

**Nepal**  
**Ministry of Energy, Water Resources and Irrigation**

**The Preparatory Survey**  
**for the Project**  
**for Rehabilitation of Irrigation System**  
**in Eastern Terai Area in Nepal**

**Report**

**June 2022**

**Japan International Cooperation Agency (JICA)**

**NTC International Co., Ltd.**  
**Nippon Koei Co., Ltd.**

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| <b>22-103</b> |



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# Preface

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey and entrust the survey to consist of NTC International Co., Ltd. and Nippon Koei Co., Ltd.. The survey team held a series of discussions with the officials concerned of the Government of Nepal, and conducted a field investigations. As a result of further studies 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 our two countries. Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Nepal for their close cooperation extended to the survey team.

June, 2022

Keiko Sano  
Director General,  
Economic Development Department  
Japan International Cooperation Agency



## **Summary**

### **1. Background of the Project**

Nepal has a land area of 147,000 km<sup>2</sup>, bordering China to the north and India to the rest. The land consists of 35% mountain area, 42% hill area, and 23% lowland area called Terai plain, which is located east to west along the boundary with India.

The Terai Plains, characterized a fertile soil with water resources and suitable weather conditions for agriculture, contributes substantially to the national domestic production of various cereals and vegetables i.e. 79% of rice, 64% of wheat, 77% of beans and 58% of vegetables (2013/14). Twenty-five large-scale irrigation systems have been constructed (total area of about 330,000 ha), but many of the facilities have deteriorated irrigation functions due to aging which result in reduced irrigated area. Therefore, in order to increase agricultural production in the area, it is required to expand the irrigation area by rehabilitating irrigation facilities.

Rehabilitation works, though insufficient, were carried out by the Ministry of Energy, Water Resources and Irrigation (MoEWRI) for various irrigation systems. The Project for Rehabilitation of Irrigation System in Eastern Terai Area (hereinafter referred to as “the Project”) targets Chandra Canal Irrigation System (hereinafter referred to as “CCIS”) of the Chandra Nahar Irrigation Scheme covering a command area of 10,500 ha that serves approximately 35,000 beneficiary households. It is one of the most important irrigation systems in the large-scale irrigation schemes located in the Terai Plain having serious aging problem because it was constructed in 1927.

A request was duly made to the Government of Japan for assistance in the rehabilitation of irrigation facilities in eastern Terai area by the Government of Nepal which resulted in the formulation of this project by the Japanese Government.

With this background, JICA had conducted a Preliminary survey collecting information related to the policy of Nepalese Government and moreover surrounding condition and emergency level of target site for determination of the appropriateness of the Grant Aid Project. Once the project is found to be appropriate, the preliminary survey team will determine the necessary and scope of preparatory survey needed. JICA believes that the increased productivity in the Terai Plain will contribute significantly to the country's food security.

Two irrigation schemes, Chandra Nahar and Khageri, were investigated through the Preliminary survey. As a result, Preliminary survey team concluded that Chandra Nahar Irrigation Scheme has serious emergency level and also bigger than Khageri from the impact prospective. The target facilities for renovation are 1) Canal Under Pass (8 in total); 2) Cross Drainage Work (about 20) and 3) Canal Crossing Bridge (around 50). Canal Under Pass which are severely damaged facilities of the Chandra Nahar Irrigation scheme. Preliminary survey team had confirmed that these were an urgently needed intervention of the project to smoothen the functionality of the scheme. In addition, it was concluded that the business impact of the renovation on the socio-economics of the region would be great, and that there would be no major problem even if the preparatory survey is conducted directly without going through the steps of feasibility study and basic survey.

Therefore, JICA had conducted a preparatory survey for confirming the Validity and Effectiveness of the project, which aimed at facility rehabilitation and soft component activity for attaining “the capacity development of operation and maintenance for rehabilitated facilities, for keeping the sustainability of facility function” at Chandra Nhar Irrigation Scheme as the Model to contribute improving productivity around Terai Plain, and proposing the project establishment based on Grant Aid.

## 2. Outline of Survey Result and Project Contents

### 2.1 Field Survey Schedule

The Preparatory Survey team conducted the Survey in Nepal from March to May 2021. Through the survey in Nepal, the Preparatory Survey team performed a series of discussion with Ministry of Energy, Water Resources and Irrigation, Department of Water resources and Irrigation, and Koshi Pump and Chandra Nahar Irrigation Management Office to rehabilitate irrigation system and conducted field inspection and data collection.

Thereafter, the contents of request and validity of cooperation were confirmed and proper scale and contents of the Project were examined during investigation in Japan. Based on the result of examination in Japan, the draft final report was prepared by the Preparatory Survey team.

JICA decided to dispatch the Preparatory Survey team to Nepal to explain and discuss the contents of the draft final report from December 9 to 19, 2021. On line meeting was held by JICA on December 16, Nepal side agreed the contents of draft final report. Finally both side agree to the proposed intervention and concluded the Minutes of Meeting.

### 2.2 Objective of the Project

The Objective of the Project is to improve the agricultural productivity in the eastern Terai region by rehabilitating the existing facilities in the target area and keeping the sustainable use of the system through capacity development for management supervision of the rehabilitated facilities that will be treated as the soft component of the project.

### 2.3 Outline of the Project

The outline of the project is shown below.

**Table S-1 Project Outline**

|                       |  |
|-----------------------|--|
| Site                  | Chandra Nahar Irrigation Scheme  |
| Representative Agency | Ministry of Energy, Water Resources and Irrigation (MoEWRI)  |
| Implementing Agency   | Department of Water Resources and Irrigation (DWRI)  |
| Purpose               | To increase agricultural production through the rehabilitation of irrigation facilities situated within the Chandra Canal Irrigation System (CCIS).  |
| Achievement           | 1. Seriously aged facilities such as Siphon (Canal Under Pass), Cross Drainage Works and Canal Crossing Bridges of Chandra Canal Irrigation System will be rehabilitated.<br>2. Irrigation conveyance efficiency in the Chandra Nahar Irrigation Scheme will be improved.  |
| Activities            | 1. Canal Under Pass (Target 8 facility sites / Existing 8 facilities sites)<br>2. Cross Drainage Work (Target 9 facility sites / Existing 14 facilities sites)<br>3. Canal Crossing Bridge (Target 15 facility sites / Existing 37 facilities sites)<br>4. Capacity development for management supervision of rehabilitated facilities |
| Beneficiary           | An estimation of 35,000 households living in irrigation area   |

### 2.4 Policy of Design

#### (1) Basic concept

- (a) The Government of Nepal had requested to rehabilitate eight (8) Canal Under Passes (CUPs), fourteen (14) Cross Drainage Works (CDWs) and approximately thirty seven (37) Canal

Crossing Bridges (CCBs). JICA Survey Team (JST) resulted to be rehabilitation of eight (8) CUPs, nine (9) CDWs and fifteen (15) CCBs as the target components, through the investigation of current status of facilities which the government requested. Furthermore, main irrigation canal, diversions and check gate would not be included in the target of the project since Nepal government can rehabilitate it by own efforts although these facilities need to be rehabilitated.

- (b) The purpose of this project is to ensure the sustainable original functioning of the irrigation system. Therefore, the existing facilities will be rehabilitated and maintained, and any new facilities will not be constructed. In addition, in principle, the existing facilities will be removed and reconstructed.

## (2) Rehabilitation of CUPs

- (a) The Cross section area of flow on CUPs shall be redesigned to allow the estimated flow rate at the time of construction i.e. about 100 years ago. In addition, the head loss of the existing facility shall be set as the allowable loss head, and the structure shall not exceed the loss of the existing facility.
- (b) The depth of culvert section will be determined based on the river bed slope and the scouring conditions around the existing facility.

## (3) Rehabilitation of CDWs

- (a) The Cross sectional areas of flow on CDWs shall be designed to the estimated flow rate which is calculated based on the latest rainfall data. In accordance with the design standards of Nepal, the flood volume is calculated based on 25-year probability rainfall.
- (b) Since there is a concern regarding scouring of the embankment on the inflow side, the embankment will be protected by wet masonry in the area that affects the CDWs.

## (4) Rehabilitation of CCBs

- (a) The Cross section area of flow on CCBs shall be designed to flow at the estimated flow rate at the time of construction i.e. about 100 years ago. It is same as CUPs.
- (b) The road surface height will basically follow the same as that of the existing bridge due to its connectivity with the existing Linkage Road.

## 2.5 Summary of components

This project components are Canal Under Pass (CUP), Cross Drainage Work (CDW) and Canal Crossing Bridge (CCB). The summaries of components are shown below.

**Table S-2 Summaries of components**

| Component                 | Summary       |  |
|---------------------------|---------------|--|
| Canal Under Pass (CUP)    | Qty.          | 8 units  |
|                           | Main facility | Box Culvert, Inlet, Outlet   |
|                           | Ancillary     | Screen: Installation at inlet<br>Transition: Establishment at up and downstream of CUP<br>Lining: Connection between existing canal and transition<br>Bank protection: Irrigation canal slope and river bank |
| Cross Drainage Work (CDW) | Qty.          | 9 units  |
|                           | Main facility | Box Culvert, Inlet, Outlet   |
|                           | Ancillary     | Lining: Connection between existing canal and transition<br>Protection: Inlet and Outlet part<br>Distribution: Re-construction when a CDW is rehabilitated   |

| Component                   | Summary                                     |  |
|-----------------------------|---|--|
| Canal Crossing Bridge (CCB) | Qty.  | 15 units   |
|                             | Main facility                               | Box Culvert  |
|                             | Ancillary                                   | Wing wall: Retaining<br>Transition: Section change point between canal and culvert<br>Lining: Connection between existing canal and transition<br>Access road<br>Check gate: Re-construction when a CCB is rehabilitated |
| Soft Component              | Capacity development for maintenance of CUP |  |

### 3. Implementation Schedule and Cost of the Project

#### 3.1 Implementation Schedule

The weather in the target areas are divided into the dry season from April to late October and the wet season from early November to late March. The target components in this project are 8 CUPs, 9 CDWs and 15 CCBs, which brings the total number of construction sites to 32. All the structures are planned to be constructed in the dry season because the main body is concrete work. On the other hand, the bank protection works, which is a supplementary structure to the cross drainage works, can be carried out during the rainy season because it is masonry works.

The construction of the project at 32 locations should be carried out utilizing two dry seasons and one rainy season from the viewpoint of workability. As for the preparatory works, 1.5 months will be set aside in the latter half of the rainy season in order to establish a system to start the main construction work immediately after the beginning of the dry season, and about 4 months will be set aside for the preparation of documents such as tariff procedures.

For this project, it is assumed that the E/N will be signed in July 2022 and then the contract will be signed in March 2023. This will result in an overall duration of 36 months.

**Table S-4 Duration and number of months for design, construction supervision and construction work**

| Stage                               | Period  | Number of Months |
|-------------------------------------|---|------------------|
| Design and Construction Supervision | Mid-July 2022 – Mid-May 2025  | 36 months        |
| Construction Work                   | Mid-May 2023 – Mid-May 2025<br>(March to August 2023 is a preparation period) | 25 Months        |
| Defect Check                        | May 2026  | 0.23 Months      |

#### 3.2 Cost

As for the initial cost borne by the Japanese side, it is confidential until the bidding for construction is carried out. Among the overall project costs, Nepalese side shall bear the costs partially according to the work sharing between both governments. Followings are the Project cost borne by Nepalese side.

##### (1) Cost borne by Nepalese Side

**Table S-5 Cost borne by the Nepalese Side**

| Item  | Project Cost (1,000 NRs) | Converted Cost (1,000 JPY) |
|---|--------------------------|----------------------------|
| To secure the necessary budget and implement land acquisition and resettlement and compensation with full replacement cost in accordance with RAP | 3,799                    | 3,498                      |
| To implement environmental & social monitoring, and to submit the monitoring results to JICA  | 248                      | 228                        |

| Item  | Project Cost<br>(1,000 NRs) | Converted Cost<br>(1,000 JPY) |
|---|-----------------------------|-------------------------------|
| To secure and clear the following lands for widening and replacing by rehabilitation of facilities temporary construction yard and stock yard   | 277                         | 255                           |
| To clear, level and reclaim the sites, and remove utilities such as power poles, power and water pipe or other public facilities, if necessary.   | 1,300                       | 1,197                         |
| To bear the following commissions to the Agent Bank for the banking services based upon B/A   | 5,000                       | 4,605                         |
| To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the country of the Recipient with respect to the purchase of the products and/or the services be exempted | 238,000                     | 219,174                       |
| To implement social monitoring, and to submit the monitoring results to JICA  | 308                         | 284                           |
| Total   | 248,932                     | 229,241                       |

## 4. Project Evaluation

### 4.1 Relevance

This project is considered to have validity to be implement as a Japanese Grant Aid project because of the following reasons.

#### (1) Target Beneficiary of the Project

The 35,000 beneficiary households of the Chandra Irrigation System depend on the irrigation system for their livelihood. By upgrading the major components of the 100-year-old irrigation system, sustainable irrigated agriculture will be possible. And by reducing water leakage and improving conveyance efficiency, irrigated agriculture will be possible as originally planned that will directly benefiting 35,000 households. Indirectly, the increase in crop production will benefit agriculture-related facilities such as rice mills and collection and shipping centres, and service sector such as stores inside and outside of the irrigation system.

#### (2) Development Plan in Nepal

In the 15<sup>th</sup> Five-Year Plan, the latest national development plan, "Prosperous Nepal, Happy Nepal" is set as the long-term vision, and "Sustainable High Production and Productivity" is set as one of the 10 major items to achieve the vision. The specific goals for "sustainable high production and productivity" are to increase productivity through irrigated agriculture and to secure farmland that can be cultivated year-round, and the renewal of the aging irrigation system will contribute to achieving such goals.

#### (3) Japanese Aid Policy

The Government of Nepal has set a goal of "shifting from being the poorest country in the world by 2022" and is working on the task of stabilizing society by promoting economic growth and spreading the benefits to the entire population. Against this background, four priority areas have been identified and support is being provided in order to encourage the efforts of the government of Nepal. This project is positioned as one of such priority areas for "Poverty Alleviation and Quality of Life Improvement," which will be achieved by support to increasing agricultural productivity and income through the dissemination of agricultural technologies, and improving the level of health care, education, and other services. Therefore, to avoid unstable rainfed agriculture, support for the stable irrigated agriculture is required.

## 4.2 Effectiveness

This Project is judged to possess effectiveness due to the following quantitative and qualitative effects.

### (1) Quantitative effects

Quantitative effects to be expected are shown in the table herein below.

**Table S-6 Indicator for Quantitative Effects**

| Index                        | Baseline (2021) | Target value*1 | Remarks                                  |
|------------------------------|-----------------|----------------|--|
| Irrigable Area               |                 |                |  |
| (a) Rainy Season Crop (Rice) | 6,500 ha        | 7,800 ha       | Irrigable Area will increase by 1,300ha. |
| (b) Dry Season Crop (Wheat)  | 4,320 ha        | 5,200 ha       | Irrigable Area will increase by 880ha.   |
| Yield                        |                 |                |  |
| (c) Rainy Season Crop (Rice) | 30,900 ton      | 32,850 ton     | Yield will increase by 1,950ton.         |
| (d) Dry Season Crop (Wheat)  | 8,900 ton       | 10,700 ton     | Yield will increase by 1,800ton.         |

### (2) Qualitative Effects

Qualitative effects to be expected are as follow.

#### (a) Stable Supplying of Irrigation Water through Preventing of the collapses of the Target Facilities

**Canal Under Pass and Cross Drainage Work:** Collapse of the facilities will make irrigation water supply to the beneficiary areas impossible. As a result, rainy-season crops will be depend solely on rain and unit yield will be reduced from the current 3.42 tons/ha to 2.35 tons/ha and production from 30,900 tons to 21,150 tons. In the dry season, cultivation of wheat equivalent to 4,320 hectares will be impossible due to lack of irrigation water. Therefore, rehabilitation and maintenance of the facilities will enable more efficient farming activities to be sustained.

**Canal Crossing Bridge:** Collapse of the facility will significantly reduce the conveyance efficiency in supplying irrigation water to the beneficiary areas. As a result, the irrigable area for both rainy and dry season will be reduced, and the farming will become more dependent on rain water, resulting in a decrease in yield to values close the case of collapse of the CUPs and CDWs. Therefore, more efficient farming activities can be sustained by rehabilitating and improving the facilities.

#### (b) Ensure Safety and Convenience of Access through Rehabilitation of Bridge as of Rural and Domestic Roads.

**Canal Crossing Bridge:** Collapse of an existing bridge can be a major disaster for smooth traffic movement within the Chandra Nahar irrigation system and neighboring residents. Even if there is few traffic movement, due to the collapse of the bridge, people will be forced to bypass the adjacent bridge, which will increasing the access distance to the collection and shipping area and rice mill by about 1.9km (the average bypass distance of 15 bridges in the case of a bridge collapse). Therefore, the rehabilitation and maintenance of this facility will prevent congestion and accidents from occurring and secure access to the road, which is used not only as an agricultural road but also as a community road.

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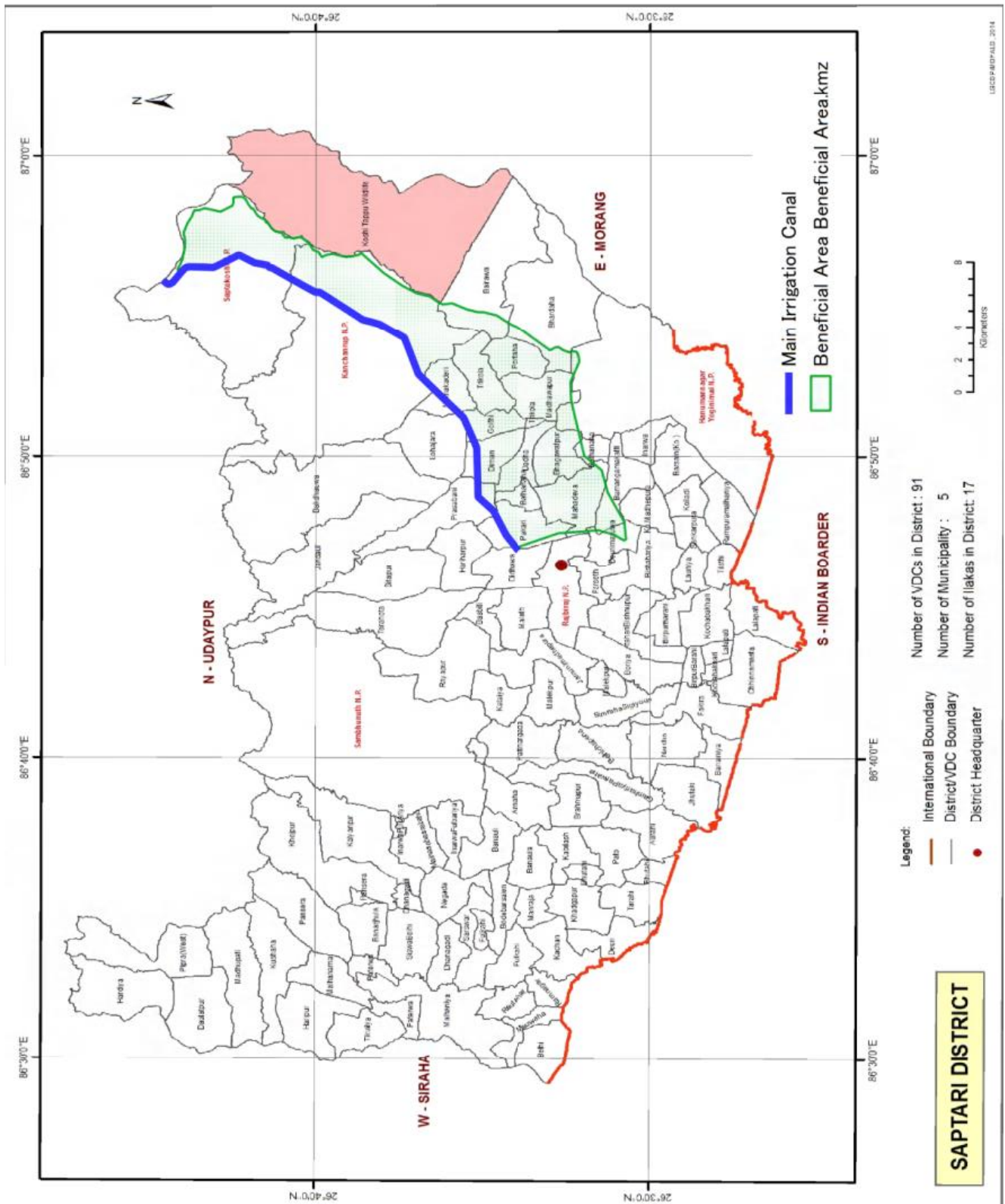
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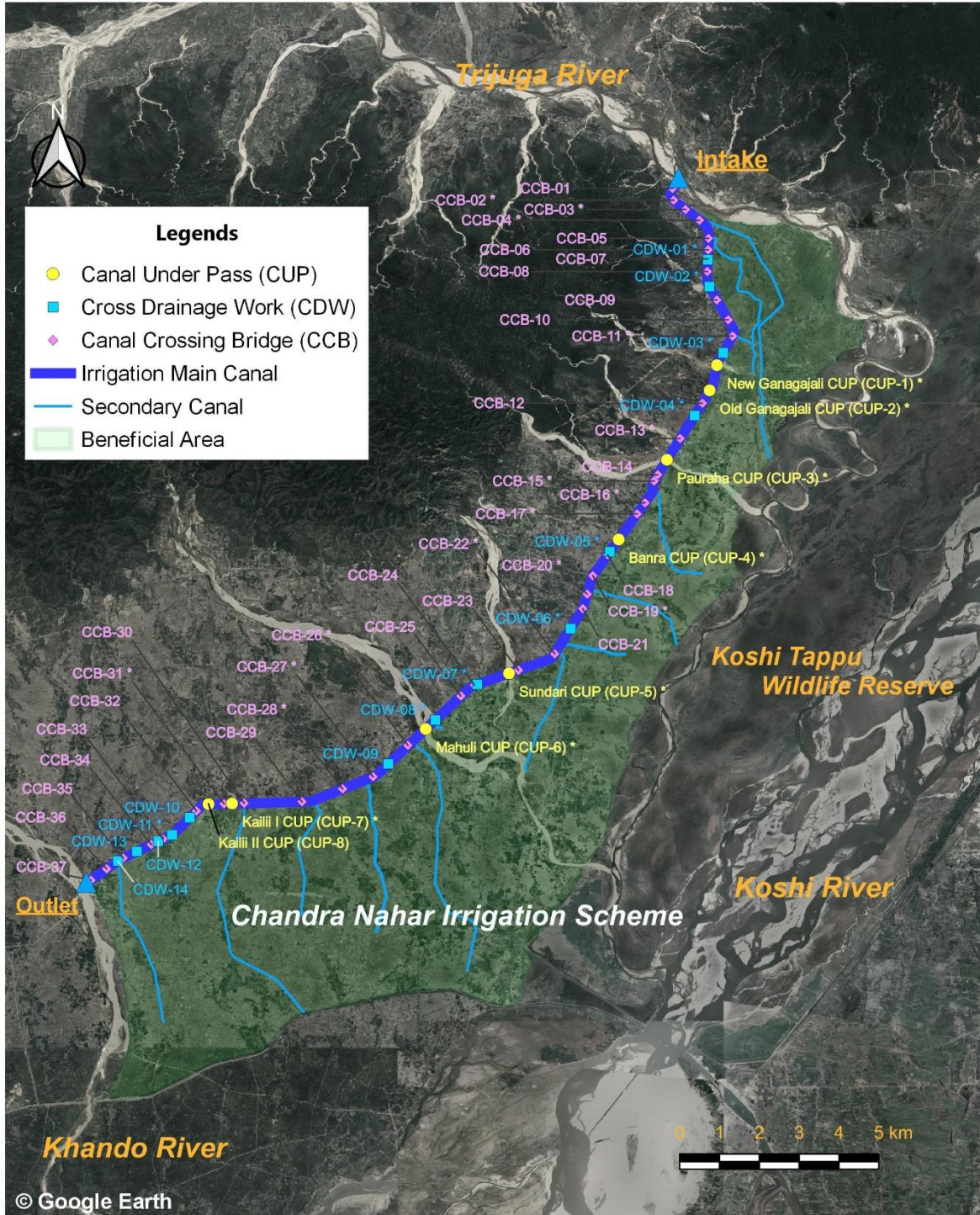
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### Location Map (Regional map)



Source: Ministry of Federal Affairs and General Administration (MoFAGA) Web site  
([http://lgcdp.gov.np/sites/default/files/GIS/15\\_Saptari\\_0.jpg](http://lgcdp.gov.np/sites/default/files/GIS/15_Saptari_0.jpg))

## Location Map (Target Facilities)



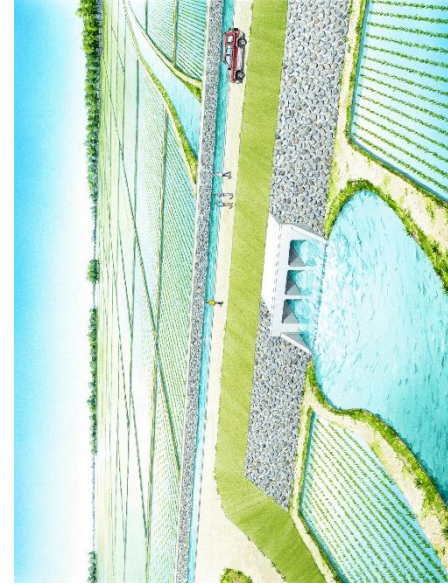
\* Facilities to be Rehabilitated



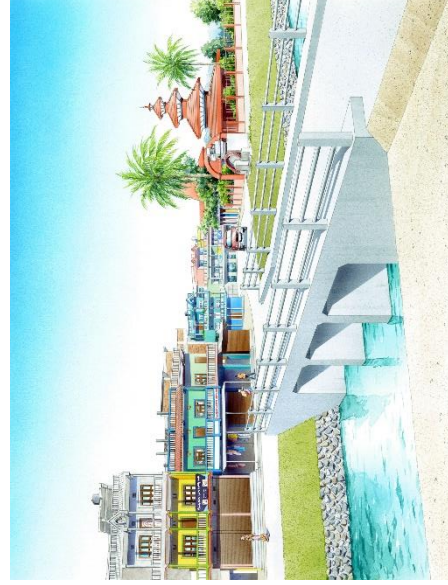
Perspective



Canal Under Pass



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Canal Crossing Bridge

**Perspective**

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...

## Abbreviations

| 略語             | 英語   |
|----------------|--|
| <b>ADB</b>     | Asian Development Bank                                 |
| <b>ADS</b>     | Agriculture Development Strategy                       |
| <b>AKC</b>     | Agriculture Knowledge Center                           |
| <b>CCB</b>     | Canal Crossing Bridge                                  |
| <b>CCIS</b>    | Chandra Canal Irrigation System                        |
| <b>CDW</b>     | Cross Drainage Work                                    |
| <b>CNIS</b>    | Chandra Nahar Irrigation Scheme                        |
| <b>CUP</b>     | Canal Under Pass (Siphon)                              |
| <b>DTW</b>     | Deep Tube Well   |
| <b>DWRI</b>    | Department of Water Resources and Irrigation           |
| <b>ICID</b>    | International Committee for Irrigation and Drainage    |
| <b>ICWM</b>    | Integrated Crop Water Management                       |
| <b>IMD</b>     | Irrigation Management Division                         |
| <b>IMT</b>     | Irrigation Management Transfer                         |
| <b>ISF</b>     | Irrigation Service Fee                                 |
| <b>JICA</b>    | Japan International Cooperation Agency                 |
| <b>KCIMD</b>   | Kosi Pump Chandra Nahar Irrigation Management Division |
| <b>MoEWRI</b>  | Ministry of Energy, Water Resources and Irrigation     |
| <b>NK</b>      | Nippon Koei Co., Ltd.                                  |
| <b>NTCI</b>    | NTC International Co., Ltd.                            |
| <b>O&amp;M</b> | Operation and Maintenance                              |
| <b>PMAMP</b>   | Prime Minister Agriculture Modernization Program       |
| <b>USAID</b>   | US Agency for International Development                |
| <b>WB</b>      | World Bank   |
| <b>WECS</b>    | Water and Energy Commission Secretariat                |
| <b>WUA</b>     | Water Users' Association                               |

## Unit

|                         |                         |
|-------------------------|-------------------------|
| kg                      | kilogram                |
| t, MT                   | Metric tones = 1,000 kg |
| h                       | hour                    |
| mm                      | millimeter              |
| cm                      | meter                   |
| km                      | kilometer               |
| ha                      | hectare                 |
| km <sup>2</sup> , sq.km | square kilometer        |
| m <sup>3</sup>          | cubic meter             |
| NRs                     | Nepal Rupees            |
| LPS, l/s                | litters per second      |
| mm/mon                  | millimeter per month    |
| mm/d                    | millimeter per day      |

## **Chapter 1 Basic Concept of the Project**



## **Chapter 1 Basic Concept of the Project**

### **1-1 Basic Concept of the Project**

#### **1-1-1 Background**

Nepal has a land area of 147,000 km<sup>2</sup>, bordering China to the north and India to the rest. The land consists of 35% mountain area, 42% hill area, and 23% lowland area called Terai plain, which is located east to west along the boundary with India<sup>1</sup>.

The Terai Plains, characterized a fertile soil with water resources and suitable weather conditions for agriculture, contributes substantially to the national domestic production of various cereals and vegetables i.e. 79% of rice, 64% of wheat, 77% of beans and 58% of vegetables (2013/14). Twenty-five large-scale irrigation systems have been constructed (total area of about 330,000 ha), but many of the facilities have deteriorated and got very old resulting in poor irrigation functions, limited irrigation area and low production. Therefore, in order to increase agricultural production in the area, it is required to expand the irrigation area by rehabilitating irrigation facilities.

Rehabilitation works, though insufficient, were carried out by the Ministry of Energy, Water Resources and Irrigation (MoEWRI) for various irrigation systems. The Project for Rehabilitation of Irrigation System in Eastern Terai Area (hereinafter referred to as “the Project”) targets Chandra Canal Irrigation System (hereinafter referred to as “CCIS”) of the Chandra Nahar Irrigation Scheme covering a command area of 10,500 ha that serves approximately 35,000 beneficiary households. It is one of the most important irrigation systems in the large-scale irrigation schemes located in the Terai Plain having serious aging problem because it was constructed in 1927.

A request was duly made to the Government of Japan for assistance in the rehabilitation of irrigation facilities in eastern Terai area by the Government of Nepal which resulted in the formulation of this project by the Japanese Government.

With this background, JICA had conducted a preliminary survey collecting information related to the policy of Nepalese Government and moreover surrounding condition and emergency level of target site for determination of the appropriateness of the Grant Aid Project. Once the project is found to be appropriate, the preliminary survey team will determine the necessary and scope of preparatory survey needed. JICA believes that the increased productivity in the Terai Plain will contribute significantly to the country's food security.

Two irrigation schemes, Chandra Nahar and Khageri, are investigated during the preliminary survey. As the result, Preliminary survey team concluded that Chandra Nahar Irrigation Scheme has serious emergency level and is also bigger than Khageri irrigation scheme from the impact prospective. In Chandra Nahar Irrigation scheme there are 8 Canal Under Pass, approximately 20 Cross Drainage Works and about 50 Canal Crossing Bridges, which are accessories of the scheme that are deteriorated and too old infrastructures. Preliminary survey team had confirmed the necessary to rehabillitee and/or replace them for better use of the scheme. The preliminary team also conclude that there are no major problems if a preparatory survey is conducted directly without going through the steps of feasibility study and basic survey, because it is confirmed that the intervention will bring huge impact to social and economy around the region

Therefore, JICA had conducted a preparatory survey for confirming the Validity and Effectiveness of the project, which is aimed at facility rehabilitation and soft component activity under the target of “Capacity development of operation and maintenance of rehabilitated facilities, to achieve the sustainable function of the facility” based on Grain Aid project at Chandra Nhar Irrigation Scheme as the Irrigation Model to contribute to the improvement of around Terai Plain, and proposing the project

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<sup>1</sup> STASTICAL INFORMATION ON NEPALES AGRICULTURE 2018/2019

to be applied to other schemes.

