NATIONAL DRAINAGE AND IRRIGATION AUTHORITY

MINISTRY OF AGRICULTURE

THE REPUBLIC OF GUYANA

PREPARATORY SURVEY FOR THE REHABILITATION OF THE EAST DEMERARA WATER CONSERVANCY IN THE REPUBLIC OF GUYANA

SEPTEMBER 2011

JAPAN INTERNATIONAL COOPERATION AGENCY

KENSETSU GIJUTSU CENTER, LTD.

PREFACE

Japan International Cooperation Agency (JICA) confirmed to conduct the preparatory survey for the Project of the Rehabilitation of the East Demerara Water Conservancy in the Republic of Guyana and set up a survey team formed by Kensetsu Gijutsu Center, LTD. with Mr. Hidemasa Tanaka as the Project Manager, from October 2010 to September 2011.

The team held discussions with the officials concerned of the Government of the Republic of Guyana, and conducted a field survey at the project area, and through further studies made in Japan, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between the two countries.

I would like to express my sincere appreciation to the officials concerned of the Government of the Republic of Guyana for their close cooperation extended to the team.

September 2011

Shinya Ejima
Director General
Global Environment Department
Japan International Cooperation Agency

Summary

1. Outline of the Country

The Republic of Guyana (hereinafter referred to as "Guyana") is a country with population of 760,000 (as of 2008, the World Bank) and land area of 215,000km^2, and can be divided into four regions in geographical features; the fertile low coastal plain along the Atlantic coast, the inland hilly sand and clay region, the rain forest and the interior savannah regions. The coastal plain is a low-lying area at an average altitude of 2m below sea level and accounts for a mere 6% of the whole land area. However, some 90% of the population and 50% of the agricultural production concentrate in there.

According to the Köppen climate classification, the country's climate is classifiable into the tropical rain forest, tropical monsoon and tropical savannah. The annual average rainfall is fairly high: 2,300mm in the coastal plain region and 3,000mm in the rain forest region. The annual average temperature in Georgetown, the capital of the country, is 27.3 degrees Celsius with moderate temperature difference throughout a year.

The GDP of Guyana totals approximately 1.16 billion USD or 1,520 USD per capita (as of 2008, the World Bank). The primary industry accounts for 45% of GDP, the secondary industry for 35% and the tertiary for 20%. The main economic activity in the country is agriculture, which accounts for some 30 to 35% of the GDP and thus is the key industry. Production of rice and sugarcane in plantations has been developed since the colonial period. Major exports include gold and bauxite; sugar, rice and shrimp; and timber, whereas major imports are fuel and lubricant oil.

2. Background and Outline of the Project

In order to respond to the climate change, the Government of Guyana sets measures in its Climate Change Action Plan (2002), against possible impacts of an increase in rainfalls, a rise of average sea level and other phenomena arising from the climate change. The government is carrying out and shall carry out disaster prevention measures in accordance with the Plan and with assistance from the World Bank and the Inter-American Development Bank (IDB). At the same time, bodies such as the National Drainage and Irrigation Authority (NDIA) of the Ministry of Agriculture, the Civil Defense Commission, the River and Sea Defense Division, and the Guyana Lands & Surveys Commission have an intention to promote a Low Carbon Development

Strategy (June 2009). The Poverty Reduction Strategy Paper (2002) also states that provision of drainage and irrigation facilities are requisites to secure Guyana's economic growth.

The East Demerara Water Conservancy (hereinafter referred to as the "EDWC") located some 20km south of Georgetown, is a reservoir built in the 19th century, with an approximate embankment length of 65km. The EDWC comprises the embankment, water canals, relief sluices, intakes and other facilities, and is under jurisdiction of the NDIA. The catchment area of the EDWC and its reservoir area are approximately 580km^2 and 460km^2, respectively. The EDWC has the function as the core of multipurpose water resource management of the capital: it is capable of preventing floods by adjusting the amount of water from heavy rainfalls which could pour into the capital region, and also serves as water storage for the farmland irrigation of some 17,900ha in the lower area and as resource of drinking water for the capital (equivalent to some 40% of water resources for the water supplied population of some 360,000).

However, the EDWC does not have sufficient bearing capacity of water from rainfalls intensifying in recent years, apparently due to the climate change; floods frequently caused damage in 2005, 06 and 09. In the event of a flood in 2005, in particular, water overflew the embankment of the EDWC. It was then reported that the overflow, together with the flood from the Mahaica river which runs in administrative regions 4 and 5 of the country, and the insufficient bearing capacity of the relief sluices installed on the coastal sea wall, caused damage to the lowland areas. Following the occurrence of the flood damage in 2005, the United Nations Disaster Assessment and Coordination (UNDAC) conducted a survey and found that the embankment of the EDWC was in a poor state requiring urgent rehabilitation. Accordingly, the Government of Guyana identified the embankment of some 20km length of the eastern zone of the northern side and the northern zone of the eastern side as the most vulnerable parts and thus required rehabilitation urgently, and is currently proceeding with strengthening work to embank subsoil on the embankment. However, due to shortage of equipment on hand, the strengthening work saw a progress of a mere 30-odd percent at the moment.

In addition to the rehabilitation of the embankment itself, it is necessary to secure the safety and stability of intake and relief sluice facilities installed along the EDWC embankment in order to maintain high Conservancy water level, and also to enhance the safety of the retaining wall structure which supports the facilities.

In such circumstances, the Government of Guyana made a request in 2008 for Japan's grant aid assistance for rehabilitation of the East Demerara Water Conservancy. In response to the request, Japan International Cooperation Agency（hereinafter referred to as "JICA"）conducted in 2009 a preparatory survey for rehabilitation of the EDWC. Following the findings of the survey and recommendations, JICA also conducted a preparatory survey for rehabilitation of the EDWC from October 2010 to September 2011 with an eye to procure equipments for rehabilitation of the embankment and to rehabilitate the facilities ("the Project"）.

The Project shall contribute to the rehabilitation of the EDWC managed by the Government of Guyana, and is an appropriate measure for the climate change. It also aims to secure a stable water resource in the lowland around the capital region, and to reduce the damages caused by floods, through procurement of equipments needed for the rehabilitation of weak portions of the embankment as well as rehabilitation of facilities.

3. The Result of the Survey and Contents of the Project

This report summarizes the field survey conducted upon request of the Government of Guyana for the purpose of confirming the relevance of the request.

The Project comprises Component-1 "procurement of equipment" and Component-2 "rehabilitation of facilities".

3.1 Procurement of Equipment (Component-1)

Component-1 in the Project has been designed in accordance with the following policies in order to procure construction equipment necessary for the rehabilitation of the EDWC in consideration of the request of the Government of Guyana and the results of the field survey and the subsequent discussions.

(1) Design policy

1) Basic policy

Required equipments to be procured under the Component-1 shall be used for the purposes of,

- excavating humus soils which sediment at canal bottom for removal,
- procuring soil materials appropriate to strengthening embankment,
- leveling and compacting transferred soils on the embankment,
- forming of embankment slope,

- driving in wooden materials for retaining wall,
- and other works.

The rehabilitation work by the Government of Guyana is currently proceeded with super-long arm excavators and pontoons without major problems.

Since operators concerned are well familiar with super-long arm excavators and pontoons operations, similar construction method and types of equipments shall be adopted as a basic policy.

2) Design standards

Since super-long arm excavators belong to a general-purpose construction machine, ready-made machines shall be procured.

Where pontoons are concerned, there are no particular standards concerning the design and production in Guyana, and thus “the special standards for steel barges” of the Ministry of Land, Infrastructure, Transport and Tourism of Japan; “the Standard for design and construction of steel structures” of the Japanese Society of Steel Structure; “the Standard for designs of excavators and dredgers” of the Japan Work-vessel Association; and other Standards shall be applied.

3) Required quantity of equipments

With a goal to complete the rehabilitation of embankment of the most vulnerable portions of 20 km in length within two years, required quantity of equipments shall be calculated.

In calculation of required quantity of the excavator and the pontoon, it is a requisite that the machines (four super-long arm excavators and six pontoons currently in operation at the EDWC) will be successively in operation for the said vulnerable portions rehabilitation.

In performing rehabilitation of the embankment, working unit of three excavators and two pontoons shall be formed – that is, two sets of an excavator and a pontoon shall be put on canal side (one set is for excavation of materials and the other is to transfer the excavated materials to the embankment); and one excavator (forming the embankment) shall be placed on embanking work side.

The required quantity of equipments calculated on the basis of the assumption is eight super-long arm excavators and two pontoons as given in Table-1.

4) Procurement plan

Since super-long arm excavators belong to a general-purpose construction machine, and there are distributors and repair shops in Guyana, it shall be planned not to procure any

special spare parts for them.

Since pontoons need to have long-term durability, they shall be procured in Japan to secure the quality. Machines shall be dissembled into a number of blocks, transported to and assembled on the Project site.

5) Guidance for start-up operations

Operational manuals and routine inspection manuals shall be prepared for the super-long arm excavators, and routine inspection manuals and maintenance and repair manuals for the pontoons. Based on these manuals, guidance for start-up operations shall be provided by engineers from the manufacturers.

6) Soft Component

The consultant shall provide no Soft Component on the grounds that Guyana is well versed in the operations of equipment to be procured, and that the Project adopts the execution method which the country has adopted for the rehabilitation work for the embankment using the said equipments.

(2) Contents and scale of equipment (Table 1)

Table 1: Summary of Equipment

Category	Equipment	Intended use	Quantity
Excavator	Super-long arm excavator (bucket capacity of 0.4 m^3)	Earthwork for the embankment (excavation, leveling, compaction, forming, etc.)	8
Pontoon	Pontoon (loading capacity of 65-70tf)	Staging ground for the excavators to be operated in the reservoir, and provisional storage for earth-filling materials in the soil storage vessel	2

3.2 Rehabilitation of Facilities (Component-2)

(1) Design policy

Component-2 in the Project has been designed in accordance with the following policies in order to contribute to implementation of the plan of Guyana to restore the EDWC water resources and solve disaster-related problems due to the climate change; rehabilitate the

facilities (two relief sluices and four intakes) which are particularly essential; and provide the Soft Component including guidance for inspection, maintenance and management methods for smooth maintenance and management of the facilities. The policies have been determined in consideration of the request of Guyana and the results of the field survey and the subsequent discussions.

1) Basic policy

For the purpose of conforming to the rehabilitation plan of Guyana in progress to reflect on the 2005 flood, the target facilities have been specified. The relief sluices shall be rehabilitated with the aims of securing the water volume of the Conservancy and improving its flood control function, and the intakes shall be rehabilitated with the aims of securing stable supply of irrigation and potable water, improving the adjustment function, stabilizing the corresponding embankment and preventing leakage of water.

The rehabilitation work for the facilities shall include the facility entity, wooden retaining walls and the embankment. More specifically, measures to be put into practices shall include leakage control of the sluice doors, water shielding beneath the facility entity, leakage control and strengthening and stabilization by improving adjacent embankment soil, and stabilization and anti-erosion of the embankment by installing retaining walls.

2) Scale of rehabilitation

The scale of rehabilitation shall be determined in accordance with the height of the planned embankment based on the standard cross-sectional surface of the embankment set with the assistance from the World Bank, and the safe highest high-water level set forth in the Draft Water Level Management Manual for the East Demerara Water Conservancy (June 2005), on the assumption that the Conservancy shall be operated with the safe highest high-water level from the current 57.5 feet to 58.5 feet (standard point: at Lama relief sluice).

3) Design standards

Rehabilitation of the facilities shall be designed in accordance with design documents (standard drawings and particular specifications) of the NDIA. These documents clearly state that the design of retaining walls and wooden and concrete materials should be determined with reference to the British Standards (BS), and steel materials for doors and other facilities should be determined with reference to ASTM standards.

Since water and soil in the reservoir are acidic, acid-resisting wooden materials (Greenheart) shall be adopted for retaining walls as they have been used for the rehabilitation work for the EDWC. As for steel materials, corrosion-proof coating shall be applied.

4) Execution method

In accordance with the discussions with the related organizations in Guyana, the structures, materials and execution methods which enable local contractors to engage in the work and make it easy to maintain the facilities shall be adopted.

A execution schedule shall be formulated to secure safe execution work at the time of rainfalls: timber piling and sheet piling can be carried out in rainy seasons, while embanking, back filling and any other work whose quality might be affected during a rainy season shall be carried out in a dry season.

As for the execution method and the supervision method, the timber piling and sheet piling using cranes and backhoes, as in common construction practice in Guyana, as well as the work to remove aged timber piles of retaining wall, shall be carried out. The fabrication and installation procedures of the sluice doors rehabilitation using hard wooden materials shall be carried out in accordance with the usual methods.

5) Soft Component

Where Soft Component is concerned, for the purpose of improving the execution work, and the maintenance and management of the facilities and the embankment, guidance concerning quality control and execution supervision methods, and the inspection and maintenance management methods shall be provided to the officials and concerned personnel in charge of the maintenance and management in the implementing organization. At the same time, the relevant manuals shall be prepared.

(2) Contents and scale (Table-2)

Table 2: Contents of Rehabilitation of the Facilities

Facility Name	Contents of Rehabilitation
Relief Sluices	
Maduni Relief Sluice	Fabrication and installation of new wooden relief sluice door Rehabilitation of inlet and outlet retaining walls Rehabilitation of embankment Back-filling
Sarah Johanna Relief Sluice	Rehabilitation of inlet retaining walls Replacement of drain pipes
Intakes	
Ann's Grove Intake	Rehabilitation of inlet and outlet retaining walls Improvement of embankment fill
Hope Intake	Rehabilitation of guides to intake door Rehabilitation of inlet and outlet retaining walls Extension of intake concrete structure entity with foundation piles Improvement of embankment fill Cut-off wall to prevent piping
Annandale Intake	Partial rehabilitation of intake door Rehabilitation of inlet and outlet retaining walls Back-filling
Nancy Intake	Rehabilitation of inlet and outlet retaining walls Back-filling

3.3 Obligations of the Recipient Country

Procurement of equipment

The item to be carried out at the expense of Guyana, together with their contents and values, is shown in Table-3. The total amount accounts for 0.007% of the budget of the NDIA, the implementing organization of the Project, for 2010, that is, 2.4 billion Guyana dollars – it is highly likely that they can afford it.

Table 3: Obligations of the Recipient Country and the Expense (Unit: thousand GYD)

Item	Contents	Amount
Expenses of various procedures	Notification fee for authorization to pay (A/P), and banking commissions	160

Rehabilitation of the facilities

The items to be carried out at the expense of Guyana, together with their contents and values, are shown in Table-4. The total amount accounts for 0.043% of the budget of the NDIA, the implementing organization of the Project, – it is highly likely that they can afford it.

Table 4: Obligations of the Recipient Country and the Expenses (Unit: thousand GYD)

Item	Contents	Amount
Expenses of various procedures	Notification fee for authorization to pay (A/P), and banking commissions	911
Expenses of equipment for soft component	Simple cone-penetrometer, molds for unconfined compression test, curing tank, test sample push-off device, molding machine, and other test tools	124
Total		1,035

3.4 Implementation Structure

(1) Organizations

The NDIA, the implementing organization of Guyana, is a relatively new organization founded in 2004. However, since it is already undertaking projects under the assistance from the World Bank and other overseas donors, there seems to be no particular problem in putting the Project into practice.

The workforce of the NDIA is some 40 people, of whom seven officials are engineers, and six officials are technicians. The NDIA consists of four sections: the Operation and Maintenance, the Finance & Administration, the Construction & Design and the Community Drainage & Irrigation Project Sections. Of these, the Operation & Maintenance Section is in charge of the

operation, maintenance and management of the facilities after the rehabilitation work is completed. This section shall station 17 staff members at a workshop to streamline the operation, maintenance and management of the four reservoirs in the country including the EDWC. At the management office built on the premises of the EDWC, one staff member and 22 security staff members under outsourcing contracts shall be stationed on a regular basis to engage in the operational, maintenance and management activities for the facilities. Staff members at the workshop shall be sent to the reservoirs if an emergency arises.

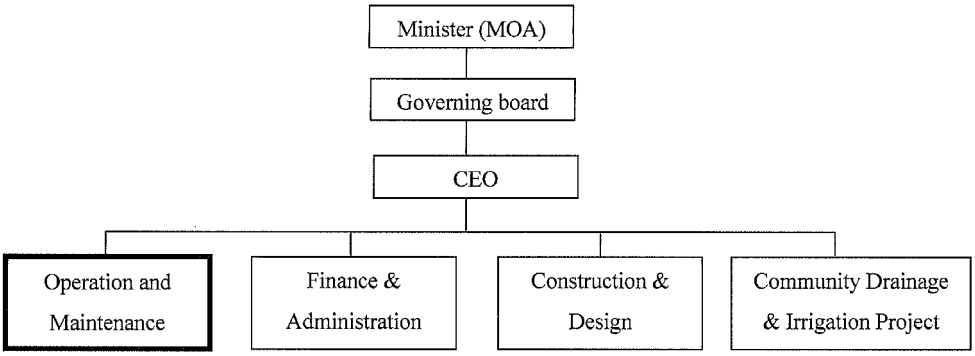

Figure 1: Organizational Chart of the NDIA

(2) Financial conditions

Table-5 shows the budget of the NDIA, the implementing organization of the Project, for 4 years between 2008 and 2011. An increase in the budget amount from 2009 to 10 is attributable to the budget earmarked for the work to construct discharge channel currently in progress with the assistance from the World Bank, and the budget for additional personnel for the management office and the workshop of the EDWC.

Table 5: Budget of the NDIA and Management Budget of EDWC (Unit: million GYD)

	2008	2009	2010	2011	Notes
Total budget of NDIA	1,972	1,957	2,400	2,400	Supplementary budget inclusive.
Budget for maintenance and management of EDWC management office	53	53	53	54	The budget implementation period starts in January and ends in December.

* The budget amount shown above includes the expenses of outsourcing (labor costs).

(3) Maintenance and management

The management office of the EDWC shall be in charge of the operation, maintenance and management of the facilities to be rehabilitated under the Project. The office has been committed to these assignments concerning the facilities and the embankment, so that there is no particular problem with its capability. It is unnecessary to secure any additional budget, either.

Even so, the technical assistance concerning the quality and supervising, and the inspection and maintenance management shall be provided through the Soft Component so as to strengthen its maintenance and management capability in a preventive manner, and improve the quality of the work.

4. Evaluation of the Project

Concerning the EDWC, the Project shall enable:

(i) to secure equipment necessary to complete the rehabilitation work of the most vulnerable part of the embankment of 20km length by 2014 and,

(ii) to complete the rehabilitation of the facilities in a poor state.

The quantitative and qualitative effects of the Project are shown in the following tables.

4.1 Quantitative Effects

Expected Effects	Quantitative Effects
Effect 1: Securing of equipment to rehabilitate the embankment	This will make the execution work twice as quickly as the rehabilitation work conducted with the equipment currently in possession of the NDIA. The overall schedule for rehabilitation work of the embankment will be shortened from four to two years.
Effect 2: Securing and maintaining a high limiting water level of the EDWC in the event of flooding	The project can raise the safe highest high-water level set forth in the Draft Water Level Management Manual for the East Demerara Water Conservancy (June 2005) from the current 57.5 feet to 58.5 feet, and improve the flood control function.

4.2 Qualitative Effects

Expected Effects	Qualitative Effects
Effect 1: Alleviation of possible flood damage	The rehabilitation of the embankment and the intakes and relief sluices will improve the stability performance of the structures, leading to alleviation of possible flood damage to the residential areas (approx. 350km^2 with approx. 300,000 people) in the downstream areas of the EDWC.
Effect 2: Stable supply of irrigation water	The rehabilitation of intakes for irrigation (Ann's Grove, Hope, Annandale and Nancy) will restore their capability to take in water, enabling to supply irrigation water stably to the farmlands (approx. 17,900ha) in the downstream areas of the EDWC even in a dry season.

Effect 3: Stable supply of drinking water	The rehabilitation of the intake for drinking water (Nancy) will restore its capability to take in water, enabling to supply drinking water stably to the areas near the capital (approx. 40% of the water supplied population of approx. 360,000).
Effect 4: Realization of management of discharging water in the Conservancy as a whole	The rehabilitation of the relief sluices (Maduni and Sarah Johanna) will improve their capability to discharge water, enabling to control discharging water of the Conservancy as a whole in accordance with the Draft Water Level Management Manual for the East Demerara Water Conservancy (June 2005).
Effect 5: Technology transfer	The implementation of the Soft Component will improve the abilities of the NDIA personnel and security staff members, enabling to streamline the rehabilitation work of embankment, the quality and supervision of the rehabilitation work of the facilities, and the inspection, maintenance and management of the embankment and the facilities.

4.3 Project Evaluation

It is considered that the Project is expected to produce a lot of effects as above-mentioned, contributing to the rehabilitation of the EDWC, Guyana is proceeding with, and also to the adaptation of the climate change, Guyana is faced with. Therefore, it is judged to be significant that the Project is implemented under the Japan's grant aid assistance.

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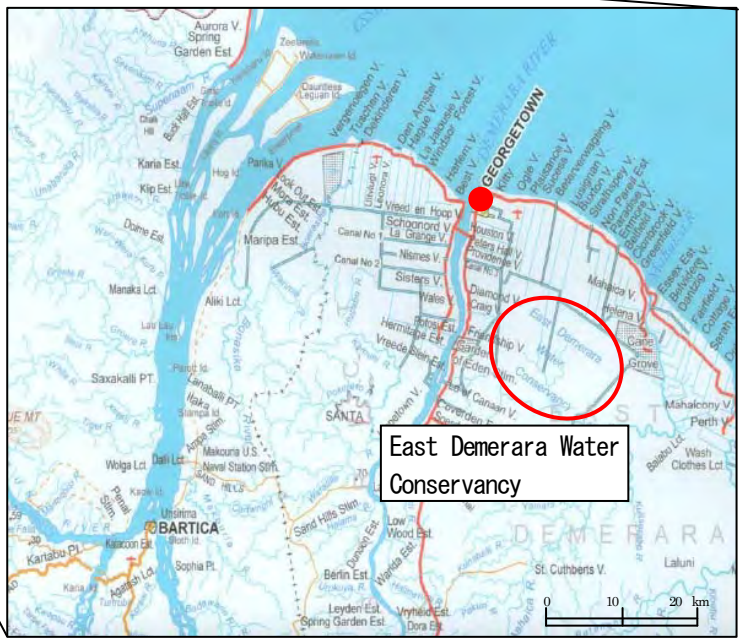
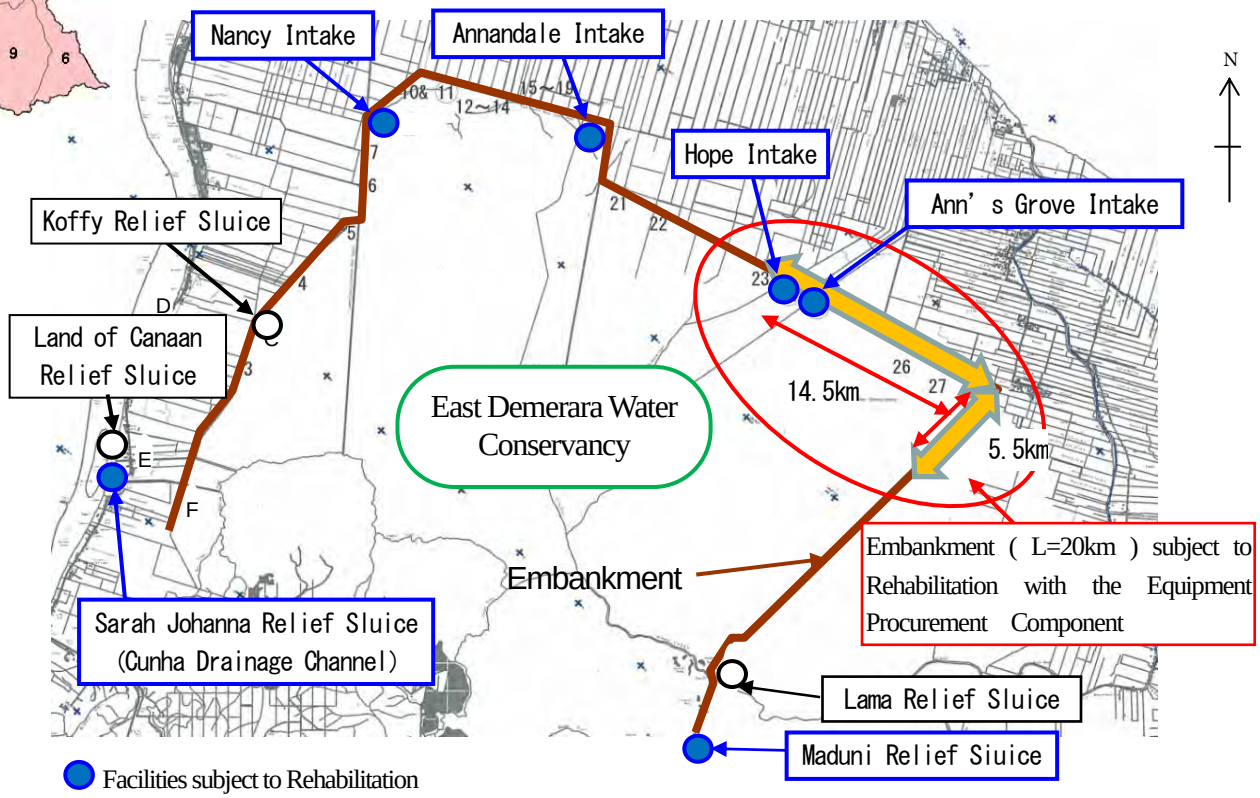
PROJECT LOCATION MAP

The Republic of GUYANA



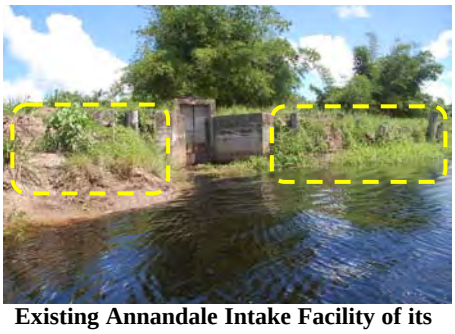
In and around Georgetown

Demerara-Mahaica Region



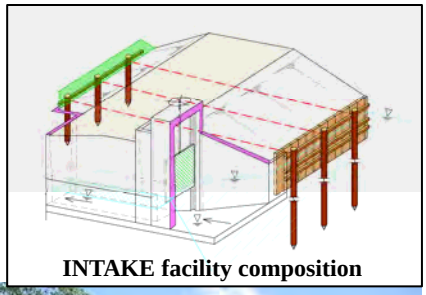
Location of East Demerara Water Conservancy

COMPLETION FIGURES EXPECTED

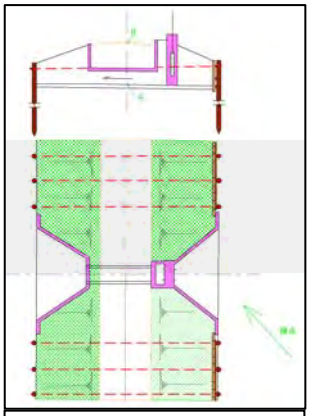


Existing Annandale Intake Facility of its Canal-side-view

Installed Timber Revetments



INTAKE facility composition



Typical INTAKE
Plan and Cross Section

【 REVETMENT REHABILITATION: Inlet-side of ANNANDALE INTAKE 】

Existing Maduni Relief Sluice

Notable Leakages

Gushing out of Water between Planks

【 MADUNI RELIEF SLUICE DOOR in NEW FABRICATION 】

(Note: Wooden fabrications with Greenheart in montage above are to be subject to Antiseptic Agent application)

the Project :
Rehabilitation of the East Demerara Water Conservancy, the Republic of Guyana

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Abbreviations

ASTM	American Society for Testing and Materials
BS	British Standard
CAP	Conservancy Adaptation Project
DEIA	Detailed Environmental Impact Assessment
EDWC	East Demerara Water Conservancy
EIA	Environmental Impact Assessment
EMD	Environmental Management Department
EPA	Environmental Protection Agency
GD	Georgetown Datum
GWI	Guyana Water Inc.
HYDROMET	Hydrometeorology Department
IDB	Inter-American Development Bank
JICA	Japan International Cooperation Agency
LCDS	Low Carbon Development Strategy
MOA	Ministry of Agriculture
MSL	Mean Sea Level
NDC	Neighborhood Democratic Council
NDIA	National Drainage and Irrigation Authority
NDS	National Development Strategy
NFMS	National Flood Management Strategy
RDC	Regional Democratic Council
SEEC	Strategic Emergency Engineering Committee
UNDAC	United Nations (UN) Disaster Assessment and Coordination
UNDP	United Nations Development Program

Chapter 1 Background of the Project

Chapter 1 Background of the Project

1.1 Background and Outline of the Grant Aid

The Government of Guyana (hereinafter referred to as "Guyana") is currently proceeding with rehabilitation work for the embankment of the East Demerara Water Conservancy (hereinafter referred to as the "EDWC"), which was damaged in 2005 flooding. Due to shortage of equipment on hand, the rehabilitation work is behind schedule. In addition to the rehabilitation of the embankment itself, it is necessary to secure safety and stability of relief sluice and intake facilities installed along the embankment in order to maintain high water level of the Conservancy, and also to enhance the safety of the retaining wall structures which support these facilities.

Guyana has proceeded with the rehabilitation work of the EDWC facilities with assistance of the World Bank and other organizations. But some facilities have been left untouched owing to shortage of finance.

In such circumstances, the Government of Guyana made in 2008 a request for Japan's grant aid assistance for the rehabilitation of the EDWC. In response to the request, Japan International Cooperation Agency (hereinafter referred to as "JICA") conducted in 2009 a preparatory survey for rehabilitation of the EDWC facilities, and confirmed the contents of the request as follows:

(i) Component 1: procurement of equipment

Equipments for rehabilitation of the EDWC embankment:

- Eight (8) super-long arm excavators
- Two (2) pontoons (with soil storage vessel)

(ii) Component 2: rehabilitation of facilities

Rehabilitation of relief sluices and intakes along the EDWC embankment:

- Four (4) intakes [Ann’s Grove, Hope, Annandale and Nancy]
- Two (2) relief sluices [Maduni and Cunha]

Upon close investigation through the current preparatory survey conducted in 2010～2011 for the contents of the request listed above, the followings were identified:

Guyana expressed its requests to rehabilitate the existing Cunha relief sluice which had been remained unused at the moment and also to reconstitute the Cunha discharge channel to more or less straight line in its horizontal alignment from current cranked state so as to improve the capacity of discharging water from the EDWC to the Demerara river. However, this plan would involve construction of a new bridge for the national road that crosses the supposed discharge channel, and thus is beyond the scope of a grant aid.

Upon discussion with the National Drainage and Irrigation Authority (hereinafter referred to as

the "NDIA"), we have seen an agreement to rehabilitate the existing Sarah Johanna relief sluice installed on the cranked discharge channel, instead of executing the rehabilitation of Cunha relief sluice as initially agreed.

1.2 Natural Conditions

(1) Land form and ground

The territory of the country can be roughly divided into four natural regions in geographical features: the fertile low coastal plain along the Atlantic coast, the inland white sand belt (hilly sand and clay ground composed of clay layers), the rain forestd and the interior savannah regions.

The coastal plain is a narrow area, accounting for 6% of the whole national land area. The ground is chiefly made of clay, and its elevation ranges between around the average sea level and 2m below the sea level. Some 90% of the 760,000 population of the country reside in this region, and the administrative organizations, agriculture and other industrial activities concentrate in there.

The ground elevation in the northern part of the EDWC is 48-53 feet GD (Georgetown Datum, MSL (mean sea level) = 51.05 feet GD). The ground of the surrounding areas comprises white clay layer of 1m or so in thickness of surface layer, overlying a layer of peat called "Pegasse" of some 5m in thickness, and a blue-gray clay layer at the bottom. Between the peat layer and the clay layer exists a transition zone of these two layers of some 2m in thickness. The lowest layer, the blue-gray clay layer turns into a light brown clay layer at location some 10km away south of the northern embankment, which has been confirmed by a boring survey conducted in this Survey. It is considered that the eastern embankment in the south of this point was built using clay of this light brown layer and it is judged to be solid embankment.

(2) Climate

According to the Köppen climate classification, the climate of Guyana is classifiable into a range of Af (tropical rainforest), Am (tropical monsoon) and Aw (tropical savannah). Annual rainfall averages 2,300mm in the coastal plain region, 1,600mm in the interior savannah and 3,000mm in the rain forest region. The temperature ranges between 34 - 16 degree Celsius, and is lower in the inner highland.

The climate in the low coastal plain is classifiable into tropical forest with moderate dry season. The temperature fluctuates little throughout a year; 26.0 degree Celsius in January - 27.6 degree in October. The daylight hours range between 6.0hrs/day (May) and 8.0hrs/day (September).

The mean maximum and minimum temperatures in Georgetown over the period 1998 to 2008 were 30.5 ℃ and 24.2 ℃, respectively. There have been no significant changes in the

maximum and minimum temperatures by year over the ten year period (reference; Urban Environmental Outlook 2009, GEO Georgetown).

(3) Hydrology and water quality

Though annual rainfall is expected to decrease in the future in Guyana, findings show the tendency of an increase in rainfalls of seven consecutive days, which in particular have considerable impact as a cause of flood of the EDWC (Figure 1.2.1).

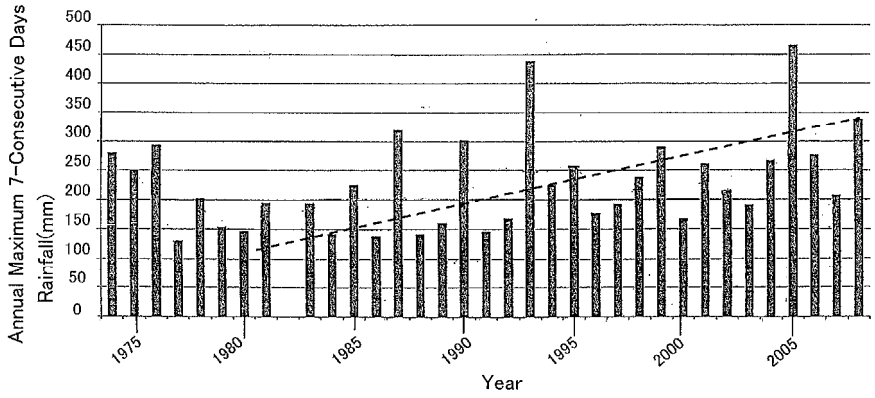


Figure 1.2.1 Annual Maximum 7-Consecutive Days Rainfall
（based on MOA HYDROMET data ：Cane Grove Observatory）

Trends in annual rainfall, the maximum monthly and daily rainfalls in each year, and rainfall for three consecutive days also indicate nearly same tendency, according to the data at Cane Grove Observatory near Flagstaff whose records were available for 34 years between 1974 and 2008.

The EDWC reservoir area and its storage capacity are approximately 335 km^2 and 340 million m^3,respectively, when the Conservancy water level is 57.5ft GD (17.53m), indicating an average reservoir depth of a mere 1m.

The EDWC is mainly a catchment of easterly Mahaica river basin. On the other hand, the Conservancy water is discharged from relief sluices located at its west to the Demerara river. The EDWC embankment on the east and west sides are considerably distant, around 20km, therefore has difference in the water level – higher on the east and lower on the west. If water face of both is leveled, the freeboard (embankment crown height – Conservancy water level) on the east embankment will increase. As a result, occurrence opportunity of overflow from the embankment can be decreased. For the west side relief sluice, on the other, the discharge capacity will improve due to rise of the Conservancy water level with respect to the Demerara river water level.

As the Conservancy water is generally remained in a stagnant state, and always contacts

with "Pegasse", blackish peat like acidic mixture of clay, transparency of acidic brownish water is quite low.

1.3 Environmental and Social Considerations

(1) Procedures for environmental impact assessment

The basic law concerning the environment in Guyana is the Environmental Protection Act, No.11 of 1996. Under the law the Environmental Protection Agency (EPA) was established and in 2000 the Environmental Protection Regulations 2000 was enacted.

The Environmental Impact Assessment Act of Guyana was enacted on June 5, 1996, and amended in 2001. The EPA is in charge of pollution control and approval of new development actions. The EPA also has the authority to monitor surrounding environment when necessary.

Matters concerning the Environmental Impact Assessment (EIA) are provided in the Part 4 of the Environmental Protection Act, and the Environmental Management Department (EMD) of the EPA is in charge.

The Project is positioned as follows in the framework of the act (Table1.3.1).

Table 1.3.1 Position of the Project in the Framework of the Environmental Impact Assessment Act

Item	Contents
Target items	Including disaster risk
Screening agency	Environmental Protection Agency (EPA)
Operator	National Drainage and Irrigation Authority (NDIA)
Other relevant party	Expert(s) who are appointed by EPA and examine submitted reports
Flow of procedures	1. NDIA presents information to EPA. 2. Expert examines the necessity of detailed environmental impact assessment (DEIA) within 12 business days. 3. In case DEIA is required, assessment expert prepares DEIA at the expense of NDIA. 4. NDIA's environmental conservation and environmental monitoring plan and opinions of residents and the local assembly are incorporated into DEIA. Then DEIA is submitted to EPA. 5. Expert examines relevance of DEIA. 6. Based on the expert's opinion, EPA makes a decision concerning the implementation of the Project.

Before the implementation of the Project, NDIA needs to create an application for the environmental authorization using EPA's form and submit it to the EPA together with such other items as land patent, written consent of Neighborhood Democratic Council (NDC) and other local relevant parties, design documents and application fee.

The EPA will examine the application, conduct field survey and screening before determining whether DEIA is required.

(2) Screening

The Project will hardly affect the environment because it is to provide equipment for rehabilitation work of the embankment and will involve only small-scale rehabilitation of the facilities. However, considering that part of the water in the EDWC is used as a source of drinking water, the Project should be classified as "Category B" (projects whose adverse potential impacts on the environment and society are less significant than those of Category A projects; impacts are generally site-specific and there are few, if any, irreversible impacts; and in most cases normal mitigation measures can be designed more readily), defined in JICA Guidelines for Environmental and Social Considerations (April 2004).

(3) Scoping

We conducted scoping using the environmental matrix as shown in Table 1.3.2 and selected the items that are expected to have impact on the environment. Considering the local conditions, we widely selected the items that may affect the environment on the assumption that impact assessment will be conducted concerning the items of B rating, and the presence and extent of impact will be checked and, if necessary, impact assessment will be conducted concerning the items of C rating.

As for the equipment procurement, as the clay at the bottom of the water canals in the EDWC will be used without being mixed with cement or other soil strengthening materials, rehabilitation of the EDWC embankment is not expected to cause water or soil pollution. Therefore, we conducted evaluation for the work of rehabilitation of the facilities. Rating was conducted with the three areas of social environment, natural environment and pollution as given in Table 1.3.2.

Table 1.3.2 Scoping Checklist

No.	Item	Rating	Reasons
[Social Environment]			
1	Involuntary resettlement	D	No impact concerning involuntary resettlement is expected as the temporary yard for the work will be located within the EDWC.
2	Local economy such as employment and livelihood, etc.	D	Although the employment situation will be partially improved, the impact will be limited due to the small size of the work. Therefore no impact on the local economy such as employment and livelihood is expected.
3	Land use and utilization of local resources	B	As the risk of flood damage will be reduced, land can be utilized more actively. Therefore, there will be some, though not significant, impact on land use and utilization of local resources.
4	Social institutions such as social infrastructure and local decision-making institutions	D	Although the risk of flood damage on social infrastructure will be reduced and there may be some impact on social institutions, little negative impact is expected.
5	Existing social infrastructures and services	B	Some, though not significant, impact on existing social infrastructures and services is expected as the traffic on arterial roads will increase due to the work of Sarah Johanna sluice.
6	The poor, indigenous and ethnic people	D	Although there is a village of indigenous people along the upper stream of Mahaica River, it is located outside the catchment area of the EDWC. Therefore, no impact on the poor, indigenous and ethnic people is expected.
7	Misdistribution of benefit and damage	D	No negative impact on misdistribution of benefit and damage is expected as the possibility of damage will be decreased for all the residents in the surrounding areas.
8	Cultural heritage	D	As there is no cultural heritage around the EDWC, no impact on cultural heritage is expected.
9	Local conflicts of interest	D	As the conflicts over flood damage compensation will be eased, no negative impact on local conflicts of interest is expected.

10	Water usage or water rights and communal rights	D	Although stable water utilization can be expected after facility rehabilitation, it will be conducted only in limited areas. Therefore, there may be some impact on water rights, but little negative impact is expected.
11	Sanitation	D	Infectious diseases will be decreased as the risk of flood damage decreases. Therefore, although there may be some impact on sanitation, little negative impact is expected.
12	Hazards (risk) Infectious diseases such as HIV/AIDS	B	As there is a possibility of creating new hazards during rehabilitation of appurtenant facilities, there will be some, though not significant, impact on hazards. Moreover, as there will be many workers in the work sites, there will be some, though not significant, impact on occurrence of infectious diseases.
[Natural Environment]			
13	Topography and geographical features	D	As the scale of the work will be small, no impact on topography and geographical features is expected.
14	Soil erosion	D	Ground work will be conducted only in limited areas. Therefore, there may be some impact on soil erosion but there will be little negative impact.
15	Groundwater	D	As there will be no type of work that affects groundwater, no impact on groundwater is expected.
16	Hydrological situation	D	As the scale of the work will be small, no impact on hydrological situation is expected.
17	Coastal zone	D	As the site is far from the coastal zone, no impact is expected.
18	Flora, fauna and biodiversity	D	As there is no designated species of flora or fauna that should be protected in and around the EDWC and the scope of work will be limited, no impact on flora, fauna and biodiversity is expected.
19	Meteorology	D	Although emission from equipment is expected, the scale of the work will be small. Therefore, no impact on meteorology is expected.
20	Landscape	D	As the scale of the work will be small, no impact on landscape is expected.

21	Global warming	D	Although emission from equipment is expected, the scale of the work will be small. Therefore, no impact on global warming is expected.
[Pollution]			
22	Air pollution	D	Although emission from equipment is expected, the scale of the work will be small. Therefore, no impact on air pollution is expected.
23	Water pollution	B	Although the scope of the work will be limited, there will be excavating work. Therefore, there will be some, though not significant, impact on water pollution.
24	Soil contamination	B	Although the scope of the work will be limited, there will be back-filling work with improved soil mixed with cement. Therefore, there will be some, though not significant, impact on soil contamination.
25	Waste	D	Although there will be some wastes, the scale of the work will be small. Therefore, no impact on wastes is expected.
26	Noise and vibration	D	Although equipment will generate noise and vibration, there are no houses around the work sites. Therefore, no impact on noise and vibration is expected.
27	Ground substance	D	Although there will be some excavation work, the scale will be small. Therefore, there is a possibility of causing some impact on ground substance but there will be little negative impact.
28	Offensive odor	D	As there will be no type of work that generates unpleasant odor, no impact on offensive odor is expected.
29	Bottom sediment	D	Although earth retaining work may have some impact on the sediment, there will be little negative impact.
30	Accidents	B	As the work site at Sarah Johanna sluice is by a major road of Guyana, there will be some, though not significant, impact on traffic.
Overall Rating		B	

Remarks: Rating

A: Serious impact is expected, B: Some impact is expected,

C: Extent of impact is unknown, D: No impact is expected.

(4) Major environmental and social impacts and measures to avoid/ease such impacts

Table 1.3.3 shows measures to avoid, or to ease if necessary, impacts concerning items of B rating.

Table 1.3.3 Measures to Avoid/Ease Environmental and Social Impacts of B rating

	Item	Measures to Avoid/Ease Impact
3	Land use and utilization of local resources	・ Exchange opinions with local residents before work. ・ Prepare detailed drawings early, hold negotiation and obtain agreement concerning the material storing site and temporary work sites.
5	Existing social infrastructures and services	・ Exchange opinions and have discussion with road administrators and local residents before work. ・ Have warning signs and lighting systems for nighttime during the work period. ・Monitor the state of the pavement surface on a regular basis. ・Take the following measures in case any change is found in pavement of a major arterial road during work. - Replacement of pavement - Improvement of roadbed - Repair of road drainage
12	Hazards (risk) Infectious diseases such as HIV/AIDS	・ Set the criteria for termination of the work in advance and keep contractors well informed, as concentrated torrential rainfall may occur. ・ Instruct contractors to carry out strict labor management.
23	Water pollution	・ Create a quality control plan in the design phase, monitor water quality during work, and monitor water quality for a certain period after work. ・Use phenolphthalein for water quality test. ・Take the following measures in case any adverse impact on water quality is found through monitoring. ・Use lime solution to improve pH. ・Use carbon dioxide gas to improve chromaticity and turbidity.

24	Soil contamination	・If improvement cement is used, develop a quality control plan and monitor soil moisture if necessary. ・Humus soil is not polluted by alkaline improved soil as it is acid. However, in case spill of such substance as highly-concentrated cement or cement slurry is found, put carbon dioxide gas into soil moisture.
30	Accidents	・Have drivers of work vehicles take safety training to prevent accidents. ・Install equipment to prevent accidents in temporary storage sites for materials and excavated soil and in excavation work sites. ・NDIA will exchange opinions with land owners and local residents.

(5) Monitoring plan

A monitoring plan shall be developed concerning especially important items of the measures to avoid/ease environmental and social impacts described above. It is given in Table 1.3.4.

Table 1.3.4 Monitoring Plan concerning Important Environmental and Social Impacts

No	Item	Monitoring Plan
5	Existing social infrastructures and services	・Monitor the pavement surface of major arterial roads during work. The monitoring items should be the followings. - Cracks on paved surfaces - Unevenness and level difference - Peeling of pavement - Damage of pavement
23	Water pollution	・Monitor the followings, especially during the work at Nancy intake point, where drinking water is taken. - pH - Chromaticity - Turbidity
24	Soil contamination	・In case improved cement is used, monitor pH of soil moisture at the work sites to watch cement spill.

1) Arterial road adjacent to Sarah Johanna relief sluice work site

(criteria in case of heavy traffic on the road)

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referenced International Standards	Remarks (Measurement Point, Frequency, Method, etc.)*1
Cracks	%	30	40	-	MCI (JAP) *2	Sketching and crack ratio calculation
Roughness (longitudinal)	mm	4.0	5.0	-	MCI (JAP)	Roughness measurement
Rutting (lateral)	mm	30	40	-	MCI (JAP)	Rut depth measurement
Overall mitigation measures evaluation	MCI	3～5	less than 3 (urgent need)	-	MCI (JAP)	Quantification of Index-value by using evaluation formula

*1 measuring at loading/unloading area on the road, at the completion of the whole works.

*2 MCI : Maintenance Control Index

2) Water pollution at the intake of Nancy for source of potable water

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referenced International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
pH	-	6.5	8.5	-	EPA (USA) *1	Sampling at the intake outlet, at 10:00 a.m., daily during work period
Chromati-city	Tcu*2	-	15	-	EPS (USA)	ditto
Turbidity	NTU*3		5.0	-	EPS (USA)	ditto

*1 EPA :(US Environmental Protection Agency)

*2 Tcu : (chromaticity)

*3 NTU : (Nephelometric Turbidity Unit)

3) Soil contamination（in cases of using cement）

Item	Unit	Measured Value（Mean）	Measured Value（Max.）	Country's Standards	Referenced International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
pH	-	-	-	-	-	Cement-mixed soil pH testing, One sampling/day, during work execution

(6) Total evaluation of the Project concerning environmental and social considerations

As the scale of the Project is small, the level of environmental and social impacts is expected to be low. With measures to avoid/ease impacts and the monitoring plan, it is estimated that few items will be affected. Thus, it is deemed that the Project can be implemented.

Discussion with the EPA during the Survey resulted in that the Project will not be needed DEIA.

1.4 Issues Related to the Climate Change

The Fourth Assessment Report (2007) of the Intergovernmental Panel on Climate Change (IPCC) states that climate change is occurring mostly as a result of human activities, and could cause serious damage. It cites, as specific events, an increase in frequencies of occurring extremely high and low temperatures, increase of intensity and frequency of concentrated rainfall and cyclone, expansion of drought, a rise in sea level as a result of expansion of sea water or shrinkage of Arctic and Antarctic ice sheets and other phenomena.

The influence of climate change expected to occur in Guyana and the commitment of the Project are explained as follows:

(1) Variation in rainfall patterns

Guyana's United Nations Framework Convention on Climate Change (UNFCCC) "Initial National Communications Report" (2002) and the Guyana National Vulnerability Assessment (2002) analyze a fall in the average rainfall and a rise in rainfall intensity since 1960 with actually observed values. These reports forecast that the temperature will rise by 1.2 degree Celsius and the rainfall will decrease by 10mm per month on average during the period between 2020 and 2040.

Another report forecasts that Guyana will experience a general drying trend, the average daily rainfall decreasing to 1mm/day by 2050, predicting that Guyana will be among the countries with the least precipitation rate. (See “Conservancy Adaptation Project”, an examination report of the World Bank (2007)). On the other hand, it is also reported on the basis of the trends in heavy rainfall and its frequency in the previous 50 years, that the frequency of heavy rains will increase in future.

As the total precipitation is in a decreasing trend, the capacity of the EDWC reservoir to retain water in dry seasons will be of importance. It is necessary to keep the water level as high as possible to reserve a large amount of water for stable supply of irrigation and drinking water. This inevitably requires to heighten the embankment and to make its structure steadier.

Where heavy rainfall and its frequency are concerned, if it rains heavily for successive days, water pours into the EDWC intensively for a short period of time. If inflow exceeds the drainage capacity of the EDWC, the water level will rise, causing overflow. This makes it more likely to collapse the embankment and lead to floods to agricultural lands and housing areas in the downstream of the EDWC. Therefore, rehabilitating aged relief sluices and maintaining their essential functions are quite important.

(2) A rise in the sea level on the coast

While sea levels are rising worldwide at a rate of 2-4 mm/year, the foregoing Guyana’s UNFCCC Initial National Communications Report (2002) and the Guyana National Vulnerability Assessment (2002) forecast more severe impact locally. The sea water level rise of Guyana from 1951 to 1979 was 10mm/year in an average, according to the sea water level records. If this level rise is applied up to 2005, the water level would have risen 55cm in 55 years. It is indicated that the seawater level in the Caribbean waters including Guyana rose 2 to 5 times faster than levels of the other worldwide seawaters.

An impact of a rise in sea levels on the coast of Guyana to the EDWC is explained as follows:

On the western side of the EDWC, water is discharged from the relief sluices via channels to the Demerara river. The water level on the river is linked to and more or less the same as the sea level off Guyana. The maximum safe operating level of the EDWC is 58.5ft, whereas the maximum water level of the Demerara river (the sea level) is 56.16ft (highest in 2010); the gap between them is narrow. This suggests that the discharge capability will lower at the time when the tide is at its highest, impeding the lowering of the water level of the EDWC during times of flooding.

In order to avoid inefficient discharge capability of the EDWC due to rise of sea level, it is important to maintain high water level of the EDWC and to enhance the functions of relief sluices.

Chapter 2 Contents of the Project

Chapter 2 Contents of the Project

2.1 Basic Concept of the Project

2.1.1 Overall Goal and Project Purpose

In Guyana, rehabilitation work for the facilities of the EDWC, which was damaged by the major flood in 2005, are undertaken based on the action plan proposed in the "Guyana Floods Geotechnical and hydraulic assessment of the East Demerara Water Conservancy Dam" reported by UNDAC in February 2005 (Table 2.1.1).

Table 2.1.1 Action Plan for EDWC Rehabilitation

Area	Short term before may 2005	Medium term Until 2006	Long term -2015
EDWC-dam	Simple repairs to prepare	Rehabilitation of the dam up to a functional state	Redesign of the water conservancy plan
Outlets of the conservancy dam	Open up the outlets that are currently out of order[3]	Rehabilitate all structures and channels that contribute to lowering the EDWC	
Drainage outlets in the sea defense	Construct temporary fixtures to facilitate drainage of dysfunctional outlets	Rehabilitation of all the outlets	Redesign of the drainage plan for the coastal zone, involving drainage channels, ducts, kokers, outlet etc.
Drainage in the coastal zone	Repair damage by the flood	Rehabilitate of the drainage system	
Others	Draw up a Disaster Management Plan (DMP). Carry out small scale simulation exercises.	Exercise these plans according to a training schedule. Increase the capacity of staff with education and training, both locally and abroad. Extent DMPs for other potential threats in Guyana (like sea defense breaches) as well.	

(Source: Guyana Floods UNDAC Geotechnical and hydraulic assessment of the EDWC dam) Joint UNEP/OCHA environment Unit, February 2005

Targeting for 2015, following works are included in the Plan; the rehabilitation of embankment, relief sluices and intakes of the EDWC, the rehabilitation of pumping stations and drainage outlets located at the east Demerara coast to facilitate discharge to the sea, and disaster management plan containing instructions tailored specifically for each person or function involved in the handling of disasters.

