



**National Emergency Management Organization
Damage Assessment and Needs Analysis**

Final Report

**TROPICAL STORM ARTHUR
Flooding Events**

1st June, 2008

BELIZE

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EXECUTIVE SUMMARY

Tropical Storm Alma made land fall along Nicaragua's Pacific Coast on Thursday, 28 May 2008. The remains of Tropical Storm Alma drifted into the Gulf of Honduras and northwestern Belize where conditions were favorable for its reorganization into Tropical Storm Arthur which significantly affected Belize.

The storm traveled across northwestern Belize at 7 miles per hour with maximum sustained winds of 40 miles per hour extending 230 miles from the center. Total rainfall measured up to 15 inches over a three-day period.

The Southern Belize and Stann Creek Districts were most significantly affected with the rains causing life threatening floods and mud slides. Some 29 villages overall were impacted. Communities hardest hit included Mullins River, Gales Point Manatee, Hope Creek, Sittee River and Hopkins. Search and rescue operations conducted in the affected areas confirmed five deaths.

Approximately 1,023 families were directly or indirectly affected by the floods. Livelihoods of these communities are based largely on small-scale fishing, subsistence farming, itinerant trading, cottage industries and casual employment in the agriculture and tourism sectors.

Significant losses were incurred in the agriculture, fisheries, petroleum, and education sectors, along with severe infrastructural damage in the affected districts. Total direct losses have been estimated at \$47.7 million. Major losses were as follows:

Infrastructure	-	\$12.18 million
Housing	-	\$11.38 million
Fisheries	-	\$ 7.89 million
Petroleum	-	\$ 4.15 million
Education	-	\$ 3.48 million

Economic losses were tabulated at \$67.37 million (inclusive of the direct losses)

In order to restore conditions to normalcy, the country will need approximately \$47.76 million for the affected communities and sectors. Most significant among these are the infrastructure and housing sectors which will need \$16.24 million and \$12.85 million respectively. The latter value includes \$10.70 million for restoration/ replacement of household items in the affected areas.

Humanitarian assistance will be necessary to facilitate households' return to normalcy. Initial activities should include cleaning and the restoration of private dwellings. Funding sources should be identified to assist families with the replacement of household items. This could take the form of grants and/or low interest loans which can be channeled through local credit unions, producer organizations, and other non-governmental organizations.

The long term food and water supply of the affected communities also requires urgent attention, since most of the affected communities live in poverty and depend on subsistence farming for their livelihoods.

Options for the resettlement of vulnerable communities must also be considered. Resettlement Programs/ projects must be based on participatory methodologies in order to ensure success, since socioeconomic issues are of paramount importance. Provision must be made for alternative livelihood options of these residents through adequate consultation and planning.

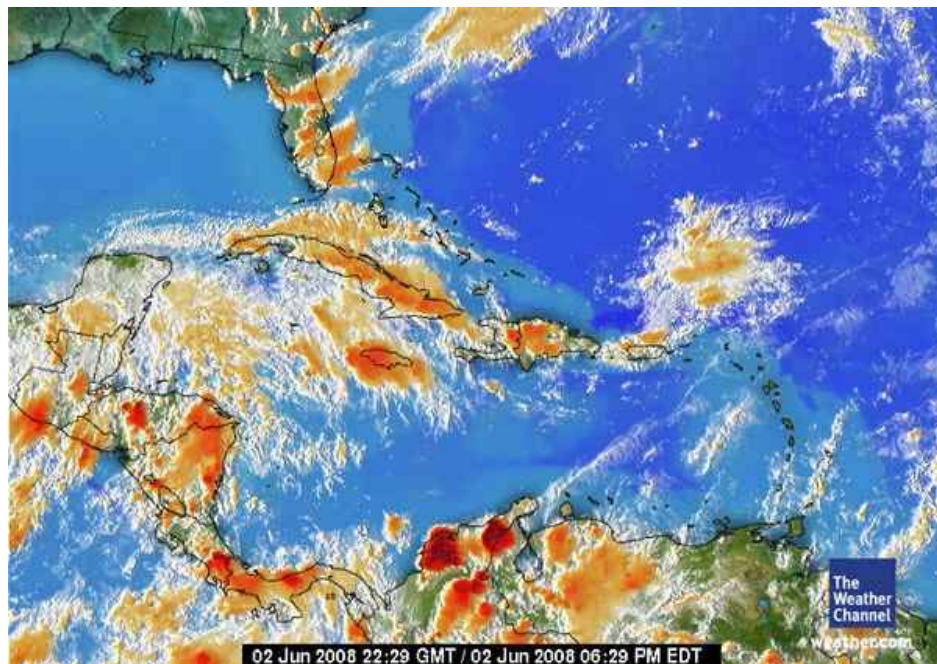
This report is submitted to NEMO for its consideration and further action.

1.0 Introduction

Tropical Storm Alma made land fall along Nicaragua's Pacific Coast on Thursday 28 May 2008. The dissipating depression moved across the Central American Region dumping as much as 36 cm of rain in Honduras, Guatemala and Belize. The remains of Tropical Storm Alma drifted into the Gulf of Honduras and northwestern Belize where conditions were favorable for its reorganization into Tropical Storm Arthur.

Around 10:30 Saturday morning (31.5.08) a center of circulation was identified over extreme northwestern Belize with tropical storm force winds observed by a weather ocean buoy off the east coast of Cozumel, Mexico. Tropical storm force winds were also observed in the broad circulation well to the east of the center in the northwest Caribbean.

