period. Flows recorded during the rainy period October 24 to November 6 indicate that the peak flow in the Hope River was 34 cubic metres per second on November 6, 1998.. This flow has a return period of less than 2 years. (Table 2 - Graph 2). The high water mark of 1.07 metres, estimated from the height of debris deposited near the confluence with the August Town Gully (Plate 8), shows that the Hope River did not, at this flow, cause any backwater effect in the August Town Gully.

3.2 Other Data Collected

Rainfall data was collected from the Physics Department of the University of the West Indies (Mona Campus)and the National Water Commission's Mona Reservoir and Hope Treatment Plant Rainfall Stations (Table 1). This data is shown plotted as Graph 1. Other data collected include the inflows and outflows of the Mona Reservoir (Table 3- Graph 3).

3.3 Observations

- The National Water Commission reported that there was no overflow from the reservoir after mid-night on Friday November 6, 1998 as all inflows from the Hope River and the Yallahs Pipeline were previously shut off. Overflow estimated from mid-night of the 5/11/98 to mid-night of the 6/11/98 was 18,176 cubic metres (4migals). The total discharge capacity of the overflow canal has been estimated at approximately 8.5 cubic metres/sec.(161.5 migd).

  The August Town Gully is joined by the Mona Reservoir overflow canal at College Common (Figure2). At this point surface runoff from sections of Mona Heights, the

TABLE 1.
RAINFALL DATA - TWENTY FOUR HOUR RAINFALL

DATE	MONA RESERVOIR (mm)	HOPE FILTER PLANT (mm)	U.W.I. (mm)
October 24	12.0	2.00	13.0
October 25	61.6	40.0	100.0
October 26	Nil	50.0	2.0
October 27	10.00	31.0	28.0
October 28	25.50	Nil	25.0
October 29	24.00	4.0	43.0
October 30	Nil	42.4	29.0
October 31	Nil	12.00	2.0
November 1	7.0	17.0	5.0
November 2	Nil	Nil	Nil
November 3	Nil	Nil	Nil
November 4	Nil	Nil	Nil
November 5	30.0	1.0	5.0
November 6	***200.0	*** 150	249.0
November 7	83.0	-	

*** Rainfall occurred between 1:00 am and 5:00 am - November 6, 1998 (August Town Residents.)
:Source National Water Commission Mona and Hope

GRAPH 1
RAINFALL DATA - TWENTY FOUR HOUR RAINFALL

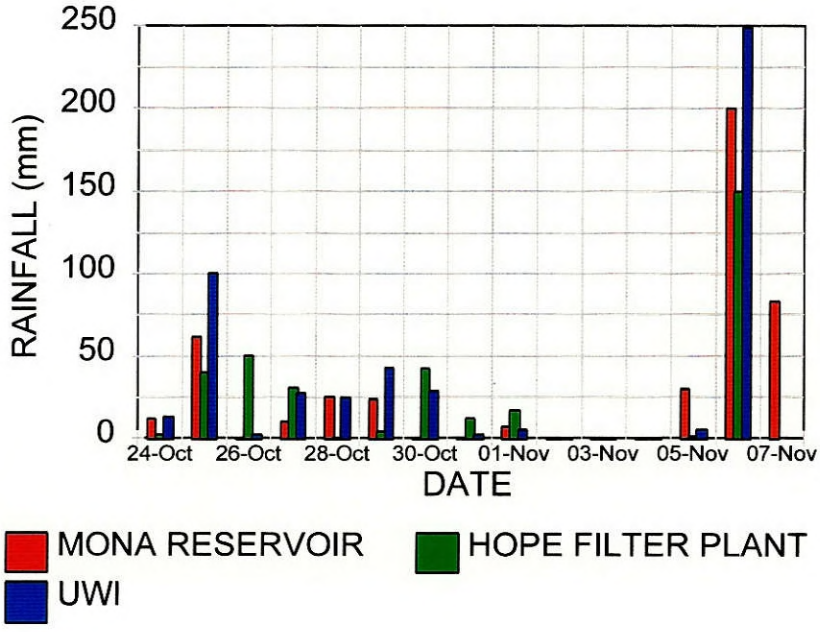


TABLE 2
HOPE RIVER - PEAK FLOWS - OCTOBER 25 - NOVEMBER 6, 1998.