On the other hand, in many of the models where future climate change is forecasted, northern area of South America including Guyana is predicted for temperature rise and reduction of rainfall. Thus, the Government of Guyana considers that heightening and strengthening of the embankment of the EDWC, the significant water resource for the capital region, is an important

project for ensuring water to its maximum extent during the rainy season, and to stably supply it to the farmlands and to the capital region. However, if the embankment of the Conservancy with high water level collapses, a severe damage larger than the major flood of 2005 which struck 40% of the population may occur, therefore the safety of the structure of embankment must be strengthened. Additionally, in order to prevent overflow from the embankment due to the recurring torrential rain predicted in the future, rehabilitation of relief sluices is indispensable for adequate operations required in case of emergencies.

For the above reasons, the Project comprising Component-1 and Component-2, described in Chapter 1 and also in 2.1.2 below, shall contribute to the rehabilitation of the EDWC managed by the Government of Guyana, and is also an appropriate measure for the climate change. The Project aims to secure stable water resources for the area around the capital region, and to reduce the damages caused by floods, through procurement of the equipments needed for the rehabilitation work of the weak sections of the embankment as well as rehabilitation of the facilities.

2.1.2 Summary of the Project

In order to achieve the foregoing purposes in the Project, the equipment shall be procured and the facilities shall be improved. As a result, stable supply of irrigation water and city water, and reduction of flood damages are expected through the urgent rehabilitation work and continuous maintenance of the embankment, as well as the rehabilitation of the facilities and appropriate operation. Of these, the Project consisted of the items under the grant aid is shown below.

Component 1: Procurement of Equipment

- 8 - super-long arm excavators
- 2 - pontoons with soil storage tank

Component 2: Rehabilitation of Facilities

- Intake - 4 locations (Ann's Grove, Hope, Annandale and Nancy)
- Relief sluice - 2 locations (Maduni and Sarah Johanna)

2.1.2.1 Component-1 (Procurement of Equipment)

The output, project purpose and overall goal which can be expected through the implementation of Component 1 (procurement of equipment) is shown in Table 2.1.2 as PDM (Project Design Matrix).

Table 2.1.2 Project to be Cooperated under the Grant Aid (PDM)

Narrative Summary (Outline of the project)	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
<u>Overall Goal</u> Through the improvement of flood control capacity of the EDWC, water resource is secured in the capital area of Guyana, as well as reducing damages from flood.	1) Reduction of flood damages in the residential area (approx. 350km^2, 300,000 people) at the downstream of the EDWC. 2) Stable supply of irrigation water to the farmlands (approx. 17,900ha) at the downstream of the EDWC. 3) Stable supply of city water to the capital area (approx. 40% of water supplied population, 360,000) at the downstream of the EDWC.	Annual report, water supply meter reading, record of flood damage	
<u>Project Purpose</u> Improvement of the flood control capacity of the EDWC.	Progress of rehabilitation work of the weakest portion of the embankment (embankment crown is higher than 60.0ft and wider than 3.0m)	Annual report, equipment operation records, field survey	Budget and system necessary for the embankment rehabilitation work, and operation and maintenance of equipment and the facilities shall be formed.
<u>Output</u> Equipments necessary for the rehabilitation work of the EDWC shall be arranged.	Starting operation of execution equipments ・8 x super-long arm excavator ・2 x pontoon	Statement of delivery, certificate of guidance for initial and on-going operation (training), field survey	Rehabilitation work borne by the recipient shall be carried out as planned.
<u>Activity</u> 1) Procurement of equipment (super-long arm shovel type excavator and pontoon) 2) Operator, engineer, and technicians shall receive guidance for the initial and on-going operation.	<u>Input</u> Japanese side 【Procurement of new equipments】 Super-long arm excavator (8 units), pontoon (2 units) 【Manpower】 Engineer, engineering instructor 【Project cost】 Procurement cost for the equipments, design and supervision costs for the procured equipments	Guyana side 【Existing machinery/equipment】 Super-long arm excavator (4 units), pontoon (6 units) , spare parts 【Manpower】 Engineer, technician, driver, laborer 【Project cost】 Operation/maintenance cost, cost for application for permits, etc.	<u>Preconditions</u> Conclusion of E/N, G/A.

2.1.2.2 Component-2 (Rehabilitation of Facilities)

The output, project purpose and overall goal which can be expected through the implementation of Component 2 (rehabilitation of facilities) is shown in Table 2.1.3 as PDM.

Table 2.1.3 Project to be Cooperated under the Grant Aid (PDM)

<table>
<tr><th>Narrative Summary
(Outline of the Project)</th><th>Objectively Verifiable Indicators</th><th>Means of Verification</th><th>Important Assumptions</th></tr>
<tr><td><u>Overall Goal</u>
Through the improvement of flood control capacity of the EDWC, water resource is secured in the capital area of Guyana, as well as reducing damages from flood.</td><td>1) Reduction of flood damages in the residential area (approx. 350km^2, 300,000 people) at the downstream of the EDWC.
2) Stable supply of irrigation water to the farmlands (approx. 17,900ha) at the downstream of the EDWC.
3) Stable supply of city water to the capital area (approx. 40% of water supplied population, 360,000) at the downstream of the EDWC.</td><td>Annual report, water supply meter reading, record of flood damage</td><td></td></tr>
<tr><td><u>Project Purpose</u>
Improvement of the flood control capacity of the EDWC.</td><td>Limited Conservancy water level in flood season set at 58.5 ft.</td><td>Annual report,
Field survey on working ability of existing relief sluices and intakes, and surrounding facilities.</td><td>Budget and system necessary for the embankment rehabilitation work, and operation and maintenance of the facilities shall be formed.</td></tr>
<tr><td><u>Output</u>
Storage capacity, flood control function and irrigation management function of the facilities shall be improved.</td><td>Each rehabilitated facility fulfilling the intended functions.</td><td>Survey on leakage test records, intake facility operation records and inspection & management records</td><td>Rehabilitation work borne by the recipient shall be carried out as planned.</td></tr>
<tr><td rowspan="2"><u>Actions</u>
1) Rehabilitation of 4 intakes
2) Rehabilitation of 2 relief sluices
3) Technical assistance concerning quality and supervision of work methods and inspection and maintenance methods (Soft Components)</td><td colspan="2"><u>Input</u></td><td rowspan="2"></td></tr>
<tr><td>Japan
【Rehabilitation of facilities】
Rehabilitation of intakes and relief sluices

【Human resources】
Contractors, consultants, procurement management agent

【Project cost】
Facilities rehabilitation cost and supervision and Soft Component costs</td><td>Guyana
【Human resources】
Engineer, technician, ranger
【Project cost】
Operation/maintenance cost, cost for application for permits, banking commission, measurement instrument for Soft Component</td></tr>
<tr><td colspan="3"></td><td><u>Preconditions</u>
Conclusion of E/N, G/A.</td></tr>
</table>

2.2 Outline Design of the Requested Japanese Assistance (Component-1: Procurement of Equipment)

2.2.1 Policy on Procurement

2.2.1.1 Basic Policy

The equipment to be procured for the Project shall be selected focusing on the urgency and necessity for restoring the weakest sections of the embankment, promptly and adequately, which is the first priority rehabilitation project of the EDWC of Guyana.

The design of equipment of the Project shall be carried out based on the field survey and discussions with concerned agencies of Guyana, as shown in the following basic policies.

（1） Project period

The Project period for the embankment rehabilitation work shall be 2 (two) years. However, the field work shall be conducted in the 14 months during the dry seasons of Guyana.

（2） Sections to be rehabilitated in the Project

Target of the rehabilitation work shall be the weakest sections of the embankment, 20.0 km, which were damaged in the flood of 2005.

・Section between Flagstaff and Annandale intake	L=14.5km
・Section between Flagstaff and Lama relief sluice	L=5.5km
Total	20.0km

（3） Currently operated equipments at the EDWC

4 super-long arm excavators and 6 pontoons are currently used for the rehabilitation work of the EDWC. Quantity of required equipments to be procured in the Project shall be based on this pre-conditions.

2.2.1.2 Technical Matter for Selection of Equipment

（1） Coping with Nature Conditions

In order to correspond to the natural conditions, the following points shall be considered upon selection of the equipment.

・Since the surrounding environment of the EDWC consists mainly of humus soil and organic soil with soft ground of high moisture content, it is difficult to ensure the mobility of the excavators around the area. Therefore, swamp type crawler track shall be chosen. Additionally, as the excavators must be positioned distant to some extent from embankment rehabilitation portions, the excavator with super-long arm is required.

・Available time for rehabilitation work of the embankment would be restricted to around

7 months a year, avoiding rainy seasons of November to January and May to June.

In order to complete the rehabilitation work within two years, actual working period is 14 months during the dry season. Quantity of equipment required for completing the rehabilitation work within the period shall be determined.

・The Conservancy is of acidic water. Therefore, the degradation of the equipment is feared to occur faster than in commonly used. Thus, the equipments of excellently maintainable shall be chosen.

（2） Ensuring of Pontoon Stability

Super-long arm excavator loaded on pontoon is for removing organic soil of canal bed, excavating soil materials for embankment and banking them on the existing embankment. Securing safety in the work procedures above shall be studied taking maximum load the pontoon burdens (soil weight in the vessel) and the position of the excavator, etc. on the pontoon into considerations.

The stability analysis was performed using the stability calculation program employed in the similar cases in Japan, and it was confirmed that the safety of the pontoon is secured under the severe conditions of maximum wind velocity of 60m/sec. and wave height of 1.5m (see Appendix 6-1). Though heavy attack of cyclone will not be expected in Guyana, the equipments in the Conservancy shall be evacuated on land in advance under such an extra-ordinary weather condition.

2.2.1.3 Procurement, Transport and Maintenance of Equipment

（1） Policies on supplier

1） Super-long arm excavator

The followings are the policies on procurement of super-long arm excavators.

・Equipment must be familiarized in Guyana.

・Agencies and workshops must be present in Guyana.

・Spare parts must be delivered promptly and maintenance system is established.

Additionally, it is considered that overhaul works and major repair of hydraulic system or engines are available promptly through local agencies in Guyana where maintenance system is well furnished.

Furthermore, as some of the local agencies are affiliated with Japanese manufacturers, the equipments can be supplied from Japanese manufactures. Since the long-arm and bearings are Japanese made, the equipment procurement shall be from Japan, where all parts are available and the product can be completely inspected before exporting.

2） Pontoon

The pontoon used in the Project is required to be particularly durable for the purposes of serving long period of operation and maintenance of the EDWC under severe conditions.

Therefore, Japanese made pontoon shall be selected for its organized system of design and manufacturing for ensuring the quality.

a) Present condition of pontoons in Guyana

・The pontoons used in the EDWC at present are manufactured based on the specifications of NDIA. Some matters as welding technology, inspection system and durability of the product, etc., are found in them. The warranty period is six months.

b) Maintenance and management system

・Although there are no local offices of Japanese manufacturers in Guyana, no problems are considered to use Japanese-made equipments since complicated parts are not employed in their fabrication.

・The engineers of the manufacturer shall instruct assembling method of the delivered pontoon. In addition, they shall provide trainings to the NDIA staff for maintenance and repair, etc. of the equipment.

・Function of each structural member, procedure for repair, welding technique, painting technique and painting repair technique, etc. are to be included in the trainings required for maintenance of the pontoon,

(2) Policies regarding transportation and customs

1) Transportation

a) Super-long arm excavator

Transport of excavator on truck from each agency or maintenance factory in Georgetown to the office of Land of Canaan, premise of NDIA , is available.

b) Pontoon

Inspection shall be conducted prior to shipping at the port in Japan. The transportation route is; Japan → Guyana (sea freight, to port of Georgetown) → office of Land of Canaan (land transport).

The disassembled block sizes of the pontoon are decided taking 40ft container transportation into account.

2) Policies on customs

The Government of Guyana shall take measure on tax exemption for Japanese companies involved in the procurement of equipments. Specifically, for giving the tax exemption for the imported equipments of the project, NDIA shall submit a document of request for tax exemption to the Government of Guyana along with the contract of the grant aid assistance and the shipping documents.

The tax exemption procedure is; Supplier → NDIA → Ministry of Agriculture → Ministry of Finance.

(3) Spare parts

(a) Super-long arm excavator

Provision of spare parts is not required, since parts procurement, inspection, and maintenance system is organized in Guyana, and the parts are available and can be ordered/supplied through the agencies, and in addition, repair and maintenance can be carried out by the agencies or repair shops promptly.

(b) Pontoon

Provision of spare parts of the pontoon is not required, since there are no special parts used, and manufacturing or materials can be ordered easily in Guyana, regardless of its origin country.

(4) Training program

The equipments procured in the Project shall be located at the management office of the EDWC.

The inspection and repair of the procured equipments shall be carried out at the workshop at Lusignan and the management offices of the EDWC, under the supervision of NDIA.

In order to facilitate effective operation, maintenance and management of the procured equipments, instruction manuals for detailed contents and procedure for operation, daily inspection, periodical inspection and repair shall be prepared.

(a) Super-long arm excavator

The same type of super-long arm excavator as those used in Guyana shall be selected. Since the operators (drivers) have basic skills required for the operation, daily/periodical maintenance manual and the operation manual shall be prepared upon delivery of the equipments.

(b) Pontoon

Periodical inspection manual and repair manual shall be prepared upon delivery of the equipment. An operation and maintenance plan related to the inspection and maintenance, etc. of equipments shall be established for efficient guidance of the works.

2.2.2 Planning of Equipments

2.2.2.1 Specification of Super-long Arm Excavator

The specification of the super-long arm excavator shall be based on the existing equipments, following the facts confirmed at work sites as follows.

a) Rehabilitation work of the embankment is carried out smoothly with the existing equipments,

b) No claims on inconvenience in excavating and embankingent works is claimed by the operators (drivers) , and,

c) Operators have full knowledge in the operation of the existing equipments.

Furthermore, the long arm part and the bearing of the rotating shafts shall be of those of Japanese made.

The excavators shall possess superior stability and mobility with wide range of operation accompanying excavating and transferring the excavated material at its maximum extended arm reach on and around unsound ground conditions.

The specification is as follows.

- Working range: Max. cutting height – 13.0m or more, Max. digging depth – 11.0m or more.
  Max. reach – 15.0m or more, Max. dumping height – 11.0m or more.
- Weight 22t ~ 25t
- Bucket capacity: 0.4 - 0.5m^3
- Undercarriage: Track shoe width – 0.8m or more

The working range in conformity with the specification of the excavator is schematically given in Figure 2.2.1.

- depth from water level to bottom of Pegasse layer : 8.0m
- excavation of clay layer thickness for embankment strengthening material : 3.0m
- pontoon height (1.6m) － draught (0.6m) : 1.0m
- height of arm-pin position above pontoon deck : 1.2m

  depth range (approx.) : 13.0m

As the warranty period of the equipment is subject to the parts used, it shall be described in the instruction manual of the equipment.

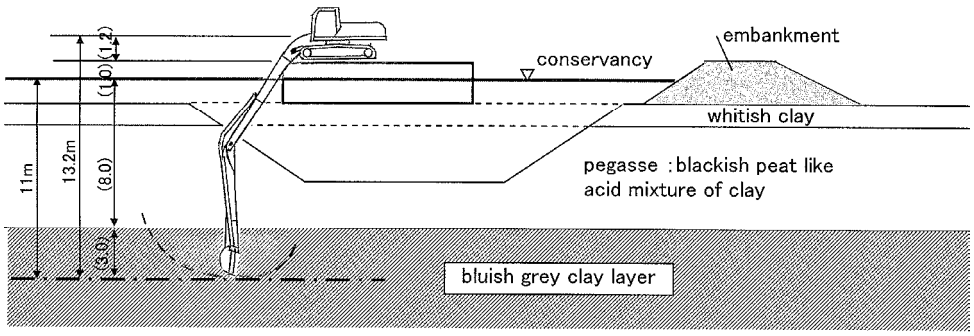


Figure 2.2.1 Excavation of Canal Clay Layer

2.2.2.2 Specifications of Pontoon

(1) Principle of pontoon design

- Pontoon to be procured shall be of joint structured by blocks (floats) similar to the pontoon in operation at present.
- Durability shall be considered upon designing the pontoon, having plate thickness with allowance for corrosion.
- Submission of the inspection certificate for the steel material shall be obligatory.
- Design standard shall be compatible with the Design Standard for Steel Structures of Japanese Society of Steel Construction, and Special Standard for Steel Pontoon of Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and Design Standard for Dredger of Japan Work-vessel Association (JWA), etc.

(2) Specification of pontoon

The pontoon is to support the working excavator in the Conservancy, as well as to store excavated soil. Therefore, excellent stability is required when the soil is loaded and also upon working.

The specification of the pontoon shall be based on the pontoon under operation at present at the EDWC as given below. Since the work environment (acidic water and high temperature, high humidity, etc.) is different from that described in the Table for Depreciation of Construction Machinery of Japan Construction Equipment Association, the durability shall be stated in the repairing manual.

- Hull structure: Single deck pontoon
- Dimension: length - 17.0m or more, Width – 8.0m or more, height – 1.35 -1.5m
- Dimension of block: length – 8.0m or less, width – 2.3m or less, height – 1.35 - 1.5m
  (due to the sea freight assumed for container cargo for economical reason)
- Load: 65tf or more (excavator – 22 ~ 25tf, soil load – 40tf or more)
- Standard of main steel material: SS400 or higher grade
- Coating: rust-removing (category 2), double anti-corrosion coating
  Double surface coating (vinyl chloride coating)

2.2.2.3 Required Quantity of Equipments

The equipment to be employed for the rehabilitation work of the EDWC embankment shall take following aspects into account upon determining the specifications and quantities.

- geological feature and meteorological environment of the site
- sectional figure of the embankment
- required length of embankment rehabilitation work and present condition of the facilities
- required quantity of rehabilitation work

・ maintenance and management system of the EDWC
・ work system of the urgent rehabilitation of the embankment

After determining the above, construction performance, features of the equipment as well as bucket volume, maximum load and features of pontoon shall be considered.

（1） Work ability and required quantity of super-long arm excavator

1） Prerequisites

The calculation of quantity of equipments to be procured is based on the capacity of the super-long arm excavator. However, since the rehabilitation work for the embankment of the EDWC applies stage embanking method, a certain period of “waiting time” is required for the embankment material to harden, and for the entire behavior to stabilize including the consolidation settlement of embankment. As a result, the work capacity cannot be simply calculated based on the bucket capacity, soil condition, and work condition, etc.

Hence, the number of super-long arm excavators shall be determined based on the work efficiency of embankment rehabilitation executed so far, and on the assumption that the equipment shall be used for the rehabilitation work of the weakest 20km. long around Flagstaff.

It is necessary to consider the following quantity of equipments owned by NDIA that are allocated at the EDWC for the maintenance as a precondition, when calculating the number of equipments required.

・4 x Super-long arm excavator
・6 x Pontoon (with mud bin)

2) Calculation of required quantity of excavator (super-long arm excavator)

Conditions for calculation:

・Distance rehabilitated and distance not-rehabilitated

Distance rehabilitated out of total 20km. of embankment subject to the repair work as of end 2010;

・Flagstaff～Annandale intake rehabilitated: 30% of 14.5km. subject to the rehabilitation work
・Flagstaff～Lama relief sluice 30% of 5.5km

Total 20.0 km

Therefore, distance already rehabilitated (Lc)

Lc = 20.0 km×30% = 6.0 km

Distance not-rehabilitated (Ln)

Followings are the embankment lengths for rehabilitation work included in the component-2 (rehabilitation of facilities),

・at around Ann's Grove intake facility : 60m

・at around Hope intake facility : 40m

Total 100m (0.1km)

Then, Ln = 20.0 －Lc －0.1 ＝13.9 km

・Composition of equipments

1 set of excavator in the canal includes;

1 unit for removing humus soil layer + 1 unit for excavation of the embankment material → 2 units (therefore, 2 units for pontoon also)

・Total number of sets and period engaged in rehabilitation work (T) (Figure 2.2.2)

・2008: 1 set x 1 month (October): rehabilitating performance = 1

・2009: 2 sets x 7 months: 〃 = 14

・2010: 2 sets x 7 months: 〃 = 14

(total) T=29 sets/month

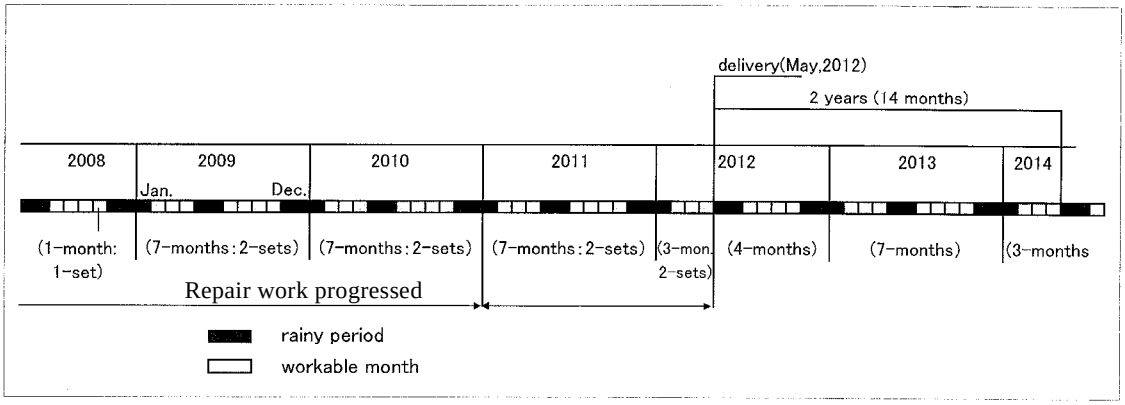


Figure 2.2.2 Embankment Rehabilitation Schedule

・Actual rehabilitation work capacity (C)

C ＝ Lc / T ＝ 6.0 / 29 ≒ 0.20 km / Set/month

・Estimated length to be rehabilitated by May 2012 (Lf) in 10 months:

Lf = C × 2 sets × 10 months = 4.0 km

・Then, remained length for rehabilitation work at the time of May 2012 (Lr)

Lr ＝ Ln － Lf ＝13.9 － 4.0＝9.9 km

・Sets of equipment required for the rehabilitation work for 2 years after the delivery (actual operation for 14 months) (S)

S ＝ Lr / (0.20×14 months) ＝9.9 / 2.8 ＝ 3.6 → 4 sets

・Number of units of equipment to be procured:

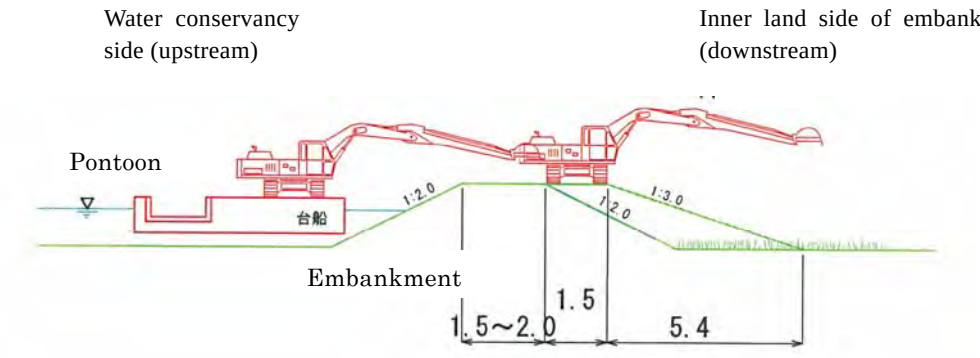
There are 4 units (2 sets) of super-long arm excavators operated by NDIA, therefore the super-long arm excavators to be procured (for operating in the canal) shall be 4-2 = 2 sets (4 units).

3) Required quantity of excavator for downstream side embankment

Most of the rehabilitation work to be executed in the future will be filling work of the embankment on the downstream side (inner land side of embankment). Looking at the embankment on the downstream side that is remained premature state at present, the embankment material should be shaped properly before slope preparation (picture 2.2.1). The reason for this matter is the fact that the forming work is conducted at the limit of arm-reach of the super-long arm excavator, and that the operator's visibility to downstream side from the pontoon is blocked by the embankment crown (in general, embankment rehabilitation work was carried out during dry seasons when the conservancy water level is low).

Picture 2.2.1 Slope of Embankment (Remained unrolled state)

For the embankment strengthening in the future, super-long arm excavators shall be located on the downstream side of the embankment, while the super-long arm excavators on the pontoons on the Conservancy side shall supply banking material (Figure 2.2.3).



(unit: m)

Figure 2.2.3 Excavators used for Soil Supply and Banking

4) Total required quantity of excavators

An ideal balance for effective work is to place two excavators on the pontoon, and one excavator on the downstream side for forming the embankment. In other words, two super-long arm excavators on the Conservancy side shall alternate the excavation of soil and loading it on the embankment, while the super-long arm excavator waiting on the downstream side can work one-on-one with the excavator on the upstream side constantly. Therefore, 3 excavators + 2 pontoons shall count as one set (Figure2.2.4).

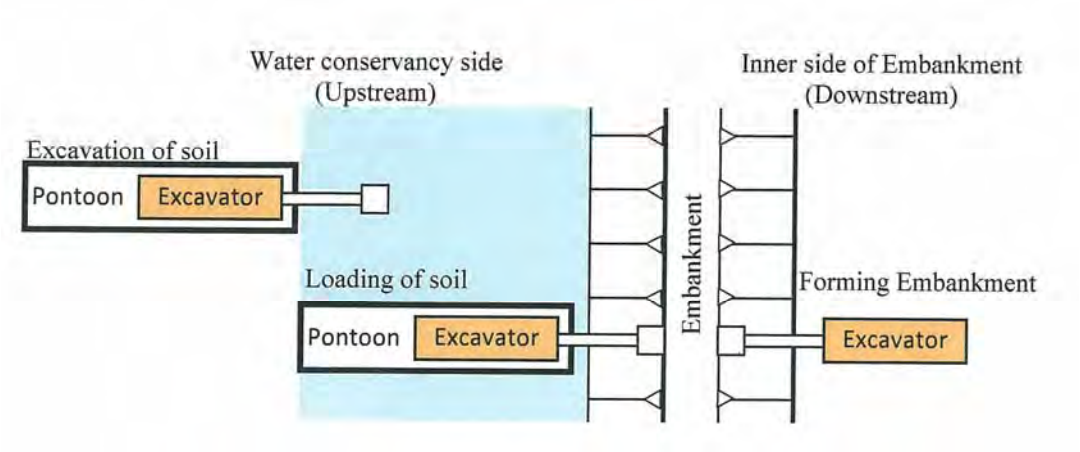


Figure 2.2.4 Combination of Excavators and Pontoons (per set)

In the combination described above, the works of an excavators on the land side shall be carried out after the loaded soil on the embankment has bearing capacity (2 ~ 3 weeks later).

Additionally, as the work volume for excavation and loading of soil and slope shaping shall be completed in two years, two excavators from the canal shall work in combination with one excavator on the land. Thus, quantity of excavators shall be as follows.

・Super-long arm excavator on the water conservancy side (upstream) for excavating and loading soil:

4 units owned by NDIA + excavators calculated in the former paragraph = 8 units

・Super-long arm excavator on the land side (downstream):

Based on the calculation from Figure 2.2.4, 8 units / 2 = 4 units

As a conclusion, the super-long arm excavators to be procured for the project shall be 8 units.

Equipment	Number of units
Super-long arm excavator (for EDWC canal side)	4
Super-long arm excavator(for downstream side of embankment)	4
Total	8

(2) Compatibility with quantity of pontoons

Six pontoons owned by NDIA are allocated at the EDWC, where four are already loaded with super-long arm excavators. Remaining two pontoons are used for transporting equipments or accommodation of the workers. These must be repaired and reorganized for normal use of pontoons, in order to use for loading the excavators to be procured in the project. Therefore, the pontoons for procurement in the Project are as shown in the figure 2.2.5.

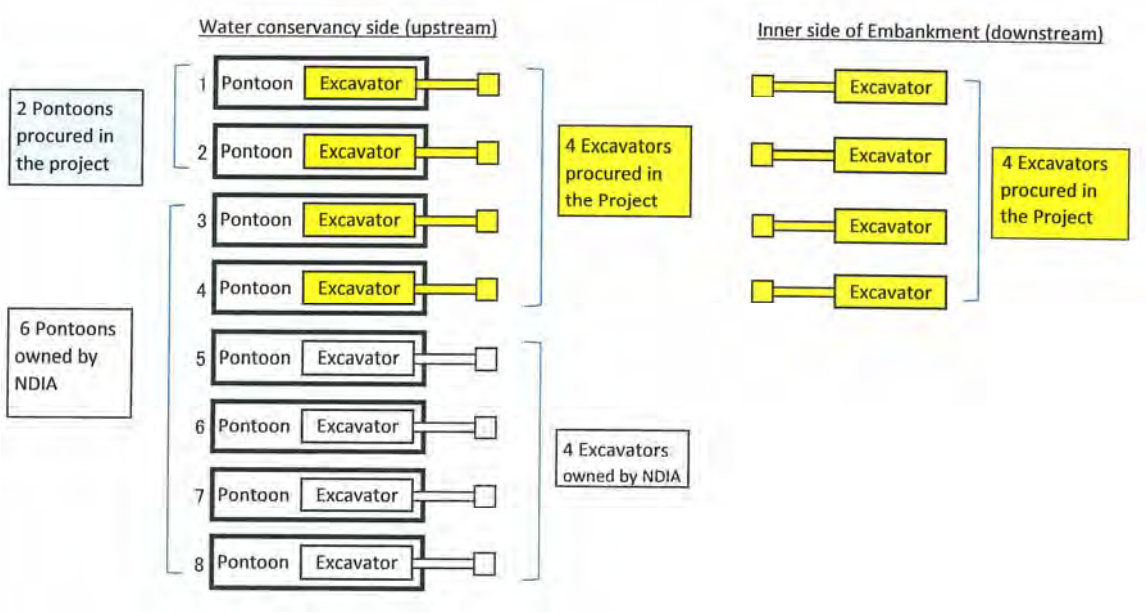


Figure 2.2.5 Excavators and Pontoons to be Procured

2.2.3 Outline Design Drawings

The design drawing of the equipments for procurement are attached as Figure 2.2.6.

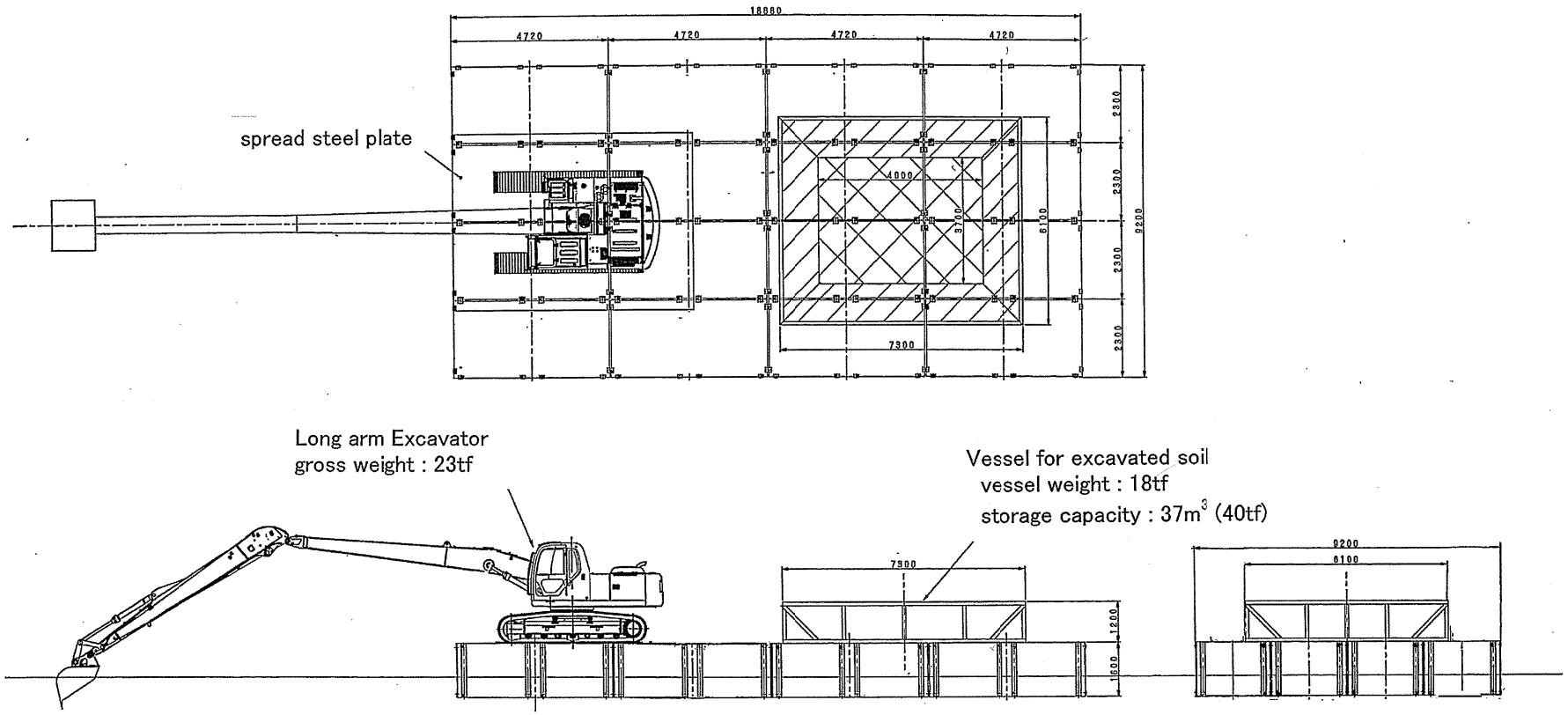


Figure 2.2.6 General View of Pontoon loaded with Excavator and Vessel

2.2.4 Procurement Plan

2.2.4.1 Procurement Policy

This project shall be implemented under the conditions described in the Exchange of Notes (E/N) between the Government of Guyana and the Government of Japan, and the Grant Agreement (G/A) with JICA. The executing body of Guyana is NDIA under the MOA. NDIA is responsible for the maintenance, management and operation of the equipments after the project. NDIA shall employ a consultant for receiving services such as creating bidding documents, assistance for bidding, and supervision for procurement of equipments, etc. Local contractors shall be utilized for installation of the equipments.

2.2.4.2 Conditions of Procurement

(1) Super-long arm excavator

- The followings shall be subjected to selection of the excavator manufacturer for ordering that it owns its agencies and repair shops in Guyana can be able to easily procure and supply change parts in urgent needs and well arranges its supporting setup as sending its skilled engineers for the site support.
- Inspection check shall be carried out for the completed excavator according to the manufacturing specifications before shipment. And a set of equipment shall be verified in collation check of its entity and shipping document list by a third party.
- In sea and land transport of the excavator, the equipment and its fitting parts shall be firmly fixed to the stationary and also be paid attention on deformation, scratch and so on.
- At the delivering of the excavator in Guyana, verification checkups on the list of articles, their quantities and concerned specifications shall be carefully confirmed in the presence of the NDIA personnel.
- At the delivering occasion of the excavator to the client, instructions on initial operation and technical skill on maintenance shall be soundly performed. Operations manual, inspection and repair manuals are also to be submitted to the NDIA.

(2) Pontoon

- Pontoons shall be procured as factory product for which the quality inspections and production inspections at each stage from design to completion, and performance inspection on completion to confirm that required performance is met, are implemented. Quality of welding portions shall be checked by X-ray inspection or magnetic / ultrasonic test.
- Additionally, the materials shall be confirmed through the quality inspection sheet, and shall undergo a physical/mechanics inspection at the factory.
- The pontoons shall be manufactured in Japan, so that the disassembled blocks must be in a

size which can fit into a 40ft container for sea freight. Product shall be carefully packaged in order to prevent deformation or deterioration during shipping.

2.2.4.3 Scope of Procurement and Installation

(1) Super-long arm excavator

・Performance test and operation test shall be carried out. Necessary documents such as instruction manuals shall be attached when delivered to Guyana at the office of Land of Canaan under the management office of the EDWC.

(2) Pontoon

・At first, Pontoon shall be temporarily assembled at the site. Welding guidance shall be conducted for the personnel of the management office of the EDWC, and along with the technical guidance from the manufacturer, welding and assembly shall be carried out.

・After blocks are assembled, floating test and leakage test shall be conducted at the EDWC. Once the equipments are qualified, necessary documents such as instruction manual, etc. shall be attached, and be delivered at the office of Land of Canaan.

2.2.4.4 Procurement Supervision Plan

(1) Super-long arm excavator

・The super-long arm excavator is a general machine, so that shipping inspection shall be carried out by confirming the inspection records and specifications after assembly.

・Performance of the assembled equipment shall be confirmed by inspecting the performance inspection documents and inspection records etc., stipulated by JIS (Japan Industrial Standards).

(2) Pontoon

・As pontoons are manufactured in a factory, material inspection, factory inspection, and final inspection shall be conducted based on the Design Standard for Steel Structures of Japanese Society of Steel Structure and Special Standard for Steel Pontoon of Ministry of Land, Infrastructure, Transport and Tourism (MLIT), and Design Standard for Dredger of JAPAN Work-vessel Association (JWA), etc. in order to ensure the performance of the parts (blocks).

・All pontoons must ensure final inspection for the appearance and temporary assembly after the completion of the parts (blocks), and shall be packaged for sea freight.

・After unpacking at the site, the pontoons shall be assembled by using assembly jigs, and shall be welded at site for completion of the product.

・After inspecting the accuracy and welding portions, the pontoon shall be welded at site. When welding, humidity and condition of the stored welding material must be checked before the work.

・Since the instrument for X-ray inspection is not available at the site, a skill test for the welders must be carried out prior to the actual welding work. The welded portions at the factory shall also undergo quality inspections before shipping.
・Magnetic or ultrasonic flaw test and color inspection are alternative methods for the X-ray inspection. These tests shall be carried out as quality inspections for the welded portions.
・Various test records shall be attached with the equipment at delivery.

2.2.4.5 Quality Management Plan

(1) Super-long arm excavator

・Quality shall be assured by performance inspection records following the standards of JIS and specifications.

(2) Pontoon

・Design standard shall be compatible with the Design Standard for Steel Structures of Japanese Society of Steel Structure, and Special Standard for Steel Pontoon of Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and Design Standard for Dredger of Japan Work-vessel Association (JWA).
・Material inspection

Tensile test of the steel material (JIS G2241)
Bending test of the steel material (JIS G2248)
Hardness test of the steel material (JIS Z2243)
Welding inspection and welding skill test
WEB 8201, 8241 and JIS Z 3801, 3841

・Welding inspection (nondestructive test)

RT: Radiographic Testing
MT: Magnetic Particle Testing
PT: Penetrant Testing
UT: Ultrasonic Testing

・Temporary assembly inspection

Compatible with the inspection standard of Special Standard for Steel Pontoon of MLIT

・Final inspection (appearance)

Compatible with the inspection standard of Special Standard for Steel Pontoon of MLIT

2.2.4.6 Procurement Plan of Materials and Equipments

(1) Super-long arm excavator

・Super-long arm excavators are used in Guyana, and same types are produced in Japan and U.S.

Since the long arm and bearings are made in Japan, procurement shall be from Japan, where all parts are available and complete product can be inspected before export.

- Spare parts or repair parts are available in Guyana, since there are agencies and workshops or suppliers for equipments. Additionally, regarding the maintenance services, the manufacturer's service engineers are located in Guyana, and supporting services of the manufacturer for complicated repairs or inspection of instruments are available. Therefore, spare parts shall not be procured in this project.
- The consultant sets (1) one year after delivery of the Super-long arm excavator for guaranteeing damages caused on it in the processes of proper usage and operation.

(2) Pontoon

- Various types of pontoons are produced in Japan, under consistent manufacturing process from design to production. Pontoons are manufactured in large numbers, and can be easily procured from Japan. The unit-type pontoon procured in this project can be disassembled into small blocks, which can fit into a 40ft. container, and has no problems to be shipped from Japan.
- Pontoons do not require spare parts in general. Additionally, replacement parts can be manufactured easily at local factories in Guyana. Therefore, they are not included in the procurement.
- The consultant sets (1) one year after delivery of the Pontoon for guaranteeing damages caused on it in the processes of proper usage and operation.

2.2.4.7 Guidance Plan on Operation

(1) Super-long arm excavator

- Because super-long arm excavators of the same type as those used in Guyana will be provided, operation manual and daily and periodical inspection manual shall be attached upon delivery, together with the initial operation guidance.

(2) Pontoon

- Periodical inspection manual and repair manual shall be attached upon delivery of the pontoon. Additionally, guidance for effective work based on the operation and maintenance plan for inspection and maintenance shall be given. Instruction for welding the unit-type pontoon shall be given, together with safe installation guidance.

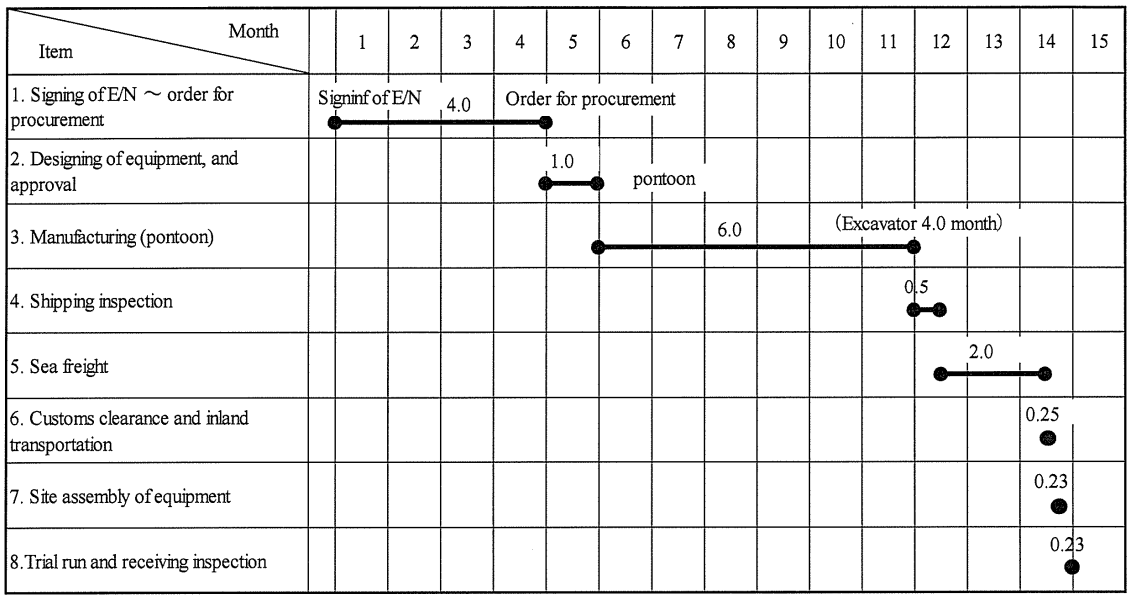
2.2.4.8 Plan of Soft Component

There are no soft component plans relevant to the procurement of equipments. Documents described above, such as daily and periodical inspection manual, repair manual, etc. shall be provided upon delivery. In addition, initial operation guidance shall be conducted by the

supplier and the local agent.

2.2.4.9 Implementation Schedule

Implementation schedule of the project is as shown below.



2.3 Outline Design of the Requested Japanese Assistance (Component-2: Rehabilitation of Facilities)

2.3.1 Policy on Design

2.3.1.1 Basic Policy

The design policy of the Project is as shown below (Table2.3.1).

Table 2.3.1 Basic Design Policy

No	Item	Policy
1	Details of the Grant Aid Scheme	Based on the understanding of the full picture of the disaster recovery and rehabilitation projects of the EDWC carried out in Guyana, the meaning, scope and contents of the Grant Aid Scheme shall be clarified. The Grant Aid Scheme shall not deviate from the original design concept, i.e., to rehabilitate existing facilities, as well as the design policy of existing facilities of the Conservancy.
2	Coordination with other donors' aid activities	Exclude the facilities and rehabilitation locations for which other donors are carrying out or plan to carry out projects.
3	Coordination of rehabilitation projects of the water conservancy	Coordinate equipment, work and schedule with other rehabilitation projects of the EDWC that will be carried out by the Guyana or other donors at the same time so that these projects will not affect each other.
4	Operating conditions after rehabilitation of the facilities	Assist the improvement of inspection and maintenance of the facilities so that the facilities will continuously fulfill its functions.

The facilities subject to the rehabilitation in the Project have been selected for prompt and proper execution of rehabilitation work of relief sluices and intakes considered to be especially urgent and necessary in the rehabilitation project of the EDWC of Guyana (Action Plan), which was considered when the facilities were damaged by a flood in 2005.

We have also studied the rehabilitation projects of Guyana and projects sponsored by the World Bank and other donors, and selected the target facilities with no overlaps.

The target facilities are two relief sluices and four intakes structures with embankment and wooden retaining walls (with parapet walls) around those facilities.

As a result of the field survey and discussion with concerned organizations, the following rehabilitation policies have been defined;

・The purposes of rehabilitation work of relief sluices shall be to ensure the water volume of the EDWC and to improve its flood control function.

・The purposes of rehabilitation work of intakes shall be to ensure the irrigation water volume and improve adjustment function and to stabilize adjacent embankment and prevent water leakage.

・The purposes of rehabilitation of revetment etc. shall be to improve the discharge capacity of the facilities and to prevent corrosion of embankment soil.

2.3.1.2 Facilities for Rehabilitation

Table 2.3.2 and Figure 2.3.1 show the facilities to be rehabilitated at the request of the Government of Guyana. We have studied rehabilitation plans for these facilities on the basis of the field survey result.

Table 2.3.2 Facilities Requested by the Government of Guyana

No	Name of Facilities	Type of Facilities
①	Ann's Grove	Intake
②	Hope	Intake
③	Annandale	Intake
④	Nancy	Intake
⑤	Maduni	Relief sluice
⑥	Sarah Johanna	Relief sluice

Figure 2.3.1 Location of the Requested Facilities

The natural conditions of the greatest concern relating to the facilities rehabilitation work of the Project is a rainy season. Considering safety and other factors, it has been decided that timber piling and revetment sheet piling will be carried out, but any work whose quality might be affected such as earth excavation and banking will not be carried out during a rainy season. Attention also has to be paid to the water quality and fluctuation of the EDWC water level.

Attention should be paid to the following points during the stage of design and work planning ;

- Timber piling and sheet piling can be carried out in rainy seasons. Embankment banking, back-filling and any other work whose quality might be affected with water should be scheduled to be carried out during dry seasons.
- If a large amount of work is expected to be left for the latter half, number of equipment, number of work parties and other measures should be well considered during planning stage.
- Ordering lots should be considered to ensure that the work will be completed within the planned work period. Partitioning of whole works should also be considered so that the work will be well managed as the work sites are far away each other. Ordering lots of the work in Maduni, Sarah Johanna, and intake works at Ann's Grove together with other three intakes might be conceived as an example. As the work volume of Ann's Grove together with other 3 intakes is large, three parties composition plan can be considered.
- There may be torrential rains before and after a dry season. Criteria for suspension and such other measures should be considered when developing a work plan to ensure work quality and safety of structures work.
- Impact of rainfalls should be considered for saturation (air-void ratio) control in each work and in-situ permeability test of embankment quality management.
- As the EDWC has acidic water and soil, steel materials with antirust coating and acid-proof wood materials will be used instead of regular steel materials. Antiseptic agent shall be applied to wood materials to improve weather resistance.

Table 2.3.3 shows the current states of the target facilities.

Table 2.3.3 Existing States of the Facilities (1)

Facilities	Outline of the structure	Intended use	Existing state
①Ann's Grove Intake  	・ Intake facility with a concrete pipe 900mm in diameter and 4.5m in length ・ Although the structure shows local damage such as small cracks and irregularities due to aging, the main concrete structural part keeps its intake function.	Intake system for irrigation	・ Although the main concrete structural part shows some degradation, it still performs the intake function and can serve in the future. ・ There is a significant depression on the crest of the embankment in immediate proximity on west-side of the intake facility. As a result of the on-site visual investigation, the presence of water hole (piping) is confirmed in the embankment. ・ Deterioration of timber revetments for extended part of the concrete wing walls (hereinafter called "wings") is obvious. ・ As the embankment banking was conducted by Pegasse (blackish peat like acid mixture of clay), there are problems in water permeability and strength of the embankment.
② Hope Intake  	・ Additional reinforced concrete rigid frame and door have been attached on top of the wings, which are aging base structures. ・ Timber piles and wooden sheet piles have been installed in outlet side as a temporary measure to hold the embankment.	Intake system for irrigation	・ Piping phenomenon is seen just beneath the intake system. ・ The parapet of outlet side wing is 1.0m lower than the crest of the embankment. To cope with the height difference, temporal structure using a wooden sheet pile has been employed. ・ There is a problem in opening/closing operation of door as it lacks door guide devices. ・ Deterioration of timber revetments of the extended part of wings is obvious. ・ As the embankment banking was conducted by Pegasse, there are problems in water permeability and strength of the embankment.
③Annandale Intake  	・ Intake facility with a concrete pipe 900mm in diameter and 5.5m in length ・ The main concrete structural part has been made solid. ・ The height of the embankment is 60 feet GD or more.	Intake system for irrigation	・ No major factor to hinder intake function is seen on the concrete structure. ・ The gate has a door guide and ditches for stop-log to prevent collision of floating matters, but there is breakage at the bottom plank of the wooden door. (There is water leakage when the door is closed.) ・ Deterioration of the timber revetments of extended part of the wings is remarkably obvious. ・ The earth slope of the embankment is collapsed because of lack of protection walls..

Table 2.3.3 Existing State of the Facilities (2)

Facilities	Outline of the structure	Intended use	Existing state
④ Nancy Intake  	・ Intake facility with a concrete pipe 900mm in diameter and 6.0m in length ・ Outlet: both wings are long enough and broaden toward the end to reduce outflow water velocity, contributing to prevent scouring on both left/right side banks and bottom of the channel.	Intake system for potable water for the residents of Georgetown and for irrigation	・ No major factor to hinder intake function is seen on the concrete structure of the system. However, there is a horizontal steel brace to prevent a wing from leaning forward at inlet. ・ Door guides are well furnished for door opening/closing operation. ・ Channel leading from the conservancy to the intake inlet is not wide enough, bringing insufficient water volume to the intake facility. ・ Deterioration of the timber revetments of extended part of the wings is obvious, particularly at outlet side.
⑤Maduni Sluice  	Single door with 4.84m in width, 4.20m in height and 0.23m in thickness ・ The concrete gate structure (frame) that supports the door is sound for continued use.	Water storage and discharge control systems to prevent overflow of the embankment and river flooding caused by raised water level	<u>Gate door</u> ・ There is significant water leak through the door. ・ The projections on both columns support the water pressure applied to the door. <u>Embankment revetments</u> Deterioration of the timber revetments of the extended part of the wings is obvious in both sides of inlet and outlet.
⑥ Sarah Johanna Sluice  	Double door with 4.91m in width, 4.40m in height and 0.23m in thickness. ・ The frame (concrete structure) that supports the door is good for continued use.	Control system to prevent embankment overflow caused by raised water level of the conservancy and back flow in Demerara river.	・ Door was repaired in 2010. ・ Inlet: right-bank -there is no retaining wall to protect banking fill at extended part of the concrete wing, thus remaining no measure to prevent the earth fill collapsing. ・ Inlet: left-bank -the timber revetment shows serious deterioration due to aging.

2.3.1.3 Design Specifications and Machines for Execution

We shall refer to the design guidelines, instructions that the NDIA adopts for repair and rehabilitation work on existing structures. The design policy for the Project should be developed with the reference to BS or ASTM standards and also in consideration of the work methods.

Concerning design of the facilities, the following points should be especially considered;

specified design criteria

ASTM and other standards adopted in Guyana are employed. However, Japan industrial Standard (JIS) shall be applied to quality standard test and supervision of work test of the embanking soil. Standards shall be clearly described in design documents.

design methods (allowable stress method)

Standards and guidelines adopted in Guyana are employed.

parts and materials of small components

They follow the standard drawings and reference documents. Materials, equipment and quality management methods that meet the specifications and rules of BS and ASTM are employed. For steel products, the current rust prevention methods and measures are verified.

loading condition

- Follow the design standards and guidelines adopted for the facilities in Guyana.
- With respect to the special loading conditions and use of special equipment and material, discussion will be held with relevant organizations before making the decision.

execution equipment

The equipment shall be procurable in Guyana and have abilities to satisfy the required design and quality.

execution conditions

Execution plan shall be developed in consideration of equipment and work ability to meet the special work conditions in adjacent areas to the water conservancy.

others

- Adopt structure types and work methods that will facilitate future maintenance and work by local contractors.
- Formulate a design and work plan tailored to the work ability of local contractors.
- Use economical and durable materials that can be locally procured, and work method and plan that can be carried out with locally-procurable equipment.
- Adopt proven work methods or methods that suit the ability of local contractors.
- Execution items and volume shall be determined based on the drawings and specifications with locally procurable materials that are created according to the results of field measurement, soil survey and local material market survey.