Picture 1: Tropical Storm Arthur



At midday Saturday, after consultation with the Hurricane Center, the Acting Chief Meteorologist was granted permission by the Cabinet Secretary to declare a Tropical Storm warning for the coast of Belize. The Mexican Government also declared a Tropical Storm watch for the Yucatan coast based on the premise that the storm was already moving across Belize, Yucatan and Guatemala.

Arthur moved across northwestern Belize at 7 miles per hour with maximum sustained winds of 40 miles per hour extending 230 miles from the center. Total rainfall measured up to 15 inches over a three-day period.

The areas affected include the Corozal, Orange Walk and Stann Creek Districts, with the rains causing life threatening floods and mud slides particularly in the Stann Creek District.

Search and rescue operations were conducted in the Stann Creek District where five deaths were confirmed. Significant losses were incurred in the agriculture, fisheries, petroleum, and education sectors, along with severe infrastructural damage in the affected districts.

2.0 Social/Humanitarian Impact

Communities hardest hit were those on the coast of southern Belize District and the Stann Creek District including Mullins River, Gales Point Manatee, Hope Creek, Sittee River and Hopkins. In the hours directly following the flood, these communities recorded up to 95% communal lands and infrastructure impacted by the raging waters. In Stann Creek, inhabitants reported flood waters of above 12 feet in some areas¹. Some 29 villages overall were impacted, with eight in Stann Creek, five in Orange Walk, and one in the Belize District being severely affected.



Picture 2: Gales Point Manatee submerged by flood waters

Women and children accounted for approximately 73% of the impacted persons. Table 1 provides updated population figures for the affected areas.

¹ Local media interviews directly following the event

Table 1 Impacted Population

DISTRICT	TOTAL POPULATION	AFFECTED AREAS	AFFECTED POPULATION	POPULATION SUFFERING DIRECT IMPACT
Stann Creek	32,200	Hopkins	1,193	1,193
		Kendall	114	-
		Hope Creek/Melinda	899	149
		Middlesex	362	38
		Mullins River	238	238
		Red Bank	788	-
		Sarawee	244	138
		Sittee River	374	167
		South Stann Creek	474	-
		Steadfast	458	-
		Valley Community	250	141
		Alta Vista	745	421
Orange Walk	47,100	Carmelita	946	43
		Douglas	640	125
		San Antonio/Rio Hondo	450	70
		San Estevan	1,775	18
		Guinea Grass	3,005	33
		OW Town	16,000	639
Belize	93,200	Gales Point Manatee	296	450
		Belize City		102
Corozal	36,300	San Roman	788	138
		Santa Clara	901	134
		San Victor	770	62
		Concepcion	1,072	25
		Louisville	776	81
		Caledonia	1,516	109
		Buena Vista	478	43
		San Narciso	2,489	353
TOTAL			30,039	4,909

NB: Figures in shaded cells have been amended based on field verification.

The storm devastated communities and caused severe damage to dwellings and household assets. Five persons have been confirmed dead including two adults (one male and one female), and three children (1 female and two males) under the age of 16.

Productive assets lost included boats, traps and dories belonging to fishing and tourism-oriented communities, and significant losses to subsistence farm lands and commercial crops in localized regions were also reported. Losses sustained within the commercial agricultural and fisheries sectors are expected to seriously impact community livelihoods. Damage to roadways and connecting bridges resulted in the isolation of some of the hardest-hit communities. Additional infrastructure such as school buildings and rudimentary water supply systems were also affected.

2.1 Shelter and Livelihoods

Flooding and gusting winds associated with Tropical Storms Alma and Arthur resulted in losses amounting to \$1.04 million. Overall, some 400 homes were partially or completely destroyed. Of these, 87.5% are located in the Belize and Stann Creek Districts and represent primarily coastal households. Table 2 provides a breakdown of the damage by district.

Table 2 Number of Damaged Dwellings by District

	Destroyed	Damaged
Belize District	6	173
Corozal District	0	26
Orange Walk District	0	19
Stann Creek District	34	142
TOTALS	40	360

Source: Ministry of Housing and Urban Development

A total of 22 shelters were opened nationwide to accommodate persons displaced by the floods. Only 14 of these are still operational as persons have returned to their communities to begin recovery efforts. These shelters are expected to remain open until permanent housing solutions can be provided.

The provision of relief supplies to impacted communities is being done by the National Relief and Supplies Management Committee and the local Red Cross Society. As at June 12th, 2008 a total of 710 persons had been provided with two to four weeks' supply of rations in the four districts.

Approximately 1023 families were directly or indirectly affected by the floods, with livelihoods largely based on small-scale fishing, subsistence farming, itinerant trading, and casual employment in the agriculture and tourism sectors.

Supply and market disruptions have led to losses in income and employment. Those households dependent on the primary sector have suffered losses as the floods have disrupted productive activity. As most farmers were in the process of planting, no crops are expected for this season. This presents a threat to food security as well as income generation.

Preliminary reports from the Fisheries Department indicated a loss of export earnings of \$5.45 million attributable to reductions in capacity and production opportunities. The agricultural sector reported some \$11.38 million in damages. The sector supports approximately 21% of the labour force in the impacted region.

Damages reported to local tourism infrastructure will also result in short term negative impacts on the livelihoods of coastal communities. The sector indicates recovery periods ranging from one to eight weeks.

2.2 Health Services

There was some disruption of the provision of health services through the various community health centers as these recorded various degrees of damage to equipment and supplies due to heavy rainfall and flood waters. In the days directly following the flood some centers were inaccessible. One priority of the health sector is the re-establishment of access to essential daily medications for diabetics and hypertensive patients in impacted regions.