### 1-1-2 Objective

The Objective of the Project is to improve the agricultural productivity of the scheme in the eastern Terai region by implementing the rehabilitation of the existing facilities in the target area and keeping the system function properly through capacity development on the management and supervision of rehabilitated facilities programmed as the soft component of the project. For this purpose, a consultant team (hereby referred to as “the Survey Team”) has been commissioned by JICA to carry out “The Preparatory Survey on the Project for Rehabilitation of Irrigation System in Eastern Terai Area” (hereby referred to as “the Survey”).

### 1-1-3 Project Outline

A Project outline is shown as below.

**Table 1-1-1 Project Outline**

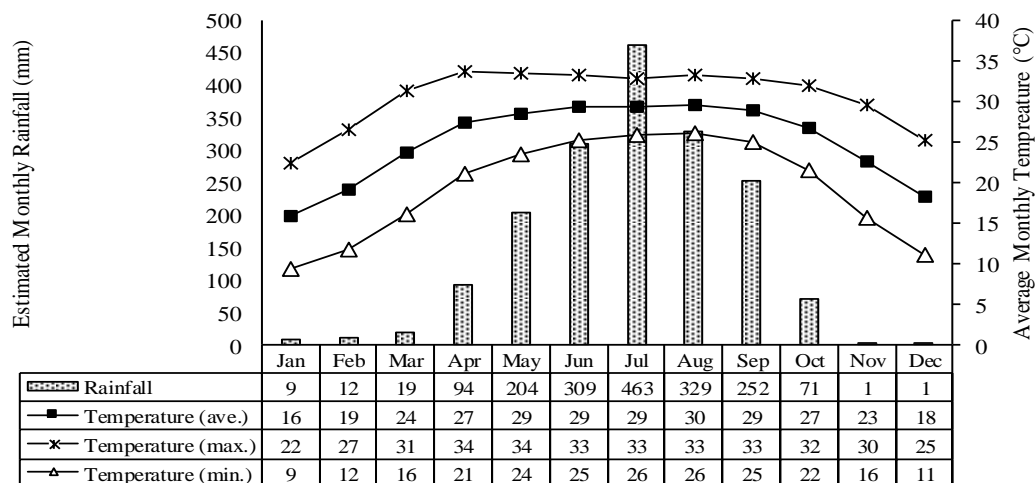
|                       |   |
|-----------------------|---|
| Site                  | Chandra Nahar Irrigation Scheme   |
| Representative Agency | Ministry of Energy, Water Resources and Irrigation (MoEWRI)   |
| Implementing Agency   | Department of Water Resources and Irrigation (DWRI)   |
| Purpose               | To increase agricultural production through the rehabilitation of irrigation facilities situated within the Chandra Canal Irrigation System (CCIS).   |
| Achievement           | 1. Seriously aged facilities such as Siphon (Canal Under Pass), Cross Drainage Works and Canal Crossing Bridges of Chandra Canal Irrigation System will be rehabilitated.<br>2. Irrigation efficiency in the Chandra Nahar Irrigation Scheme will be rehabilitated and improved.  |
| Activities            | 1. Canal Under Pass (Target 8 facility sites / Existing 8 facilities sites)<br>2. Cross Drainage Work (Target 9 facility sites / Existing 14 facilities sites)<br>3. Canal Crossing Bridge (Target 15 facility sites / Existing 37 facilities sites)<br>4. Capacity development on the management & supervision of rehabilitated facilities |
| Beneficiary           | An estimation of 35,000 households living in irrigation area  |

## 1-2 Natural condition

### 1-2-1 Climate

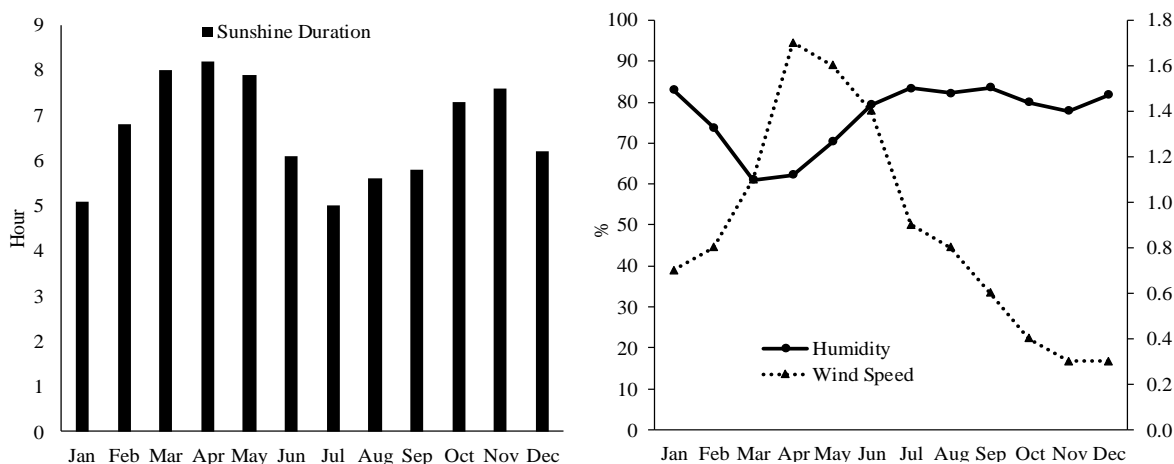
Monthly data (1967~2018) of weather condition around target area is shown below. The data is collected from a weather station at Biratnagar which is located at 40km east side of target area.

Target area has rainy season between April and October and dry season between November and February. The period from July to September gets heavy rain in particular. The monthly temperature of the target area is more than 30 degrees except during the period from November to February which is different situation compared to Kathmandu. Such a temperature situation is the same between June to August when the sunshine duration is small, therefore the dry period shall get high humidity and it will be necessary to take good care of the body condition so that one can avoid heatstroke during construction works.



Source: Biratnagar Weather Station

Figure 1-2-1 Temperature and Rainfall around target area

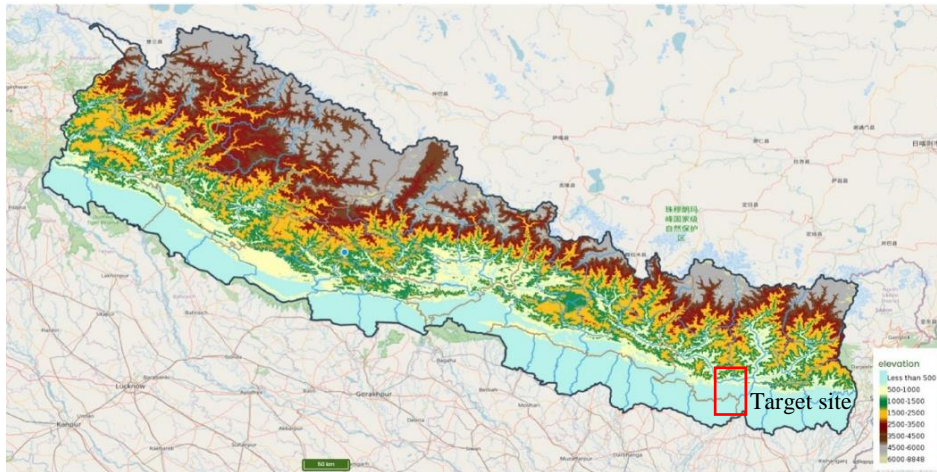


Source: Biratnagar Weather Station

Figure 1-2-2 Sunshine, Humidity and Wind speed around target area

### 1-2-2 Geography

The geographical map of Nepal is shown below. The elevation around Chandra Canal Irrigation System (CCIS) is characterized as lowland at elevation less than 500m. It is the lowest area in Nepal. The area at the north and west of CCIS are characterized as hilly and mountainous. On the other hand, there is lowland at east and south part of CCIS and there is no any characteristic inclination geographically. Trijuga River, the water resource of CCIS, and other rivers and drainage canals that crosses the main canal of CCIS are the tributaries of Koshi-River which is located at east side of Chandra Nahar Irrigation Scheme. Koshi River enters Ganges River at approximately 120km downstream of CCIS. CCIS has been established on delta region that is created from the sediment depositions coming from Himalayas. The irrigation water is distributed easily because of the nature of low areal inclination of the command area.

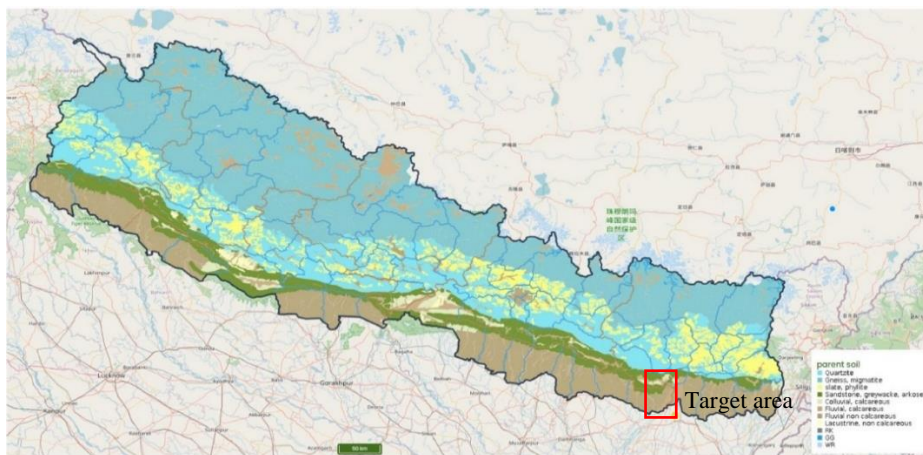


Source: National Soil Science Research Center (NARC) Web site (<https://soil.narc.gov.np/soil/soilmap/>)

**Figure 1-2-3 Geography map of Nepal**

### 1-2-3 Soil Condition

The Soil Map of Nepal is shown below. The Soil condition around CCIS is categorized into Non calcareous. As mentioned above, CCIS has been established on delta region that is created with sediments coming from Himalayas. Therefore, the soils are presumed mainly to be alluvial and relatively new soil created with sediment deposition, due to river flooding.



Source: National Soil Science Research Center (NARC) Web site (<https://soil.narc.gov.np/soil/soilmap/>)

**Figure 1-2-4 Soil Map of Nepal**

### 1-2-4 River

The Main Rivers of CCIS is Trijuga River that is the water source of CCIS. Other rivers in the scheme are the 8 streams where the Canal Under Passes are set and 15 streams where Cross Drainage Works are installed. The end of the main canal (outlet of the main canal) flows into Khando River. There is Koshi River at east side, which has natural reserve. Trijuga River, the water resource of the scheme, has 709km<sup>2</sup> catchment area and is a perennial river that flows throughout the year. The other 23 streams that cross the main canal are considered seasonal river that doesn't have water during dry season.

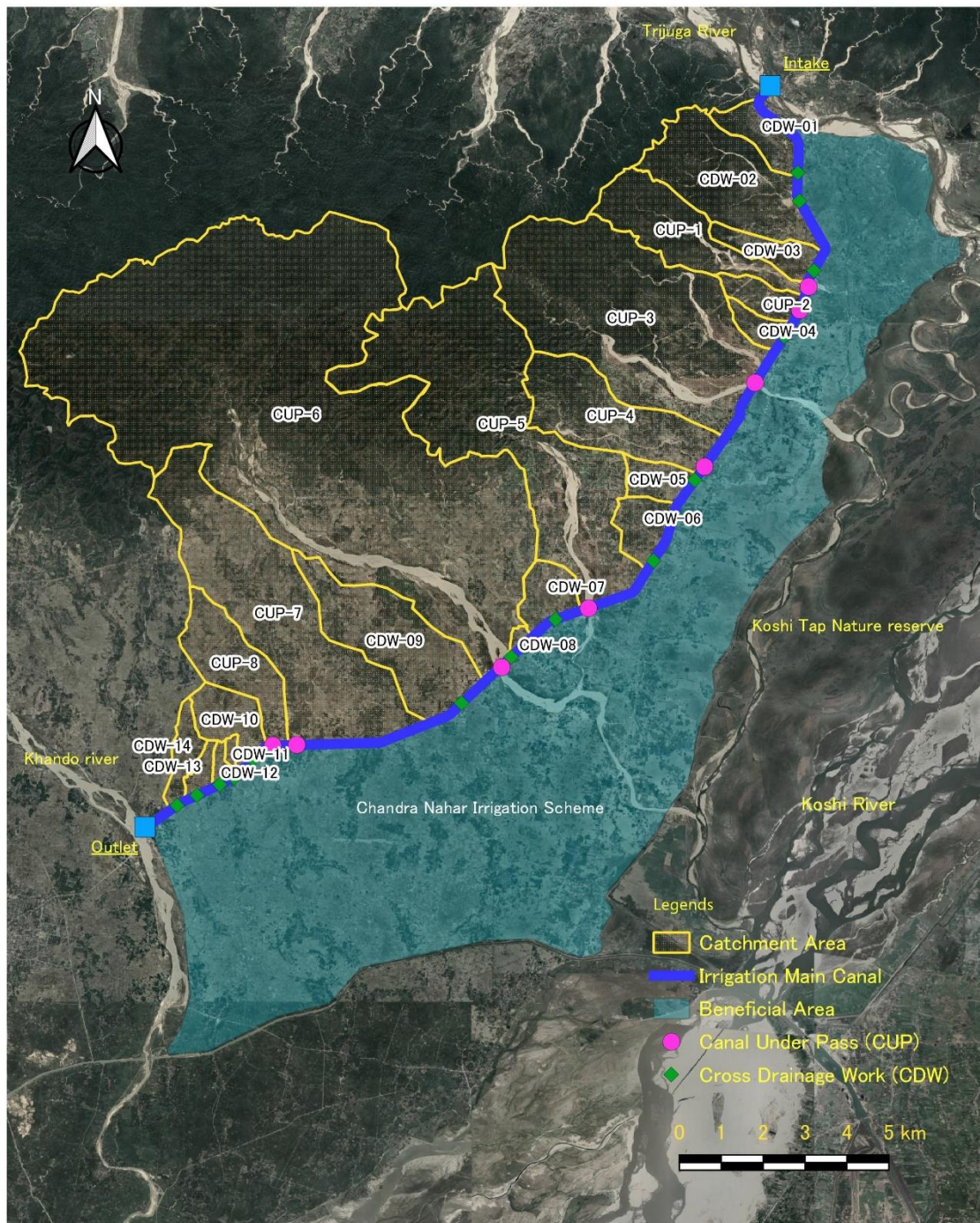


Figure 1-2-5 Catchment area and facilities' location crossing the main canal

### 1-2-5 Survey Result of other Natural Condition

#### (1) Survey Contents

JICA Survey Teams (JST) conducted Topographic survey, Soil condition survey and Geological analysis to clear the detail natural condition to make a rehabilitation plan. Quantities of each surveys are as below.

**Table 1-2-1 Survey Quantities of Natural Condition**

| Survey Item   | Description  | Qty.  | Purpose of the survey   |
|---|--|---|---|
| Topographic survey                                    | (1) Profile and Cross section<br>(a) Main canal Profile<br>(b) Canal Siphon<br>(c) Cross Drainage Work<br>(d) Canal Crossing Bridge<br><br>(2) Checking facility damage, Size measurement and photography for understanding current situation<br>(a) Canal Under Pass<br>(b) Cross Drainage Work<br>(c) Canal Crossing Bridge<br>(d) Check gate<br>(e) Distribution<br><br>(3) Taking an image from three direction, top view, right side and left side by UAV | (a) 31,000m<br>(b) 9,750m<br>(c) 8,775m<br>(d) 21,400m<br><br><br><br><br><br><br><br><br><br><br><br><br><br>87km<br>(29km×3times) | ✓ Prepare a draft drawing<br>✓ Determine the size of target facilities<br>✓ Understand the irrigation water flow situation through preparing the profile of main canal.<br><br>This survey conducted to confirm the detail condition of target facilities closely<br>It will be done remotely due the outbreak of COVID-19.<br><br><br><br><br><br><br><br><br><br><br><br><br><br>This survey conducted to confirm the surrounding condition of target facilities and done remotely due to COVID-19. |
| Soil condition Survey                                 | Bearing Capacity and soil contents<br>(a) Canal Under Pass<br>(b) Cross Drainage Work<br>(c) Canal Crossing Bridge   | (a) 8 sites<br>(b) 14 sites<br>(c) 37 sites   | This survey conducted to confirm the suitability foundation through standard penetration test and particle size analysis. The results shall be used to design the best foundation and construction type for each facility.  |
| High-precision version of topographical data Analysis | Establish database for all irrigation block of the target area<br>(a) Satellite Data<br>(b) Elevation Data (DTM)   | (a) 12,000ha<br>(b) 12,000ha  | This analysis shall be used to establish database of irrigation block of the target site.   |

Sauce: JICA Survey Team

## (2) Topographic Survey

### 1) Profile and Cross section

Profile and cross section survey for each facility was done to understand the actual profile and cross section of the facilities and use for rehabilitation planning and design. This survey shall be conducted on 75.0m sectional width and necessary length of each facilities. The profile and cross section survey of the main canal is conducted at 100m interval to understand irrigation flow situation and analyze the hydrology of the main canal.

Other necessary work for topographic survey was conducted such as establish benchmark, benchmark measurement and setting the GCP point for satellite image analysis.

### 2) Data collection of existing facility

This survey was conducted to confirm the detail condition of target facilities more closely. In this survey, measurement of damaged facilities, extent of damages and operation situation was confirmed. This survey was conducted on Canal Under Passes, Cross Drainage Works and Canal Crossing Bridges which are the target components of the project. In addition, the survey also include investigation on spillways and diversion works which are important facilities of irrigation system. The collected data on spillways and diversion works shall not be used for the rehabilitation plan, but the data will be useful basic data for Nepal government to make a rehabilitation plans for

future.

### 3) Image by UAV (Unmanned Aerial Vehicle)

The outbreak of COVID-19 throughout the world from the beginning 2020 has caused no member of JST travel to the project sites during the beginning of the survey. Therefore, the images of the site by UAV from the sky was taken so that JST understood the surrounding situation around the target facilities without visiting the country.

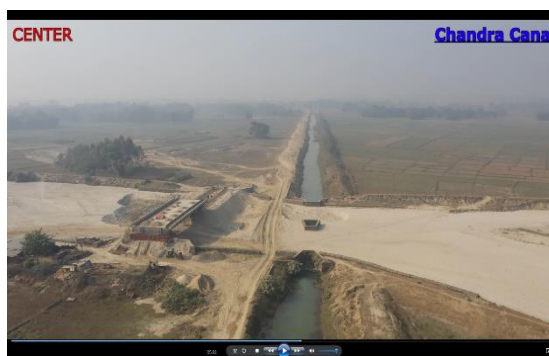


Figure 1-2-6 Image taken by UAV  
(sample)

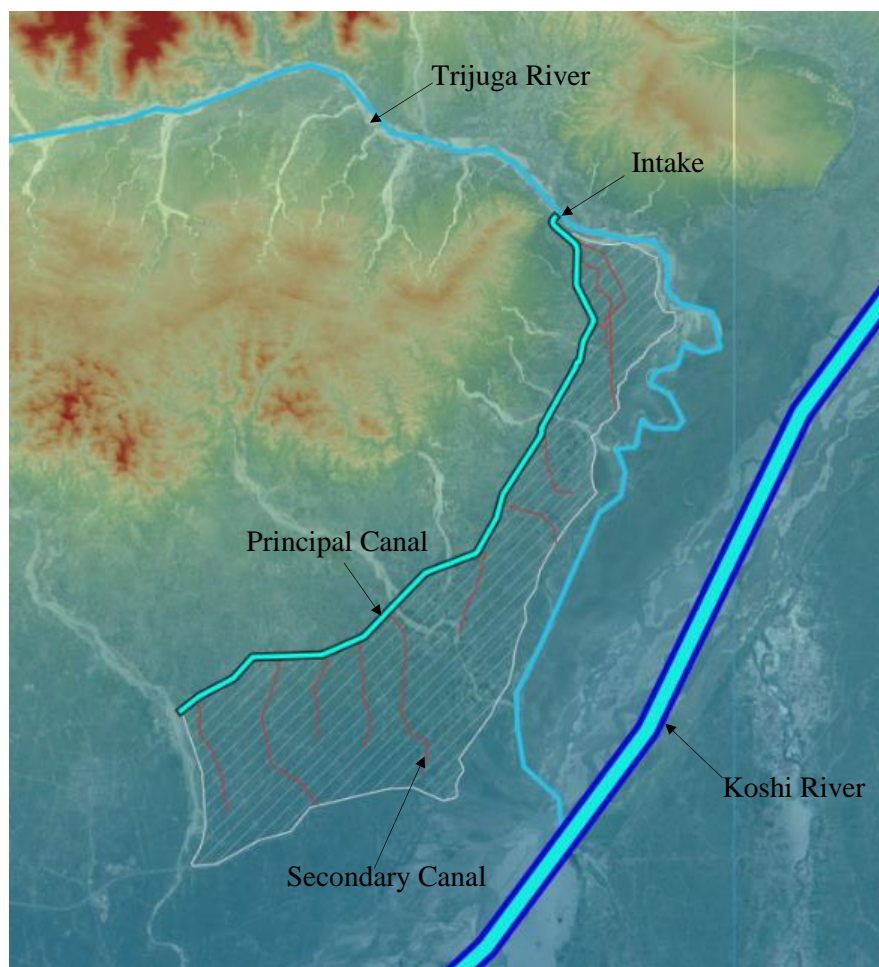
### (3) Soil condition survey

Soil condition survey includes standard penetration test and particle size analysis using core sample taking from the foundation nearby target facilities. This survey was conducted on all target facilities that are the components of the project. The result of this survey is summarized as follows.

- a) Soil layer having more than 50 N value can be found on 10~15m depth from the ground level. It means that more than 10m length of piles should be needed, if piles would be used for the foundation structure. However, spread foundation is found to be better for this site, considering workability. Therefore, box culvert type is recommended for the canal crossing bridges.
- b) Surface layer is mainly consist of clayey silt. It means that all traffic including construction equipment during construction should be given careful consideration from the perspective of trafficability such as cases where clay soil adheres to the vehicle body and tires. On the other hand, the main composition of soil around the intake site is sands and gravels and at the location 20km downstream from B.P. of the main canal the soil is predominantly composed of clayey sand.
- c) At many locations in the survey area, groundwater appeared within 3.0 meters below the ground level. During construction, it is recommended that a combination of shallow sump and pumping be used to prevent groundwater inflow.

### (4) Analysis of Satellite data

Despite the time constraint to conduct this survey approximately 10,000 ha of the target site can be covered by satellite image. The topographical information was analyzed from satellite images. Sample images from the analysis of elevation relationships around CNIS are shown below.



Source: JICA Survey Team

**Figure 1-2-7 Elevation made from Satellite data**

## **1-3 Environmental and Social Considerations**

### **1-3-1 Environmental and Social Considerations**

#### **(1) Overview**

##### **1) Project Component**

The project components that have given to environmental and social consideration are shown in Table 1-1-1.

##### **2) Project area**

The project area is located in Saptari District, Province 2, Nepal, as shown in Figure at the beginning of the report.

##### **3) Scope of Environmental Impact Assessment**

The scope of the environmental impact assessment is the area around the proposed target facilities for rehabilitation CUP and the command area of the irrigation canal.

## (2) Basic information on environmental and social conditions

### 1) Natural (Physical) Environment

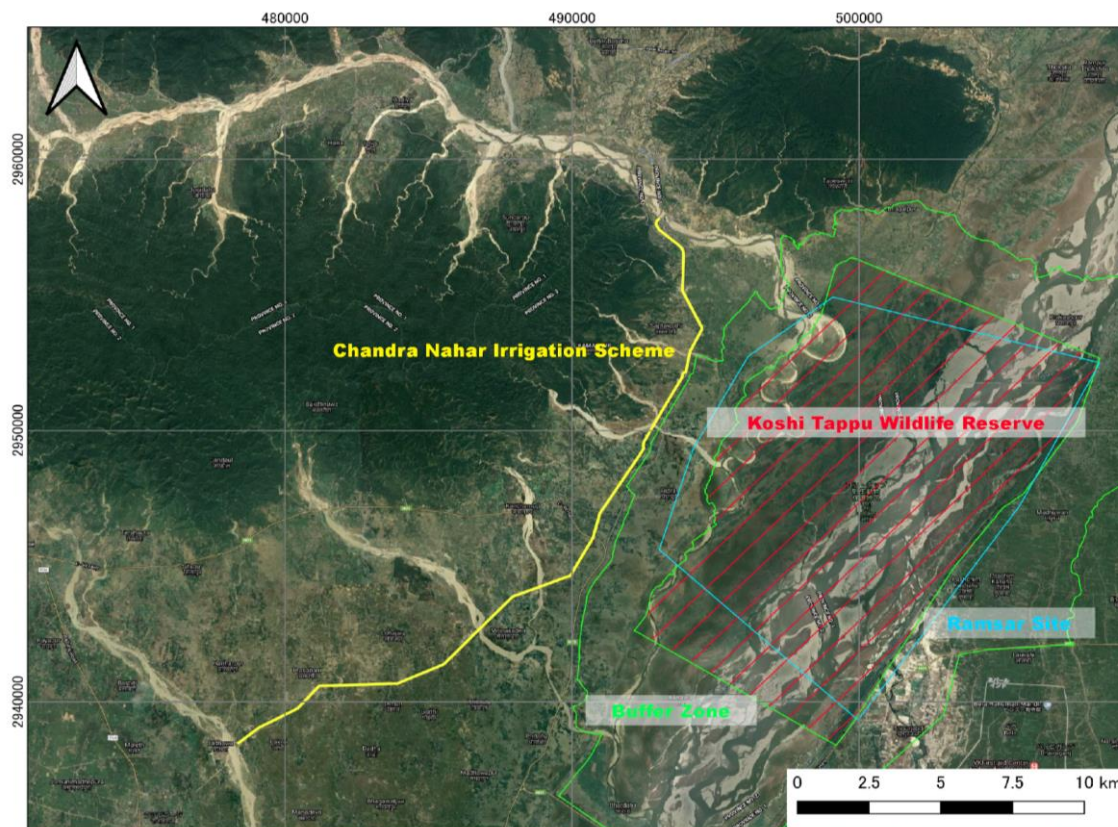
#### (a) Protected Areas

Koshi Tappu Wildlife Reserve Area, Ramsar wetland, and buffer zone are located around the facilities to be rehabilitated. Some part of the western edge of the buffer zone is adjacent to the Chandra Nahar Irrigation Scheme (CNIS), and the other areas are about 3km away horizontally at the nearest point (see the Figure below). A brief description of each protected area is given below.

**Table 1-3-1 Summary of Protected Areas**

| Category                     | Registration | Area (km <sup>2</sup> ) | Summary   |
|------------------------------|--------------|-------------------------|---|
| Koshi Tappu Wildlife Reserve | 1976         | 175                     | Established for the conservation of Buffalos and migratory birds and wise use of wetlands (Buffalos increased from 63 in 1976 to 441 in 2018). Major wildlife species include 40 species of mammals, including Buffalos and Asian Elephants, 200 species of migratory birds, 127 species of fishes, 34 species of reptiles, 11 species of amphibians, 77 species of butterflies, and 514 species of plants. There are 92 employees in the management office. An overview of the management plan for the reserve and its buffer zone is provided later under Section (3) "Environmental and Social Legislative Framework and Organizations". |
| Ramsar site                  | 1987         | 175                     | Registered as the first Ramsar wetland in Nepal, ratified in 2003.  |
| Buffer Zone                  | 2004         | 173                     | 14,865 households and 84,423 population within the buffer zone; a management plan was developed in 2018. The conflict between humans and wildlife is on the rise.   |

Source: Prepared by JICA Survey Team based on KTWR 2018. Koshi Tappu Wildlife Reserve and its Buffer Zone Management Plan (2074/75 - 2078/79), Koshi Tappu Wildlife Reserve Office, Paschim Kushaha, Sunsari, Nepal, and other sources.



Source: Prepared by JICA Survey Team based on World Protected Area Database (IUCN) and other sources.

**Figure 1-3-1 Location of Chandra Nahar Irrigation System and Protected Areas**

**(b) Others**

See Section 1-2 for other natural environments such as meteorology, topography, soil and geology, hydrology, and river flow, etc.

**2) Social Environment**

**(a) Administration divisions and languages**

The following table shows the status of populations and their major languages in the municipalities where the candidate facilities for rehabilitation are located. Although there is no universal definition of Madhesi, the main languages of the municipalities in the project area were analyzed according to the definition of Madhesi as "a collective term for people who live in the Terai plains and speak North Indian languages such as Maithili, Bhojpuri, and Awadhil". Among all the municipalities, the percentage of Madhesi people is lower in Saptakoshi municipality and Agnisair Krishna Savaran in comparison to the other municipalities of Saptari district which is due to the inclusion of migrants from hilly areas, while the other municipalities have a high percentage of residents whose main language is Maithili, which is classified as so-called Madhesi.

**Table 1-3-2 List of concerned local Governments and their main languages**

| Municipality name       | Population (persons) | Major language  | Percentage of Madhesi * (%) | S/N of candidate facilities |                     |                       |
|-------------------------|----------------------|---|-----------------------------|-----------------------------|---------------------|-----------------------|
|                         |                      |   |                             | Canal Under Pass            | Cross Drainage Work | Canal Crossing Bridge |
| Saptakoshi municipality | 21,131               | Maithili (43.7 %),<br>Nepali (25.4%),<br>Tharu (24.7 %) | 43.7                        | 1, 2                        | 1, 2, 3             | 1, 2                  |

| Municipality name                           | Population (persons) | Major language  | Percentage of Madhesi * (%) | S/N of candidate facilities |                     |                               |
|---|----------------------|---|-----------------------------|-----------------------------|---------------------|-------------------------------|
|   |                      |   |                             | Canal Under Pass            | Cross Drainage Work | Canal Crossing Bridge         |
| Kanchanrup municipality                     | 53,288               | Maithili (66.7%),<br>Tharu (13.9%),<br>Nepali (10.9 %),   | 66.9                        | 3, 4, 5                     | 5, 6                | 12, 14, 15, 16,<br>18, 19, 21 |
| Tirahut rural municipality                  | 22,010               | Maithili (97.3 %),<br>Sunuwar (0.7 %),<br>Nepali (0.4 %), | 97.3                        | 6                           | 7, 8, 9             | 24, 25, 26                    |
| Agnisair Krishna Savaran rural municipality | 27,129               | Maithili (45.1 %),<br>Tharu (34.9%),<br>Nepali (8.8 %),   | 45.3                        | 7, 8                        | 11                  | 29                            |
| Mahadewa rural municipality                 | 28,542               | Maithili (96.7 %),<br>Nepali (1.2 %),<br>Urdu (0.5 %)     | 96.7                        | No facilities               | -                   | -                             |
| Saptari district                            | 639,284              | Maithili (79.1 %),<br>Tharu (10.4 %),<br>Nepali (4.1 %),  | 79.2                        |                             |                     |                               |

Source: JICA Survey Team

### (b) Educational standards

The following table presents education status in the target area. The total percentage of primary level and S. L. C. (School Leaving Certificate) level (Class 11 and Class 12 final examinations) accounts for about 90% of the total.

**Table 1-3-3 Educational level in the target areas**

| Education Level  | Population | %      |
|------------------|------------|--------|
| Beginner         | 3,089      | 2.60   |
| Basic Level      | 66,300     | 55.85  |
| School Level     | 39,918     | 33.63  |
| Graduate & above | 5,755      | 4.85   |
| Others           | 3,648      | 3.07   |
| Total            | 118,710    | 100.00 |

Source: CBS, 2011

### (c) Sanitary facilities

About 65% of the households in the target area do not have a toilet, about 22% own a flush toilet and about 11% own a conventional toilet.

**Table 1-3-4 Percentage of households in the -4 target areas that own sanitation facilities**

| Toilet Facility | Household | %      |
|-----------------|-----------|--------|
| Without Toilet  | 28,256    | 65.75  |
| Flush Toilet    | 9,512     | 22.13  |
| Ordinary Toilet | 4,551     | 10.59  |
| Not stated      | 657       | 1.53   |
| Total           | 42,976    | 100.00 |

Source; CBS, 2011

### (d) Access to drinking water

In the target area, the highest percentage of households (93%) owned a well with a hand pump as a source of drinking water, while the use of tap water supply was only about 3%.

