



Dam Safety
Emergency Preparedness Plan

**Chalillo Hydroelectric Project
Macal River, Cayo District
Belize Central America**

Foreword

The Dam Safety Emergency Preparedness Plan (EPP) is a key component of Belize Electric Company Limited's (BECOL) Dam Safety Program. BECOL has developed this EPP in accordance with the requirements of the April 5, 2002, Environmental Compliance Plan (ECP) signed with the Department of the Environment (DOE) for the Chalillo Hydroelectric Project.

The EPP is designed to deal with any problem (even though highly unlikely) experienced with the Chalillo Dam structure. The plan is developed in conjunction with relevant authority bodies responsible for activities during natural disasters in the area in the interest of public safety.

With the completion of Chalillo, the impact of natural disasters from the Macal will be lessened and the response different than at present. Unfortunately there isn't a current plan in place to deal with such events. This will be incorporated into this plan. The dam design will incorporate features, which will measure rate of rise of water level as well as any vibration in the structure. As part of the ECP additional rain gauges will be installed in the catchment area and these gauges will be monitored to provide early warning of potential flooding. This information will be relayed to BECOL's Control Room and BEL's System Control Center operators as well as governmental authorities, permitting them to initiate emergency actions earlier than is possible today.

While the dam is designed not to fail, these measuring devices will help predict possible higher risk events allowing corrective measures to be implemented. A failure of the dam when full would result in less flow in the river than is possible today with the maximum possible flood (also called the probable maximum flood or PMF).

Much of the specific detail required for such a plan is site and construction specific and hence the plan should be developed as construction progresses. Mapping was prepared to show downstream impacts so that appropriate action can be planned.

This EPP is prepared in the interest of public safety. In the event of an emergency, an effective, well-tested EPP will increase public safety and reduce property damage.

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List of Abbreviations

EPP	Emergency Preparedness Plan
ECP	Environmental Compliance Plan
PMF	Probable Maximum Flood
SCC	BEL's System Control Center

1 General

1.1 Introduction

Belize Electric Company Limited (BECOL) is the owner and operator of the Mollejon Hydroelectric Facility, on the Macal River, Cayo District, Belize, Central America. The 25 megawatt Mollejon facility is a run-of the river plant, which has been in operation since 1995. This was the first phase of a possible three-stage development on the Macal River. On April 5, 2002, the Department of Environment approved construction of the Chalillo Hydroelectric Project, which is a storage facility for the Mollejon run-of-river Plant.

An integral part of any hydroelectric development is the preparation of an Emergency Preparedness Plan (EPP). The Chalillo Hydroelectric Facility's EPP is prepared to meet the requirement of the April 5, 2002 Environmental Compliance Plan established for this project. It should be noted that the Probable Maximum Flood (PMF) for the Macal River, provides a greater river flow than a dam break, under normal weather conditions, and a plan such as this is a desirable document without the Chalillo Hydroelectric Facility. The dam is designed to meet and exceed all standards for dam safety however the plan is developed in the interest of public safety should an unlikely emergency situation arise.

1.2 Purpose of the Plan

The purpose of the EPP is to:

- Provide a plan, which facilitates public safety by notifying all appropriate authorities;
- Provide information to all stakeholders to allow for an informed evaluation to be made during emergency events;
- Provide plans of action for foreseeable flood emergencies affecting safety of the Chalillo Hydroelectric Facility and affected property downstream;
- Provide for a plan of action to carry out repairs and reduce the impact of any such event where possible.

The plan is intended to assist BECOL, local community authorities, the District Emergency Management Organization (DEMO), the National Emergency Management Organization (NEMO) and other agencies in responding swiftly and effectively in the event of a dam safety emergency at the Chalillo Hydroelectric Facility.

1.3 Description of Facility

The Chalillo Hydroelectric Facility is located on the Macal River in the Cayo District, western Belize. The project site is 12 miles upstream from the Mollejon Hydroelectric Facility and 20 miles from Cristo Rey Village. Cristo Rey is the nearest community along the river to the project site.

The Chalillo Hydroelectric Facility is designed to generate 7.3 megawatts of additional power and to provide seasonal storage for Mollejon Hydroelectric Facility, effectively doubling the energy output of the combined development from 80 gigawatt hours (GWh) annually to 170 GWh annually.