Vector control also remains a priority as the prevalence rate of malaria was three times that of the national rates even before the flood event. Stagnant waters in coastal lowlands may result in the upsurge of incidences if not properly treated.

As of June 3, 2008, the following have been reported from the Stann Creek district in the daily disaster summary report: fever, fever and cough, fever and rash, watery diarrhoea, conjunctivitis, injuries and a case of chicken pox.

It is assumed that all persons directly impacted by Tropical Storm Arthur and associated flooding will possibly exhibit various degrees of trauma and depression. The Family assessment conducted by the Relief and Supplies Management Committee identified eighty one (81) individuals in the Stann Creek District who demonstrated one or more signs of Post Traumatic Stress Disorder (PTSD). Immediate psycho-social intervention is recommended as a part of recovery efforts.

2.3 Recovery/ Reconstruction Strategy

Immediate and medium-term recovery and reconstruction, particularly related to shelter, housing, livelihoods, education, health, and water sanitation is necessary. Restoration of educational, maternal and childcare, and health facilities in the affected areas is an urgent necessity. Adequate water and sanitation facilities and solid waste management systems need to be in place.

1. Attempts should be made to return families in temporary shelters to permanent housing. Secondary displacement and resettlement should be avoided.
2. In the medium to long term, households whose dwellings are located in risk prone areas should be consulted extensively about their vulnerabilities and be provided the option of relocating.

In the medium to long term assistance should be given to enable people to rebuild their homes within acceptable building codes, thus reducing vulnerabilities. Communities are to be included in their own reconstruction.

3. In the short term assistance should be provided to small farmers and artisan fishers to restore their capacities to produce. In the medium to long term, attempts should be made to build coping mechanisms of communities and to build risk reduction measures into livelihood practices.

The option of providing compensation for loss of small livestock and subsistence crops should be considered as a medium term measure.

4. Female headed households, children and the elderly should be targeted for psycho-social support and livelihood restoration.

3.0 Damages by Sector

Data sources for this section of the report included DANA Field Team reports, Aerial Reconnaissance reports, data collected from the National Emergency Operating Centre of the NEMO, and official sectoral reports submitted by government and non-governmental agencies.

3.1 Social Sectors

3.1.1 Housing

Buildings in the Belize and Stann Creek districts were severely affected by flood waters, but minimal damage was recorded for Corozal and Orange Walk. A total of forty buildings valued at \$0.64 million were totally destroyed. An additional 360 buildings sustained damage totaling \$0.40 million. Total damage is estimated at \$1.04 million. Table 3 provides details of buildings damaged by district.

Table 3 Schedule of Estimated Damage to Housing

District	Destroyed		Damaged		TOTAL	
	Number	Value	Number	Value	Number	Value
BELIZE	6	34,500.00	173	168,627.00	179	203,127.00
STANN CREEK	34	601,750.00	142	207,100.00	176	808,850.00
ORANGE WALK	0	0.00	19	15,700.00	19	15,700.00
COROZAL	0	0.00	26	13,100.00	26	13,100.00
TOTALS	40	636,250.00	360	404,527.00	400	1,040,777.00

Source: Ministry of Housing and Urban Development

Replacement costs are estimated at \$1.78 million, excluding replacement of household items. Expenditure in this latter area will be in the region of \$10.70 million. Many of the families affected will require financial assistance to rebuild their homes. Details are provided in Table 4 below.

Table 4 Dwelling Replacement Costs by District

Item/District	BELIZE		STANN CREEK		ORANGE WALK		COROZAL		TOTAL		GRAND TOTAL
	Materials	Labour	Materials	Labour	Materials	Labour	Materials	Labour	Materials	Labour	
Building Replacement	90,000.00	60,000.00	528,600.00	352,400.00					618,600.00	412,400.00	1,031,000.00
Roof Damage	146,210.00	58,484.00	9,260.00	3,704.00	13,960.00	5,584.00	8,260.00	3,304.00	177,690.00	71,076.00	248,766.00
Floor and Wall Damage	18,000.00	7,200.00	6,150.00	2,460.00	7,025.00	2,810.00	5,925.00	2,370.00	37,100.00	14,840.00	51,940.00
Windows and Doors	1,400.00	560.00	1,400.00	560.00			3,375.00	1,350.00	6,175.00	2,470.00	8,645.00
Sewerage	15,000.00	6,000.00	57,000.00	22,800.00					72,000.00	28,800.00	100,800.00
Electrical/Plumbing		0.00	46,000.00	18,400.00					46,000.00	18,400.00	64,400.00
Miscellaneous	44,515.00	17,806.00	155,551.00	62,220.40					200,066.00	80,026.40	280,092.40
TOTALS	315,125.00	150,050.00	803,961.00	462,544.40	20,985.00	8,394.00	17,560.00	7,024.00	1,157,631.00	628,012.40	1,785,643.40

3.1.2 Education

Classes were suspended countrywide due to excessively wet conditions.

In Hope Creek Village, the Government Primary School and the ITVET complex sustained significant damage. The four pre-fabricated Makiber buildings at the primary school, along with equipment, appliances and furniture were totally destroyed. The ITVET complex experienced significant flooding on the lower flat, resulting in severe damage to equipment and appliances. Loss/damage to equipment for ITVET has been estimated at \$1.50 million.

Total damage for the education sector is estimated at \$3.45 million, including \$1.61 million for ITVET and \$1.84 million for other schools. Replacement costs for the affected institutions will be in the order of \$4.31 million (*See Appendix I*).

3.1.3 Health

3.1.3.1 Health Facilities

There was no major structural damage to health centers in the affected areas. However, operations were affected by flood waters and cleaning/restorative activities are currently in progress. These will cost an estimated \$0.1 million.