**Table 1-3-5 Access to drinking water among households in the target areas**

| Sources of drinking water | Household     | %             |
|---------------------------|---------------|---------------|
| Tap/piped water           | 1,207         | 2.81          |
| Tube well/hand pump       | 40,156        | 93.44         |
| Covered well/kuwa         | 93            | 0.22          |
| Uncovered well/kuwa       | 482           | 1.12          |
| Spout water               | 43            | 0.10          |
| River/stream              | 21            | 0.05          |
| Others                    | 305           | 0.71          |
| Not stated                | 669           | 1.56          |
| <b>Total</b>              | <b>42,976</b> | <b>100.00</b> |

Source: CBS, 2011

**(e) Lighting facilities**

The coverage of electricity is relatively high in the target area which is about 60%, followed by kerosene lamps at 36%. Biogas and solar power have also been identified, albeit to a lesser extent.

**Table 1-3-6 Lighting facilities in households in the target area**

| Lighting energy | Household     | %             |
|-----------------|---------------|---------------|
| Electricity     | 26,068        | 60.66         |
| Kerosene        | 15,689        | 36.51         |
| Biogas          | 120           | 0.28          |
| Solar           | 340           | 0.79          |
| Other           | 72            | 0.17          |
| Not stated      | 687           | 1.60          |
| <b>Total</b>    | <b>42,976</b> | <b>100.00</b> |

Source: CBS, 2011

**(f) Heat source for cooking fuel**

In terms of the percentage of sources of cooking fuel by the households in the target area, the use of wood and charcoal was the highest at 48%, followed by the use of Santhi or Guitha, which is a traditional fuel made of cow dung mixed with straw and dried in the form of disks, at 38%, and LP gas at about 10%.

**Table 1-3-7 Heat sources for cooking in households in the target area**

| Cooking energy | Household     | %             |
|----------------|---------------|---------------|
| Firewood       | 20,638        | 48.02         |
| Kerosene       | 751           | 1.75          |
| LP Gas         | 4,263         | 9.92          |
| Santhi/Guitha  | 16,325        | 37.99         |
| Bio-gas        | 190           | 0.44          |
| Electricity    | 23            | 0.05          |
| Others         | 97            | 0.23          |
| Not stated     | 689           | 1.60          |
| <b>Total</b>   | <b>42,976</b> | <b>100.00</b> |

Source: CBS, 2011

**(g) Communication tools**

The following table presents the major means of communication for households in the target area. The people use mobile phones account for about 50%, and radio or TV (including cable TV) about 40%.

**Table 1-3-8 Communication tool in the target site**

| Means of Communication | Household     | %        |
|------------------------|---------------|----------|
| Radio                  | 16,805        | 39.10    |
| Television             | 14,688        | 34.18    |
| Cable Television       | 3,822         | 8.89     |
| Computer               | 1,284         | 2.99     |
| Internet               | 293           | 0.68     |
| Telephone              | 2,047         | 4.76     |
| Mobile phone           | 22,840        | 53.15    |
| <b>Total</b>           | <b>42,976</b> | <b>-</b> |

Source; CBS, 2011

**(h) Cultural facilities (art galleries, tea rooms, etc.)**

The following table shows the cultural and religious facilities located in the vicinity of the facilities to be renovated are listed below.

**Table 1-3-9 Cultural facilities in the target site**

| S.N | Name                                     | Location  |
|-----|--|---|
| 1   | Hanuman Temple                           | SaptakoshiMunicipality, ward no.4, Balardaha      |
| 2   | Durga Temple                             | SaptakoshiMunicipality, ward no.10, Bhagani       |
| 3   | Shree 108 MaaDurga Bhagwati Temple       | Saptakoshi Municipality, ward no.-1, Fattepur     |
| 4   | Ganesh Temple                            | Kanchanrup Municipality, Saptari                  |
| 5   | Shivalaye Temple                         | Tirahut RM, ward no. 4, Diman                     |
| 6   | Kamala Temple                            | Tirahut RM, ward no. 4,                           |
| 7   | Hanuman Temple                           | Tirahut RM, ward no. 4,                           |
| 8   | Shree Ramjanaki Temple                   | Agmisair Krishna Sabaran RM, ward no. 4, Parswani |
| 9   | Ram Temple                               | Agmisair Krishna Sabaran RM, ward no. 4, Parswani |
| 10  | Devi Temple                              | Agmisair Krishna Sabaran RM, ward no. 4, Parswani |
| 11  | Saangcholing Ghumba (under Construction) | Saptakoshi Municipality, ward no-1, Fattepur      |
| 12  | Bholenath Temple (under construction)    | Saptakoshi Municipality, ward no-1, Fattepur      |
| 13  | Hanuman Temple                           | Saptakoshi Municipality, ward no-1, Fattepur      |
| 14  | Hanuman Temple                           | Saptakoshi Municipality, ward no-10, Bhagini      |
| 15  | Rajaji Temple                            | Saptakoshi Municipality, ward no-10, Kamalpur     |
| 16  | Santoshi Temple                          | Kanchanrup Municipality, ward no.-6, Ghoghanpur   |
| 17  | Hanuman Temple                           | Kanchanrup Municipality, ward no.-6, Baluwachowk  |
| 18  | Sideshwornath Temple                     | Tirahut RM, Ward no. 2, MAInakareri               |



Hanuman Temple



Shiva Temple

**Figure 1-3-2 Examples of cultural facilities in the target area**

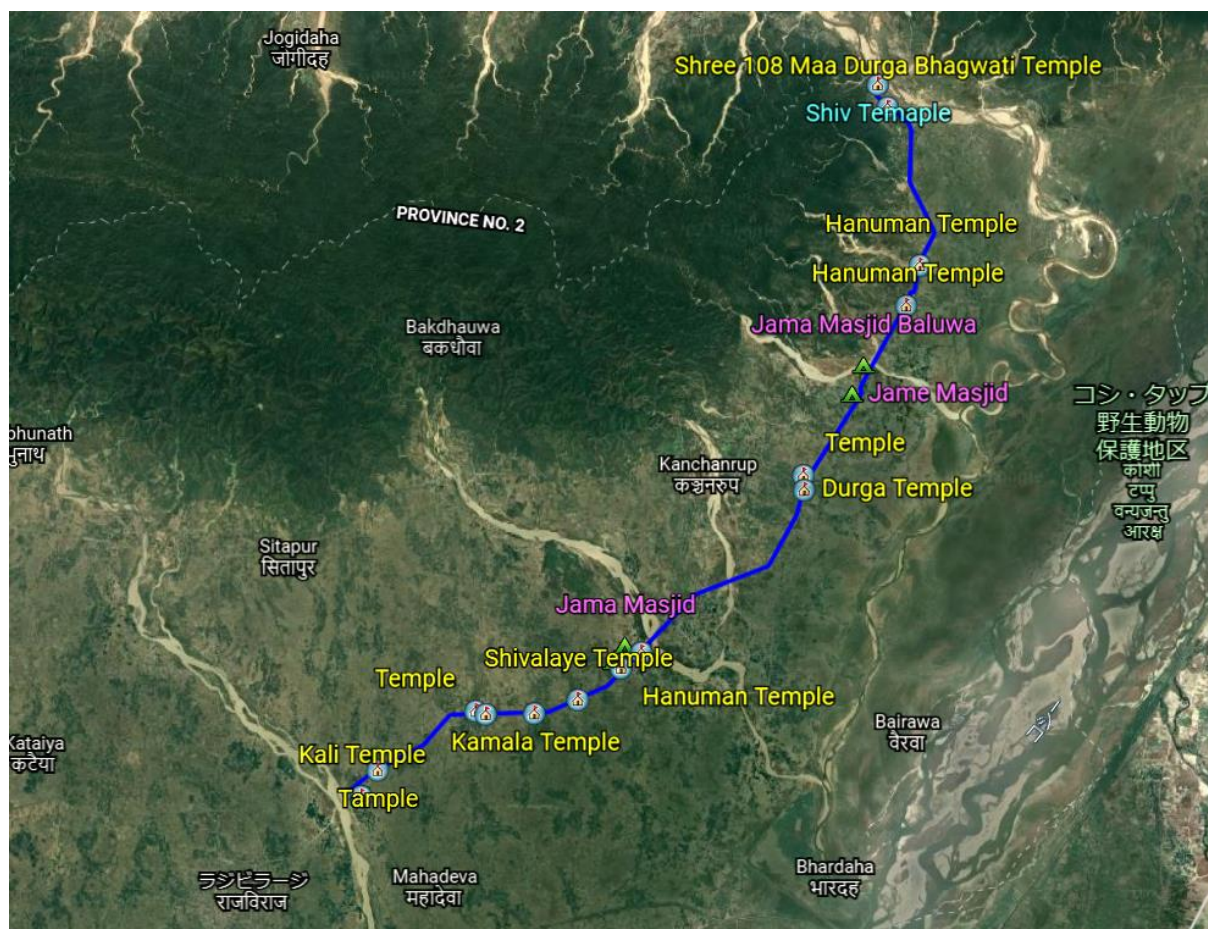


Figure 1-3-3 Location map of the cultural facilities

(i) Others

For other social environments such as farm economy, farming system, flood damage, and water use, see Section 2-2 also.

3) Pollution

Periodic observation data by public organizations on air quality, water quality, noise, etc. in Nepal are limited to the area around Kathmandu, the capital city of Nepal. Therefore, the results of the baseline survey in the IEE<sup>2</sup> by the individual projects that have been implemented in the vicinity of the project site in the past are referred here.

(a) Air quality

The air quality data measured along the roadside in Kanchanpur town is shown in the table below. The measurement period was May 2018, and the measurement time was 8 hours for CO and 24 hours for the others. The measured value of PM<sub>2.5</sub> (46.00 $\mu\text{g}/\text{m}^3$ ) slightly exceeded the national standard value (40.00  $\mu\text{g}/\text{m}^3$ ), but the other values were within the standard value.

<sup>2</sup> Department of Roads, Ministry of Physical Infrastructure and Transport, Government of Nepal for the Asian Development Bank (2018), IEE Report, NEP: SASEC Highway Improvement Project

**Table 1-3-10 Air Quality Data for 10 Target Areas**

| Location               | PM <sub>2.5</sub> | PM <sub>10</sub> | TSP    | SO <sub>x</sub>             | NO <sub>x</sub>                    | CO<br>(8 hrs) |
|------------------------|-------------------|------------------|--------|-----------------------------|------------------------------------|---------------|
| Kanchanpur             | 46.00             | 59.69            | 159.80 | 5.60                        | 0.42                               | ND            |
| NAAQS*                 | 40.00             | 120.00           | 230.00 | ---                         | ---                                | 10,000        |
| WHO** (Reference only) | 75 ~ 25           | 150 ~ 50         | ---    | 20.00<br>(SO <sub>2</sub> ) | 200.00<br>(1 hr, NO <sub>2</sub> ) | ---           |

Unit:  $\mu\text{g}/\text{m}^3$

Note: \* NAAQS: National Ambient Air Quality Standards of Nepal, 2012 \*\* WHO (Ambient Air Quality Guidelines, 2005)

Source: DOR (2018)

### (b) Noise

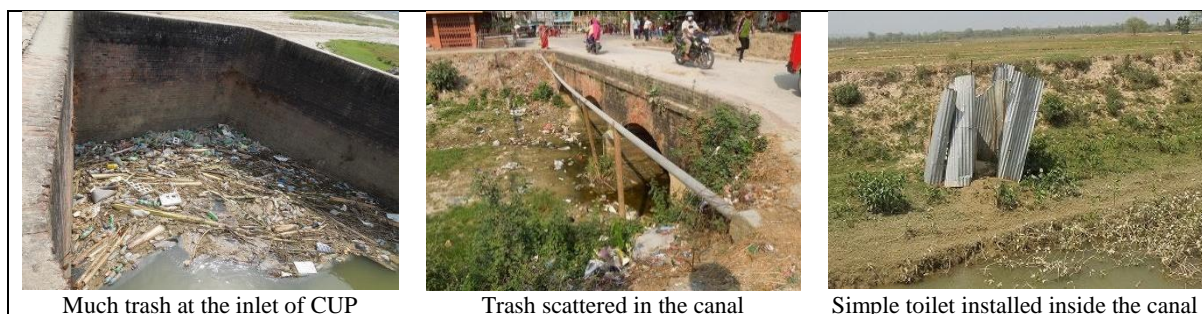
The noise level at the roadside in Kanchanpur town measured at the same time as the air quality mentioned above was  $L_{eq}77.30$  dB (A) at equivalent noise level. The location and time of the measurement were not described clearly, but assuming that the measurement was made in a rural residential area, the noise level significantly exceeded the national standards, 45 dB (A) during the day and 40 dB (A) at night.

### (c) Water pollution

As described in the next section, garbage, manure, and miscellaneous domestic wastewater flow into the irrigation canal, and it is presumed that significant water pollution occurs, but the actual situation is unknown because the measured data could not be confirmed. The details are described in the results of the environmental and social consideration survey.

### (d) Waste

All kinds of combustible and non-combustible garbage were dumped in the irrigation canals. In addition, livestock and human droppings were observed under bridges and culverts, and domestic wastewater flowed directly into the irrigation canals in some areas.



Much trash at the inlet of CUP  
Source: JICA Survey Team

Trash scattered in the canal

Simple toilet installed inside the canal

## (3) Environmental and Social Legislative Framework and Organizations

### 1) Environmental and social policies, laws, and regulations in Nepal

Major laws and policies related to environmental and social considerations in the irrigation development sector in Nepal are shown in the table below.

**Table 1-3-11 Environmental and social laws and policies in irrigation sector in Nepal**

| Category                                     | Document  |
|--|---|
| Constitution                                 | The Constitution of Nepal, 2071 BS (2015 AD)  |
| Policies                                     | The Approach Paper of the 15 <sup>th</sup> Plan (BS 2076/77 – 2080/81)<br>Nepal's National Biodiversity Strategy and Action Plan, (2014-2020)<br>Land Acquisition, Rehabilitation and Resettlement Policy, 2072 BS<br>National Forest Policy, 2075 BS<br>National Environment Policy, 2076 BS<br>National Water Resources Policy, 2077 BS<br>Irrigation Policy, 2070 BS<br>National Climate Change Policy, 2076 BS<br>Range Land Policy, 2069 BS<br>National Agriculture Policy, 2061 BS<br>Koshi Tappu Wildlife Reserve and Its Buffer Zone Management Plan (2074/75-2078/79)  |
| Laws   | Environmental Protection Act, 2076 BS<br>Soil and Water Conservation Act, 2039 BS<br>Land Acquisition Act, 2034 BS<br>Water Resource Act, 2049 BS<br>Ancient Monument Protection Act, 2013 BS<br>Land Reform Act, 2021 BS<br>Labor Act, 2074 BS<br>The Sexual Harassment at Workplace Prevention Act, 2071 BS<br>Solid Waste Management Act 2068 BS<br>Right to Information Act, 2064 BS<br>Local Government Operation Act, 2074 BS<br>Land Use Act, 2076 BS<br>National Foundation for Upliftment of Aadibasi/Janjati Act, 2058 BS<br>Regulate and Control International Trade in Endangered Wild Fauna and Flora, 2073 BS<br>National Parks and Wildlife Conservation Act, 2029 BS (1973) |
| Rules and Regulations                        | Environmental Protection Rules, 2077 BS<br>Forest Rules, 2051 BS<br>Labor Regulations, 2075 BS<br>Water Resource Regulations, 2050 BS<br>Irrigation Rule, 2056 BS<br>Child Labor (prohibition and regulations) Rules, 2062 BS<br>Contributions Based Social Security Regulation, 2075 BS  |
| Guidelines                                   | National EIA Guidelines, 2050 BS  |
| Standards                                    | Irrigation Water Quality Guidelines, 2008 AD<br>Generic Tolerance (part 1) Limits for Industrial Effluent Discharged into inland Surface water, 2001<br>Nepal Vehicle Mass Emission Standard, 2069 BS<br>Nepal Ambient Air Quality Standard, 2069 BS<br>Drinking-Water Quality Standard, 2069 BS<br>Nepal Noise Level Standard, 2069 BS<br>National Indoor Air Quality Standards (NIAQS), 2066 BS   |
| International agreements, and treaties, etc. | Convention on Biological Diversity, 2049 BS<br>Convention (No.169) Concerning Indigenous and Tribal Peoples in Independent Countries, 2046 BS<br>Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 2029 BS<br>United Nation Convention on Combating Climate Change (UNFCCC) 1992 AD<br>United Nations Declaration on the Rights of Indigenous Peoples, 2007 AD<br>Convention on Wetlands of International Importance Especially as Waterfowl Habitat, 1971   |

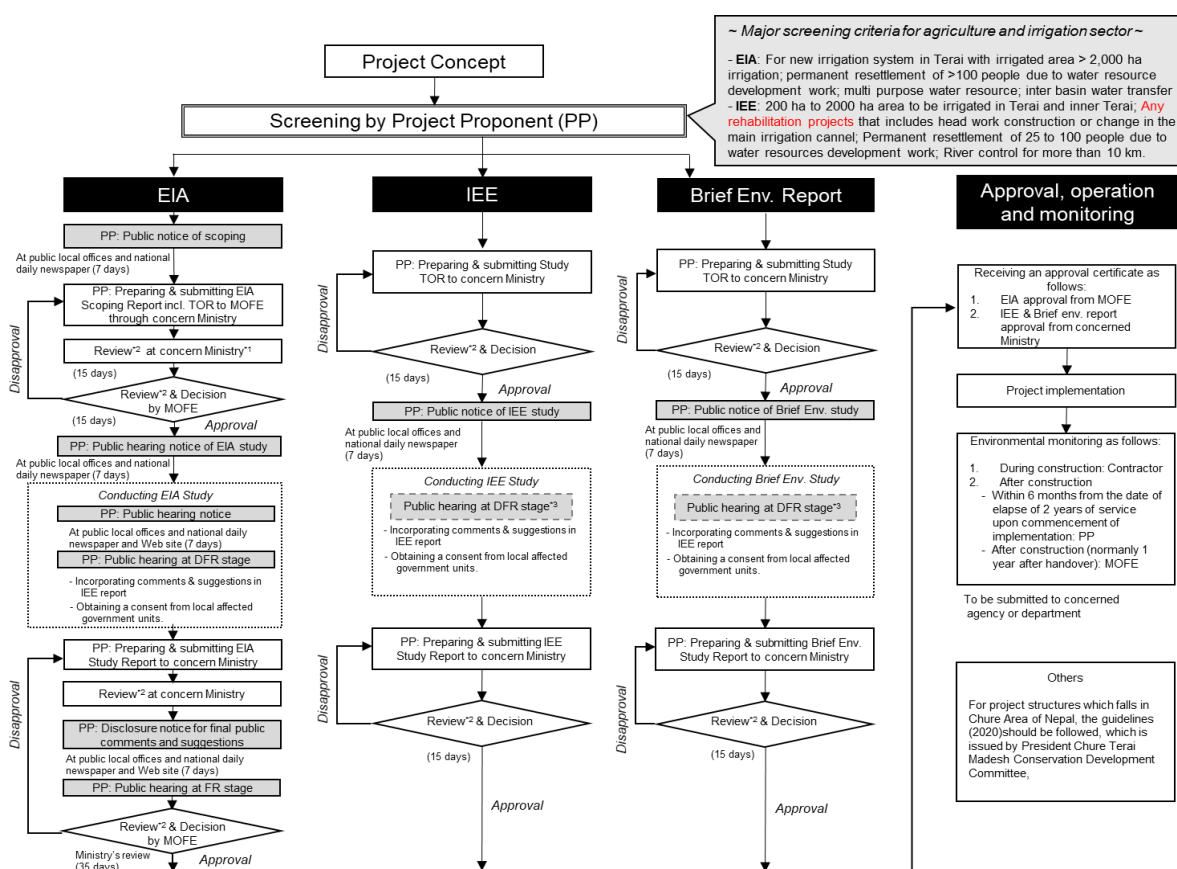
Source: JICA Survey Team

Among the above-mentioned relevant laws and regulations, the Environmental Protection Act (EPA, amended in 2019) and the Environmental Protection Rule (EPR, amended in 2020) are the key legislative framework that stipulates environmental impact assessment in Nepal. Its flowchart

is summarized in the figure below.

In the environmental impact assessment flow in Nepal, first of all, the project proponent decides whether the project falls under the category of EIA, IEE, or Brief Environmental Report according to the screening requirements specified in each field. In the case of IEE, after screening, a TOR review is conducted, and then an impact assessment study is conducted. However, in the case of this preparatory survey, due to the spread of the COVID-19 in the world including Nepal the impact of the prohibitory orders enforced as a countermeasure, the TOR screening for this project should have been completed in 15 working days, but it took about 40 working days.

Based on this workflow, the JICA Survey Team is assisting the implementing agencies to prepare IEE, and the approval is obtained March 2022.



Source: Prepared by JICA Survey Team based on interviews with related organizations and reviewing EPA and EPR

**Figure 1-3-4 Flow chart of environmental impact assessment in Nepal**

The comparative results of JICA Environmental and Social Consideration Guidelines (hereinafter referred to as JICA ESC Guidelines) and environmental laws in Nepal are shown in the table below.

**Table 1-3-12 Gap analysis between JICA ESCs Guidelines and environmental laws in Nepal**

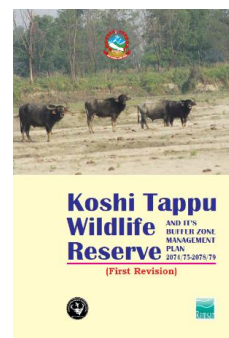
| Category                  | Nepal environmental laws  | JICA ESCs Guidelines  | Comparison Results  |
|---------------------------|---|---|---|
| Definition                | Environmental Impact Assessment" means a detailed study and assessment undertaken to ascertain whether or not a proposed project will have a significant negative impact on the environment and to propose measures to avoid or reduce that impact by any means   | Environmental and social considerations studies include baseline surveys, predicting and evaluating the adverse impacts and likely impacts that projects may have on the environment and on local society, and mitigation measures to avoid and minimize these. (1.3. Definition)   | No significant gaps in between.   |
| Objective                 | The main objectives are to examine the major positive and negative impacts of the project implementation for each alternative, to propose cost-effective, realistic, and appropriate mitigation measures, to develop environmental management and audit plans, and to inform decision-makers and relevant agencies of the environmental impacts.                      | To encourage the recipient governments to take appropriate consideration of environmental and social issues and to ensure that JICA's support for and examination of environmental and social issues are implemented properly. JICA thus promotes sustainable development in developing countries. (1.2. Objectives)  | No significant gaps in between.   |
| Screening Categorization  | Environmental management rules are classified into the following three types based on the characteristics of the business, its scale, and the environmental impact it may have. From top to bottom, the environmental impact is greater.<br>- Environmental Impact Assessment (EIA)<br>- Initial Environmental Examination (IEE)<br>- Brief Environmental Study (BES) | <ul style="list-style-type: none"> <li>• Category A: if likely to have significant adverse impacts</li> <li>• Category B: if its potential adverse impacts are less than those of Category A</li> <li>• Category C: if likely to have a minimal adverse impact, and</li> <li>• Category FI: if likely to have a potential impact, but a spec of the project is unknown unless JICA approves for funding to financial intermediary or executing agency. (2.2. Categorization)</li> </ul>   | Differences can be seen in the classification method and requirements. In this case, IEE survey will be conducted.  |
| Points for concerning     | Differences can be seen in the classification method and requirements. In this case, an IEE survey will be conducted.   | Environmental and social considerations" means taking into account impacts on air, water, and soil, impacts on nature, including ecosystems and biota, involuntary resettlement, respect for indigenous peoples, and other impacts on society. (1.3. Definition)  | Establish items to be noted following JICA guidelines.  |
| Stockholder Consultation  | Stakeholder consultations are required to be carried out at the TOR and research stages.  | Stakeholder consultations at Scoping stage and Draft Final Report stage are recommended, but not limited. (Appendix.2)  | There are no major differences between the two, but the survey team considers holding the meeting in small groups and using the telephone as appropriate to counter COVID-19. |
| Disclosure of information | The implementation of the IEE will be announced by local authorities, schools, health facilities, and local newspapers. Information will be made available to affected persons during public consultation and their views will be collected. The report will be made available on the implementing agency's website.  | JICA encourages project proponents etc. to disclose and present information about environmental and social considerations to local stakeholders. JICA discloses information on its website in Japanese, English, and/or local languages, and provides related reports for public reading at its library and related overseas offices. (2.1. Information Disclosure)   | No significant gaps in between.   |
| Monitoring                | Monitoring during construction and in-service is required; the IEE report should include a monitoring plan (including monitoring methods, locations, implementers, timing, budget, and responsible agencies).   | Over a certain period of time, JICA confirms with project proponents, etc. the results of monitoring the items that have significant environmental impacts. This is done to confirm that project proponents etc. are undertaking environmental and social considerations for projects that fall under Categories A, B, and FI. The information necessary for monitoring confirmation by JICA must be supplied by project proponents etc. by appropriate means, including in writing. When necessary, JICA may also conduct its investigations. (3.2.2. Monitoring and its confirmation by JICA) | No significant gaps in between.   |

Source: JICA Survey Team

### **Executive summary of the Koshi Tappu Wildlife Reserve and its Buffer Zone Management Plan**

#### **Koshi Tappu Wildlife Reserve**

- ✓ Vision: Conservation of biodiversity and ecosystems in Koshi Tappu Wildlife Reserve
- ✓ Objectives: (i) to safeguard and restore the unique and characteristic wildlife species and habitats of the reserve, (ii) to conserve the rare, endangered, endemic, and common wildlife species of the reserve, (iii) to build and strengthen the capacity of the reserve and buffer zone institution, (iv) to conserve wetland for livelihood improvement of local people and enhance their ownership of reserve and buffer zone, (v) to enhance climate resilience of the area with a specific focus on local communities and species of significance, (vi) to develop biological corridor for wildlife movement, and (vii) to develop avitourism as a part of nature-based tourism
- ✓ Major issues: Feral cattle and illegal grazing in the reserves, human-wildlife conflicts, development of conservation plans targeting specific species (Wild Water Buffaloes, Dolphin, Fishing Cat, Bengal Florican, Swamp Francolin, Turtle, and Crocodile)



#### **Management of buffer zone**

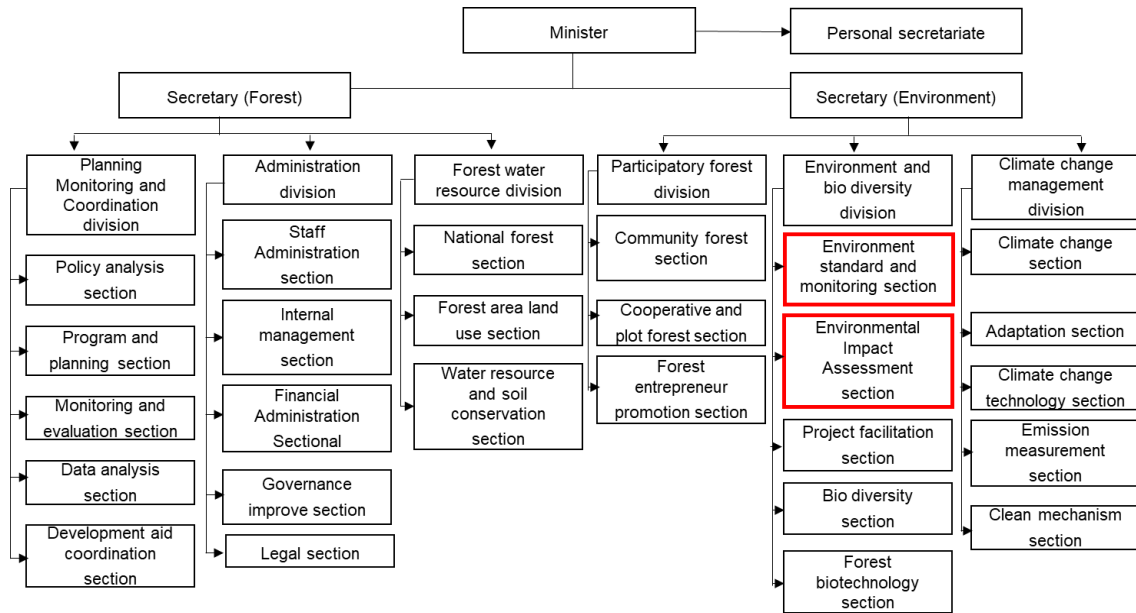
- ✓ Location and purpose: The buffer zone is an area established as a social protection zone around the core area of the protected area. The main objective is to foster local people's ownership for wildlife conservation, and as a basis for ensuring local people's participation in conservation activities, 30~50% of the protected area's income will be allocated for conservation activities and community development in the buffer zone.
- ✓ Management structure: there are nine buffer zone user associations under one buffer zone management committee and a further 469 buffer zone user groups; the population in the buffer zone as at 2017 was 84,423 (14,865 households).
- ✓ Management strategies: (i) zonation, (ii) community development, (iii) biodiversity conservation, (iv) eco-tourism promotion, (v) functional coordination, (vi) capacity building, (vii) conflicts minimization, (viii) income generation and skill development, (ix) conservation education, and (x) regulation of forest products.

Source: Prepared by JICA Survey Team based on KTWR 2018. Koshi Tappu Wildlife Reserve and its Buffer Zone Management Plan (2074/75 - 2078/79)

## **2) Organizations related to environmental and social considerations in Nepal**

### **(a) Ministry of Forest and Environment: MoFE**

The Ministry of Forests and Environment implements forest resource management, wildlife protection, environmental management, pollution control, etc., and formulates relevant laws, regulations, standards, guidelines, etc., and conducts environmental monitoring in Nepal. Since the 2020 amendment of the Environmental Protection Rule (EPR), the Ministry has been designated as the implementing agency for the review and approval of EIAs, and the Environmental Impact Assessment Division (four members in total) is responsible for this role. The Environmental Standards Monitoring Section (4 members in total) is the section in charge of conducting environmental monitoring. The organizational chart is shown below.

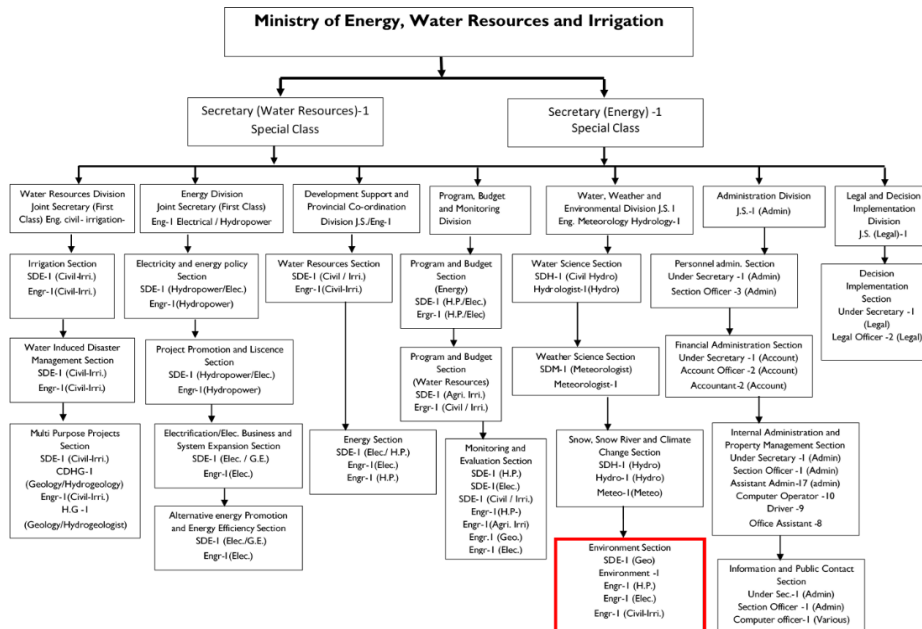


Source: English translation and some additions by the JICA Survey Team based on the organization chart (revised version on April 3, 2018) on the Ministry of Forest and Environment website.