The main components of the Chalillo Hydroelectric Facility are:

- A 161 feet high and 1378 feet wide dam on the Macal River, 7.5 miles downstream of its confluence with the Raspaculo River;
- A reservoir with a total surface area of 3.7 square miles; including the existing river of 0.6 square miles.
- 7.3-megawatt power house just downstream of the Chalillo dam;
- An 11.2 miles transmission line from the Chalillo power house to the Mollejon Hydroelectric Facility.

1.4 Responsibilities

The persons identified in this EPP with primary responsibility for emergency response are listed below.

- **Control Room Operator, BECOL** – The Control Room Operator, BECOL will be responsible for making immediate decisions regarding operations of the dam during an emergency, in co-ordination with the Superintendent, BECOL.
- **System Control Center, BEL** – The System Control Center (SCC) Operator, BEL must ensure that all key BEL persons to be notified are contacted as soon as possible. Decisions on emergency response are the responsibility of the key personnel noted in this document. The primary responsibility of the SCC is to manage the notification process. This involves co-coordinating all communications and recording activities of all involved personnel.
- **Superintendent, BECOL** – The Superintendent will be responsible to deploy resources as required to prevent or delay the incident. This involves coordination with engineers, consultants, and contractors. The Superintendent, BECOL will also coordinate with the Dispatch Engineer, BEL regarding immediate decisions for

operation of the dam. The Superintendent, BECOL will also decide if/when to recommend facility evacuation. In addition the Superintendent, BECOL, together with the Dispatch Engineer, BEL, will determine action with regards to the operation of the hydroelectric plant.

- **Dispatch Engineer, BEL** – The Dispatch Engineer will be responsible to take corrective actions to ensure integrity of the BEL grid system.
- **Vice President, Operations, BEL-** The Vice President, Operations, BEL will be responsible to ensure overall activities are coordinated. This includes liaison with BECOL, liaison with outside agencies (Meteorological Office, DEMO, and NEMO) and providing information to the Corporate Communications Manager, BEL. In certain dam incidents, the Vice President, Operations, BEL may deem it necessary to contact the President and Chief Executive Officer, BEL even though the notification chart may indicate otherwise.

1.5 Dam Surveillance

Following commissioning of the Chalillo Hydroelectric Facility, daily operations will be monitored by the Plant Operator, Chalillo, Control Room Operator, BECOL and the System Control Center, BEL. This will include remote monitoring of water levels on a real time basis as well as any vibration or movement of the structures. The site will be inspected by the BECOL technical staff once per week during the first year of operation. These visits will involve visual inspections of the dam, surveillance of gallery, spillway, penstock and other structures.

A formal inspection of the facility will be done every two weeks by the Superintendent, BECOL. Bi-annual inspections will be done by the BECOL staff along with civil engineering consultants and/or official of NEMO and the Ministry of Works commencing after year one. These processes and time frames will be reviewed after the first year.

1.6 Outside Agencies

A copy of the EPP is provided to all outside agencies involved in the emergency response procedures associated with this development. A list of Registered EPP Holders is provided in Appendix A.

- Each listed agency is asked to be involved in the review and modification of the plan and therefore minimize potential for incorrect interpretation;
- Each listed agency is asked to assist with the coordination of the duties of the agencies.

2 Emergency Identification

2.1 Potential Serious Situation

A Potential Serious Situation is defined as a hazardous condition at the dam, which, if not attended to, may develop into an emergency situation. Listed below are examples of conditions, which could potentially lead to dam failure if mitigative measures are not taken. Respective inspection checks are also listed.

- Excessive/increase amounts of seepage;
 - Check drains in the gallery for any abnormal increase in quantities of seepage.
- Movement on the dam crest;
 - Check for deflection on the dam crest.
- Spillway Obstruction
 - Check spillway to ensure no blockage due to debris.
- High inflows;
 - Check for water levels that are higher than normal reservoir levels.
 - Check weather forecast for expected amounts of precipitation.
 - Check for rapid rate of rise of water levels.
- Widespread flooding;
 - Perform an aerial site inspection.