・Make efforts to get information about the procurement and work abilities of equipment through surveys of the local market and the actual situation of rehabilitation work in Guyana. Develop actually workable designs based on the discussions with relevant organizations and personnel of Guyana as well as BS and ASTM standards and standard designs and reference materials of existing facilities and structures. Reflect such information in development of a work plan and calculation of cost.

・Create guidelines if supervision of work standards, quality management standards, report forms or classification of secure documents are not clear. Also create forms of facility inspection ledgers.

Under the above-stated conditions, equipment and materials distributed in Guyana shall be used for the facilities.

Execution equipment shall especially be selected after sufficient market research and local survey and in consideration of the condition of the work sites adjacent to the water conservancy. The major work types will be revetment works and rehabilitation work of concrete items, doors and other facilities and they will be carried out mainly with the equipment listed in Table 2.3.4. As these equipment are locally procurable and the work plan can be developed with the equipment owned by the contractors and leasing companies.

Table 2.3.4 List of Major Construction Machines

Machine	Specification	No. of equipment	Intended use	Note
35-40t underslung crane		3	Earth retaining, loading and unloading of equipment and materials etc.	
25t underslung crane		3	Discharging and loading of earth retaining materials etc.	
25t underslung crane		1	Discharging and loading of equipment and materials etc.	To be installed at Cananan
Barge	Capacity 60t	15	For equipment for work on the water	
	Capacity 30t	2	Transportation of equipment and materials	
Towboat		3	Transportation of equipment and materials	
Ferry boat		3	Transportation and communication of workers	
Pile hammer	5000kg type (with caps)	3	Piling	
	400kg type	3	Sheet piling	
Excavator	25t class long-arm excavator	6	With a 0.4m^3 bucket	Same as above
	25t class standard arm excavator	6	With a 0.4-0.7m^3 bucket	
	8t class standard arm excavator	3	With a 0.28m^3 bucket	
Compacting machine	4t class tire roller	3	Compaction of banking and back-filling	
Compacting machine	1t class hand guide roller	3	Compaction of banking and back-filling (small area)	
Fastening device and equipment for tie rods and bolts		1 set		
Portable concrete mixer	For stirring 1.0m^3	1	Concrete production for the frames of facilities	
Concrete bucket	1.0 m^3	1	Concrete production for the frames	
Vibrator	Bar 30mm in diameter (with engine)	1	Same as above	
Fastening tool for sluice gates		1 set		

2.3.1.4 Policy on Operation and Management

The management of the facilities and embankment restored in the Project will be transferred to the management office of the EDWC after inspection of the finished work and completion test. The operation and maintenance on those transferred will be conducted by the EDWC

management office under the supervision of NDIA.

As a concrete means to conduct smooth and effective inspection and maintenance of the facilities; manuals on inspection and maintenance which describe operation methods and details and methods of daily/periodic inspection and rehabilitation of facilities and devices are prepared and provided through Soft Components. Also through soft component, manuals on quality control and execution supervision of work are prepared with an aim of technical improvement of quality and supervision of work methods for embanking and rehabilitation of the facilities.

2.3.2 Planning of the Facilities Rehabilitation

2.3.2.1 Items Subject to the Rehabilitation

Work items for rehabilitation by respective facility is shown in Table 2.3.5

Table 2.3.5 Items subject to rehabilitation

Facilities	Rehabilitation items
Relief sluice	
Maduni Relief Sluice	Fabrication and installation of new wooden relief sluice door, Rehabilitation of inlet and outlet retaining walls, Rehabilitation of embankment, Back-filling.
Sarah Johanna Relief Sluice	Rehabilitation of inlet retaining walls, Replacement of drain pipes.
Intake	
Ann's Grove Intake	Rehabilitation of inlet and outlet retaining walls, Improvement of embankment fill.
Hope Intake	Rehabilitation of inlet and outlet retaining walls, Extension of intake concrete structure entity with foundation piles, Improvement of embankment fill, Cut-off wall to prevent piping, Rehabilitation of guides to intake door.
Annandale Intake	Rehabilitation of inlet and outlet retaining walls, Partial rehabilitation of intake door, Back-filling.
Nancy Intake	Rehabilitation of inlet and outlet retaining walls, Back-filling.

The following changes have been made to the original request;

- The Cunha discharge channel, where the Sarah Johanna relief sluice is located, is one of the three major discharge channels running westward from EDWC to the Demerara river. At an implementation work of the national road that connects the airport to downtown Georgetown around 1993, the discharge channel was shifted to the cranked state and that is said to have impaired the discharge ability.
- Government of Guyana requested to rehabilitate the existing Cunha relief sluice which was remained unused and also to reconstitute the Cunha discharge channel to more or less straight line in its horizontal alignment from current cranked state so as to improve the discharge ability from the EDWC. However, the plan would require the construction of a new bridge on the national road that crosses the supposed discharge channel, and such work would be outside the scope of the Project. After discussion with NDIA, it has been agreed that the Sarah Johanna sluice will be rehabilitated instead of the relief sluice at the Cunha discharge channel (Figure 2.3.2).

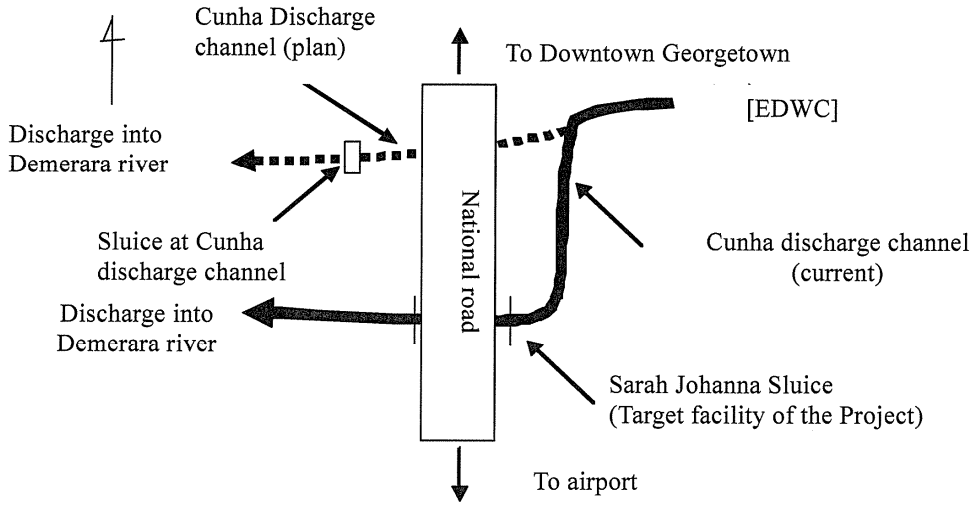


Figure 2.3.2 Schematic Diagram of the Cunha Discharge Channel

The requested work at Sarah Johanna relief sluice included the replacement of doors. However, as the work was completed by Guyana side in 2010, it has been excluded from the request.

Rehabilitation plan for each Facility is given in Table 2.3.6.

Table 2.3.6 Rehabilitation Plan for each Facility (1)

Facilities	Rehabilitation plan	Expected effect
①Ann's Grove Intake  	-As there is a concern about the stability of the surrounding embankment, repair work to gain stability of the embankment needs to be planned. -Specifically, revetments should be constructed along the surrounding embankment to reinforce it and also to stop water leakage through the embankment. -Considering that the existing revetments have been markedly deteriorated, the timber revetments shall be constructed at inlet and outlet sides -For the construction of the revetments, the existing method comprising timber piles, walings and wooden sheet piles shall basically be employed. -Design and stability analyses for revetment/anchoring reinforcement and embankment are required.	・ Further progression of the depression of the surrounding embankment would seriously impact the whole system. Therefore the rehabilitation plan will contribute to the increase of stability of the main structure. ・ If the structure gains stability, the water supply to irrigation area located downstream will become more stable.
②Hope Intake  	-As there is a concern about the stability of the surrounding embankment, repair work to gain stability of it needs to be planned. -For the improvement of operability of door, door guides need to be furnished. -As for the concrete method to secure stability of the embankment, revetments along the surrounding embankment shall be constructed to reinforce it and also to stop water leakage. -Timber revetments shall be constructed on the right and left at the inlet and outlet sides. -Reconstruction of parapet to match the height with the embankment is required to be furnished. -Installation of cut-off walls to stop water inflow under the bottom slab is required. The locations of cut-off walls should be determined from comprehensive viewpoints based on the geological research result.	・ Further progression of the depression of the surrounding embankment would seriously impact the whole system. Therefore the rehabilitation plan will contribute to the increase of stability of the main structure. ・ If the structure gains stability, the water supply to irrigation area located downstream will become more stable. ・ Improved operability will increase the efficiency of the labor of the system user.

Table 2.3.6 Rehabilitation Plan for each Facility (2)

Facilities	Rehabilitation plan	Expected effect
③ Annandale Intake  	-Recovery of stability of the surrounding embankment and recovery of functions as an intake system need to be planned. -As a concrete method to repair the embankment, timber revetments shall be installed. -Installation of timber revetments at the following locations; ・on the right and left at the inlet side ・on the right and left at the outlet side -As for the repair of the bottom plank of the door, only the damaged portion will be replaced. However, if the whole of door planks is judged to be removed due to its deterioration, replacement of the whole door shall be considered.	・Increased stability of the surrounding embankment is expected to increase the stability of the main structure. ・If the structure gains stability, the water supply to irrigation area located downstream will become more stable. ・Recovery of door cut-off function will improve water storage function.
④ Nancy Intake  	-Recovery of stability of the surrounding embankment and recovery of functions as an intake system need to be planned. -To recover the stability of the embankment, timber revetments shall be installed. - The revetments shall be constructed on the right and left at the inlet and outlet sides. - As the canal width at inlet side is not wide enough, it needs to be increased by selecting appropriate execution location of timber revetment.	・Increased stability of the surrounding embankment is expected to increase the stability of the main structure. ・If the structure gains stability, the water supply to the residential area will become more stable.

Table 2.3.6 Rehabilitation Plan for each Facility (3)

Facilities	Rehabilitation plan	Expected effect
⑤□Maduni Sluice  	-Recovery of stability of the surrounding embankment and recovery of functions as relief sluice system need to be planned. -To recover the stability of the embankment, revetments shall be executed. Installation location of revetments is at ; ・on the right and left at the inlet side ・on the right and left at the outlet side -As there are lots of water leakage allover the door surface, wooden parts shall be completely replaced.	・Recovery of cut-off function will improve water storage function and prevention of flooding at river and its adjacent area.
⑥ Sarah Johanna Sluice  	-Recovery of stability of the surrounding embankment and municipal road and recovery of functions as relief sluice system need to be planned. -To recover the stability of the embankment, revetments shall be executed. -Construction of revetments at following locations; ・on the right and left at the inlet side	・Increased stability of the embankment at right bank and left side road will increase the stability of the main relief sluice structure. ・Recovery of cut-off function will improve water storage function.

2.3.2.2 Rehabilitation Design of Facilities

(1) Design planning

The design of the rehabilitation work of the facilities shall be based on the standard design, design policy and reference materials on existing structures or reconstructed structures, or design documents of existing structures presented by Guyana. Design and work methods shall be in line with the BS, ASTM and other design guidelines and methods of Guyana and reflect the result of discussion with relevant organizations of the country. The design documents shall also reflect various construction guidelines of the country.

The concrete policy for the basic rehabilitation work of intakes and relief sluices are as follows.

- Use as many reusable members as possible and adopt the same materials and work methods as those used for existing structures.
- Reconstruct structural objects that cause unreliable concerns and inconvenience
- If existing structures are short in measurement due to change of planned level etc, take such measures as reinforcement and height increasing.
- Unstable or unsafe structures including foundation piles and frames should be partially reinforced or fully repaired.
- If cases of that existing structures such as drain pipes and foundation piles may cause collapse of the embankment, measures against water leak from the embankment or heaving have to be taken, as demolition of existing structures, replacement with good-quality banking materials, installation of impermeable bottom walls or impermeable banking.
- Construction methods shall be employed in line with the design condition and methods, and equipment used at the EDWC.
- Where the embankment lacks enough profile section due to scouring, extend the length of revetment and embanking, and bank-shaping.
- When recovering embankment height, ensure the planned height will match the safe highest high water level of 58.50 ft. rehabilitation plan of the EDWC.

The specifications of the facility design, materials and work methods of the rehabilitation work and the work volume have been considered as described below.

- Construction volume required for the rehabilitation work of the facilities has been calculated for each work type (unit cost item).
- Based on the result of the field survey, quantity of materials required for the rehabilitation work of the facilities has been calculated for each specification.
- Quantity of bolts and nuts for revetments and tie rods with anchor piles has been calculated for each standard.

・As for wooden materials, length, cubic volume and number of lots have been calculated for each specification and size.

When specifying the design, materials and work methods of the facilities, the rehabilitation volume shall be determined in line with the design method based on discussion with the relevant organizations of Guyana and also the existing work methods, materials and specifications used for rehabilitation of the facilities in the country. The points to consider are as follows.

・local geographic and climatic environment
・design conditions, standards, dimensions and structure shapes of existing facilities
・parts of facilities that need to be rehabilitated and current state of target facilities
・quantity of work and shapes of structures
・execution method and plan
・material standards and specifications
・maintenance and management structure for the water Conservancy
・structure for urgent rehabilitation work of the embankment and the facilities

(2) Conformity with other scheme

Among the ongoing projects, Hope/Dochfour discharge channel and its related canals and intakes construction are undertaken by the NDIA. The proposed channel joins the conservancy at a point on its north-eastern embankment and then cuts across about 10km. of the coast to spill directly into the Atlantic Ocean.

The location of existing drainage facilities at EDWC is shown in Figure 2.3.3. .

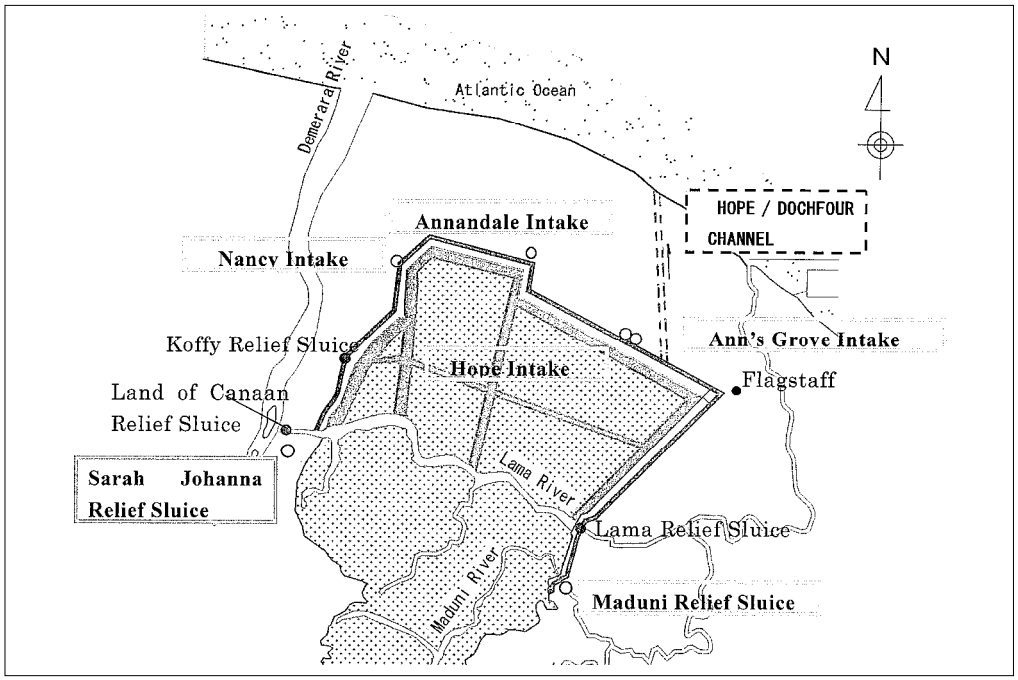
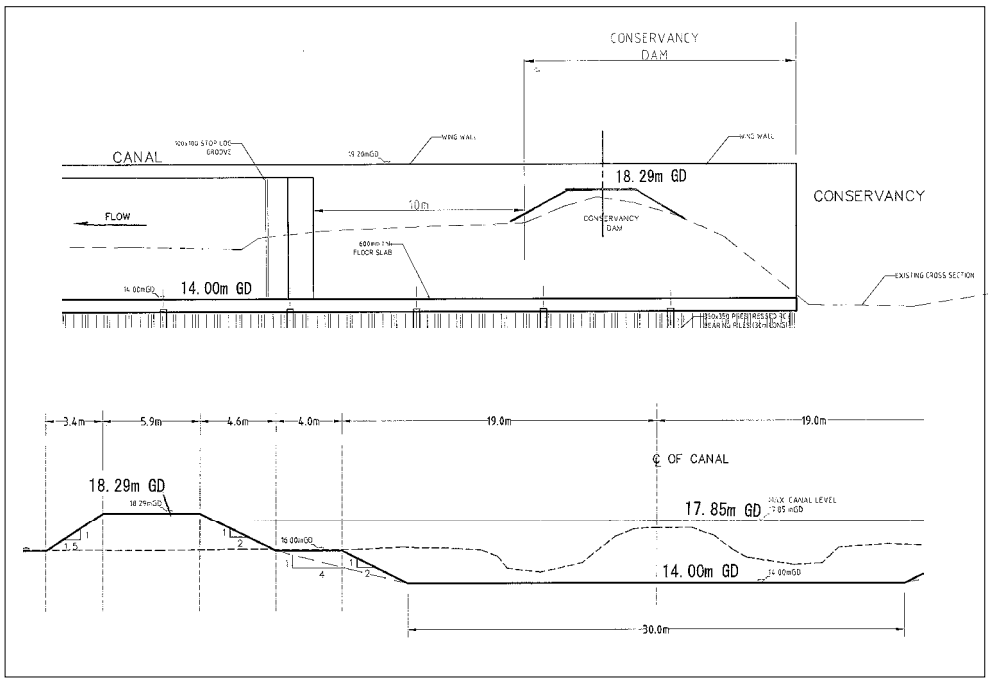


Figure 2.3.3 Location of the Facilities and Hope/Dochfour Channel

Design feature of Hope/Dochfour channel is given in Figure 2.3.4.

- Embankment height 60.0 ft GD
- Planned flood level: 58.5 ft GD (same as safe highest high-water level of EDWC)
- Base width of the discharge channel: 30.0 meters
- Length of the discharge channel： approx. 10km



* Draft Design Report on the East Demerara Water Conservancy Northern Relief Channel at Hope/Dochfour, December 2009、NDIA

Figure 2.3.4 Hope/Dochfour Drainage Channel

For planning and designing of the Hope/Dochfour discharge channel, study has been conducted concerning the properties of the EDWC water level against 1000-year probability precipitation with the existing five sluices and the planned Cunha Sluice (that will replace the existing Sarah Johanna sluice). According to the study, if the existing sluices are not operated after the Hope/Dochfour discharge channel is completed, there will still be a risk of overflow of the embankment, similar to the one that happened in 2005. Therefore, the existing aging sluices have to be rehabilitated for the stable and safe operation of the EDWC.

As for the embankment height of the EDWC, the Project design needs to secure the same height or higher of the Hope/Dochfour discharge channel.

The rehabilitation of the facilities needs to be planned to satisfy the planned flood level of 58.5ft GD.

(3) Consideration on Embankment Axis

At some parts of the embankment between Flagstaff and Annandale, embankment alignment has been shifted backward due to the former urgent repair work which caused failure of the embankment slope. If the current embankment states should be moved to the original position, the existing intake facilities would have to be demolished and replaced with new one. Such action would require a large amount of cost and time. The rehabilitation work of the Project shall be carried out in a way that will not change the existing embankment axis.

1) Ann's Grove Intake

Around the intake, the axis of the embankment has moved significantly back by the repairing work due to flood in 2005. In realizing the original axis, involved works would exceed more than 50-meters in each side, taking much repairing cost. Therefore, the extent of rehabilitation work of embankment shall be restricted within the intake rehabilitation extent.

2) Hope Intake

Like the Ann's Grove intake, the axis of the embankment has moved back significantly also by repairing work due to the flood. In realizing the original axis, involved works would exceed more than 40-meters in each side, taking much repairing cost. Therefore, the extent of rehabilitation work of embankment shall be restricted within the intake rehabilitation extent.

2.3.3 Outline Design Drawings

The design drawings for the Project were prepared based on the local survey and geotechnical investigation. Design drawings and Specifications for the work are separately attached to this report (Typical revetment design is given in Figure 2.3.5).

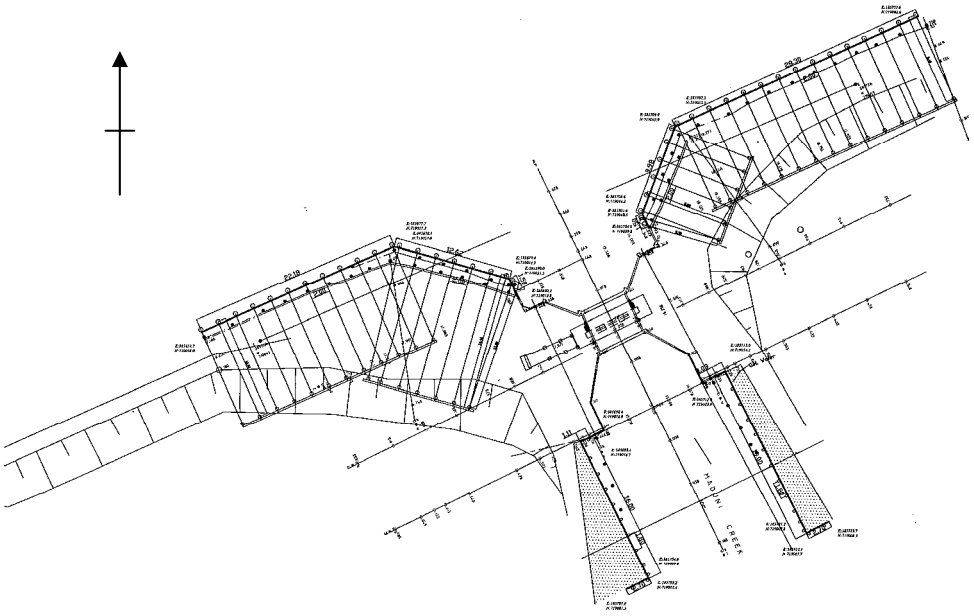


Figure 2.3.5

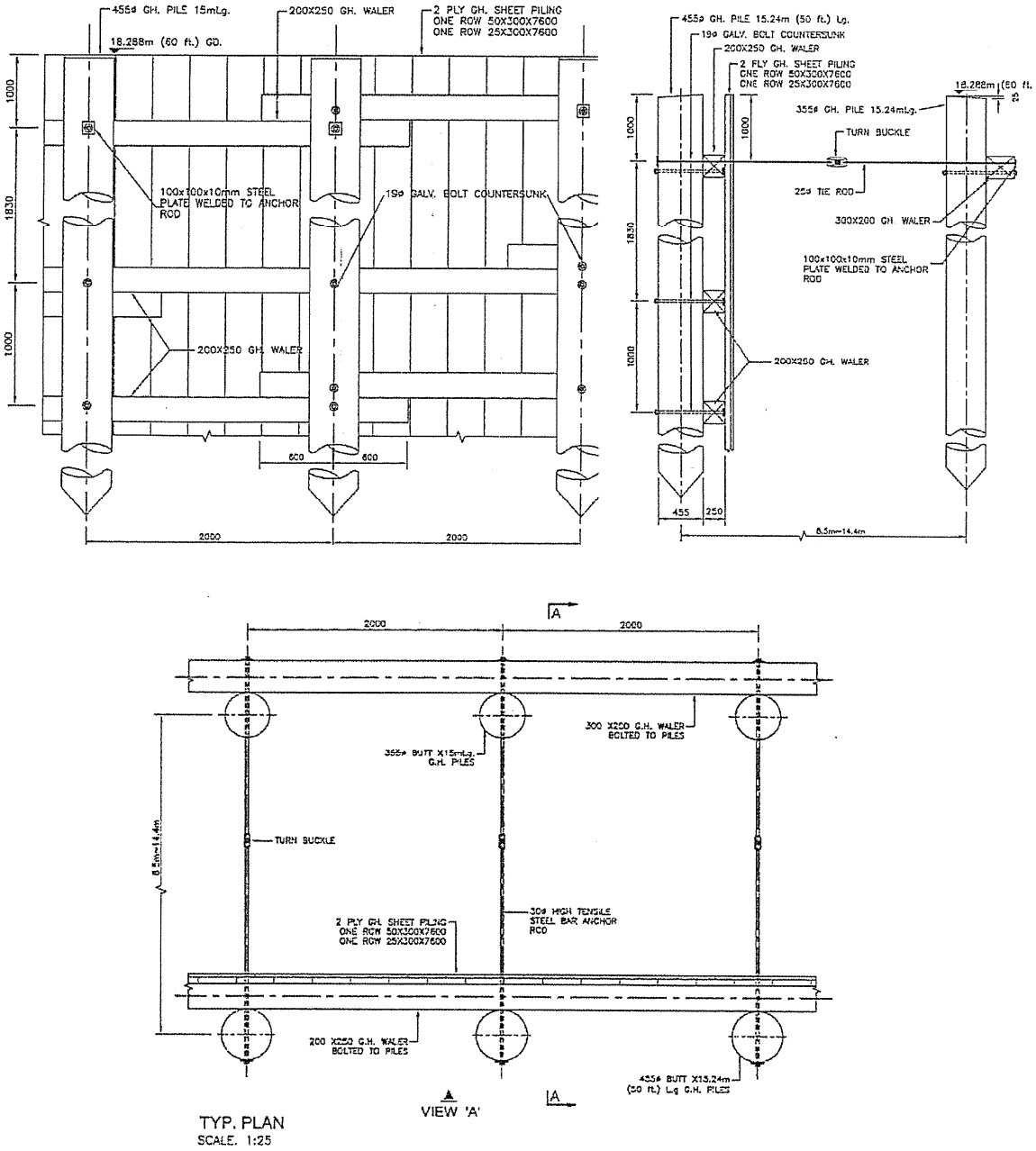


Figure 2.3.5 Typical Design of Revetment

2.3.4 Implementation Plan and Procurement Plan

2.3.4.1 Implementation and Procurement Policy

(1) Implementation Structure

Figure 2.3.6 shows the implementation flow of the Project and Figure 2.3.7 the implementation structure of the Project.

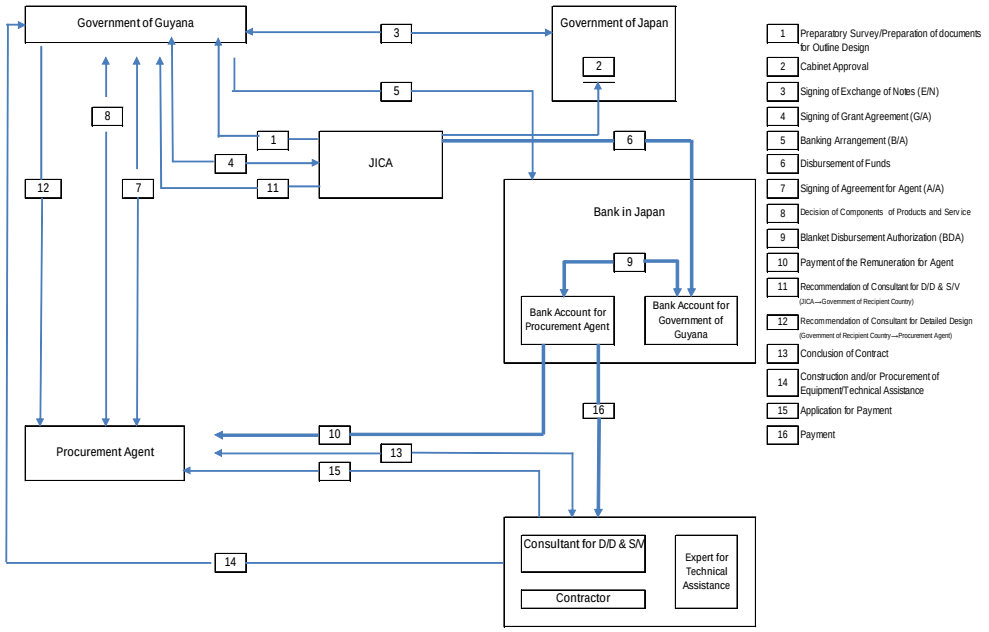


Figure 2.3.6 Implementation Flow of the Project

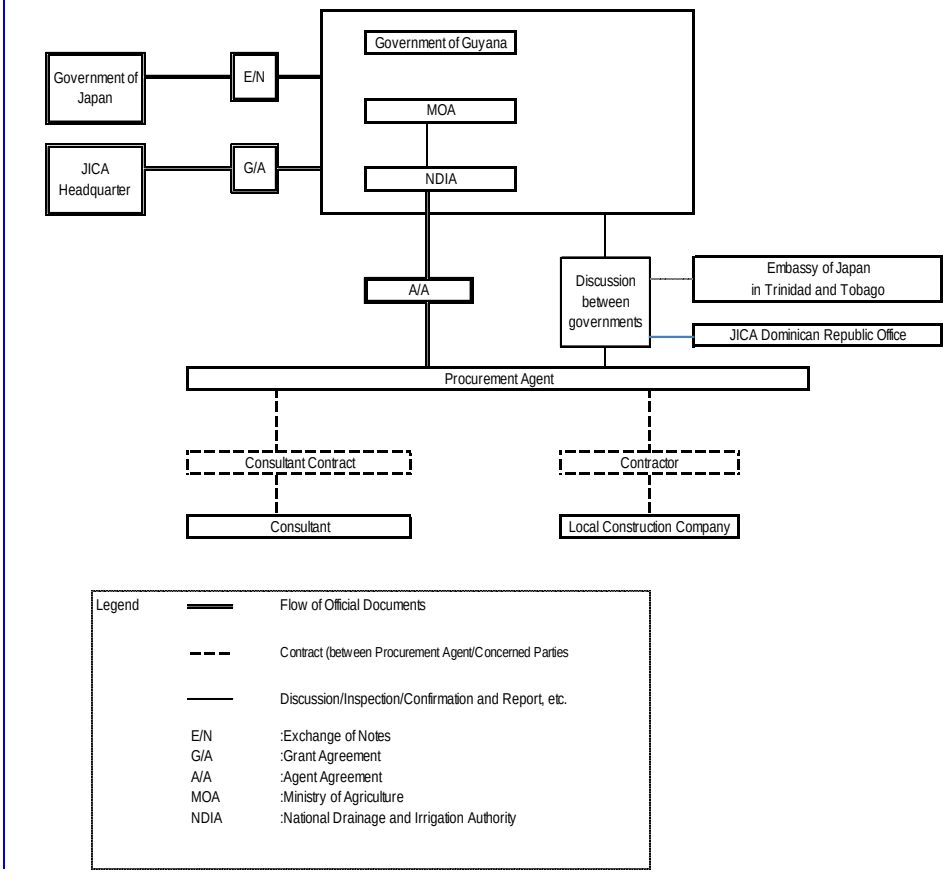


Figure 2.3.7 Implementation Structure of the Project

Table 2.3.7 shows duties of implementing agencies.

Table 2.3.7 Duties of Implementing Agencies

Implementing agency	Duties
NDIA	Implementation of items to be carried out at the expense of the GOG
Procurement Agency	Consultancy contract, preparation of bidding documents, procedures of vendor selection, contract with contractors, management of project implementation, interim and completion inspections, fund management, and payments
Consultant	Examination of design drawings and specifications, preparation of reference materials for the creation of bidding documents, management of rehabilitation work of the facilities, and soft components
Contractor for rehabilitation work of the facilities	Rehabilitation work of the facilities

1) Project implementing agency

The implementing agency of the Project of Guyana side is NDIA, who will have a responsibility for the operation and maintenance of the facilities. As for the process of the Grant Aid using Procurement Management Agent, Exchange of Notes (E/N) will first be signed between the GOG and Japan to form an international agreement concerning the implementation of the Project and then Grant Agreement (G/A) will be signed between the GOG and JICA, who will manage the implementation of the Project. Under the framework of these agreements, the Grant Aid will be implemented. For the coordination of cooperation and other various matters in the implementation stage, Consultative Committee shall be established with representative government agencies of the two countries. Members of the conference shall be as follows.

Representative of NDIA

Representative of the Procurement Management Agent

Representative of JICA Dominican Republic Office

The Project shall adopt a Procurement Management Agent system and the agency shall conduct procurement of services, equipment and materials as well as fund management on behalf of the GOG.

2) Procurement Management Agent

The Procurement Management Agent shall conclude a Agent Agreement (A/A) with the GOG and provide services for consultancy contract, preparation of bidding documents, vendor selection procedures, contract with contractors, project implementation management, mid-term and completion inspection of the Project, fund management and payments.

3) Consultant

After the A/A is concluded, the Procurement Management Agent shall enter into a consultancy contract concerning the Project implementation with the Japanese consultant for supervision of work. The consultant who signed the contract shall provide technical assistance such as execution design, preparation of bidding documents (draft), bidding, and supervision of work.

Technical assistance for quality control and supervision of work and inspection and maintenance shall also be provided through Soft Component.

4) Contractors

Successful bidder shall enter into a contract for the rehabilitation work of the facilities with the Procurement Management Agent.

(2) Rehabilitation/Procurement policy

1) Use of timber materials

Timber and wooden materials that are commonly used for structures and can be easily procured in Guyana shall be used for the rehabilitation of the facilities.

The wood that will be used for the rehabilitation of the facilities shall be the core part (product name Greenheart) or raw wood of Ocotea radiaei of Lauraceae family. The processed material is used for general products as Greenheart, sold for structures as ironwood D70, and used in many countries including EU and USA as given in Table 2.3.9.

Timber piles and wooden sheet piles have been selected in consideration of the followings.

in comparison with steel products

① Wooden materials are more resistant to high pH (3-4) of the natural soil and excavated soil. (There are geologic layers that include large amounts of corrosives containing high level of corrosive or organic acid.)

② Wood is a hard material that has the same level of strength as steel, and is highly resistant to acid. While the durability period of steel materials is around 30 years, around 50 years of use is guaranteed for the wood.

As for the material strength, with the compressive strength of 220kgf/cm^2, bending strength of 220kgf/cm^2, and shear strength of 25kgf/cm^2, the material is in the category of ironwood 70D (Table 2.3.8).

As for the durability, the existing acid substance has the same elements as the acid substance given off from the wood material. Corrosive acid or fungus does not cause corrosion with the wood material.

Table 2.3.8 Characteristics of Timber Material:Greenheart

Table 8 — Grade stresses and moduli of elasticity for various strength classes: for service classes 1 and 2

Strength class	Bending parallel to grain	Tension parallel to grain	Compression parallel to grain	Compression perpendicular to grain [a]		Shear parallel to grain	Modulus of elasticity		Characteristic density, ρ_k [b]	Average density, ρ_{mean} [b]
							Mean	Minimum		
	N/mm²	N/mm²	N/mm²	N/mm²		N/mm²	N/mm²	N/mm²	kg/m³	kg/m³
C14	4.1	2.5	5.2	2.1	1.6	0.60	6 800	4 600	290	350
C16	5.3	3.2	6.8	2.2	1.7	0.67	8 800	5 800	310	370
C18	5.8	3.5	7.1	2.2	1.7	0.67	9 100	6 000	320	380
C22	6.8	4.1	7.5	2.3	1.7	0.71	9 700	6 500	340	410
C24	7.5	4.5	7.9	2.4	1.9	0.71	10 800	7 200	350	420
C27	10.0	6.0	8.2	2.5	2.0	1.10	12 300	8 200	370	450
C30	11.0	6.6	8.6	2.7	2.2	1.20	12 300	8 200	380	460
C35	12.0	7.2	8.7	2.9	2.4	1.30	13 400	9 000	400	480
C40	13.0	7.8	8.7	3.0	2.6	1.40	14 500	10 000	420	500
D30	9.0	5.4	8.1	2.8	2.2	1.40	9 500	6 000	530	640
D35	11.0	6.6	8.6	3.4	2.6	1.70	10 000	6 500	560	670
D40	12.5	7.5	12.6	3.9	3.0	2.00	10 800	7 500	590	700
D50	16.0	9.6	15.2	4.5	3.5	2.20	15 000	12 600	650	780
D60	18.0	10.8	18.0	5.2	4.0	2.40	18 500	15 600	700	840
D70	23.0	13.8	23.0	6.0	4.6	2.60	21 000	18 000	900	1 080

NOTE Strength classes C14 to C40 are for softwoods and D30 to D70 are for hardwoods.

[a] When the specification specifically prohibits wane at bearing areas, the higher values of compression perpendicular to grain stress may be used, otherwise the lower values apply.

[b] The values of characteristic density given above are for use when designing joints. For the calculation of dead load, the average density should be used.

Reference：BS5268-2:2002

BASIC PROPERTIES OF THIRTY SELECTED SPECIES

No.	Species	Strength Group	Durability Class	Air Dry Density Class lbs/cu. ft.
1	Aromata	B	1	65
2	Baromalli	C	2	35
3	Cedar, White	C	2A	35
4	Crabwood	C	1	35
5	Duka	D	2	30
6	Dukali	D	2	30
7	Fukadi	C	2A	45
8	Futui	D	2	30
9	Greenheart	A*	1A**	65
10	Haiariballi	D	2	35
11	Hububalli	D	1A	40
12	Kabukalli	B	1	50
13	Kakaralli, Black	A	1A**	70
14	Kirikaua	D	2	35
15	Kurokai	D	2A	35
16	Locust	B	1	55
17	Manni	C	1	45
18	Manniballi	B	1	55
19	Maporokon	D	2	35
20	Mora	A	1A	65
21	Morabukea	A	1A	65
22	Purpleheart	A	1	60
23	Shibadan	B	1	40
24	Silverballi group	D	1	40
25	Simarupa	D	2	30
26	Suya	D	2	35
27	Tatabu	B	1	65
28	Tauroniro	B	1A	55
29	Wallaba	B	1A	60
30	Wamara	A	1A	75

* *See also special design stresses for greenheart*

** *Highly resistant to marine borer attack.*

1.041 tf/m^3

「The Guyana Grading Rules for Hardwood Timber」
Forest Department,
Georgetown, Guyana.
September, 1974

③ If steel sheet piles were used, the total weight of the equipment would be around 100t (1.2-2.0 tf/m^2). The bearing support of the embankment would not be enough and the weight of the equipment would have to be limited. There would also be other problems such as the combination of equipment (pontoon and crane). Machines could not be used as the current load bearing capacity Qa is 0.5-1.0 tf/m^2 and smaller than 1.2-2.0 tf/m^2. The total weight of equipment would be around 100tf and there would be issues in road reinforcement at the time of equipment transportation and in transportation of heavy items by pontoon. Procurement of equipment in Guyana would also be difficult.

On the other hand, the wood material can be locally procured and can be constructed with machines with a low bearing capacity.

④ The use of steel products would require higher costs for equipment and materials, compared with wood products.

<u>in comparison with concrete structures</u>

① Components of water used for cast-in-place concrete

The water of the conservancy used for cast-in-place concrete contains lignin sulfonic acid, which would delay the strength development of concrete. The tap water contains the same element.

② Structures made with high-quality ironwood will be superior to concrete structures.

The above-described wood has the same level of strength as concrete or even higher. Construction with wood materials can achieve the same level of functions and strength as concrete structures.

③ Unlike concrete, wood materials do not have chemical corrosion, which occurs with concrete, and therefore are more durable than concrete.

2) Overall policy

① Economical facility plan shall be developed in consideration of meteorological conditions, time period required for equipment and material procurement, appropriate work methods etc.

② Safety plan shall be developed in consideration of traffic and pedestrians on the roads around the work sites or used for material transportation and be reflected in the work plan.

③ For smooth implementation of the rehabilitation work of the Project, a close communication system shall be established among the GOG, the EDWC personnel, parties involved in work in adjacent areas, consultants and contractors.

3) Countries eligible for equipment and material procurement

① General information

Among equipment and materials to be procured for the Project, major steel products distributed in Guyana are imported from EC countries, USA, China etc. As the domestic market for steel products for civil engineering is small, foreign manufacturers do not have directly owned distributors but have an agency agreement with local sales companies. As for wooden products, materials produced in Guyana shall be used.

In case of test devices, painting materials, antiseptic agents and other products that are not available in Guyana have to be procured directly with foreign vendors.

② Issues in procurement

As a result of interviews with relevant personnel concerning materials to be used for rehabilitation work of the facilities, the following issues have been identified.

a. Distributors of material

In Guyana there are no trading companies dealing with materials. Under a basic policy to sell proven products that satisfy international standards, material distributors purchase steel products mainly from EU countries and USA. However, Indian and Chinese products have a price advantage and are widely distributed in Guyana as key items of the distributors although they have quality issues.

b. MOA and NDIA

MOA and NDIA are aware of the market environment described above. When MOA and NDIA procure materials, it is difficult to limit countries of origin due to the terms for bidding. As a result, they select products based on the price competitiveness. Prices of Chinese and Indian products are around 90-70% compared with products from EU and USA.

As for steel products and other import materials used as members, standards and design strength shall be clearly shown in design drawings and specifications so that high-quality products will be used.

③ Countries eligible for material procurement (steel products)

Construction materials distributed in Guyana and procured by MOA and NDIA tend to be inexpensive and low-quality. However, as the use of such products might impair the safety and durability of the facilities and therefore the effect of the Project, they should be excluded from procured materials. Therefore, it has been decided that quality and standard measurements shall be clearly defined in design drawings and specifications and the use of products from EU and USA shall be encouraged.

④ Wooden products

Among wooden products, piles, boards and pillars can be procured in Guyana and are generally distributed in the country. The use of wooden materials that satisfy BS and ASTM standards and other wooden product standards of Guyana shall be encouraged. As the use of problematic products might impair the safety and durability of the created

structures and therefore the effect of the Project, defective products and low standard products should be eliminated. Therefore, it has been decided that quality, measurements and other standards shall be clearly defined in design drawings and specifications and the use of quality products shall be encouraged.

Table 2.3.9 shows a list of major materials.

Table 2.3.9 List of Major Materials

Item	Specification	Quality certificate
Ocotea radiaei		
Timber Pile	φ355～455mm	BS
Timber Sheet Pile	t=25,50mm	BS
Timber Waling	300～150mm	BS
M.S. Bolt & Nut	W1/2” 0.65～0.85	BS
Chemical Anchor Bolts	φW1/2	BS・ASTM
Tie rod and Connector	φ30mm ℓ= 10 m	BS・ASTM
Tie rod and Connector	φ30mm ℓ= 15 m	BS・ASTM
Cement	OPC	BS ・ASTM
Sand	Natural sand	BS ・ASTM
Aggregates	Max 20mm	BS ・ASTM

2.3.4.2 Precautions for Procurement

(1) Duty exemption procedures

Equipment and materials for the rehabilitation work of the facilities shall be import products distributed in Guyana. Orders will be placed after contracts are signed and no materials will require steel roll production or request for new production. Therefore no item will require duty exemption procedures.

(2) Transportation

There will be no transportation cost for equipment and materials to be procured for rehabilitation work of the facilities.

(3) Construction contract

NDIA bidding is conducted according to the clauses of a civil engineering work agreement of Guyana. After bid opening, a bid examination agency examines technical matters and quoted prices and then successful bidders are selected.

Although major construction companies other than those mentioned above do not show great differences in construction ability, quality and supervision of work, past construction record suggests low accuracy in management.

2.3.4.3 Execution Classification

The scope of rehabilitation work of the Project is as below. Procurement items are not included in the rehabilitation work of the facilities.

Scope of Construction

- The Japan side shall conduct the followings.
  - ① Consulting services of assistance to bidding and supervision of work
  - ② Rehabilitation work of the facilities
- There are no items to be conducted by the Guyana side.

2.3.4.4 Execution Supervision and Procurement Management Plan

(1) Basic policy of supervision of work plan

Supervision of work of the Project shall be conducted by a Procurement Management Agent, which will have a contract with a government organization of Guyana.

For the execution of rehabilitation work of the facilities, an implementation structure with personnel with abundant experience in execution design and supervision of work, especially in consideration of the following matters.

Details of persons in charge of and points to consider for execution design and supervision of work

① Contents of Exchange of Notes (E/N) between the two GOG and Japan and Grant Agreement (G/A) between the GOG and JICA shall be observed.

② The Grant Aid Scheme shall be fully understood.

③ Contents of the Preparatory Survey Report shall be understood and rehabilitation work shall be carried out quickly and without any mistakes.

(2) Operations

1) Execution design

- fund management
- preparation of bidding documents and delivery of design drawings
- bidding
- bid evaluation

・facilitation of contract with contractors

2) Supervision of work

・examination of contract drawings

・preliminary quality research of materials to be used

・observation of quality and supervision of work inspection and inspection

・observation of completed work test and completion test

・confirmation of delivery

・construction schedule management and fund management

Roles of the Procurement Management Agent and the consultant are as follows.

Services to be provided by the Procurement Management Agent

According to G/A, services to be provided by the Procurement Management Agent shall be defined in the agency contract between NDIA, which is the implementing agency, and the Japanese procurement agent. The services to be provided by the Procurement Management Agent are shown in Table 2.3.10.

Table 2.3.10 Duties of Procurement Management Agent

Duty	Contents
Bidding management	Contract with the principal contractor Preparation of bidding documents Bidding and contract with contractors Evaluation of open bids Contract with contractors
Supervision of Work	Fund management Management and supervision concerning design change, quality and construction defects
Selection of lawyer	-

Services to be provided by the construction consultant

According to G/A, services to be provided by the supervision of work、consultant shall be defined in the supervision of work contract with the procurement agency, which is the executing organization. The supervision of work services are as shown in Table 2.3.11 Duties of Consultant.

Table 2.3.11 Duties of Consultant

Duty	Contents
Bidding assistance	Assistance to the Procurement Management Agent for bidding Assistance in creation of bidding documents Assistance in evaluation of open bids
Supervision of Work	Management of amount of completed work and preparation of design change documents Management of execution and quality of Work and execution schedule

(3) Assignment plan of supervisors

1) The consultant shall dispatch construction supervisors to the sites to manage rehabilitation work of the facilities.

2) The procurement agency shall dispatch construction supervisors to manage rehabilitation work of ancillary facilities. They shall also provide management and supervision concerning fund operation, design change and construction defects. The defect liability period shall be stated in the Conditions of Contract. The agency shall also dispatch a leader for inspection at the end of the construction, for delivery inspection and for completion inspection.

3) The leader and the sub-leader shall conduct matters related to project progress management and fund management. The sub-leader shall be dispatched to the sites when construction and repair work of the facilities are completed. A clerical worker shall also be assigned in Guyana to assist services of the Procurement Management Agent for rehabilitation work of the facilities.

4) For the selection of these supervisors, considerable experience, ability to make proper technical decisions and coordination ability shall be the criteria.

2.3.4.5 Quality Management Plan

Quality management for rehabilitation work of the facilities shall be conducted as shown in Table 2.3.12 List of Items for Quality Management.

Table 2.3.12 List of Items for Quality Management

Item	Test	Timing	Frequency
Steel products			
Reinforcing steel	Tensile, bend and material analysis	Before use and sampling	For each lot and material
Steel plates, mold steel, bolts, nuts, tie rods	Tensile, bend and material analysis	Before use and sampling	For each lot and material
Fresh concrete (material test)	Materials used (cement, fine aggregate, coarse aggregate, additives etc.)	Before use	
Fresh concrete (periodic management test)	Materials used	At the end of every month	Once a month, for each lot of cement
Fresh concrete (daily management test)	Slump, air quantity, concrete temperature, compressive strength	Day of use Compressive strength test on $7^{th,}$ 28^{th} and last day of every month in addition to day of use	At the time of casting
Raw wood (material test)	Wooden piles: moisture content, bend, elastic coefficient, compression and breaking strength	Before use and sampling	Once before use
Raw wood (daily maintenance test)	Tensile, bend and breakdown	At the end of every month	For each lot, material and place of production
Processed wood (material test)	Pillar and board material: moisture content, bend, spring constant, compression and breakdown strength	Before use and sampling	Once before use
Processed wood (daily management test)	Tensile test, bend test and breakdown test	At the end of every month	For each lot, material and place of production
Tie rod bolt and nut tightening test	Bold tightening test (standard value to be set)	Before work	Once before use
Test piling	Piling management test	To be conducted with test piles before construction	In each work site
Soil standard test	All standard test items	Before use	In each site
Soil standard test (daily management of bank soil)	All daily management test items	On the day of construction	On the day of construction
Model banking	Bank soil quality management items	Before banking work	Once before test banking
Item	Test	Timing	Frequency
Bearing test of natural ground	Simple cone penetrator test	On the day of construction	On the day of construction
Paint and antiseptic agent	Selected test items	Before use	For each material
Painting test	Coating thickness	On the day of construction	On the day of construction
Daily management test of paint and antiseptic agent	Selected test items	On the day of construction	On the day of construction

Other materials shall be tested before use in the test items specified for the material and the result shall be reported to the construction supervisor.

All the items of the quality management tests for rehabilitation work of the facilities are already conducted in Guyana except some quality management items for banking soil. Therefore the tests can be easily carried out by local engineers.

Banking should be managed according to the management standards for viscous soil banking, i.e., with saturation degree or air content ratio. As such management methods are not employed in Guyana, instructions and training shall be provided so that construction engineers and NDIA and the EDWC staff will master the methods.

2.3.4.6 Procurement Plan of Materials and Equipments

(1) Supplier

The procurement policy for construction materials are as follows.

1) Procure locally-produced products whenever possible.
2) Procure imported products in case they are constantly distributed in the market of Guyana. Procure steel products that are produced by order placed after the construction order.
3) Equipment and materials of which local procurement is difficult shall be procured from Japan or a third country.
4) Points to consider concerning procurement for each facility
   - For intakes and relief sluices, use materials produced and processed in Guyana except steel products. Use steel products that are procurable in Guyana and match the design drawings and specifications. Before using any material, submit application and get approval from the construction supervisor.
   - Select a production company that carries out production in Guyana, whose products can be easily rehabilitated, whose parts can be easily obtained and procured, and that has a well-established support system for dispatch of facility engineers and transportation of materials.
   - Select products that can be easily maintained and managed and whose structure allows easy part replacement and rehabilitation by rangers and other relevant personnel at the time of inspection.
   - If the same types of products as those currently used in other facilities are selected, the inspection and maintenance personnel can easily conduct repair and provide maintenance instructions.
   - Considering the maintenance and rehabilitation work with acid water and at high temperature and high humidity, select rustproof paints and lubricant oil and apply/fill them regularly.
   - Replacement and repair parts can be easily procured as the manufacturers have agents and factories in Guyana, and the EDWC staff and rangers are used to maintenance and

rehabilitation of existing structures. Therefore, procurement, rehabilitation and replacement of parts can be easily conducted in Guyana.

- Rustproof materials and plated parts shall be ordered and procured overseas
- Metal materials for doors and relief sluices shall be procured from EU countries or USA.
- In case doors, spindles, handles, hoisting machine etc. can not be repaired in Guyana, they shall be transported to EU countries or USA for repair.
- Adjustment of doors, guides and attached components shall be conducted by engineers of a door production company in Guyana. As for fine adjustment, water leakage control and such other issues that might occur during production, a Guyana door production company shall conduct actual test (sluice gate standards) before carrying and installing at the sites.
- Replacement and rehabilitation of intakes and relief sluices will be conducted by a Guyana door production company at the sites. On such occasions, request the presence of NDIA and the EDWC personnel, rangers and/or other engineers and provide training concerning technical guidance, inspection and maintenance methods. Wood processing shall be conducted at the factory as the material is iron wood. If materials need to be added or attached, it should be conducted with the consent of the supervisor.

5) Wood structures for the construction of parapet and wing walls

- For parapet and wing walls, use wood materials specified in BS or ASTM. Submit the results of material tests such as compression test and bent test and get approval before using materials.
- In case there is a knot or breakage, calculate the reduction of design strength using a predefined formulas and use materials that meet the specification.
- Use materials that have the required strength after checking cuts, holes, nailing etc. based on the production standard for wooden structures.
- Whether to use or discard wood materials broken by equipment should be decided according to the supervisor's instruction.
- Select painting materials to improve durability of wooden materials that meet the usage standard and apply the specified quantity.
- Wood materials used for wood structures can be easily procured as they are produced and sold in Guyana. It is also easy to procure prescribed products as they are available in the market and manufacturing order can be placed.
- Tie rods, bolts, nuts and such other steel products shall be procured from overseas as there are no production/processing factories for plating or rust-proofing in Guyana.