3.1.3.2 Morbidity and Mortality

A total of five fatalities have been confirmed in the aftermath of Tropical Storm Arthur. Immediately after the event, medical complaints included cough and fever, skin infections, conjunctivitis, diarrhea, jaundice, and respiratory infections. In the Stann Creek Valley communities, there were increased incidents of conjunctivitis and diarrhea,

but this situation has since normalized. No major outbreaks of communicable diseases are expected at this time.

Efforts are being made to provide essential daily medications since issues of access continue to be a major concern for diabetic and hypertensive patients, in particular.

An emergency operating theatre was established at Southern Regional Hospital, particularly for C-Sections. Vector control personnel have been deployed to the affected areas as a matter of priority.

Stress-related complaints have been documented including tension headaches, anxiety and insomnia.

Concerns regarding water quality have been alleviated through the efforts of the Belize Water Services and the Public Health Department. The supply of potable water to the affected areas has been restored.

3.1.3.3 Emergency Supplies

Medical supplies in the affected areas (clinics and private homes) have either been damaged or destroyed and will need to be replaced. The Ministry of Health has compiled a listing of essential medical supplies which will cost approximately \$0.2 million.

3.1.3.4 Environmental Health

This continues to be a serious threat to the affected population in regards to the quality of drinking water, food safety, and the incidence of vector borne diseases. Immediately after the event, the Ministry of Health mobilized teams from Punta Gorda and Stann Creek to conduct ULV and indoor spraying operations, as well as larviciding of stagnant water in the affected communities.

The regular spraying cycle which coincides with the onset of the rainy season will commence shortly with priority being given to the Stann Creek Valley and surrounding areas.

3.1.3.5 Action taken

Work continues towards restoring conditions to normalcy.

Multidisciplinary teams comprising physicians, nurses, health inspectors, health educators, and psychiatric nurse practitioners were deployed to the affected areas. These were active up until 12th June, 2008.

Sentinel sites were established at the Pomona and Hopkins health centers to conduct surveillance activities for communicable diseases (conjunctivitis, diarrhea, etc.).

Restoration of basic operations at the health centers are in progress. Vector control teams have been deployed and work continues.

3.2 Productive Sectors

3.2.1 Agriculture

At the time of this report, field data from the agriculture sector remained outstanding. Preliminary updates were received from the Citrus Growers' Association and the Sugar Industry Control Board, and the values for these sub-sectors were revised accordingly. All other values have been taken from the Preliminary Report.

Agriculture in the Southern District is dominated by the citrus, banana, mango and shrimp sub-sectors. Additionally, root crops and fruit tree production are important activities in this region. Livestock production involves small stock and cattle. The sector sustained losses of approximately \$11.34 million.

3.2.1.1 Citrus

Immediate direct damage to citrus groves in the flooded areas occurred in isolated locations; it was not widespread. This was because the flood lasted for a relatively short period of time: around 8 hours on average. Longer term damage might be more extensive, however. Where soils remained water logged for extended periods of time, damage to citrus roots from the fungus *Phytophthora* will result but such infections will take some time to develop. The staff of the research arm of the Citrus Growers Association, the Citrus Research & Education Institute, will conduct a re-assessment of the areas affected by the floods for *Phytophthora* infections in August 2008.

Some fruits, already harvested, were on the grove floor awaiting collection for delivery to the processing factory when the flood arrived. These fruits were washed away. The flood left a lot of debris in many groves which, while causing little direct damage, will be costly to clean-up.

Growers with land next to flooded creeks or rivers lost trees and experienced damage to river banks.

The flood also damaged grower's houses, household contents grove roads and culverts.

With respect to the Citrus Growers' Association, flood waters reached levels of up to 8 feet in the Association's offices, laboratory, and research facilities. All computers, office equipment, furniture, files, documents, library contents and laboratory equipment (used for the diagnosis of citrus diseases and the implementation of the industry Mexican fruit-fly control programme), nursery plants, and variety collections were severely if not totally damaged. Three of the Association's 4-wheel drive vehicles were swept away in the flood. The estimated value of the damage to the Association's assets is around \$2.7 million.

As at June 13th, 2008 damage to the citrus industry had been estimated at \$5.31 million. This is a preliminary estimate only as assessments from citrus processors and from the fields remain outstanding.

3.2.1.2 Rice

Destruction of this crop included some 914 acres at Blue Creek, and 460 acres at Big Falls Ranch in the Belize District, all of which were ready for harvesting. Estimated loss for this sector is \$1.7 million.

3.2.1.3 Sugar-cane

Losses to this sector include 3200 tons of burnt and cut cane awaiting transportation to the factory, as well as 1800 acres inundated by flood waters. Estimated losses are to the tune of \$1.6 million.

3.2.1.4. Other

In the Valley area, root crops including cassava, coco-yam and sweet potatoes were totally destroyed. Losses to fruit crops such as pineapples could not be determined.

Livestock losses could not be confirmed by aerial reconnaissance; however it was observed that about 40% of the pasture acreage was inundated. Losses to the livestock sub-sector remain unconfirmed.

With respect to Belize Rural South (Gales Point Manatee and Mullins River) crop production activity is concentrated on citrus, mango and other fruit trees. Approximately 60% – 65% of agricultural land in this area is inundated.

3.2.1.5 Economic Loss to the Agriculture Sector

Total economic loss to the agriculture sector resulting from Tropical Storm Arthur is estimated at around \$20.33 million. This includes direct loss to the farmer (damage assessment), which is estimated at around \$11.33 million, and other losses to the country of Belize.