DATE	GAUGE HEIGHT (Metres)	FLOW VOLUMES (m^3/second)	FLOW VOLUMES (m^3/day)	RETURN PERIOD	REMARKS
October 25	2.07	23	1635120	<2 years	
October 27	2.03	21	1532925	<2 years	
October 28	1.73	12	900830	<2 years	
October 29	2.32	30	2165020	< 2 years	Because of High Turbidity most of the flows remained in the river channel and was not diverted to the Mona Reservoir
October 30	1.69	11	817560	< 2 years	
November 1	1.53	6	465555	< 2 years	
November 6	2.44	34	2433755	< 2 years	

GRAPH 2
HOPE RIVER - PEAK FLOWS - OCTOBER 25 - NOVEMBER 6, 1998.

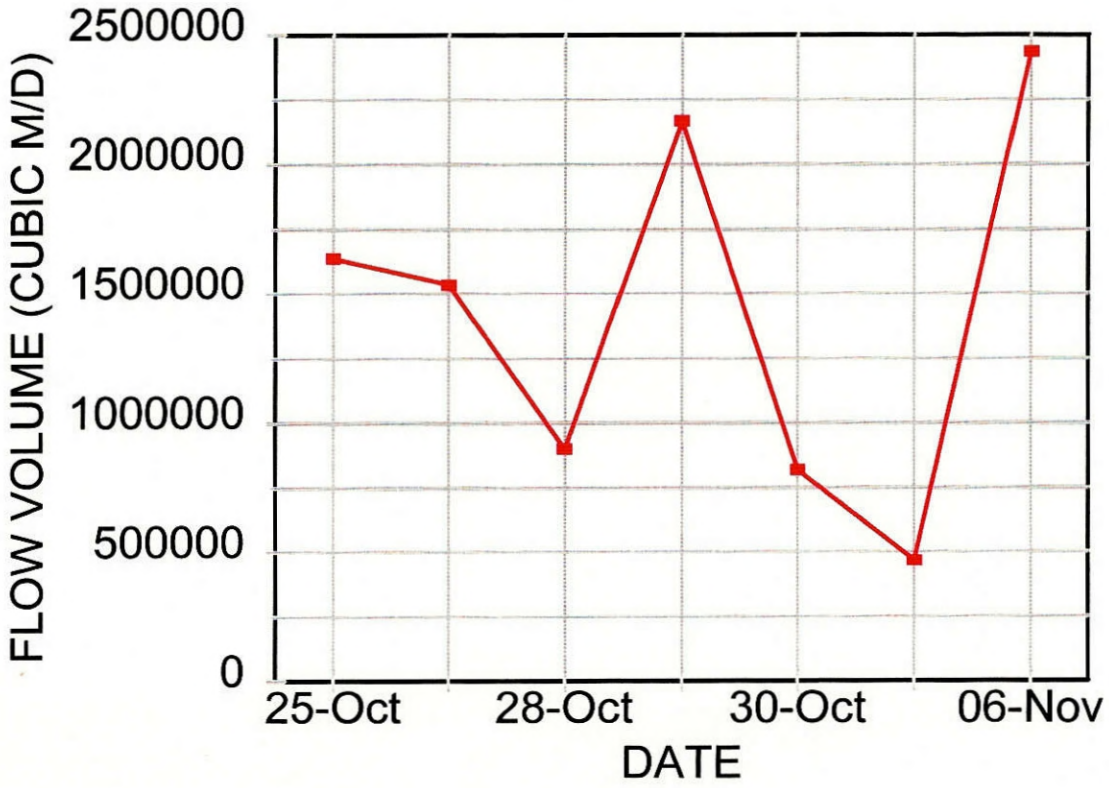
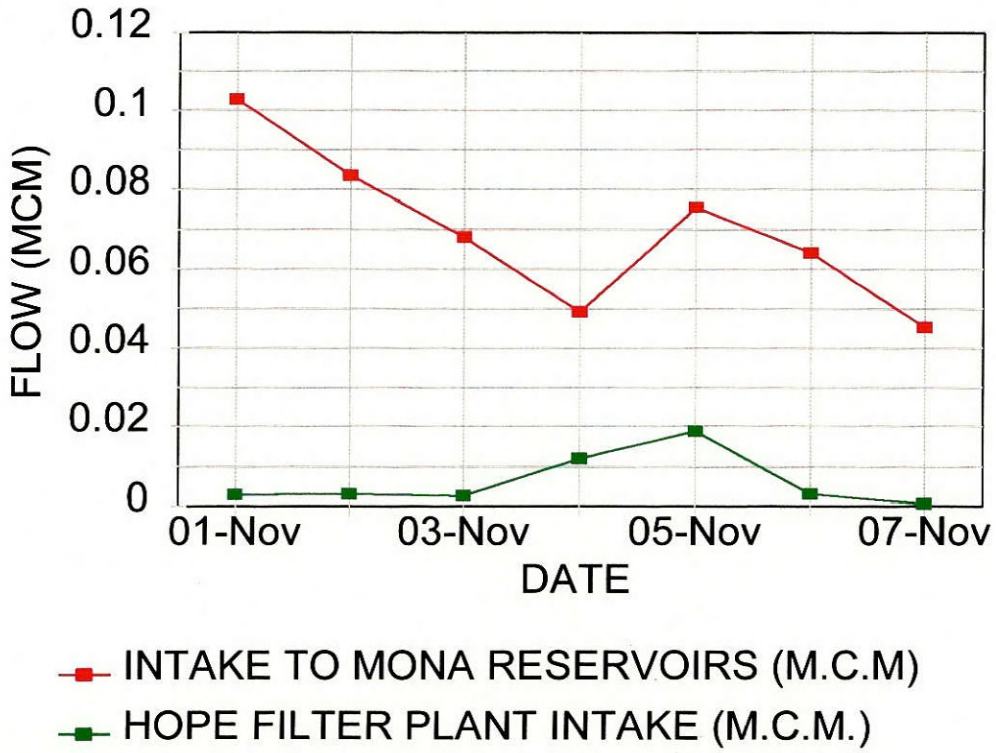