6) Banking materials and construction

- Conduct standard tests specified in the standards and set criteria for supervision of work

before using materials for the embankment, back filling, bank replacement etc.

- For construction, conduct daily management tests at prescribed intervals to confirm the quality is maintained.
- Understand the local construction conditions and soil conditions and determine standards for equipment, number of times of compaction, natural moisture content of banking soil etc. to achieve the desired quality. Also carry out model construction before selecting equipment.
- Testing equipment for the management method and laboratory procedures for banking materials shall be procured from EU countries or USA as they are not available in Guyana.

As a result of the local survey, it has been confirmed that general materials (steel products, wooden products, concrete-related materials, bank soil etc.) and drain pipes are either produced in or imported to Guyana. Steel products for relief sluices and related members are also distributed in the local market. Moreover, it has been confirmed that the materials distributed in the country satisfy the standards and measurement specified in the Project design.

Therefore, materials for the Project shall be procured in Guyana.

Materials shall be procured as shown in Table 2.3.13.

Table 2.3.13 Material Procurement

Material				Note
	Guyana	Japan	Third country	
Cement	●			Imported product
Concrete aggregate and road aggregate	●			
Steel products	●			Imported product
Wooden products (pile, pillars and boards)	●			
Drain pipes	●			
Soil test devices		●		

As for the equipment, construction companies in Guyana own excavators, cranes and paving equipment. As for pontoons, towboats and ferry boats, construction companies do not own many of them and it is difficult to get enough number of such items for the Project. We need to consider renting such items from a leasing company or construction companies that have failed to get the contract.

(2) Transportation route

The transportation routes for rehabilitation work of the facilities are as follows.

1) Equipment and equipment

As a basic rule, equipment and material shall be carried to the Land of Canaan management office by truck or trailer, and then to the work site by pontoon.

2) Imported materials and large-size materials (wooden piles)

Steel products and other imported materials shall be carried to the Land of Canaan management office by trailer or truck after discharged at Georgetown port, and then to the work site by pontoon.

Large-size materials (wooden piles) shall also be carried to the Land of Canaan management office by trailer from the place of production or the processing factory, and then to the work site by pontoon. Greenheart wood shall be carried by pontoon as the density is around 1.00 and it sinks if not dry.

2.3.4.7 Plan of Soft Component

(1) Background of the planning of the Soft Component

This Project is composed by two components; procurement of equipment for repair works of the embankment (Component-1), and rehabilitation of the facilities (relief sluice/intake) (Component-2). In order to maximize the effect of the Project, restoration works for the embankment must be executed appropriately by the procured equipment (super-long arm excavators and pontoons), and the embankment or the facilities must be continuously utilized while implementing inspection, maintenance, and management. Consequently, the quality and construction supervision and inspection and maintenance management capacity of the related staff for the maintenance management of the water conservancy must be improved. Therefore, the necessity of the soft component (technical cooperation) for improving the quality and construction supervision and inspection and maintenance management capacity related to restoration of the embankment and the facilities is extremely high, for the purpose of enhancing the sustainability of the output of the Project.

(2) Objective of the Soft Component

The objective of the Soft Component is to help concerned personnel of the EDWC acquire knowledge on quality and construction supervision for restoration of the embankment and the facilities by the procured equipment, as well as for the appropriate maintenance management of the facilities, for a sustainable and stable operation of the water resource, while reducing the flood damages.

(3) Output of the Soft Component

Table 2.3.14 shows the expected outputs of the soft component.

Table 2.3.14 Output of the Soft Component and the Method of Validation

Output	Content	Method of validation
Output 1: (Improvement of capacity for quality and construction supervision for repair of the dam body and ancillary facilities)	Documented manuals for the quality and construction supervision of repair of the dam body and ancillary facilities are created and utilized.	Validate the proficiency and understanding by visual inspection or records of the ledgers such as management record, etc. and check whether the quality and construction supervision were compliant to the manual.
Output 2: (Improvement of capacity for inspection and maintenance management of the dam body and ancillary facilities	Inspection and maintenance management manuals for the dam body and ancillary facilities of the water conservancy is created and utilized.	Validate the proficiency and understanding by visual inspection reports or creating maintenance management records, and check whether the inspection and maintenance management and planning were compliant to the manual.

(4) Validation of the Outputs

The method for the validation of the outputs is as shown in Table 2.3.14.

Detail description on plan of Soft Component is given in Appendix-5.

2.3.4.8 Implementation Schedule

Implementation schedule of this Project is shown in Figure 2.3.8.

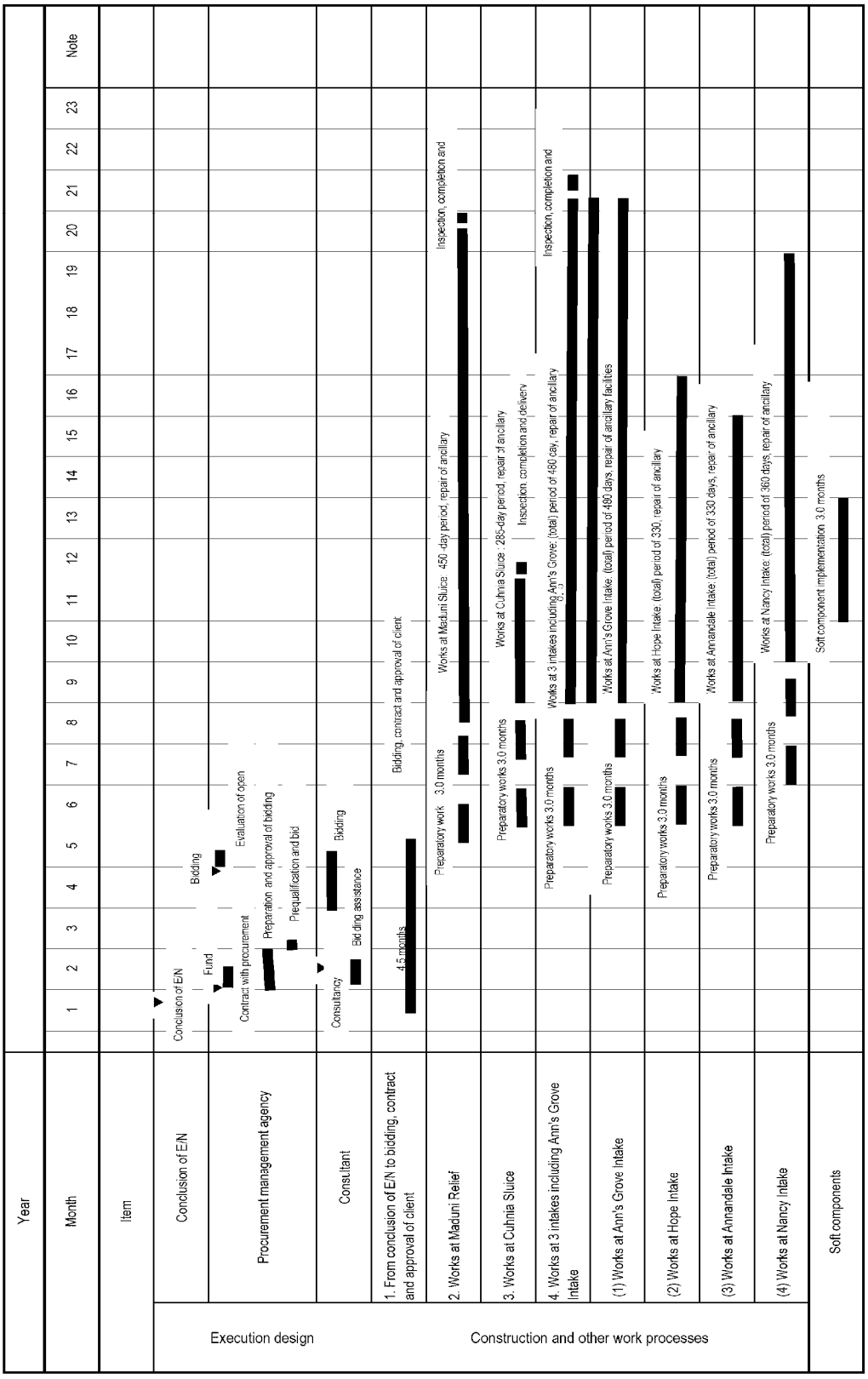


Figure 2.3.8 Implementation Schedule of Rehabilitation Work

2.4 Obligations of Recipient Country

2.4.1 Component-1：Procurement of Equipment

Along with the progress of the procurement of equipments by Japan, Guyana shall proceed with the following items as shown in Table 2.4.1, under the responsibility of Guyana.

Table 2.4.1 Items under the Responsibility of Guyana

Item	Items under the responsibility of Guyana
1. General	・Application/obtaining authorization from concerned agencies (import tax, tax exemption for custom clearance) ・Procedure for Banking Arrangement (B/A), etc. ・Bear banking commission for opening account, etc. ・Assurance for offloading at port, custom clearance, domestic transport, for the procured equipments. ・Apply for tax exemption for customs, inland tax, and other taxation for the procured equipments ・Accommodate entry, departure, or stay of consultant or equipment supplier, etc. involved in the project ・Ensure safety for activities concerning the project
2. Preparation for procurement of equipments	・Secure and organize storage for equipments
3. Preparation for installation of equipments	・Secure and organize space for assembling pontoons, and arms to excavators (Canaan) ・Secure location and personnel for welding technique training for repair, etc. of pontoons ・Secure electric power for welding
4. Guidance for initial operation	・Employ and allocate personnel for operation, maintenance, management, and safety management ・Prepare operation, maintenance, and management records ・Select initial operation guidance recipients
5. Organizational structure	・Assign and employ appropriate personnel for machine operators and workshop
6. Operation and maintenance of equipment	・Implement appropriate operation, maintenance, management, and safety management of the equipments

2.4.2 Component-2：Rehabilitation of Facilities

Along with the progress of the rehabilitation work of the facilities, Government of Guyana shall proceed with the following items as shown in Table 2.4.2, under the responsibility of Guyana.

Table 2.4.2 Items under the Responsibility of Guyana

1. General	・Procedure for banking Arrangement (B/A), etc. ・Bear banking commission for opening B/A account, etc. ・Accommodate entry, departure, or stay of Procurement Management Agent or consultant involved in the Project ・Ensure safety for activities concerning the Project ・Application/obtaining authorization from concerned agencies (import tax, tax exemption for custom clearance)
2. Preparation for procurement of equipment and materials	・Secure and improve a site for storage and discharge of construction materials and equipment, transport equipment etc. (Land of Canaan Management Office).
3. Preparation for implementation of soft components	・Secure necessary human resources, training facilities and equipment. ・Secure budget for labor, training facilities and equipment. (Equipment: test devices such as simple cone-penetrometer, molds for unconfined compression test, curing tank, test sample push-off device)

2.5 Operation and Management Plan of the Project

The equipments procured in the project shall be operated, maintained and managed under the responsibility of the Workshop of NDIA and the management offices of the EDWC. The equipments shall generally be used for fundamental development as well as rehabilitation, maintenance and management of the EDWC in a long-term.

Figure 2.5.1 shows the organizational chart of NDIA which is the superior organization responsible for the management offices of the EDWC. NDIA, the executing body, consists of the following four sections; Operation & Maintenance, Finance & Administration, Construction & Design and Community Drainage & Irrigation Project, under the CEO (Chief Executive Officer). Operation and Maintenance Section which is in charge of the maintenance and management of the equipments procured in the project, shall form the organization as shown in the Figure 2.5.2, after the completion of the Workshop at Lusignan. Table 2.5.1 shows the plan of member composition of the Workshop. It is planned to develop with completion of the Workshop and an increase of number of equipments in charge of in the future. Additionally, for the purpose of reducing repair cost and time period required for repair work of equipment, it aims at expanding range of repair work which is manageable by them. Skilled technicians are planned to be hired at the Workshop,

and moreover, technical training programs are being planned.

The machine operators (drivers) shall be outsourced to local firms which undertake maintenance execution work by the management office of the EDWC. Additionally, NDIA is planning to expand the manpower for the Workshop, since number of excavators and pontoons are planned to increase for the construction of the discharge channel at Hope/Dochfour, and for rehabilitation work of the discharge facilities.

Therefore, required number of equipment will be ensured, and manpower will be also secured.

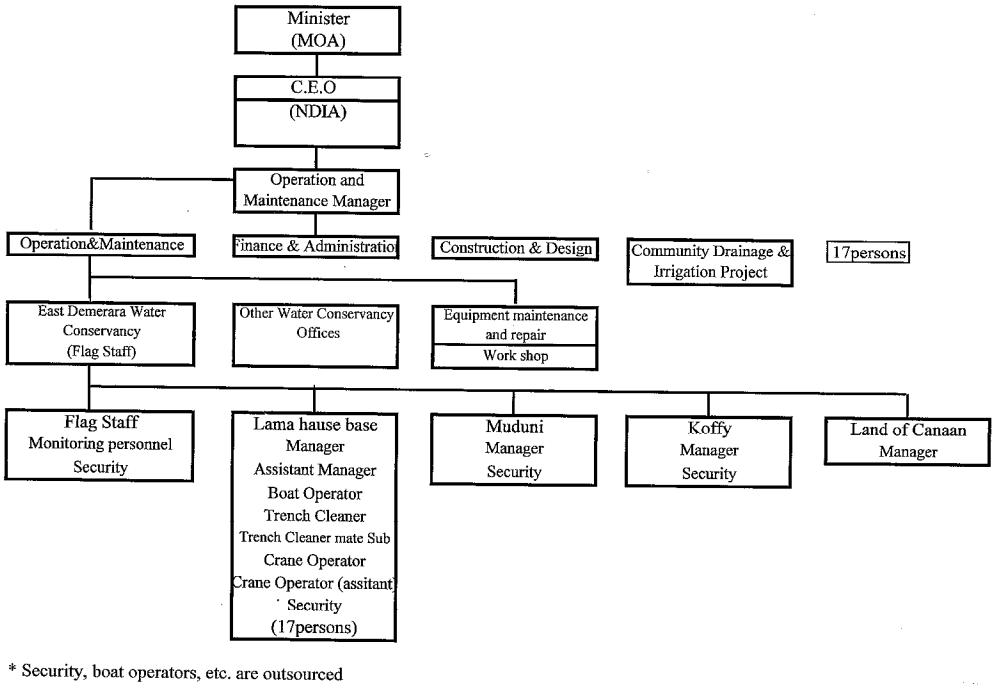


Figure 2.5.1 Organization of NDIA

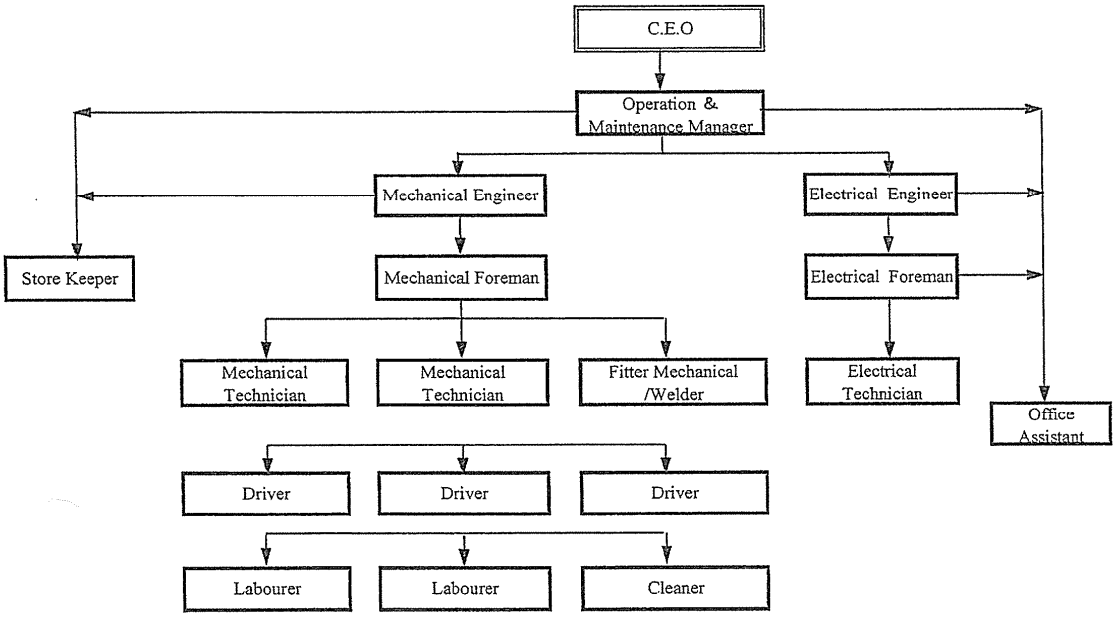


Figure 2.5.2 Organization Plan of Workshop

Table 2.5.1 Member Composition Plan of Workshop

NAMES	STAFF DESGINATION	AMOUNT REQUIRED
Avinash Singh	Operation and Maintenance Manager	1
Aneel Chowbay	Mechanical Engineer	1
Dhanraj Bachai	Electrical Engineer	1
S.Omram	Mechanical Foreman	1
Nil	Electrical Foreman	1
Nil	Mechanical Technician	1
Nil	Mechanical Technician	1
Nil	Fitter Mechanist /Welder	1
Nil	Electrical Technician	1
James McRae	Store Keeper	1
Nil	Office Assistant	1
Nil	Driver	1
Nil	Driver	1
Nil	Driver	1
Nil	Labourer	1
Nil	Labourer	1
Nil	Cleaner	1
	Total Staff Required	**17**

2.6 Cost Estimation

2.6.1 Initial Cost

(1) Cost borne by the Government of Guyana

- Component-1
  - Notification of fee for the authorization to pay (A/P)
  - banking commission
  - others (issuing certificates, etc.)

    160×10^3 GUD (approx. 0.07 million JPY)
- Component-2
  - fees
    - Notification of fee for the authorization to pay (A/P)
    - banking commission
    - others (issuing certificates, etc.)

      910×10^3 GUD (approx. 0.37 million JPY)
  - measuring instruments for Soft Component.

    125×10^3 GUD (approx. 0.05 million JPY)

Total $1,035 \times 10^3$ GUD (approx. 0.42 million JPY)

（2）Parameters of Cost Estimation

Time of cost estimate: October 2010

Exchange rate: 86.97JPY/1USD

Construction Period As shown in the implementation plan

Others: This plan will be put into execution in accordance with the Grant Aid scheme of the Government of Japan

2.6.2 Operation and Maintenance Costs

In Guyana, maintaining the function of the EDWC continuously is focused on as a significant factor for the economy and sustainable society of Guyana, so that approx. 2.4 billion GUD in total, including approx. 1.2 billion GUD for the project expenses is allocated to NDIA in 2008 to 2010. It is also estimated that 200 million GUD is added for 2010 as budget for the discharge channels of Hope/Dochfour, and Cunha, etc.

The budget allocated for the maintenance and management of the EDWC is as shown in Table 2.6.1 53 million GUD is allocated for 2010, therefore necessary budget for the operation of the equipments is ensured.

Table 2.6.1 Operation/maintenance/management cost for the EDWC (unit: 1,000GUD)

	2008	2009	2010	2011 (planned)	Note
Management office of the EDWC	52,700	53,000	53,000	54,000	Including supplementary budget
(reference) persons	17	17	17	25	

* Above costs include outsourced operator (driver), patrol, and manager of the discharge facility

Costs necessary for equipments after the procurement are shown in Table 2.6.2. The costs are calculated based on the actual figures of 2009, however, approx. 12,000 GUD (around 23% against the budget of the management office of the EDWC and 0.5% against the budget of NDIA) increase is indicated, which can be borne by Guyana without difficulty if compared to the budget of NDIA. Therefore, the project is feasible.

Table 2.6.2 Maintenance/management cost of the procured equipments (unit: 1,000GUD)

Contents of burden	Quantity	Cost	note
Manpower cost like drivers, etc.	1 set	4,611	Additional cost for 8 drivers
Fuel cost	1 set	2,248	Fuel cost for 8 excavators
Maintenance cost	1 set	5,492	
Total		12,351	

2.7 Precautions for Implementation

As EDWC facilities are getting old and the embankment and the facilities have deteriorated and have a lower strength, periodic inspection should be conducted and a maintenance and rehabilitation plan based on the result should be carried out in a phased manner.

Currently there are 17 staff members in the EDWC Management Office, but there is still a shortage of engineers and skilled workers with expertise and a full understanding of inspection and maintenance procedures to carry out maintenance and rehabilitation of the vast EDWC and many facilities. Therefore, workshop seminars should be held for the staff members including contractors at the time of inspections and checks during the construction period to improve the knowledge in technologies and management of the current staff members.

Chapter 3 Evaluation of the Project

Chapter 3 Evaluation of the Project

3.1 Prerequisites for the Project

3.l.1 Prerequisite Task for the Implementation

(1) Land

The super-long arm excavators and the pontoons which subject to the procurement in Component-1 are to be procured in Japan, then sea transported and discharged at Georgetown port in Guyana. After that, public roads shall be used for the land transport of their segment parts, and assembly of them is to be made within the premises of the NDIA, and accordingly they do not involve passing through private land or temporary lease of land, therefore land acquisition is not an issue in Component 1.

As the relief sluice of Sarah Johanna which is subject to the rehabilitation work in Component 2 is located just beside the public road, it is anticipated to interfere with adjacent road. Therefore it is deemed necessary to apply for permission of partial occupancy of the roads in advance. Other facilities (5 facilities) which subject to the rehabilitation are located either within the premises of NDIA or within the outfall channel right-of-way, therefore, are not required for land acquisition or lease of land, etc.

(2) Environmental and social impact

As for the environmental clearance involved in this Project, NDIA acquired the permission from the Environmental Protection Agency on February 2011, therefore Detailed Environmental Impact Assessment is not required. However, following items that have been rated as "B" for the environmental scoping are required for monitoring during the rehabilitation work execution;

- National road by Sarah Johanna relief sluice: Measurement of damages to the road or degree of wear on paved surfaces anticipated to be caused by transporting materials and heavy machinery, and their loading/unloading work.
- Water quality of the Nancy intake: Measurement of degree of water contamination due to earth work – this intake is the source for the drinking water of citizens of Georgetown.
- Soil contamination: Measurement of pH for the impact assessment of the soil when using cement for earthwork.

(3) Responsibility of the recipient country

1) Storing procured equipments

The procured equipment shall be stored at the management office of the EDWC. Maintenance or repair for the equipment, when necessary, is planned to be conducted at the

management office and also at workshop of Lusignan under the supervision of NDIA. Therefore, the workshop building and its ancillary facilities must be completed by Guyana side.

2) Customs clearance of equipments

Guyana shall exempt the taxation for the equipment supplier (Japanese company), upon customs clearance for delivery of equipments.

3) Accommodating equipments and materials

There are no access roads to the facilities that are subject to the rehabilitation, besides the relief sluice of Sarah Johanna. An ideal location for transferring large and heavy equipments shall be Land of Canaan, where the EDWC management office is located by the paved road with wide width. Land of Canaan is also well positioned as a starting point for transporting equipments and materials to the facilities rehabilitation sites through the Conservancy canals. Therefore, the premises area at Land of Canaan is required to ensure space and to properly arrange for storing and relaying materials, machinery and land conveyors for the rehabilitation execution purposes.

4) Technology transfer for rehabilitation of facilities

Upon supervising the rehabilitation work, the consultant is planning to conduct practical trainings for the staff engaged in the maintenance and management of the EDWC facilities, for improving their skills and transferring technology related to quality control, execution supervision and inspection/maintenance management after the completion of the rehabilitation work. Followings are also the responsibilities of the Guyana.

- Securing an indoor training room and gathering related personnel
- Preparation of base equipments necessary for the practical training (cone- penetrometer － a simplified measurement instrument for measuring the strength of soil by inserting it into cohesive soil to measure its resistance －, as well as small equipment such as molds for unconfined compression test, test sample push-off device, etc.)

3.1.2 Prerequisite Conditions for Achieving Entire Plan of the Project

(1) Cooperation with other donors

The main factors for the flood that attacked the coast area of Guyana in January 2005 were due to concentrated heavy rain that occurred in approx. once every 1,000 years, and the door operation management of relief sluices of the EDWC. More specifically, the embankment of the EDWC did not collapse, but the Conservancy water overflew the embankment. When the relief sluices set at the Mahaica river were opened to discharge, it caused a major flood in

the downstream (coast area). Sea level rise, adverse gradient of bed of the Mahaica river and the lack of flow capacity of the river also were attributed to the factors of the inundation.

To cope with the heavy rainfall of the same scale that may occur in the future, construction of a new relief channel (Hope/Dochfour) is in progress, which is intended to improve the discharge capacity of the EDWC. Although this relief channel has a large capacity, the conservancy water level may exceed the limit level of 58.5ft in case of heavy rain, even when discharging simultaneously with the existing six relief sluices (Based on the simulation result "Report (Draft) on the EDWC Northern Relief Channel at Hope/Dochfour", Dec. 2009, NDIA).

This Project is for heightening / enhancing the embankment and rehabilitating the facilities, therefore when combined with the relief channel of Hope/Duchfour, the Project can contribute to the proper function for flood control, stable irrigation and drinking water supply, even under the high EDWC water level around the limit level during flood season.

(2) Inspection and maintenance management of embankment of EDWC

Regarding the execution supervision of the Project, a cone-penetrometer is planned to be employed in the quality control of cohesive soil instead of the sand replacement method, which requires long hours due to its complex measuring processes. The cone-penetrometer enables prompt and simplified measurement for the quality control, therefore is ideal to be used for the daily and periodic maintenance and inspections that shall be carried out by the staff of the EDWC after the completion of the Project.

3.2 Evaluation of the Project

3.2.1 Relevance

In Guyana, fall in the average annual rainfall and a rise in rainfall intensity arising from the effects of climate change are predicted. With respect to these, it is urgently required to rehabilitate the EDWC in states to secure water resources for dry seasons by managing the Conservancy water in high level, and to appropriately drain the restored water in cases of torrential rainfalls. With operations of the super-long arm excavators and the pontoons for the embankment rehabilitation work, the Project can contribute to preventing overflow or collapse of the embankment and improve its safety even if the water level exceeds the safe highest high water level of 58.5ft., and also it can contribute to maintaining high Conservancy water level, while improving the discharging efficiency and lowering the water level by rehabilitating the aged relief sluice and intake structures, as well as eliminating vulnerabilities of the surrounding embankment.

As for sea water, the sea level rise of Guyana from 1951 to 1979 was 10mm/year in an average, according to the sea water level records, and an impact of the sea rise due to global greenhouse effects has been worried. On the western side of the EDWC, the Conservancy water is discharged from the relief sluices via channels to the Demerara river, where the water level of the river is linked to and more or less the same as the sea level off Guyana. This suggests that the discharge capability will lower at the time when the tide is at its highest, impeding the lowering of the water level of the EDWC during times of flooding. With respect to this, the Project can make possible to manage high water level of the Conservancy and appropriate drainage operation by heightening and strengthening the vulnerable points of the EDWC embankment, together with rehabilitation of the aged relief sluice and intake structures as well as the surrounding embankments.

Considering these, the Project is adequate to the adaptation measures for the climate change.

The Project corresponds to the rehabilitation of the EDWC, Guyana is proceeding with, and includes much beneficial effects as alleviation of flooding, security of irrigation water and stable supply of potable water. Vulnerability of the EDWC to the flooding reduces with the implementation of the raising up of the embankment and the rehabilitation of the relief sluices and intakes included in the Project. In Guyana, agriculture sector with major export products of double cropped sugarcane and rice is an important industry, accounting for some 27% of the GDP. Irrigation water for the farmland of approx. 18,000 ha. between the north embankment of the EDWC and the Atlantic coast is supplied from the EDWC, therefore the rehabilitation of the EDWC facilities of this Project contributes much on it. Nancy intake facility through which the source of drinking water to Georgetown citizens is supplied, is subject to the rehabilitation. The rehabilitation of embankment and retaining walls of the intake enables stable supply of water by preventing pipe clogging of the intake structure and earth collapse of its surroundings.

As these will bring much beneficial effects over the people living downstream of the EDWC, contributing to those in stabilizing and improving their livelihood and living, the Project which is implemented as the object of Japan’s grant aid assistance is adequate.

As equipments and execution methods employed in the Project are ones of commonly used in Guyana, operation and maintenance management for the rehabilitation of the EDWC can easily be achieved with the engineering levels in Guyana. As for influence of negative impacts arising from the Project implementation to the environmental and social aspects, it will be small. Further, the application of the engineering technology employed in Japan to the execution supervision and fabrication of pontoon brings higher durability on rehabilitated facilities and procured equipment than ones fabricated with usual methods in Guyana. For example, in design of pontoon in NDIA, as it had not taken damages effects resulted from

contacts with excavator's bucket and corrosion margin into design principle of plate thickness, there were cases they did not stand for longer services. For longer use, therefore, pontoons procured in this Project are to be designed following the design specifications employed in Japan, taking corrosion margin and damages effects into consideration. And further, in some earthworks for the embankment executed in the past in Guyana, it was observed some water paths through embankment from canal side to slope end downstream, partly due to shortage of knowledge and experience on treating cohesive soils. As such a situation found around intake structures is unfavorable for securing stability of the facilities, Japanese consultants shall be assigned as supervisor to conduct quality control and execution supervision.

In consideration of those circumstances as abovementioned, it is appropriate that the Project will be implemented under Japan's grant aid assistance.

3.2.2 Effectiveness

Concerning the EDWC, the Project enables to secure equipments necessary to complete the rehabilitation of the most vulnerable parts of the embankment of 20km length by 2014, and to complete the rehabilitation of the old relief sluice and intake facilities in poor states.

The quantitative and qualitative effects of the Project are shown in the following tables.

(1) Quantitative Effects

Expected Effects	Quantitative Effects
Effect 1: Securing of equipment to rehabilitate the embankment	This will make the execution work twice as quickly as the rehabilitation work conducted with the equipment currently in possession of the NDIA. The overall schedule for rehabilitation work of the embankment will be shortened from four to two years.
Effect 2: Securing and maintaining a high limiting water level of the Conservancy in the event of the flooding	The project can raise the safe highest high-water level set forth in the Draft Water Level Management Manual for the East Demerara Water Conservancy (June 2005) from the current 57.5 feet to 58.5 feet, and improve the flood control function.

(2) Qualitative Effects

Expected Effects	Qualitative Effects
Effect 1: Alleviation of possible flood damage	The rehabilitation of the embankment and the intakes and relief sluices will improve the stability performance of the structures, leading to alleviation of possible flood damage to the residential areas (approx. 350km^2 with approx. 300,000 people) in the downstream areas of the Conservancy.
Effect 2: Stable supply of irrigation water	The rehabilitation of intakes for irrigation (Ann's Grove, Hope, Annandale and Nancy) will restore their capability to take in water, enabling to supply irrigation water stably to the farmlands (approx. 17,900ha) in the downstream areas of the Conservancy even in a dry season.
Effect 3: Stable supply of drinking water	The rehabilitation of the intake for drinking water (Nancy) will restore its capability to take in water, enabling to supply drinking water stably to the areas near the capital (approx. 40% of the water supplied population of approx. 360,000).
Effect 4: Realization of management of discharging water in the Conservancy as a whole	The rehabilitation of the relief sluices (Maduni and Sarah Johanna) will improve their capability to discharge water, enabling to control discharging water of the Conservancy as a whole in accordance with the Draft Water Level Management Manual for the East Demerara Water Conservancy (June 2005).

Effect 5: Technology transfer	The implementation of the Soft Component will improve the abilities of the NDIA personnel and security staff members, enabling to streamline the rehabilitation work of the embankment, the quality and supervision of the rehabilitation work of the facilities, and the inspection, maintenance and management of the embankment and the facilities.

After the heightening and strengthening of the embankment of the EDWC, the priority work which procured equipments accomplish are completed, it is recommended to reveal further effects of the Project through the following continuous operations.

1) Operations for ensuring Conservancy capacity of EDWC

The EDWC is quite wide as the area is 335km^2 and the storage capacity is 340 million m^3, when the water level is 57.5ft (17.53m) GD (Georgetown Datum), however, the average Conservancy depth is a mere 1 meter.

The rainfall is expected to decrease in the future. Therefore, it will be necessitated to increase storing water volume of the Conservancy by deepening the reservoir bed. The procured equipments would be of use in their continuous engagement for it.

2) Developing additional canals in Conservancy

The EDWC is mainly a catchment of the Mahaica river basin which runs on its east. On the other hand, the water is discharged from the three relief slices located in the west side embankment to the Demerara river. The embankment on the east and west sides are quite distant, around 20km, therefore have difference in the water level – higher on the east and lower on the west. If the difference of water level becomes small, the freeboard on the east embankment will increase; (embankment crest) – (conservancy water level) = (freeboard). As a result, occurrence opportunity of overflow from the embankment can be reduced. For the west side relief sluice, on the other, the discharge capacity will improve due to the increase of the water level difference by a rise of the EDWC water level.

With use of procured equipments, it is ideal to accelerate fluidization of the EDWC water in east-west direction by installing additional canals connecting the east embankment with west one.

Appendices

Appendix-1 Member List of the Study Team

On-site Investigation

Name	Responsibility	Position	Remarks
Mr. Noriaki NAGATOMO	Team Leader	Senior Advisor to the Director General Water Resources and Disaster Management Group, Global Environment Department, JICA	
Mr. Akira HAYAKAWA	Project Planning	Associate Expert Disaster Management Division 2, Water Resources and Disaster Management Group, Global Environment Department, JICA	
Ms. Denise de Souza	Procurement Planning	Crown Agents, Guyana	
Consultant			
Mr. Hidemasa TANAKA	Chief Consultant	Kensetsu Gijutsu Center, LTD.	10/8/2010 (Study begins) - 6/30/2011
	Operation and Maintenance Planning		
Mr. Takeshi MINETA	Facility Design	Kensetsu Gijutsu Center, LTD.	
	Chief consultant/ Operation and Maintenance Planning		7/1/2011 - 9/30/2011 (Study finished)
Mr. Yuichi MATSUMOTO	Equipment Planning / Cost Estimation	Sanyu Consultants Inc.	
Mr. Haruo HIKI	Equipment Planning	Sanyu Consultants Inc.	
Mr. Koji MORI	Hydrology Survey / Environmental and Social Considerations	Kensetsu Gijutsu Center, LTD.	until 11/30/2010
Mr. Satoshi HAYAKAWA		Kensetsu Gijutsu Center, LTD.	from 12/1/2010
Mr. Yuichi NISHIZONO	Construction Planning / Cost Estimation	Kensetsu Gijutsu Center, LTD.	
Mr. Shuntaro MIYOSHI	Logistics, Interpreter	Kensetsu Gijutsu Center, LTD.	cost absorbed

Component 1: Equipment Procurement Preliminary Design Overview

Name	Responsibility	Position	Remarks
Mr. Shigeyuki MATSUMOTO	Team Leader	Director Disaster Management Division 2, Water Resources and Disaster Management Group, Global Environment Department, JICA	
Mr. Akira HAYAKAWA	Project Planning	Associate Expert Disaster Management Division 2, Water Resources and Disaster Management Group, Global Environment Department, JICA	
Consultant			
Mr. Hidemasa TANAKA	Chief Consultant/ Operation and Maintenance Planning	Kensetsu Gijutsu Center, LTD.	
Mr. Yuichi NISHIZONO	Construction Planning / Cost Estimation	Kensetsu Gijutsu Center, LTD.	
Mr. Shuntaro MIYOSHI	Logistics, Interpreter	Kensetsu Gijutsu Center, LTD.	cost absorbed

Component 2: Facilities Rehabilitation Preliminary Design Overview

Name	Responsibility	Position	Remarks
Mr. Naotaka YAMAGUCHI	Team Leader	Deputy Director JICA Dominican Republic Branch	
Mr. Akira HAYAKAWA	Project Planning	Associate Expert Disaster Management Division 2, Water Resources and Disaster Management Group, Global Environment Department, JICA	
Ms. Denise de Souza	Procurement Planning	Crown Agents Guyana, Representative	
Consultant			
Mr. Takeshi MINETA	Facility Design	Kensetsu Gijutsu Center, LTD.	
Mr. Satoshi HAYAKAWA	Hydrology Survey / Environmental and Social Considerations	Kensetsu Gijutsu Center, LTD.	
Mr. Yuichi NISHIZONO	Construction Planning / Cost Estimation	Kensetsu Gijutsu Center, LTD.	cost absorbed
Mr. Shuntaro MIYOSHI	Logistics, Interpreter	Kensetsu Gijutsu Center, LTD.	cost absorbed

Appendix-2 Study Schedule

On-site Investigation

	JICA Members				Crown Agents Guyana
	Noriaki NAGATOMO Overall Coordinator	Shigeyuki MATSUMOTO Overall Coordinator	Naotaka YAMAGUCHI Overall Coordinator	Akira HAYAKAWA Coordinator/Advisor	Denise de Souza Procurement Agent
2010					
Oct.					
/11	(Departure:Japan)			(Departure:Japan)	
/12	・Courtesy visit:			・Courtesy visit:	
	Embassy of Japan,			Embassy of Japan,	
	Trinidad and Tobago			Trinidad and Tobago	
	(Arrival at Guyana)			(Arrival at Guyana)	
/13	・Courtesy visit:			・Courtesy visit:	・Meeting with JICA
	NDIA and MoFTIC,			NDIA and MoFTIC,	members
	Site visit			Site visit	
/14	・Discussion on I/R			・Discussion on I/R	・Discussion on I/R with
	with NDIA			with NDIA	NDIA
	・Discussion on M/D			・Discussion on M/D	・Discussion on M/DM
	with NDIA			with NDIA	with NDIA
/15	・Discussion on M/D			・Discussion on M/D	・Discussion on M/DM
	with NDIA			with NDIA	with NDIA
	・Signing M/D with			・Signing of M/D with	・Signing of M/M with
	NDIA			NDIA	NDIA
/16	(Departure:Guyana)			(Departure:Guyana)	
/17	(Other Mission)				
/18				(Return to Japan)	

Component 1: Equipment Procurement Preliminary Design Overview

	JICA Members				Crown Agents Guyana
	Noriaki NAGATOMO Overall Coordinator	Shigeyuki MATSUMOTO Overall Coordinator	Naotaka YAMAGUCHI Overall Coordinator	Akira HAYAKAWA Coordinator/Advisor	Denise de Souza Procurement Agent
2011					
Jan.					
/4		(Departure:Japan)		(Departure:Japan)	
/5		・Arrival at Guyana		・Arrival at Guyana	
		・Courtesy visit:		・Courtesy visit:	
		MoFTIC		MoFTIC	
		・Meeting with NDIA		・Meeting with NDIA	
/6		・Meeting with NDIA		・Meeting with NDIA	
/7		・Discussion on M/D		・Discussion on M/D	
		with NDIA		with NDIA	
		・Signing M/D with		・(Signing) M/D with	
		NDIA		NDIA	
/8		(Departure:Guyana)		(Departure:Guyana)	
/9					
/10		(Return to Japan)		(Return to Japan)	

Component 2: Facilities Rehabilitation Preliminary Design Overview

	JICA Members				Crown Agents Guyana
	Noriaki NAGATOMO Overall Coordinator	Shigeyuki MATSUMOTO Overall Coordinator	Naotaka YAMAGUCHI Overall Coordinator	Akira HAYAKAWA Coordinator/Advisor	Denise de Souza Procurement Agent
2011					
May					
/29			・Arrival at Guyana		
/30			（Other Mission)	（Departure：Japan）	
/31				・Arrival at Guyana	
			・Courtesy visit:	・Courtesy visit:	
			MoFTIC	MoFTIC	
			・Explanation on	・Explanation on	・Explanation on
			Facilities'	Facilities'	Facilities'
			Rehabilitation to	Rehabilitation to	Rehabilitation to
			NDIA	NDIA	NDIA
6/1			・Site visit	・Site visit	
			・Discussion on M/D	・Discussion on M/D	・Discussion on M/M
			with NDIA	with NDIA	with NDIA
/2			・Site inspection	・Site inspection	
			・Signing of M/D with	・Signing of M/D with	・Signing of M/D with
			NDIA	NDIA	NDIA
/3			（Departure：Guyana）	（Departure：Guyana）	
			・Reporting: Embassy	・Reporting: Embassy	
			of Japan,Trinidad	of Japan,Trinidad	
			and Tobago	and Tobago	
			（Departure：Trinidad	（Departure：Trinidad	
			and Tobago）	and Tobago）	
/4			(Return to Dominica)		
/5				(Return to Japan)	

Consultant Members

	Hidemasa TANAKA	Takeshi MINETA	Yuuichi MATSUMOTO	Haruo HIKI
2010				
10/9				
10/10				
10/11	(Departure)		(Departure)	
10/12	Arrive Guyana		Arrive Guyana	
10/13	NDIA, Ministry of Foreign Trade and International Cooperation, site inspection, Crown Agents meeting		NDIA, Ministry of Foreign Trade and International Cooperation, site inspection, Crown Agents meeting	
10/14	Minutes of Meeting		Minutes of Meeting, local consultant interview	
10/15	Collect related materials		Local consultant interview	
10/16	Collect related materials			
10/17				
10/18	Equipment manufacturer interview	(Departure)	Collect related materials	(Departure)
10/19	Equipment manufacturer interview	Arrive Guyana, investigation preparation	Collect related materials	Arrive Guyana, investigation preparation
10/20	Equipment manufacturer interview	NDIA meeting, visit local consultant	Collect related materials	Equipment procurement investigation
10/21	Equipment manufacturer interview	On-site inspection	Departure Guyana	Equipment procurement investigation
10/22	Equipment manufacturer interview	On-site inspection		Equipment procurement investigation
10/23	Geotechnical investigation, design meeting	Geotechnical investigation, design meeting	(Return)	
10/24				
10/25	NDIA meeting	Preparation of geological, soil property survey TOR		Equipment procurement investigation
10/26	NDIA meeting	NDIA meeting		Equipment procurement investigation
10/27	Preparation of geotechnical, soil property survey TOR	Preparation of geotechnical, soil property survey TOR		Equipment procurement investigation
10/28	Preparation of geotechnical, soil property survey TOR	Preparation of geotechnical, soil property survey TOR		Equipment procurement investigation
10/29	Geotechnical Investigation meeting	Geotechnical investigation meeting		Equipment procurement investigation
10/30	On-site inspection: Maduni, Hope	On-site inspection: Maduni, Hope		Departure Guyana
10/31	Joint inspection for boring at Maduni	Joint inspection for boring at Maduni		
11/1				(Return)
11/2	Equipment manufacturer interview	NDIA meeting		
11/3	Equipment manufacturer interview	Design meeting		
11/4	On-site investigation, NDIA meeting	On-site investigation, NDIA meeting		
11/5	Soil cement	Soil cement		
11/6	Survey meeting, Geotechnical investigation meeting	Survey meeting, Geotechnical I nvestigation meeting		
11/7				
11/8	Equipment manufacture interview			
11/9	On-site investigation (Hope, Anns Grove)	On-site investigation (Hope, Anns Grove)		
11/10	Equipment manufacture interview	soil cement 4 days curing test		
11/11	On-site soil cement 4 days curing test	On-site soil cement 4 days curing test		
11/12	On-site soil cement	On-site soil cement		
11/13	On-site soil cement 7 days curing test	On-site soil cement 7 days curing test		
11/14				
11/15	Departure Guyana	On-site investigation: Anns Grove		
11/16		On-site soil cement 4 days curing test		
11/17	(Return)	Preparation of design TOR		
11/18		On-site soil cement 7 days curing test		
11/19		On-site investigation (Hope, Anns Grove)		
11/20		On-site investigation: Anns Grove		
11/21				
11/22				
11/23		NDIA meeing		
11/24		Design meeting		
11/25		Design meeting		
11/26		Departure Guyana		
11/27				
11/28		(Return)		
12/13				
12/14				
12/15				
12/16				
12/17				
12/18				
12/19				
12/20				
12/21				
12/22				
12/23				
12/24				
12/25				
12/25 – 1/3				

	Koji MORI	Satoshi HAYAKAWA	Yuuichi NISHIZONO	
2010				
10/9	(Departure)			
10/10	Arrive Guyana			
10/11	Preparation of construction, investigation		(Departure)	
10/12	Preparation of construction, investigation		Arrive Guyana	
10/13	NDIA, Ministry of Foreign Trade and International Cooperation, site inspection, Crown Agents meeting		NDIA, Ministry of Foreign Trade and International Cooperation, site inspection, Crown Agents meeting	
10/14	Collect related materials		Collect related materials	
10/15	Local consultant interview		Collect related materials	
10/16	Collect related materials		Collect related materials	
10/17				
10/18	Local consultant interview, on-site investigation		Local consultant interview, on-site investigation	
10/19	Survey meeting		Survey, scheme of execution, estimate	
10/20	NDIA meeting, visit local consultant			
10/21	Ground truth		Ground truth	
10/22	Ground truth		Ground truth	
10/23	Geotechnical investigation, design meeting			
10/24				
10/25	NDIA meeting		On-site investigation	
10/26	NDIA meeting		Estimate preparation	
10/27	Survey meeting		Survey meeting	
10/28	NDIA meeting		NDIA meeting	
10/29	Geotechnical, survey meeting		Geotechnical, survey meeting	
10/30	On-site investigation (Maduni, Hope)		Departure guyana	
10/31	Joint inspection for boring at Maduni			
11/1			(Return)	
11/2	NDIA meeting			
11/3	Design meeting			
11/4	NDIA meeting			
11/5	Soil cement			
11/6	Geotechnical, survey meeting			
11/7				
11/8	Survey, NDIA meeting			
11/9	On-site investigation, NDIA meeting			
11/10	Soil cement test, NDIA meeting			
11/11	NDIA meeting			
11/12	On-site soil cement			
11/13	On-site soil cement 7 days curing test			
11/14				
11/15	On-site investigation: Anns Grove			
11/16	Soil cement curing test/NDIA meeting			
11/17	Design meeting			
11/18	NDIA meeting			
11/19	NDIA meeting			
11/20	On-site investigation: Anns Grove			
11/21				
11/22	NDIA meeting/GWI			
11/23	NDIA meeting			
11/24	On-site investigation, EPA			
11/25	On-site investigation, GWI			
11/26	Departure Guyana			
11/27				
11/28	(Return)			
12/13		(Departure)		
12/14		Arrive Guyana NDIA greeting		
12/15		Ground truth		
12/16		NDIA meeting		
12/17		Meeting with cooperative company		
12/18		Ground truth, additional survey		
12/19				
12/20		NDIA meeting		
12/21		Meeting with cooperative company		
12/22		Survey map verification		
12/23		Survey, geological condition verification		
12/24		Design calculation verification		
12/25		Departure Guyana		
12/25 − 1/3		(Stand by at New York)		
		Minute preparation		

	Hidemasa TANAKA	Takeshi MINETA	Yuuichi MATSUMOTO	Haruo HIKI
2011				
1/3	(Departure)			
1/4	Arrive Guyana			
1/5	Minutes of meeting			
1/6	Minutes of meeting			
1/7	Minutes of meeting			
1/8	Supplement investigation			
1/9	Departure Guyana			
1/10	(New York)			
1/11	(Return)			
1/12				
2/3				
2/4				
2/5				
2/6				
2/7				
2/8				
2/9				
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2/23				
2/24				
2/25				
2/26				
2/27				
2/28				
3/1				
3/2				
5/30		(Departure)		
5/31		NDIA: investigative report submission, Minutes of meeting		
6/1		Minutes of meeting		
6/2		Ground truth		
		Sign the minutes		
6/3		Meeting with Mr. Surendra, NDIA		
6/4		Organize materials		
6/5				
6/6		SRKN meeting		
6/7		Meeting with Mr. Surendra, NDIA		
6/8		Mr. Surendra,Ms.Denise TOR explanation		
6/9		NDIA：visit Hope Dutch Four		
6/10		Organize materials		
6/11		Departure Guyana		
6/12				
6/13		(Arrive)		

	Koji MORI	Satoshi HAYAKAWA	Yuuichi NISHIZONO	
2011				
1/3		(Departure New York)	(Departure)	
1/4		Arrive Guyana, NDIA greeting	Arrive Guyana	
1/5		Minutes of meeting	Minutes of meeting	
1/6		NIDA meeting	Minutes of meeting	
1/7		NIDA meeting	Minutes of meeting	
1/8		Departure Guyana		
1/9		(New York)	Departure Guyana	
1/10		(Return)	(New York)	
1/11			(Return)	
1/12				
2/3				
2/4				
2/5		(Departure)		
2/6		Arrive Guyana		
2/7		Meeting with cooperative company		
2/8		NDIA meeting		
2/9		Meeting with cooperative company		
2/10		Gound truth		
2/11		Meeting with coope.co., ground truth		
2/12		Meeting with coope.co., ground truth		
2/13				
2/14		Meeting with coope.co., gound truth		
2/15		Meeting with cooperative company		
2/16		Meeting with cooperative company		
2/17		Submit drawings to NDIA		
2/18		Meeting with cooperative company		
2/19		Meeting with cooperative company		
2/20				
2/21		Meeting with cooperative company		
2/22		Meeting with cooperative company, NDIA meeting		
2/23		Meeting with cooperative company		
2/24		Meeting with cooperative company		
2/25		Meeting with cooperative company		
2/26		Meeting with cooperative company, NDIA meeting		
2/27		Departure		
2/28		(New York)		
3/1		(Return)		
3/2				
5/30		(Departure)		
5/31		NDIA: investigative report		
		submission		
		Minutes of meeting		
6/1		Minutes of meeting		
6/2		Ground truth		
		Sign the minutes		
6/3		Meeting with Mr. Surendra, NDIA		
6/4		Organize materials		
6/5				
6/6		SRKN meeting		
6/7		Meeting with Mr. Surendra, NDIA		
6/8		Mr. Surendra,Ms.Denise TOR		
6/9		NDIA：visit Hope Dutch Four		
6/10		Organize materials		
6/11		Departure Guyana		
6/12				
6/13		(Arrive)		

Appendix-3 List of Parties Concerned

FIRM	NAME	TITLE
Ministry of Foreign Trade and International Cooperation (MoFTIC) - Department of International Cooperation	Ms.Lorene Baird	Permanent Secretary
	Mr.Safraaz Shadood	Foreign Trade Officer
Ministry of Agriculture -National Drainage and Irrigation Authority (NDIA)	Mr. Robert Montogomery Persaud	Minister
	Mr. Walter Willis	Chairman of NDIA Board
	Mr. Lionel Wordsworth	Chief Executive Officer
	Mr. Surendra Singh	Liaison Engineer
	Mr. Dave Hicks	Senior Engineer
	Mr. Timot HY Inness	Senior Section Engineer
	Mr. Kelvin Thorne	Engineer
	Mr.Chowbay Aneel	Mechanical Engineer
	Mr. Avinasa Singh	Mechanical Engineer
	Mr.Changur Bhudu	Superintendent EDWC
Japanese Embassy in Trinidad and Tobago	Mr. Masanobu Yoshii	Deputy Head of Mission and Counsellor
	Mr. Fujimura Kouji	Second Secretary
JICA	Mr. Sakae Yamada	Adviser for the Japanese Aid Coordination, Ministry of Foreign Trade and International Cooperation
	Mr. Taku Yoshida	Project Identifiation Expert, CARICOM Secretariat

Appendix－4　Minutes of Discussions(M/D)

Appendix 4-1 Outline Design Survey

MINUTES OF DISCUSSIONS
ON THE PREPARATORY SURVEY
ON THE PROJECT FOR THE REHABILITATION
OF THE EAST DEMERARA WATER CONSERVANCY
IN REGION No.4
IN THE REPUBLIC OF GUYANA

Based on the results of the Preparatory Survey conducted in 2009, the Government of Japan decided to conduct a second Preparatory Survey (hereinafter referred to as "the Survey") for the Rehabilitation of the East Demerara Water Conservancy in Region No.4 (hereinafter referred to as "the Project") and entrusted the implementation of the Survey to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent to the Republic of Guyana (hereinafter referred to as "Guyana") a Preparatory Survey team (hereinafter referred to as "the Team"), which is headed by Mr. Noriaki Nagatomo, Senior Advisor to the Director General, Global Environment Department, JICA. The duration of the Team's work in the country is from October 12 to November 24, 2010.

The Team held a series of discussions with the officials representing the Government of Guyana (hereinafter referred to as "GOG") and conducted a field survey in the study area.

In the course of the discussions and field survey, both parties confirmed the main items described on the attached sheets. The Team will continue further works and prepare the Preparatory Report.