In computing economic loss, deprived economic activity associated with the production process is considered. The process varies across sectors and includes the processing of paddy into milled rice, conversion of sugar-cane into sugar and molasses, producing concentrate, juice and oil from citrus fruits, as well as the various support activities related to the production process.

These deprived activities are important factors in the medium term since they represent economic losses for Belize such as loss of employment, fewer purchases of input materials, decreased demand for support services such as transport and distribution. Consequently, imports will increase and exports will decrease.

3.2.2 Fisheries

The long term impacts on the local fishery cannot be determined at this point, but losses will be sustained as a result of siltation of sea-grass beds which serve as habitats for marine life (*see Section 4.0*).

The lobster season in Belize commences on June 15 and lobster farmers had already lodged their traps in preparation. Production is usually highest at the start of the season and it is anticipated that approximately 25 % of the average annual lobster production will be lost due to damage to sea-grass beds and traps. This represents about 125,000 pounds of tails having an estimated value of \$5 million.

With regards to conch, there has only been one month of production and indications are that the production rate will be lower than expected. It is estimated that about 62,000 pounds of conch will be lost this season as a consequence of the tropical storm. This will result in economic losses of approximately \$428,000.

Within the aquaculture sub-sector, Paradise Shrimp Farm and Melinda Mariculture Ltd. suffered damage to equipment estimated at \$2.4 million. In the case of the former, losses of \$0.4 million were sustained as a result of excessive flooding of production ponds. Melinda Mariculture did not suffer production losses, but sustained severe damage to farm machinery, buildings and equipment estimated at approximately \$2 million.

Although the other shrimp farming operations further South of Belize did not suffer any significant damage due to the flooding, the main constraint to these producers was access by road to the Mexican market given the situation with the Kendall Bridge. This has been alleviated by the temporary causeway constructed across the river.

The economic losses to the aquaculture sub-sector in Belize have been estimated at \$7.84 million, including direct costs of \$2.42 million.

3.3.3 Tourism

Reports from the tourism sector have been sketchy and the figures presented herein are inconclusive.

In the Stann Creek District major tourism sites include Hopkins, Sittee River and Placencia. No visible damage was recorded for the Placencia area. In the villages of Hopkins and Sittee River aerial reconnaissance indicate flood damage to hotels and guest houses. There is no reliable data on the value of such damages at this time, but Sittee River appears to be hardest hit. Most of the establishments in this area are small and suffered major losses.

There was no major damage reported at properties in the Orange Walk and Corozal districts, and all establishments are currently operational.

Preliminary indications are that damage to the tourism sector is in the order of \$600,000.00 BZ. This figure is expected to increase as more information becomes available.

3.2.4 Petroleum

Belize Natural Energy, Ltd. (BNE) produces approximately 3,700 barrels of crude oil per day, 95% of which is sold internationally via the Big Creek port. Crude is shipped by road from the central storage facility in Iguana Creek, Spanish Lookout to a storage facility in Big Creek by third party trucking companies. BNE currently employs 102 persons in its exploration and production operations. The loss of the Kendall Bridge during the floods resulted in a 10-day cessation of operations leading to economic losses of approximately \$4.2 million (*see Table 5 below*).

Table 5 Schedule of Losses to the Petroleum Industry

Item	Direct Cost	Economic Cost
Net Revenues	1,154,400.00	
Transportation Revenues	240,000.00	
Port Dues	160,000.00	
Employment	100,000.00	
Royalties and Taxes	2,200,000.00	
GOB Interest (10%)	300,000.00	
Total	4,154,400.00	4,154,400.00

Source: Belize Natural Energy

Sale of Belize's crude oil internationally generates revenues of \$0.844 million per day assuming an average price of US\$120/barrel. BNE's operating costs averages 87% of gross revenues. This translates into a direct cost of approximately \$1.2 million for the 10-day period.

On an average BNE dispatches twenty-nine tankers per day from Iguana Creek to the Big Creek storage facility. With damage to the transportation route due to the loss of the bridge, trucking had to be discontinued and resulted in a loss of revenue to that sector is \$0.24 million.

The Big Creek port stands to lose significantly as well, since the usual two shipments per month will not be processed. Based on average international sales, losses will be in the order of \$8000.00 per day, or \$0.16 million.

Employment losses due to down-time averaged \$10,000.00 per day or \$0.1 million for the 10-day period.

At the current rate of production and sale, the oil industry (BNE) generates about \$0.220 million per day in royalties and taxes to the Government of Belize. Additionally, GOB will lose its 10% working interest of approximately \$15,000 per day or \$0.3 million.

4.0 Environment

Note: the information in this section has been reproduced from the Preliminary Report since no update has been provided by the Department of the Environment.

This information is based on an aerial survey conducted after the storm, in conjunction with on the ground assessments of impacted areas. A more comprehensive and detailed assessment of the various environmental impacts of Tropical Storm Arthur is currently being developed. The assessment in this section is more qualitative in nature and is not intended to give a quantitative assessment of the environmental-economic loss sustained, as a result of the impacts of Tropical Storm Arthur on Belize.

The aerial survey focused on the affected areas in the Stann Creek, Belize, Orange Walk and Corozal Districts, as well as the area between the coast and Ambergris Caye.

4.1 Environmental Impacts of Immediate Concern

The environmental impacts of immediate concern are those associated with the contamination of surface and ground water in the coastal and inland areas that have been subject to flooding. Chemical contamination of these water resources have been minimized due to rapid response in containing spilled chemicals, and by preemptive action taken by stakeholders, which ensured that chemicals in previously identified **High Risk Areas** were either secured or evacuated. The former is true for the Citrus Growers' Association which had two drums of Malathion which spilled on their compound.