TABLE 3.
INTAKE FROM HOPE RIVER TO MONA RESERVOIR AND HOPE TREATMENT PLANT, NOVEMBER 1 - 7, 1998.

DATE	INTAKE TO MONA RESERVOIRS (M.C.M)	HOPE FILTER PLANT INTAKE (M.C.M)	REMARKS
November 1	0.1030	0.0030	Reservoir full
November 2	0.0836	0.0031	No overflow
November 3	0.0681	0.0026	-
November 4	0.0492	0.0120	-
November 5	0.0757	0.0189	Estimated overflow from Reservoir=4 millions gal. from
November 6	0.0643	0.0031	6/11/98. No overflows from the 6/11/98-7/11/98
November 7	0.0454	0.0007	

GRAPH 3
INTAKE FROM HOPE RIVER TO MONA RESERVOIR AND HOPE TREATMENT PLANT, NOVEMBER 1 - 7, 1998.



University of the West Indies and Mona Road joins the August Town Gully and adds to the surface runoff from the Long Mountain, Hermitage and August Town.

- Surface runoff from the Long Mountain and Beverly Hills region flows through a limestone quarry approximately 61 metres east and upgradient of the Mona Reservoir. This causes loose limestone material to be washed down from the quarry and deposited into the reservoir (Plates 10-12).

- As shown in Plates 1 - 7, the erosion of the gully channel and undermining of the foundation of the gully walls at several sections along the river gave rise to collapse of the wall at these locations. Residents confirmed that the walls were washed away or collapsed as a result of previous high volume surface runoff.

- There was evidence (springs in bottom of gully) of subsurface drainage in the August Town Gully on November 9, 1998. This could be due to overflow of storage from the August Town alluvial fill which was saturated by 2 weeks of rainfall.

4.0 DETERMINATION OF PEAK RUNOFF FOR THE AUGUST TOWN GULLY

Unlike the Hope River the August Town Gully is not gauged, hence, there is no stream flow data available on flood events for the area. Peak storm runoff for the flood event on November 6, 1998, near the confluence of the Hope River and the August Town Gully was generated from modeling the sub-basin drained by the gully (Figure 2).