Figure 1-3-5 Organization Chart of Ministry of Forest and Environment

(b) Ministry of Energy, Water Resources and Irrigation: MoEWRI

As for the environmental and social considerations, since the amendment of EPR in 2020, the project implementation agency has been designated as the reviewing and approving agency for IEE and Brief Environmental Report. The organization chart is shown below and the section in charge of the environment is indicated in the red frame.

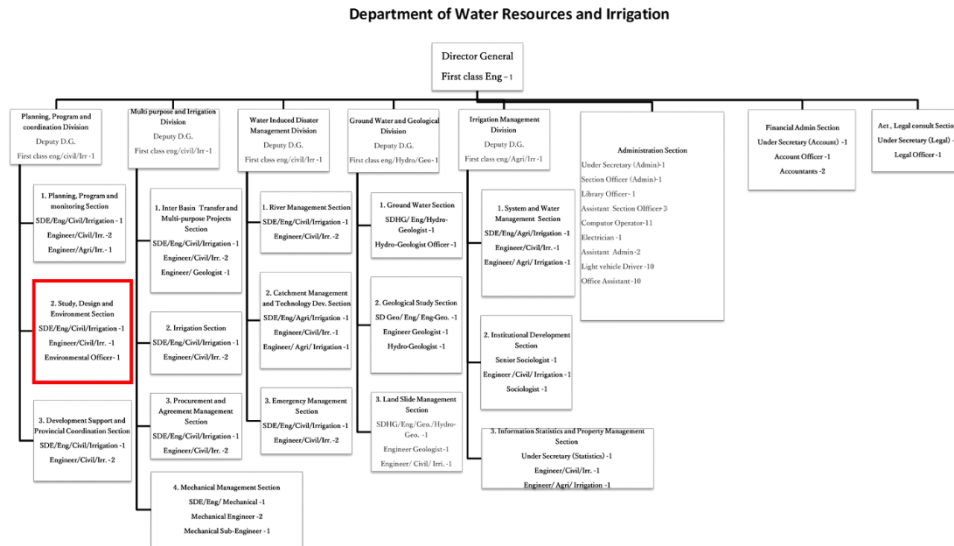


Source: Edited by JICA Survey team based on organogram provided by MoEWRI

Figure 1-3-6 Organization Chart of the Ministry of Energy and Water Resources Irrigation

**(c) Department of Water Resources and Irrigation: DWRI**

As the work implemented by the Ministry of Energy, Water Resources and Irrigation is divided into the energy sector and the water resources and irrigation sector, the Water Resources and Irrigation Department is the responsible agency for irrigation development projects such as this project. As for the work related to environmental and social considerations, the Survey, Design, and Environment Section (3 members in total) in the Planning, Program, and Coordination Department is in charge. The organization chart and the sections in charge are shown below with red frames

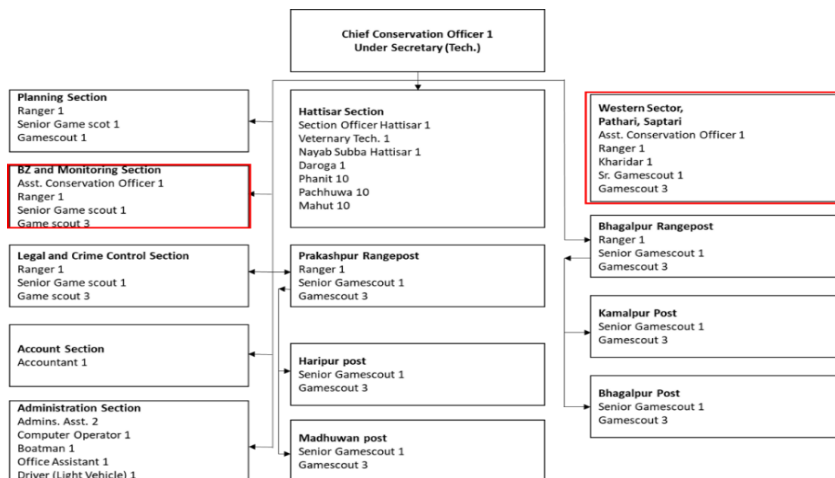


Source: Edited by JICA Survey team based on organogram provided by MoEWRI

**Figure 1-3-7 Organization Chart of Water Resources and Irrigation Department**

**(d) Koshi Tappu Wildlife Reserve Management Office**

The organizational chart of the Koshi Tappu Wildlife Reserve Management Office is shown in the figure below. The Western Division, which includes Saptari District, and the Buffer Zone and Monitoring Division are the relevant departments in studying and monitoring the impacts of the Project.



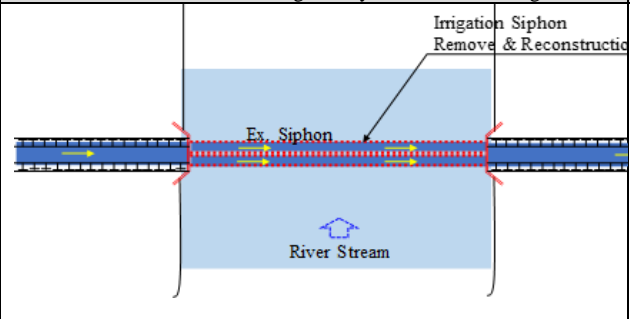
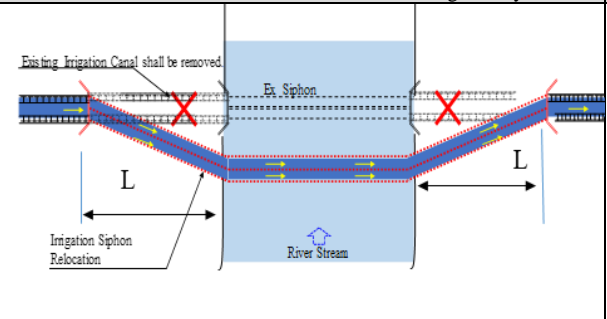
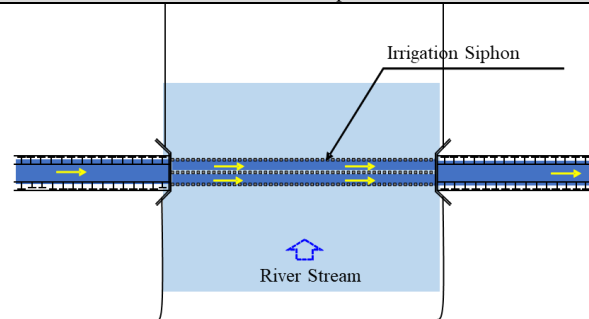
Source: Figure obtained from Koshi Tappu Wildlife Reserve Management Office, with additions by the JICA Survey Team.

**Figure 1-3-8 Organization of Koshi Tappu Wildlife Reserve Management Office**

#### **(4) Alternatives**

The results of the comparative study of the alternatives, including the zero option, are shown in the table below. Basically, Plan 1, which minimizes the impact of land acquisition, is the most recommended, but Plan 2 is recommended only when the existing canal alignment is undesirable from the perspective of hydrology and subsequent maintenance.

**Table 1-3-13 Results of Comparative Study of -13 Alternatives**

| Alternative                 | Alt-1 Remove of existing facility and Reconstructing   | Alt-2 Set a new route on the next of existing facility   | Alt-3 Zero-Option  |
|-----------------------------|--|--|--|
| Plan                        |   |    |   |
| Hydrology                   | The concrete structure is more advantageous than the current condition.  | As in Plan 1, there are structural advantages, but there will be hydraulic head loss due to the extension.   | The brick structure has deteriorated over time and leaks are occurring.  |
| Maintenance                 | Conventional functions can be secured by regular cleaning.   | The labor and cost will be largely due to the long extension. However, if the existing alignment is inappropriate (CUP-02), the risk of sedimentation and workload can be reduced by changing the alignment.   | Although it is possible to achieve the existing functions without immediate renovation, more than 100 years have passed since the construction, so facility renovation, as well as regular maintenance, is required. |
| Workability of construction | There are more processes than Alt-2.   | It is necessary to construct with appropriate separation from the existing CUP.  | No construction.   |
| Natural Environment         | The degree of impact is smaller than Alt-2.  | Trees will be cut down in the detour area (the section indicated by L in the general diagram above).   | No impact on the natural environment will occur.   |
| Social Environment          | No new land acquisition will be required. There will be no impact on downstream farmland as water will continue to flow during the construction period. The project will contribute to stable agricultural production in the region. | Temporary land acquisition will be required during construction. Compensation will be required if there are buildings or farmland on the ground in the detour area. There will be no impact on downstream farmland as water will continue to flow during the construction period. The project will contribute to stable agricultural production in the region. | No land acquisition will occur. Contribution to stable agricultural production in the region will be limited.  |
| Pollution control           | Muddy water, noise, and vibration are expected to be generated during construction.  | Same as Alt-1.   | Same as the current status.  |
| Cost                        | More advantageous than Alt-2   | About three times more expensive than Alt-1.   | No construction cost.  |
| Consideration               | Recommended.   | Not recommended unless there is a particular problem with the current Canal alignment.   | Not recommended.   |

## (5) Scoping

To narrow down the scope of the field survey, scoping was carried out. In the selection of the impact items, the environmental and social impacts before, during and after the construction works were examined by referring to the environmental checklist "16. Agriculture, Irrigation and Livestock" in the JICA ESC Guidelines and available documents, and the items with potential impacts were marked with "✓". The results of the study are shown in the table below.

**Table 1-3-14 Scoping Result**

| Impact Item                    | Selection Status*1   |    | Description and Reason of Rating |   |
|--------------------------------|--|----|----------------------------------|---|
|                                | P-Co/Co  | Op |                                  |   |
| <b>I. Pollution</b>            |  |    |                                  |   |
| 1                              | Air Pollution  | ✓  |                                  | <u>Construction Stage</u> : Temporary impact of dust and exhaust gas emitted from construction and construction vehicles is expected<br><u>Operation Stage</u> : No activities are anticipated that would result in air pollution.  |
| 2                              | Water Pollution  | ✓  |                                  | <u>Construction Stage</u> : There is concern about the impact on water quality due to the discharge of turbid water.<br><u>Operation Stage</u> : No activities are anticipated that would result in water pollution.  |
| 3                              | Solid Wastes   | ✓  | ✓                                | <u>Construction Stage</u> : It is assumed that waste materials and non-reusable excavated soil will be generated due to the removal and relocation of the existing structures.<br><u>Operation Stage</u> : No waste is expected to be generated, but littering of waste into the canal is expected.   |
| 4                              | Soil Contamination   | ✓  |                                  | <u>Construction Stage</u> : There are concerns about the effects of soil contamination caused by oil leaks, etc., during the maintenance of construction vehicles.<br><u>Operation Stage</u> : No activities are anticipated that would result in soil contamination.   |
| 5                              | Noise and Vibration  | ✓  |                                  | <u>Construction Stage</u> : Noise and vibration associated with construction machinery and work will be temporarily generated. However, no noisy operations such as blasting or pile driving are expected.<br><u>Operation Stage</u> : No work involving noise or vibration is expected.  |
| 6                              | Ground Subsidence  |    |                                  | It is not expected that the work will involve pumping up large volumes of groundwater.  |
| 7                              | Offensive Odor   |    |                                  | It is not anticipated that the work will create an offensive odor.  |
| 8                              | Bottom Sediment  |    |                                  | No impact on bottom sediment is anticipated.  |
| <b>II. Nature Environment</b>  |  |    |                                  |   |
| 9                              | Protection Area  | ✓  | ✓                                | The extent of the impact is unknown and will be confirmed by a field survey.  |
| 10                             | Ecosystem  | ✓  | ✓                                | Ditto   |
| 11                             | Hydrological Situation   |    |                                  | <u>Pre-Construction Stage</u> : No impact is anticipated because the construction is based on the assumption that the irrigation Canal will be constructed with water flowing downstream through a temporary turnaround Canal.<br><u>Operation Stage</u> : No work involving noise or vibration is expected.  |
| 12                             | Topography and Geographical Features                           |    |                                  | No work that would significantly alter the topography or geology is anticipated.  |
| <b>III. Social Environment</b> |  |    |                                  |   |
| 13                             | Involuntary Resettlement                                       | ✓  |                                  | No work is anticipated that would involve resettlement, but this will be confirmed on-site.   |
| 14                             | Land Acquisition   | ✓  |                                  | <u>Pre-Construction Stage</u> : If a line change is advantageous, it is assumed that land will be acquired during construction, but details will be confirmed during the site survey.<br><u>Operation Stage</u> : No land acquisition will occur  |
| 15                             | Vulnerable social groups, such as indigenous and ethnic people | ✓  | ✓                                | The presence of socially vulnerable groups will be confirmed during the field survey.   |
| 16                             | A local economy such as employment and livelihood, etc         | ✓  | ✓                                | <u>Construction Stage</u> : Employment opportunities for local farmers as workers are expected to be created. In addition, the use of goods and services by workers, drivers, and other construction workers is expected to stimulate the economy around the site. On the other hand, if the relocation occurs before construction, negative impacts on livelihoods are expected. |

| Impact Item | Selection Status*1                                 |    | Description and Reason of Rating  |   |
|-------------|--|----|---|---|
|             | P-Co/Co  | Op |   |   |
|             |  |    | <u>Operation Stage</u> : With the development of irrigation facilities, a stable supply of irrigation water will be provided and a positive impact on the local economy is envisaged. |   |
| 17          | Land use and utilization of local resources        | ✓  | ✓   | <u>Construction Stage</u> : Minor site acquisition during construction is anticipated.<br><u>Operation Stage</u> : Rehabilitation of irrigation and drainage facilities will allow for more efficient use of water resources.   |
| 18          | Water Use  | ✓  |   | <u>Construction Stage</u> : Wells used by local residents could be impeded.<br><u>Operation Stage</u> : No impacts are anticipated.   |
| 19          | Existing social infrastructures and services       | ✓  | ✓   | <u>Before/under construction</u> : It will be necessary to relocate utility poles, wires, and internet cables. In addition, pedestrian and vehicular circulation routes will need to be secured.<br><u>Operation Stage</u> : The construction of the canal crossing bridge will improve transportation accessibility.             |
| 20          | Local organization                                 |    |   | No work is envisaged that would reorganize existing decision-making bodies or other social organizations.   |
| 21          | Misdistribution of benefit and damage              |    |   | No uneven distribution of damages and benefits is assumed because the project is an improvement of existing social infrastructure.  |
| 22          | Local Conflict of Interest                         |    |   | Ditto   |
| 23          | Cultural Heritage                                  |    |   | There are no facilities registered as cultural heritage on the project site.  |
| 24          | Landscape  |    |   | The scenic area is not included in the project site.  |
| 25          | Gender   |    |   | No negative impacts on gender are envisaged.  |
| 26          | Children's Right                                   | ✓  |   | <u>Construction Stage</u> : Since there are concerns about the risk of child labour and disruption of school children's access to school, the availability of school routes and ILO and national regulations should be checked.   |
| 27          | Hazards(Risk) Infectious diseases such as HIV/AIDS | ✓  |   | <u>Construction Stage</u> : There is concern about the spread of the new coronavirus in spaces where people gather, such as camps.<br><u>Operation Stage</u> : It is not expected.  |
| 28          | Working Conditions, Occupational Safety            | ✓  |   | <u>Construction Stage</u> : There is a concern that an appropriate working environment may not be provided for workers at sites where noise and dust are generated.<br><u>Operation Stage</u> : It does not envisage any activity that would employ workers.  |
| IV. Others  |  |    |   |   |
| 29          | Accidents  | ✓  | ✓   | <u>Construction Stage</u> : With the operation of construction vehicles and construction equipment, there is concern that traffic accidents will occur.<br><u>Operation Stage</u> : There is a concern about the occurrence of water hazards in the irrigation canals.  |
| 30          | Climate Change                                     | ✓  | ✓   | <u>Construction Stage</u> : Greenhouse gases will be emitted as a result of the operation of construction vehicles, but the extent of the impact will be minor.<br><u>Operation Stage</u> : It is expected to improve resilience to climate change by enabling the more stable use of water resources than is currently possible. |

\*1 P-Co: Pre-Construction Stage, Co: Construction Stage, Op: Operation Stage  
Source: JICA Survey Team

## (6) TOR for Environmental and Social Considerations Survey

The following is a summary of the survey content and methods currently envisaged for the items judged to have an impact in the above scoping as TORs for the environmental and social considerations survey.

**Table 1-3-15 TOR for Environmental and Social Consideration Survey**

| Evaluation item    | Survey item  | Survey methodology  |
|--------------------|--|---|
| 1. Air Pollution   | (1) Regulations and/or acts of ambient air quality<br>(2) Impact during the construction | (1) To do a literature survey<br>(2) To confirm: type, method, and period of construction, the distance between the construction site and residential area and public facilities like school and hospital |
| 2. Water Pollution | (1) Regulations or act on water quality /effluent water                                  | (1) To do a literature survey<br>(2) To confirm: type, method, and period of construction, the distance between the construction site and residential area  |

| Evaluation item  | Survey item   | Survey methodology  |
|--|---|---|
|  | (2) Impact during construction<br>(3) Current water use condition   | and public facilities like school and hospital<br>(3) Hearing to water users  |
| 3. Solid Wastes  | (1) Act or regulations about disposal management<br>(2) Impact during construction<br>(3) Measures against littering  | (1) To do a literature survey<br>(2) To confirm the type, method, and material of construction.<br>(3) To conduct field observation and interview   |
| 4. Soil Contamination  | (1) Act or regulations about disposal management<br>(2) Impact during construction  | (1) To do a literature survey<br>(2) To confirm the type, method, and material of construction.<br>(3) To do soil chemical characteristic test and confirm contents of heavy metal in soil.   |
| 5. Noise and Vibration   | (1) Act or regulations of noise and vibrations<br>(2) Impact during construction  | (1) To do a literature survey<br>(2) To confirm: type, method, and period of construction, the distance between the construction site and residential area and public facilities like school and hospital   |
| 9. Protected Area  | (1) Impacts on protected areas  | (1) To do literature review and interview   |
| 10. Ecosystem  | (1) Existence of endangered/threatened species<br>(2) Impact during construction<br>(3) Impact in the operation stage   | (1) To do literature survey, ecological survey, interviews<br>(2) To confirm the content, scale, construction method, location, duration, etc. of the construction work, and field observation<br>(3) To confirm impacts of changing alignment, confirm transplanting/planting plan |
| 13. Resettlement   | (1) Impact of relocation<br>(2) Confirmation of compensation policy   | (1) To do literature survey, ecosystem survey, and interviews, and the content, location, and duration of construction<br>(2) To confirm of laws to be complied with and cases in similar cases   |
| 14. Land Acquisition   | (1) Regulations and acts regarding land acquisition and resettlement<br>(2) The necessity of land acquisition and resettlement in this project<br>(3) Compensation method | (1) To do a literature review<br>(2) To confirm: type, method, and period of construction, field visit, landowners, and users in the site<br>(3) To confirm good practices of compensation methods in a similar project, and interview  |
| 15. Vulnerable groups  | (1) Presence of vulnerable social groups<br>(2) Mode of compensation and/or assistance  | (1) To do a literature review, and interview<br>(2) Good practices of compensation methods in a similar project, and interview  |
| 16. Local economy, employment                                    | (1) Impact during construction<br>(2) Impact in the operation stage   | (1) To do a literature review<br>(2) To confirm project impact  |
| 17. Land use and utilization of local resources                  | (1) Impact during construction  | (1) Same as 14. Land acquisition.   |
| 18. Water use  | (1) Impact during construction  | (1) The current condition of water use in the area is likely to be affected, interviewing, and examining relocation or construction of alternative facilities   |
| 26. Children's Right   | (1) Identification of child labor   | (1) Confirmation of the employable age under the Labor Law and the ILO, etc., examples of countermeasures in other similar cases, and confirmation of schools in the vicinity of the facilities to be collected   |
| 27. Hazards(Risk), Infectious diseases such as HIV/AIDS, Malaria | (1) Impact of COVID-19  | (1) Confirmation of measures to prevent the spread of the COVID-19, examples of measures taken in other similar cases, and interview  |
| 28. Working Conditions, Occupation Safety                        | (1) Regulations and acts regarding occupational health and safety<br>(2) Impact on the construction workers during construction   | (1) To do a literature review<br>(2) To confirm: type, method, and period of construction, good practices done by other similar projects  |
| 29. Accident   | (1) Measures against drowning accident  | (1) Confirmation of black spot by interview, good practices about safety measures by other similar projects   |
| 30. Crossing the   | (1) Impact due to climate   | (1) To confirm project impact, plan for replanting affected   |

| Evaluation item       | Survey item | Survey methodology                  |
|-----------------------|-------------|-------------------------------------|
| border/Climate Change | change      | trees, and legal requirements, etc. |

Source: JICA Survey Team

## (7) Results of environmental and social consideration surveys (including forecast results)

### 1) Air quality

The analysis of air quality data measured 24 hours a day in July 2021 in the irrigation canal ROW as shown in the table below, and compared to the standard values, all items were found to be within the standard values.

**Table 1-3-16 Air Quality Data Measurement Results**

| Location                | PM <sub>2.5</sub> | PM <sub>10</sub> | TSP    | SO <sub>x</sub>             | NO <sub>x</sub>                   | CO (8 hrs) |
|-------------------------|-------------------|------------------|--------|-----------------------------|-----------------------------------|------------|
| ROW of Irrigation canal | 15.01             | 36.68            | 51.69  | < 1                         | 4.66                              | 187        |
| NAAQS*                  | 40.00             | 120.00           | 230.00 | ---                         | ---                               | 10,000     |
| WHO** (Reference only)  | 75 ~ 25           | 150 ~ 50         | ---    | 20.00<br>(SO <sub>2</sub> ) | 200.00<br>(1hr, NO <sub>2</sub> ) | ---        |

Unit: µg/m<sup>3</sup>

Note: \* NAAQS: National Ambient Air Quality Standards of Nepal, 2012 \*\* WHO (Ambient Air Quality Guidelines, 2005)

Source: based on DoR (2018), with some additions by the research team

As for the impact during the construction, the main types of works that generate dust are earth excavation and demolition of existing structures. Since there is no recorded wind direction data at the project site, interviews were conducted with local residents and it was confirmed that the dominant wind directions are westerly and northwesterly. In addition, as a result of interviewing the neighboring residents of the Postal Highway Project, which is a road improvement project being implemented by the Government of Nepal adjacent to the project site, no complaints were found regarding the pollution including dust caused by the road construction. The facilities that require special consideration are the Birth Centre under construction in the vicinity of CUP-02, and the residential facilities near the CDW and CCB construction sites. Due to the proximity between the facilities subject to impact assessment and the construction area and the diminished diffusion effect, there is concern that dust from the operation of construction machinery may cause discomfort; however, it is considered possible to effectively control dust by installing temporary enclosures and spraying water at the source<sup>3</sup>.



Birth center under construction adjacent to targeted CUP-02

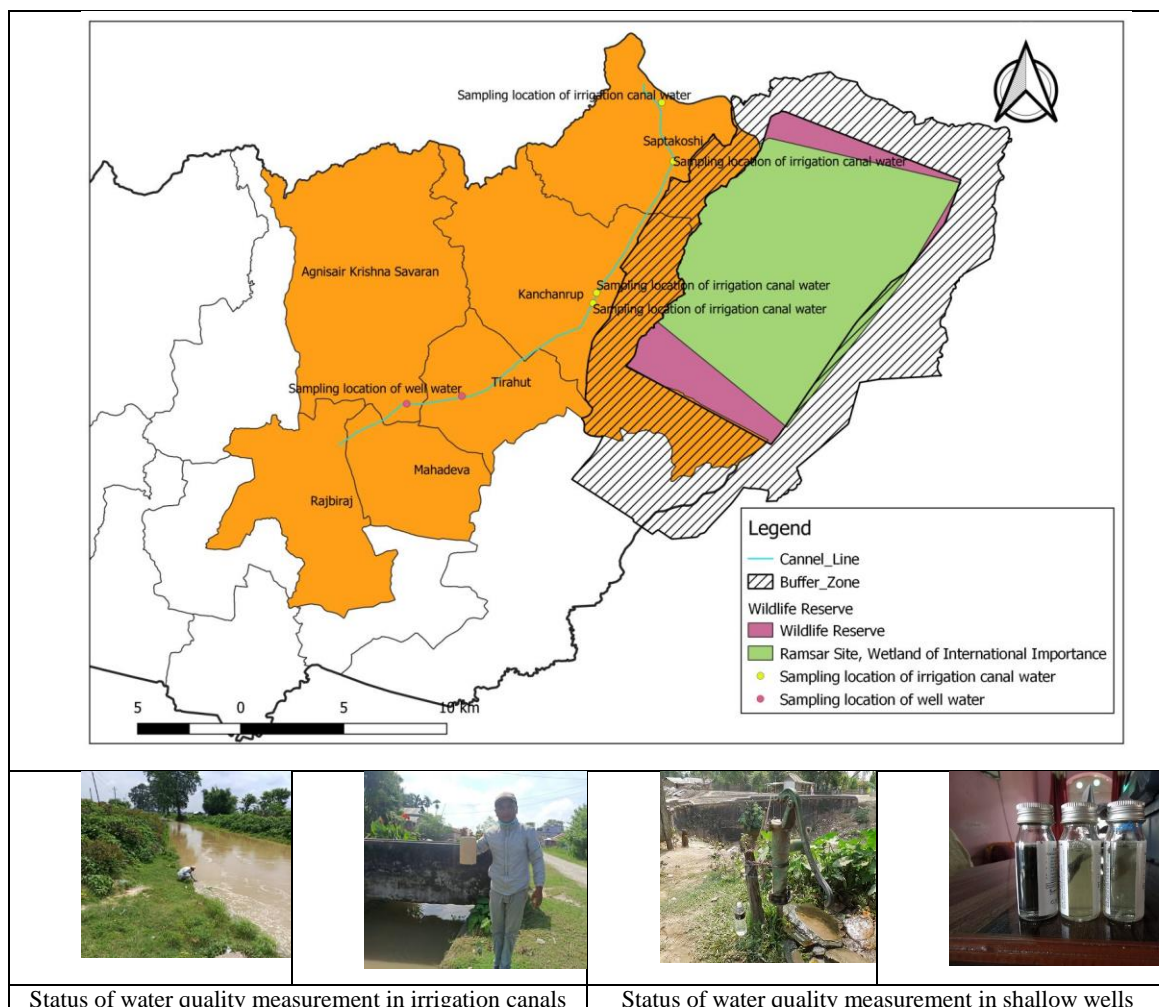


Example of surface watering by Postal Highway Project

<sup>3</sup> National Institute of Land and Infrastructure Management (NILIM), Japan Document No.714 Public Works Research Institute (PWRI) Document No.4254 Technical Methodology for Road Environment Impact Assessment (2012 Edition)

## 2) Water Pollution

Water quality measurements were conducted in irrigation canals and in shallow wells that may be affected by construction. Sampling points are shown in the figure below.



Status of water quality measurement in irrigation canals

Status of water quality measurement in shallow wells

**Figure 1-3-9 Water quality sampling location map**

The results of the water quality analysis in the irrigation canal are shown in the table below. Although there was no significant difference in water quality between upstream and downstream, total suspended particulate matter and fecal coliform bacteria were detected at all sites, and oil content was also detected. Most likely, it seems that total suspended solids were affected by rainfall, unlined canal structure, and agricultural activities such as soil puddling, while fecal coliform and oil content was mainly caused by domestic wastewater discharge and direct contamination from livestock waste entering the irrigation canal.

**Table 1-3-17 Water Quality Analysis of Irrigation Canal**

| S.N | Parameters                       | Observed values  |                  |                  |                  | Water Quality Guidelines/Standards                 |                          |                   |
|-----|----------------------------------|------------------|------------------|------------------|------------------|--|--------------------------|-------------------|
|     |                                  | Sample 1         | Sample 2         | Sample 3         | Sample 4         | Irrigation Water (GON)*1                           | Irrigation Water (FAO)*2 | Discharge (GON)*3 |
| 1   | pH                               | 7.7              | 7.5              | 7.4              | 7.3              | 6.5 – 8.5  | <7.0                     | 5.5 – 9.0         |
| 2   | EC (µS/cm)                       | 240              | 268              | 181              | 237              | 400 – 5,400  | –                        | –                 |
| 3   | Total Suspended Solids (mg/L)    | <b>346</b>       | <b>110</b>       | <b>424</b>       | <b>98</b>        | 50, max  | 50                       | –                 |
| 4   | Total Dissolved Solids (mg/L)    | 160              | 178              | 121              | 150              | –  | 500                      | –                 |
| 5   | Total Phosphorous (mg/L)         | 0.45             | 0.23             | 0.47             | 0.41             | –  | –                        | –                 |
| 6   | Total Kjeldahl Nitrogen (mg/L)   | 5.71             | 8.57             | 8.57             | 8.57             | –  | –                        | –                 |
| 7   | Biological Oxygen Demand (mg/L)  | 6                | 16               | 7                | 12               | –  | –                        | 30 – 100          |
| 8   | Chemical Oxygen Demand (mg/L)    | 14               | 30               | 22               | 20               | –  | –                        | 250, max          |
| 9   | Oil and Grease (mg/L)            | 3                | 2                | 4                | 2                | –  | –                        | 10, max           |
| 10  | Fecal Coliform Count (MPN/100ml) | <b>&gt;1,100</b> | <b>&gt;1,100</b> | <b>&gt;1,100</b> | <b>&gt;1,100</b> | 1 – 1,000 for plants where edible parts not wetted | 10,000                   | –                 |

Note: Observed values bolded are beyond threshold values.

\*1 GON, Guidelines for Irrigation Water Quality, 2065

\*2 Water Quality for Agriculture, FAO 1985

\*3 Generic Effluent Standards for Industrial Wastewater Discharged into Inland Surface Water, GoN 2058

Since all the rivers crossed by the CUP become dry up (no water) during the dry season when the construction work is carried out, the influence of water pollution on the downstream of the rivers where the protected areas, etc. are located is not assumed. When the alkali drainage from the concrete placement site is calculated from the following equation to calculate the river hydrogen ion concentration after drainage discharge, it is predicted that the rapid change of the hydrogen ion concentration in the downstream side of the irrigation canal can be suppressed by keeping the discharge of the alkali drainage within about 25 ~ 30% of the dry season irrigation water flow of 1.6 m<sup>3</sup>/s<sup>4</sup>.

$$H_1^+ = \frac{(H_0^+ \cdot Q_0 + H_r^+ \cdot Q_r)}{(Q_0 + Q_r)}$$

Where,

$H_0^+$ : Effluent hydrogen ion concentration 8.6

$Q_r$ : Water flow rate at drainage discharge point 1.6m<sup>3</sup>/s

$H_r^+$ : Canal hydrogen ion concentration 7.4 (Average of field survey results)

$H_1^+$ : Canal hydrogen ion concentration after effluent discharge

The results of water quality analysis of three shallow wells in the study area are shown in the table below. Sample numbers 1 and 2, which were sampled near the CUP, are still used by residents, and no health damage has been reported. As a result of the analysis, E. coli and iron were detected slightly high in sample No. 3, which is not currently used, and the other levels were generally within the standard values.