Other chemical contamination of the surface waters would have resulted primarily from agricultural runoffs. However, it is believed that because of the tremendous volumes of water flowing through these areas, any chemical contained in the runoff may have been greatly diluted to levels that may be "undetectable" and which may pose little or no significant risk to public health.

Contamination with fecal coliform is the parameter of greatest immediate concern to the environment and public health. This bacterial contamination is primarily as a result of the overflow of pit latrines and the inundation of septic tanks in the affected areas. The recreational and other domestic use of these waters should be avoided as much as possible and where the use of these waters for domestic purposes is unavoidable, it must be properly boiled or treated with household chlorine.

Solid waste disposal in flooded areas will need to be given priority consideration. Carcasses of dead animals must be burnt or buried immediately. Portable toilets should be provided to these affected areas to ensure the proper disposal of human waste, in

particular for Clean-up and Emergency Response Crews, and for those left homeless or seeking refuge.

4.2 Coastal Erosion

Preliminary assessment indicates that the environmental impact associated with coastal erosion was not as severe as expected when one considers the intensity and duration of Tropical Storm Arthur. Reports however indicate that mainland coastal areas have experienced significant erosion. Mullins River, a coastal community, has had large areas of beach completely wiped away, and a small road running adjacent to the shoreline in front of homes also had some sections washed away as a result of flood water.

Significant erosion was also noted along the various rivers in the south as a result of flash flooding. Clearly evident in the aftermath of Tropical Storm Arthur were roads and river banks that had been scoured and eaten away by the tremendous volumes of flood water that passed through various rivers and streams.

4.3 Damage to Reef, Mangrove, and Sea-grass Bed Ecosystems

The waters within the Reef Lagoon were extremely turbid. Fortunately, this turbidity has not yet extended beyond the Belize Barrier Reef system. The turbid/murky waters were clearly evident in the inner lagoon west of Ambergris Caye. The effects of this tremendous amount of silt on sections of the Belize Barrier Reef will need to be assessed in order to determine its immediate, medium and long-term impacts. These sections of the Reef may suffer long-term irreversible damage from the smothering effect of this silt plume, since both soft and hard corals may have been severely damaged on the western fringe of the Reef along these areas. A more comprehensive report is being prepared.

Sea-grass beds within the Reef Lagoon in this area have also been impacted by the mechanical motion of the water due to Tropical Storm Arthur. Those beds that remain will continue to be affected by the smothering effects of the silt as it is deposited on the seafloor.

Generally, the island's mangrove stands were not affected; all were intact and appeared to suffer little or no damage.

4.4 Impacts to Wildlife

Perhaps the most visible impacts are those associated with the damage to vegetation in the impacted zone with these becoming more evident immediately along river banks and flood plains. Although areas adjacent to the Rio Hondo and New River were under varying depths of water, there was no obvious physical destruction of vegetation. It is expected that wildlife in these areas will be displaced temporarily until the flood waters recede. There were no signs of flash flooding, suggesting that the flood waters rose gradually affording wildlife time and opportunity to evacuate the area.

The southern rivers were markedly different and vegetation on river banks and in the path of the flash flooding was completely leveled. Local wildlife would have similarly been displaced. There were no obvious signs of dead wildlife.

4.5 Flood Impact

Most of the villages bordering the Rio Hondo, the New River, the Belize River, and their main tributaries, have been impacted by the flooding resulting from the rains of Tropical Storm Arthur.

Farmlands and pastures were also affected and displayed signs of minimal water logging, but with very few being completely submerged. Villages along the Belize River Valley also showed some signs flooding.

Pollution in the coastal areas resulted from increased sedimentation and agricultural run-off. This situation was exacerbated in areas along the rivers and streams where the vegetation had been cleared up to the edge of the water bodies and replaced with crops. The absence of this buffer prevented the filtration and absorption of some of these pollutants. Increased sediment loads were due to deposits of soil from denuded areas and cleared riverbanks. Another issue of concern was pollution of water resources from sewage due to inundated septic tanks and pit latrines in flooded areas.

4.6 Recommendations

1. Immediate concerns for the affected areas are those associated with water contamination and the need for appropriate disposal of human and solid waste (debris). Portable toilets must be provided to these communities to reduce the risk of further contamination of these waters with fecal coliform and other pathogens. Animal carcasses must be immediately burnt or properly buried.
2. Special attention should be given to reducing the risks of outbreaks of environmental diseases such as cholera, hepatitis and gastro-intestinal diseases. The Ministry of Health should increase its vector control programmes in the affected areas. Pools of stagnant water should be expected after the floods recede. Measures should be taken to ensure that the potential development of these as breeding grounds for vectors is minimized.
3. The Department of the Environment and the Public Health Bureau should continue to monitor the waters around these affected areas. Special emphasis must be placed on sources of drinking water and, in the case of the cayes, recreational waters used by tourists.
4. The Environment Committee should be commissioned to assess the economic consequences of Tropical Storm Arthur on these resources, and should consider the following:
 1. The value of the resources lost or damaged;
 2. Loss of income resulting from #1;

3. Cost of resource substitution;
4. Cost of resource recovery; and
5. Cost of protecting these resources from similar future events.

5.0 Infrastructure

Damage to infrastructure is estimated at some \$12.2 million.

Most of the damage to infrastructure was as a result of severe flooding in the Stann Creek, Cayo and Orange Walk Districts. Some wind damage was also reported in the Belize District. Highways, feeder roads, culverts and bridges also sustained significant damage.