4.1 Sub-basin Characteristics

The sub-basin area is approximately 6.8 km^2 which consists predominantly of urbanized areas and forest lands. The drainage density, i.e. the length of all channels in the drainage area divided by the area, of the sub-basin is low, approximately 0.7 km^2 with a dendritic drainage network; areas with high drainage density are associated with high flood peaks, high sediment production and steep hill slopes. Approximately 4 km^2 of the sub-basin area is urbanized; these areas have low to zero infiltration capacity and effectively increase the velocity or speed of water transmission to the channels. August Town Gully is a second order stream near the confluence, with a channel gradient of 0.1. Based on the land use, soil type, geology and soil moisture of the sub-basin two SCS Curve Number values were used to generate the flood hydrographs for urbanized areas and forested lands respectively. The Soil Conservation Service (SCS) is a soil classification system relating soil group type to curve number as a function of soil cover, land use and antecedent moisture conditions.

4.2 Rainfall Data

Rainfall intensity data obtained from the Physics Department of the University of the West Indies -Mona, indicated 249 mm of rainfall over a 24 hour period on November 6, starting from mid-night. Of this amount, 225 mm was recorded in 6 hours, between mid-night and 6:00 a.m. (Table 4-Graph 4). Based on a 24 hr.maximum rainfall chart published by the National Meteorological Service (Flood Plain Mapping Project on Transfer of Technology) the 6 hr. rainfall of 225 mm in the sub-basin has a return period of approximately 10 years. This means that rainfall events of this magnitude are likely to occur on average once in every 10 years. The data also indicated 24 hour rainfall of 200mm and 150mm at the Mona Reservoir and the Hope Filter Plant respectively for the corresponding period (Tables 1 to 3).

4.3 Hydrologic Analysis

The HEC-1 model was used to compute the storm runoff at a selected point (near the confluence of the Hope River and the August Town Gully) along the reach, using hourly rainfall intensity data, for November 6, 1998 from the University of the West Indies-Mona.

The HEC-1 model is a flood hydrograph package developed at the Hydrologic Engineering Centre by the US Army Corps of Engineers. It is used mainly for the simulation of a discharge hydrograph based on input of rainfall data and the response of drainage area based on the catchment characteristics. The sub-basin of the August Town Gully (figure 2) was delineated using a 1:10,000 scale topographic map, this area was defined according to contributions from the overall drainage network and urban runoff areas. The hourly rainfall intensity data was used to generate the cumulative precipitation time series which was used as an input for the HEC-1 model.

Based on the hydrologic analysis conducted, the peak discharge at the selected site on November 6, 1998, was 70.67 m^3/s (2497 cfs) - (Table 5).

TABLE 4.
HOURLY INTENSITY DATA, NOVEMBER 6, 1998.

TIME	RAINFALL (mm)
0000 - 0100 HRS	28.00
0100 - 0200 HRS	50.00
0200 - 0300 HRS	67.00
0300 - 0400 HRS	35.00
0400 - 0500 HRS	25.00
0500 - 0600 HRS	20.00
0600 - 0700 HRS	15.00
0700 - 0800 HRS	8.00
0800 - 2400 HRS	1.00

GRAPH 4
HOURLY INTENSITY DATA, NOVEMBER 6, 1998.