**Table 1-3-18 Results of water quality analysis in shallow wells**

| Parameters  | Unit | Sample 1                                     | Sample 2                                    | Sample 3                                     | National Guidelines*    | WHO Guidelines**        |
|-------------|------|--|---|--|-------------------------|-------------------------|
|             |      | N 26° 38' 36"<br>E 86° 54' 33"<br>Near CCB19 | N 26° 35' 09"<br>E 86° 49' 07"<br>Near CUP7 | N 26° 40' 38"<br>E 86° 55' 52"<br>Near CCB13 | ---                     | ---                     |
| Turbidity   | NTU  | less   | less  | Less   | 5 (10) <sup>1</sup>     | Less than 5             |
| pH          | -    | 6.5  | 6.5   | 7.5  | 6.5 – 8.5 <sup>2)</sup> | 6.5 - 8.5 <sup>3)</sup> |
| Temperature | °C   | 30   | 30  | 30   | ---                     | ---                     |

<sup>4</sup> Ministry of the Environment, Japan (2009) "Guidelines for Environmental Impact Assessment on Turbidity of River Water in Road and Railway Construction Projects". Since the effluent standard of Nepal does not specify the upper limit of effluent pH, the effluent standard (8.6) based on the Water Pollution Control Act of Japan was applied.

| Parameters     | Unit           | Sample 1                       | Sample 2                       | Sample 3                       | National Guidelines*  | WHO Guidelines**        |
|----------------|----------------|--------------------------------|--------------------------------|--------------------------------|-----------------------|-------------------------|
|                |                | N 26° 38' 36"<br>E 86° 54' 33" | N 26° 35' 09"<br>E 86° 49' 07" | N 26° 40' 38"<br>E 86° 55' 52" | ---                   | ---                     |
|                |                | Near CCB19                     | Near CUP7                      | Near CCB13                     | ----                  | ---                     |
| Total Hardness | mg/L           | 250                            | 250                            | 300                            | 500                   | 100 - 300 <sup>3)</sup> |
| Ammonia        | mg/L           | 0.5                            | 0.2                            | 0.5                            | 1.5                   | ---                     |
| Nitrate        | mg/L           | 10                             | 0                              | 10                             | 50                    | 50                      |
| Chloride       | mg/L           | 90                             | 90                             | 90                             | 250                   | 250 <sup>3)</sup>       |
| Iron (Fe)      | mg/L           | 0                              | 0                              | 3                              | 0.3 (3) <sup>1)</sup> | 0.3 <sup>3)</sup>       |
| Phosphate      | mg/L           | 0.05                           | 0                              | 0.05                           | Not harmful           | ---                     |
| Arsenic (As)   | mg/L           | 0.01                           | 0.01                           | 0.01                           | 0.01                  | 0.01                    |
| Coliforms      | CFU /<br>100ml | Not<br>presence                | Not presence                   | Presence                       | 0 (95%<br>sample)     | 0                       |

\* Nepal's Drinking Water Standards, Nepal Gazette (26 June 2006), \*\* WHO (2011), Guidelines for drinking water quality – 4<sup>th</sup> ed.

Note 1) Figures in parenthesis are an upper range of the standards recommended, 2) indicates the maximum and minimum limits, 3) Not of health concern at levels found in drinking water. However, concentrations in excess of the said amount can give rise to complains by users/customers.

Source: JICA Survey Team

### 3) Waste

Because of the characteristics of this project, the main wastes generated during the construction are old bricks and concrete rubble from the demolition of existing structures and earth and sand from the excavation work. The excavated soil will be reused as backfill material as much as possible to reduce the amount of waste generated. The estimated amount of waste generated is shown in the table below, and the contractor plans to transport these wastes to the disposal site designated by Saptari district for burial in accordance with the Local Government Operation Act, 2017.

**Table 1-3-19 Expected volume of main wastes to be disposed**

| Category                             | Quantity | Unit           |
|--------------------------------------|----------|----------------|
| Irrigation Siphon (Canal Under Pass) | 3,800    | m <sup>3</sup> |
| Drainage Facilities                  | 2,200    | m <sup>3</sup> |
| Canal Crossing Bridges               | 2,100    | m <sup>3</sup> |
| Total                                | 8,100    | m <sup>3</sup> |

### 4) Noise and Vibration

The facilities that require special consideration in the vicinity of the construction area include the residential facilities mentioned above and the birth center under construction. In addition, the impact of noise and vibration is limited to the daytime because nighttime construction is not scheduled. In the case of the demolition of the existing structure (119 dB), which is expected to have the highest noise power level, the equivalent noise level at a house 15 m away is expected to be  $L_{eq}$  77.7 dB (A) due to distance attenuation. This level is not extremely different<sup>5</sup> from the  $L_{eq}$  77.30 dB (A) measured in Nepal by the road improvement project funded by the Asian Development Bank. Furthermore, it is possible to further reduce the noise level by about 10 dB (A) by installing a temporary wall at the boundary<sup>6</sup>. Onsite workers should be provided with ear protection and work hours should be controlled as necessary.

Besides, the noise and vibration levels expected during construction are not expected to be

<sup>5</sup> The prediction is based on the prediction method by construction type shown in the "Prediction Model for Construction Work" of the Acoustical Society of Japan.

<sup>6</sup> The 65th Annual Conference of Japan Society of Civil Engineers (September 2010) "Evaluation of Noise Reduction Effect by Temporary Enclosure" (Hazama, Hideo Inaba et al.)

significantly different from those of the ongoing Postal Road Highway project, and no complaints have been received from nearby residents, local authorities, or other interested parties regarding the construction of this project.

## 5) Protected Area

A part of the western end of the buffer zone is adjacent to the Chandra Nahar irrigation canal and the other areas are about 3 km horizontal distance at the nearest part. As a result of the field survey, it is assessed that the impact of the project is limited because the requirements for exceptions in the protected area described in the JICA ESCs Guidelines FAQ are satisfied by the following reasons. In addition, the only environmental permit required to be obtained for the project implementation is IEE, but it was confirmed that the progress of the project should be reported to the Koshi Tappu Wildlife Reserve Management Office as appropriate and shared before the project implementation.

- a) As a result of interviewing the warden of the Koshi Tappu Wildlife Reserve Management Office and the Head of the Buffer Zone Management Association, although the impact of the project on the protected area is not expected, they advised the project to consider measures to mitigate the impact by the construction, including securing wildlife migration routes and continue to strive to share information as a stakeholder.
- b) Koshi Tappu Wildlife Reserve and Buffer Zone Management Plan (2018)<sup>7</sup> aims to achieve both sustainable ecosystem services and community prosperity, and is consistent with this project, as the document clearly states the need to rehabilitate Chandra Nahar irrigation facilities.
- c) The Postal Highway Project (approximately 20 km long, two lanes), which is under construction on the east side of the Chandra Nahar Irrigation Canal to be rehabilitated, has been in operation since 2017, but according to the above-mentioned stakeholders, the project has not affected the reserve.
- d) Rivers such as the Puraha River, which is crossed by CUP to be rehabilitated by this project, will become dead rivers during the dry season when construction is carried out, so muddy water inflow to Ramsar wetlands via rivers is not expected.
- e) As of 2018, approximately 14,000 households (84,000 people) have lived in the buffer zone (some protected areas) and ceremonial occasions with loud volumes and various economic activities have already been carried out, so there is no significant impact from noise during construction.



Location with Postal Highway Project



Traffic conditions in the buffer zone



Settlements around Ramsar wetlands

<sup>7</sup> KTWR 2018: Koshi Tappu Wildlife Reserve and Its Buffer Zone Management Plan (2074/75 - 2078/79) Koshi Tappu Wildlife Reserve Office, Paschim Kushaha, Sunsari, Nepal



A river in the dry season



Postal Highway Project yard



Signs in the buffer zone

Images: The environment around the project area

## 6) Ecosystem

During the field survey, in addition to direct observation in the vicinity of the project area, the presence of footprints, excrement, bird feathers, and mammal hairs, and sightings by local people were also interviewed. As a result, three mammals, two birds, and two reptiles listed in Parks and Wildlife Conservation Act (2029) registered as VU, EN, or CR in IUCN Red List or listed in CITES were identified (abbreviations are presented at the bottom of the next table). Based on the above, consultation with the local experts including Koshi Tappu Wildlife Reserve Management Office and rangers was conducted, and as a result, it was assessed that the impact of the project on the ecosystem is minor or can be mitigated, considering the fact that the project is not new construction but a renovation of existing facilities, and that various economic activities are already being conducted around the project site. The impact of the project on the ecosystem was evaluated to be minor or mitigable. The results for each category are shown below.

### (a) Mammals

Although no mammals were directly observed in the ROW targeted for the rehabilitation during the limited field survey period, a total of 20 species of mammals were reported from the surrounding areas as shown in the table below, including two species listed as VU or EN in the IUCN Red List, three CITES-listed species, and one species listed in the National Parks and Wildlife Conservation Act (2029) of Nepal. The results of the assessment of these species are described in detail separately in the subsequent sections.

**Table 1-3-20 List of mammals found in and around the project area**

| SN | Scientific Name               | Local Name  | Common Name            | Conservation Status |      |       |
|----|-------------------------------|-------------|------------------------|---------------------|------|-------|
|    |                               |             |                        | NPWC                | IUCN | CITES |
| 1  | <i>Axis axis</i>              | Chital      | Chital deer            | NA                  | VU   | I     |
| 2  | <i>Canis aureus</i>           | Syal        | Jackal                 | NA                  | LC   | I     |
| 3  | <i>Cervus unicolor</i>        | Sambar      | Sambhar                | NA                  | VU   | I     |
| 4  | <i>Cuon alpinus</i>           | Ban kukur   | Wild dog               | NA                  | NE   | NA    |
| 5  | <i>Dremomys lokriah</i>       | Lokharke    | Squirrel               | NA                  | NE   | NA    |
| 6  | <i>Felis chaus</i>            | Bandhade    | Wild Cat               | NA                  | NE   | NA    |
| 7  | <i>Funambulus pennanti</i>    | Lokharke    | Squirrel               | NA                  | NE   | NA    |
| 8  | <i>Herpestes edwardi</i>      | Nyauri      | mongoose               | NA                  | LC   | I     |
| 9  | <i>Hystrix indica</i>         | Dumsi       | Porcupine              | NA                  | LC   | NA    |
| 10 | <i>Lepus nigricollis</i>      | Kharayo     | Hare                   | NA                  | NE   | NA    |
| 11 | <i>Macaca mulatta</i>         | Bandar      | Rhesus Monkey          | NA                  | NE   | NA    |
| 12 | <i>Martes flavigula</i>       | Malsapro    | Yellow Throated Martin | NA                  | NE   | NA    |
| 13 | <i>Melursus ursinus</i>       | Bhalu       | Sloth bear             | NA                  | NE   | NA    |
| 14 | <i>Muntiacus muntjac</i>      | Mirga       | Barking Deer           | NA                  | VU   | I     |
| 15 | <i>Paguma larvata</i>         | Varse       | Civet                  | NA                  | LC   | I     |
| 16 | <i>Petaurista petaurista</i>  | Raj panchhi | Flying squirrel        | NA                  | NE   | NA    |
| 17 | <i>Rousettus leschenaulti</i> | Chamero     | Bat                    | NA                  | LC   | NA    |
| 18 | <i>Semnopithecus entellus</i> | Guna        | Langur                 | NA                  | NE   | NA    |
| 19 | <i>Sus scroffa</i>            | Bandel      | Wild Boar              | NA                  | NE   | NA    |
| 20 | <i>Elephas maximus</i>        | Hathee      | Elephant               | P                   | EN   | I     |



Note: NPWC Act, 2029: National Parks and Wildlife Conservation Act, 2029: P-Schedule-I, NA= Not available,

IUCN Red List Categories: EX=Extinct, EW= Extinct in the Wild, CR= Critically Endangered, EN= Endangered, VU= Vulnerable, NT= Near Threatened, LC=Least Concern, DD: Data Deficient, NE: Not Evaluated

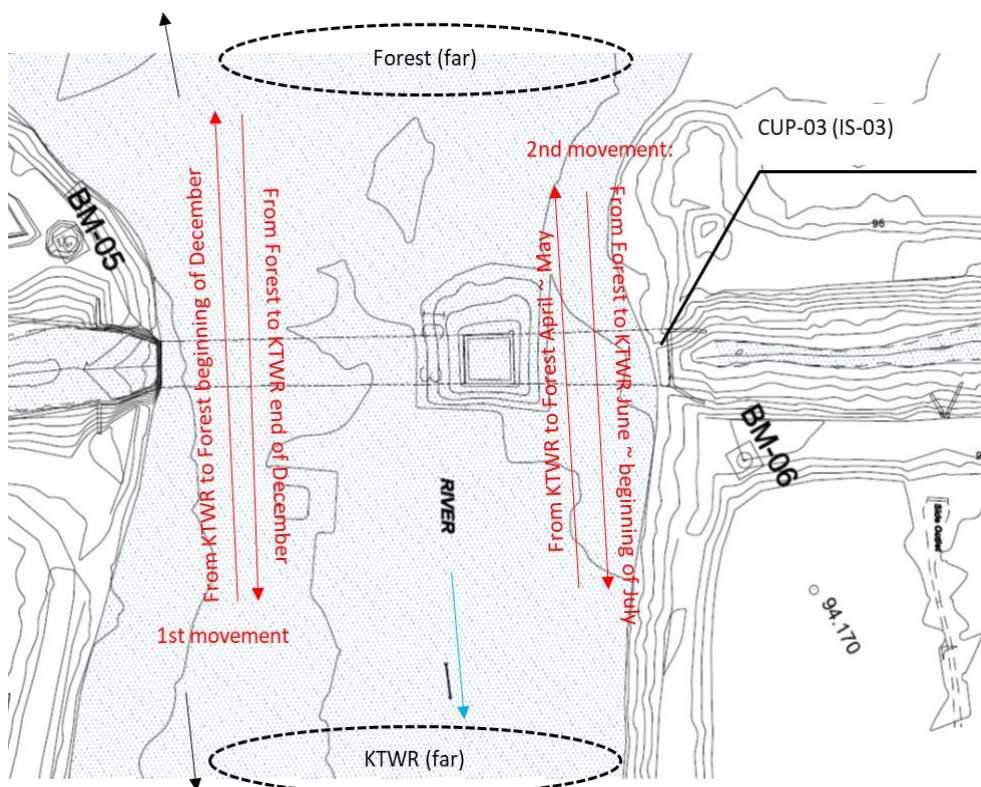
CITES Categories: I -Appendix I ( are species that are threatened with extinction and are or may be affected by trade), II - Appendix II (are species that are not necessarily threatened with extinction, but may become so unless trade in specimens of such species is subject to strict regulation to avoid utilization incompatible with the survival of the species in the wild), and III - Appendix III

Source: JICA Survey Team

**Table 1-3-21 Results of studies on mammals that require special consideration**

|   |  |
|---|--|
|  | <p><b>Sloth bear <i>Melurss ursinus</i></b><br/>Vulnerable Version 2021-2 (Accessed on November 2021), and CITES Category I, Population Trend: Decreasing,<br/>The reported sightings by local residents are outside of the ROW of the canal to be rehabilitated, in a forest about 5 km away from the main irrigation canal. In addition, no direct impacts are expected as termite nests, which have been reported as the main food source, have not been observed in the vicinity of the project site.</p>  |
|  | <p><b>Asian Elephant <i>Elephas maximus</i></b><br/>Endangered Version 2021-2 (Accessed on November 2021) and CITES I, Population Trend: Decreasing, NPWC 2029- Protected<br/>It migrates through the Pauraha River, which is crossed by the CUP No. 3 to be rehabilitated, to the western forest, and then migrates back to the reserve a few weeks or months later. The first migration occurs twice a year, from early to late December, and the second from April to May and June to July (see overview map below). The main migration period is during the night. As the construction period partly overlaps with the above-mentioned migration period, several mitigation measures were discussed with KTWR staff, rangers, and others. Eventually, it was confirmed that it would be possible to mitigate the impact by securing migration routes during the construction, assigning night guard(s) to enable communication with rangers.</p> |

During the operation phase (after handover), the CUP will be buried underground as in the current situation, so disturbance on wildlife movement is not expected.



Reference: Location of CUP to be renovated and travel route

Note: The actual locations of KTWR and the forest are isolated by several to tens of kilometers from the facilities to be retrofitted.



**Golden jackal *Canis aureus***

Least Concern, Version 2021-2 (Accessed on November 2021) and CITES III, Population Trend: Increasing

Although there have been reports of observation by community within the ROW, no impact is expected from this project as the species can be found in a variety of habitats from semiarid environments to forests, mangroves, farmland, rural areas and semi-urban areas at elevations above 2,000 m and the population trend is increasing in accordance with IUCN.

Source: Prepared by the research team based on the results of interviews with IUCN, CITES, and local officials.  
Photo source: IUCN.

**(b) Birds**

The following 50 species of birds were observed in and around the project area. The representative species observed were Sturnidae, Cuckoo, Sparrows, and House crow. One CR-registered species in the IUCN Red List and two CITES-registered species were confirmed (no species registered



under the national legislation were confirmed), and the results of the assessment of these species are described in detail in a later section.

**Table 1-3-22 List of bird species found in and around the project area**

| SN | Scientific name                 | Local Name      | Common name           | Conservation Status |      |       |
|----|---------------------------------|-----------------|-----------------------|---------------------|------|-------|
|    |                                 |                 |                       | NPWC                | IUCN | CITES |
| 1  | <i>Coturnix coturnix</i>        | Batai           | Common Quail          | NA                  | LC   | NA    |
| 2  | <i>Passer domesticus</i>        | Bhangera        | Hose Sparrow          | NA                  | LC   | NA    |
| 3  | <i>Dicurus macrocercus</i>      | Chibe           | Black drongo          | NA                  | LC   | NA    |
| 4  | <i>Milvus migrans</i>           | Chil            | Black Kite            | NA                  | LC   | NA    |
| 5  | <i>Anthus similis</i>           | Chuinya         | Long-billed Pipit     | NA                  | LC   | NA    |
| 6  | <i>Alectoris chukar</i>         | Chyakhura       | Chucker               | NA                  | LC   | NA    |
| 7  | <i>Acrideros fuscus</i>         | Dangre          | Common Maina          | NA                  | LC   | NA    |
| 9  | <i>Copsychus saularis</i>       | Dhobichara      | Robin bird            | NA                  | LC   | NA    |
| 10 | <i>Streptopelia chinensis</i>   | Dhukur          | Spotted dove          | NA                  | LC   | NA    |
| 11 | <i>Chrysocolaptes festivus</i>  | Dingulche       | Large Woodpecker      | NA                  | LC   | NA    |
| 12 | <i>Phylloscopus collybita</i>   | Fisto           | Warbler               | NA                  | LC   | NA    |
| 13 | <i>Apus affinis</i>             | Gauthali        | Little Buffalo        | NA                  | LC   | NA    |
| 14 | <i>Hirundo daurica</i>          | Gauthali        | Buffalo/swallow       | NA                  | LC   | NA    |
| 15 | <i>Riparia riparia</i>          | Gauthali        | Sand Martin           | NA                  | LC   | NA    |
| 16 | <i>Gyps bengalensis</i>         | Gidhha          | Vulture               | NA                  | CR   | II    |
| 17 | <i>Treson phoenicoptera</i>     | Haleso          | Green pigeon          | NA                  | LC   | NA    |
| 18 | <i>Ketupa zeylonensis</i>       | Humbak          | Owl                   | NA                  | LC   | NA    |
| 19 | <i>Hypsipetes leucocephalus</i> | Jureli          | Black bulbul          | NA                  | LC   | NA    |
| 20 | <i>Pycnonotus cafer</i>         | Jureli          | Red Vented Bulbul     | NA                  | LC   | NA    |
| 21 | <i>Corvus splendens</i>         | Kaag            | House Crow            | NA                  | LC   | NA    |
| 22 | <i>Corvus macrorhynchos</i>     | Kag             | Large billed crow     | NA                  | LC   | NA    |
| 23 | <i>Spilorrus cheela</i>         | Kakakul         | Crested serpent eagle | NA                  | LC   | NA    |
| 24 | <i>Lophura leucomelanos</i>     | Kaliz           | Kaliz Pheasants       | NA                  | LC   | III   |
| 25 | <i>Cuculus canorus</i>          | Koili           | Cuckoo                | NA                  | LC   | NA    |
| 26 | <i>Eudynamis scolopaceus</i>    | Koili           | Cuckoo                | NA                  | LC   | NA    |
| 27 | <i>Celeus brachyurus</i>        | Lahache         | Woodpecker            | NA                  | LC   | NA    |
| 28 | <i>Urocissa erythrorhyncha</i>  | Lampuchhare     | Indian tree pie       | NA                  | LC   | NA    |
| 29 | <i>Glaucidium radiatum</i>      | Latkosero       | Owlet                 | NA                  | LC   | NA    |
| 30 | <i>Gallus gallus</i>            | Luinche         | Red Junglefowl        | NA                  | LC   | NA    |
| 31 | <i>Sturnus contra</i>           | Maina           | Pied Myna             | NA                  | LC   | NA    |
| 32 | <i>Halcyon smyrnensis</i>       | Matikore        | Kingfisher            | NA                  | LC   | NA    |
| 33 | <i>Merops philippinus</i>       | Murali Chari    | Bee-eater             | NA                  | LC   | NA    |
| 34 | <i>Anas poicilorhyncha</i>      | Pani hans       | Spotbilled Duck       | NA                  | LC   | NA    |
| 35 | <i>Columba livia</i>            | Parewa          | Rock pigeon           | NA                  | LC   | NA    |
| 36 | <i>Merops leschenaulti</i>      | Patenga         | Bee-eater             | NA                  | LC   | NA    |
| 37 | <i>Psittacula krameri</i>       | Pattu           | Parrot                | NA                  | LC   | NA    |
| 38 | <i>Pericrocotus ethologus</i>   | Rani chara      | Long-tailed Minivet   | NA                  | LC   | NA    |
| 39 | <i>Acredotheres tristis</i>     | Saron           | Common Myna           | NA                  | LC   | NA    |
| 40 | <i>Psittacula himalayana</i>    | Suga            | Parrot                | NA                  | LC   | NA    |
| 41 | <i>Picus canus</i>              | Thulo Rukhphora | Grey-faced Woodpecker | NA                  | LC   | NA    |
| 42 | <i>Francolinus francolinus</i>  | Titra           | Francolin             | NA                  | LC   | NA    |
| 43 | <i>Bubo bubo</i>                | Vudrung         | Eurasian Eagle-owl    | NA                  | LC   | NA    |

Source: JICA Survey Team

**Table 1-3-23 Results of studies on birds requiring special consideration**

|   |   |
|---|---|
|  | <p><b>Bengal Vulture <i>Gyps bengalensis</i></b><br/>Critically Endangered Version 2021-2 (Accessed on November 2021), and CITES Category II, Population Trend: Decreasing,</p> <p>They feed on animal carcasses and carrion. Since the area around the renovation of the existing irrigation facilities and the canal crossing bridge is not inhabited by many animals that are the main food source, and the observation reports are not from the ROW but from the Parika (town) level, the impact of the construction is considered to be small.</p>                         |
|  | <p><b>Kaliz Pheasants <i>Lophura leucomelanos</i></b><br/>Least Concern Version 2021-2 (Accessed on November 2021) and CITES III, Population Trend: Decreasing</p> <p>This is a species of least concern and no major threats have been reported. Also, it was reported that this species was not observed within ROW but outside. However, as it is a CITES registered species, it is necessary to provide prior education to construction workers to avoid unnecessary killing if encountered during construction. No impacts during the operation phase are anticipated.</p> |

Source: Prepared by the JICA Survey Team based on the results of interviews with IUCN, CITES and local officials.  
Photo source: IUCN

### (c) Reptiles and Amphibians



Sixteen species of reptiles were identified and reported in the field survey as shown in the table below. Among them, one NT-registered species in the IUCN Red List and two CITES-registered species were confirmed.

**Table 1-3-24 List of reptile amphibians found in and around the project area**

| SN | Scientific name                    | Local Name      | Common Name        | Family       | Conservation Status |      |       |
|----|------------------------------------|-----------------|--------------------|--------------|---------------------|------|-------|
|    |                                    |                 |                    |              | NPWC                | IUCN | CITES |
| 1  | <i>Aspideretes gangeticus</i>      | Thotari         | Turtle             | Trionychidae | NA                  | EN   | I     |
| 2  | <i>Asymblepharus sikimensis</i>    | Vale Mungro     | Skink              | Scincidae    | EN                  | NE   | NA    |
| 3  | <i>Boiga trigonata</i>             | Tiris Sanp      | Cat snake          | Colubridae   | NA                  | LC   | NA    |
| 4  | <i>Bufo melanocostric</i>          | Khasre Bhyaguto | Toad               | Bufoidea     | LC                  | NE   | NA    |
| 5  | <i>Bungarus caeruleus</i>          | Krait           | Common krait       | Elapidae     | NA                  | NE   | NA    |
| 6  | <i>Callotes versicolor</i>         | Cheparo         | Callotes           | Agamidae.    | NA                  | NE   | NA    |
| 7  | <i>Hemidactylus frenatus</i>       | Chipkali        | Wall Lizard        | Gekkonidae   | NA                  | LC   | NA    |
| 8  | <i>Laudakia tuerkulata</i>         | Chheparo        | Rock aagma         | Agamidae     | LC                  | NE   | NA    |
| 9  | <i>Lycodon aulicus</i>             | Chichinde sanp  | Wolf snake         | Colubridae   | NA                  | NE   | NA    |
| 10 | <i>Naja naja</i>                   | Gauman snake    | cobra              | Elapidae     | NA                  | VU   | II    |
| 11 | <i>Nerodia sipedon</i>             | Dhodiya         | Common water snake | Colubridae.  | VU                  | LC   | NA    |
| 12 | <i>Parias hageni</i>               | Hareu sanp      | Green Pit viper    | Viperidae.   | LC                  | LC   | NA    |
| 13 | <i>Ptyas mucosa</i>                | Dhaman          | Indian rat snake   | Colubridae   | LC                  | NE   | NA    |
| 14 | <i>Rana tigrina</i>                | Byaguto         | Asian Bullfrog     | Ranidae      | NA                  | LC   | II    |
| 15 | <i>Varanus Indicus</i>             | Gohoro          | Monitor Lizard     | Varanidae    | LC                  | LC   | II    |
| 16 | <i>Xenochrophis sanctijohannis</i> | Goraya sanp     | Water snake        | Colubridae   | LC                  | NE   | NA    |

Source: JICA Survey Team

**Table 1-3-25 Results of studies on birds that require special consideration**

|   |  |
|---|--|
|  | <p><b>Indian cobra <i>Naja naja</i></b><br/>No Data Version 2021-2 (Accessed on November 2021), and CITES Category II</p> <p>The sighting report is within the project site ROW, which is not registered in the IUCN Redlist and national legislation (NPWC 2029) but belongs to CITES Category II, so it is necessary to provide prior education to workers to avoid unnecessary killing if encountered during construction. No impact during service is anticipated.</p>   |
|  | <p><b>Rock python <i>Python molurus</i></b><br/>Near Threatened Version 2021-2 (Accessed on November 2021) and CITES I, and NPWC 2029 Protected, Population Trend: Decreasing</p> <p>Poaching mainly for pets and snakeskin, forest fires, and mine development are reported to be the main causes of population decline, and since observation report was outside the ROW, the impact of this project is assumed to be minor. As it is a CITES registered species as well as Rock python, it is necessary to educate workers in advance not to kill them unnecessarily if they are encountered during construction. No impact is expected in operation phase.</p> |

Source: Prepared by the research team based on the results of interviews with IUCN, CITES and local officials.  
Photo source: IUCN.

**(d) Fishes**

The two fish species identified and reported during the field survey are listed in the table below. They are found in areas where water is accumulated, such as cross-drainage works. Both of them were confirmed not protected species in IUCN Red List or national laws.

**Table 1-3-26 List of fish species identified in and around the project area**

| SN | Scientific name                | Local Name | Common Name        | Conservation Status |      |       |
|----|--------------------------------|------------|--------------------|---------------------|------|-------|
|    |                                |            |                    | NPWC                | IUCN | CITES |
| 1  | <i>Channa stewartii</i>        | Hile       | Assamese snakehead | NA                  | NE   | NA    |
| 2  | <i>Plicofollis platystomus</i> | Mungri     | Cat fish           | NA                  | NE   | NA    |

Source: JICA Survey Team



Fish species identified during the field survey



Status of capture in the canal

**7) Resettlement, land acquisition, and use of land and community resources**

Relocation of residential facilities is not anticipated, but temporary relocation of livestock pens, stalls, etc. and land acquisition in CUP-02 will occur. For details, see the section on Land Acquisition and Resettlement.

## **8) Socially vulnerable person**

The socially vulnerable groups in Nepal are defined as (1) single women aged 65 and above, (2) elderly people aged 70 and above, (3) orphans under 16 years old, and (4) people with disabilities. The Government of Nepal, with the Ministry of Women, Children and Social Welfare (MoWC&SW) as the agency in charge, provide social security benefits to these vulnerable groups. In implementing the ARAP, it is advisable to share information with the Ministry to ensure that appropriate consideration is given as needed.

## **9) Local economy (employment, livelihoods, etc.) and children's rights**

During project implementation, regular workers, drivers, security guards, and cleaners are likely to be procured from the site, which is expected to have a positive effect on job creation.

The Child Labour (Prohibition and Regulation) Act, 2000 stipulates that the working hours of 14-16-year-olds should be less than 36 hours per week and prohibits children under 16 years old from engaging in hazardous work. Therefore, it is necessary to pay attention to the age and nature of the work when hiring local personnel.

Since the field survey confirmed that the canal crossing bridge is used by school children as a route to school and as a necessary route for economic activities, the plan is to set up a temporary road during the construction so as not to disturb the traffic of local residents.

## **10) Water Use**

As a result of the survey on the users of the wells that may be impacted by the construction, the highest percentage of the users indicated drinking water as the main use, followed by removing dirt from hands and feet, washing face and teeth, washing dishes, etc. Since the groundwater level is high and the structure of the well is such that even local residents can easily install a shallow well, the DWRI staff agreed that DWRI would construct and install an alternative well in case the well is disturbed by the project implementation.

## **11) Infectious diseases and working environment (including occupational safety)**

As a result of the review of similar projects in Nepal, the following occupational safety measures were confirmed: provision of dust masks and earmuffs to workers, compliance with the working hours stipulated in the labor standards, and implementation of safety meetings. No major accident (e.g. fatal accident) has been confirmed in a similar project. It is important to take similar or better preventive measures for the safety measures for the workers of this project to prevent the occurrence of accidents.

In addition, since the risk of COVID-19 increases at construction sites where many workers gather, it is necessary to take necessary infection prevention measures, such as wearing masks and disinfecting hands, in accordance with the guidelines and regulations set by the CCMCC (COVID-19 Crisis Management Coordination Center) and local governments according to the spread of infection.

## **12) Accident**

Since it has been confirmed that a water-related accident has occurred in which livestock and local residents were sucked into the intake of CUP, it is necessary to consider measures to prevent people from falling in. In addition, as mentioned above, the canal crossing bridge has a relatively high volume of vehicular and pedestrian traffic in some areas, so it is necessary to properly assign

security guards to the site and share the construction schedule with the community in advance to prevent accidents from occurring.

### 13) Climate Change

According to the Climate Risk Profile (USAID, 2017) and other sources, Nepal is projected to experience lower crop yields, increased risk of flooding, and changes in rainfall patterns due to climate change. In addition, the aforementioned Koshi Tappu Wildlife Reserve and Buffer Zone Management Plan also states the need for infrastructure development such as Chandra Nahar irrigation canal and bridge as part of climate change countermeasures. Therefore, the rehabilitation of the currently leaking CUPs and structures that are severely deteriorated by this project will enable the efficient use of irrigation water and improve the stability of agricultural productivity.

In addition, a list of trees that will need to be cut down, rooted, or transplanted during construction is given below. Out of these, the partial pruning of branches and transplanting of young trees of religious importance such as *Ficus benghalensis* and *Ficus religiosa* has been discussed with the municipality having jurisdiction during the field survey and it has been confirmed that there is no problem in pruning and transplanting for the implementation of the project.