- At least 3 culverts on the Hummingbird Highway suffered from wash outs. Replacement costs are estimated at \$150,000.
- Kendall Bridge on the Southern Highway was completely destroyed and will cost approximately \$10 million to replace.
- Mullins River Bridge on the Manatee Road was completely washed away. The cost of replacing this bridge is estimated at \$5 million.
- The Soldier Creek Bridge previously suspected to be severely damaged was found relatively unaffected after flood waters subsided.
- The approach to the San Lazaro Bridge was washed out, compromising the structural integrity of the bridge. It will cost approximately \$20,000.00 to remedy this situation.

In the Orange Walk District two bridges were damaged in the Mameyal and Trinidad Area, as well as two culverts in August Pine Ridge and Santa Martha.

In the Corozal District, the road linking San Narciso and San Victor was made impassable by a 12 ft washout.

In the Cayo District, the Iguana Creek Bridge and the temporary bypass bridge were flooded but no damage has been reported.

In the Belize District flooding was reported at the Hector Creek Bridge and along certain portions of the Burrell Boom Road and Northern Highway. No damage was reported at these sites.

Restoration works including restoration of road shoulders and clearing of waterways are estimated at roughly \$16 million. Table 6 provides details of these costs by district.

Table 6 Replacement/Restoration Costs

ACTIVITY	CZL	OWK	BZE	CYO	SCK	TOTAL
Highway Rehabilitation	\$ 10,000.00	\$ 10,000.00	\$ 70,000.00	\$ 10,000.00	\$ 300,000.00	\$ 400,000.00
Feeder Roads Restoration	\$ 240,115.00	\$ 360,233.00	\$ 180,000.00	\$ 40,000.00	\$ 750,000.00	\$ 1,570,348.00
Culvert Repairs/Replacement	\$ 40,000.00	\$ 60,000.00	\$ 81,260.00	\$ -	\$ 300,000.00	\$ 481,260.00
Bridge Repair/Replacement	\$ -	\$ 20,000.00	\$ 50,000.00	\$ 15,000.00	\$ 12,500,000.00	\$ 12,585,000.00
Village Street Restoration	\$ 30,000.00	\$ 50,000.00	\$ 50,000.00	\$ -	\$ 450,000.00	\$ 580,000.00
Waterway Cleaning	\$ -	\$ -	\$ 25,000.00	\$ -	\$ 150,000.00	\$ 175,000.00
Drainage Works	\$ 24,240.00	\$ 78,378.00	\$ -	\$ -	\$ 150,000.00	\$ 252,618.00
Debris Cleaning	\$ -	\$ -	\$ -	\$ -	\$ 200,000.00	\$ 200,000.00
TOTALS	\$ 344,355.00	\$ 578,611.00	\$ 456,260.00	\$ 65,000.00	\$ 14,800,000.00	\$ 16,244,226.00

Source: Ministry of Works

6.0 Utilities

Most communities supplied by rudimentary water systems experienced interruption in water supply.

Belize Water Services Limited (BWSL) has indicated that all of its pumping stations in the affected areas are functional. However, potable water supply was disrupted due to damage sustained by the distribution network (pipes and meters).

Leaks in the system at Sittee River were repaired and chlorine treatments were applied to the water supply. The entire pumping system at ITVET was damaged but was to be restored by June 5th, 2008. The sewer system at this institution is now functional.

As at June 5th, half of the Hope Creek water system was operational. However, some redirecting of the network is required because of damage to a small dam used as a water source for the system. BWS was expected to assist with this activity in order to fully restore the system by the following day.

No damage was reported to the Hopkins system.

7.0 Summary of Damages and Needs

7.1 Damages

The housing, infrastructure and agriculture sectors suffered the most damage. Losses in the housing sector included structural damage/destruction to homes due to flooding (*See Appendix 2*).

Table 7 provides an assessment of the damage for the various sectors. The total damage has been estimated at \$47.7 million. This figure is expected to increase when the citrus,

banana and tourism industries conclude their assessments. Total economic cost to the country will be in the order of \$67.4 million.

Table 7

SECTOR AFFECTED	DIRECT COST	ECONOMIC LOSS	REMARKS
Infrastructure	12,183,169.50	16,244,226.00	Assuming 25% depreciation
Housing	7,140,777.00	12,485,643.40	
Damaged buildings	404,527.00	754,643.40	
Destroyed buildings	636,250.00	1,031,000.00	
Damage to Household Items	6,100,000.00	10,700,000.00	1000 households
Vehicles & Machinery	580,000.00	580,000.00	Boats, cars, buses and tractors
Agriculture	11,338,346.00	20,335,209.00	
Banana	2,304,000.00	4,320,000.00	
Rice	1,700,000.00	3,388,840.00	1,374 acres - avg yield 4,000lb/0.3 per lb
Citrus:			
Crop lost	529,901.00	839,664.58	49,385 boxes @ \$10.73 per box
Field damage	2,048,352.00	3,245,754.64	Includes damage to nursery, groves, infrastructure and inputs
CGA Assets	2,730,000.00	4,325,872.78	Office and Laboratory Equipment, vehicles, furniture, library, etc.
Sugar Cane:			
Crop in Field	1,438,200.00	2,829,403.20	1,800 acres inundated @ \$47/ton
Crop in Storage	150,400.00	281,548.80	3200 tons burnt and awaiting harvesting @ \$47/ton
Other Crops	242,543.00	822,275.00	
Livestock and Pasture	131,950.00	218,850.00	
Processed Products	63,000.00	63,000.00	
Fisheries	7,848,000.00	7,848,000.00	
Production:	5,448,000.00	5,448,000.00	
Shrimp	20,000.00	20,000.00	
Conch	428,000.00	428,000.00	
Lobster	5,000,000.00	5,000,000.00	
Aquaculture Equipment	2,400,000.00	2,400,000.00	
Petroleum	4,154,400.00	4,154,400.00	
Education	3,450,349.75	4,305,776.40	
ITVET	1,612,000.00	1,612,000.00	
Other Schools	1,838,349.75	2,693,776.40	
Health	411,649.84	619,416.40	
Medical Equipment	311,649.84	519,416.40	Assumes 40% depreciation
Building	100,000.00	100,000.00	Estimated damage to clinics
Tourism	600,000.00	800,000.00	Estimates for San Pedro and Stann Creek (Information outstanding)
Environment			Info o/s
TOTAL	47,706,692.09	67,372,671.20	