Georgetown, October 14, 2010

永友紀章

Mr. Noriaki Nagatomo
Leader
Preparatory Survey Team
Japan International Cooperation Agency
Japan

Mr. Lionel Wordsworth
Chief Executive Officer (ag)
National Drainage and Irrigation Authority
Ministry of Agriculture
The Republic of Guyana

In witness of

Mr. Safraaz Shadood
Foreign Trade Officer
Ministry of Foreign Trade and International Cooperation
The Republic of Guyana

1

ATTACHMENT

1. Objective of the Project

The objective of the Project is to procure equipment and rehabilitate facilities for the improvement of the flood-control capacity of the East Demerara Water Conservancy (hereinafter referred to as "EDWC").

2. Project Site

The Project site is the EDWC in Region No. 4 as shown in **Annex-I** (as attached).

3. Responsible and Implementing Agency

3-1. The responsible agency is the Ministry of Agriculture of the GOG.

3-2. The implementing agency is the National Drainage and Irrigation Authority, Ministry of Agriculture (hereinafter referred to as "NDIA"). The Organization chart of NDIA is shown in **Annex-II**.

4. Items requested by the GOG

4-1. Following discussions with the Team, the items described in **Annex-III** were finally requested by the GOG.

4-2. The Project is divided into two components considering the difference of schedule and procurement procedure under Japan's Grant Aid Scheme.

Component-1. Procurement of Equipment

Component-2. Rehabilitation of Facilities

4-3. JICA will assess the appropriateness of the request from the GOG and will recommend to the Government of Japan for approval.

5. Japan's Programme Grant Aid

5-1. The GOG understands Japan's Grant Aid Scheme and the necessary measures to be taken by the GOG as explained by the Team and described in **Annex-IV** of the Minutes of Meeting signed by both parties on July 29, 2009.

5-2. The GOG understands Japan's Grant Aid Scheme using the Procurement Management Agent of the Government of Japan (hereinafter referred to as "the Agent") and the necessary measures to be taken by the GOG as explained by the Team and described in **Annex-IV**, **Annex-V** and **Annex-VI** of these Minutes of Discussions.

5-3. The former (5-1) shall be adopted for the procurement of equipment (Component-1). The latter (5-2) shall be adopted for the rehabilitation of facilities (Component-2).

6. Administration of Japan's Programme Grant Aid using the Agent

6-1. The Team explained the administrative setup of the Programme as shown in **Annex-VII**, and the GOG concurred.

6-2. For promoting proper and smooth execution of the Programme, both sides confirmed that the Consultative Committee of the Programme (hereinafter referred to as "the Committee") would be established by the Ministry of Foreign Trade and International Cooperation (hereinafter referred to as "MOFTIC") after the approval of the Programme by the Government of Japan. The functions and provisional composition are described in **Annex-VIII**.

7. Schedule of the Survey

7-1. Component-1

1) The consultant members of the Team (hereinafter referred to as "the Consultants") will proceed with further studies in Guyana until October 30, 2010.
2) JICA will prepare the draft Preparatory Report in English and dispatch a mission in order to explain its contents to the GOG around January 2011.

7-2. Component-2

1) The Consultants will proceed with further studies in Guyana until November 24, 2010.
2) JICA will prepare the draft Preparatory Report in English and dispatch a mission in order to explain its contents to the GOG around March 2011.
3) The Consultants will proceed with further studies in Japan for the detail design of the facilities and prepare the reference documents for tender by the middle of April 2011.
4) Once the contents of the report are accepted in principle by the GOG, JICA will proceed with further examination of the study results in Japan, complete the final Preparatory Report and send it to the GOG by June 2011.

8. Other Relevant Issues

8-1. Necessity and Justification of the Project

Both sides confirmed that the rehabilitation of the EDWC is consistent with the counter-flood policy of the GOG and would improve the capacity to discharge excess water from the EDWC which has functioned as flood control in heavy rainfall.

8-2. Relevance of the Project as Adaptation to Climate Change

Both sides confirmed that the Project shall be positioned as part of the adaptation measures to climate change in the policy of the GOG.

8-3. Rehabilitation of the Embankment

Both sides confirmed that the rehabilitation of the EDWC embankment is the responsibility of NDIA using procured equipment. The Consultants will share their findings on the operation and maintenance of the embankment with NDIA.

8-4. Operation and Maintenance of Equipment and Facilities

The GOG agrees to take any necessary measures including allocation of required budget and personnel in order to operate and maintain the equipment and facilities provided by the Project.

8-5. Technical Assistance

The GOG concurs that technical assistance, such as soft components, will be included in the Project, as necessary.

8-6. Tax Exemption

The GOG will ensure exemptions to taxes including Value Added Tax (VAT), customs duty, and all other taxes and imposts in Guyana which may arise from the activities of the Project.

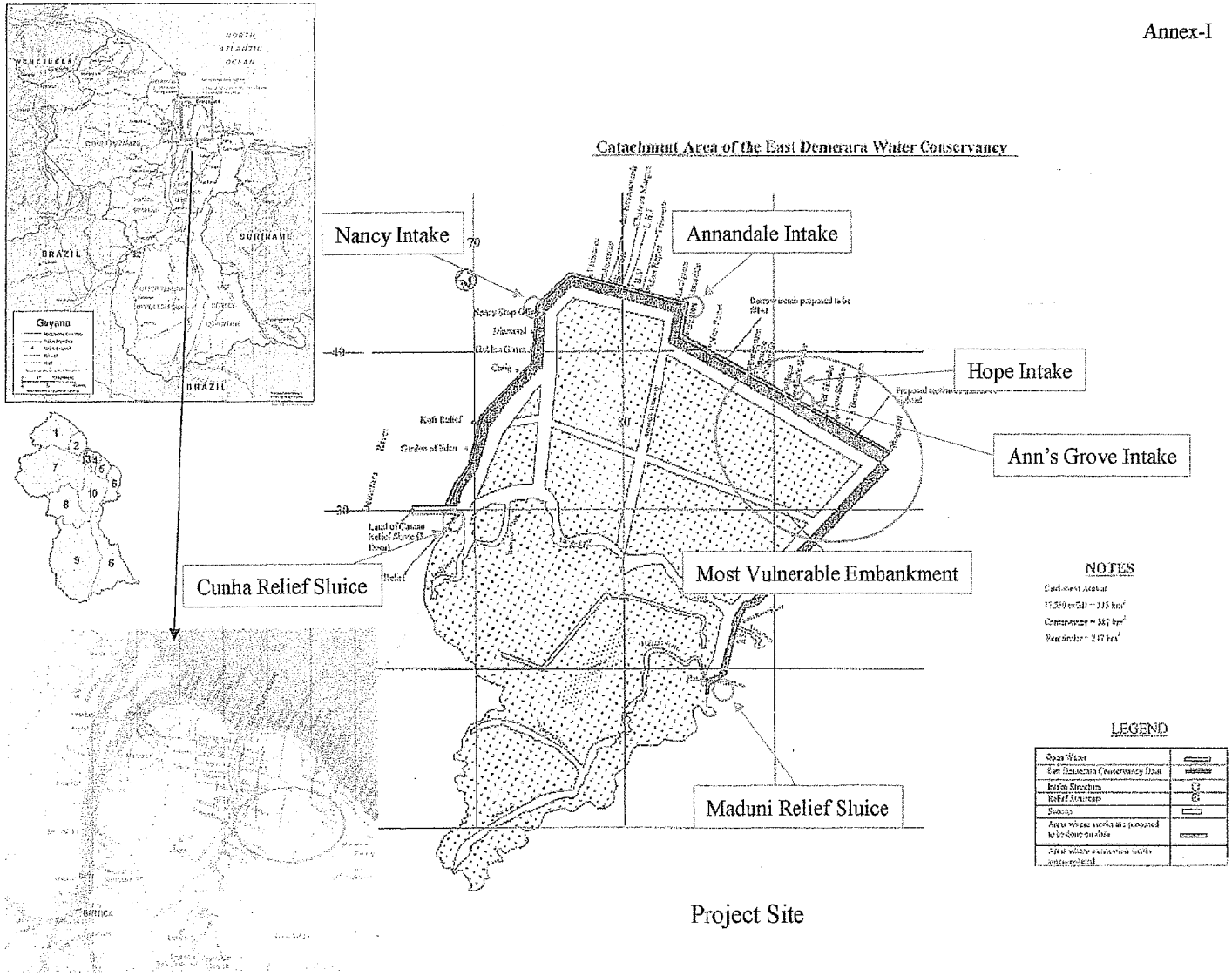
8-7. Environmental Impact Assessment (EIA)

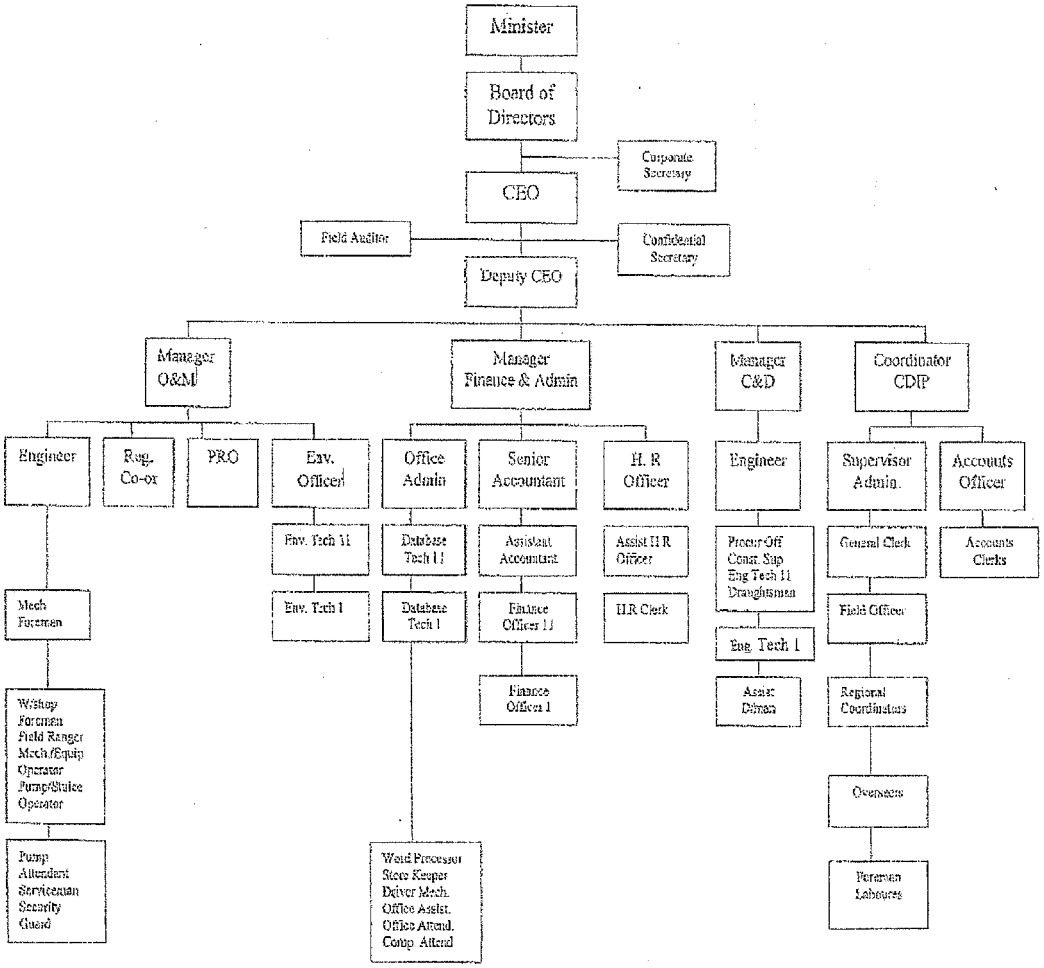
Both sides confirmed that an EIA shall be completed in accordance with the regulations of Guyana by the middle of March 2011, if necessary.

8-8. Coordination with Other Donors

The GOG will coordinate with other donor agencies to avoid duplication of the Project activities.

Annex-I	Project Site
Annex-II	Organization Chart of NDIA
Annex-III	Items Requested by the GOG
Annex-IV	Grant Aid using the Procurement Management Agent of the Government of Japan
Annex-V	Flow of Funds and Implementation of the Programme
Annex-VI	Major Undertakings to be Taken by Each Government
Annex-VII	Organization Chart for the Implementation of the Programme
Annex-VIII	Consultative Committee


Catachment Area of the East Demerara Water Conservancy
Nancy Intake
Annandale Intake
Hope Intake
Ann's Grove Intake
Most Vulnerable Embankment
Cunha Relief Sluice
Maduni Relief Sluice
NOTES
LEGEND
Project Site



Organization Chart of NDIA

Items Requested by the GOG

Component-1. Procurement of Equipment

No.	Item	Quantity
1	Super long reach track type hydraulic excavators, wide track	8
2	Pontoon with a mud bin to mount hydraulic excavators to work within conservancy waterways	2

Component-2. Rehabilitation of Facilities

No.	Item	Quantity
1	Cunha relief sluice	1
2	Maduni relief sluice	1
3	Hope intake structure	1
4	Anns Grove intake structure	1
5	Annandale intake structure	1
6	Nancy intake structure	1

Grant Aid using the Procurement Management Agent of the Government of Japan

(Provisional)

The Grant Aid provides a recipient country (hereinafter referred to as "the Recipient") with non-reimbursable funds to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for economic and social development of the country under principles in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

Multiple components can be combined to effectively meet the needs. Contractors, suppliers or consultants are not confined to Japanese firms only, and construction can be done based on the local method.

1. Procedures

Japan's Grant Aid Programme (hereinafter referred to as "the Programme") is executed trough the following procedures.

- Application
  - Request made by the Recipient
- Outline Design Study (hereinafter referred to as "the Study") by a Preparatory Survey
  - Outline Design Study conducted by JICA
- Appraisal &Approval
  - Appraisal by the Government of Japan and Approval by the Cabinet
- Determination of Implementation
  - The Notes exchanged between the Government of Japan (hereinafter referred to as "GOJ") and the Recipient
- Grant Agreement (hereinafter referred to as "the G/A")
  - Agreement concluded between JICA and the Recipient
- Implementation
  - Implementation of the Programme on the basis of the G/A

Firstly, the application or request for the Grant Aid submitted by the Recipient is examined by GOJ (the Ministry of Foreign Affairs) to determine whether or not it is eligible for the Grant Aid.

Secondly, if the request is deemed appropriate, JICA conducts the Outline Design Study, using Japanese consulting firms.

Thirdly, GOJ appraises the programme to see whether or not it is suitable for Japan's grant aid, based on the Outline Design Study report prepared by JICA, and the results are then submitted to the Cabinet for approval.

Fourthly, the programme, once approved by the Cabinet, becomes official with the Exchange

of Notes (E/N) signed by GOJ and the Recipient. Simultaneously, the Grant will be made available by concluding a grant agreement between the Government of the Recipient or its designated authority and JICA (hereinafter referred to as "the G/A").

JICA is designated by GOJ as an organization responsible for the execution of the Grant.

Procurement management agent ("the Agent") is designated to conduct the procurement services of products and services (including fund management, preparing tenders, contracts and so on) on behalf of the Recipient. The Agent is an impartial and specialized organization and shall render services according to the Agent Agreement with the Recipient. The Agent is recommended to the Recipient by GOJ and agreed between the two Governments in the Agreed Minutes ("A/M").

2. Outline Design Study

1) Contents of the Study

The aim of the Outline Design Study ("the Study"), conducted by JICA on a requested programme ("the Programme"), is to provide a basic document necessary for the appraisal of the Programme by GOJ. The contents of the Study are as follows:

(1) Confirmation of the background, objectives, and benefits of the Programme and also institutional capacity of agencies and communities concerned of the Recipient necessary for the Programme's implementation.
(2) Evaluation of the appropriateness of the Programme to be implemented under the Grant Aid Scheme from a technical, social and economic point of view;
(3) Confirmation of items agreed upon by both parties concerning the basic concept of the Programme.
(4) Preparation of an outline design of the Programme.
(5) Estimation of cost for the Programme.

The contents of the original request are not necessarily approved in their initial form as the contents of the Grant Aid programme. The Outline Design of the Programme is confirmed considering the guidelines of Japan's Grant Aid scheme.

GOJ requests the Government of the Recipient to take whatever measures are necessary to ensure its self-reliance in the implementation of the Programme. Such measures must be guaranteed even through they may fall outside of the jurisdiction of the organization in the Recipient actually implementing the Programme. Therefore, the implementation of the Programme is confirmed by all relevant organizations of the Recipient through the Minutes of Discussions.

2) Selection of Consultants

For smooth implementation of the Study, JICA uses consulting firms. JICA selects firms based

on proposals submitted by interested firms. The firms selected carry out an Outline Design Study and write a report, based upon terms of reference set by JICA.

The consulting firms to work on the Programme's implementation after the Exchange of Notes could be, in principle, of any nationality as long as the Firm satisfies the conditions specified in the tender documents.

3. Implementation of the Grant Aid after the E/N

1) Exchange of Notes (E/N) and Grant Agreement (G/A)

The Grant Aid is extended in accordance with the Notes exchanged by the two Governments concerned, in which the objectives of the programme, period of execution, conditions and amount of the Grant Aid, etc., are confirmed. The conclusion of the Grant Agreement (hereinafter referred to as "the G/A") between JICA and the recipient government will be followed to define the necessary engagement to implement the project such as payment conditions, responsibilities of the recipient government and procurement conditions.

2) Procedural details

Procedural details on the procurement of products and services under the Grant Aid will be agreed upon between the Recipient and JICA at the time of the signing of the E/N and G/A.

Essential points to be agreed upon are outlined as follows:

a) JICA is in a position to expedite the proper execution of the program.

b) The products and services shall be procured and provided in accordance with "Procurement Guidelines for Environment and Climate Change (Type I-E)" of JICA.

c) The Recipient shall conclude an employment contract with the Agent.

d) The Agent is the representative acting in the name of the Recipient concerning all transfers of funds to the Agent.

3) Focal Points of "The Procurement Guidelines of Japan's Programme Grant Aid for Environment and Climate Change (Type I - E)"

a) The Agent

The Agent is the organization which provides procurement services of products and services on behalf of the Recipient according to the Agent Agreement with the Recipient. The Agent is recommended to the Recipient by GOJ and agreed between the two Governments in the A/M.

b) Agent Agreement

The Recipient shall conclude an Agent Agreement, within two months after the date of entry into force of the E/N and the G/A, in accordance with the A/M. The scope of the Agent's services shall be clearly specified in the Agent Agreement.

c) Approval of the Agent Agreement

The Agent Agreement, which is prepared as two identical documents, shall be submitted to JICA by the Recipient through the Agent. JICA confirms whether or not the Agent Agreement is concluded in conformity with the G/A and the Procurement Guidelines, and approves the Agreement.

The Agent Agreement concluded between the Recipient and the Agent shall become effective after the approval by JICA in a written form.

d) Payment Methods

The Agent Agreement shall stipulate that "regarding all transfers of the fund to the Agent, the Recipient shall designate the Agent to act on behalf of the Recipient and issue a Blanket Disbursement Authorization ("the BDA") to conduct the transfer of the fund (Advances) to the Procurement Account from the Recipient Account."

The Agent Agreement shall clearly state that the payment to the Agent shall be made in Japanese yen from the Advances and that the final payment to the Agent shall be made when the total Remaining Amount becomes less than 3 % of the Grant and its accrued interest.

e) Products and Services Eligible for Procurement

Products and services to be procured shall be selected from those defined in the G/A.

f) Firms

In principle, a firm of any nationality could be contracted as long as the Firm satisfies the conditions specified in the tender documents.

The Firm, with approval by JICA, may be Japanese nationals and the products to be procured may be the products made in Japan or produced or manufactured by Japanese manufacturer(s) and/or its (their) affiliate(s) in any country.

g) Experts for Technical Assistance

Expert(s) could be deployed to carry out technical assistance. The expert(s) may be recommended by JICA when the conceptual consistency with the Studies is required. In principle, expert(s) is/are preferable to be Japanese nationals if appropriate.

h) Method of Procurement

In implementing procurement, sufficient attention shall be paid so that there is no unfairness among tenderers who are eligible for the procurement of products and services.

For this purpose, competitive tendering shall be employed in principle.

i) Tender Documents

The tender documents should contain all information necessary to enable tenderers to prepare valid offers for the products and services to be procured by the Grant Aid.

The rights and obligations of the Recipient, the Agent and the Suppliers of the products and services should be stipulated in the tender documents to be prepared by the Agent. Besides this, the tender documents shall be prepared in consultation with the Recipient.

j) Pre-qualification Examination of Tenderers

The Agent may conduct a pre-qualification examination of tenderers in advance of the tender so that the invitation to the tender can be extended only to eligible firms. The pre-qualification examination should be performed only with respect to whether or not the prospective tenderers have the capability of accomplishing the contracts concerned without fail. In this case, the following points should be taken into consideration:

(1) Experience and past performance in contracts of a similar kind
(2) Property foundation or financial credibility
(3) Existence of offices, etc. to be specified in the tender documents.

k) Tender Evaluation

The tender evaluation should be implemented on the basis of the conditions specified in the tender documents.

Those tenders which substantially conform to the technical specifications, and are responsive to other stipulations of the tender documents, shall be judged in principle on the basis of the submitted price, and the tenderer who offers the lowest price shall be designated as the successful tenderer.

The Agent shall prepare a detailed tender evaluation report clarifying the reasons for the successful tender and the disqualification and submit it to the Recipient to obtain confirmation before concluding the contract with the successful tenderer.

The Agent shall furnish JICA with a detailed evaluation report of tenders, giving the reasons for the acceptance or rejection of tenders.

l) Additional Procurement

If there is an additional procurement fund after competitive and / or selective tendering and / or direct negotiation for a contract, and the Recipient would like an additional procurement, the Agent is allowed to conduct an additional procurement, following the points mentioned below:

(1) Procurement of the same products and services

When the products and services to be additionally procured are identical with the initial tender and a competitive tendering is judged to be disadvantageous, the additional procurement can be implemented by a direct contract with the successful tenderer of the initial tender.

(2) Other procurements

When products and services other than those mentioned above in (1) are to be procured, the procurement should be implemented through a competitive tendering. In this case, the products and services for additional procurement shall be selected from among those in accordance with the G/A.

m) Conclusion of the Contracts

In order to procure products and services in accordance with the G/A, the Agent shall conclude contracts with firms selected by tendering or other methods.

n) Terms of Payment

The contract shall clearly state the terms of payment. The Agent shall make payment from the "Advances", against the submission of the necessary documents from the Firm on the basis of the conditions specified in the contract, after the obligations of the Firm have been fulfilled. When the services are the object of procurement, the Agent may pay certain portion of the contract amount in advance to the firms on the conditions that such firms submit the advance payment guarantee worth the amount of the advance payment to the Agent.

4) Undertakings required to the Government of the Recipient

In the implementation of the Grant Aid Programme, the Recipient is required to undertake such necessary measures as the following:

a) To secure land necessary for the sites of the Programme and to clear, level and reclaim the land prior to commencement of the Programme,
b) To provide facilities for the distribution of electricity, water supply and drainage and other incidental facilities in and around the sites,
c) To secure buildings prior to the procurement in case the installation of the equipment,
d) To ensure prompt unloading and customs clearance at the port of disembarkation and to assist internal transportation therein,
e) To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the Recipient with respect to the purchase of the Components including the employment of the Agent,
f) To accord all the concerned parties, whose services may be required in connection with supply of the products and services under the contracts, such facilities as may be necessary for their entry into the Recipient and stay therein for the performance of their work,
g) To ensure that the Facilities and/or the Components be maintained and used properly and effectively for the implementation of the Programme,

h) To bear all the expenses, other than those covered by the Grant and its accrued interest, necessary for the implementation of the Programme, and

i) To give due environmental and social consideration in the implementation of the Programme.

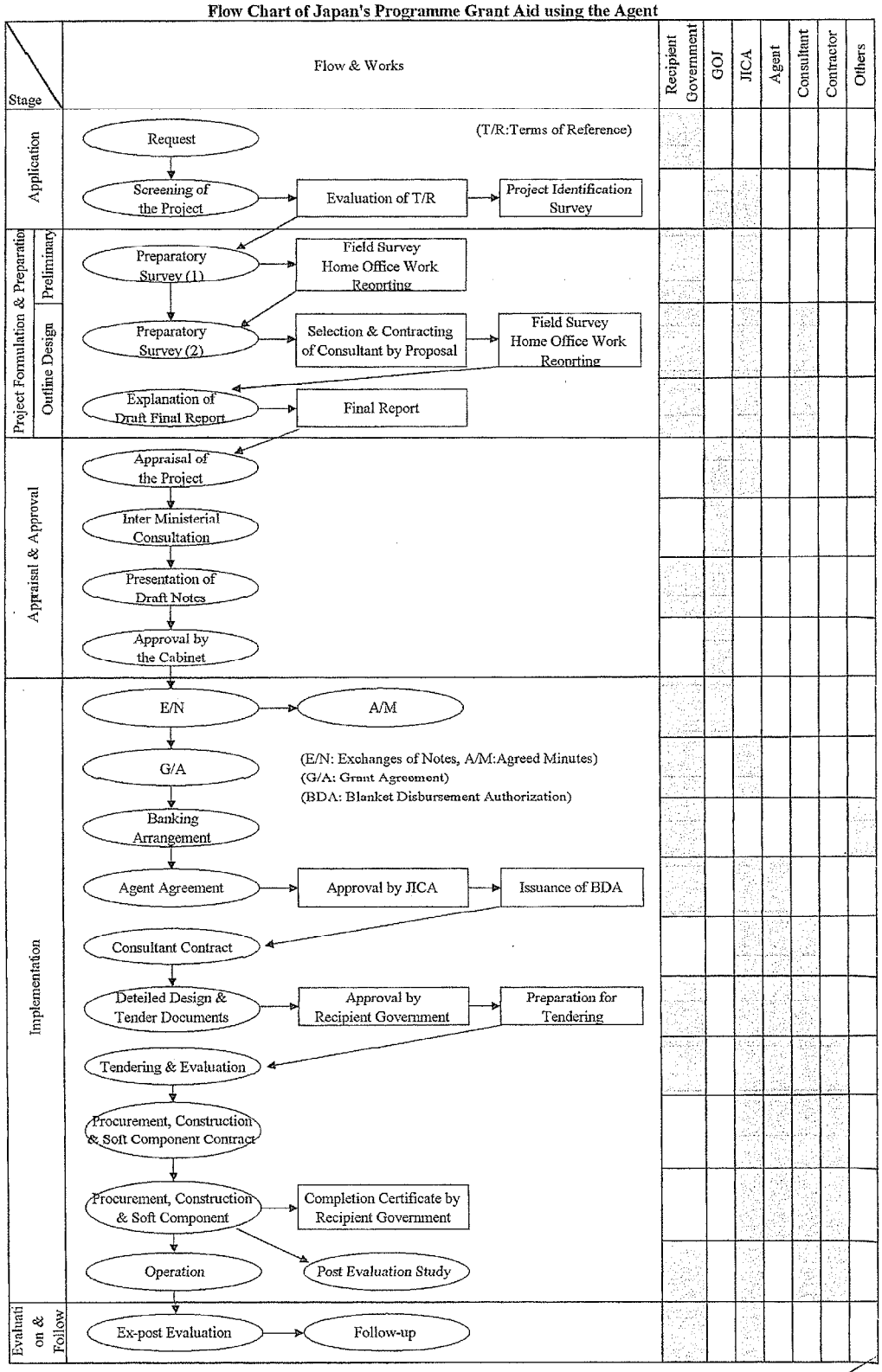
5) Proper Use

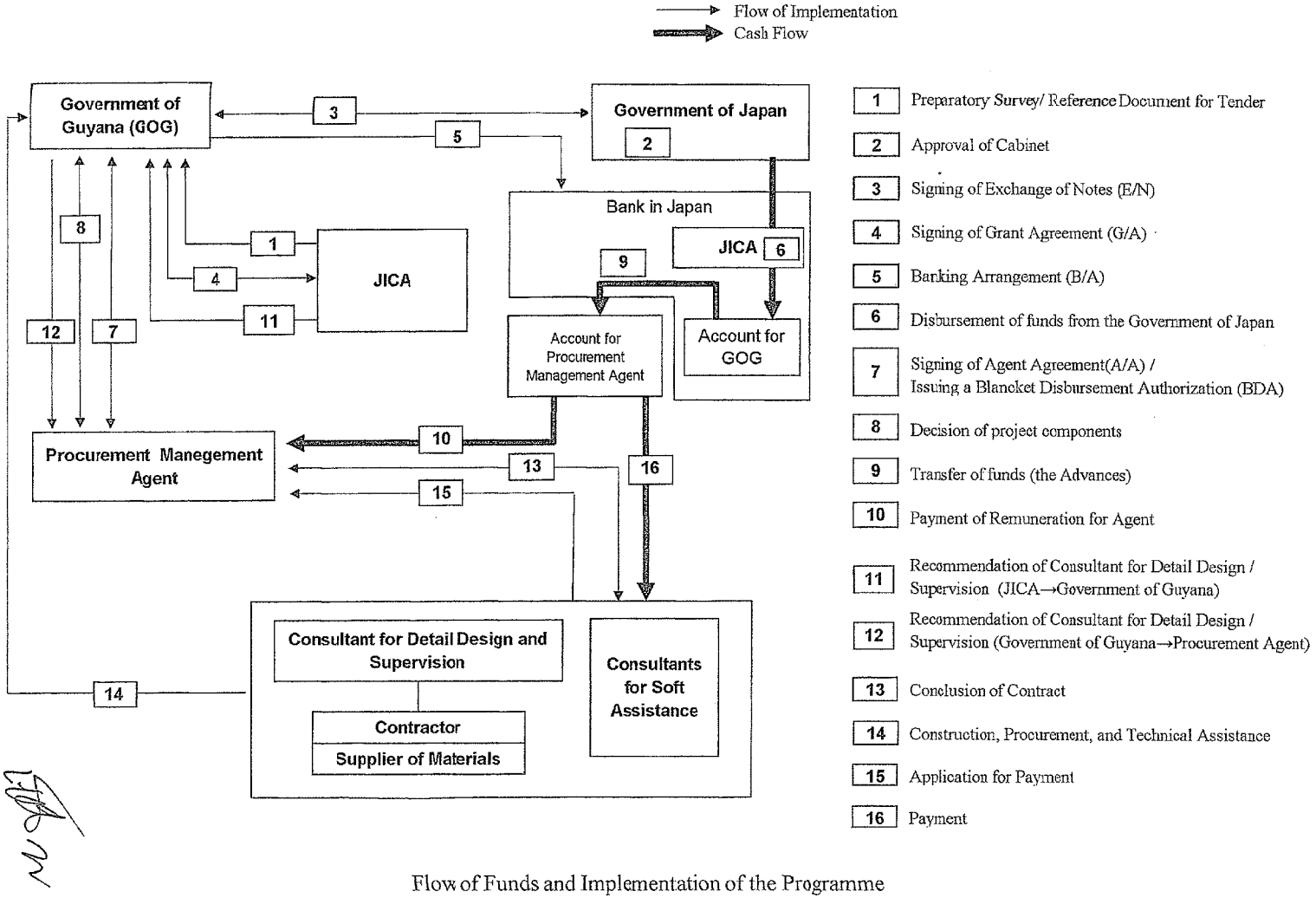
The Recipient is required to operate and maintain the facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign staff necessary for this operation and maintenance as well as to bear all the expenses other than those covered by the Grant Aid.

6) Re-export

The products purchased under the Grant Aid should not be re-exported from the Recipient.

Flow Chart of Japan's Programme Grant Aid using the Agent





Flow of Funds and Implementation of the Programme

Major Undertakings to be taken by Each Government in relation to Equipment procurement (Component-1)

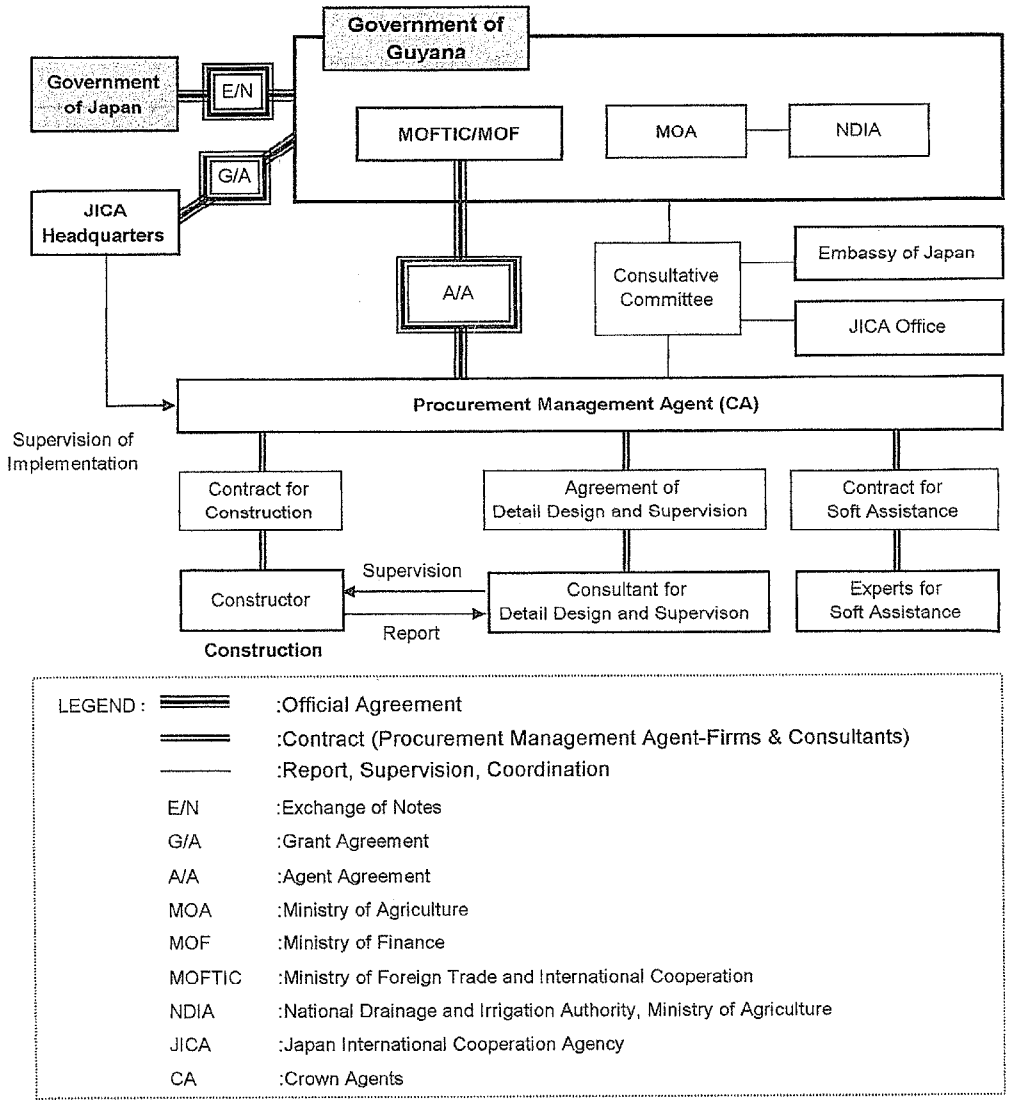
	Items	To be covered by the Grant	To be covered by Recipient side
1	To bear the following commissions to a bank of Japan for the banking services based upon the B/A		
	1) Advising on commission of A/P		●
	2) Payment of commission		●
2	To ensure prompt unloading and customs clearance at the port of entry in the Recipient country		
	1) Marine (Air) transportation of the products from Japan to the Recipient	●	
	2) Tax exemption and customs clearance of the products at the port of entry in the Recipient country		●
	3) Internal transportation from the port of entry to the Project site	●	
3	To accord all concerned parties, whose services may be required in relation to the supply of the products and the services under the approved contract such facilities as may be necessary for their entry into the Recipient country and stay therein for the performance of their work		●
4	To exempt or bear for all concerned parties the customs duties, internal taxes and other imposts which may be imposed in the Recipient country with respect to the supply of the products and services under the approved contract		●
5	To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant		●
6	To bear all the expenses, other than those to be borne by the Grant, necessary for construction of the facilities as well as for the transportation and installation of the equipment		●
7	To give due environmental and social consideration in the implementation of the Programme		●

(B/A: Banking Arrangement, A/P: Authorization to Pay, N/A: Not Applicable)

Major Undertakings to be taken by Each Government in relation to Facility rehabilitation (Component-2)

	Items	To be covered by the Grant	To be covered by Recipient side
1	To secure land		●
2	To clear, level and reclaim the site when needed		●
3	To bear the following commissions to a bank of Japan for the banking services based upon the B/A		
	1) Payment of commission		●
4	To ensure prompt unloading and customs clearance at the port of entry in the Recipient country		
	1) Marine (Air) transportation of the products from Japan to the Recipient	●	
	2) Tax exemption and customs clearance of the products at the port of entry in the Recipient country		●
	3) Internal transportation from the port of entry to the Project site	●	
5	To accord all concerned parties, whose services may be required in relation to supplies, construction works and services under the approved contract such facilities as may be necessary for their entry into the Recipient country and stay therein for the performance of their work		●
6	To exempt or bear for all concerned parties the customs duties, internal taxes and other imposts which may be imposed in the Recipient country with respect to the supply of the products and services under the approved contract		●
7	To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant		●
8	To bear all the expenses, other than those to be borne by the Grant, necessary for construction of the facilities as well as for the transportation and installation of the equipment		●
9	To give due environmental and social consideration in the implementation of the Programme		●

(B/A: Banking Arrangement, N/A: Not Applicable)



Organization Chart for the Implementation of the Programme

Consultative Committee

1. Function

The Consultative Committe (hereinafter referred to as "the Committee") will be established in order to fulfill the following functions:

1) To confirm an implementation schedule of the Programme for the speedy and effective utilization of the Grant and its accrued interest,
2) To discuss determination and/or modification of the Components, taking into account of the products enumerated in the list attached to the Procurement Guidelines and/or the result of the preparatory survey for the Programme by JICA,
3) To discuss modifications of the Programme,
4) To exchange views on allocations of the Grant and its accrued interest as well as on potential end-users,
5) To identify problems which may delay the utilization of the Grant and its accrued interest, and to explore solutions to such problems,
6) To exchange views on publicity related to the utilization of the Grant and its accrued interest; and
7) To discuss any other matters that may arise from or in connection with the G/A.

The first meeting of the Committee shall be held immediately after the approval of the Agent Agreement by JICA, which shall be convened by MOFTIC and the Procurement Management Agent (hereinafter referred to as "the Agent").

The selection of the Agent will be agreed between the two governments in the Agreed Minutes attached in the Exchange of Notes.

Further meetings will be held by the request of either the Guyanese side or the Japanese side. The Agent will also advise both sides on the necessity to call a meeting of the Committee.

2. Composition (Provisional)

1) Representative of Ministry of Agriculture
2) Representative of National Drainage and Irrigation Authority, Ministry of Agriculture
3) Representative of Ministry of Foreign Trade and International Cooperation
4) Representative of Ministry of Finance
5) Representative of the Procurement Management Agent
6) Representative of Embassy of Japan in Trinidad and Tobago
7) Representative of JICA Dominican Republic Office

Appendix 4-2 Explanation on Component-1

MINUTES OF DISCUSSIONS
ON THE PREPARATORY SURVEY (OUTLINE DESIGN STUDY)
ON THE PROJECT FOR THE REHABILITATION
OF THE EAST DEMERARA WATER CONSERVANCY
IN REGION No.4
IN THE REPUBLIC OF GUYANA
(EXPLANATION ON DRAFT REPORT)

In October 2010, the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched a second Preparatory Survey Team on the Project for the Rehabilitation of the East Demerara Water Conservancy (hereinafter referred to as "the Project") to the Republic of Guyana (hereinafter referred to as "Guyana") and through discussion, field survey and technical evaluation of the results in Japan, JICA prepared a draft report of the survey for the procurement of equipment (Component-1) (hereinafter referred to as "the Draft Report").

In order to explain and consult with Guyana on the components of the Draft Report, JICA sent to Guyana the Draft Report Explanation Team (hereinafter referred to as "the Team"), which is headed by Mr. Shigeyuki Matsumoto, Director, Disaster Management Division 2, Global Environment Department, JICA, from January 5 to 8, 2011.

As a result of discussions, both parties confirmed the main items described on the attached sheets.

Georgetown, January 7, 2011

Mr. Shigeyuki Matsumoto
Leader
Draft Report Explanation Team
Japan International Cooperation Agency
Japan

Mr. Lionel Wordsworth
Chief Executive Officer (ag)
National Drainage and Irrigation Authority
Ministry of Agriculture
The Republic of Guyana

In witness of

Mr. Safraaz Shadood
Foreign Trade Officer
Ministry of Foreign Trade and International Cooperation
The Republic of Guyana

1

Attachment

1. Components of the Draft Report

1-1. The Government of Guyana (hereinafter referred to as "GOG") agreed and accepted in principle the contents of the Draft Report for the procurement of equipment (Component-1) explained by the Team. The contents of the procured equipment are as shown in Annex-1.

1-2. GOG agreed that the contents of the Draft Report would be confidential, be dealt with carefully and not be disclosed to any third parties.

1-3. GOG agreed that the Government of Japan (hereinafter referred to as "GOJ") would make a final decision on the procurement of equipment (Component-1) for the Project.

2. Japan's Grant Aid Scheme

GOG understood the Japan's Grant Aid Scheme and the necessary measures to be taken by GOG as explained by the Team and described in Annex-VI in the Minutes of Discussions (hereinafter referred to as "M/D") signed by both parties on October 14, 2010 as well as Annex-IV of the Minutes of Meeting signed by both parties on July 29, 2009.

3. Schedule of the Study

JICA will complete the final report in accordance with the confirmed items including not only the procurement of equipment (Component-1) but also the rehabilitation of facilities (Component-2), and send it to GOG by June 2011.

4. Confidentiality of the Project Cost Estimation

4-1. The Team explained the cost estimation of the Project as described in Annex-2. GOG agreed that the project cost estimation should never be duplicated or released to any outside parties before signing of all the contracts for the Project.

4-2. GOG agreed that the project cost estimation described in Annex-2 is a provisional one as a result of the Survey and could be subject to change following further examination by GOJ.

5. Other Relevant Issues

5-1. Undertakings to be taken by GOG

In the implementation of the Project, GOG is required to undertake such necessary measures as the following as well as measures mentioned in 2 of this attachment.

(1) Assembly and Installation of Equipment

- To secure storage sites for the equipment procured by the Project
- To secure assembly sites of the equipment procured by the Project at Land of Canaan
- To secure electric power for welding to assemble pontoons
- To assign staff for welding skill training conducted at the time of the pontoons' assembly
- To assign staff for initial operation and guidance of the equipment procured by the

Project

(2) Necessary Budget and Personnel

- To allocate enough budgets to properly operate and maintain the equipment procured by the Project by the time of the acceptance inspection
- To assign staff to properly operate and maintain the equipment procured by the Project by the time of the acceptance inspection

(3) Proper Use and Maintenance

- To facilitate proper use and maintenance of the equipment procured by the Project.
- To prepare records for the operation and maintenance of the equipment procured by the Project

(4) Use of Existing Equipment

- To secure 6 pontoons and 4 excavators other than the equipment procured by the Project to rehabilitate the embankment

5-2. Social and Environmental Considerations

(1) Both sides confirmed that the rehabilitation of the embankment to be conducted by the procured equipment would not impact the East Demerara Water Conservancy (EDWC) and its surroundings negatively since the conventional method of rehabilitation works in Guyana would be adopted.

(2) Since there are ongoing rehabilitation works on the embankment, the Environmental Permit is not required in Guyana. However, GOG shall confirm the need of the permit from Environmental Protection Agency (EPA) and report the result to JICA by 20th of January, 2011.

(3) Regarding the rehabilitation of facilities (Component-2), GOG shall confirm the need of the permit from EPA and report the result to JICA by February, 2011.

5-3. Projects with Other Donors

GOG explained projects with other donors and JICA confirmed that the equipment provided by the World Bank to GOG has been procured under the Conservancy Adaptation Project (CAP). The equipment is used to clear internal waterways in order to improve the flow in the EDWC. Since the CAP includes rehabilitation of some facilities, GOG shall submit their list (name of the facilities repaired or to be repaired, purpose and contents of their repair work) to JICA by 20th of January, 2011. Both sides confirmed that projects supported by other donors would avoid duplication with the Project as described in the M/D.

5-4. Rehabilitation of Facilities (Component-2)

(1) Cunha Relief Sluice

a) GOG requested to rehabilitate Cunha relief sluice, reconstruct discharge channel and construct a new access bridge which is necessary along with main public road to facilitate and improve discharge of excess water from the EDWC. However, the Team explained that the rehabilitation of the existing Cunha relief sluice was beyond the scope of the Project because it includes construction of a new bridge along with the

reestablishment of a section of the discharge channel. The Project in principle does not provide for any new construction of facilities.

b) Both sides confirmed that the gates of Sara Johanna sluice for Cunha outlet had already been rehabilitated in November 2010, and the wing walls of the inlet side of the gates would be rehabilitated in the Project.

(2) Hope Intake Structure

a) The Team explained that Hope intake structure may fail under high water level.

b) GOG agreed that the Hope intake structure would be rehabilitated with shielding water flow through the embankment using timber sheet piles to prevent failure of the structure under high water level, and with installing the guide rails for the door to open smoothly.

END

Annex-1: Contents of the Project
Annex-2: Project Cost Estimation

Annex-1

Contents of the Project
(Componet-1. Procurement of equipment)

Item	Quantity
Super long reach track type excavators, wide track (Operating weight : 25ton, Bucket capacity : 0.4 - 0.5m^3)	8
Pontoon with a mud bin to mount excavators to work within conservancy waterways (Live load : 65 ton or more)	2

Project Cost Estimation
(Componet-1. Procurement of Equipment)

(1) Project Cost borne by GOJ

The project cost borne by GOJ is estimated to be Japanese Yen 289 million. The contents of the project cost are shown in the table below.

Category	Amount (JY million)
Procurement of Equipment	275
Supervision of Procurement	14
Total	289

(2) Project Cost borne by GOG

The project cost borne by GOG is estimated to be USD 70,115. The contents of the project cost are shown the table below.

Category	Amount (USD)
Commission for Issuance of Authorization to Pay	115
Commission for Banking Arrangement	70,000
Total	70,115

(3) Condition of Estimation

a) Date of Estimation Base : October 2010
b) Exchange Rate : 1.00USD = 86.97 yen (Average of the past 6 months)
1.00GYD = 0.42 yen (Average of the past 6 months)
c) Implementation Period : As shown in the Annex of the Draft Report
d) Others : Cost estimation is in accordance with the framework with the Japan's Grant Aid Scheme.

(4) Remarks

a) The cost estimation is provisional and will be further examined by GOJ for the approval of the Grant.
b) According to the Guyanese tax system, the equipment procured by Japan's Grand Aid is exempted from value added tax (VAT) and import customs, etc.

Appendix 4-3 Explanation on Component-2

MINUTES OF DISCUSSIONS
ON THE PREPARATORY SURVEY (OUTLINE DESIGN STUDY)
ON THE PROJECT FOR THE REHABILITATION
OF THE EAST DEMERARA WATER CONSERVANCY (COMPONENT II)
IN THE REPUBLIC OF GUYANA
(EXPLANATION OF DRAFT REPORT)

In October 2010, the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the second Preparatory Survey Team on the Project for the Rehabilitation of the East Demerara Water Conservancy (hereinafter referred to as "the Project") to the Republic of Guyana (hereinafter referred to as "Guyana") and through discussion, field survey and technical evaluation of the results in Japan, JICA prepared a draft report of the survey for the rehabilitation of facilities (Component-2) (hereinafter referred to as "the Draft Report").

In order to explain and consult with Guyana on the components of the Draft Report, JICA sent the Draft Report Explanation Team (hereinafter referred to as "the Team") to Guyana, which is headed by Mr. Naotaka Yamaguchi, Senior Representative, JICA Caribbean Regional Representation Office in the Dominican Republic, JICA, from May 31 to June 2, 2011.

As a result of discussions, both parties confirmed the main items described on the attached sheets.

Georgetown, June 2, 2011

山口尚孝

Mr. Naotaka Yamaguchi
Leader
Draft Report Explanation Team
Japan International Cooperation Agency
Japan

Lionel Wordsworth

Mr. Lionel Wordsworth
Chief Executive Officer
National Drainage and Irrigation Authority
Ministry of Agriculture
Republic of Guyana

In witness of

Mr. Safraaz Shadood
Foreign Trade Officer
Ministry of Foreign Trade and International Cooperation
Republic of Guyana

Attachment

1. Components of the Draft Report

1-1. The Government of Guyana (hereinafter referred to as "GOG") agrees with and accepts in principle the contents of the Draft Report for the rehabilitation of facilities (Component-2) explained by the Team. The contents of the Project are as shown in Annex-1.

1-2. GOG agrees that the contents of the Draft Report would be confidential, be dealt with carefully and not be disclosed to any third parties.

1-3. GOG agrees that the Government of Japan (hereinafter referred to as "GOJ") has to make a final decision on the rehabilitation of facilities (Component-2) for the Project.

2. Japan's Grant Aid Scheme using a Procurement Management Agent

GOG understands the Japanese Grant Aid Scheme using the procurement management agent and the necessary measures to be taken by GOG as explained by the Team and described in **Annex-IV**, **Annex-V** and **Annex-VI** in the Minutes of Discussions (hereinafter referred to as "M/D") signed by both parties on October 14, 2010.

3. Schedule of the Study

3-1. The Consultants will proceed with further studies in Guyana to prepare the reference documents for the tendering process until the middle of June, 2011.

3-2. JICA will complete the final report in accordance with the confirmed items including not only the rehabilitation of facilities (Component-2) but also the procurement of equipment (Component-1), and send it to GOG by September, 2011.

4. Confidentiality of the Project Cost Estimation

4-1. The Team explained the cost estimation of the Project as described in Annex-2. Both parties agree that the project cost estimation should not be duplicated or released to any outside parties before signing of all the contracts for the Project.

4-2. GOG agrees that the project cost estimate described in Annex-2 is a provisional one as a result of the Survey and could be subject to change following further examination by GOJ.

5. Other Relevant Issues

5-1. Undertakings by GOG

In the implementation of the Project, the GOG shall be required to undertake such necessary measures as the following as well as measures mentioned in Annex-2 of this attachment.

(1) Rehabilitation Works

- To provide suitable storage sites for all materials, machinery and testing equipment for rehabilitation works

(2) Technical Assistance (Soft Components)

- To assign staff and identify rangers for technical training
- To provide space for technical training and workshops
- To provide necessary equipment to be used in the technical training

5-2. Operation and Maintenance System

(1) Allocation of Budget and Personnel

Both parties reconfirm that the GOG shall be responsible for taking any necessary measures including allocation of required budget and personnel in order to operate and maintain the facilities rehabilitated by the Project.

(2) Establishment of New Workshop

GOG reported on the progress on the establishment of the new workshop. The workshop is expected to be completed by the end of June, 2011.

(3) Continuing Capacity Development

Both parties confirmed that it would be important for GOG to train workers with expertise in inspection, operation and maintenance of the East Demerara Water Conservancy (hereinafter referred to as "EDWC"). Therefore, GOG agrees to hold necessary workshops and seminars for capacity development of rangers, contractors and staff.

5-3. Environmental and Social Considerations

(1) Acquisition of Environmental Permit

From the information submitted by NDIA and the site visit conducted, the Environmental Protection Agency (hereinafter referred to as "EPA") has determined on February, 2011 that the rehabilitation and revetment works within the EDWC would not have significant impacts on the environment and the Project would not need a detailed environmental impact assessment (DEIA).

(2) Summary Environmental Checklist

The environmental and social considerations including major impacts and mitigation measures for the Project are summarized in the Environmental Checklist based on JICA Guidelines for Environmental and Social Considerations attached as Annex-3. The checklist will be attached to the Final Report of the Preparatory Survey.

(3) Monitoring the impact of implementation on Environmental and Social Conditions

Monitoring the Environmental and Social conditions will be conducted by the National Drainage and Irrigation Authority, and the Ministry of Agriculture (hereinafter referred as to "NDIA") in accordance with the Monitoring Plan for the Project described in the Draft Report. The monitoring findings will be reported to JICA in the Monitoring Form, which is attached as Annex-4, as part of progress reports during the rehabilitation phase.