**Table 1-3-27 List of trees to be supported**

| SN | Plant Species |                             | Number and Volume |            |               |                   |                  |
|----|---------------|-----------------------------|-------------------|------------|---------------|-------------------|------------------|
|    | Local name    | Botanical name              | Pole class        | Tree class | Timber (cft)  | Fuelwood (chatta) | Biomass (kg)     |
| 1  | Aanp          | <i>Mangifera indica</i>     | 0                 | 4          | 63.25         | 0.15              | 2,208.43         |
| 2  | Bakaino       | <i>Melia azedarach</i>      | 1                 | 0          | 0             | 0.01              | 131.97           |
| 3  | Bar           | <i>Ficus benghalensis</i>   | 0                 | 1          | 6.76          | 0.02              | 236.09           |
| 4  | Kadam         | <i>Neolamarckia cadamba</i> | 3                 | 2          | 43.08         | 0.11              | 1,562.64         |
| 5  | Masala        | <i>Eucalyptus Species</i>   | 1                 | 0          | 0             | 0.02              | 190.89           |
| 6  | Moringa       | <i>Moringa oleifera</i>     | 3                 | 0          | 0             | 0.02              | 193.29           |
| 7  | Pipal         | <i>Ficus religiosa</i>      | 1                 | 3          | 287.49        | 0.69              | 10,130.08        |
| 8  | Pithari       | <i>Trewia nudiflora</i>     | 0                 | 1          | 6.71          | 0.01              | 234.27           |
| 9  | Siris         | <i>Albizia procera</i>      | 2                 | 0          | 0             | 0.02              | 144.94           |
|    |               |                             | <b>11</b>         | <b>11</b>  | <b>407.29</b> | <b>1.05</b>       | <b>15,032.60</b> |

Source: JICA Survey Team

For trees that cannot be avoided to be cut down during the construction, DWRI plans to transplant 10 times the number of trees cut down according to the "Working procedure of the standard for national priority project for the use of national forest 2076 (2020)". The species of trees to be transplanted were selected in consultation with the District Forest Office (DFO) from the viewpoint of ease of growth and ecosystem management. It was also confirmed that the forest office could provide seedlings for this project free of charge as part of their regular duties. The candidate tree species for transplantation are shown below.

**Table 1-3-28 Candidate tree species for transplantation**

| SN | Local name | Botanical Name               |
|----|------------|------------------------------|
| 1  | Khayer     | <i>Acacia catechu</i>        |
| 2  | Mahogani   | <i>Swietenia macrophylla</i> |
| 3  | Masala     | <i>Eucalyptus spp</i>        |
| 4  | Teak       | <i>Teaktona grandis</i>      |
| 5  | Kadam      | <i>Neolamarckia cadamba</i>  |

Source: Prepared by the research team based on interviews with county forest offices

## (8) Impact Assessment

The results of the impact assessment are presented below.

**Table 1-3-29 Impact Assessment Results**

| Impact Category                | Scoping                              |    | EIA Study |     | Description and Reason of Rating |  |
|--------------------------------|--------------------------------------|----|-----------|-----|----------------------------------|--|
|                                | P-Co / Co                            | Op | P-Co / Co | Op  |                                  |  |
| <b>I. Pollution Control</b>    |                                      |    |           |     |                                  |  |
| 1                              | Air Pollution                        | ✓  |           | B-  | N/A                              | <p><u>During construction:</u> It is assumed that there will be temporary impacts from dust and exhaust gas emitted from construction and construction vehicles. The degree of impact is expected to be minor due to the implementation of water sprinkling and the use of temporary walls in areas adjacent to facilities that require consideration.</p> <p><u>Operation phase:</u> No activities are expected to generate air pollution.</p>  |
| 2                              | Water Pollution                      | ✓  |           | B-  | N/A                              | <p><u>During construction:</u> Cofferdam will be constructed with large sandbags which reduce the discharge volume of muddy water downstream. Suspended materials contained in the turbid water will be precipitated in the temporary sedimentation pond, and discharge intermediate water to downstream. Turbidity and pH will be monitored periodically as a part of EMMP, and countermeasures to minimize impact shall be considered as necessary.</p> <p><u>Operation phase:</u> No activities are expected to generate water pollution.</p> |
| 3                              | Solid Wastes                         | ✓  |           | B-  | B-                               | <p><u>During construction:</u> Waste materials such as bricks and concrete are expected to be generated due to the removal of the existing structures. The excavated soil will be reused as backfill material as much as possible to reduce the amount of waste.</p> <p><u>Operation phase:</u> No waste is expected to be generated, but there is concern about littering in the canal by nearby residents.</p>   |
| 4                              | Soil Contamination                   | ✓  |           | B-  | N/A                              | <p><u>During construction:</u> Since there are concerns about the effects of soil contamination caused by oil leaks, etc., during the maintenance of construction vehicles, concrete laying and the use of oil trays in the maintenance area will be thoroughly implemented.</p> <p><u>Operation phase:</u> No activities are expected to cause soil contamination.</p>  |
| 5                              | Noise and Vibration                  | ✓  |           | B-  | N/A                              | <p><u>During construction:</u> Noise and vibration associated with construction machinery and work will be generated temporarily. The impact is expected to be minor through the use of temporary enclosures and construction time schedules.</p> <p><u>Operation phase:</u> No noise or vibration is expected to occur.</p>   |
| 6                              | Ground Subsidence                    |    |           | N/A | N/A                              | It is not expected that the work will involve pumping up large volumes of groundwater.   |
| 7                              | Offensive Odor                       |    |           | N/A | N/A                              | It is not anticipated that the work will create an offensive odor.   |
| 8                              | Bottom Sediment                      |    |           | N/A | N/A                              | No impact on bottom sediment is anticipated.   |
| <b>II. Natural Condition</b>   |                                      |    |           |     |                                  |  |
| 9                              | Protected Area                       | ✓  | ✓         | D   | D                                | <u>During the construction and operation phase:</u> No impact on the protected area is anticipated as the work involves the renovation of existing facilities which was proposed in the protected area and its buffer zone management plans.   |
| 10                             | Ecosystem                            | ✓  | ✓         | B-  | D                                | <p><u>During construction:</u> Although the species specified in the IUCN Red List, CITES, and national laws were confirmed in the project area, the degree of impact is assumed to be minor as a result of consultation with specialists, rangers, and local governments, etc., and by educating workers to secure migration routes and not to kill unnecessarily.</p> <p><u>Operation phase:</u> No impact is anticipated due to the renovation of existing facilities.</p>  |
| 11                             | Hydrological Situation               |    |           | N/A | N/A                              | <p><u>During construction:</u> No impact is expected because the construction is based on the premise that the irrigation Canal will be constructed with water flowing downstream through a temporary turning Canal.</p> <p><u>Operation phase:</u> No impact on water quality is expected.</p>  |
| 12                             | Topography and Geographical Features |    |           | N/A | N/A                              | No work that would significantly alter the topography or geology is anticipated.   |
| <b>III. Social Environment</b> |                                      |    |           |     |                                  |  |
| 13                             | Involuntary Resettlement             | ✓  |           | B-  | N/A                              | <u>Pre-construction:</u> No displacement of residences will occur; relocatable stalls and livestock huts will be relocated, but the impact will be minor.  |

| Impact Category   | Scoping  |    | EIA Study |     | Description and Reason of Rating                     |  |
|-------------------|--|----|-----------|-----|--|--|
|                   | P-Co / Co  | Op | P-Co / Co | Op  |  |  |
|                   |  |    |           |     | <u>Operation phase</u> : No resettlement will occur. |  |
| 14                | Land Acquisition   | ✓  |           | B-  | N/A  | <u>Pre-construction</u> : Minor land acquisition for two households will occur at the CUP alignment change point. In addition, the land will be temporarily acquired to secure a plant yard for construction, but the impact will be minor.<br><u>Operation phase</u> : No land acquisition will occur.  |
| 15                | Vulnerable social groups, such as indigenous and ethnic people | ✓  | ✓         | B-  | D  | <u>Pre-construction/construction</u> : Due to concerns that socially vulnerable groups (e.g., elderly, widows) may not be able to properly access information related to compensation payments and assessments, consideration will be given to socially vulnerable groups in the ARAP. In addition, information will be shared with existing government assistance programs.<br><u>Operation phase</u> : No impacts on vulnerable groups are anticipated.  |
| 16                | Local economy such as employment and livelihood, etc.          | ✓  | ✓         | B+  | B+   | <u>During construction</u> : The project is expected to create employment opportunities for local farmers as workers. In addition, the use of goods and services by workers, drivers, and other construction workers is expected to stimulate the economy of the towns surrounding the site. Since irrigation water will continue to be available during the construction period, no negative impact on the livelihoods of downstream farmers and other residents is expected.<br><u>Operation phase</u> : A stable supply of irrigation water will be provided as the facilities are developed, and a positive impact on the local economy is expected. |
| 17                | Land use and utilization of local resources                    | ✓  | ✓         | B-  | B+   | <u>During Construction</u> : Minor site acquisition during construction is anticipated.<br><u>Operation phase</u> : Rehabilitation of irrigation and drainage facilities will allow for more efficient use of water resources.   |
| 18                | Water Use  | ✓  |           | B-  | N/A  | <u>During construction</u> : Alternative facilities will be constructed for wells that may be disturbed.<br><u>Operation phase</u> : No impacts are anticipated  |
| 19                | Existing social infrastructures and services                   | ✓  | ✓         | B-  | B+   | <u>Pre-construction/construction</u> : Utility relocation and temporary roads need to be installed appropriately so as not to interfere with the lives of residents.<br><u>Operation phase</u> : The road improvement will improve the convenience of transportation.  |
| 20                | Local organization   |    |           | N/A | N/A  | It is not envisaged that the work will involve reorganizing existing decision-making bodies or other social organizations.   |
| 21                | Misdistribution of benefit and damage                          |    |           | N/A | N/A  | No uneven distribution of damages and benefits is assumed because the project is an improvement of existing social infrastructure.   |
| 22                | Local Conflict of Interest                                     |    |           | N/A | N/A  | ditto  |
| 23                | Cultural Heritage  |    |           | N/A | N/A  | There are no facilities registered as cultural heritage in the project site.   |
| 24                | Landscape  |    |           | N/A | N/A  | The project site does not include scenic areas   |
| 25                | Gender   |    |           | N/A | N/A  | No impact on gender is envisaged.  |
| 26                | Children's Right   | ✓  |           | B-  | N/A  | <u>During construction</u> : there are concerns about the risk of child labour. Include in the specification to meet the requirements set out in the labour Act.   |
| 27                | Hazards(Risk) Infectious diseases such as HIV/AIDS             | ✓  |           | B-  | N/A  | <u>During construction</u> : Actions and preventive controls should be taken in accordance with the measures to prevent the spread of novel coronaviruses issued by CCMCC and local authorities.<br><u>Operation phase</u> : No impacts are anticipated.   |
| 28                | Working Conditions, Occupation Safety                          | ✓  |           | B-  | N/A  | <u>During construction</u> : Due to occupational safety concerns, appropriate occupational safety equipment (helmets, goggles, shoes, etc.) will be provided depending on the nature of the work.<br><u>Operation phase</u> : No activities that would employ workers are envisaged.   |
| <b>IV. Others</b> |  |    |           |     |  |  |
| 29                | Accident   | ✓  | ✓         | B-  | B-   | <u>During construction</u> : Signage, flagging, and advance notice of schedules are required due to the potential for accidents as construction vehicles pass through and construction equipment is in operation.<br><u>Operation phase</u> : Since there is a concern about the occurrence of water accidents, fall prevention measures should be considered.   |

| Impact Category   | Scoping   |    | EIA Study |    | Description and Reason of Rating  |
|-------------------|-----------|----|-----------|----|---|
|                   | P-Co / Co | Op | P-Co / Co | Op |   |
| 30 Climate Change | ✓         | ✓  | B-        | B+ | <p><u>During construction:</u> Greenhouse gases will be emitted as a result of the operation of construction vehicles, but the degree of impact will be minor. Trees to be cut down during construction will be transplanted.</p> <p><u>Operation phase:</u> Resilience against unstable rainfall patterns due to climate change is expected to be improved, as the use of water resources will be more stable than at present.</p> |

A+/-: Significant positive/negative impact is expected, B+/-: Positive/negative impact is expected to some extent.

C+/-: Extent of positive/negative impact is slight or unknown, D: No impact is expected.

\*1 P-Co: Pre-Construction Stage, Co: Construction Stage, Op: Operation Stage

Source: JICA Survey Team

## (9) Mitigation measures and Environmental Management Plan

Environmental management plan that mitigate anticipated impacts and its costs are shown in the table below.

**Table 1-3-30 Environmental Management Plan**

| No.   | Impact Category           | Management activities (mitigation measures)   | Implementation  | Responsibility          | Cost (USD)      |
|---|---------------------------|---|---|-------------------------|-----------------|
| <b>Before Construction/ During Construction</b> |                           |   |   |                         |                 |
| 1   | Air Pollution             | <ul style="list-style-type: none"> <li>Watering of road surfaces and areas to be demolished.</li> <li>Provide training to construction vehicle drivers and workers to avoid idling vehicles and equipment.</li> <li>Properly maintain construction equipment and prevent abnormal black or white smoke from the machine</li> </ul>                          | Contractor  | DWRI                    | Included in BOQ |
| 2   | Water Pollution           | <ul style="list-style-type: none"> <li>Turbid water associated with the construction will be drained downstream after precipitation of sediment by using a temporary cofferdam.</li> <li>Discharge of alkaline drainage from concrete work site should be gradual so as not to have a sudden impact downstream.</li> </ul>                                  | Contractor  | DWRI                    | Included in BOQ |
| 3   | Solid Wastes              | <ul style="list-style-type: none"> <li>Reuse excavated soil and other materials as much as possible.</li> <li>Old bricks, concrete rubble, and earth and sand resulting from the demolition of existing structures should be disposed of in locations designated by the local government.</li> </ul>  | Contractor  | DWRI                    | Included in BOQ |
|   |                           | <ul style="list-style-type: none"> <li>Guide the prevention and management of littering of refuse into canals.</li> </ul>   | Soft Component  | DWRI                    | Soft Component  |
| 4   | Soil Contamination        | <ul style="list-style-type: none"> <li>Use a drip tray when working with potential oil spills.</li> <li>Regularly inspect and maintain heavy machinery and equipment to prevent oil leaks.</li> </ul>   | Contractor  | DWRI                    | Included in BOQ |
| 5   | Noise and Vibration       | <ul style="list-style-type: none"> <li>Perform regular maintenance of equipment to prevent abnormal noise and vibration.</li> <li>Workers working near noisy equipment should be provided with ear protection.</li> <li>In the vicinity of facilities that require special consideration, we will devise a schedule and set up temporary fences.</li> </ul> | Contractor  | DWRI                    | Included in BOQ |
| 10  | Ecosystem                 | <ul style="list-style-type: none"> <li>Provide education to avoid the unnecessary killing of wildlife at construction sites.</li> <li>Secure the migration routes of Asian Elephants and assign night guards to ensure a system that enables necessary communication with rangers.</li> <li>Implementation of monitoring of wildlife.</li> </ul>            | Contractor  | DWRI                    | Included in BOQ |
| 14  | Land Acquisition          | Land acquisition and compensation or assistance in accordance with the ARAP   | DWRI, DCD (District Compensation Determination Committee) | DWRI                    | ARAP Cost       |
| 15  | Vulnerable social groups, | • ditto   | ditto   | DWRI (with MoWC and SW) | ARAP Cost       |
| 16 &  | Local economy economy     | • Adherence to the minimum age set by the Child Labor Law   | Contractor  | DWRI                    | Included in BOQ |

| No.                | Impact Category   | Management activities (mitigation measures)   | Implementation              | Responsibility | Cost (USD)      |
|--------------------|---|---|-----------------------------|----------------|-----------------|
| 26                 | (employment, livelihoods, etc.), children's rights                              | <ul style="list-style-type: none"> <li>Securing movement routes for vehicles and pedestrians during construction by installing temporary roads</li> </ul>   |                             |                |                 |
| 18                 | Water Use   | <ul style="list-style-type: none"> <li>Construction of alternative wells.</li> <li>After construction, the results will be compared with WHO drinking water quality standards.</li> <li>During construction, a constant volume of water will be discharged downstream.</li> </ul>   | DWRI                        | DWRI           | ARAP Cost       |
| 27 & 28            | Infectious Disease Control. Working environment (including occupational safety) | <ul style="list-style-type: none"> <li>Take preventive measures in accordance with declarations and action regulations related to the prevention of the spread of COVID-19.</li> <li>Thoroughly implement general infection prevention measures, such as masks, hand disinfection, and temperature checks.</li> <li>Appropriate occupational safety equipment (helmets, shoes, etc.) will be provided according to the nature of the work.</li> <li>Conduct a safety convention for workers.</li> </ul> | Contractor                  | DWRI           | Included in BOQ |
| 29                 | Accidents   | <ul style="list-style-type: none"> <li>Perform routine maintenance on heavy machinery and equipment.</li> <li>Take measures to prevent water-related accidents at the CUP.</li> </ul>   | Contractor                  | DWRI           | Included in BOQ |
| 30                 | Climate Change  | <ul style="list-style-type: none"> <li>Perform routine maintenance on heavy machinery and equipment.</li> <li>Prevents unnecessary idling.</li> </ul>   | Contractor                  | DWRI           | Included in BOQ |
|                    |   | <ul style="list-style-type: none"> <li>Tree planting for cut down trees.</li> </ul>   | DWRI (with DFO)             | DWRI           | GON admin. cost |
| After Construction |   |   |                             |                |                 |
| 3                  | Waste   | <ul style="list-style-type: none"> <li>Conduct monitoring and educational activities related to the prevention of waste littering.</li> </ul>   | DWRI (with local community) | DWRI           | GON admin. cost |
| 10                 | Ecosystem   | <ul style="list-style-type: none"> <li>Confirm that Asian Elephants migration impediments are not occurring.</li> </ul>   | DWRI (with KTWR)            | DWRI           | GON admin. cost |
| 29                 | Accidents   | <ul style="list-style-type: none"> <li>Organize records of the occurrence of accidents and take measures to prevent a recurrence.</li> </ul>  | DWRI (with local community) | DWRI           | GON admin. cost |

Source: JICA Survey Team

## (10) Environmental Monitoring Plan

An environmental monitoring plan as described in the table below will be implemented during the pre-construction, construction, and operation phases to mitigate impacts. The implementing agency will be different depending on the monitoring items, but all the supervising agencies will be DWRI as a project proponent in collaboration with local stakeholders.

**Table 1-3-31 Environmental Monitoring Plan (EMoP)**

| Category                                    | Monitoring Item                                 | Frequency                           | Indicator  | Place  | Implementer                                       |
|---|---|-------------------------------------|--|--|---|
| < Before Construction / During Construction |   |                                     |  |  |   |
| 0. Common                                   | Record of Complain and Grievance management     | Once a Week                         | Presence of complaints and grievance handling record | DWRI Office, Land acquisition and compensation committee | DWRI, Land acquisition and compensation committee |
|   | Maintenance and inspection records of equipment | Daily: 1 time<br>Periodic: Optional | Presence of maintenance records                      | Project Site   | Contractor  |
| 1. Air Pollution                            | Status of water sprinkling implementation       | Once a Month                        | Presence of implementation record                    | Project Site   | Contractor  |
|   | Abnormal actuation of machine and equipment     | Once a Month                        | Presence of white/dark smoke                         | Project Site   | Contractor  |
|   | Dust generation status by visual inspection     | Once a Month                        | Presence of dust spread                              | Project Site   | Contractor  |

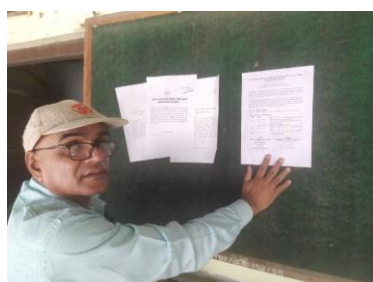
| Category  | Monitoring Item   | Frequency  | Indicator  | Place  | Implementer |
|---|---|--|--|--|-------------|
| 2. Water Pollution                                      | Water quality (turbidity, pH) of irrigation Canals as baseline values   | One time before construction in the dry season     | Test record  | Locations where the discharge of muddy water and concrete effluent is expected | Contractor  |
|   | Water quality of treated wastewater   | Once a Week  | Less than baseline   |  | Contractor  |
| 3. Solid Waste  | Status of reuse of soil generated on-site   | Once a Month                                       | Presence of reuse record                                     | Project Site   | Contractor  |
|   | Status of disposal of concrete rubble, formwork, waste oil, etc. at designated disposal sites                                 | Once a Month                                       | Presence of record of disposal at the appropriate site       | Disposal site  | Contractor  |
|   | Training for workers on waste and waste disposal  | Once a Month                                       | Presence of record   | Project Site   | Contractor  |
| 4. Soil Contamination                                   | Drip tray usage   | Once a Month                                       | Presence of record   | Project Site   | Contractor  |
| 10. Ecosystem   | Implementation of environmental education for workers   | Beginning and Once a Month                         | Presence of record   | Project Site   | Contractor  |
|   | Wildlife Crossing Status  | Once a Month                                       | Presence of record   | Project Site   | Contractor  |
|   | Monitoring on wildlife  | Once a Month                                       | Presence of record, species and number of wildlife monitored | Project Site   | Contractor  |
| 14. Land Acquisition                                    | Status of final valuation assessment  | Once at the time of implementation                 | Presence of record   | PAHs (PAFs)  | DWRI/CDC    |
|   | Status of land acquisition and compensation payments based on the resettlement plan   | Once a month during the ARAP implementation period | Deviation from ARAP, presence of receipts                    | PAHs (PAFs)  | DWRI/CDC    |
| 15. Socially vulnerable people                          | Status of Support for Households with Socially Vulnerable Members   | Once a month during the ARAP implementation period | Deviation from resettlement plan, whether support            | PAHs (PAFs)  | DWRI/CDC    |
| 18. Water Use   | Construction status of alternative water intake facilities  | Once per completed month                           | Presence of record   | Well construction site   | DWRI        |
|   | Water quality at alternative intake facilities  | Once upon completion of good drilling              | WHO water quality standards, Nepali standards                | ditto  | DWRI        |
| 26. Children's Right                                    | (Confirmation of Underage Workers in the Worker Register)   | Once a Month                                       | Employment record under 16 years old,                        | Project Site   | Contractor  |
| 27. Working environment (including occupational safety) | Status of distribution of helmets, protective goggles, ear protection, etc. to workers  | Month of execution                                 | Presence of implementation record                            | Project Site   | Contractor  |
|   | Implementation of countermeasures against new coronary infections   | Once a Month                                       | Presence of implementation record                            | Project Site   | Contractor  |
|   | First Aid Kits installation (FAK) deployment status   | Once a Month                                       | Presence of deployment record                                | Project Site   | Contractor  |
|   | Preparation of accident and emergency response manual and dissemination to workers  | Month of execution                                 | Presence of manual and record of dissemination to workers    | Project Site   | Contractor  |
| 29. Accidents   | Status of prior notification of construction sections to surrounding municipalities   | Once a Month                                       | Record of notice   | Project Site   | Contractor  |
|   | Status of signage, guides, and night patrols  | Once a Month                                       | Presence of record   | Project Site   | Contractor  |
|   | Confirmation of records describing the extent, frequency, causes, and future countermeasures for accidents that have occurred | Once a Month                                       | Presence of record   | Project Site   | Contractor  |
| <Operation phase>                                       |   |  |  |  |             |
| 3. Waste  | Garbage disposal situation  | Twice a year (for                                  | Presence of record   | Project Site   | DWRI        |

| Category      | Monitoring Item  | Frequency  | Indicator                                 | Place   | Implementer                                |
|---------------|--|--|---|---|--|
|               |  | three years after handover of the project)                   |   |   |  |
| 10. Ecosystem | Confirmation of wildlife migration   | Twice a year (for three years after handover of the project) | Presence of record                        | Project Site  | DWRI (with KTWR and ranger if necessarily) |
| 29. Accidents | Accident occurrence records (including measures to prevent future accidents) | Once a year (for three years after handover of the project)  | Presence of record of accident occurrence | Traffic police, interviewing residents if necessary | DWRI                                       |

Source: JICA Survey Team

## (11) Stakeholder Meeting

In the early stage of the survey, the COVID-19 infection was spreading and vaccination had not progressed, so the JICA Survey Team conducted a series of interviews via meetings with as small several people as possible and telephone. In addition, at the end of the survey, around September 2021, the infection situation had calmed down and local governments had relaxed their prohibitory orders, so the survey team held medium-scale meetings with a wide range of stakeholders representing the project area. In addition, taking into consideration the fact that the project area is long from north to south, the meetings were held in different locations. As a result, more than 30 meetings were held, and its executive summary is shown below. In addition to these consultation meetings, opinions were collected using local newspapers and bulletin boards at public facilities, and individual interviews were conducted with nearby residents as part of the field survey. The comments obtained were examined and reflected in the project plan and design as appropriate.



Publication of Notice of Public Consultation



Interviews with women's groups



Interviews with women's groups

**Table 1-3-32 Summary of stakeholder consultations**

| No                             | Date          | Venue  | Attended Organization  | Num. of Attendance |      |        | Agenda  |
|--------------------------------|---------------|--|--|--------------------|------|--------|---|
|                                |               |  |  | Total              | Male | Female |   |
| <b>I. Consultation Meeting</b> |               |  |  |                    |      |        |   |
| 1                              | 2021 April 09 | Koshi Tappu Wildlife Reserve Office                | Koshi Tappu Wildlife Reserve (KTWR) Chief Warden, Chairman of Buffer zone user group | 2                  | 1    | 0      | Project Summary, Description, and Anticipated Impacts/Mitigation Measures for Koshi Tappu Wildlife Sanctuary            |
| 2                              | 2021 April 10 | Buffer Zone office of Koshi Tappu Wildlife Reserve | Ranger of Buffer Zone of KTWR, Chairman of Buffer zone user group                    | 1                  | 1    | 0      | Project Summary Description and Impacts/Mitigation Measures for Buffer Zones  |
| 3                              | 2021 April 12 | Home of Chairman                                   | PurbaPipra-Dharampur-GhoganPur Buffer Zone User Committee (Western)                  | 1                  | 1    | 0      | ditto   |
| 4                              | 2021 April 21 | Ranger Office, Sitapur                             | District Forest Office, Rajbiraj, Saptari  | 1                  | 1    | 0      | Explanation of the project outline and confirmation of requirements for tree cutting and transplantation / compensation |

| No                                       | Date           | Venue                                  | Attended Organization   | Num. of Attendance |      |        | Agenda  |
|--|----------------|--|---|--------------------|------|--------|---|
|  |                |  |   | Total              | Male | Female |   |
| 5  | 2021 April 21  | Postal Highway Project Office, Itahari | Postal Highway Project Office   | 1                  | 1    | 0      | Extraction of lessons from similar cases, procedures that require special consideration, etc.   |
| 6  | 2021 July 05   | Kanchanrup                             | Farmers   | 2                  | 2    | 0      | Compensation for a potential temporary site acquisition site for construction   |
| 7  | 2021 August 29 | Along CUP-02                           | Farmers   | 2                  | 2    | 0      | Land acquisition and compensation for line changes  |
| <b>II. Key Informant Interview (KII)</b> |                |  |   |                    |      |        |   |
| 8  | 2021 July 07   | Gangajali-4, Saptakoshi Na.Paa.        | Province Member of Province 2   | 1                  | 1    | 0      | Explanation of the project outline, prevention of deforestation in the catchment area, and collection of requests for the construction of a canal crossing bridge and drainage facilities |
| 9  | 2021 July 08   | Kanchanrup Na. Paa.                    | ward Adhyaksha  | 1                  | 1    | 0      | Planned renovation projects (general)   |
| 10                                       | 2021 July 08   | Saptakoshi Na.Paa                      | Mayor, Saptakoshi Municipality  | 1                  | 1    | 0      | Actual project schedule, maintenance of access roads, pollution control   |
| 11                                       | 2021 July 09   | Saptakoshi Na.Paa-1, Fattepur          | Ward President, ward no 1   | 1                  | 1    | 0      | Relocation of affected households   |
| 12                                       | 2021 July 09   | Kanchanrup Na. Paa.-6, Ghoghanpur      | Main Officer, Kanchanrup municipality   | 1                  | 1    | 0      | Coordination with local stakeholders  |
| 13                                       | 2021 July 09   | Telecom-Fattepur sub Branch            | linemen Telecom Fattepur sub Branch   | 1                  | 1    | 0      | Optical communication cable relocation  |
| 14                                       | 2021 July 10   | Kanchanrup Na. Paa.                    | Mayor, kanchanrup municipality  | 1                  | 1    | 0      | The conflict between humans and wildlife  |
| 15                                       | 2021 July 10   | Kanchanrup Na. Paa                     | Nimitta Administration Officer  | 1                  | 1    | 0      | Tree Planting and Wildlife Conservation   |
| 16                                       | 2021 July 10   | Kanchanrup Na. Paa.-Kanchanpur         | Kharidar  | 1                  | 1    | 0      | Planned rehabilitation projects in general  |
| 17                                       | 2021 July 10   | Koshi Pamp Nahar Irrigation            | Branch Office Head, Nepal Bidhyut   | 1                  | 1    | 0      | Relocation of power poles   |
| 18                                       | 2021 July 10   | Tirahut Ga.Paa. - 2                    | Engineer  | 1                  | 1    | 0      | Improvement of agricultural productivity  |
| <b>III. Focus Group Discussion</b>       |                |  |   |                    |      |        |   |
| 19                                       | 2021 July 07   | Saptakoshi Municipality,               | Women group, water user association, vegetable seller group   | 47                 | 28   | 19     | Allocation of water, promotion of employment of local human resources, and implementation of training and other activities in parallel with facility development                          |
| 20                                       | 2021 July 08   | Kanchanrup Municipality,               | Women group, water user association, vegetable seller group, Muslim   | 25                 | 21   | 4      | Requests related to capacity building training  |
| 21                                       | 2021 July 09   | Rajbiraj                               | District Forest Rajbiraj  | 3                  | 3    | 0      | Environmental impact mitigation, flood damage mitigation  |
| 22                                       | 2021 July 09   | Pathari                                |   | 4                  | 4    | 0      | The conflict between people and wildlife, agricultural promotion  |
| 23                                       | 2021 July 09   | Tirahut Municipality                   | Women group and male group  | 6                  | 6    | 0      | Planned rehabilitation projects in general  |
| 24                                       | 2021 July 10   | Agnisair Municipality                  |   | 7                  | 7    | 0      | Request for agricultural promotion program or training  |
| 25                                       | 2021 July 10   | Rajbiraj                               |   | 6                  | 6    | 0      | Need for facility renovation  |
| 26                                       | 2021 Sept 28   | Saptakoshi Municipality, Ward no 4     | Mayor, chairman of ward no 4, NGO representative, local leaders, Water Users Association (WUA) Chairperson, Heath Post, affected communities of the RM, representatives | 66                 | 31   | 35     | Disclosure of information on IEE survey results (survey methodology, findings, possible impacts, concerns, mitigation measures) and exchange of views on these findings                   |

| No | Date         | Venue  | Attended Organization  | Num. of Attendance |            |           | Agenda  |
|----|--------------|--|--|--------------------|------------|-----------|---|
|    |              |  |  | Total              | Male       | Female    |   |
|    |              |  | of political parties, local school teachers, representative from DWRI, Koshi Pump Chandra Nahar Irrigation Management Office, Local Businessman,   |                    |            |           |   |
| 27 | 2021 Sept 28 | Tirhut Rural Municipality (RM), Ward no 3            | Tiruhath RM (Chairperson), Tiruhath RM affected Wards (Chairperson), local leaders, Water Users Association (WUA) Chairperson, Health Post, affected communities of the RM, representatives of political parties, local school teachers  | 36                 | 34         | 2         | ditto   |
| 28 | 2021 Sept 28 | Kanchanrup Municipality, Ward no 7                   | Mayor of Kanchanrup municipality, deputy mayor of Kanchanrup municipality, ward chairman of ward 6, and 7, local people, businessmen, School Teachers, environment experts from DWRI   | 46                 | 34         | 12        | ditto   |
| 29 | 2021 Sept 28 | Agnisar Krishnasabaran Rural Municipality, Ward no 4 | Agnisar Krishnasabaran Rural Municipality (Chairperson of the affected Wards), affected communities of the Agnisar Krishnasabaran Rural Municipality, local leaders, local school teachers, Health Post, representatives of political parties, Koshi Pump Chandra Nahar Irrigation Management Office, Department of Water Resources and Irrigation | 48                 | 42         | 6         | ditto   |
| 30 | 2021 Sept 29 | Mahadeva Rural Municipality, Ward no 1               | Mahadeva Rural Municipality (Chairperson of the affected Wards), Division Forest Officer (DFO), Health Post, local leader, local school teachers, representatives of political parties, affected communities of the Mahadeva Rural Municipality, and Rajbiraj Municipality   | 29                 | 28         | 1         | ditto   |
| 31 | 2021 Sept 27 | Koshi Tappu Wildlife Reserve (KTWR) Office           | Koshi Tappu Wildlife Reserve (KTWR) Chief Warden   | 1                  | 1          | 0         | Ditto (in particular, possible impacts on ecosystems and mitigation measures) |
|    |              |  | <b>Total</b>   | <b>345</b>         | <b>266</b> | <b>79</b> |   |

Source: JICA Survey Team

### 1-3-2 Land acquisition and resettlement

#### (1) The necessity of land acquisition and resettlement, and consideration of minimizing impacts

The target of this project is the rehabilitation of existing irrigation and drainage facilities and bridge

facilities. To minimize the negative impacts of land acquisition and resettlement, the project will not change from the current alignment. Therefore, no large-scale land acquisition is anticipated, but stalls, livestock corrals, barns, and trees, including fruit trees, constructed in the vicinity of the facilities to be rehabilitated in the ROW will interfere. The exception to this is CUP-02, where a change in alignment would occur. For this location, the existing alignment is distorted, and it is desirable to change the alignment from the perspective of future sediment control, so the plan is to acquire the minimum amount of land. Moreover, there will be no resettlement of residence due to this alignment change.