Rapid reservoir drawdown could also be a sign of a potential problem. This condition should be detected through continuous water level monitoring at **Control Room, BECOL** and **SCC, BEL**.

2.2 Dam Failure

A **Dam Failure** is defined as the failure of the dam itself or its foundation, which results in large or rapidly increasing uncontrolled releases of water from the reservoir. It can be identified by the formation of a breach in the dam or foundation. It is impossible to determine how long it will take for a complete failure to occur once a significant breach has formed. Once a significant breach has occurred regular updates of the warning will be issued as long as the threat exists.

3 Emergency Response

3.1 Technical Information

Response to any emergency arising out of a Dam Incident or Dam Failure will be greatly improved by having information in the hands of responsible persons in order to properly determine risks and possible outcomes. This information will allow the Control Room Operator, BECOL and the Superintendent, BECOL to keep abreast of the prevailing hydrological condition and resulting rainfall/runoff patterns.

3.2 Access to the Site

Another important factor in responding to an emergency is access to the site. This access can be severely hampered during major storms. Such storms also cause floods creating a requirement to get to the site. This section provides information on gaining access to the site and the various methods available.

Vehicles

BECOL has the following equipment at their disposal to travel to the site

- Four wheel drive SUVs
- Van
- Loader

Vehicles required during an emergency will also be available from BEL. Access to vehicle after hours will be available from the Vice President, Operations, BEL.

Road Access

Access to the Chalillo Hydroelectric Facility is via the Douglas D'Silva Forest Station located in the Mountain Pine Ridge Forest Reserve.

Air Access

Generally the only type of aircraft, which could be used in an emergency or non-emergency situation, would be helicopter. Helicopter landing near the dam site is possible. The following is a list of helicopter services in the case of an emergency.

- BATSUB

3.3 Response During Darkness and Adverse Weather

Periods of Darkness

BECOL's emergency response teams are equipped to respond during periods of darkness. Vehicles are equipped with emergency lighting (i.e. spotlights). In addition to the standby diesel generator at the Chalillo power house BECOL has small 5 kW diesel generators available or BEL can be requested to provide additional lighting requirements if necessary.

Periods of Adverse Weather

The response plan is unchanged in principle in periods of adverse weather. BECOL emergency response teams are equipped to handle extreme working conditions resulting from adverse weather.

3.4 Power Sources

Powerhouse

The main power source of the Chalillo Plant is drawn from the 6.9kV bus of the generator. The power source is separated into two branches, and each branch connects to a 480V plant power panel via a 6900/480V auxiliary transformer. Should the station service become inoperable, power can be supplied by the 115 kV system directly with all generators shut down. A small diesel generator will also be available at the power house.

Impact on Communication Systems

- ❑ **Telephones** – The impact of the loss of power to the telephone system is expected to be minimal as a communications circuit on the 115 kV transmission line poles from Chalillo to Mollejon is used for communications.
- ❑ **VHF Radio** – Power at the repeater sites is backed up by small, self-contained generating units. Mobile radio units are generally powered by the vehicles in which they are located.
- ❑ **Data Transmission** – The impact of the loss of power is expected to be minimal as a communications circuit on the transmission line poles from Chalillo to Mollejon is used for data communications.
- ❑ **Cellular Phones** – Do not currently work at the site.

Effect of Dam Failure

A dam failure under extreme flood conditions may cause excessive flooding at the powerhouse. This may result in the loss of monitoring devices and/or communications to the Control Room, BECOL or SCC, BEL. When the Operator has reason to believe such has happened he will advise the Superintendent, BECOL and the System Control Center Operator so as to implement the appropriate measures.

Emergency Power Sources

The only emergency power source required will be to effect repairs for lighting, pumping, tools, etc. This power requirement can be met by BECOL's gas and/or diesel generators.

3.5 Incidental Procedures During Breach

It is important that information relating to any incident including a breach be recorded. Staff shall be assigned to obtain the following information provided they do not compromise their own personal safety;

- Reservoir and dam conditions prior to breach,
- Size and rate of development of the breach,
- Changes in the reservoir level during the breach,
- Spillway and penstock conditions,
- Status of generating unit

In order to assist in the collection of such data, photographic and video records will be made to assist in determining the cause and mode of development of the breach.