END

Annex-1: Contents of the Project
Annex-2: Project Cost Estimation (Confidential)
Annex-3: Environmental Checklist
Annex-4: Monitoring form

Contents of the Project

(Component-2. Rehabilitation of Facilities)

1. Rehabilitation works

Item		Contents of Rehabilitation				
		Gate	Structure	Cut-off wall	Retaining wall	Embankment
Intake structure	Ann's Grove	-	-	-	◎	◎
	Hope	◎	◎	◎	◎	◎
	Annandale	◎	-	-	◎	◎
	Nancy	-	-	-	◎	◎
Relief sluice	Maduni	◎	-	-	◎	◎
	Sarah Johanna (Cunha)	-	-	-	◎	-

2. Technical Assistance (Soft components)

(1) Capacity development for quality control and supervision of rehabilitation works

(2) Capacity development for inspection and maintenance of embankment and facilities

Confidential

Annex-2

Project Cost Estimation

(Component-2. Rehabilitation of Facilities)

1. Project Cost borne by GOJ

The project cost borne by GOJ is estimated to be Japanese Yen 310 million. The contents of the project cost are shown in the table below.

Rehabilitation works

Category	Amount (JY million)
Rehabilitation of Facilities	176
Procurement Management Agent	51
Supervision of Rehabilitation	68
Legal Services	3
Total	298

Technical Assistance (Soft components) : 12 JY million

2. Project Cost borne by GOG

The project cost borne by GOG is estimated to be USD 8,415. The contents of the project cost are shown the table below.

Category	**Amount (USD)**
Commission for Banking Arrangement	7,815
Equipment for Technical Assistance	600
Total	8,415

3. Condition of Estimation

a) Date of Estimation Base : October 2010

b) Exchange Rate : 1.00USD = 86.97 yen (Average of the past 6 months)
1.00GYD = 0.42 yen (Average of the past 6 months)

c) Implementation Period : As shown in the Annex of the Draft Report

d) Other : Cost estimation is in accordance with the framework of the Japanese Grant Aid Scheme that uses the procurement management agent.

4. Remarks

a) The cost estimation is provisional and will be further examined by GOJ for the approval of the Grant.

b) According to the Guyanese tax system, the material and equipment procured by Japanese Grant Aid

using the Procurement Management Agent shall be exempted from all taxes and duties in Guyana.

Annex 3 Environmental Checklist to be inserted.

Environmental Checklist: 3. Hydropower Stations, Dams and Reservoirs (1)

Annex-3

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) Y (b) Y (c) N (d) N	(a)(b)(c) Environmental Protection Agency (EPA, Guyana) has determined that it was not necessary to conduct EIA as the rehabilitation and revetment works on the East Demerara Water Conservancy (EDWC) would not have significant impacts on the environment on February 8, 2011. (d) There are no other approvals required.
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) N (b) N	(a)(b) General scope of the Project was disseminated to stakeholders via the media. Although there will be some minor impact on land use and local resources, there will be reduced risk of flood damage. As such local stakeholders are not likely to raise objections.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) N	(a) As the scale of the rehabilitation is small, the social and environmental considerations are not relevant.
2 Pollution Control	(1) Water Quality	(a) 1.Does the water quality of dam pond/reservoir comply with the country's ambient water quality standards? (a) 2. Is there a possibility that proliferation of phytoplankton and zooplankton will occur? (b) Does the quality of water discharged from the dam pond/reservoir comply with the country's ambient water quality standards? (c) Are adequate measures, such as clearance of woody vegetation from the inundation zone prior to flooding planned to prevent water quality degradation in the dam pond/reservoir? (d) Is there a possibility that reduced the river flow downstream will cause water quality degradation resulting in areas that do not comply with the country's ambient water quality standards? (e) Is the discharge of water from the lower portion of the dam pond/reservoir (the water temperature of the lower portion is generally lower than the water temperature of the upper portion) planned by considering the impacts to downstream areas?	(a)1 Y (a)2 N (b) Y (c) Y (d) N (e) Y	(a)(b)(c)(d)(e) Although there is excavation work in the scope of the rehabilitation, social and environmental considerations will not be affected. There will be some minor impact on water pollution. However, quality control plan in the design phase provides for monitoring water quality during rehabilitation and for some time after rehabilitation.
	(2) Wastes	(a) Are earth and sand generated by excavation properly treated and disposed of in accordance with the country's regulations?	(a) Y	(a) As earth and sand generated by excavation is reused for the embankment work, there is little waste generated by excavation.
	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) It is not a protected area.

Environmental Checklist: 3. Hydropower Stations, Dams and Reservoirs (2)

Annex-3

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
3 Natural Environment	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) Is there a possibility that the project will adversely affect downstream aquatic organisms, animals, plants, and ecosystems? If yes, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Is there a possibility that installation of structures, such as dams will block the movement of the migratory fish species (such as salmon, trout and eel those move between rivers and sea for spawning)? If yes, are adequate measures taken to reduce the impacts on these species?	(a) N (b) N (c) N (d) N	(a)(b)(c)(d) There is no designated species of flora or fauna that should be protected in and around the EDWC. The scope of rehabilitation is limited, therefore, no impact on ecosystem will be expected.
	(3) Hydrology	(a) Is there a possibility that hydrologic changes due to the installation of structures, such as weirs will adversely affect the surface and groundwater flows (especially in "run of the river generation" projects)?	(a) N	(a) As there is no type of rehabilitation that affects groundwater and the scale of the rehabilitation is small, no impact on hydrological situation will be expected.
	(4) Topography and Geology	(a) Is there a possibility that reductions in sediment loads downstream due to settling of suspended particles in the reservoir will cause impacts, such as scouring of the downstream riverbeds and soil erosion? Is there a possibility that sedimentation of the reservoir will cause loss of the storage capacity, water logging upstream, and formation of sediment deposits at the reservoir entrance? If yes, are the possibilities of the impacts studied, and adequate prevention measures taken? (b) Is there a possibility that the project will cause a large-scale alteration of the topographic features and geologic structures in the surrounding areas (especially in run of the river generation projects and geothermal power generation projects)?	(a) N (b) N	(a)(b) As the scale of the rehabilitation is small, no impact on topography and geographical features will be expected.

Environmental Checklist: 3. Hydropower Stations, Dams and Reservoirs (3)

Annex-3

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Are the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a) N (b) N (c) N (d) N (e) N (f) N (g) N (h) N (i) N (j) N	(a)(b)(c)(d)(e)(f)(g)(h)(i)(j) The rehabilitation is located within the EDWC, no impact concerning involuntary resettlement will be expected.

Environmental Checklist: 3. Hydropower Stations, Dams and Reservoirs (4)

Annex-3

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(2) Living and Livelihood	(a) Is there any possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is there any possibility that the project causes the change of land uses in the neighboring areas to affect adversely livelihood of local people? (c) Is there any possibility that the project facilities adversely affect the traffic systems? (d) Is there any possibility that diseases, including infectious diseases, such as HIV, will be brought due to the immigration of workers associated with the project? Are adequate considerations given to public health, if necessary? (e) Is the minimum flow required for maintaining downstream water uses secured? (f) Is there any possibility that reductions in water flow downstream or seawater intrusion will have impacts on downstream water and land uses? (g) Is there any possibility that water-borne or water-related diseases (e.g., schistosomiasis, malaria, filariasis) will be introduced? (h) Is there any possibility that fishery rights, water usage rights, and common usage rights, etc. would be restricted?	(a) N (b) N (c) N (d) N (e) Y (f) N (g) N (h) N	(a) Although the risk of flood damage on social infrastructure is reduced and there may be some impact on social institutions, little negative impact is expected. (b) As the risk of flood damage is reduced for all the residents in the surrounding areas, land can be utilized more actively. Therefore, there will be some, though not significant, impact on the local economy such as employment and livelihood. No negative impact on distribution of benefit and damage and local conflicts of interest will also be expected. (c) As the traffic on arterial roads increases due to the construction of Cunha Sluice, some, though not significant, impact on existing social infrastructures and services will be expected. Infectious diseases will be decreased as the risk of flood damage decreases. Therefore, although there may be some impact on sanitation, little negative impact will be expected. (d) No possibility that diseases, including infectious diseases, such as HIV, will be brought due to the immigration of workers associated with the project will be expected. (e) The minimum flow required for maintaining downstream water uses will be secured. (f) No impact on downstream water and land uses will be expected. (g) Infectious diseases will be decreased as the risk of flood damage decreases. Therefore, although there may be some impact on sanitation, little negative impact will be expected. (h) As the rehabilitation of existing facilities is conducted only in limited areas, there will not be any problems of water rights.
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage sites? If yes, are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) As there is no cultural heritage sites in the EDWC, no impact will be expected.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? If yes, are necessary measures taken?	(a) N	(a) As the scale of the rehabilitation is small, no impact on landscape will be expected.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources to be respected?	(a) N (b) Y	(a)(b) Although there is a village of indigenous people along the upper stream of Mahaica River, it is located outside the catchment area of the EDWC. Therefore, no impact on the indigenous and ethnic people will be expected.

Environmental Checklist: 3. Hydropower Stations, Dams and Reservoirs (5)

Annex-3

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a) Y (b) Y (c) Y (d) Y	(a)(b)(c)(d) As laws and ordinances are complied with and appropriate measures are ensured, no problem with the working conditions will be expected.
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce the impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce the impacts?	(a) Y (b) Y (c) Y	(a) Although machinery for the rehabilitation generates noise and vibration, there are no residential settlements around the project site. Therefore, no impact from noise and vibration will be expected. (b)(c) As the scale of the rehabilitation is small, no impact on the natural and social environment will be expected.
	(2) Accident Prevention Measures	(a) Is a warning system established to alert the inhabitants to water discharge from the dam?	(a) Y	(a) The warning system is established to alert the inhabitants to water discharge from the dam by NDIA.
	(3) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) Y (c) Y (d) Y	(a)(b)(c)(d) Monitoring items, methods and frequencies will be shown in the monitoring form.

Environmental Checklist: 3. Hydropower Stations, Dams and Reservoirs (6)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Forestry Projects checklist should also be checked (e.g., projects in the mountains including large areas of deforestation). (b) In the case of dams and reservoirs, such as irrigation, water supply, and industrial water purposes, where necessary, pertinent items described in the Agriculture and Water Supply checklists should also be checked. (c) Where necessary, pertinent items described in the Power Transmission and Distribution Lines checklist should also be checked (e.g., projects including installation of electric transmission lines and/or electric distribution facilities).	(a) N (b) N (c) N	(a)(b)(c) This item is not relevant to the Project.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) N	(a) As the scale of the rehabilitation is small, no impact on transboundary or global issues will be expected.

1) Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are requested to be made.
In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.

Monitoring Form

NDIA will follow-up corrective actions taken by the contractors of any issues that are identified on the environmental checklist. The environmental checklist and reports on corrective actions including test data will be submitted to JICA as attachments to the periodic reports. . NDIA should utilize the attached monitoring forms for submitting reports.

-When monitoring plans including monitoring items, frequencies and methods are decided, project phase or project life cycle (such as construction phase and operation phase) should be identified.

1. Responses/Actions to Feedback and Suggestions from Public and Authorities

Monitoring Item and Phase of Project	Monitoring Results during Report Period
eg.) Phase: Constructions/ Operations, Responses/Actions to Feedback and Suggestions from Public and Authorities	

2. Mitigation Measures

(1) Arterial road adjacent to Cunha (Sarah Johanna) Relief Sluice work site

(Criteria in case of heavy traffic on the road)

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referenced International Standards	Remarks (Measurement Point, Frequency, Method, etc.) *
Cracks	%	30	40	-	MCI(JAP)	Sketching and crack ratio calculation
Roughness (longitudinal)	mm	4.0	5.0	-	MCI(JAP)	Roughness measurement
Rutting (lateral)	mm	30	40	-	MCI(JAP)	Rut depth measurement
Overall mitigation measures evaluation	MCI	3～5	less than 3 (urgent need)	-	MCI(JAP)	Quantification of Index-value by using evaluation formula

*Measuring at loading/Unloading area on the road, at the completion of the whole works.

(2) Water pollution at the potable water Intake of Nancy

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referenced International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
pH	-	6.5	8.5	WHO	EPS(USA)	Sampling at the outlet of the Intake structure, at suggested time of 10:00 a.m., daily during work period
Chromaticity	Tcu	-	15	-	EPS(USA)	ditto
Turbidity	NTU	-	5	-	EPS(USA)	ditto

(3) Soil Test (in cases of using cement)

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referenced International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
pH	-	-	-	-	-	Cement-mixed soil pH testing, one sample/day, during work execution

Appendix-5 Soft Component Plan

5.1 Background of Planning of Soft Component

This Project is composed of two components; procurement of equipment for rehabilitation works of the EDWC embankment (Component-1), and rehabilitation of the facilities (relief sluice/intake) (Component-2). In order to maximize the effect of this Project, the rehabilitation works for the embankment must be properly executed by use of the procured equipments (super-long arm excavators and pontoons), and the embankment and the facilities must be in use for a long period through inspection and maintenance management. Consequently, ability of the related staff for the maintenance management of the water conservancy must be improved. Therefore, the necessity of the Soft Component (technical assistance) for improving the quality and execution supervision, and inspection and maintenance management is quite high, for the purpose of enhancing the sustainability of the output of this Project.

5.2 Objective of the Soft Component

The objective of the Soft Component is to help concerned personnel of the EDWC acquire knowledge on quality and execution supervision for rehabilitation of the EDWC embankment and facilities, and appropriate maintenance management by use of the procured equipments, for sustainable and stable operation of the water resource, while reducing the flood damages.

5.3 Output of the Soft Component

Table 1 shows the expected outputs of the Soft Component.

Table 1: Output of the Soft Component and the Method of Validation

Output	Content	Method of validation
Output 1: (Improvement of quality and execution supervision for capacity for rehabilitation of the embankment and the facilities)	Documented manuals for the quality and execution supervision of rehabilitation of the embankment and the facilities are created and utilized.	Validate the proficiency and understanding by visual inspection or records of the ledgers such as management record, etc. and check whether the quality and execution supervision were compatible with the manuals.
Output 2: (Enhancement of inspection and maintenance management capacity for the embankment and the facilities)	Inspection and maintenance management manuals for the embankment and the facilities of the Conservancy are created and utilized.	Validate the proficiency and understanding by visual inspection reports or creating maintenance management records, and check whether the inspection and maintenance management and planning were compatible with the manuals.

5.4 Validation of the Outputs

The method for the validation of the outputs is as shown in Table 1.

5.5 Activities of the Soft Component (Input Plan)

The Soft Component shall be implemented by direct assistance by two consultants from Japan for 3.0 months (5.3M/M) including the works in Japan, for the purpose of improving the quality and

execution supervision capacity for the rehabilitation work of embankment and facilities, and the inspection and maintenance management capacity for the water conservancy. Table 2 shows the activities of the soft component.

Table 2 Activity Plan for the Soft Component

Output	Required skills or line of work	Present skills and required skill level	Targeted personnel	Method for implementation	Resource for implementation	Outcome
Output 1: Improvement of quality and execution supervision capacity for rehabilitation of the embankment and the facilities	(Consultant) First-class civil engineering works execution management ability, or Engineer experienced in dam management, or Engineer experienced in conservancy execution supervision[1)]	Judging from the existing uneven rehabilitated state of embankment and facilities, it is judged knowledge on the quality control and execution supervision is insufficient. Therefore, manuals must be created for the quality and execution supervision for the embankment rehabilitation work. It is required that the quality and execution supervision must be accurate and homogeneous.	・Workshop staff (6-persons) ・Quality and execution supervision staff at the EDWC Lama office (8-persons) ・Ranges in charge of quality and execution supervisions (2-persons)	・Preparation of draft manual for quality and execution supervision ・Verification of quality and execution supervision in progress ・OJT of quality and execution supervision (including embankment material test, permeability test, etc.) ・Revise and finalize the manuals for the quality and execution supervision ・ Hold workshop (once) ・Create and verify records for quality and execution supervision	2.50 M/M for consultant for quality and execution supervision (direct assistance)	・Manual for quality and execution supervision ・Records for quality and execution supervision
Output 2: Enhancement of inspection and Maintenance management capacity for the embankment and the facilities	(Consultant) First-class civil engineering works execution management ability, or Engineer experienced in dam management, or Engineer experienced in conservancy inspection and execution supervision[1)]	Judging from the existing post-management state on the embankment and facilities, it is judged knowledge on the inspection and maintenance management is insufficient. Therefore, manuals for inspection and maintenance management which describe implementation procedure, daily and periodic inspection method, recording and so on..	・Inspection and maintenance management staff at the EDWC Lama office (2-persons) ・Ranges in charge of inspection and maintenance management (8-persons)	・Preparation of draft manual for inspection and maintenance management ・Verification of inspection and maintenance management in progress ・OJT of inspection and maintenance management ・ ・Revise and finalize the manuals for the inspection and maintenance management. ・Hold workshop(once) ・Create and verify records for inspection and maintenance management.	3.00 M/M for consultant for inspection and maintenance management (direct assistance)	・Manual for inspection and maintenance management ・Records for inspection and maintenance management .

1) Required for work experience in embankment construction of dams, reservoirs, or rivers, or, construction of concrete structures (quality of embankment, construction supervision test and daily management, quality and construction management of general concrete structures, etc.), or, operation and maintenance management of reservoirs.

5.6 Method of Procuring the Resource of Implementation of the Soft Component

The resource of implementation is the consultant from Japan concerned in the equipment procurement and rehabilitation of the facilities, by a direct cooperation. The reasons are as follows.

- The output - manuals for the quality and construction supervision and daily inspection of structures which local consultants knowledge is lacking; shall be created based on the manuals of Japan, etc. Therefore, Japanese consultants that understand the technology of Japan shall provide direct cooperation.
- Out of the tests and inspections based on the manuals of Japan[2)] which currently are not conducted in Guyana, there are some that have high necessity to be introduced in Guyana, therefore, engineers that have through understanding and advanced technique are indispensable. For this reason, a Japanese consultant shall provide direct cooperation.

5.7 Process of the Soft Component

The soft component shall be implemented in 3.0 months during the period for the embankment restoration and rehabilitation work for the facilities. Table 3 shows the total process of the soft component, and daily activity schedule plans and required vehicles for the site work is shown in attachment.

Table 3: Schedule Plan for the Soft Component

Outcome	Staff	Year: 1 (10 20 30) 2 (10 20 30) 3 (10 20 30) 4 (10 20 30)
Outcome 1 : Improvement of quality and execution supervision capacity for rehabilitation of the embankment and the facilities	Consultant in charge of quality and execution supervision	(15 0.50) (45 1.50) (12 0.40)
Outcome 2 : Enhancement of inspection and maintenance management capacity for the embankment and the facilities	Consultant in charge of inspection and maintenance management	(15 0.5) (60 2.00) (12 0.4)
Submission of reports, etc.	Output 1: (draft for manual for quality and construction supervision)	▲ English
	Output 2: (draft for manual for inspection and maintenance management)	▲ English
	Completion report	▲ English

(Legend) Work in Japan ▭ Work at site ▬

2) Included in the quality and execution supervision manuals as standard test and quality and execution supervision test for stabilization of mixed cement or sand, and, permeability test and quality and construction supervision test for dam embankment using clay with super high water content.

・Outcome 1 shall be implemented on the period when the earth work is most severe (immediately after the rainy season when the conservancy water level is maximized).

・Outcome 2 shall be implemented on the period when the structure of the embankment and the facilities are unstable (immediately after the rainy season when the conservancy water level is gradually lowering from the maximum level).

5.8 Output of the Soft Component

Output of the soft component and period for submission are as shown in Table 4

Table 4: List of Output

Type	Name of material	Contents	Pages
Manual	Draft manual for quality and execution supervision (English)	・Method of quality and execution supervision and precautions ・Implementation structure of the construction ・TOR draft for contract of work	30
	Draft manual for inspection and maintenance management (English)	・Daily and regular inspection and maintenance management method, and precautions ・Inspection and maintenance management method in case of emergency, and precautions ・Inspection and maintenance management structure ・TOR draft for contract of work	50
Report	Completion report (English, Japanese)	・Activity plan and performance ・Inspection and maintenance management training result ・Achievements of activities and outputs ・Factors that influenced the achievement of output ・Issues or proposals for sustainable effect and future development ・Set of outputs	30
Presentation material	Material for distribution at the workshop	・Points of the draft of manuals for quality and execution supervision ・Points of the draft of manuals for inspection and maintenance management	30
		Total	140

5.9 Responsibility of the Executing Agency of Guyana

For the implementation of the soft component, Guyana is responsible for the following.

・Secure personnel, training facility, and equipment[3)] necessary for the soft component

・Bear the expenses for manpower, training facility, and equipment[3)] necessary for the activities of the soft component.

3) Equipment such as simple cone-penetrometer, molds for unconfined compression test, curing tank, test sample push-off device, molding machine, test tools and instruments, sand bags, about 50,000 yen in total.

[Attachment] Planning Schedule of Activities on Soft Component

【 Consultant A 】 In charge of Quality Control and Execution Supervision for Embankment and Facilities Rehabilitation	
[Outcome A] Upgrading of Abilities on Quality Control and Supervison for EDWC Facilities	
1	
2	①Extraction of problems and contents to be modified for the existing manual
3	
4	②Collection of concerned materials on quality control and execution supervision
5	
6	holiday
7	holiday
8	①Extraction of problems and contents to be modified for the existing manual, ②Preparation of modified draft manual plan which supplements lacking items of the existing manual,
9	
10	
11	③Preparation of explanation materials to the personnel concerned in Guyana
12	Meeting with JICA personnel on the contents and instruction methods concerning the materials prepared in previous days
13	holiday
14	holiday
15	①Modification of contents to the materials given above, and arrangement of data, ②Preparation of explanation materials to the personnel concerned in Guyana
16	traveling
17	traveling
18	①Preparation of materials for a meeting, ②Explanation to JICA experts on the prepared materials, ③Taking a site inspection
19	Explanation to NDIA personnel on revision and supplement to the existing manual, and holding meeting/discussion with NDIA personnnel concerned
20	Modification of the contents of the manual on the basis of the meeting and discussion with NDIA personnel
21	holiday
22	Explanation to EDWC personnel in charge of duty, on revision and supplement to the existing manual, and holding meeting/ discussion with them
23	①Modification of the contents of the manual on the basis of the discussion with EDWC personnel, ②Reporting the modified contents of the manual plan to NDIA
24	①Grasping actual situations on quality control, execution
25	supervision and field tests based on the modified manual
26	plan, ②Instruction to personnel (workshop and EDWC personnel, rangers) in charge of duty, at site, ③Extraction of problems on banking and embankment improvement, etc., ④Arrangement of items and contents to be modified on the manual plan
27	①Additional modification and improvement to the manual plan on which the field work was based during the week, ②Holding a meeting of concerned parties
28	holiday
29	①Grasping actual situations on quality control, execution
30	supervision and field tests based on the modified manual
31	plan (the manual plan used for the field work in the previous week), ②Instruction to the personnel (workshop and EDWC personnel, rangers) in charge of duty, at site, ③Extraction of problems on banking and embankment improvement, ④Arrangement of contents to be modified on the manual plan, ⑤Preparation of materials for the workshop
32	①Additional modification and improvement to the manual plan on which the field work was based during the week, ⑤Preparation of materials for the workshop
33	①Holding a workshop, ②Reporting to NDIA on ongoing matters, and explanation on the modified and improved parts to the modified manual plan, ③Arrangement of the modified manual plan

【 Consultant B 】 In charge of Inspection and Maintenance Management for Embankment and Facilities Rehabilitation	
[Outcome B] Upgrading of Abilities on Inspection and Management for EDWC Facilities	
1	
2	①Extraction of problems and contents to be modified on the existing manual
3	
4	②Collection of concerned materials on inspection and maintenance management
5	
6	holiday
7	holiday
8	①Extraction of problems and contents to be modified for the existing manual, ②Preparation of modified draft manual plan which supplements lacking items of the existing manual,
9	
10	
11	③Preparation of explanation materials to the personnel concerned in Guyana
12	Meeting with JICA personnel on the contents and instruction methods concerning the materials prepared in previous days
13	holiday
14	holiday
15	①Modification of contents to the materials given above, and arrangement of data, ②Preparation of explanation materials to the personnel concerned in Guyana
16	traveling
17	traveling
18	①Preparation of materials for a meeting, ②Explanation to JICA experts on the prepared materials ③Taking a site inspection
19	Explanation to NDIA personnel on revision and supplement to the exiting manual, and holding meeting/discussion with NDIA personnnel concerned
20	Modification of contents of the manual on the basis of the meeting and discussion with NDIA personnel
21	holiday
22	Explanation to EDWC personnel in charge of duty, on revision and supplement to the existing manual, and holding meeting/discussion with them
23	①Modification of the contents of the manual on the basis of the discussion with EDWC prsonnel, ②Reporting the modified contents of the manual plan to NDIA
24	①Confirmation of the contents on inspection and
25	maintenance management methods, description methods
26	and report preparation methods etc., based on the modified manual plan, ②Grasping actual situations on inspection and maintenance management
27	①Additional modification and improvement to the manual plan on which the field work was based during the week, ②Holding a meeting of concerned parties
28	holiday
29	①Confirmation of the contents on the inspection and
30	maintenance management methods and report preparation
31	etc., based on the modified manual plan (the manual plan used for the field work in the previous week), ②Instruction on the contents and inspection methods etc. to the personnel (EDWC personnel and rangers) in charge of duty, at site, ③Extraction of problems, ④Arrangement of contents to be modified on the manual plan, ⑤Preparation of materials for the workshop
32	①Additional modification and improvement to the manual plan on which the field work was based during the week, ⑤Preparation of materials for the workshop
33	①Holding a workshop, ②Reporting to NDIA on ongoing matters, and explanation on the modified and improved parts to the modified manual plan, ③Arrangement of the modified manual plan

[Outcome A] Upgrading of Abilities on Quality Control and Supervison for EDWC Facilities		[Outcome B] Upgrading of Abilities on Inspection and Management for EDWC Facilities	
34	①Holding a workshop, ②Explanation of the modified and improved parts to the modified manual plan, and explanation on the modification of instruction procedures, ③Preparation of the first revised version of manual plan (incorporating Japanese manual currently used, through discussion)	34	①Holding a workshop, ②Explanation of the modified and improved parts to the modified manual plan, and explanation on the modification of instruction pocedures, ③Preparation of the first revised version of manual plan (incorporating Japanese manual currently used, through discussion)
35	holiday	35	holiday
36 37 38 39	①Grasping mastery by personnel (workshop and EDWC personnel, rangers) in charge of duty, of the first revised version of manual plan, ②Extraction of problems in quality control and execution supervison, ③Opinon hearing from personnel in charge of duty (arrangement of the revised contents)	36 37 38 39	①Confirmation of the contents on the inspection and maintenance management methods, their description metods and report preparation methods etc., and grasping actual situations on inspection and maintenance management based on the first revised version of the manual plan, ②Instruction to the personnel (EDWC personnel and rangers) in charge of duty, at site, ③Extraction of problems in inspection and maintenance managemet, ④Opinion hearing from personnel in charge of duty (arrangement of the revised contents)
40	①Preparation of the second revised version of manual plan, ②Holding a meeting of concerned parties	40	①Preparation of the second revised version of manual plan, ②Holding a meeting of concerned parties
41	holiday	41	holiday
42 43 44 45	①Confirmation of quality control, execution supervision and field tests based on the second revised version of the manual plan, and extraction of problems in actual execution, ②Holding a study meeting of concerned parties	42 43 44 45	①Confirmation of the contents on the inspection and maintenance management methods, describing ways on them and report preparation methods etc., based on the second revised version of the manual plan, ②Grasping actual situations on inspection and maintenance, ③Extraction of problems in the time, and opinon hearing from personnel in charge of duty , ④Grasping attainment of mastery of the manual plan by personnel in charge of, and instruction on inspection and maintenance management
46	①Preparation of the third revised version of manual plan, ②Holding a meeting of concerned parties	46	①Preparation of the third revised version of manual plan, ②Holding a meeting of concerned parties
47	holiday	47	holiday
48 49 50	①Grasping attainment of mastery of the third revised version of manual plan, by personnel in charge of duty, ②Instruction on quality control and execution supervision, ③Extraction of problems on execution of embanking etc.	48 49 50 51	①Confirmation of the contents on the inspection and maintenance management methods, describing ways for them and report preparation etc., based on the third revised version of the manual plan,and grasping present situations, ②Extraction of problems in the time, and opinon hearing on the manual plan, ③Grasping attainment of mastery of the manual plan by personnel in charge of, and instruction on inspection and maintenance management (setting major points on describing contents and conveying ways etc.)
51 52	Holding a study meeting and exchange of opinions with personnel concerned (explanation on the revised parts and whole manual on the final revised version of quality control and execution supervision)	52	Revision and improvement to the third revised version of the manual plan, and holding a meeting of concerned parties
53	holiday	53	holiday
54 55	①Discussion with the personnel concerned on description methods and contents for the final revised version of the manual for quality control andexecution supervision, ②Revising on the final revised version of the manual for quality control and execution supervision	54 55	①Confirmation of the contents on the inspection and maintenance management methods, describing ways for them and report preparation etc., based on the revised version of the manual plan, and grasping of present situations, ②Extraction of problems in the time, and opinon hearing on the manual plan,
56 57 58	①Submission of final version of the manual on the quality control and execution supervision to NDIA, ②Explanation on the revised parts and whole contents concerning the instruction items etc.	56 57 58	③Grasping attainment of mastery of the manual plan by personnel in charge of, and instruction on inspection and maintenance management (setting major points for the whole contents on inspection and maintenance management) ①Arrangement of problems on the fourth revised version of the manual plan, ②Holding a meeting of concerned parties (also to be held next week)
59	traveling, holiday	59	holiday

[Outcome A] Upgrading of Abilities on Quality Control and Supervison for EDWC Facilities	
60	traveling
61	Preparation of draft completion report
62	
63	
64	Submission of the draft completion report to JICA
65	holiday
66	holiday
67	Revising on the draft completion report
68	
69	
70	①Completion and submission of the completion report to JICA ②Submission of the final version of the manual for quality control and execution supervision to JICA
71	
1	holiday
2	holiday

[Outcome B] Upgrading of Abilities on Inspection and Management for EDWC Facilities	
60	①Confirmation of the contents on the inspection and maintenance management methods, describing ways for them and report preparation etc., based on the forth revised version of manual plan, and grasping present situations, ②Instruction to the personnel in charge of duty at site, ③Extraction of problems in the time, and opinon hearing on the manual plan, ④Grasping attainment of mastery of the manual plan by personnel in charge, and instruction of inspection and maintenance management (setting major points for the whole contents on inspection and maintenance management)
61	
62	
63	
64	①Arrangement of problems on the fourth revised version of the manual plan, ②Holding a meeting of concerned parties
65	Lecturing on the preparation methods of the inspection and maintenance management plan, at site
66	holiday
67	①Holding a meeting of concerned parties(reconfirmation of contents and problems, describing ways for them and report preparation etc.), ②Revision of problems to the fourth revised version of the manual plan
68	
69	①Explanation on the instruction situations etc. on the final revised manual for the EDWC inspection and maintenance management, and discussion on problems etc.
70	②Preparation of the final revised version of the manual plan
71	③Preparation of the meeting contents and discussion records
1	①Meeting and discussion with NDIA on the final revised version of the manual on the inspection and maintenance management, ②Submission of records of documents on the instruction items and revision records and meetings, ③Submission of the final revised manual to NDIA
2	holiday
3	traveling
4	traveling
5	Preparation of draft completion report
77	
78	
79	holiday
80	holiday
81	Submission of the draft completion report to JICA
82	Revising on the draft completion report
83	
84	
85	①Completion and submission of the completion report to JICA ②Submission of the final version of manual for the inspection and maintenance management to JICA
86	holiday
87	holiday

Legend :

- Activities in Japan
- Activities in Guyana
- ****** Preparation of Materials
- ****** Meeting / Discussion with NDIA/EDWC Personnel

Appendix-6 Engineering Materials Studieid and Calculated

Appendix 6 - 1 Stability Studies of Pontoon in Operation

Appendix 6 - 2 Determination of Soil Coefficients and Revetment Design

Appendix 6 - 3 Planning of Revetment Execution

Appendix 6 - 1 Stability Studies of Pontoon in Operation

1. Stability Study of Pontoon

Studies on stability of pontoon which loads the excavator and the vessel for excavated soil are carried out based on the following conditions.

2. Conditions

Studies are based on the following conditions;

1) Following 2-cases are studied:

a） In case of the least burdens of one excavator and vacant soil vessel on the pontoon

b） In case of full burdens of one ecavator and the filled vessel on the pontoon.

2) 4-labours board on the pontoon in both a) and b) cases.

3) The pontoon is operated at fresh water conservancy .

4) Restoration of pontoon is studied in the conditions of wind-storm of wind velocity of 60m/sec, and wave height of 1.5m, at case of 1)-a) above.

5) Restoration of pontoon is studied in the condition that the excavator and the vessel are firmly fixed to the pontoon.

3. Pontoon with Excavator and Vessel

The general views of the pontoon loaded with the excavator and the vessel is shown in Figure-1.

4. Stability Studies on Pontoon ：(in case of 2-1)-a) above）

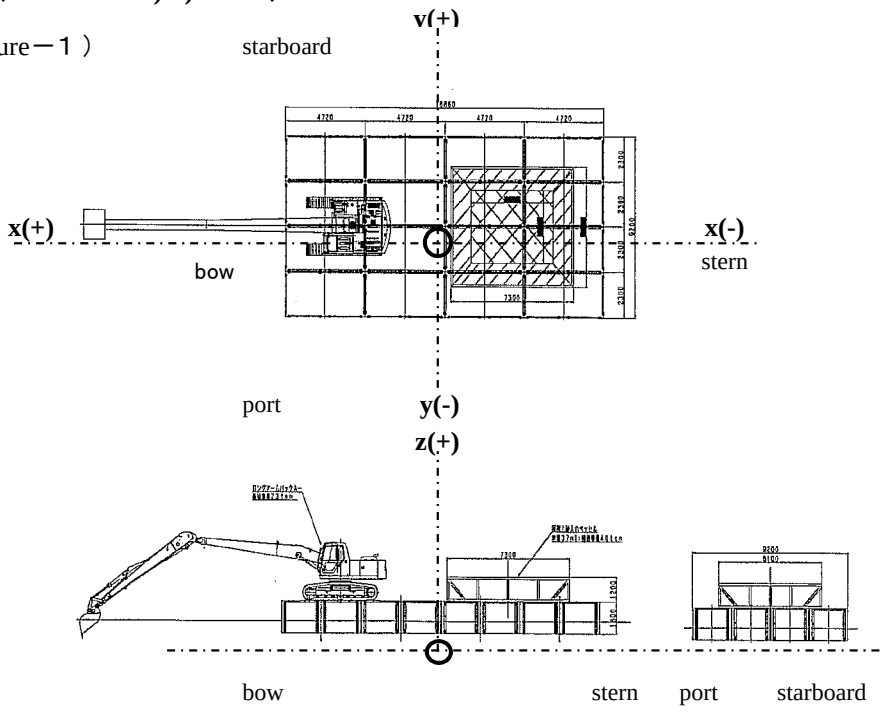
1) Sizes of Pontoon（refer to Figure－１）

length L = 18.88m

width B = 9.20m

height D = 1.60m

average draught d = 0.63m



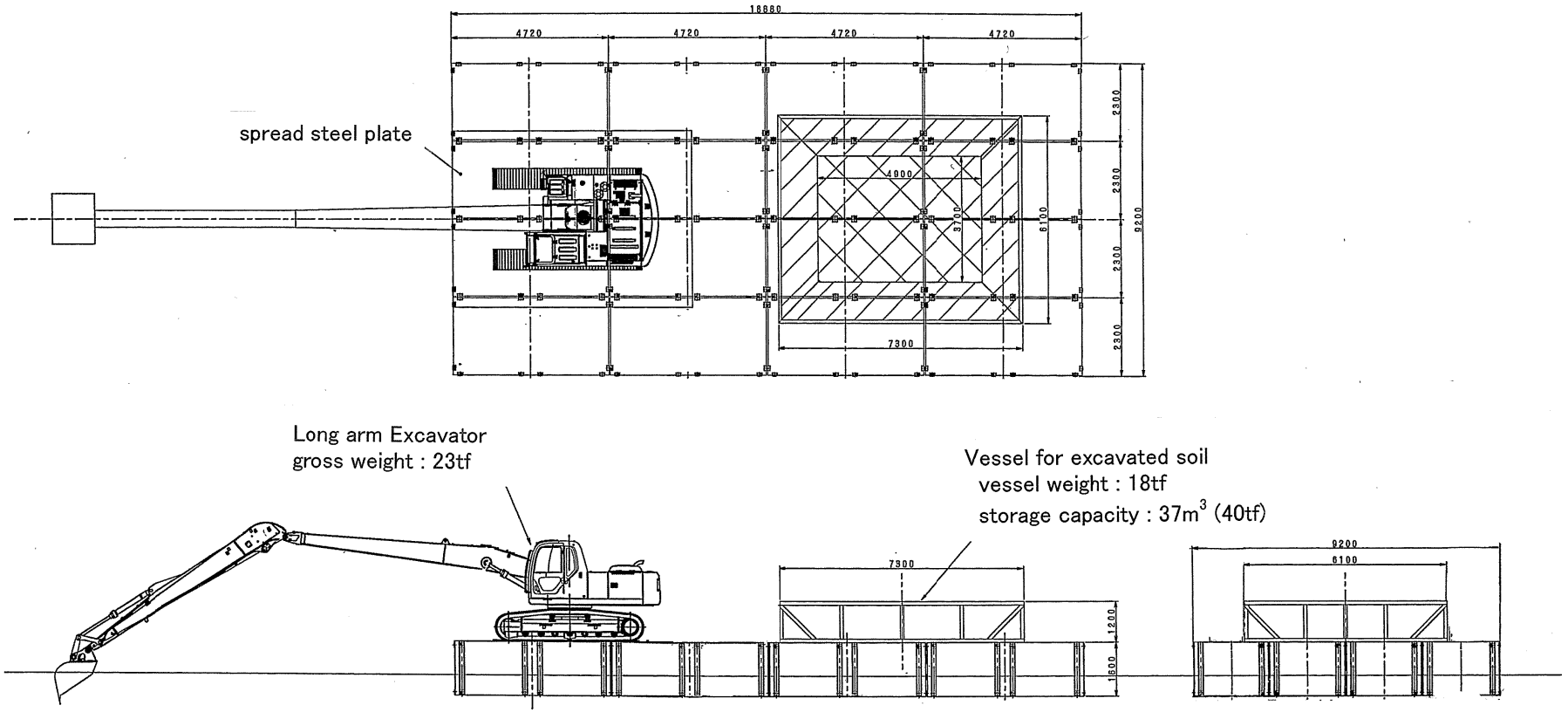


Figure-1 General views of the Pontoon loaded with the Excavator and the Vessel

2) Weight Distribution and Center of Gravity

Items	Weight	X-direction			Y-direction			Z-direction	
		X-axis	Moment（tf・m）		Y-axis	Moment（tf・m）		Z-axis	Moment
	W(tf)	CG(m)	(+)bow	(-)stern	HG(m)	(-) L.	(+) R.	KG(m)	（tf・m）
Pontoon	64	0	0	0	0	0	0	0.8	51.2
Bessel Self-weight	18	-4	0	-72	0	0	0	1.9	34.2
Excavated soil in Vessel	0	-4	0	0	0	0	0	2.4	0
Excavator Crawler(Right)	11.5	3.5	40.25	0	1.2	0	13.8	1.6	18.4
Excavator Crawler(Left)	11.5	3.5	40.25	0	-1.2	-13.8	0	1.6	18.4
Bollard－1	0.2	8	1.6	0	4	0	0.8	1.9	0.38
〃 －2	0.2	8	1.6	0	-4	-0.8	0	1.9	0.38
〃 －3	0.2	-8	0	-1.6	4	0	0.8	1.9	0.38
〃 －4	0.2	-8	0	-1.6	-4	-0.8	0	1.9	0.38
Fairleader－1	0.3	9.2	2.76	0	3.8	0	1.14	1.8	0.54
〃 －1	0.3	9.2	2.76	0	-3.8	-1.14	0	1.8	0.54
Labourers	0.3	3	0.9	0	3	0	0.9	3	0.9
Fuels	0.2	0	0	0	0	0	0	2.1	0.42
Machine tools for work	2	2	4	0	0	0	0	1.6	3.2
Total	108.9		94.12	-75.2		-16.54	17.44		129.32
Center of Gravity		0.17			0.01			1.19	

$\frac{94.12-75.2}{108.9} = 0.17(m)$ $\frac{17.44-16.54}{108.9} = 0.01(m)$ $\frac{129.32}{108.9} = 1.19(m)$

3) Calculation Results of Trim and Heel

Displacement tonnage（W）	tf	108.900
Draught (d) with respect to (W)	m	0.630
Lateral Metacenter (KM) with respect to (d)	m	11.250
Longitudinal Metacenter (KM) with respect to (d)	m	47.379
Height of Gravity center (KG)	m	1.190
Lateral Metacenter Height (GMB)	m	10.060
Longitudinal Metacenter Height (GML)	m	46.189
Center of Gravity in longitudinal axis (MG)	m	0.170
Centers of Gravity and Vuoyancy in longitudial axis (BG)	m	0.170
Trim Moment (MTC) with respect to (d)	tf・m	2.660
Heel Moment (MHC) with respect to (d)	tf・m	1.190
Trim T = W・BG／100・MTC	m	0.070
Heel H = W・HG／100・MHC	m	0.010
Bau Draught (df)	m	0.592
Stern Draught (da)	m	0.662
Average Draught (dm)	m	0.627
Port Draught (dp)	m	0.622
Starboard Draught (ds)	m	0.632

5. Stability Studies on Pontoon ：(in case of 2-1)-b) above)

1) Sizes of Pontoon（refer to Figure－１）

Length L = 18.88m , Width B = 9.20m , Height D = 1.60m , Average Draught d = 0.86m .

2) Weight Distribution and Center of Gravity

Items	Weight	X-direction			Y-direction			Z-direction	
		X-axis	Moment(tf･m)		Y-axis	Moment(tf･m)		Z-axis	Moment
	W(tf)	CG(m)	(+)bow	(-)stern	HG(m)	(-) L.	(+) R.	KG(m)	(tf･m)
Pontoon	64	0	0	0	0	0	0	0.8	51.2
Bessel Self-weight	18	-4	0	-72	0	0	0	1.9	34.2
Excavated soil in Vessel	40	-4	0	-160	0	0	0	2.4	96
Excavator Crawler(Right)	23	5.4	124.2	0	1.2	0	27.6	1.6	36.8
Excavator Crawler(Left)	0	5.4	0	0	-1.2	0	0	1.6	0
Bollard－1	0.2	8	1.6	0	4	0	0.8	1.9	0.38
〃 －２	0.2	8	1.6	0	-4	-0.8	0	1.9	0.38
〃 －３	0.2	-8	0	-1.6	4	0	0.8	1.9	0.38
〃 －4	0.2	-8	0	-1.6	-4	-0.8	0	1.9	0.38
Fairleader－２	0.3	9.2	2.76	0	3.8	0	1.14	1.8	0.54
〃 －２	0.3	9.2	2.76	0	-3.8	-1.14	0	1.8	0.54
Labourers	0.3	3	0.9	0	3	0	0.9	3	0.9
Fuels	0.2	0	0	0	0	0	0	2.1	0.42
Machine tools for work	2	2	4	0	1.8	0	3.6	1.6	3.2
Total	148.9		137.8	-235.2		-2.74	34.84		225.32
Center of Gravity		-0.65			0.22			1.51	

$$\frac{137.82-235.2}{148.9} = -0.65(m) \qquad \frac{34.84-2.74}{148.9} = 0.22(m) \qquad \frac{225.32}{148.9} = 1.51(m)$$

3) Calculation Results of Trim and Heel

Displacement tonnage（W）	tf	148.9
Draught (d) with respect to (W)	m	0.86
Lateral Metacenter (KM) with respect to (d)	m	8.228
Longitudinal Metacenter (KM) with respect to (d)	m	34.651
Height of Gravity center (KG)	m	1.51
Lateral Metacenter Height (GMB)	m	6.718
Longitudinal Metacenter Height (GML)	m	33.141
Center of Gravity in longitudinal axis (MG)	m	-0.65
Centers of Gravity and Vuoyancy in longitudial axis (BG)	m	-0.65
Trim Moment (MTC) with respect to (d)	tf･m	2.61
Heel Moment (MHC) with respect to (d)	tf･m	1.09
Trim T = W･BG／100･MTC	m	0.37
Heel H = W･HG／100･MHC	m	0.3
Bau Draught (df)	m	0.672
Stern Draught (da)	m	1.042
Average Draught (dm)	m	0.857
Port Draught (dp)	m	0.707
Starboard Draught (ds)	m	1.007

6. Restoration of Pontoon

1) Study conditions

Wind Velocity V = 60m/sec
Wave Height H = 1.5m
Draught of Pontoon d = 0.63m
Area suffered Pressure A = A1 + A2 + A3 = 199m^2
Side area of Pontoon A1 = 162m^2
Side area of Vessel A2 = 9m^2
Side area of Excavator A3 = 28m^2

2) Critical slant angle(angle formed when board contacts with water surface)

α= tan-1(Dm/(B/2)) * 0.8
= tan-1(0.97/4.6)*0.8 = 0.167 rad (9.56°)

3) Restoraton arm length in Critical slant angle

GZ = GMB * tanα= 10.06 * 0.167 = 1.69m
where, GMB is a Lateral Metacenter height (GMB = 10.06m)

4) Inclination of Pontoon due to Wind Pressure and Wave Pressure

・Inclination Moment due to Wind Pressure Rw = Fw * H1= 53.95 * 2 = 107.9 tf・m
Wind Load Fw = 1/2 * ρa * Cw * A * V2
= 1/2 * 1.23 * 1.2 * 199 * 602 = 528703.2N = 53.95tf

Density of Air ρa = 1.23kgf/m^3
Wind-resistant Coefficient Cw = 1.2
Area suffered Pressure(Side area) A = 199m^2
Center of Wind Pressure(above water surface) H1=2m

・Inclination Moment due to Wave Pressure Ra = ρ1 * Hmax * L * d * H3
= 1.0 * 2.7 * 18.88 * 0.63 * 1.35 = 43.35 tf・m
(Wind Pressure is deduced by the difference of water levels of the pontoon's bow and stern)

Unit weight of Water ρ1 = 1.0 tf/m^3
Maximum Wave Height Hmax = 1.8*H = 2.7m
Center of Wave Pressure H3 = Hmax/2 = 1.35m

5) Inclination angle of Pontoon due to Wind Pressure and Wave Pressure θ = tan-1(Inclination Height/B)
= tan-1(1.28/9.2) = 0.139 rad (7.92°) ＜ 9.56° O.K.

Inclination Height(Diference of Heel) = (Rw + Ra)/(100*MHC)
= (107.9 + 43.35)/(100*1.19) = 1.28(m)

6) The arm of Couple Moment in the above Inclination angle
LL = GMB * tanθ = 10.06 * 0.139 = 1.40m ＜ 1.69m O.K.

Seeing that the foregoing calculation results, the restoration of the pontoon is secured even under the severe storm-wind stated in the conditions above.

Appendix 6-2 Determination of Soil Coefficients and Revetment Design

1. Determination of Soil Modulus Employed in Design

(1) Overview

Soil modulus employed in design of revetment shall be determined based on the result of the site survey and the general soil modulus. Unit weight of soil "γ" is decided referring to the references the standard of port and the specification for highway bridges, and the relation between N-value and cohesive strength-c is calculated by c=qu/2, using Mohr's Theorem (qu means unconfined compressive strength of soil). The relation between N-value and cohesive strength-c shall also be verified by referencing "the Design and Use of Sheet pile Wall in Stream Restoration and Stabilization Projects (abstract described in design policy)", and "Road Earth Work, Temporary Structure Construction Guideline (March 1999)" by Japan Road Association

Relational table of N-value and Cohesive Strength-c

(2) Relation of N-value and cohesive strength-c

The ideal cohesive strength-c of the viscous soil is determined by obtaining the strength "qu" from the unconfined compression test. Various types of relation of the cohesive soil's unconfined compression strength –qu, cohesive strength-c and N-value have been proposed. Typical values are shown in Table 3.2.8 and Figure 3.2.6.

Table 3.2.8: Relations of N-value and qu, c

	q_u, c (kN/m²)
Terzaghi,Peck	$q_u = \frac{N}{0.082}$
Peck	$q_u = \frac{N}{0.060}$
Dunham	$q_u = \frac{N}{0.077}$
Morita	$q_u = \frac{N}{0.040} \sim \frac{N}{0.055}$ (Excluding clay of high sensitivity ratio)
Fukuoka	c = 5 + 7.5 N (Silty clay (N<10)) c = 10 + 7.5 N (Clay (N<10))
Miki	$q_u = \frac{N}{0.075}$

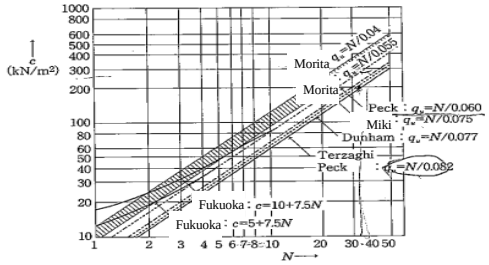


Figure 3.2.6: Relation of N-value and c

qu and c apply to the following relational expression, based on Mohr's theorem

$$c = \frac{q_u}{2} \tan\left(\frac{\pi}{4} - \frac{\phi}{2}\right) \quad (3.2.10)$$

When φ is approximately 0, the following formula is true (3.2.11)

$$c = \frac{q_u}{2} \quad (3.2.11)$$

Unit weight γ (Table 3.2.2)

(The standard of port)

The specifications for highway bridges

Table 3.2.2: Unit Weight and Water Content of Typical Soil[1]

Item	Alluvial clay	Diluvial clay	Sandy soil
Wet unit weight γ_t (kN/m³)	12~16	16~20	16~20
Dry unit weight γ_d (kN/m³)	5~14	11~14	12~18
Water content w (%)	150~30	60~20	30~10

Table 3.2.3: Unit Weight of Wet Soil (kN/m3)

Ground	Soil property	Loose	Dense
Natural ground	Sand and gravel	18	20
	Sandy soil	17	19
	Cohesive soil	14	18
Embankment	Sand and gravel	20	
	Sandy soil	19	
	Cohesive soil	18	

Table 2-2-3: Relation of Strength of Cohesive Soil and N-value

Hardness	Very soft	Soft	Intermediate	Hard	Very hard	Hardened
N-value	2 or less	2 ～ 4	4 ～ 8	8 ～ 15	15 ～ 30	30 or more
Cohesive strength (kN/m^2(tf/m^2))	12 or less (1.2or less)	12 ～ 25 (1.2～2.5)	25 ～ 50 (5.0～10)	50 ～ 100 (5.0～10)	100～200 (10～20)	200 or more (20 or more)

(2) List of ground survey result and values of soil moduli for design employed

2-1.Ann's Grove～Hope

Ann's GroveJust Point	P1	BH1				Calculation of C			Employed		
	DEEP	γ	C	N	S	C	N	S	DEEP	γ	c
Soft silty CLAY	8		24.15	2		24.15	12.2		9.8		24.15
Firm silty CLAY	13	14		28			170.7		13		170.7

	P2	EMB1				Calculation of C			Employed		
	DEEP	γ	C	N	S	C	N	S	DEEP	γ	c
Soft silty CLAY	9	17	0	0					9	17	0
Firm silty CLAY	10	21		15	183		91.46	183	10	21	183

	P2	EMB2				Calculation of C			Employed		
	DEEP	γ	C	N	S	C	N	S	DEEP	γ	c
Soft silty CLAY	0								0		
Firm silty CLAY	10		46.04	15		46.04	91.46		10		46.04

	P2	EMB3				Calculation of C			Employed		
	DEEP	γ	C	N	S	C	N	S	DEEP	γ	c
Soft silty CLAY	7.3			3			18.29		0		18.29
Firm silty CLAY	10			38.5			234.8				234.8

	P2	EMB4				Calculation of C			Employed		
	DEEP	γ	C	N	S	C	N	S	DEEP	γ	c
Soft silty CLAY									0		
Firm silty CLAY	8		21.3			21.3			8		21.3
silty CLAY	15.8			21			128				128

Hope Just Point	P1	BH2				Calculation of C			Employed		
	DEEP	γ	C	N	S	C	N	S	DEEP	γ	c
Soft silty CLAY	8	13	24.15			24.15			13	13	24
Firm silty CLAY	14.3			18			109.8		14	18	105

Ann's Grove						Calculation of C			Employed		
	DEEP	γ	C	N	S	C	N	S	DEEP	γ	c
Soft silty	Values shall be determined by considering the following: Deep (just point of bore-depth), γ and c (average value or general value)								8	15	24
Firm silty CLAY									13	17	125

Hope						Calculation of C			Employed		
	DEEP	γ	C	N	s	C	N	S	DEEP	γ	c
Soft silty CLAY	Values shall be determined by considering the following: Deep (just point of bore-depth), γ and c (average value or general value)								11	15	24
Firm silty CLAY									14	17	125
Soft silty CLAY											

2-2.Annadale～Nancy

	P2	EMB8				Calculation of C			Employed		
	DEEP	γ	C	N	s	C	N	S	DEEP	γ	c
Soft silty CLAY	6	20	0	0					6	20	
Firm silty CLAY	10	19	0	22	53.42		134.1	53.42	10	19	53.42
Soft silty CLAY											

	P2	EMB9				Calculation of C			Employed		
	DEEP	γ	C	N	s	C	N	S	DEEP	γ	c
Soft silty CLAY	8		36.42	0		36.42			8		36.42
Firm silty CLAY	10			34			207.3		9		207.3
Soft silty CLAY											

	P2	EMB10				Calculation of C			Employed		
	DEEP	γ	C	N	s	C	N	S	DEEP	γ	c
Soft silty CLAY	8	16.5	0	0					8	16.5	
Firm silty CLAY	10		0	19			115.9		10		115.9
Soft silty CLAY											

Annadale Just Point	P2	EMB11				Calculation of C			Employed		
	DEEP	γ	C	N	s	C	N	S	DEEP	γ	c
Soft silty CLAY	11	19	41.91	0					11	19	41.91
Firm silty CLAY	16		0	24			146.3		16		146.3
Soft silty CLAY											

Annadale,Nancy						Calculation of C			Employed		
	DEEP	γ	C	N	s	C	N	S	DEEP	γ	c
Soft silty CLAY	Values shall be determined by considering the following: Deep (just point of bore-depth), γ and c (average value or general value)								11	17	40
Firm silty CLAY									16	18	130

2-3.Maduni

Maduni JUST POINT	P1	BH3				Calculation of C			Employed		
	DEEP	γ	C	N	S	C	N	S	DEEP	γ	c
Soft silty CLAY	5.2	17	59.1						5.2	17	59.1
Firm silty CLAY	7			60	25.77		365.9	25.77	7		300
silty CLAY											

	P2	#10				Calculation of C			Employed		
	DEEP	γ	C	N	S	C	N	S	DEEP	γ	c
Soft silty CLAY	9	16.5							9	16.5	
Firm silty CLAY				18			150				150
silty CLAY											

Maduni						Calculation of C			Employed		
	DEEP	γ	C	N	S	C	N	S	DEEP	γ	c
Soft silty CLAY	Values shall be determined by considering the following: Deep (just point of bore-depth), γ and c (average value or general value)								5.2	17	60
Firm silty CLAY									7	18	150
silty CLAY											

2. Design of Revetment

(1) Overview

For the design of the timber revetment, tie-rod connected anchor type revetment shall be used for preventive maintenance of the embankment on the inlet side. On the other hand, self-supporting type sheet piles shall be used for the design of the outlet side. Materials shall be of timber piles and wooden sheet piles, since these are for low cost and are easy to purchase in Guyana.