## (2) Legal Framework for Land Acquisition and Resettlement

### 1) Land Acquisition Act (1977; (2034 BS), enacted 1962, amended in part in 1993)

The Land Acquisition Act, 1977 (2034 BS), has been enacted to integrate the laws for Acquisition of Land, 1962, and partially updated in 1993 by its subsequent amendment. Section 3 of the Act empowers the government to acquire land at any place, for public works by providing the required compensation to its owners. The Act obliges the government to consider the compensation for the acquisition of land for the benefit of the local people. Article 12 established Compensation Fixed (Determination) Committee as a leading organization for fixing compensation unit price. Steps of the Land Acquisition plan as per the Land Acquisition Act 1977 are presented in the figure below.

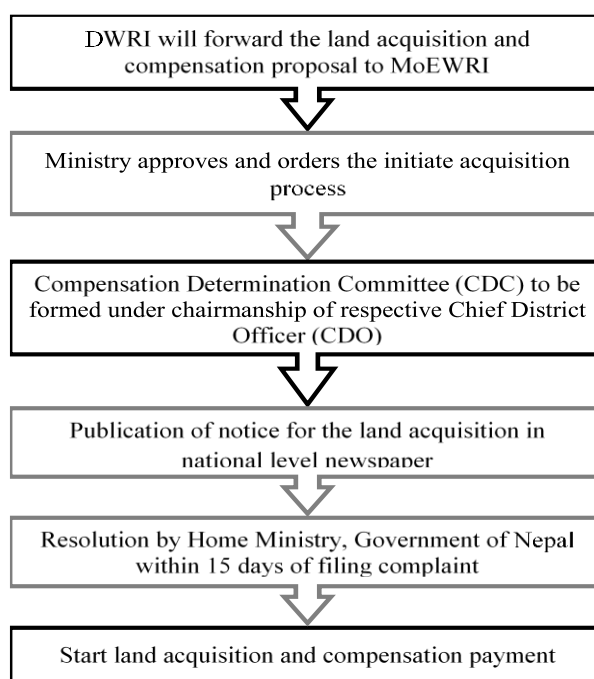


Figure 1-3-10 Land Acquisition Procedures in Nepal

### 2) Guidelines for Land Acquisition (1989)

The Land Acquisition Guidelines and guidelines according to sections 16 and 17 of the Land Acquisition Act 1977 specify two categories of affected families, namely Project Affected Families (PAF) and Seriously Project Affected Family (SPAF). A PAF consists of the members of a household including elderly dependents and minor children (under 18 years) residing under one roof and operating as a single economic unit, who are adversely affected by the project. SPAF is defined as a family that loses over 25% of its total land holdings or whose land is reduced to an uneconomic holding (less than 5.0 katha<sup>8</sup> or who is being displaced).

Under these guidelines, the concerned officials, with the assistance of the project team, are to carry out assessments of project-affected families to identify their standard of living and types of assets.

Valuation of land and asset lost were to be based on comparative market values of similar assets in the vicinity. The guidelines also included arrangements for the rehabilitation of project-affected families. For PAF's, the compensation package includes cash for assets acquired or damaged by the project and a rehabilitation grant (assistance allowance) to cover any suffering and hardship. For SPAF's, the compensation additionally includes employment for one family member and provision of skill training.

<sup>8</sup> 1 katha is equivalent to 338.63 square meters

The Guidelines specify the establishment of an Acquisition and Rehabilitation Committee (also known as Compensation Determination Committee, “CDC”) consisting of the concerned Chief District Officer (Chair), Land Revenue Officer, representative of the District Coordination Committee (DCC), and the Project Manager and others as deemed necessary. The Committee is responsible for acquiring land and paying compensation. In 1993, the second set of guidelines reduced the Acquisition and Rehabilitation Committee to a four-member Compensation Fixation/Determination and Rehabilitation Management Committee by dropping the Land Revenue Officer and other governmental appointees. The functions and powers of the committee were clarified, as were methods of payment and means of ensuring fair valuation of land quality.

### 3) Land Acquisition, Resettlement and Rehabilitation Policy (not yet enforced)

The Government of Nepal, Ministry of Land Reform, has prepared Land Acquisition, Resettlement, and Rehabilitation Policy under technical assistance with ADB, however, the policy has not yet been enacted in the Nepalese Gazette. The drafted policy emphasizes scientific standards for land valuation and extension of compensation equivalent to the minimum market value of the land. A provision in the policy allows the government to take action against those who try to disrupt land acquisition process or create hurdles for the project. In this regard, the policy has stressed the need to first assess of socio-economic impacts of a project. All expenses related to land acquisition, compensation, and implementation of resettlement and rehabilitation plans should be considered as a project cost.

### 4) Gap Analysis on Legal System for Land Acquisition and Resettlement

The results of the gap analysis between the legal system for land acquisition and resettlement in Nepal and the JICA Environmental and Social Consideration Guidelines and the World Bank Safeguard Policy and the policy adopted in this project are shown in the table below.

**Table 1-3-33 Gap Analysis between Nepal's Legal System and JICA ESCs Guidelines and World Bank Safeguard Policies for Land Acquisition and Resettlement**

| No. | JICA ESC Guidelines and World Bank OP 4.12 (A)  | Nepal Law (B)  | The gap between (A) and (B)   | Policy by this project  |
|-----|---|--|---|---|
| 1   | Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)  | To authorize the acquisition of land at any place by providing the owner thereof with compensation necessary for public works. (Land Acquisition Act)                      | In Nepal, relocation and land acquisition is considered unavoidable in the public interest.   | As the certain land acquisition is inevitable, effective measures to minimize the scope of land acquisition and compensate for losses will be considered. |
| 2   | When population displacement is unavoidable, effective measures to minimize impact and compensate for losses should be taken. (JICA GL)   | It is stated that avoidance, mitigation, and minimization of negative impacts must be considered in the EIA and IEE. (EPR)   | There is no mention of this matter in the Land Acquisition Act, but there are no particular gaps between the description in EPR and JICA ESCs Guidelines. |   |
| 3   | People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported so that they can improve or at least restore their standard of living, income opportunities, and production levels to pre-project levels. (JICA GL) | The compensation package for affected families will include cash payments, livelihood restoration assistance, and employment opportunity creation. (Land Acquisition Act). | There is no description of the specific target level.   | Actual cases will also be checked and compensation and support based on the replacement cost will be considered.  |
| 4   | Compensation must be based on the full replacement cost as much as possible. (JICA GL)  | Where the land acquisition is carried out in the public interest, compensation based on market prices shall be paid. (Land Acquisition Act)                                | Under Nepalese law, compensation is paid based on market prices.  |   |

| No. | JICA ESC Guidelines and World Bank OP 4.12 (A)  | Nepal Law (B)  | The gap between (A) and (B)   | Policy by this project  |
|-----|---|--|---|---|
| 5   | Compensation and other kinds of assistance must be provided before displacement. (JICA GL)  | Contents that correspond to this article were not confirmed.   | There is no mention of it in the Nepalese domestic law.   | Compensation and other assistance will be provided before physical relocation.  |
| 6   | For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. (JICA GL)   | Contents that correspond to this article were not confirmed.   | Nepal does not require to prepare a RAP.  | Prepare an ARAP under OP 4.12 of the World Bank Safeguard Policy.   |
| 7   | In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. (JICA GL)   | When acquiring land for use, the information shall be disclosed through local newspapers (Land Acquisition Act).   | Disclosure of information (notice) is provided for, but couldn't find any mention of prior disclosure or language.  | When preparing the resettlement plan (including resident consultation), information on the project outline and expected impacts should be given in advance, and explanations should be given in the local language. |
| 8   | When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. (JICA GL)   |  |   |   |
| 9   | Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans. (JICA GL)   | The promotion of stakeholder participation is advocated in environmental management regulations.   | There is no significant difference between the two.   | Conduct public consultations, taking care to ensure that there is no bias towards gender or participants from particular regions.   |
| 10  | Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. (JICA GL)  | There is a description of complaints and compensation through local communities in the EPR. In addition, many ministries and agencies in Nepal, including MoEWRI, have published contact addresses for grievance redress on their websites, which can be accessed by anyone. | There is no significant difference between the two.   | Develop a grievance mechanism that takes into account the accessibility of local people.  |
| 11  | Affected people are to be identified and recorded as early as possible to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits. (WB OP4.12 Para.6) | The determination of the beneficiaries and the scope of land acquisition must be carried out by the Compensation Committee as soon as possible after the project is officially approved.   | For land tenure holders, the cut-off date will be under Nepalese national law, while the cut-off date for informal residents will be at the start of the census survey. | After formal approval of the project, the Compensation Determination Committee of Saptari district will conduct the reassessment and payment after securing the necessary budget.                                   |
| 12  | Eligibility of benefits includes, the a) PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), b) the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and c) the PAPs who have no recognizable legal right to the land they are occupying. (WB OP4.12 Para.15)  | Eligible persons shall be limited to those who have legal rights to land and property.   | Items b) and c) mentioned in the JICA ESCs / WB OP 4.12 are not included in the eligibility requirements in Nepal.  | Items b) and c) in the JICA ESCs guidelines will also be considered for assistance.   |
| 13  | Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 Para.11)  | There are mentions of "arrangements for rehabilitation" and "priority in employment", but no mention of priority for land. There is no mention of priority for land.   | There is no mention of land as a priority in Nepal's domestic laws.   | Priority will be given to land-based compensation for farmers who depend on land for their livelihood.  |
| 14  | Provide support for the transition period (between  | There is no mention of support during the transition period.   | There is no mention of support during the transition  | The impact of the transition period and   |

| No. | JICA ESC Guidelines and World Bank OP 4.12 (A)   | Nepal Law (B)   | The gap between (A) and (B)              | Policy by this project   |
|-----|--|---|--|--|
|     | displacement and livelihood restoration). (WB OP4.12 Para.6)   |   | period in Nepal's domestic law.          | the need for support will be discussed.  |
| 15  | Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc. (WB OP4.12 Para.8) | The definition of Serious Project Affected Families (SAPF) and the necessary support measures are provided. (Land acquisition method) For the definition of socially vulnerable groups, see the section on environmental impact assessment. | No significant difference is identified. | Employment and skills training will also be considered where socially vulnerable persons and households containing socially vulnerable persons are among the affected persons. |

Source: JICA Survey Team

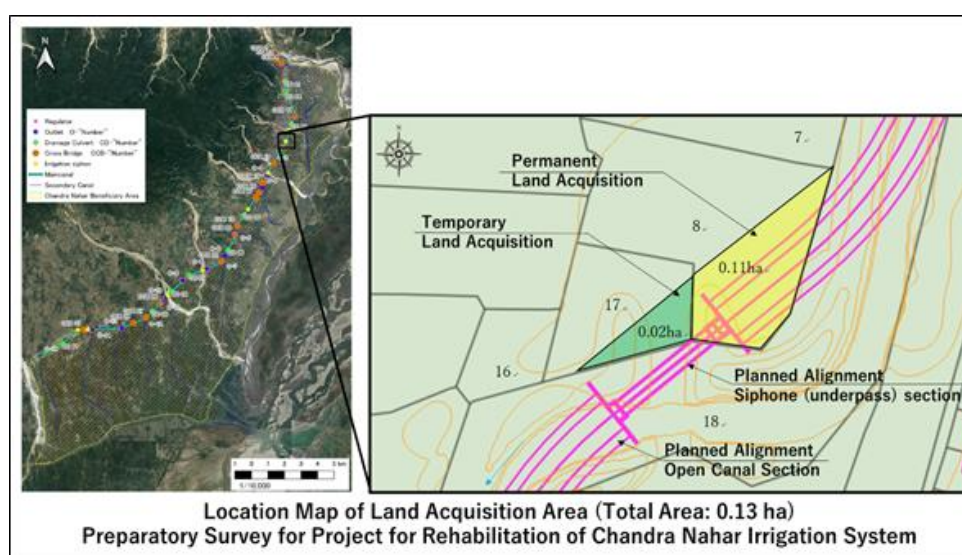
### (3) Scale and scope of land acquisition and resettlement

#### 1) Land Acquisition

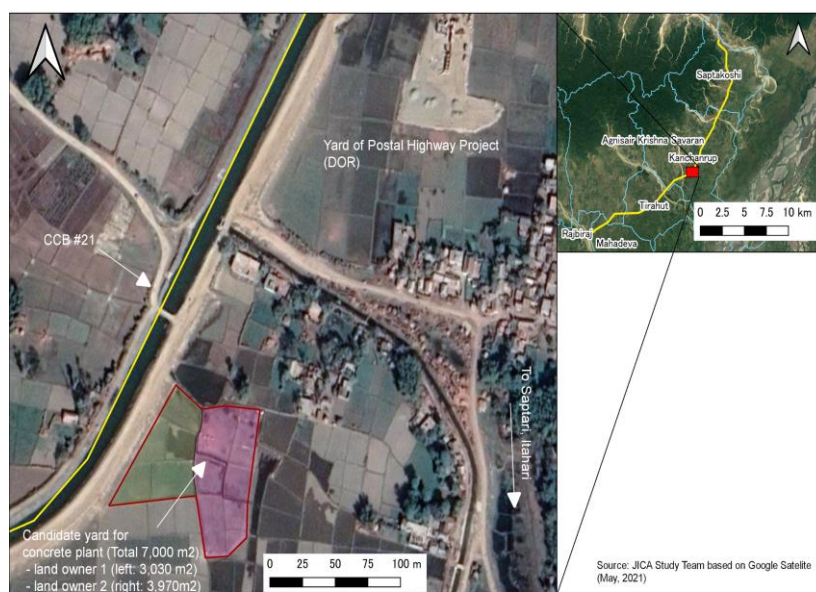
As mentioned above, this project is to be carried out within the existing irrigation canal ROW in general, and therefore, the scope of land acquisition is limited to two locations: the CUP No. 2, where an exceptional alignment change will be carried out, and the concrete plant yard for construction work. Where to secure the concrete plant yard is at the discretion of the contractor, but since the survey team could not confirm a sufficiently large area of government-owned land in the vicinity of the facilities to be rehabilitated, the survey team confirmed it as a temporary concrete plant yard for the purpose of securing an estimated budget. The total area of the acquired land is 0.83 ha. The breakdown of the area and the location map are shown below

**Table 1-3-34 Scope of land acquisition**

| Purpose                          | Temporary land acquisition |                  | Permanent land acquisition |                  | Total       |                  |
|----------------------------------|----------------------------|------------------|----------------------------|------------------|-------------|------------------|
|                                  | Area (ha)                  | PAHs (Household) | Area (ha)                  | PAHs (Household) | Area (ha)   | PAHs (Household) |
| Change in alignment of CUP No. 2 | 0.02                       | 1                | 0.11                       | 1                | 0.13        | 2                |
| Construction Yard                | 0.70                       | 2                | 0.00                       | 0                | 0.70        | 2                |
| <b>Total</b>                     | <b>0.72</b>                | <b>3</b>         | <b>0.11</b>                | <b>1</b>         | <b>0.83</b> | <b>4</b>         |



**Figure 1-3-11 Scope of land acquisition for the alignment change of CUP**



**Location Map of Candidate Concrete Plant Yard (Area: About 7,000 m<sup>2</sup>)**  
**Preparatory Survey for Project for Rehabilitation of Chandra Nahar Irrigation System**

**Figure 1-3-12 Candidate sites for construction of concrete plant yard**

## 2) Affected Persons

In the project site, several households may live in the same facility, and these households are referred to as a PAF (Project Affected Family) as a single aggregate, but in this report, they are described as affected households.

As a result of the field survey, the number of affected households is 22 and the number of affected persons is 142. The breakdown is shown in the table below: 18 households have hindered properties such as livestock sheds, fruit trees, and stalls constructed in the irrigation canal ROW, and a total of 4 households are affected by land acquisition. No relocation of residential facilities will occur.

**Table 1-3-35 Number of affected persons**

| Category   | Nos. of PAHs | Nos. of PAPs |
|--|--------------|--------------|
| Within the irrigation Canal ROW                  | 18           | 125          |
| Outside irrigation Canal ROW (alignment changes) | 2            | 8            |
| Outside irrigation Canal ROW (plant yard)        | 2            | 9            |
| Total  | 22           | 142          |

The following table lists the properties owned by the affected households classified as "within the irrigation Canal ROW" in the above table that will be affected by the Project. Most of the affected properties are simple livestock facilities, trees, or stalls related to agriculture.

**Table 1-3-36 List of affected properties**

| Affected Item* <sup>1</sup> | Remarks          | Number of Properties | Number of households (Total number of households) |
|-----------------------------|------------------|----------------------|---|
| Vendor shop / stalls        | Kitchen Included | 13                   | 12  |
| Cattle barn                 |                  | 5                    | 4   |
| Hen cage                    |                  | 2                    | 2   |
| Well                        |                  | 5                    | 5   |
| Straw mound                 |                  | 3                    | 2   |

| Affected Item* <sup>1</sup> | Remarks | Number of Properties | Number of households<br>(Total number of households) |
|-----------------------------|---------|----------------------|--|
| Trees                       | Banana  | 34                   | 3  |
|                             | Mango   | 2                    | 2  |
|                             | Citrus  | 1                    | 1  |
|                             | Papaya  | 3                    | 1  |
|                             | Others  | 10                   | 4  |
| Total* <sup>2</sup>         |         | 78                   | 36   |

\*1: The stalls to be relocated do not include residential facilities. This list also does not include electric poles owned by Nepal Electricity Authority: NEA.

\*2: The total number of households does not equal the number of affected households because there are multiple affected assets in the same household.

Photographs of the major obstructed properties and a list of affected properties for each facility to be rehabilitated are shown below.



CCB02 (Pipal tree: pruning some branches for vehicular traffic)



CCB03 (Fiber optic cable: administered by NEA)



CDW02 (cattle shed directly above the cross-drainage works)



CDW04 (bananas planted directly above the cross drainage works)



CCB31 (Stalls and huts located around the location of the temporary bridge)



CUP7 (stall and well near left bank side of CUP exit)

### 3) Socio-Economic Survey

A socio-economic survey was conducted on 15 of the affected households. The results of the survey are presented below.

#### (a) Family Structure

Forty percent of the households surveyed live together in a form known as a Joint Family.

**Table 1-3-37 Family Structure**

| By Family Type | Surveyed Households (No) | %   |
|----------------|--------------------------|-----|
| Single Family  | 9                        | 60  |
| Joint Family   | 6                        | 40  |
| Total          | 15                       | 100 |

Source: Household Survey, 2021

### (b) Occupation and Income

The most common occupation among the households surveyed was farming or a combination of farming and street vendors, bicycle repairers, and migrant workers abroad (40%), followed by small businesses including street vendors (33%), security guards, and day laborers. The average monthly income was NRs. 21,000 with the highest household earning NRs. 35,000 and the lowest NRs. 13,000.

### (c) Educational Standards

The literacy rate of 78.94% is above the national average (67.9%), but the percentage of Grade +2 graduates is low at 8%.

**Table 1-3-38 Educational Standard**

| SN | Level of Education | Individual (No) | %     |
|----|--------------------|-----------------|-------|
| 1. | Literate           | 90              | 78.94 |
| 2. | SEE                | 15              | 13.15 |
| 3. | +2                 | 9               | 7.89  |
|    | Total              | 114             | 100%  |

Source: Household Survey, 2021

### (4) Entitlement Matrix

Although the illegal occupants in the ROW are not covered by the compensation in other projects implemented by the Government of Nepal, they are considered for compensation and relocation assistance in this project based on the JICA ESCs Guidelines (2010) and the World Bank OP4.12.

**Table 1-3-39 Entitlement Matrix**

| Type of Loss   | Eligibility Criteria   | Entitlement   |
|--|------------------------|---|
| 1. Loss of Private Land                                |                        |   |
| 1.1 Permanent Loss                                     | Landowner (Cultivator) | Priority will be given to land-based compensation, but if it is difficult to secure alternative land, monetary compensation based on the replacement cost will be provided. |
| 1.2 Temporary Loss                                     | Landowner (Cultivator) | Compensation shall be provided in cash. The land shall be returned after the restoration of the existing conditions before the completion of construction.                  |
| 2. Loss of assets on government-owned land             |                        |   |
| 2-1 Compensation for crops and trees                   | Owner of the trees     | Monetary compensation will be provided. Annual crops are not eligible for compensation as prior recommendations are made.   |
| 2-2 Assistance for removal of movable stalls and sheds | Owner of the assets    | Provide monetary relocation assistance.   |
| 3. Compensation for Community Wells                    | Community              | DWRI will construct and install the replacement well.   |

Note: DWRI will notify the NEA in advance of the relocation of fiber optic cables, poles, and wires.

Source: JICA Survey Team

### (5) Grievance Handling Mechanism

The grievance redress mechanism proposed in the implementation of the project is described below.

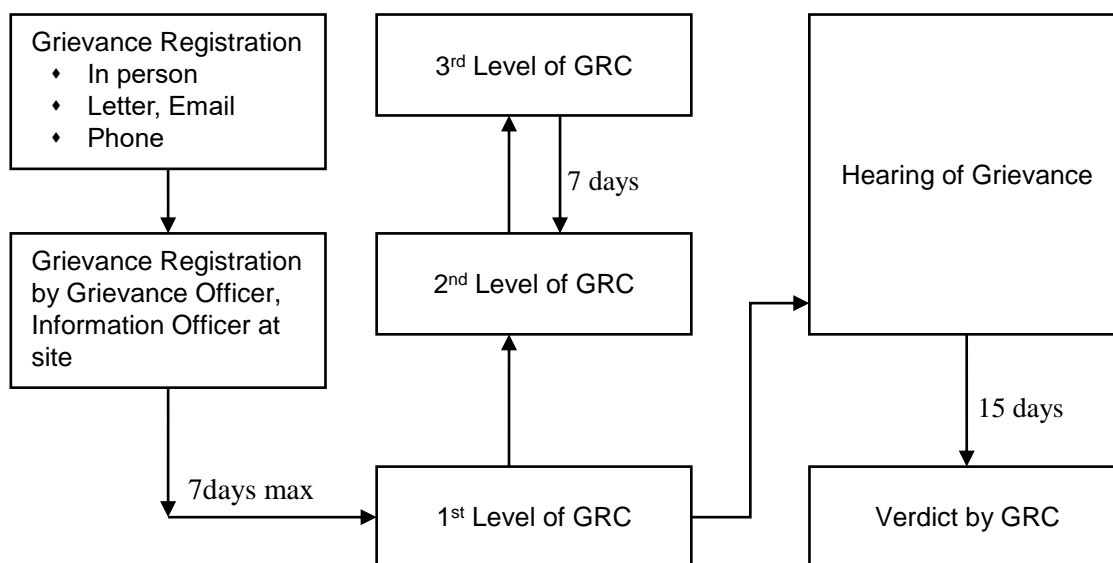


Figure 1-3-13 Complaint and grievance redress mechanism

### (6) Implementation Structure

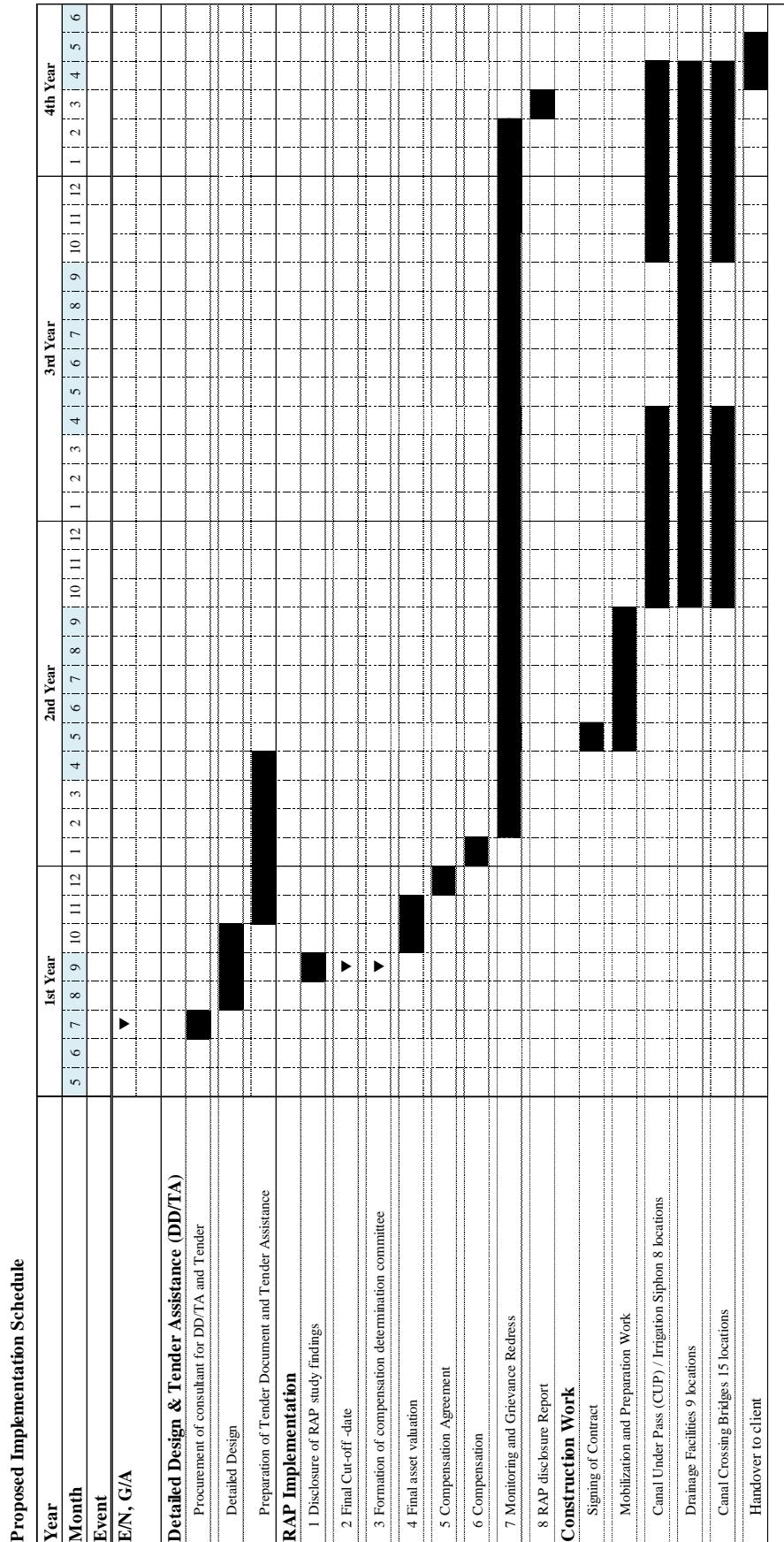
The scope of responsibilities of the agencies involved in the implementation of the ARAP is shown in the table below; DWRI will implement the ARAP in coordination with the district compensation determination committee and district administrative entities.

Table 1-3-40 Scope of responsibility of each organization in ARAP implementation

| S.N. | Activities  | Responsibility                             | Role   |
|------|---|--|--|
| 1    | Preparation of ARAP report                        | DWRI                                       | Survey and preparation of ARAP                   |
| 2    | Disclosure of RAP Findings                        | DWRI                                       |  |
| 3    | Final Cut-Off-Date                                | DWRI                                       |  |
| 4    | Formation of Compensation Determination Committee | District Administrative Office (Saptari)   | Lead role: CDO office<br>Facilitation role: DWRI |
| 5    | Final Asset Valuation                             | Compensation Determination Committee (CDC) | Lead: CDC<br>Facilitation: DWRI                  |
| 6    | Compensation Agreement                            | DWRI                                       |  |
| 7    | Compensation Payment                              | CDC  | Lead: CDC<br>Facilitation: DWRI                  |
| 8    | Monitoring of Grievance Redress                   | DWRI                                       |  |
| 9    | RAP Disclosure Report                             | DWRI                                       |  |

### (7) Implementation Schedule

Generally, when a project acquires land from private property, payment is made in about two months after the final assessment is made by the county compensation commissioner and if the affected parties agree to the compensation amount. Therefore, it is assumed that the land acquisition procedure can be completed by the time of bidding if the alignment is finalized at the time of detailed design and the final scope of land acquisition is presented to the Commission.



**Figure 1-3-14 ARAP Implementation Plan**

## (8) Costs and Financial Resources

The ARAP implementation and monitoring costs are shown in the table below.

**Table 1-3-41 Costs associated with the ARAP**

| No                               | Item description  | Unit    | QTY            | Unit cost (NRs.) | Total (NRs.)     | Source   |
|----------------------------------|---|---------|----------------|------------------|------------------|----------|
| <b>I.RAP Implementation Cost</b> |   |         |                |                  |                  |          |
| <b>1</b>                         | <b>Compensation (private)*1</b>                                   |         |                |                  |                  |          |
| 1-1                              | Temporary loss of private land (CUP-02)                           | Ha/year | 0.02           | 100,000          | 2,000            | DWRI     |
| 1-2                              | Temporary loss of private land (Concrete plant yard)              | Ha/year | 0.70 x 2 years | 180,000          | 630,180          | DWRI     |
| 1-3                              | Permanent loss of private land (CUP-02)                           | Ha      | 0.11           | 12,000,000       | 1,320,000        | DWRI     |
| 1-4                              | Loss of means of livelihood and damage on properties (relocation) | HHs     | 18             | *2               | 1,681,520        | DWRI     |
| <b>2</b>                         | <b>Compensation (public)</b>                                      |         |                |                  |                  |          |
| 2-1                              | Relocation of electric pole                                       | Pcs     | 10             | 10,000~8,000     | 111,000          | NEA      |
| 2-2                              | Reconstruction of water well                                      | Pcs.    | 5              | 20,000           | 100,000          | DWRI     |
| 2-3                              | Cutting and relocating trees                                      | Pcs.    | 22             | LS               | 100,000          | DWRI*3   |
| 2-4                              | Replanting tree (1:10)  | Pcs.    | 220            | 3,960            | 871,000          | DWRI*3   |
| <b>3</b>                         | <b>Other operation cost</b>                                       |         |                |                  |                  |          |
| 3-1                              | Staffing (social env. officer)                                    | Nos.    | 1              | LS               | ---              | DWRI*4   |
| 3-2                              | Final assets valuation  | Set     | 1              | 200,000          | 200,000          | CDC/DWRI |
| 3-3                              | Grievance Handling  | Set     | 1              | LS               | 150,000          | DWRI/GRC |
| 3-4                              | Reporting   | Set     | 1              | LS               | 100,000          | DWRI     |
|                                  | <b>Sub-Total (from 1 to 3 )</b>                                   |         |                |                  | <b>4,887,520</b> |          |
|                                  | Contingencies (10% of sub-total )                                 |         |                |                  | 488,700          |          |
|                                  | <b>Total</b>  |         |                |                  | <b>5,376,520</b> |          |

Note:

\*1: Figures mentioned above are a provisional amount based on the consultation with PAPs. The final amount shall be determined by the compensation determination committee.

\*2: See ARAP report for detail of provisional calculation of valuation for each affected asset.

\*3: Transportation of felling trees will be consulted with DFO.