3.6 Mitigative Measures

The following describes remedial actions, which may be taken given various conditions.

(a) Cracks in the Dam

The following actions should be taken in the case of excessive cracking in the dam;

- Lower the water level by releasing it through the low level outlet,
- Continue lowering the water level until a safe elevation is reached.
- Continue operating at a reduced level until the repairs can be made.

(b) Failure of Appurtenant Structures such as Outlets or Spillways;

If gates or other appurtenant structures fail, the following actions should be taken;

- Implement temporary measures to protect the damaged structure, such as closing an outlet or providing temporary protection for a damaged spillway.
- Employ experienced professional divers if necessary to assess the problem.

(c) Movement of the Dam on its Foundation

Movement of the dam would be indicated by relative deflections between the surface monuments adjacent to the joints on the crest of the dam. A sliding failure should be dealt with through the following actions;

- Immediately lower the water level until the movement stops,

- ❑ Continue to lower the water until a safe level is reached,
- ❑ Continue operating at a reduced level until repairs can be made.

(d) Excessive Seepage

If excessive seepage is encountered;

- ❑ Lower the water to a safe level,
- ❑ Determine source of seepage,
- ❑ Continue frequent monitoring for signs of cracking or concentrated seepage,
- ❑ Continue operation at a reduced level until repairs can be made.

4 Notification

This EPP sets forth the chain of command to be followed (for notification purposes) in response to an emergency situation. The chain of command is shown schematically in the attached Notification Chart (Figure 4.1). Discussed below are the proper notification procedures to be followed in the case of;

- **Dam Incident,**
- **Dam Failure.**

4.1 Notification Procedures – Dam Incident

Any employee who learns or suspects for good reason that there is a possibility of a potential dam breach shall immediately report the situation to the Control Room Operator, BECOL and as a Dam Incident. Phone numbers are given in the Communications Directory (Appendix B). This employee shall provide the Control Room Operator with the following information.

- Name
- Location of the Dam Incident (structure, location on the structure, extent)
- Type of problem
- Risk of deterioration
- Reservoir and tail water elevations
- Prevailing weather conditions
- Other pertinent information

In addition to observed dam conditions that could potentially lead to failure (e.g. cracks, seepage, movement) field personnel should also alert the Control Room Operator, BECOL of any other condition, that may develop into an emergency situation (e.g. high inflows, spillway blockage).

The **Control Room Operator** and the **SCC Operator** shall keep a written record of any information provided by the observer on an Emergency Report Form as provided in Appendix C.

Upon a report of a **Dam Incident**, the **Control Room Operator** shall immediately contact the **Superintendent, BECOL** and the **System Control Center Operator, BEL** giving them as much detail as the observing employee could provide. The **Dispatch Engineer, BEL** shall immediately be contacted by the **SCC Operator** and provided with similar details. Depending on the severity of the **Dam Incident**, the **Vice President, Operations, BEL** shall be contacted at the discretion of the **Dispatch Engineer, BEL**.

When a **Dam Incident** is reported by someone other than a trained observer the **Control Room Operator** shall treat it with added caution. The same procedures shall be used and an attempt to verify the caller should be made. When reporting this incident to the

Superintendent, BECOL and the **SCC Operator, BEL** it should be made clear where the report originated.

It should be noted that in some cases the **Control Room Operator** could be the original observer of a **Dam Incident**. Such a situation could arise in the case of rapid reservoir drawdown as indicated by the water level recorder.

Further investigation of a **Dam Incident** will then determine if the incident is serious enough to upgrade the situation to a further level. At this stage the **Dam Incident** may be re-classified as a **Dam Failure**. In such a case, the procedures outlines in section 4.2 below should be followed.

In some cases, alternate contact persons are identified in the notification chart. Alternates have full authority to respond in the absence of the primary contact person.

4.2 Notification Procedures – Dam Failure

The notification process will follow the following four steps in the case of a reported dam failure.