NB: Economic loss includes direct costs.

7.2 Needs

Resources required to restore the affected areas have been estimated at \$47.8 million. This figure is expected to increase as additional data becomes available for the tourism, agriculture, and environmental sectors. Table 8 provides details.

Table 8

SECTOR AFFECTED	QUANTITY	ESTIMATED COSTS	REMARKS
Infrastructure		16,244,226	
Housing		12,485,643.40	Households
Replacement of Buildings	40	1,031,000.00	
Repairs to Buildings	360	754,643.40	
Damage to Household Items	1000	10,700,000.00	
Vehicles & Machinery		580,000.00	Boats, cars, buses and tractors
Health		1,571,856.00	
Emergency Medical Equipment		751,646.00	Required for relief operations
Furniture & Equipment (Replacement)		519,416.40	For restoration of Health Centers
Building Repairs		100,000.00	Estimated cost of repairs
Medicine & Supplies		200,793.60	
Agriculture		4,460,302.00	Figures likely to increase with additional information
Fertilizer		735,000.00	
Planting Material		400,000.00	
Agrochemicals		350,000.00	
CGA		2,975,302.00	
Fisheries		2,420,000.00	
Shrimp Production		20,000.00	
Aquaculture Equipment		2,400,000.00	
Petroleum		4,154,400.00	
Education		4,305,776.40	
ITVET		1,612,000.00	
Other Schools		2,693,776.40	
Tourism		800,000.00	To be updated
Social/Humanitarian Needs		735,000.00	
Blankets	5,000	50,000.00	
Pillows	5,000	25,000.00	
Personal Hygiene Kits	10,000	150,000.00	
Temporary Water Storage Tanks		30,000.00	
Portable Toilet for Affected Areas	28	30,000.00	\$75/day w/ \$3/ml and 1 toilet/20 persons
Food		450,000.00	500 person x 60 days
TOTAL		47,757,203.80	

NB: Economic loss includes direct cost.

8.0 Conclusion

Humanitarian assistance will be necessary to facilitate households' return to normalcy. Initial activities should include cleaning and the restoration of private dwellings.

Long term food and water supply also requires urgent attention since most of the affected communities depend on subsistence farming and itinerant trading for their livelihoods. The Ministry of Agriculture and Fisheries has an important role to play in terms of providing planting material, agrochemical inputs, and technical assistance.

Funding sources should be identified to assist families with the replacement of household items. This could take the form of grants and/or low interest loans which can be

channeled through local credit unions, producer organizations, and other non-governmental organizations.

Options for the resettlement of vulnerable communities must be considered by the authorities as well as residents of the affected areas. Socioeconomic issues complicate resettlement programs and provision must be made for alternative livelihood options. Programs must be based on participatory methodologies in order to ensure success.

This report is submitted to NEMO for its consideration and further action.

9.0 References and Information Sources

DANA Aerial Reconnaissance Team

Five Field Teams made up of personnel from DANA and United Nations Agencies

Lands and Surveys Department, Environmental Statistics for Belize 2004

Central Statistical Office, Central Statistical Office Abstract of Statistics Report 2004

Ministry of Agriculture and Fisheries

The National Emergency Management Organization

Ministry of Works

Ministry of Health

Ministry of Housing and Urban Development

Belize Tourism Board

Department of the Environment

Appendix 1: Damages and Replacement Costs–Education

Schedule of Damages

Item	Damages
ITVET	
Infrastructure	96,000.00
Furniture & Equipment	1,500,000.00
Books	6,000.00
Other	10,000.00
Sub-total	1,612,000.00
Other Institutions	
Infrastructure	1,009,602.00
Furniture	112,880.00
Equipment	630,368.66
Books	78,844.09
Other	6,655.00
Sub-Total	1,838,349.75
Grand Total	3,450,349.75

Schedule of Replacement Costs

Item/District	S/ Creek	Corozal	O/Walk	Total
Infrastructure	1,100,000.00	19,000.00	2,780.00	1,121,780.00
Furniture	225,760.00	-	-	225,760.00
Equipment	1,224,398.31	23,189.00	13,150.00	1,260,737.31
Books	62,258.30	10,060.00	6,525.79	78,844.09
Other	4,000.00	2,550.00	105.00	6,655.00
Sub-total	2,616,416.61	54,799.00	22,560.79	2,693,776.40
ITVET	1,612,000.00			1,612,000.00
TOTAL	4,228,416.61	54,799.00	22,560.79	4,305,776.40

Source: Ministry of Education

Appendix 2: Photographs of Affected Areas

Agricultural Sector- Sugar Cane



Agricultural Sector- Rice



Agricultural Sector- Banana



Agricultural Sector- Citrus



Infrastructure



Kendall Bridge Location