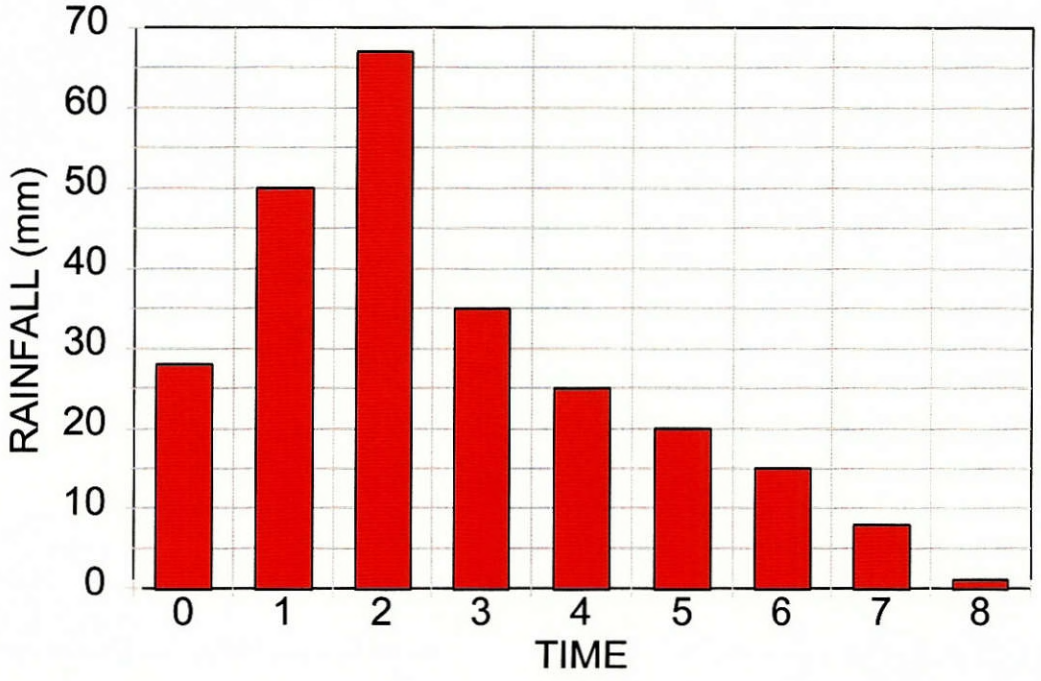


TABLE 5

AUGUST TOWN GULLY FLOODING

SUMMARY OF HYDROLOGIC ANALYSIS

STORAGE VOLUME ACRE-FEET
SURFACE AREA ACRES
TEMPERATURE DEGREES FAHRENHEIT

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE M

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIM 6-HOUR	24-HOUR
+	HYDROGRAPH AT	HOPEU	1858.	5.00	852.	263.
+	HYDROGRAPH AT	HOPEF	890.	5.67	547.	168.
+	2 COMBINED AT		2497.	5.00	1376.	431.

*** NORMAL END OF HEC-1 ***

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1*****************************************
 *                                       *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
 *           SEPTEMBER 1990              *
 *            VERSION 4.0                *
 *                                       *
 *  RUN DATE  11/19/1998  TIME  10:04:48 *
 *                                       *
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5. CONCLUSIONS.

- The main cause of the failure of the bank of the August Town Gully was the erosion of the lined channel and undercutting of the retaining wall over a period of several rainfall events.

- The lives of over 1,000 persons living in the flood way of the Hope River and August Town gully are at risk from future flood events. This is based on a preliminary count of houses and calculated at an estimated 5 persons per household.

- The August Town Gully drains the urban storm runoff from Mona, University of the West Indies, Hermitage and August Town area as well as the natural runoff from the Long Mountain and is likely to be backed up by the Hope River at its confluence causing inundation of houses in the lower August Town area.

6. RECOMMENDATIONS

- A programme of continuous repairs and maintenance of gully retaining walls and channels should be implemented in the August Town Gully and all other gullies draining urban runoff.

- Government should regulate against any further development and discourage squatting, on the Hope River Flood Plains within the August Town area.

- A public education and a flood awareness programme, including a community flood warning system, should be implemented in the Hope River Flood Plain between Grove and August Town.

- The Ministry of Works should carry out an investigation on the suitability of the existing type of gully construction in the August Town area based on the geology and soil type of the area.

AUGUST TOWN GULLY PHOTOGRAPHS

Plate 1. Scouring of concrete channel of Lower August Town Gully near confluence with Hope River (Section 1).

Plate 2. Bridge exposed to scouring of gully channel near confluence with Hope River.

Plate 3. Upstream view of collapsed gully retaining wall (Section 2).

Plate 4. Downstream view of section of gully embankment that was damaged by flood water overflow.

Plate 5. Gully bank slumping destroys retaining wall.

Plate 6. Undermined gully wall caused by erosion of the gully channel (Section 3).

Plate 7. House from which two lives were lost by the gully flooding (6 November 1998). Notice exposed Gully embankment near house without retaining wall.

Plate 8. Debris showing flood levels of 3.5 feet on Hope River at August Town (9 November 1998).

Plate 9. Mona Reservoir overflow canal (9 November 1998).

Plate 10. Limestone quarry located 200 feet above Mona reservoir causing debris flow into the Mona Reservoir.

Plate 11. Loose limestone material (from existing quarry operations) some of which was deposited in the Mona Reservoir (9 November 1998).

Plate 12. Quarried material deposited in the Mona Reservoir after heavy rainfall (6 November 1998).