(2) Applicable Specifications

(i) BS 8002: Code of Practice for Earth Retaining Structures

(ii) THE GUYANA GRADING RULES FOR HARDWOOD TIMBER
Published by Forest Department, Georgetown, Guyana, September 1977

(iii) Road earth work, temporary structure construction guideline, by Japan Road Association, March 1999

(iv) Additional specifications for design policy

(3) Material

a) Timber Piles, Earth Retaining Sheet Piles

Strength Classes: Greenheart D70 HS

Bending paralleled to grain: 23 N/mm2

Shear parallel to grain: 2.6 N/mm2

Modulus of elasticity: 21000 N/mm2

Safety factor: 0.8

Table 1 Strength graded hardwoods assigned to BS EN 338 strength classes

Species	Strength class				
	D30	D40	D50	D60	D70
Balau					HS
Ekki				HS	
Greenheart					HS
Iroko		HS			
Jarrah		HS			
Kapur				HS	
Karri			HS		
Kempas				HS	
Keruing			HS		
Merbau			HS		
Oak *	TH1 THB	THA			
Opepe			HS		
Teak		HS			

* Note that the TH2 grade of oak does not meet the requirements for the D30 strength class. Designs using TH2 grade oak should be based on the grade stresses given in BS 5268-2 for the individual species and grade.

Table 2 Characteristic values for hardwood strength classes (BS EN 338)

Strength properties N/mm²	**D30**	**D40**	**D50**	**D60**	**D70**
Bending	30	40	50	60	70
Tension parallel to grain	18	24	30	36	42
Tension perpendicular to grain	0.6	0.6	0.6	0.7	0.9
Compression parallel to grain	23	26	29	32	34
Compression perpendicular to grain	8.0	8.8	9.7	10.5	13.5
Shear	3.0	3.8	4.6	5.3	6.0
Stiffness properties kN/mm²					
Mean MOE parallel to grain	10	11	14	17	20
5th percentile MOE parallel to grain	8.0	9.4	11.8	14.3	16.8
Mean MOE perpendicular to grain	0.64	0.75	0.93	1.13	1.33
Mean shear modulus	0.60	0.70	0.88	1.06	1.25
Characteristic density kg/m³	530	590	650	700	900

Table 3 Grade stresses and moduli of elasticity for hardwood strength classes for Service Classes 1 and 2 (BS 5268-2).

N/mm²	D30	D40	D50	D60	D70
Bending parallel to grain	9.0	12.5	16.0	18.0	23.0
Tension parallel to grain	5.4	7.5	9.6	10.8	13.8
Compression parallel to grain	8.1	12.6	15.2	18.0	23.0
Compression perpendicular to grain*	2.8 / 2.2	3.9 / 3.0	4.5 / 3.5	5.2 / 4.0	6.0 / 4.6
Shear parallel to grain	1.4	2.0	2.2	2.4	2.6
Modulus of elasticity Mean Minimum	 9500 6000	 10800 7500	 15000 12600	 18500 15600	 21000 18000
Average density kg/m³ at 20°C/65% RH	640	700	780	840	1080
* When specification excludes wane at bearing areas, the higher value of compression perpendicular to grain stress may be used, otherwise the lower values apply					

b) Steel Materials

b-1. Anchor (tie-rod)

Tensile strength of Steel Fy = 460N/mm^2

Allowable bending stress fa = 0.9・Fy = 0.9・460N/mm^2 = 414N/mm^2

b-2. Bolt-Nut(3.6)

Tensile strength of Steel Fy = 180N/mm^2

Allowable bending stress fa = 0.9・Fy = 0.9・180N/mm^2 = 160N/mm^2

(4) Design Method

1) Load

a. Surcharge load W=12kN/m^2

b. Unit weight of water γw=9.81kN/m^3

c. Unit weight of soil: γ, cohesive strength: C, internal angle of friction: φ (see “soil constants” attached on subsequent page)

d. Earth pressure, water pressure, and surcharge load used for calculating the embedded length

$Pa = Ka (\Sigma\gamma h + q) - 2c\sqrt{ka}$

$Pp = Kp (\Sigma\gamma h' + q) + 2c\sqrt{kp}$

where,

Pa: Active earth pressure (kN/m^2)

Pp: Passive earth pressure (kN/m^2)

Ka: Coefficient of active earth pressure on attention point

$Ka=\tan^2 (45°- \varphi/2)$

Kp: Coefficient of passive earth pressure on attention point

$Kp=\tan^2(45°+ \varphi/2)$

φ： Angle of shear resistance of earth on attention point

Σγh： Effective overburden pressure of active side on attention point (kN/m^2)

Σγh'： Effective overburden pressure of passive side on attention point (kN/m^2)

γ： Unit wet weight of soil (kN/m^3) of each layer, the submerged unit weight must be considered for the layers at a lower level than the groundwater level.

H： Thickness of each layer of active side to the attention point (m)

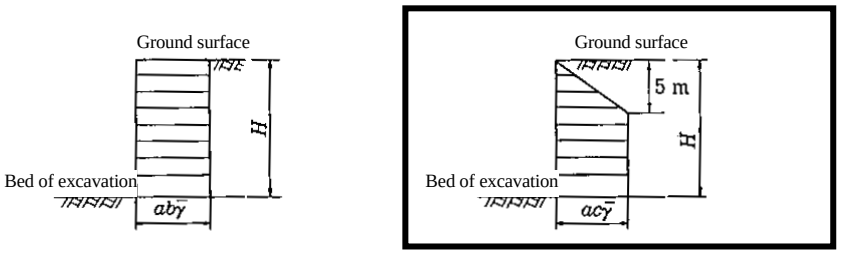
h'： Thickness of each layer of passive side to the attention point (m)

q： Surcharge load to the ground surface (kN/m^2)

c： Cohesive strength of earth on attention point (kN/m^2)

e. Earth pressure applied for unit width

Regarding the determination of sectional area of the revetment and anchor, following (b) type earth pressure is employed.



(a) Distribution of earth pressure of sandy soil (b) Distribution of earth pressure of cohesive soil

$\bar{\gamma}$: Average unit weight of earth (kN/m^3 (tf/m^3))

a, b, c : Based on Table 2-3-4 and Table 2-3-5

H : Depth of excavation

Figure 2-3-4: Earth pressure for decision of section

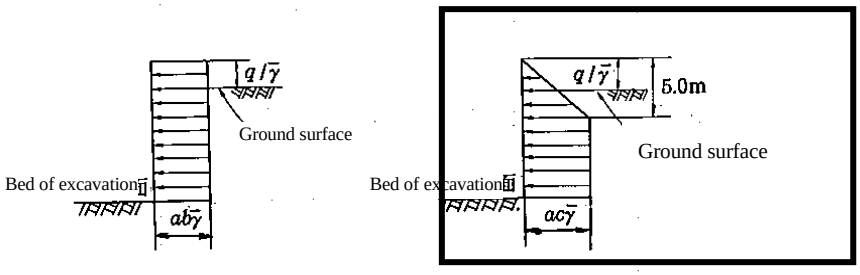
Table 2-3-4: Coefficient by excavation depth H

5.0m≦H	$a=1$
5.0m>H>3.0m	$a=\frac{1}{4}(H-1)$

Table 2-3-5: Coefficient by soil property

b	c	
Sandy soil	Cohesive soil	
2	N>5	4
	N≦5	6

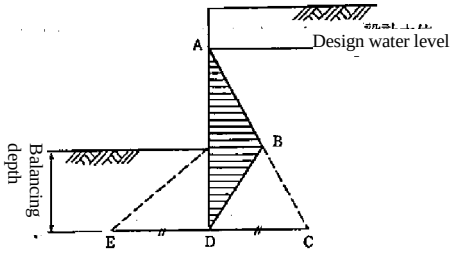
On the rear side of the revetment, surcharge load on the ground surface of q=12kN/m^2 is applied taking the hypothesis earth height as following (b) figure.



(a) Distribution of earth pressure of sandy soil (b) Distribution of earth pressure of viscous soil

f. Water pressure

The water pressure for the revetment shall be hydrostatic, and the distribution of water pressure shall be within the following triangle A-B-D.



2) Design Calculation

a. Minimum embedded length of Timber piles

・Minimum embedded length shall be 15m.

・Embedded length of anchor pile shall be based on the calculation of the embedded length of self-supporting piles.

However, pile length must reach the N-value 15~25 of the firm silty clay layer to prevent settlement of embankment.

b. Securing stabilization of the embedded part due to earth pressure and water pressure

b-1. Anchor type

The embedded length shall be at the depth where the moment of action of the active side pressure and the bending moment resistance caused by the passive side pressure of the water conservancy side are balanced, centering the anchor support position, using a ultimate equilibrium method.

b-2. Self-supporting type

The embedded length shall be calculated by Chang's method. However, the embedded length of the revetment is basically a semi-infinite length, and its length is known as 3/β or longer. However, the difference of the displacement of the pile head and the difference of bending moment is only a few percent when comparing the case of 2.5/β , therefore, 2.5/β is employed in calculation of embedded length (Lo).

c. Calculation of Cross sectional Area

c-1. Anchor type

(i) Calculation of anchor

Total horizontal load of the active side from top of sheet pile to balancing position is to be "ΣH". Supposing that the half of the ΣH is supported by anchor taking the sheet pile as simply supported beam, then, anchor tension (T) is as follows; T=ΣH/2. Then tensile stress is calculated in the following formula;

$f = T/As \leqq fa$

Allowable tensile stress	$fa = 0.9 \cdot Fy = 0.9 \cdot 460N/mm^2$ $=414N/mm^2$
Tensile strength of Steel	$fy = 460N/mm^2$
Anchor tension	T
Cross section of anchor	As

(ii) Calculation of timber pile

The maximum bending moment of timber pile "Mmax" can be calculated for the cross section calculation by a uniformly distributed load "w" when anchor to the river bed is span "S" of a simple pile.

$W = \Sigma H/S, \quad Mmax = W \cdot S\text{^}2/8, \quad \sigma b = Mmax/z \leqq \sigma ba$

Where

Total horizontal load of active side	:ΣH
Span	:S
Uniformly distributed load	:w
Maximum bending moment	:Mmax
Bending strength of Greenheart Timber	:σb
Allowable bending stress	:σba = 0.8・σb

(iii) Calculation of waling

The load shall be calculated by the earth pressure for deciding the cross section. Additionally, water pressure and surcharge load shall be taken into consideration. The load of waling on the 1st stage shall be shared on the upper and lower stage, and on the 2nd stage shall be on the lower stage. Span "S" is the span between piles of continuous beam, and shall be calculated by the maximum bending moment Mmax=w・s^2/10.

(iv) Calculation of the wooden sheet pile

The load is calculated by the earth pressure for deciding the cross section. Additionally, water pressure and surcharge load shall be taken into consideration. The design span "s" for the sheet pile is at each waling, and maximum bending moment shall be Mmax=w・s^2/10.

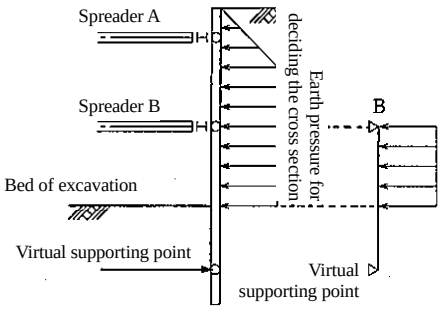


Figure 2-9-22: Calculation of cross section of soldier pile

(v) Calculation of Anchor Pile

v-1. Embedded length, cross section calculation, displacement

L =2.5 / β

Mm=0.3224・H / β

Where

L : Required embedded length (m)

Mm: Maximum bending moment (kN・m)

H : Horizontal force acting on raking pile (tensile strength of tie-rod) (kN)

β : Characteristic value of pile (m-1)

The displacement of the installation point of the tie-rod of the anchor pile can be calculated using the following formula.

$\delta = H / 2EI\beta^3$

Where,

δ : Displacement of installation point of the tier-rod (m)

H : Horizontal force acting on the anchor pile (kN)

E : Young's modulus of the anchor pile (kN/m2)

I : Second moment of area of the anchor pile (m4)

β : Characteristic value of the pile (m^{-1})

v-2. Installation point of the anchor pile

As shown in the following figure, as a general rule, the anchor pile shall be installed at a point where the active sliding surface of the rear side starting from the virtual supporting point of the revetment, and the passive sliding surface starting from the lower 1 / β of the tie-rod installation point of the anchor pile does not cross at a lower point than the tie-rod.

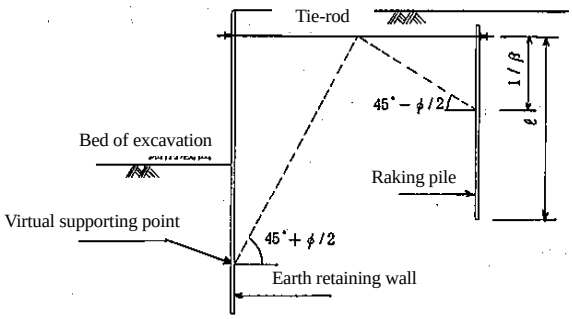


Figure 2-14-3: Installation point of the raking pile

c-2. Self-supporting type

・Cross section calculation of the pile

The bending moment used for the cross section of the earth retaining wall shall act on the load on the rear side of the earth retaining wall, and be calculated by the following formula.

$$M = \frac{P}{2\beta}\sqrt{(1+2\beta h_0)^2+1}\ \exp\left(-\tan^{-1}\frac{1}{1+2\beta h_0}\right)$$

M : Maximum bending moment that occurs on the revetment (kN・m)

P : Unit width of resultant force of lateral pressure.

H0 : Height from the river bed to the acting point (m)

B : Characteristic value of the pile (m-1)

(However, the unit of inverse trigonometric function used here is “rad”.)

d. Calculation of displacement

d-1. Anchor type

The displacement of the anchor pile must be verified for an anchor type. The allowable displacement is 3% of the height from the top of the sheet pile to the conservancy bed. The displacement shall be calculated by Chang’s method.

d-2. Self-suporting type

Displacement shall be calculated by the following formula. The allowable value of displacement is divided into 3 stages depending on the surrounding condition.

I. When no facilities around and no risk of secondary disaster in case of collapse → 5% of earth retainer height “H” (δa=0.05xH: Ann's Grove,hope)

II. When management road (including pedestrian road) around → 4% of earth retainer height “H” (δa=0.04xH：0.04xH：Annandale,Nancy,Maduni)

III. When facilities around, such as community road, etc. → 3% of earth retainer height “H” (δa=0.03xH：Cuhnia)

Following is the formula for displacement of the top of the revetment.

$$\delta = \delta 1 + \delta 2 + \delta 3$$

where ,

δ : Displacement of top of retaining wall (m)

δ1: Displacement of river bed (m)

δ2: Displacement due to angle of slope of river bed (m)

δ3: Angle of slope of cantilever higher than the river bed (m)

$$\delta 1 = (1+\beta h_0) \cdot P / 2EI\beta^3$$

$$\delta 2 = (1+2\beta h_0) \cdot P \cdot H / 2EI\beta^2$$

β: Characteristic value of pile (m^{-1})

h0: Height from river bed to acting point of resultant force (m)

P: Resultant force of lateral pressure (kN)

E: Young's modulus of earth retaining wall (kN/m2)

I: Second moment of area of earth retaining wall (m4)

H: Depth of river bed (m)

$$\delta 3 = p_2' \cdot H^4 / 30EI$$

p_2': Triangle when moment is distributed equally

Load intensity of river bed at distributed load (kN/m)

$$p_2' = 6 \cdot \Sigma M / H^2$$

ΣM: Moment of surrounding area of river bed at lateral pressure (kN・m)

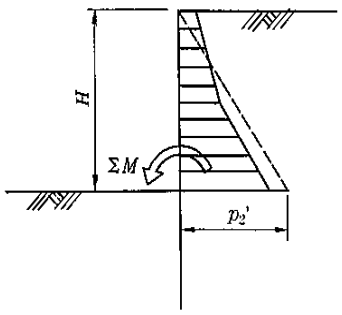


Figure 2-12-3 Triangle load when moment is distributed equally

3) Review on heaving

Ground of high water content with cohesive soil such as diluvial clay has high risk of heaving. In general, stability number "Nb" is used for the judgment of stability of conservancy beds. If stability number Nb is 3.14 or lower, review on heaving is not required. However, if the stability number Nb is above 3.14, plastic zone will start to occur from the edge of the conservancy bed, and when Nb reaches 5.14, the conservancy bed may collapse.

$$Nb = (\gamma \cdot H / c) < 3.14$$

(5) Review of Impermeable Work (Earth Retaining Sheet)

1) Overview

Earth retaining sheets shall be used for seepage of embankments. Sufficient embedded length is necessary upon determination for the length of earth retaining sheet. The embedded length is calculated by Lane's method. This shall be reviewed for 6 embankments.

2) Application and Reference Materials

JAPAN RIVER, Revised Technical Criteria for River Works (Draft), by the Construction Ministry, Exposition and Design [I] P60, P28

3) Lane's Method

$C \leqq (L / 3 + \Sigma L) / \Delta H$

Where;

C: Weighted creep ratio

L: Length of seepage of main body and axes in four directions (m)

ΣL: Length of seepage of impermeable sheet pile, etc. (m)

⊿H: Water level difference between inside and outside (m)

Weighted creep ratio

Category (* indicates category selected)	C
*Very fine sand or silt	8.5
Fine sand	7.0
Medium sand	6.0
Coarse sand	5.0
Fine gravel	4.0
Medium gravel	3.5
Coarse gravel with cobblestones	3.0
Gravel with cobblestones and pebbles	2.5
Soft clay	3.0
Medium soft clay	2.0
Hard clay	1.8

4) Creep ratio of Clay

Cohesive layer is soft clay based on the weighted creep ratio table, therefore, C=3.0.

5) Review of length of earth retaining sheet

When converting above formula to "X",

$X > 1/2 \cdot (C \cdot \Delta H - 1/3 \cdot L)$

$\Sigma L = 2 \cdot X$

$Lreq = X + \Delta H + h$

(Lreq: Required length of earth retaining sheet, h: height of embankment, H.W.L)

<Result of review>

Item	Ann'sglove	Hope	Annandale	Nancy	Maduni	Cuhnia	Application
	INLET	INLET	INLET	INLET	INLET	INLET	
	Right	Right	Right	Right	Left	---	
C	3.0	3.0	3.0	3.0	3.0	---	Heavy creep ratio
ΔH	2.833	0.950	2.603	2.793	1.977	---	Water head difference
L	12.970	13.518	10.659	12.056	10.105	---	Horizontal length
X	2.088	0.000	2.128	2.180	1.281	---	Vertical length
ΔH＋h	3.290	1.407	3.060	3.250	2.434	---	
ΣLreq	5.378	1.407	5.188	5.430	3.715	---	Required length of earth retainer
ΣL	7.60	7.60	7.60	7.60	7.60	---	Actual length of earth retainer
Judgment	OK	OK	OK	OK	OK	---	ΣLreq<ΣL

Note: Cunha is omitted due to its long length of embankment

<Conclusion>

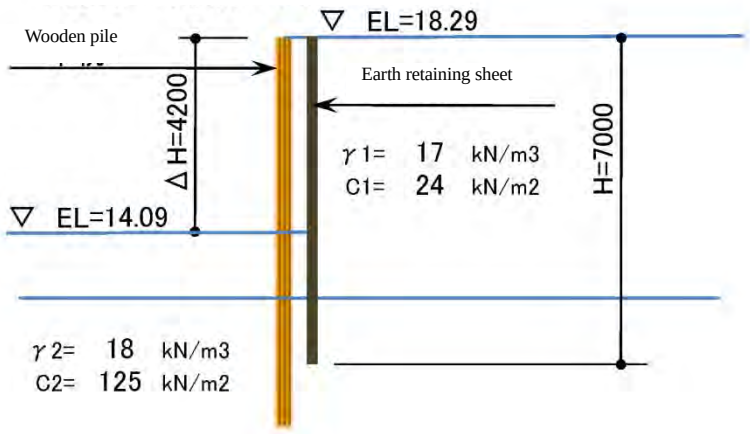
Impermeable works (earth retaining sheet) is planned for a length of 7.6m, and the impermeability is ΣLreq (logical required length) based on above table, therefore, is safe.

(6) Review of external stability

In order to review the external stability, circular slip shall be taken into consideration. A case of the highest risk shall be reviewed. Below are the combinations of possible risks.

- When the ground height of the back side of embankment is the same height as the top of embankment;
- Earth retainer height is H=4.2m, the highest in this Project
- γ1＝17kN/m3、γ2=18kN/m3　Weight of soil
- C1＝24kN/m2、C2=125kN/m2　Adhesive strength
- Earth retaining sheet length is 7.6m, but shall be L=7.0m, for taking safety into consideration.
- Earth retaining sheet shall not be a slide surface of the circular slip.

Model for reviewing circular slip



<Result>

Fs=2.53＞1.2 ----- Circular slip shall not occur.

The calculation result shall be attached to the calculation for the earth retaining sheet pile.

Appendix 6-3 Planning of Revetment Execution

１．Timber Pile Driving and Execution

（１）Condition for Selection

1) Hoisting load

・Hook weight :W=0.41t (see 40T Hitachi Sumitomo Heavy Industries Construction Crane Co., Ltd. of Table 1)

・Load of hoist material (self weight of pile)

W= 15.24m x 0.126Kg/m =1,920kg = 1.92t = 2.0t

・Weight of pincer W=5.0t

Hoisting load W= 0.41 + 2.0 + 5.0 = 7.41 ≒ 8.0t

Table 1: Table for Hook Weight

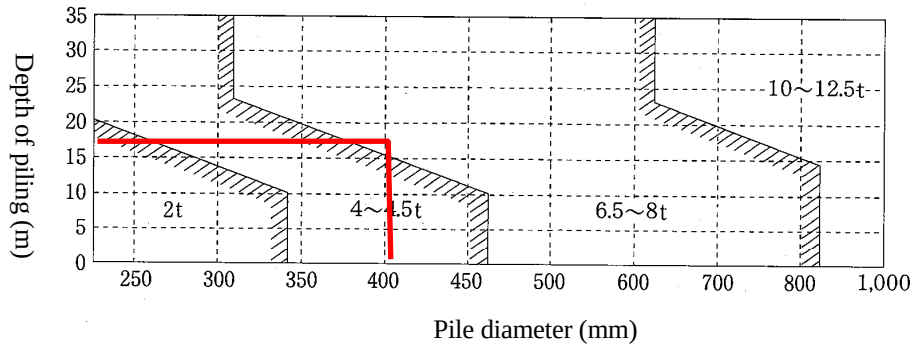
(Number of hooks of hoisting rope and maximum value of rated total load, mass of main hook is as shown in the table)

Hook capacity (t)	Hook mass	Maximum value of rated total load					
		6 hooks	5 hooks	4 hooks	3 hooks	2 hooks	1 hook
40.0	0.41	40.00	32.50	26.00	19.50	13.00	-
15.0	0.32				15.00	13.00	-

Calculation of load of pincer

・ When pile diameter is 455mm and pile length is L=15.24m, the load of pincer is on the linear of W=4.5ｔ~6.5t in Table 2, however, due to the soft ground and the research of Guyana, W=5.0t.

In case of precast concrete pile



Note:

1. Use one rank larger pile when piling depth is more than 10m and under following conditions apply.
   1) When N value is larger than 15, and piling through intermediate layer of 3m or thicker sand and sand/gravel layer.
   2) When N value is larger than 15, and piling through layer of 3m or thicker cohesive soil.
2. Depth of piling (m) includes depth of pincer (m).

Figure-1 Load of pincer of precast concrete pile

(Abstract from: Load of pincer, of Civil engineering measurement standard of MLIT (2010))

2) Boom length

Lifting height **H=23m**

Work radius **B= 12m**

Boom length (of Figure-2) **L=28m**

・Lifting height

・Max. length of material (of Table 1) H= 15.240m

・Upper limit of coil of hook (hook height) H= 1.000m

・Allowance height H= 1.000m

・Pincer + length of fall H= 5.000m

Lifting height H= 15.24 + 1.000 + 1.000 + 5.000 =22.24≒23.0m

・Work radius

Length of caterpillar / 2 – (rotating shaft and eccentricity of caterpillar) + piling point

= 5.095/2 － 1.00 ＋ (3.0~10.0) = 4.55～11.54 ≒ **5.0m~ 12.0 m**

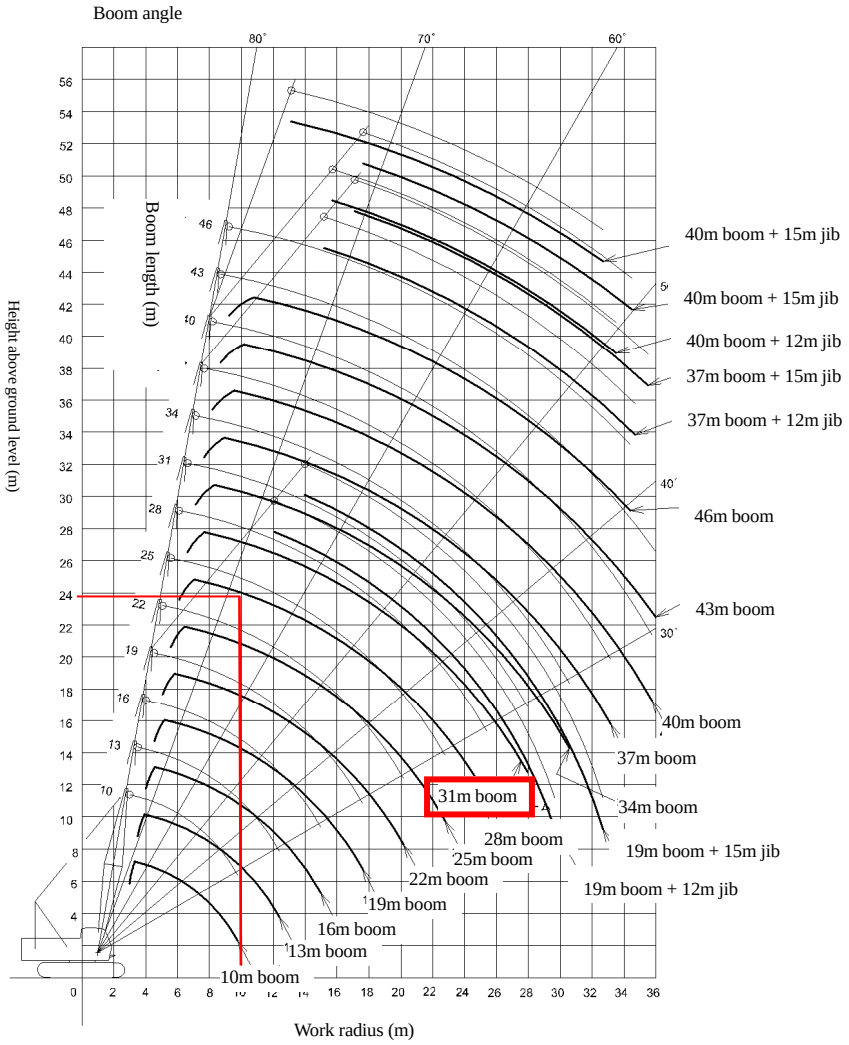


Figure 2: Boom length corresponding to the work radius and lifting height

（2）Determination of the rated max. total load of the crawler crane

Conditions for selection

- Hoisting load W= 8.0t
- Work radius W=10.0m
- Boom length L=31.0m

<Conclusion>

Based on <Table 5> for the 40t crawler crane,

Hoisting load “=8.0t <hoisting capacity W=9.35t,

Therefore, is safe.

Table 2: Rated max. total load 40t

General rated max. total load of boom

unit: t

Work radius (m) \ Boom length (m)	10	13	16	19	22	25	28	31	34	37	40	43	46
3.5	40.00												
3.7	40.00	40.00											
4.0	35.45	35.40	4.2 / 32.65										
4.5	29.45	29.35	29.30	4.7 / 27.35									
5.0	25.15	25.05	25.00	24.95	5.3 / 22.85								
5.5	21.90	21.80	21.75	21.70	21.65	5.8 / 20.00							
6.0	19.40	19.30	19.20	19.15	19.10	19.05	6.4 / 17.35	6.9 / 15.55					
7.0	15.70	15.65	15.55	15.50	15.45	15.35	15.30	15.25	7.5 / 13.75				
8.0	13.20	13.10	13.00	12.95	12.90	12.80	12.75	12.65	12.60	11.95	8.6 / 10.40		
9.0	11.35	11.25	11.10	11.05	11.00	10.95	10.85	10.80	10.70	10.70	10.25	9.1 / 9.05	9.7 / 7.80
10.0	9.7 / 10.30	9.80	9.70	9.65	9.55	9.50	9.45	9.35	9.25	9.25	9.15	8.80	7.75
12.0		7.80	7.65	7.60	7.55	7.45	7.40	7.30	7.20	7.20	7.10	7.00	6.90
14.0		12.3 / 7.55	6.30	6.20	6.15	6.05	6.00	5.90	5.80	5.80	5.70	5.60	5.50
16.0			14.9 / 5.80	5.25	5.15	5.05	5.00	4.90	4.80	4.75	4.70	4.60	4.50
18.0				17.5 / 4.65	4.40	4.30	4.20	4.15	4.05	4.00	3.90	3.85	3.75
20.0					3.80	3.70	3.65	3.55	3.45	3.40	3.30	3.20	3.15
22.0					20.1 / 3.80	3.25	3.15	3.05	2.95	2.90	2.85	2.75	2.65
24.0						22.7 / 3.10	2.75	2.70	2.55	2.55	2.45	2.35	2.20
26.0							25.3 / 2.55	2.35	2.25	2.20	2.10	1.95	1.85
28.0								27.9 / 2.10	1.95	1.90	1.75	1.65	1.55
30.0									1.70	1.65	1.50	1.40	1.25
32.0									30.5 / 1.65	1.40	1.25	1.15	1.05
34.0										33.1 / 1.30	1.05	0.95	0.85
36.0											35.7 / 0.90	0.80	34.5 / 0.80

Note:

1. Rated max. total load of above table is a value of load at fixed position on a level and solid foundation, therefore is within 78% of tipping load, and forward stability is higher than 1.15 based on the standard for structure of mobile crane.
2. The actual hoisting load is a value deducting all mass for hoisting such as hooks, etc. from above rated max. total load.
3. Work radius is the horizontal distance from the rotating center to the gravity center of the hoisted material in air.
4. Mass of counterweight is 12.5t.
5. Extend position to standard position of side frame during operation.
6. Number of hooks of hoisting rope, rated max. total load, and mass of main hook is as shown in below table.

Hook capacity (t)	Hook mass (t)	Rated max. total load (t)					
		6 hooks	5 hooks	4 hooks	3 hooks	2 hooks	1 hook
40.0	0.41	40.00	32.50	26.00	19.50	13.00	-
15.0	0.32				15.00	13.00	-

7. XX/XX in table indicates “work radius (m) / rated max. total load (t)”

（3）Verification of soil bearing capacity

・Contact pressure <see Table 6>

P ＝ 0.61kg/cm2=5.98N/cm2=59.8kN/m2=60kN/m2

・Soil bearing capacity <see Table 7>

Qa=1/N・ a (α･c･Nc+1/2・β･γ1･B･Nr+γ2･Df･Nq)

=1/2x2x(1.0x2.0x5.3 + 0 + 0)= 10.6 kg/m2 = 103.9 kN/m2

C=2.0kg/m2x2 times ⇒ 2. 0kg/m2 of Table 7

=4.0 kg/m2

N＝2 (Safety factor of short-term)

a＝2 (Extra coefficient of simple dynamic cone penetration test)

α、β=1.0 (belt figure)

θ=0°⇒Nc=5.3, Nr=0.0, Nq=1.0, Df＝0.0m

<Result>

P＝60kN/m2 ＜ Qa=103kN/m2————OK

Safety must be secured at site.

Table 3: Specification (see Hitachi Sumitomo 40t crawler crane)

■Specification

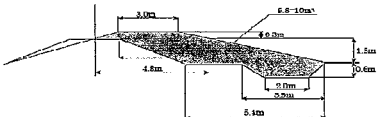
			Specification of crane	
Hoisting load x work radius		t xm	40 x 3.7	
Basic boom length		m	10	
Max. boom length		m	46	
Length of crane jib		m	6 – 15	
Length of boom + crane jib		m	40 + 15	
Wire rope speed	Main/sub hoisting (up)	m/min	* 74/37	Rope diameter: 59.822mm
	Main/sub hoisting (down)	m/min	74/37	
	Boom derrick hoisting (up)	m/min	*60	Rope diameter: 16mm
	Boom derrick hoisting (down)	m/min	60	
Rotating speed		min^{-1}(rpm)	3.7 (3.7)	
Driving speed		km/h	* 1.9	
Climbing capacity		%	40 (22)	
Contact pressure		kPa (kgf/cm^2)	59.8 (0.61)	
Name of engine			Isuzu 4HK1X	
Rated output		kW/min- (ps/rpm)	147/2, 100 (200/2, 100) (without fan)	
Total mass of all equipment		t	42.8 (10m boom + 40t hook)	

1. Unit in this table is SI (International System or Units). Units in ( ) indicate conventional unit.

2. Speed of values with * are subject to change by load.

Table 4: Test result of simple cone penetration test

List of test result of geological survey of the dam body (qc test)



1) Waterfront line of slope 2) 50cm from shoulder of dam crest (right) 3) 50cm from shoulder of dam crest (left) 4)) Middle of back steel (2.0m from shoulder) 5) Waterfront line of slope of back steel (random)

#		(1)	(2)	(3)	(4)	(5)
	Flag Staff~Lama sluice			6km		
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	No 0+300	0.2	2.8	2.8	0.6	0.2
2	No 0+600	0.2	3.2	2.4	0.8	0.2
3	No 0+900	0.1	2.4	3.6	0.8	0.4
4	No 1+200	0.2	1.6	2.0	1.0	0.2
5	No 1+500	0.4	4.0	2.4	0.4	0.2
6	No 1+800	0.4	2.4	4.0	0.6	0.2
7	No 2+100	0.2	1.6	2.4	0.4	0.4
8	No 2+400	0.2	4.0	2.8	0.6	0.4
9	No 2+700	0.4	2.0	4.4	1.0	0.2
10	No 3+000	0.4	2.8	2.0	0.8	0.2
11	No 3+300	0.1	1.2	3.2	0.6	0.1
12	No 3+600	0.2	4.0	2.8	0.4	0.4
13	No 3+900	0.4	2.8	2.0	0.4	0.2
14	No 4+200	0.2	3.6	2.4	0.6	0.4
15	No 4+500	0.2	1.2	2.8	0.8	0.2
16	No 4+800	0.1	2.8	1.2	0.6	0.4
17	No 5+100	0.2	2.4	2.8	0.8	0.4
18	No 5+400	0.4	1.2	3.6	1.0	0.4
19	No 5+700	0.2	2.8	1.8	1.0	0.4
20	No 6+000	0.2	3.6	2.4	0.6	0.2
	Flag Staff~Annandeal			10km		
		kN/m2	kN/m2	kN/m2	kN/m2	kN/m2
1	No 0+300	0.2	3.6	2.8	0.8	0.4
2	No 0+600	0.4	2.8	2.4	0.6	0.4
3	No 0+900	0.2	4.0	2.4	0.6	0.6
4	No 1+200	0.2	2.4	1.6	0.6	0.2
5	No 1+500	0.4	2.0	4.4	0.4	0.6
6	No 1+800	0.2	3.6	2.8	0.4	0.4
7	No 2+100	0.2	3.6	2.4	0.4	0.2
8	No 2+400	0.2	2.4	2.8	0.6	0.6
9	No 2+700	0.4	1.2	2.4	0.6	0.2
10	No 3+000	0.2	2.4	2.8	0.4	0.2
11	No 3+300	0.2	2.8	1.2	0.4	0.2
12	No 3+600	0.4	2.0	2.8	0.4	0.4
13	No 3+900	0.2	3.8	2.0	0.4	0.2
14	No 4+200	0.4	1.2	2.4	0.6	0.2
15	No 4+500	0.2	2.8	4.0	0.6	0.4
16	No 4+800	0.4	2.4	2.8	0.6	0.6
17	No 5+100	0.2	3.6	2.8	0.8	0.4
18	No 5+400	0.4	2.4	2.0	1.0	0.4
19	No 5+700	0.4	4.0	2.4	1.2	0.2
20	No 6+000	0.2	2.0	4.0	0.8	0.4
21	No 6+300	0.4	2.4	3.2	0.4	0.4
22	No 6+600	0.4	1.2	2.4	0.4	0.6
23	No 6+900	0.4	3.6	2.8	0.4	0.2
24	No 7+200	0.4	1.6	2.4	0.8	0.2
25	No 7+500	0.2	2.4	1.6	0.6	0.4
26	No 7+800	0.4	2.0	2.4	0.4	0.4
27	No 8+100	0.4	2.4	2.0	0.4	0.2
28	No 8+400	0.4	1.2	2.4	0.4	0.2
29	No 8+700	0.2	2.4	1.2	0.4	0.4
30	No 9+000	0.2	2.0	2.0	0.6	0.6
31	No 9+300	0.4	4.0	1.6	0.6	0.4
32	No 9+600	0.4	2.0	2.0	0.6	0.4
33	No10+000	0.2	2.0	1.2	0.8	0.2
	Average	14.90 0.28	136.40 2.57	134.00 2.53	32.60 0.62	17.50 0.33

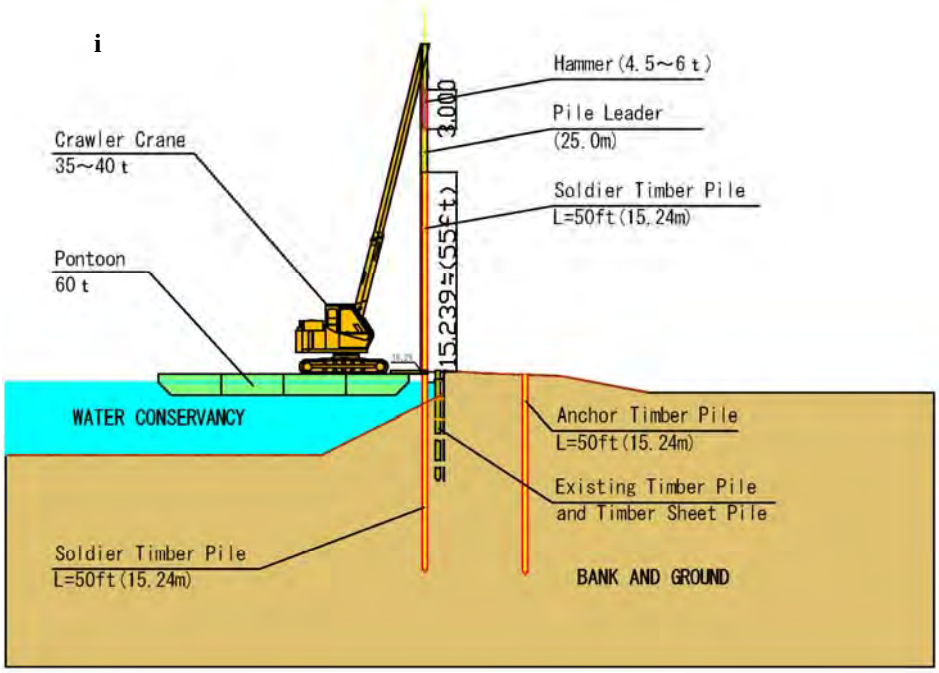
Calculation of bearing capacity

1) block 2) block 3) block 4) block 5) block

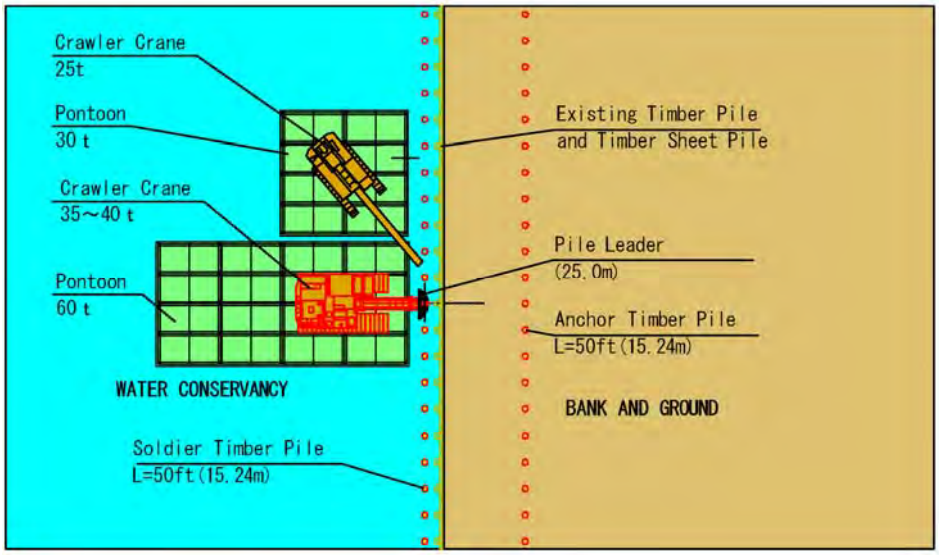
２．Execution Images

(1) Revetment：Timber-Pile Driving

i

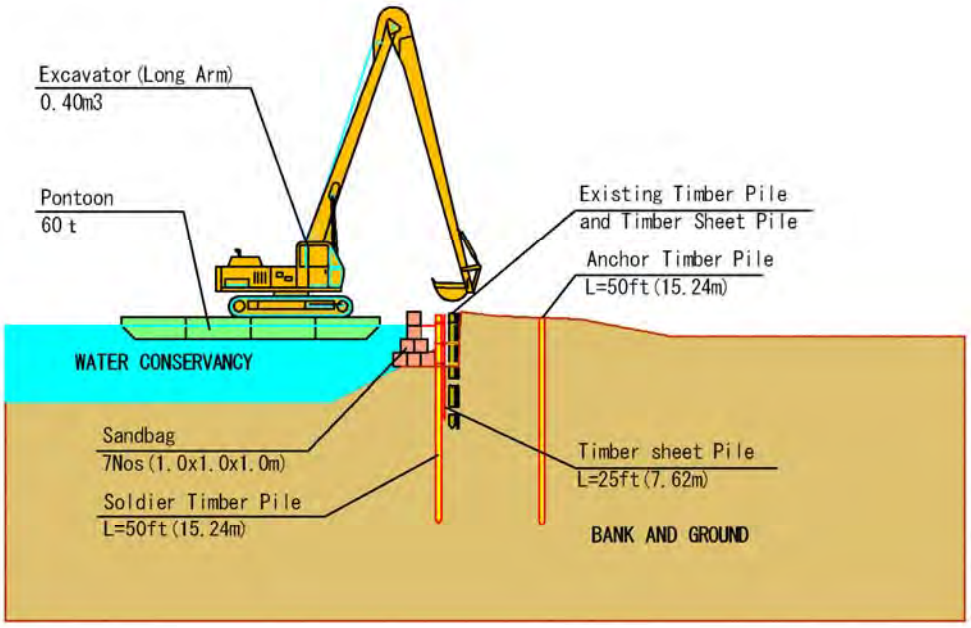


Pile Driving ：Side-view

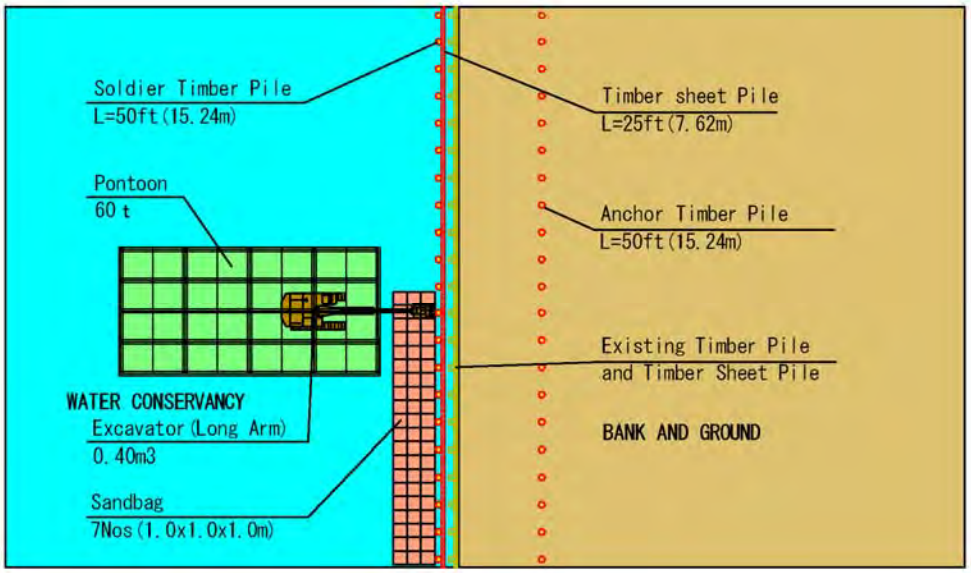


Pile Driving ：Side-view

(2) Sand-bag Installation (Temporary enclosure)

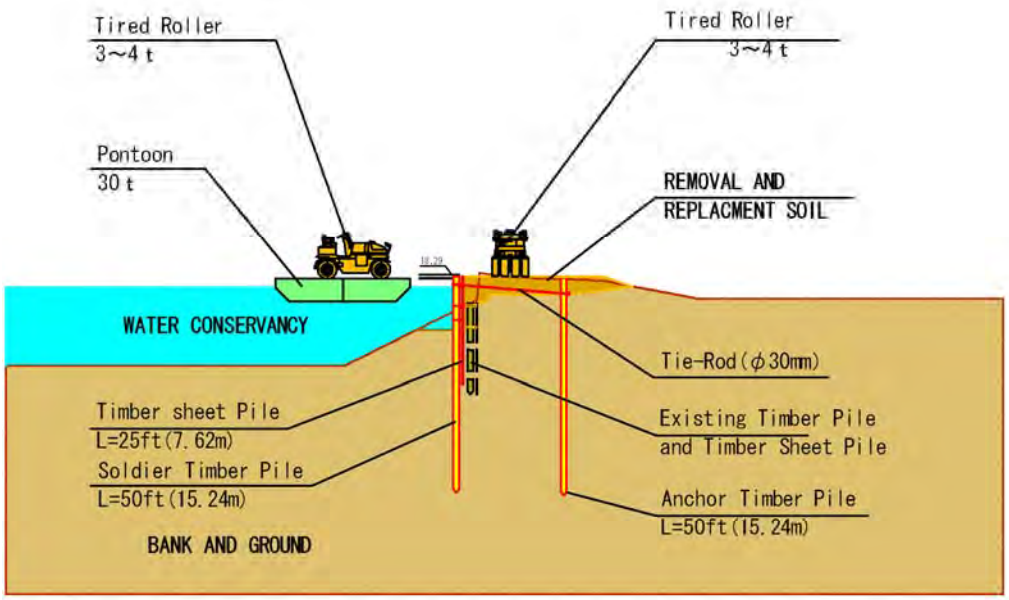


Sand-bag Installation : Side-view

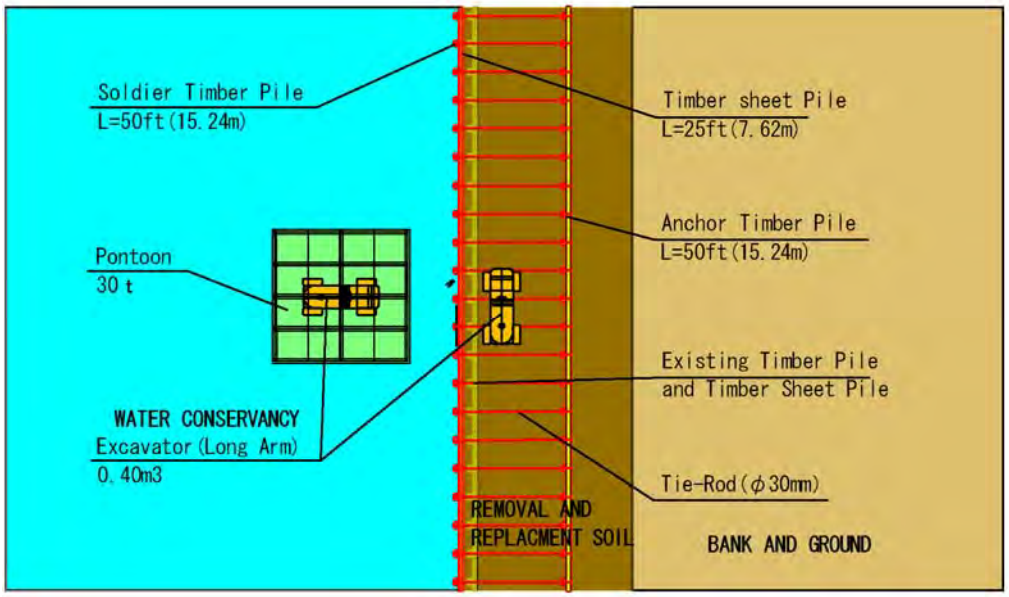


Sand-bag Installation : Plan

(3) Embankment Work Execution



Embankment Work : Side-view



Embankment Work : Plan

Appendix－7 Relevant Materials

Appendix 7-1 Result of Site Surveys

Appendix 7-2 Result of Geotechnical Investigations

Appendix 7-3 Cone Penetrometer for Earthwork Quality Management

Appendix 7-1 Result of Site Surveys

(1) Object

Survey	Purpose
・Topography and General Plan Survey	・Location determination for rehablitation design of
for relief sluice and intake facilities	facilities
	・Calculation of earthwork Volumes
・Vertical Height Survey along	・Determination of embankment height in conformity
Embankment Crest	with the prescribed embankment height design
・Cros Section Survey of embankment	・Determination of cross section of embankment
and outfall canal	and location of revetment/anchor pile installations
	・Calculation of earthwork Volumes
	・Determination of timber-pile length in conformity
	with geological data
・Detailed Survey of existing relief	・Rehabilitation Design of the existing facilities
sluice and intake facilities	

(2) Drawings

Facilities	Survey			
	Topography Survey	Embankment Crest Survey	Embankment Cross Section Survey	Structure Survey
Ann's Grove Intake	○	4-sections	8	2
Hope Intake	○	1	9	3
Annandale Intake	○	2	9	2
Nancy Intake	○	3	9	3
Maduni Relief Sluice	○	4	9	2
Sarah Johanna Relief Sluice	○		3	

(3) Surveyor

Sworn Land Surveyor : Dwarka Ramkarran

Appendix 7-2 Result of Geotechnical Investigations

Summary

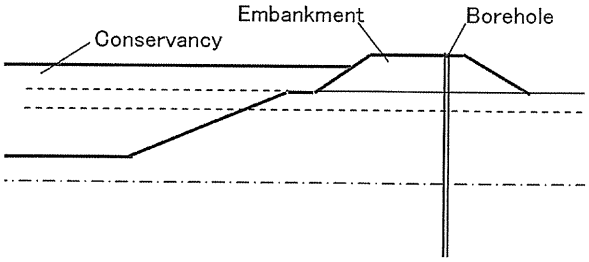
(1) Geotechnical Investigation was carried out to grasp situations of the EDWC embankment earth-banking and foundation conditions beneath the embankment for the rehabilitation of relief sluice and intake facilities.