Observe and Verify Breach
Initiate Notification Procedures Shown on Figure 4.1
Evacuation
Media Contacts

1. Observe and Verify Breach

A trained employee observing a **Dam Failure** shall immediately report the situation to the **Control Room Operator, BECOL**. The **Control Room Operator** shall then immediately contact the **Superintendent, BECOL** and the **SCC**. The **SCC Operator** shall immediately contact the **Dispatch Engineer, BEL**. If the **Superintendent, BECOL** and the **Dispatch Engineer, BEL** feel that the report is credible then the **Vice President, Operations, BEL** shall be contacted by the **Dispatch Engineer, BEL**.

When the **Control Room Operator** gets a call from an observer (whether employee or other) an Emergency Report Form (Appendix C) shall be used to record all relevant information.

When notification of **Dam Failure** comes from someone other than a trained employee the **Control Room Operator** shall treat it with added caution. The **Superintendent, BECOL** and the **Dispatch Engineer, BEL** will make a decision on the credibility immediately, if the observer is not an employee.

Verification of **Dam Failure** is primarily the responsibility of the **Superintendent, BECOL**, assuming quick access to the site is possible. A **Dam Failure** may otherwise be called without the benefit of visual verification based on other sources of information (e.g. water level indicators, heavy rainfall.)

2. Initiate Notification Procedures Shown on Figure 4.1

Immediate notification is to be made as shown on the Notification Chart (Figure 4.1). Notification is listed in the order of increasing priority, in an attempt to maximize time available for safe evacuation of threatened downstream populations and for remedial action to minimize flood effects.

It is the responsibility of all parties involved in this process to ensure that their personnel are readily available in such an event.

The **Superintendent, BECOL**, or other, may specify additional people or agencies that should be notified and initiate action which may reduce downstream hazards. Refer to Communications Directory in Appendix B for a complete list of phone numbers.

The **SCC Operator, BEL** must be fully informed of any change affecting reported condition of the emergency situation.

The **Control Room Operator, BECOL** shall complete and distribute a written report of the emergency situation (Emergency Report Form)