(2) Work periods (2010): field work in two Phases
1) October 29 ～ November 4
2) November 15 ～ November 23

(3) Work items
- Machine Boring 20-boreholes
- Vane shear test : borehole in situ test
- Observation of water table in boreholes
- Samplings for laboratory tests (Conservancy canal raw-soil and cement-mixed soil)
- Laboratory tests
  - Specimen of conservancy canal raw-soil and cement-mixed soil
  - 4-days curing and 7-days curing

(4) Major laboratory tests
- Atterberg Limits
- Grain Size Distribution
- Soil Moisture Content
- Specific Gravity
- Wet Density
- pH test
- Unconfined Compression Test
- One-dimensional Compression Test

(5) Soil, Strata general characteristics



(embankment)
Soft dark-grey silty clay with organics
Highly saturated brown and black highly organic silty clay stratum
Soft to firm to stiff to very stiff brown yellow and grey silty clay stratum

(6) Groundwater conditions
Groundwater was encountered at depths ranging from 1.22 to 1.52m in the boreholes. The water levels are for the times noted on the borehole logs only. These levels do not reflect flood,tidal or seasonal fluctuations in groundwater levels.

(7) Samplings
In most instances, undisturbed samples of the highly saturated highly organic silty clay were not recoverable due to the saturated nature of the stratum. These samples were therefore substituted by the recovery of SPT samples by a split spoon equipped with a sample catcher.

SUMMARY OF GEOTECHNICAL INVESTIGATION
EAST DEMERARA WATER CONSERVANCY

Table of Contents

1. Scope of Work

Ground Structures Engineering Consultants in Guyana was contracted by KETSU GIJUTSU CENTER, LTD., with head office at 4-7-10, Iidabashi, Chiyoda-ku, Tokyo 102-0072 Japan, dated October 15, 2010 to conduct a geotechnical investigation for the East Demerara Water Conservancy (EDWC) restoration project.

The investigation was conducted to understand the characteristics of EDWC embankment soil and foundation conditions of relief sluice and intake facilities.

This report presents the results of the geotechnical investigation undertaken for the Basic Design Study of the Project.

The geotechnical investigation was composed of field surveys, laboratory tests, analysis of data obtained and preparation of investigation report.

The analytical results are to be used for the quality control of the soil banking of the conservancy embankment and foundation/revetment designs of the relief sluice and intake structures.

The field survey was performed in two phases of October 29, 2010 to November 4, and November 15 to 23, comprising

- Machine boring of twenty(20) boreholes, of which hole was dug up to specified depth (ranging from 6 m to 16 m at which N-Value exceeding 15 blows/30 cm were recorded),
- Collection of soil test-piece out of borehole for laboratory tests, and
- Vane shear test in the borehole.

The following laboratory tests were performed in accordance with ASTM Specifications;

- Soil Sample collection (D1857-74)
- Vane shearing test of site (D2573-72)
- Classification of soil (D2487-69)
- Distinction of soil (D2488-69)
- Liquid limit test (D 423-66)
- Plastic limit test
- Grain Size Distribution test
- Soil Moisture Content test (D2216)
- Specific gravity of soil test
- pH test
- Ignition Loss test
- Organic Matter Content test
- Unconfined compression test(D2850)
- One-Dimensional Consolidation test(D2435)
- Wet & dry density

2. Subsurface Investigation

Disturbed or undisturbed soil test-piece was collected from the borehole in accordance with methods in ASTM D-1586 and ASTM D-1587 respectively.

Disturbed test-pieces were collected by Standard Penetration Test (SPT) at arbitrary depth in boreholes. Undisturbed samples were recovered by Shelby Tube sampling at selected intervals.

Immediately after recovery, all samples were visually classified in the field in terms of color, compactness or consistency and major and minor soil constituents.

Several attempts were made to recover undisturbed (Shelby Tube) samples of the very soft to soft silty clays encountered at locations. However, these attempts were all unsuccessful due to the very soft consistency of these clays. A partial sample was recovered at some locations where there was an intersection with the dense silty sand.

2.1 Regional and Site Geology

The project site is located within Guyana coastal plain. This coastal plain lies near sea level and is underlain by clays of the Demerara Clay and Coropina Formations*[1]. The area is also crossed by old shorelines and ridges mostly parallel with the present shoreline. The Coastal Plains occupy a strip approximately 40 km wide along Guyana entire coast (Bleackley, 1956).

In probably late Pleistocene times, the sea receded and the soft tidal flats and sandbars were subjected to strong erosion and weathering. The clays became oxidized and firmer in consistency by loss of water and the sandy areas podsolised*[2] resulting in what is now mapped as the Coropina Formation.

A rise in sea level in post glacial times to practically its former level caused inundation of the Coropina Formation and the laying down of soft clays of the Demerara Formation surrounding Coropina islands and filling river valleys.

The younger parts of the Demerara Clay formation are recent in age and clay indistinguishable from the Demerara Clay is being added at the present time to parts of the coast.

The borings confirmed the occurrence of both the Demerara Clay and Coropina Formations at the sites.

*[1] Coropina Formation

This type of soil formation is derived from older freshwater sediments (Pliocene and Pleistocene). It occurs in low-lying areas on flat or nearly flat topography and in situations with high rainfall. There is usually excessive leaching of plant nutrients and migration of clay from surface layers to lower depths over time. Relatively light texture surface layer dominated by silt and fine sand and very dense and compact subsurface horizon.

This type of formation gives SPT N-values in excess of 50 blows per 30cm.

*[2] Podsolised

This describes a soil that has experienced an extreme form of leaching which causes the eluviation of iron and aluminum sesquioxides.

The process generally occurs in areas where precipitation is greater than evapotranspiration. The minerals are removed by a process known as leaching.

2.2 Subsurface Stratigraphy

Field boring logs included in the report depict the soil stratigraphy encountered for each borehole.

<u>soil stratigraphy at Maduni(BH-3)</u>

Ground surface (0～5m stratum) is a firm red brown and grey silty clay, which is underlain by a stiff to very stiff red and grey silty clay of N-value≧60.

<u>soil stratigraphies except Maduni</u>

The general stratigraphy encountered consists of a soft dark grey clay with organics occurring at ground surface, overlying a highly saturated brown and black highly organic silty clay stratum. This highly saturated brown and black highly organic silty clay is underlain by a soft to firm to stiff to very stiff brown yellow and grey silty clay stratum.

2.2.1 Firm Silty Clay (CH)

A firm silty clay stratum was encountered at ground surface in the borehole at East Demerara Region.

The stratum extended to a depth of approximately 4.0 m of the fill and the humus layers are contained. The firm consistency of this stratum is very likely attributable to desiccation.

The consistency of this stratum was determined by performing the Vane- Tests. This test consists of torque value . Vane value of this material ranged between 30 and 70 kpa torque value.

2.2.2 Soft to Very Soft Silty Clay (CH)

A soft to very soft silty clay, second stratum encountered at borehole is a highly saturated brown and black highly organic silty clay. This stratum extended to depths ranging from approximately 7 m at all boring holes to 8 m at

Vane Tests (Vane -Values) in this material were generally less than10 kPa torque value at all boreholes.

2.2.3 Firm to Stiff Silty Clay (CL)

This stratum was encountered immediately below the very soft to soft silty clay. It extended to depths of approximately10m.

The consistency of this stratum determined by performing the Vane-Tests in this material ranged between 35～50 kPa torque value .

2.2.4 Very Stiff to Hard Silty Clay

Maduni borehole site encounters at shallow depth of about 5 meters a stiff to very stiff to hard, red and grey silty clays of N-value≧60. This red and grey silty clays layer is assumed to be base layer of the low to hilly region

Overlying ground surface (0～5m stratum) embankment which is considered to be made of the excavated silty clay indicates a firm red brown and grey silty clay with Vane-values of 40～80kPa.

2.2.5 Groundwater Conditions

Groundwater was encountered at depths ranging from 1.0 to 1.5 m in the boreholes. The water levels are for the times noted on the drilling logs only. These levels do not reflect flood, tidal or seasonal fluctuations in groundwater levels.

It is highly likely that groundwater will be encountered during excavation for below grade structures. An adequate number of sumps and pumps should therefore be provided to control groundwater inflows.

2.2.6 Earthworks and Sub-grade Preparation

It is likely that embankment adjacent to conservancy facilities will require fill placement. Before placing new fills, all topsoil, organic matter and other deleterious materials shall be removed from the ground surface. The exposed sub-grade shall then be proof rolled to check whether any unstable areas exist. If any soft areas are detected by proof rolling, the unstable area shall be removed and be replaced with compacted granular fill. After confirming the test result of soil test, the site soil shall be used as much as possible as a backfill. The soil not satisfy the standard shall be removed from the site.

. The fill shall be placed at 30cm. loose thicknesses at its maximum. All fills shall be compacted to not less than 3% of the laboratory determined minimam air void content in accordance with ASTM Method D-698. The sub-grade soils at these sites are silty. These soils will consequently remold and loose strength when saturated. It is therefore highly recommended that the sub-grade be covered with a layer of granular fill immediately after the completion of excavation.

2.3 Results

The results of the Vane-Tests are depicted graphically on the logs. Vane Shearing values for each borehole are given in Table 2-1.

Table 2-1 Results of Vane Shearing Tests(kPa)

Sample Depth(m)	BH1	BH2	BH3	BH5	BH7	BH8
0～2	21～29	29～25	54～82	33～37	33～25	33～16
2～4	33	29	41	33	33	25
4～6	37	33	max	25	16	16
6～8	21～16	16	max	33～49	21～29	16
8～10	12	21		91	54	20
10～12						

Sample Depth(m)	EMB-2	EMB-4	EMB-5	EMB-9	EMB-11	EMB-12
0～2	58～54	0～37	33	54～29	41～54	45～66
2～4	54	33	29	29	45	70
4～6	41	21	25	29	29	29
6～8	37～32	21～16	28～62	33～45	29～33	21
8～10						
10～12						

The results of the Standard penetration Tests are depicted graphically on the logs. Standard penetration values for each borehole are detailed in Table 2-2

Table 2-2 Results of Standard Penetration Tests

Table 2-2 Results of Standard Penetration Tests

Borehole Depth(m)	BH1	BH2	BH3	BH4	BH5	BH6	BH7	BH8	EMB-1	EMB-2	EMB-3	EMB-4
0～4												
4～8	3		60								2-35	
8～12	3	2		50	90	20	20		15	15	43	
12～16	28	18						5-15				22

Borehole Depth(m)	EMB-5	EMB-6	EMB-7	EMB-8	EMB-9	EMB-10	EMB-11	EMB-12
0～4								
4～8								
8～12	32	30	30	22	32	17	23	
12～16								23

3 Laboratory Test

Laboratory tests were performed on selected soil samples after review in the laboratory. In general, classification, strength and deformation tests were performed on all undisturbed samples from each borehole.

All tests were performed in accordance with Volume 4.08 of the Annual Book of ASTM Standards (1999) Edition.

The laboratory tests results are presented in attached material.

3.1 Tests Performed and Methodology

Classifications tests were performed on at least five samples from each borehole. Soil strength and deformation tests were performed on all undisturbed samples recovered from each borehole.

The tests that were performed and the associated ASTM methods are presented below:

ASTM Method Description

D-2216 Soil Moisture Content
D-4318 Atterberg Limits
D-854 Specific Gravity
D-2850 Unconfined Compression Test
D-2435 One-Dimensional Consolidation

The wet and dry densities were also determined for undisturbed samples.

3.2 Summary of Test Results

The results obtained from the laboratory investigation are similar to those obtained from equivalent tests on samples recovered from Coastal Plain deposits elsewhere in Guyana. Detailed results are presented in the laboratory test results of Tables 3-1 and 3-2 below

.

3.2.1 Classification Test

The results of the classification tests indicate that primarily high plasticity silty clays underlie all borehole sites. Table 3-1 summarizes the results of the classification tests on samples from each borehole.

3.2.2 Unconfined Compression Tests

Soil unconfined compression strengths were determined. The soil undrained shear strength was obtained by taking one half the unconfined compression strength. In general, the Unconfined Compression strength of the very soft to soft silty clay (Demerara Clay) does not exceed 3.5 t/m2. Unconfined Compression strengths generally greater than 3 t/m2 but less than 10 t/m2 were recorded for the desiccated crust encountered at ground surface. Unconfined Compression strengths are also reported in Table 3-1. Stress-strain plots for these tests are provided in the laboratory test sum maries of attached material.

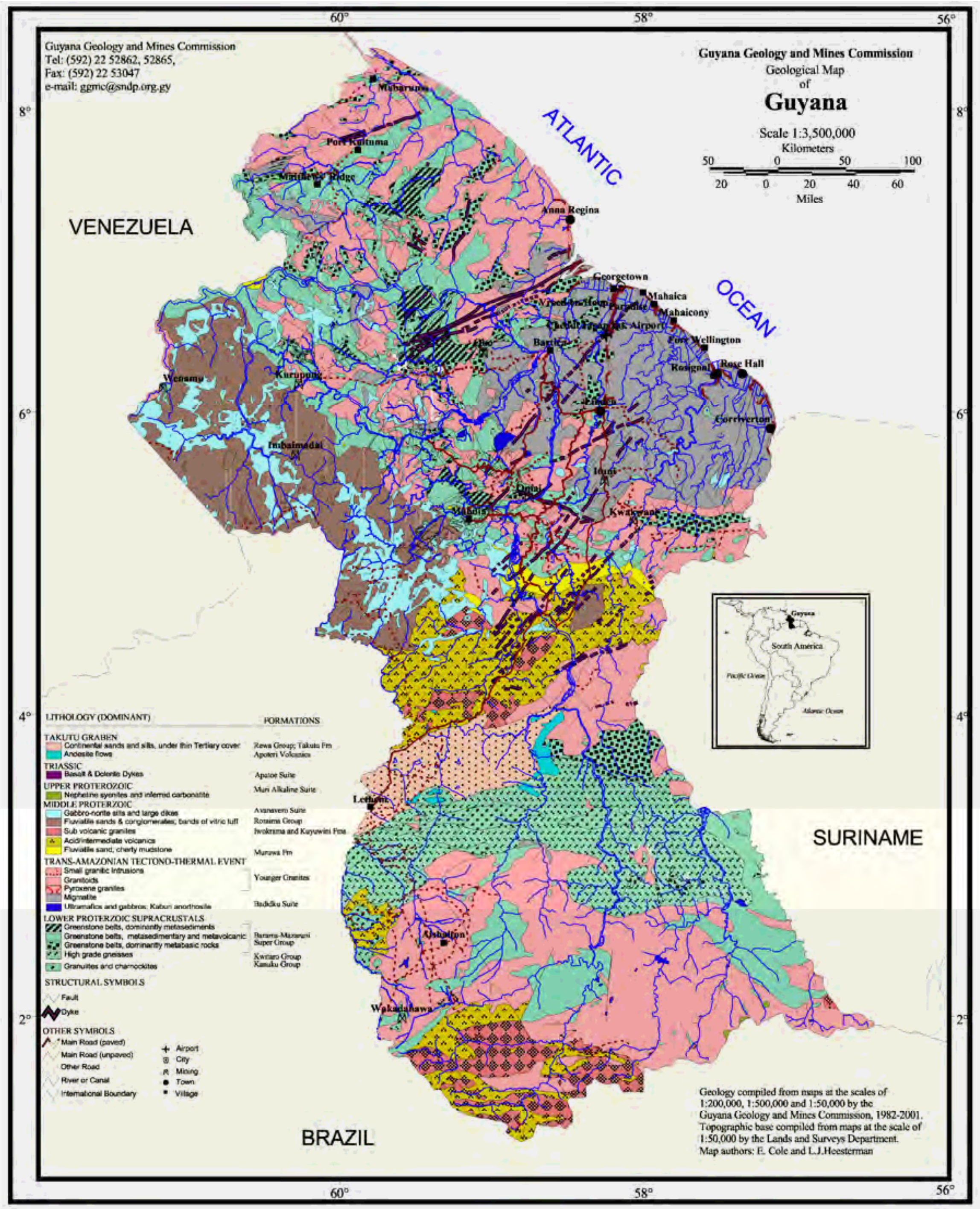
Table3-1 Summary of Classification And Soil Strength Tests

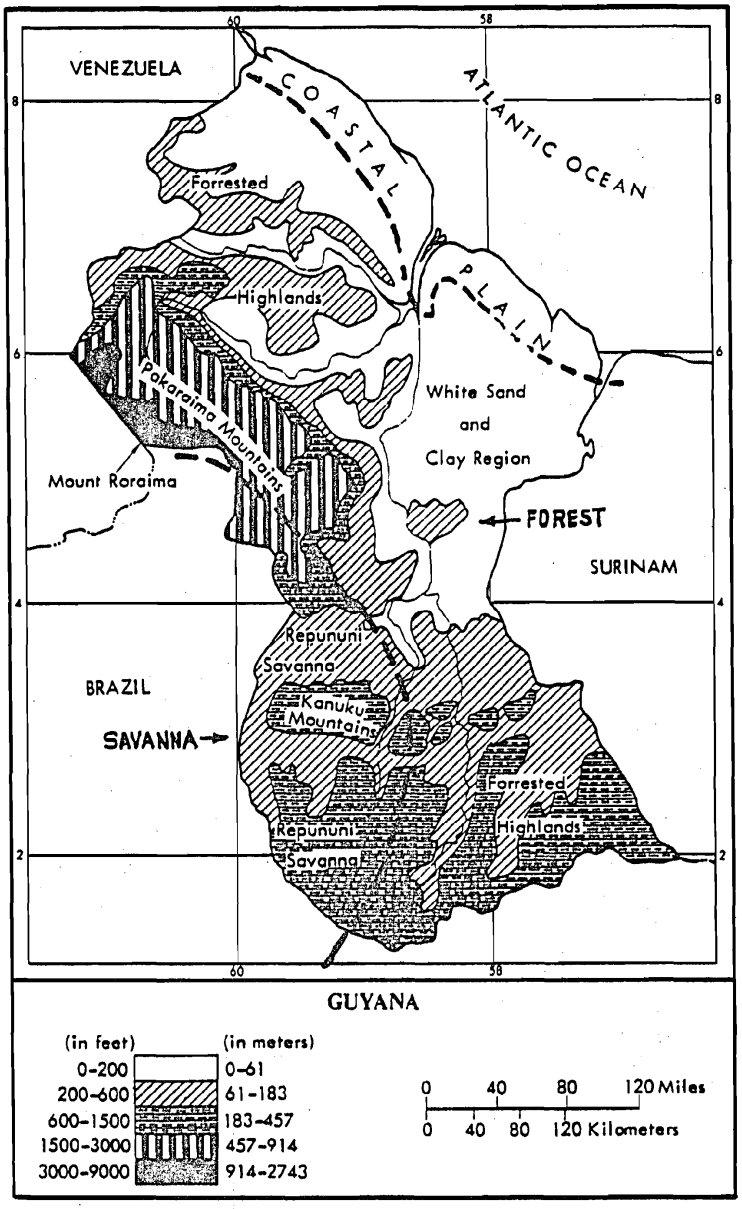
Borehole No	Sample No	Sample Depth (m)	LL	PL	PI	MC (%)	Specific Gravity	Unconfined Comp. Strength (tf /㎡)
BH1	1	10	57	36	21	19	2.59	2.8
BH2	1	7	147	101	46	120	2.50	0.5
BH3	1	5	55	31	24	39	2.53	2.6
BH4	1	7.6	38	24	14	48	2.53	0.6
BH6	1	7.6	69	35	34	32	2.53	0.4
EMB-1	2	9.1	75	24	51	27	2.63	18.3
EMB-6	2	9.5	89	23	65	102	2.67	3.1
EMB-8	2	6.5	71	25	46	62	2.53	5.3
EMB-10	2	4.5	74	25	49	32	2.50	
EMB-12	2	9.0	58	30	28	49	2.63	

3.2.3 One-Dimensional Consolidation Tests

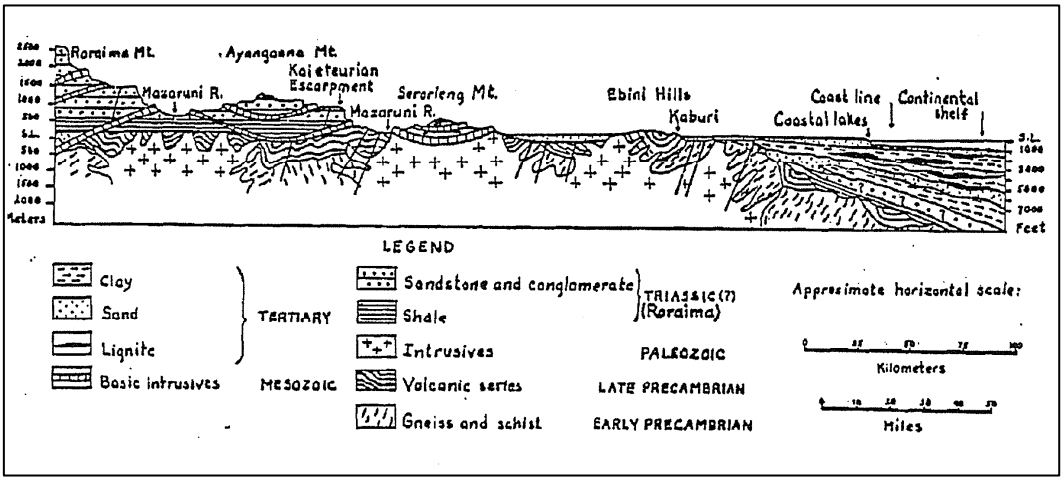
One-dimensional consolidation tests confirmed the high Compression Index, Cc, of the soft to very soft silty clays (Demerara Formation) in virgin compression.

Some over-consolidation was recorded for the upper zone of firm soil encountered at ground surface. This over-consolidation is due primarily to desiccation.

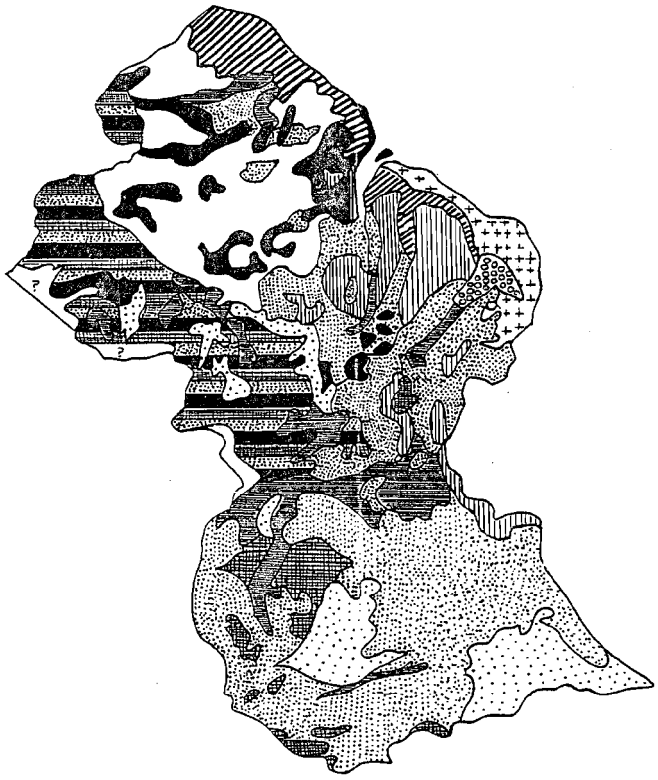

Guyana Geology and Mines Commission
Tel: (592) 22 52862, 52865,
Fax: (592) 22 53047
e-mail: ggmc@sndp.org.gy
Guyana Geology and Mines Commission
Geological Map
of
Guyana
Scale 1:3,500,000
Kilometers
50 0 50 100
20 0 20 40 60
Miles
ATLANTIC
OCEAN
VENEZUELA
SURINAME
BRAZIL
Anna Regina
Georgetown
Mahaica
Mahaicony
Fort Wellington
Rose Hall
Corriverton
Port Kaituma
Matthews Ridge
Kurupung
Wenamu
Imbaimadai
Lethem
Aishalton
Wakadanawa
Kwakwani
60°
58°
56°
8°
6°
4°
2°
South America
Pacific Ocean
Atlantic Ocean
LITHOLOGY (DOMINANT)
FORMATIONS
TAKUTU GRABEN
Continental sands and silts, under thin Tertiary cover
Andesite flows
Rewa Group; Takutu Fm
Apoteri Volcanics
TRIASSIC
Basalt & Dolerite Dykes
Apatoe Suite
UPPER PROTEROZOIC
Nepheline syenites and inferred carbonatite
Muri Alkaline Suite
MIDDLE PROTERZOIC
Gabbro-norite sills and large dikes
Fluviatile sands & conglomerates; bands of vitric tuff
Sub volcanic granites
Acid/intermediate volcanics
Fluviatile sand; cherty mudstone
Avanavero Suite
Roraima Group
Iwokrama and Kuyuwini Fms
Muruwa Fm
TRANS-AMAZONIAN TECTONO-THERMAL EVENT
Small granitic intrusions
Granitoids
Pyroxene granites
Migmatite
Ultramafics and gabbros; Kaburi anorthosite
Younger Granites
Badidku Suite
LOWER PROTERZOIC SUPRACRUSTALS
Greenstone belts, dominantly metasediments
Greenstone belts, metasedimentary and metavolcanic
Greenstone belts, dominantly metabasic rocks
High grade gneisses
Granulites and charnockites
Barama-Mazaruni Super Group
Kwitaro Group
Kanuku Group
STRUCTURAL SYMBOLS
Fault
Dyke
OTHER SYMBOLS
Main Road (paved)
Main Road (unpaved)
Other Road
River or Canal
International Boundary
Airport
City
Mining
Town
Village
Geology compiled from maps at the scales of
1:200,000, 1:500,000 and 1:50,000 by the
Guyana Geology and Mines Commission, 1982-2001.
Topographic base compiled from maps at the scale of
1:50,000 by the Lands and Surveys Department.
Map authors: E. Cole and L.J.Heesterman



Typical geological features profile of Guyana



Geological plan of Guyana



COASTAL SOILS

FLUVISOLS. Good agricultural soils.

DYSTRIC HISTOSOL. Thick, sticky, poorly osygenated, poor drainage; little value for modern agriculture, fair grassland.

PLINTHIC ACRISOL. Low fertility, mostly savanna.

SOILS OF INTERIOR

DYSTRIC NITOSOL. Moderate suitability for agriculture and grassland; can be improved with careful management.

EUTRIC GLEYSOL. Highly variable. Along coast when drained are good for agriculture; inland usually forest cover.

ALBIC ARENOSOL. Extremely low fertility, very sandy. Natural vegetation may be forest but when cleared, scrub or grass returns. Poorest soils in Guyana for agriculture.

ORTHIC ACRISOL. Not used for agriculture in Guyana. Usually on hilly terrain and low fertility; subsoil dense. Restricted agric. use.

ACRIC FERRALSOL. Low nutrient content; usually support savanna.

SOILS OF SOUTHERN THIRD OF COUNTRY

ORTHIC FERRALSOL. Low nutrient content; usually support forest; suitable mainly for shifting agriculture.

ORTHIC FERRALSOL. As above. Distinction between these two Orthic Ferralsols, as shown on FAO map unclear.

MIXED: ORTHIC FERRALSOL, DYSTRIC NITOSOL, LITHOSOL. Lithosol. Rocky and on steep slopes. Not suitable for modern agriculture and rarely used.

Drilling Operation at EDWC Embankment

Soil Test（Ⅰ）

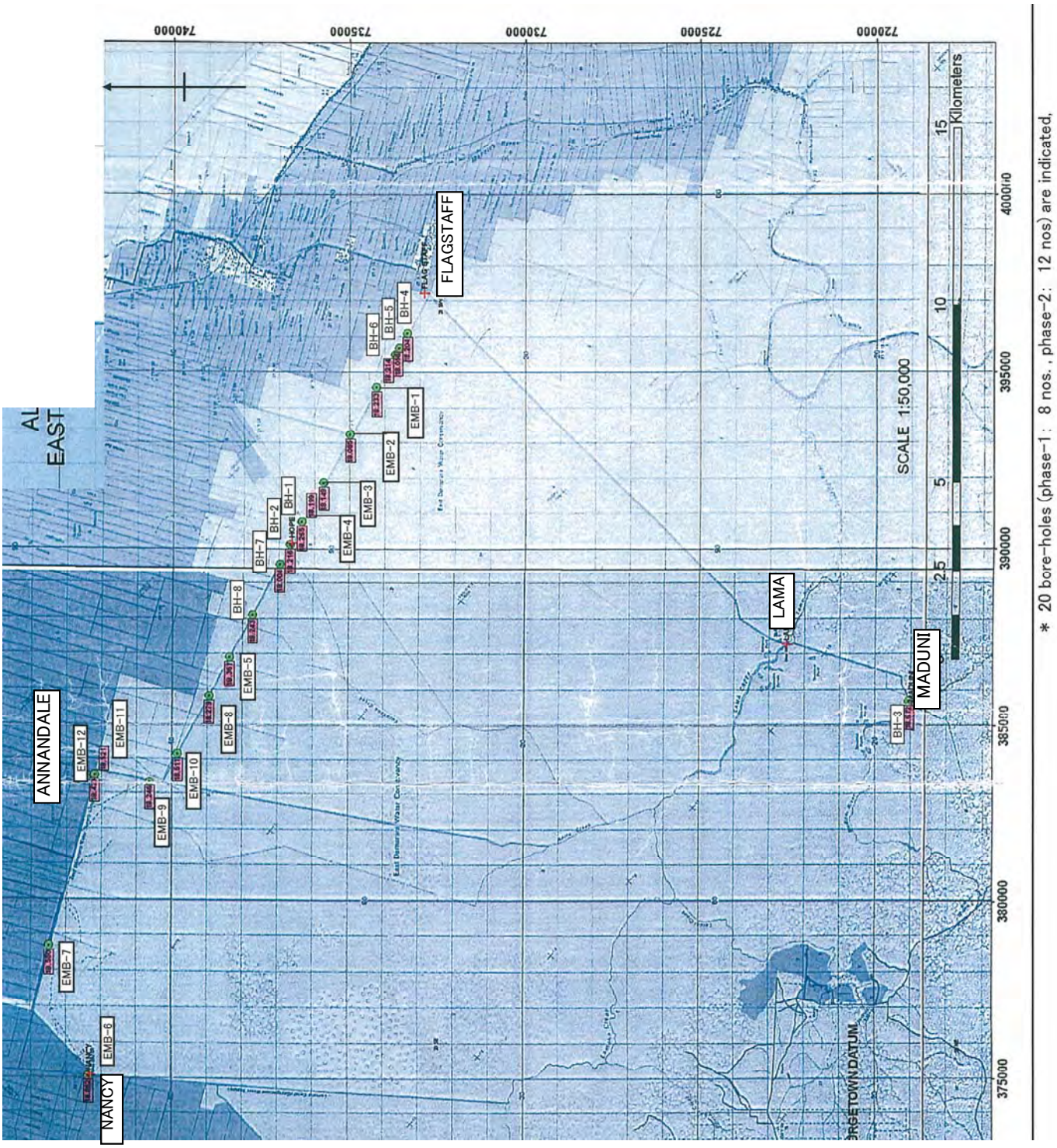
Boring location	BH 1	BH 2	BH 3	BH 4	BH 5	BH 6	BH 7	BH 8	Total
In-situ tests									
Investigation boring depth (m)	12.6	14.3	6.5	9.8	10.3	9.7	10.4	15.8	89.4
Standard penetration test (no.)	3	2	1	1	1	1	1	2	12
Thin-walled sampling (no.)	1	1	1	2		2			7
Spot vane shear test (no.)	7	7	5		7		7	7	40
Physical tests (no.)									
Technological classification method of soil	1	1	1	1		1			5
Density examination of soil particles	1	1	1	1		1			5
Moisture content test of soil	1	1	1	1		1			5
Mechanical analysis of soil grain	1	1	1	1		1			5
Liquid and plastic limits test of soil	1	1	1	1		1			5
Wet density test	1	1	1	1		1			5
Chemical tests (no.)									
pH test		1	1			1			3
Ignition loss test of soil	1			1					2
Organic matter content test of soil		1	1			1			3
Mechanical tests (no.)									
Standard consolidation test	1	1	1	1		1			5
Unconfined compression test	1	1	1	1		1			5
Shrinkage factor test									

Soil Test（Ⅱ）

Boring location	EMB- 1	EMB- 2	EMB- 3	EMB- 4	EMB- 5	EMB- 6	EMB- 7	EMB- 8	EMB- 9
In-situ tests									
Investigation boring depth (m)	10.3	9.7	9.9	15.8	9.7	12.6	9.7	9.7	9.7
Standard penetration test (no.)	1	1	3	1	1	1	1	1	1
Thin-walled sampling (no.)	2					2		2	
Spot vane shear test (no.)		6		6	6				6
Physical tests (no.)									
Technological classification method of soil	1					1		1	
Density examination of soil particles	1					1		1	
Moisture content test of soil	1					1		1	
Mechanical analysis of soil grain	1					1		1	
Liquid and plastic limits test of soil	1					1		1	
Wet density test	1					1		1	
Chemical tests (no.)									
pH test	1					1			
Ignition loss test of soil	1					1			
Organic matter content test of soil								1	
Mechanical tests (no.)									
Standard consolidation test	1					1		1	
Unconfined compression test	1					1		1	
Shrinkage factor test									

Boring location	EMB-10	EMB-11	EMB-12	Total
In-situ tests				
Investigation boring depth (m)	9.7	9.7	15.8	132.3
Standard penetration test (no.)	1	1	1	14
Thin-walled sampling (no.)	2		2	10
Spot vane shear test (no.)		6	6	36
Physical tests (no.)				
Technological classification method of soil	1		1	5
Density examination of soil particles	1		1	5
Moisture content test of soil	1		1	5
Mechanical analysis of soil grain	1		1	5
Liquid and plastic limits test of soil	1		1	5
Wet density test	1		1	5
Chemical tests (no.)				
pH test				2
Ignition loss test of soil			1	3
Organic matter content test of soil			1	2
Mechanical tests (no.)				
Standard consolidation test				3
Unconfined compression test				3
Shrinkage factor test				

Borehole Location



Subsurface Soil and Geology

dep.(m)	BH-1	N-Value	Soil Description		BH-2	N-Value	Soil Description		BH-3	N-Value	Soil Description		BH-4	N-Value	Soil Description	
		20v	Soft dark grey silty clay with organics	moist		30v	Stiff dark grey silty clay with organics	moist		55v	Firm red brown and grey silty clay c=8t/㎡～15t/㎡	moist			Stiff dark grey silty clay with organics	moist
1																
		30v				25v				80v						
2			Soft dark grey silty clay with organics	moist											Soft brown and grey silty clay with organics	moist
3		35v	Highly saturated brown and black highly organic silty clay	very moist		30v				40v						
4		40v														
						35v										
5		3							MH							
										60	Stiff to very stiff red and grey silty clay c=10t/㎡	moist			Soft light grey silty clay	moist
6		20v	Very soft silty clay	moist		15v										
7						15v	Soft dark grey silty clay	moist					CL			
		15v			MH											
8																
														50	Stiff yellow, brown, red and grey silty clay	moist
9		15v				20v										
10	MH	3	Soft to firm light grey silty clay	moist		2	Soft light grey silty clay	moist								
11																
12		28	Firm yellow and grey silty clay	moist												
13																
14																
						18	Firm brown and grey silty clay	moist								
15																

v:In-situ Vane shear(kpa)

N value	Consistency	qu(t/㎡)	c(t/㎡)
～2	Very soft （ごく軟らかい）	～2.5	～1.3
2～4	Soft （軟らかい）	2.5～5	1.3～2.5
4～8	Intermediate （中位）	5～10	2.5～5
8～15	Hard （粘り強い）	10～20	5～10
15～30	Very hard （ごく粘り強い）	20～40	10～20
30～	Hardened. （硬い）	40～	20～

	BH-5	N-Values	Soil Description		BH-6	N-Value	Soil Description		BH-7	N-Value	Soil Description		BH-8	N-Value	Soil Description	
		30v	Soft dark grey silty clay with organics c=4t/㎡～13t/㎡	moist			Soft grey silty clay with organics	moist		30v	Soft dark grey silty clay with organics	moist		30v	Soft dark grey silty clay with organics c=3.3t/㎡～5t/㎡	moist
1																
		35v								15v				15v		
2																
3		30v								25v				25v		
4																
		25v								15v				15v		
5																
6		30v								15v				15v		
7													CL			
		50v			MH		Firm light grey silty clay	moist		15v				15v		
8																
9		90v								20v				20v		
						20	Very stiff red yellow and grey silty clay	moist			Very stiff red brown and grey silty clay	moist				
10	MH	90	Stiff yellow red brown grey silty clay	moist						20						
11																
12																
13																
															Soft light grey silty clay	moist
14														5		
15														15	Stiff yellow brown and grey silty clay	moist

N value	Consistency	qu(t/㎡)	c(t/㎡)
～2	Very soft	～2.5	～1.3
2～4	Soft	2.5～5	1.3～2.5
4～8	Intermediate	5～10	2.5～5
8～15	Hard	10～20	5～10
15～30	Very hard	20～40	10～20
30～	Hardened.	40～	20～

	EMB-1	N-Value	Soil Description		EMB-2	N-Value	Soil Description		EMB-3	N-Value	Soil Description		EMB-4	N-Value	Soil Description	
			Soft dark greenish black highly organic silty clay and fibrous matter	moist		60v	Soft dark greenish black highly organic silty clay and fibrous matter c=5t/㎡～10t/㎡	moist			Soft dark brown highly organic silty clay and fibrous matter	moist		0v	Soft dark greenish black highly organic silty clay and fibrous matter c=4t/㎡～8.4/㎡	moist
1						50v								40v		
2																
3						55v								35v		
4																
5						40v				2				20v		
6						40v								20v		
7																
8						30v				35	Firm reddish brown silty clay	moist		15v		
9						15	Firm brownish greenish dark grey silty clay	moist		43				50v		
10		15	Very stiff dark brown silty clay	moist											Firm reddish dark brown silty clay	moist
11																
12																
13																
14																
15														22	Dark brown silty clay	

N value	Consistency	qu(t/㎡)	c(t/㎡)
～2	Very soft	～2.5	～1.3
2～4	Soft	2.5～5	1.3～2.5
4～8	Intermediate	5～10	2.5～5
8～15	Hard	10～20	5～10
15～30	Very hard	20～40	10～20
30～	Hardened.	40～	20～

	EMB-5	N-Value	Soil Description		EMB-6	N-Value	Soil Description		EMB-7	N-Value	Soil Description		EMB-8	N-Value	Soil Description	
		30v	Soft dark greenish black highly organic silty clay and fibrous matter,damp c=4t/㎡～10/㎡	moist			Soft dark brown highly organic silty clay and fibrous matter	moist			Soft dark greenish black highly organic silty clay and fibrous matter	moist			Soft dark brown highly organic silty clay and fibrous matter	moist
1																
		30v														
2																
3		30v											CH			
4																
		25v														
5																
6		30v											CH		Firm greyish,greenish light brown silty clay	moist
7																
		60v														
8																
										30						
9		32					Firm brownish grey silty clay	moist						22	Firm greyish greenish light brown silty clay	moist
			Firm reddish grey silty clay	moist	CH						Firm greenish brownish light grey silty clay	moist				
10																
11																
12						30										
							Firm greenish brownish	moist								
13							grey silty clay									
14																
15																

N value	Consistency	qu(t/㎡)	c(t/㎡)
～2	Very soft	～2.5	～1.3
2～4	Soft	2.5～5	1.3～2.5
4～8	Intermediate	5～10	2.5～5
8～15	Hard	10～20	5～10
15～30	Very hard	20～40	10～20
30～	Hardened.	40～	20～

	EMB-9	N-Value	Soil Description		EMB-10	N-Value	Soil Description		EMB-11	N-Value	Soil Description		EMB-12	N-Value	Soil Description	
		50v	Soft dark greenish black highly organic silty clay and fibrous matter,damp c=5t/㎡～8.5/㎡	moist			Soft grey silty clay	moist		40v	Soft dark greenish black highly organic silty clay and fibrous matter c=5t/㎡～9.0/㎡	moist		45v	Soft dark grey silty clay	moist
1																
		30v								55v				65v		
2																
3		30v								45v				70v		
4																
		30v			CH					30v			CH	30v		
5							Soft brown silty clay	moist								
6		30v								30v				20v		
7																
		45v														
8										30v				20v		
9		32				17	Firm greyish brown silty clay	moist		23			CH			
			Firm dark grey silty clay								Firm dark greyish green silty clay					
10															Soft dark grey silty clay	moist
11																
12															Firm dark grey silty clay	
13																
14																
15														23		

N value	Consistency	qu(t/㎡)	c(t/㎡)
～2	Very soft	～2.5	～1.3
2～4	Soft	2.5～5	1.3～2.5
4～8	Intermediate	5～10	2.5～5
8～15	Hard	10～20	5～10
15～30	Very hard	20～40	10～20
30～	Hardened.	40～	20～

Laboratory Tests of Cement-mixed Soils

Laboratory tests on cement-mixed soil samples mixed both at embankment site and at laboratory respectively were conducted.

(1) Soil/cement Mixing at Field

(a) Soil is an organic matter excavated from canal bed.

(b) The soil of prescribed volume was spread in the bucket furnished on the pontoon.

(c) Cement content ratio in three(3) cases and number of specimen are as follows;

・60kg, 120kg and 180kg weight of cement respectively for 1-metric cubic of soil

・Six(6) specimen for each cement content case, 3 for 4-days curing and 3 for 7-days curing

(2) Soil/cement Mixing at Laboratory

(a) Soil is an organic matter excavated from canal bed.

(b) The soil sample was carried into the laboratory in tightly sealed manner and the soil of prescribed volume was taken into the mixing bucket.

(c) Cement content ratio in three(3) cases and number of specimen are as follows;

・60kg, 120kg and 180kg weight of cement respectively for 1-metric cubic of soil.

・Six(6) specimen for each cement content case, 3 for 4-days curing and 3 for 7-days curing.

(3) Test Schedule

	Dates job-conductrd
Sampling and Mixing at Field	▬
	(11/11)
Sampling at Field	
and Mixing at Laboratory	▬
	(11/5)
Laboratory Tests	▬(L4) ▬(L7) ▬(F4) ▬(F7)
(4-days and 7-days curing)	(11/10) (11/13) (11/16 (11/18)

(4) Laboratory Tests

Following tests according to the ASTM test procedures were conducted;

・Unconfined Compression Test

・Wet Density test of Soil

(5) Laboratory Test Results

5-1 Field Mixing

Cement Content ratio (kgf/1m^3)	Wet Density (gf/cm^3) Curing		Undrained Shear Strength (kpa)	
	4-days	7-days	4-days	7-days
60	1.46 ~ 1.62	1.46 ~ 1.52	4 ~ 11	4 ~ 16
120	1.39 ~ 1.82	1.44 ~ 1.53	5 ~ 42	25 ~ 57
180	1.44 ~ 1.54	1.42 ~ 1.53	74 ~ 82	41 ~131

5-2 Laboratory Mixing

Cement Content ratio (kgf/1m^3)	Wet Density (gf/cm^3) Curing		Undrained Shear Strength (kpa)	
	4-days	7-days	4-days	7-days
60	1.46 ~ 1.77	1.29 ~ 1.44	23 ~ 33	23 ~ 30
120	1.49 ~ 1.58	1.35 ~ 1.39	50 ~ 70	36 ~ 56
180	1.74 ~ 1.86	1.40 ~ 1.45	73 ~134	117 ~156

Work Exercises for Soil Tests

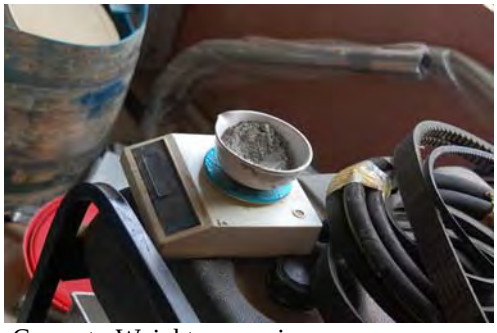
Laborarory Mixing and Tests

Excavated Soil stored in pontoon bucket at Field

Soil sampling

Soil Sample tightly sealed in bucket

Soil Sample brought to the laboratory



Cement : Weight measuring

Moulds for the test

Numbering for the specimen

Curing (18-specimen in total)

Compression test instrument

In process of testing

Specimen after testing (Nov. 13th)

Field Mixing and Tests

Excavated Soil in bucket on pontoon

Soil Volume measuring

Sampling and specimen in mould

Cement adding and Mixing

Test after 4-days curing

Specimen after testing (Nov. 16th)

Appendix 7-3 Cone-penetrometer for Earthwork Quality Management

【Quality management of EDWC-concerned earthworks with CONE PENETROMETER】

(1) **Conventional quality control method for in-situ soil density**

Earthworks on the 'EDWC Facilities Rehabilitation' comprise excavating and banking for conservancy embankment and outfall canal banks as schematically given in Figure-1. To achieve superior quality control and maintenance performance on earthworks, soil test procedures and work execution criteria are precisely described in the proposed Technical Specifications.

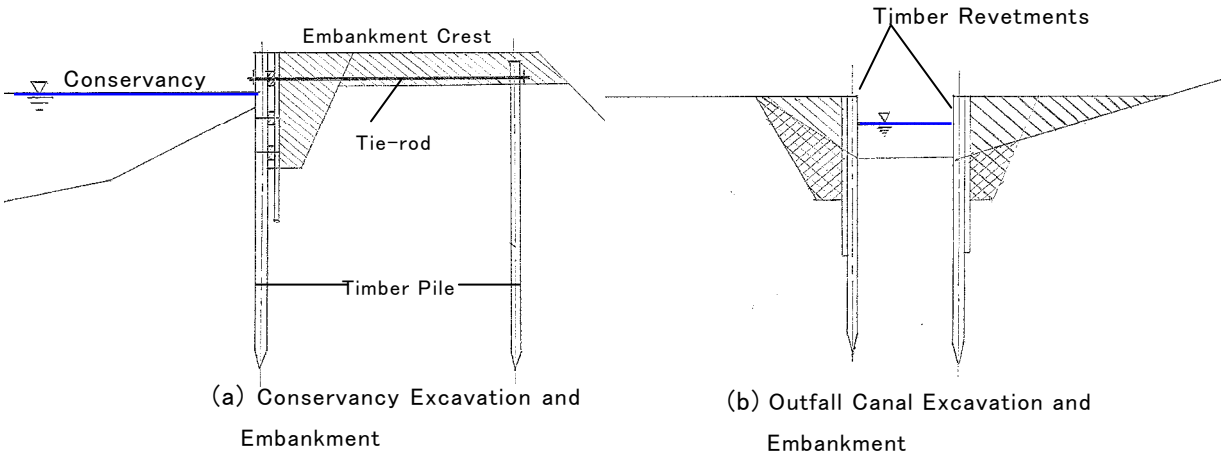


Figure-1 Excavation and Embankment for Revetment Works

As for "in-situ density control management", it is recommended in the said Specifications to follow the "In-situ Density, Sand Replacement Method, large and small cylinders. BS 1377-9 1990 Clause 2.1 & 2.2".

The in-situ density measurement by sand replacement method is to

- dig hole of specified-size (diameter & depth) in the embankment,
- weigh whole dug soils,
- replace the soil volume dug out with standard (particle sizes) sand, and measure the sand volume, and
- calculate the soil density by dividing the soils weight by the sand volume.

The procedure of the measurement has to go through various processes to complete taking much labor and time.

(2) **Compaction control with use of CONE PENETROMETER**

The embankment subsurface soil generally consists of alternate stratum of pegasse, blackish peat and silty clay of soft dark-grey. The soil properties in terms of cohesion, internal friction and permeability vary at location/stratum, but are in general unsuitable and poor.

For quality control of earthworks with such soil properties, CONE PENETROMETER has been conveniently employed for in-situ tests of natural or compacted soils. It serves as a rapid means for determining penetration resistance of the soil.

The penetration resistance which is expressed as cone-index (q_c N/mm^2) can well assess the intensity of subject soil in correlation with unconfined compressive strength (q_u N/mm^2), cohesive strength(c N/mm^2) and so on.

Measured data are timely applied to daily quality control and execution supervision, and regular inspection and maintenance of embankment.

The CONE PENETROMETER shown in Plate-1 is a handy, portable instrument in which the device is consisted mainly of;

- cross handle,
- proving ring for capacity measure,
- cone with top angle of 30-degrees , and
- extension rods(10-nos./50cm long each).

Plate-1 Set of CONE PENETROMETER

(courtesy； 関西機器製作所)

Actual handling of the Instrument is shown in Plate-2.

Plate-2 Handlings of CONE PENETROMETER

(3) **Merits of introducing CONE PENETROMETER**

Employing CONE PENETROMETER for the earthworks has the advantages over the sand replacement method as follows;

- measured data are applied immediately to the succeeding work steps and accordingly the field works can be expedited.
- the equipments can be easily operated at narrow work area.
- special techniques are not required for handlings of the equipments.
- serious damages are not anticipated to the equipment.

Appendix-8 References

Title	Issuance
Guyana Floods : UNDAC Geotechnical and hydraulic assessment of the East Demerara Water Conservancy dam	Joint UNEP/OCHA Environment Unit, February 2005
DRAFT DESIGN REPORT on Engineering Design for the East Demerara Water Conservancy Northern Relief Channel at Hope/Dochfour, East Coast Demerara, Region 4	National Drainage and Irrigation Authority, December 2009 (CEMCo, SRKN'gineering Joint Venture in association with Mott MacDonald)
Draft Water Level Management Manual ; East Demerara Water Conservancy	June 2005 Draft submitted to the Task Force
On East Demerara Water Conservancy	National Assembly Minutes of Proceedings, GUYANA 3rd June 2010
GUYANA Tide Tables and List of Lights for 2010	by Authority of the Director General, Maritime Administration Department, GUYANA
The GUYANA Grading Rules for Hardwood Timber	by Forest Department, Georgetown, Guyana, September 1974 May 1977 revised
GEF(Global Environmental Facility) Project Document on a Proposed Grant from the Special Climate Change Fund to the Government of GUYANA for a Conservancy Adaptation Project	GEF(Global Environment Facility) : World Bank June 20 2007
Engineering Survey showing Location of Kokers (Intake and Sluice) in the Demerara Water Conservancy from Plantation Land of Canaan to Maduni Lock December 2006 Surveyor : Vinyak V.H.Bandon	Prepared by the Guyana Lands and Surveys Commission. Land Information and Mapping Division January 2007
Topography Map (GUYANA 1988) GEORGETOWN,MAHAICA scale 1:50,000	Government of GUYANA, 2007 (by Guyana Lands & Surveys Commission 2007)
Survey Drawings (Plan, Profile and Cross Section) of EDWC : from Flagstaff to Big Island (8km)	NDIA, Government of GUYANA, September 2010

Title	Issuance
Contract Document on Procurement of Hydraulic Excavator, May 2009	Government of GUYANA, The World Bank, GEF SCCF (Global Environmental Facility, Special Climate Change Fund) Trust Grant, Ministry of Agriculture Conservancy Adaptation Project
Contract Document on Fabrication of Punt and Pontoon for the East Demerara Water Conservancy, May 2009	ditto
Contract Document on Rehabilitation of Structures in the East Demerara Water Conservancy, May 2009 (Lama Relief Sluice 1,2)	ditto
Urban Environment Outlook 2009 GEO Georgetown －An Integrated Environmental Assessment of Georgetown －	Prepared by a team led by Dr.Paulette Bynoe and 10 authors
Engineering Assessment of 2006 Floods	UNDP, February 2006