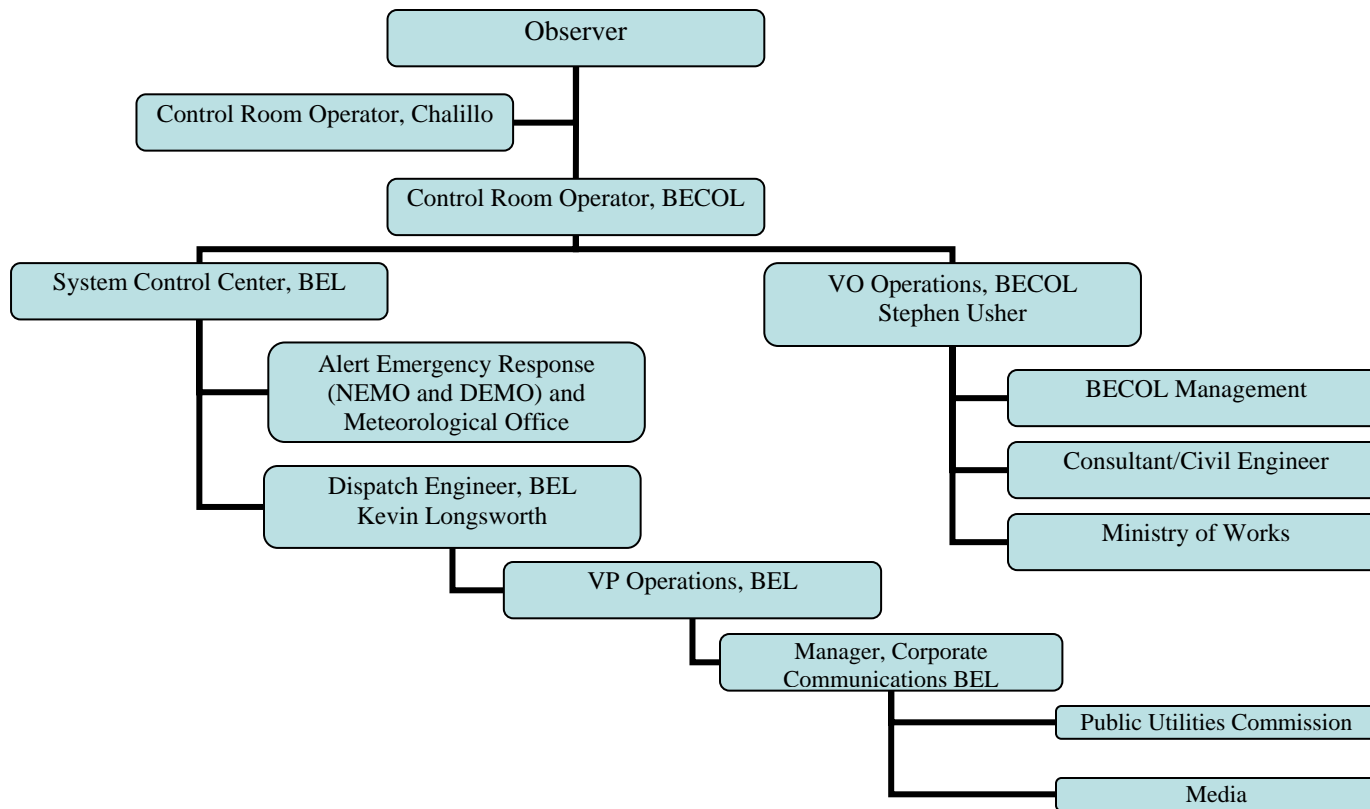
3. Evacuation

Evacuation of inhabited areas, which could be inundated, is the responsibility of NEMO and, DEMO. Inundation maps showing extreme water levels on the Macal, Mopan and Belize Rivers during a natural PMF, Dam Failure with PMF or a fair weather Dam Failure are provided with this EPP.

4. Media Contacts

Emergency announcements through the local media will generally be the responsibility of the **Manager, Corporate Communications, BEL**.

Notification Chart – Figure 4.1



5 Inundation

5.1 Mapping

The estimated extent of flooding resulting from the hypothetical breach of the Chalillo dam is shown on the inundation maps in Appendix E. On these maps, significant data such as the maximum water depth, maximum flow, and flood peak arrival time is provided for selected locations.

6 Maintenance and Testing

6.1 EPP Maintenance

The EPP will be reviewed and revised annually or more often if necessary during the initial years of operation of the Facility. Revisions will also be made as required to reflect personnel changes. Contact persons' names and telephone numbers will be updated at any time that changes take place. Information will also be kept up-to date with regard to the list of materials, equipment, labor and engineering expertise available in the case of an emergency.

Copies of the EPP are to be distributed by the Superintendent, BECOL to all staff and all external agencies that have responsibilities detailed in the plan. Amendments are also to be forwarded to all Registered EPP Holders listed in Appendix A.

6.2 EPP Testing

Testing is an integral part of the EPP and will be done on a regular basis. Tests may range from a limited tabletop exercise to a full-scale simulation of an emergency event and would include making contact with all persons responsible for initiating action but not initiating an actual evacuation of a town.

All external and local government agencies are to be invited to participate in testing of the EPP procedures. Participation may vary from clerical reporting functions to on-site involvement with simulated emergencies.

7 Communications

7.1 Communications Directory

A detailed Communications Directory is provided in Appendix B. It contains specific contacts, which may be necessary in handling an emergency. The Communications Directory complements rather than replaces the Notification Chart.

Contents are grouped as follows:

1. Belize Electric Company Limited
2. Belize Electricity Limited
3. NEMO
4. DEMO
5. Meteorological Office
6. Local Towns and Villages
7. Central Government
8. Helicopter Services
9. Public Utilities Commission
10. San Ignacio Police Department

Appendix A
Registered EPP Holders

Registered EPP Holders

Book Number	Registered EPP Holder	Book Number	Registered EPP Holder	
01-101	Stephen Usher Vice President Operations, BECOL	01-601	Cadet Henderson, Chief Engineer Ministry of Works	
01-102	Control Room, BECOL (issue to David Reynolds)	01-701	Ronald Frazer, Substation Officer Ignacio Fire Service	San
01-201	Kevin Longsworth Dispatch Engineer, BEL	01-801	Alfonso Cruz Jr., Mayor Ignacio Town Council	San
01-202	System Control Center, BEL (issue to Eduardo Castillo)	01-901	Said Badi Guerra, Mayor Benque Viejo Town Council	
01-203	Mateo Guerra, District Supervisor, BEL, Cayo	01-1001	Gilroy Nicholas, Senior Superintendent Ignacio Police Department	San
01-204	Joseph Sukhnandan V.P., Engineering and Energy Supply, BEL	01-1101	Rick Simpson, Resort Owner Owners Association	Resort
01-205	Felix Murrin V.P., Operations, BEL	01-1201	Commander General, Lloyd Gillett Belize Defence Force	
01-301	Ramon Frutos, Deputy Meteorology Officer National Meteorology Service Philip Goldson International Airport PO Box 717 Belize City, Belize	01-1301	Ismael Fabro, Chief Environmental Officer Department of the Environment	
01-401	Lt. Col. George B.K. Lovell National Emergency Management Organization			
01-501	Elsa Vasquez, District Coordinator District Emergency Management Organization			

Appendix C
Emergency Report Form

Emergency Report Form

1. REPORT

Name and position of person calling in:

Name _____ Position _____ Tel No. _____

Date _____ Time _____

Identification of Dam:

Name _____ Location _____ Reservoir _____

Description of the Problem:

Type of Event: _____ Breach _____ Potential Breach

 _____ Structural Damage _____ Other

 _____ High Water Levels

Size of Breach _____
Rate of Enlargement _____
Size of Uncontrolled Flow _____
Rate of Increase in Flow _____
Time of Start of Breach _____
Cause _____

Other observations:

Reservoir Water level _____
Water Level Rising/Falling _____
Is the Situation Worsening _____
Current Weather Condition _____
Weather Forecast _____

General Comments: _____

Operator Taking Call: Name _____

Signature _____

2. VERIFICATION

-Method of Verification

_____ Recognition of Caller
_____ Caller's Demonstrated Knowledge

_____ Corroborative Evidence from Current
Weather Conditions and Water Levels
_____ Obtaining the Observer's Name, Tel. No.,
Location.

3. NOTIFICATION

-Time of Notification of;

Superintendent, BECOL _____

System Control Center, BEL

Date: _____

Page: _____

Appendix D
Inundation Maps

Appendix E
Letters of Acknowledgement

Acknowledgement of Updated EPP

(This letter is to be sent to BECOL Superintendent of Operations by all Registered EPP Holders acknowledging receipt of EPP revisions/updates)

[Name of Registered EPP Holder]
[Address of Registered EPP Holder]

[Date]

Belize Electric Co. Ltd.
Arenal Road
Benque Viejo
Cayo District

Attn: Stephen Usher
Vice President, Operations

Re: Chalillo Hydroelectric Development
Dam Safety Emergency Preparedness Plan

Dear Sir:

I, _____, holder of Registered Copy Number _____ of the Dam Safety Emergency Preparedness Plan (EPP), acknowledge receipt of revision Number _____.

I agree to dispose of all obsolete pages and replace with the revisions provided by BECOL.

Regards,

[Signature]
[Name]
[Title]

Appendix F
EPP Revisions and Testing

Table F.1
List Of Revisions

Revision No.	Date	Details
2005-04	April, 2005	Initial issue

Table F.2
Acknowledgement of EPP Revisions

Book Number	Registered EPP Holder	Revision Number				
		2005- 04				
01-101	Stephen Usher					
01-102	Control Room, BECOL					
01-201	Kevin Longsworth					
01-202	SCC, BEL					
01-203	Mateo Guerra					
01-204	Joseph Sukhnandan					
01-205	Felix Murrin					
01-301	Ramon Frutos					
01-401	Lt. Col. George Lovell					
01-501	Elsa Vasquez					
01-601	Cadet Henderson					
01-701	Ronald Frazer					
01-801	Alfonso Cruz Jr.					
01-901	Said Badi Guerra					
01-1001	Gilroy Nicholas					
01-1101	Rick Simpson					
01-1201	General Lloyd Gillett					
01-1301	Ismael Fabro					

Table F.3
Schedule of EPP Testing

Test No.	Date	Details
1		Focus of the first test will be to assess the Company's initial response and to test the effectiveness of the notification procedures.