\*4: Deputed directly from DWRI

Source: JICA Survey Team

**Table 1-3-42 Costs associated with ARAP monitoring**

| Activity   | Indicator                   | Quantity | Unit cost (NRs.) | Total Cost (NRs.) |
|--|-----------------------------|----------|------------------|-------------------|
| Meeting for set up compensation determination committees | Established committee       | 4        | 20,000.00        | 80,000.00         |
| Follow up valuation and compensation process             | Field report                | 1        | LS               | 100,000.00        |
| Meetings for grievance redress                           | Meetings/grievance resolved | 5        | 15,000.00        | 75,000.00         |
| PAPs Livelihoods assessment                              | Assessment report           | 1        | LS               | 250,000.00        |
| Subtotal   |                             |          |                  | 505,000.00        |
| Contingency (10%)  |                             |          |                  | 50,500.00         |
| Total  |                             |          |                  | 555,500.00        |

## (9) Monitoring system and monitoring form by implementing agency

The main purpose of the monitoring is to confirm that the compensation and support planned in the ARAP have been implemented to the affected people at the appropriate time and that their livelihood level has been restored to at least the same or better level than before the project implementation. DWRI, the implementing agency of the project, will prepare the monitoring form and submit it to JICA with the

cooperation of the Land Acquisition and Compensation Committee. The proposed monitoring form is attached as Appendix 4 (2).

### **(10) Public Consultation**

Public consultations are also carried out together with stakeholder meetings. For more information, see "Stakeholder Consultation" in Environmental and Social Considerations.

### **1-3-3 Others**

#### **(1) TOR Approval Letter**

cf.: Appendix 4

#### **(2) Environmental Checklist**

cf.: Appendix 4 (2).

#### **(3) Draft Monitoring Form**

cf.: Appendix 4 (2).

#### **(4) Initial Environmental Examination Report**

cf.: Appendix 4 (2).

#### **(5) Abbreviated Resettlement Action Plan**

cf.: Appendix 4 (2).

## **Chapter 2 Contents of the Project**



## Chapter 2 Contents of the Project

### 2-1 Basic Concept of the Project

#### (1) Project component

The components of the project are the rehabilitation of Canal Under Pass, Cross Drainage Work and Canal Crossing Bridge. The summaries of the project components are shown below.

**Table 2-1-1 Summaries of components**

| Component                      | Summary  |  |
|--------------------------------|--|--|
| Canal Under Pass<br>(CUP)      | Qty.   | 8 units  |
|                                | Main facility  | Box Culvert, Inlet, Outlet   |
|                                | Ancillary  | Screen: Installation at inlet<br>Transition: Establishment at up and down stream of the CUP<br>Lining: Connection between existing canal and transition<br>Bank protection: Irrigation canal slope and river bank        |
| Cross Drainage Work<br>(CDW)   | Qty.   | 9 units  |
|                                | Main facility  | Box Culvert, Inlet, Outlet   |
|                                | Ancillary  | Lining: Connection between existing canal and transition<br>Protection: Inlet and Outlet part<br>Intake facility: Re-construction when the facility is rehabilitated   |
| Canal Crossing Bridge<br>(CCB) | Qty.   | 15 units   |
|                                | Main facility  | Box Culvert  |
|                                | Ancillary  | Wing wall: Retaining<br>Transition: Section change point between canal and culvert<br>Lining: Connection between existing canal and transition<br>Access road<br>Check gate: Re-construction when a CCB is rehabilitated |
| Soft Component                 | Capacity development for maintenance of rehabilitated facilities (CUP) |  |

#### (2) Direct effectiveness

Around the project site, paddy rice and other crops like wheat and sugarcane have been cultivated using the Chandra Canal Irrigation System (CCIS). Based on the site survey, the JICA Survey Teams (JST) has confirmed that irrigable area could be expanded further from the current situation, once the conveyance efficiency is improved by rehabilitating facilities like Canal Under Passes which have leakage. JST has found that it is difficult to cultivate crops during dry season as in rainy season, because irrigation water could not fully conveyed to the field as the target facilities were collapsed. Preventive measures against collapse would make irrigation water supply stable and irrigated farming possible. Additionally, collapse of Canal Crossing Bridges would make negative impact on ease of access to fields, rice mill and distribution center, in addition to the impact on stable irrigation water supply. Farmers would be forced to make detour in such cases, and it would be a significant burden in terms of time and effort. The rehabilitation of the facility before it is completely collapsed would contribute to sustainable and stable farming activities.

Based on the above background, the direct effectiveness are summarized below.

**Table 2-1-2 Direct effectiveness of the project**

| Index                        | Baseline (2021) | Target value*1 | Remarks                                  |
|------------------------------|-----------------|----------------|--|
| Irrigable Area               |                 |                |  |
| (a) Rainy Season Crop (Rice) | 6,500 ha        | 7,800 ha       | Irrigable Area will increase by 1,300ha. |
| (b) Dry Season Crop (Wheat)  | 4,320 ha        | 5,200 ha       | Irrigable Area will increase by 880ha.   |
| Yield                        |                 |                |  |
| (c) Rainy Season Crop (Rice) | 30,900 ton      | 32,850 ton     | Yield will increase by 1,950ton.         |
| (d) Dry Season Crop (Wheat)  | 8,900 ton       | 10,700 ton     | Yield will increase by 1,800ton.         |

\*1: Target means 3 years after the completion of the project

\*2: The detail of calculation for target values shall be refer to Table 3-4-2

### (3) Indirect and long-term effectiveness

This project aims to increase the irrigable area, increase the rice productivity stably, and shorten the access distance to agricultural facilities by rehabilitating the target facilities, which are auxiliary facilities of main canals of Chandra Nahar Irrigation Scheme in the Terai area, thereby contributing to poverty reduction.

## 2-2 Outline Design of the Japanese Assistance

### 2-2-1 Design Policy

#### (1) Basic Policy

- a) The Government of Nepal had requested to rehabilitate eight (8) Canal Under Passes (CUPs), fourteen (14) Cross Drainage Works (CDWs) and approximately thirty seven (37) Canal Crossing Bridges (CCBs). Through the investigation on the current status of the facilities which the government requested, the JICA Survey Team (JST) concluded on the rehabilitation of eight (8) CUPs, nine (9) CDWs and fifteen (15) CCBs as the target components of the project, . (Details are shown in section 2-2-2-1 )

Furthermore, the rehabilitation of main canal, diversions and check gate would not be included as the target of the project since Nepal government can rehabilitate it by its own efforts although these facilities need rehabilitation.

- b) The purpose of this project is to ensure the sustainable functioning of the irrigation system as originally planned. Therefore, the existing facilities will be rehabilitated and maintained, and no new facilities will be constructed. In principle, the existing old facilities will be removed and reconstructed.
- c) Rehabilitation of CUPs
  - The cross section area of flow on CUPs shall be designed to allow the flow of estimated discharge at the time of construction i.e. about 100 years ago. In addition, the head loss of the existing facility shall be set as the allowable head loss, and the structure shall not exceed the loss of the existing facility. (Details are shown in section 2-2-2-6 )
  - The depth of culvert section will be determined based on the river bed slope and the scouring conditions around the existing facility.
- d) Rehabilitation of CDWs
  - The Cross sectional areas of flow on CDWs shall be designed to the estimated flow rate which is calculated based on the latest rainfall data. In accordance with the design standards of Nepal, the flood volume is calculated based on the 25-year

probability rainfall. (Details are shown in section 2-2-2-5 and 2-2-2-7)

- Since there is a concern regarding scouring of the embankment on the inflow side, the embankment will be protected by wet masonry in the area that affects the CDWs. (Details are shown in section 2-2-2-7 (5))
- e) Rehabilitation of CCBs
  - The Cross section area of flow on CCBs shall be designed to flow at the estimated flow rate at the time of construction i.e. about 100 years ago. It is same as CUPs
  - The road surface height will basically follow the same as that of the existing bridge due to its connectivity with the existing linkage road.

## **(2) Policy for Natural/ Environmental Conditions**

- a) The annual rainfall in Saptari District, where the Chandra Nahar Irrigation Scheme (CNIS) is located, is about 1,760 mm, and 94% of the annual rainfall is observed during the rainy season i.e. from April to September. The rainfall gradually increases from April, goes to the peaks from May to August, and is at intermittent level until the end of September. In preparing the project implementation process, it should be planned while considering such rainfall status.
- b) The construction work of this project is based on the principle of removal and restoration of existing facilities. Since the condition of the ground foundation is an important factor for the facilities, the ground condition around the existing structure has been confirmed during the natural condition survey and reflected to the design. However, it should be mentioned that the ground conditions directly under the existing structures need to be reconfirmed after the structures are removed, because the data at the time of planning are not preserved. The geological survey should be carried out during the detail design phase, and the geological conditions should be checked by the consulting engineers during the construction phase when the existing structures are removed.
- c) In this project, many of the construction works are directly affected by rainfall, such as rivers and drainage. Therefore, construction work during the rainy season shall be minimized and only those works that can be carried out without the influence of rivers and drainage shall be carried out.

## **(3) Policy for Social and Economic Conditions**

- a) Since the target area is irrigated throughout the year, it is not possible to stop the flow of irrigation water during construction. Therefore, irrigation water supply shall be ensured by installing a temporary canal and closing the canal halfway at the construction site.
- b) The irrigation canal crossing bridge is one of the transportation networks in the target area. Temporary bridges shall be set up to secure the operation of local traffic as bridges will be closed due to the renovation work.

## **(4) Policy for Construction and Procurement situation**

- a) The construction work of the project shall be carried out based on the basic policy that maximizes the use of local human power and materials and equipment, considering the local construction conditions and technical level.
- b) The main irrigation canal in the target area convey water throughout the year. In order to minimize the impact on agricultural activities, temporary irrigation canals shall be established during construction. It is required to share awareness of irrigation during construction with the Irrigation Management office, WUAs and farmers at all level.

- c) The number of facilities to be rehabilitated will be 32. Since each of the structures are installed independently, it is important to secure a temporary storage place for materials during the construction, and the basic policy for this is to secure a place as close as possible to the construction area of the target facilities.
- d) Procurement of concrete around the target site is very difficult, because there is no ready-mixed concrete plant near the site. In order to ensure the smooth progress of the construction work, a ready-mixed concrete plant for this project shall be installed near the middle of the main irrigation canal in the target area. The location where the ready-mixed concrete plant is installed shall be the main storage area for materials and equipment as a Temporary Yard of the Project.
- e) The construction equipment to be used in this project is mainly backhoes, bulldozers, vibratory rollers, truck cranes (15-25 ton), dump trucks, concrete mixer trucks, etc. Basically, they can be procured from leasing companies or construction companies in Nepal. However, a limited number of construction equipment such as concrete mixer trucks, generators, and concrete plants will be procured from Japan.
- f) As for materials, water stop plates shall be procured from Japan.
- g) As for reinforcement bars that conform to the Indian Standard is produced in Nepal where appropriate bars can be procured. Based on interviews with consultants and general contractors who have experience in design and construction in Nepal, it has been confirmed that the design strength of the (JIS) standard can be handled by the Indian standard. However, it should be mentioned that it is necessary to clarify the strength instructions in the construction specifications and design drawings.

#### **(5) Policy for Capacity of Operation and Maintenance**

- a) Koshi Pump and Chandra Nahar Irrigation Management Office (Irrigation Management Office), DWRI sub-agency that manages the Chandra Nahar Irrigation Scheme (CNIS), is staffed with technicians such as irrigation engineers and gate operating engineers. In addition, the Irrigation Management Office has been allocated a budget for operation and maintenance, and has a long period record of operation and maintenance. Therefore, it can be considered that the Irrigation Management Office can adequately handle the operation and maintenance of the facilities after the Project.
- b) For the rehabilitation of the Canal Under Passes (CUPs), it is proposed that the type of the structure to be changed to minimize sedimentation in the structure (Details are shown in section 2-2-2-6 ). This change will facilitate the maintenance of the CUPs, but it will also change the maintenance method. Therefore, the Irrigation Management Office needs to get the technical know-how and knowledge for maintenance and management of the rehabilitated CUPs. In order to develop capacity of the maintenance and management of the irrigation management office for the rehabilitated CUPs, Capacity Development Program shall be carried out as a Soft Component activities. (Details are shown in section 2-2-4-8 )

#### **(6) Policy for Supervision**

- a) The ground conditions of the target facilities' foundation will be cleared only after the existing structures are removed. Since it is difficult for a geotechnical engineer to check all 32 structures, a geotechnical engineer shall be assigned as a "spot engineer" to guide the resident supervisor and field engineers on the points which should be checked at the beginning of construction. Therefore, at the beginning of construction, the geotechnical engineer shall instruct the resident supervisor and local engineers on the points to be checked to improve efficiency.
- b) Since the target area is irrigated throughout the year, agricultural activities in CNIS should not be disturbed during the construction period. Therefore, an irrigation engineer shall be assigned as a "spot engineer" to discuss the irrigation plan with the WUA and the irrigation management

office for using temporary irrigation, and finally coordinate with the contractor of the project.

## **(7) Policy for Safety measure**

- a) The river crossing Pauraha CUP (CUP-3) is within the behavioral range of wild Asian elephants, and there is a possibility that they may move across the construction area. In the vicinity of the area, the Asian elephant has caused deaths and damage to residents, so extreme caution is required in the implementation of the construction. Therefore, security guards (wildlife) shall be assigned in the construction area. The guards should be two in number to be able to overlook the entire construction area and to ensure a communication system for safety by multiple persons.
- b) The construction of the CUPs will be carried out under a river. Since it is difficult to predict the flow conditions of the river due to climate change, the weather and flow conditions of hillside as well as the site should be considered during the construction of CUPs.

## **2-2-2 Basic Plan**

### **2-2-2-1 Evaluation and Selection of Targets on this Project**

#### **(1) Canal Under Pass**

In the existing Canal Under Passes (CUPs) cracks and leakages, were found and there was a serious risk of collapse as the cracks developed.

In order to achieve the objectives of the project, it is necessary to rehabilitate the functions of all CUPs and recover the conveyance efficiency for a sustainable irrigation system. Therefore, it was considered that all CUPs should be fully rehabilitated. In addition, it is necessary to propose a facility structure considering the ease of maintenance and management for the facilities to be rehabilitated.

#### **(2) Cross Drainage Works**

The Cross Drainage Works (CDWs) to be rehabilitated were determined by examining both, the capacity of drainage (flood) volume and the drainage function.

##### **1) Damage status of CDWs**

The leakages of irrigation water due to the crack in the canal wall and slab, the situation of collapse of embankment and canal wall will reduce the conveyance efficiency of the irrigation canal. Therefore, such facilities were determined to have serious impacts on the contribution to agricultural productivity, which is also the objective of this project.

##### **2) Functions as a Drainage facility**

It was verified that whether the CDWs were capable of adequately streaming the drainage (flood) from the catchment area or not. CDWs whose flow velocity, calculated by dividing the flood volume by the cross-sectional area to be drained, exceeds the maximum permissible flow velocity of 2.50m/s and thus are considered to have insufficient cross-sectional area. These CDWs shall be improved in this project.

##### **3) Necessary CDWs to be rehabilitated**

It is summarized in the table below. Nine (9) CDWs (Code: 01, 02, 03, 04, 05, 06, 07, 08 and 11)

shall be rehabilitated based on the flow velocity and the facility conditions obtained from the field survey.

**Table 2-2-1 Current Status of Cross Drainage Culvert**

| Code   | Prof. No | Type Material | Section*1                          | Section Area m <sup>2</sup> | Flood Volume m <sup>3</sup> /s | Velocity m/s | Damage Status  |
|--------|----------|---------------|------------------------------------|-----------------------------|--------------------------------|--------------|--|
| CDW-01 | 2+517    | Siphon Brick  | 2.50 × 2.00 × 1                    | 5.00                        | 15.200                         | <u>3.040</u> | Not Seriously  |
| CDW-02 | 3+258    | Siphon Brick  | 2.50 × 2.00 × 2                    | 10.00                       | 37.500                         | <u>3.750</u> | Clacks on the Main body<br><u>Leakage from Canal</u>   |
| CDW-03 | 5+517    | Siphon Brick  | 1.50 × 1.50 × 2                    | 4.50                        | 26.200                         | <u>5.822</u> | Clacks on the Main body                                |
| CDW-04 | 7+370    | Siphon Brick  | 1.50 × 1.50 × 1                    | 2.25                        | 7.400                          | <u>3.289</u> | Clacks on the Main body                                |
| CDW-05 | 11+336   | Culvert Brick | 1.50 × 1.50 × 2<br>1.50 × 1.50 × 1 | 6.75                        | 9.000                          | 1.333        | <u>Breakage of side wall</u>                           |
| CDW-06 | 13+772   | Culvert Brick | 2.40 × 1.60 × 2<br>1.60 × 1.60 × 2 | 10.24                       | 13.600                         | 1.328        | Clacks on the Main body<br><u>Leakage from Canal</u>   |
| CDW-07 | 16+713   | Siphon Brick  | 2.50 × 2.50 × 4                    |                             | 12.100                         |              | <u>Collaps of facility</u>                             |
| CDW-08 | 18+178   | Siphon Brick  | 1.50 × 1.50 × 2                    | 4.50                        | 2.400                          | 0.533        | <u>Breakage of side wall</u>                           |
| CDW-09 | 19+932   | Culvert RC*2  | 4.00 × 6.50 × 2<br>3.00 × 6.50 × 2 | 91.00                       | 48.800                         | 0.536        | Not seriously. But canal bridge set next has breakage. |
| CDW-10 | 25+479   | Siphon RC     | φ900 × 1 (Pipe)                    | 0.64                        | 1.600                          | 2.500        | Not Seriously  |
| CDW-11 | 26+135   | Siphon RC     | φ900 × 1 (Pipe)                    | 0.64                        | 2.400                          | <u>3.750</u> | Not Seriously  |
| CDW-12 | 26+385   | Culvert RC    | 4.50 × 1.70 × 3 (Pipe)             | 22.95                       | 16.000                         | 0.697        | Not Seriously  |
| CDW-13 | 27+125   | Culvert RC    | 2.60 × 2.70 × 2<br>4.50 × 2.63 × 1 | 26.19                       | 10.700                         | 0.409        | Not Seriously  |
| CDW-14 | 27+693   | Siphon RC     | φ900 × 1 (Pipe)                    | 0.64                        | 1.600                          | 2.500        | Not Seriously  |

\*1 Spelling the order of Width × Height × Barrels. Since it was difficult to accurately measure the cross-section of the Cross Drainage Work under the water, approximate dimensions were referred from photographs.

\*2 RC: Reinforced Concrete

\*3 Underline: Situation or/and condition considering to be rehabilitated.

Sauce: JICA Study Team

### (3) Canal Crossing Bridge

According to the damage level classified by the field survey, fifteen (15) Canal Crossing Bridges (CCB code: 02, 03, 04, 11, 13, 15, 16, 17, 19, 20, 22, 26, 27, 28, 31) should be rehabilitated to avoid the risk of collapse.

#### 2-2-2-2 Assessment of Agriculture Impacts

This project shall not directly intervene on agriculture activities in the area, as the priority is to improve sustainability of the rehabilitated canal structures. However, principally the impact of the project will positively influence the agriculture practices and productivity by securing stable irrigation water to the farming fields through improvement of the structures. The project interventions are expected to provide sustainability to the current agriculture patterns of the major crops.

The main crops in the target area are rice in the rainy season (monsoon season) and wheat and maize in the dry season, and it is assumed that the current cropping pattern will be maintained as the facilities are improved through this project.

It is assumed that the loss caused by collapse of irrigation structures shall be avoided if the project rehabilitates the structures to prolong their lifespans. Followings are the estimates of the economic gain from averting the production loss by constant supply of irrigation water through rehabilitation of the structure. Through the calculation of production loss in case of collapse of the structure, the economic benefit of the project on agriculture is estimated to be 644 million NRs per year of gross income and 362 million NRs per year of net profit.

**Table 2-2-2 Estimated Impact of the project on the Agriculture as a version of the Estimated Loss**

|   | Monsoon Paddy | Spring Paddy | Winter Wheat | Maize (irrigated)*4 |
|---|---------------|--------------|--------------|---------------------|
| Current average yield (Mt/ha)*1                             | 3.42          | 4.46         | 2.05         | 4.85                |
| Estimated yield without irrigation (Mt/ha) *2               | 2.35          | 0            | 0            | 0                   |
| Yield loss (Mt/ha)  | 1.07          | 4.46         | 2.05         | 4.85                |
| Cultivated area (ha) *3                                     | 9,000         | 1,000        | 6,000        | 450                 |
| Sales price at the farm (NRs./kg)                           | 20            | 22.5         | 25           | 20                  |
| Income loss (NRs./ha)                                       | 21,400        | 100,350      | 51,250       | 97,000              |
| Annual income loss of the area (NRs. in Million/year)       | 192.6         | 100.35       | 307.5        | 43.65               |
| Annual total income loss in the area (NRs. in Million/year) |               |              |              | 644.1               |
| Saving of cost by not cultivating*5 (NRs./ha)               | -             | 39,027       | 38,016       | 32,827              |
| Loss in consideration of reduction of cost (NRs./ha)        | 21,400        | 61,323       | 13,234       | 64,173              |
| Annual profit loss in the area (NRs. in Million/year)       | 192.6         | 61.32        | 79.40        | 28.87               |
| Annual total profit loss in the area (NRs. in Million/year) |               |              |              | 362.2               |

\*1 Data from the Baseline survey 2021. Statistical Information on Nepalese Agriculture, 2075/76 [2018/19], MOALD, GON, 2020 for the spring paddy.

\*2 Estimated yield without irrigation is applied from the rain-fed paddy yield of the improved paddy variety that consist of 90% of the paddy cultivation in Terai (Source: "Rice Varietal Mapping in Nepal: Implication for Development and Adoption", DoA, MoAD 2015) . Yields of spring paddy, wheat and irrigated maize are estimated to be none if the irrigation water stops, as such cultivation depend on irrigation water.

\*3 Values mentioned in the table explain cultivated area in 2020 based on field survey. It should be noted that the area of Chandra Nahar Irrigation Scheme is 10,500 ha.

\*4 Calculating maize cultivation applying irrigation water from Chandra Nahar.

\*5 Variable costs with deducted 65% of human labour that are covered by family contribution (based on the baseline data) (Source of cost data: "Production cost & Marketing of Cereal, Cash Vegetable & Industrial Crops in Nepal 2072/2073 (2015/2016), DoA, MoAD")

Source : JICA Survey Team

### 2-2-2-3 Irrigation Plan (Current situation)

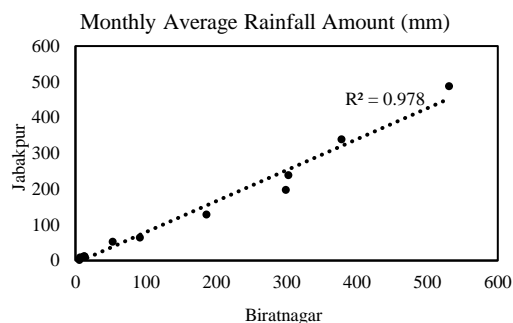
#### (1) Irrigation Plan

##### 1) Objective

To consider the rehabilitation of target facilities, the irrigation area and design flow rate of the facility shall be examined by comparing the design flow rate of the current irrigation system with the gross water requirement obtained from the recent meteorological data and cropping patterns.

##### 2) Meteorology Condition around the Target Site

Meteorological data such as rainfall, temperature, humidity, wind speed and sunshine duration) recorded at Biratnagar weather station located 40 km east of the project area were obtained to formulate the irrigation plan. A number of meteorological stations were identified in the vicinity of the project. Among these stations, to ensure the reliability of the data, stations were selected based on the assumption that they have more than 30 years of observation data and that they are under the jurisdiction of the Bureau of Hydrology and Meteorology. The



stations that are in close proximity to the project and meet these conditions are Janakpur station located 90km to the west of the district and Biratnagar station located 40 km to the east. As a result of comparing the monthly mean precipitation of the two stations, a high correlation ( $R^2 = 0.98$ ) was obtained; the Biratnagar meteorological data is used because it is close to the project and has few missing measurements, and its high correlation with Janakpur has been confirmed.

The detail meteorological data are mentioned as follows.

**Table 2-2-3 Weather data**

| Items                     | Jan. | Feb. | Mar. | Apr. | May  | Jun. | Jly. | Aug. | Sept. | Oct. | Nov. | Dec. | Amount /Average |
|---------------------------|------|------|------|------|------|------|------|------|-------|------|------|------|-----------------|
| Rainfall (mm)             | 9    | 12   | 19   | 94   | 204  | 309  | 463  | 329  | 252   | 71   | 1    | 1    | 1764            |
| Temperature (°C)          | 15.9 | 19.2 | 23.7 | 27.4 | 28.5 | 29.3 | 29.4 | 29.7 | 29.0  | 26.7 | 22.6 | 18.2 | 25.0            |
| Max Temp (°C)             | 22.4 | 26.5 | 31.3 | 33.8 | 33.5 | 33.3 | 32.8 | 33.3 | 32.9  | 31.9 | 29.6 | 25.3 | 30.6            |
| Min Temp. (°C)            | 9.3  | 11.7 | 16.1 | 21.1 | 23.5 | 25.3 | 25.9 | 26.1 | 25.1  | 21.5 | 15.6 | 11.1 | 19.4            |
| Humidity (%)              | 82.9 | 73.8 | 61.0 | 62.2 | 70.4 | 79.4 | 83.4 | 82.8 | 83.6  | 79.9 | 77.9 | 81.8 | 76.6            |
| Wind (m/s)                | 0.7  | 0.8  | 1.1  | 1.7  | 1.6  | 1.4  | 0.9  | 0.8  | 0.6   | 0.4  | 0.3  | 0.3  | 0.9             |
| Sunshine duration (hours) | 5.1  | 6.8  | 8.0  | 8.2  | 7.9  | 6.1  | 5.0  | 5.6  | 5.8   | 7.3  | 7.6  | 6.2  | 6.6             |

Source: Biratnagar Weather Station

### 3) Probable Rainfall

According to the Design Manual for Irrigation Project in Nepal, M3 Hydrology and Agro-meteorology Manual, the planned probability years for irrigation water planning are indicated in the table below. Accordingly, 5-year probability is adopted in this project.

**Table 2-2-4 Return period mentioned on design manual of Nepal**

| Scheme                    | Return period     |
|---------------------------|-------------------|
| Irrigation Planning       | 5 years (adopted) |
| Scale of irrigation canal | 5 years           |

Source: JICA Survey Team

### (2) Cropping Pattern

Regarding the cropping pattern and area under cultivation, monsoon rice is the main cultivation, and spring rice is also grown. In the dry season, wheat is widely grown, and maize and vegetables are also produced.

### (3) Calculation of Water Requirement

#### 1) Evapotranspiration

Evapotranspiration was calculated by using the Penman-Mortis method according to FAO

Irrigation and Drainage Paper No. 56 from year 2000 to 2019 for both paddy and field crops, and an example of calculation for paddy in 2016 is shown below.

**Table 2-2-5 Evapotranspiration result**

|                                    |                    |               |                   |
|------------------------------------|--------------------|---------------|-------------------|
| <b>Year:</b>                       | <b>2016</b>        |               |                   |
| <b>Country:</b>                    | <b>Nepal</b>       |               |                   |
| <b>Place:</b>                      | <b>Chandra</b>     |               |                   |
| <b>Latitude(<math>\phi</math>)</b> | <b>25.60</b> (deg) | $\rightarrow$ | <b>0.45</b> (rad) |
| <b>Altitude(Z)</b>                 | <b>90</b> (m)      |               |                   |
| <b>P=</b>                          | 100.2 (Kpa)        |               |                   |
| <b><math>\lambda</math>=</b>       | 2.45 (MJ/kg)       |               |                   |
| <b><math>\gamma</math>=</b>        | 0.067 (Kpa/°C)     |               |                   |
| <b><math>\alpha</math>=</b>        | <b>0.06</b>        |               |                   |

| Item                       | Unit      | Jan   |       | Feb   |       | May   |       | Apr   |       | May   |       | Jun   |       | July  |       | Aug   |       | Sep   |       | Oct   |       | Nov   |       | Dec   |       |
|----------------------------|-----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|                            |           | 1     | 2     | 1     | 2     | 1     | 2     | 1     | 2     | 1     | 2     | 1     | 2     | 1     | 2     | 1     | 2     | 1     | 2     | 1     | 2     | 1     | 2     | 1     | 2     |
| Half Month                 |           |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| J                          |           | 8     | 24    | 38    | 52    | 67    | 83    | 105   | 113   | 128   | 143   | 159   | 174   | 189   | 204   | 220   | 235   | 251   | 266   | 281   | 296   | 312   | 327   | 342   | 358   |
| Temp                       | °C        | 17.2  | 15.4  | 18.5  | 21.6  | 24.2  | 25.0  | 28.4  | 29.5  | 28.1  | 28.0  | 29.6  | 29.1  | 29.4  | 28.2  | 30.8  | 30.2  | 29.0  | 28.0  | 28.2  | 26.2  | 23.7  | 21.4  | 18.5  | 19.2  |
| Wind                       | m/s       | 0.7   | 0.6   | 0.6   | 0.9   | 0.9   | 1.3   | 1.5   | 1.9   | 1.6   | 1.6   | 1.5   | 1.3   | 1.0   | 0.8   | 0.9   | 0.7   | 0.7   | 0.6   | 0.4   | 0.3   | 0.2   | 0.3   | 0.3   | 0.4   |
| RH                         | %         | 84.4  | 85.2  | 77.8  | 71.9  | 68.3  | 60.0  | 59.8  | 59.9  | 68.5  | 75.7  | 76.0  | 86.2  | 82.7  | 89.5  | 77.1  | 80.1  | 88.1  | 88.3  | 83.3  | 76.8  | 77.4  | 78.3  | 87.7  | 82.6  |
| Sunshine                   | hr        | 6.1   | 4.0   | 6.1   | 7.6   | 7.9   | 8.0   | 7.6   | 7.6   | 7.2   | 8.2   | 7.2   | 4.2   | 4.8   | 5.2   | 5.9   | 5.3   | 6.1   | 5.6   | 7.1   | 7.5   | 9.3   | 8.4   | 5.6   | 6.3   |
| ea                         | Kpa       | 1.97  | 1.74  | 2.14  | 2.59  | 3.01  | 3.17  | 3.87  | 4.12  | 3.80  | 3.78  | 4.14  | 4.03  | 4.09  | 3.83  | 4.45  | 4.29  | 4.00  | 3.79  | 3.83  | 3.40  | 2.93  | 2.55  | 2.13  | 2.23  |
| ed                         | Kpa       | 1.66  | 1.49  | 1.66  | 1.86  | 2.06  | 1.90  | 2.31  | 2.47  | 2.61  | 2.86  | 3.15  | 3.47  | 3.38  | 3.43  | 3.43  | 3.44  | 3.52  | 3.34  | 3.19  | 2.61  | 2.27  | 2.00  | 1.87  | 1.84  |
| $\Delta$                   | Kpa/°C    | 0.12  | 0.11  | 0.13  | 0.16  | 0.18  | 0.19  | 0.22  | 0.24  | 0.22  | 0.22  | 0.24  | 0.23  | 0.24  | 0.22  | 0.25  | 0.25  | 0.23  | 0.22  | 0.22  | 0.20  | 0.18  | 0.16  | 0.13  | 0.14  |
| $\gamma^*$                 | Kpa/°C    | 0.082 | 0.080 | 0.080 | 0.086 | 0.086 | 0.095 | 0.099 | 0.107 | 0.102 | 0.102 | 0.099 | 0.096 | 0.088 | 0.085 | 0.087 | 0.082 | 0.082 | 0.079 | 0.076 | 0.073 | 0.071 | 0.073 | 0.072 | 0.076 |
| $\psi/(\Delta+\gamma^*)$   |           | 0.32  | 0.35  | 0.31  | 0.27  | 0.25  | 0.24  | 0.21  | 0.19  | 0.21  | 0.21  | 0.20  | 0.20  | 0.21  | 0.22  | 0.20  | 0.20  | 0.21  | 0.22  | 0.22  | 0.24  | 0.27  | 0.29  | 0.32  | 0.31  |
| 900/(T+275)                |           | 3.08  | 3.10  | 3.07  | 3.03  | 3.01  | 3.00  | 2.97  | 2.96  | 2.97  | 2.97  | 2.95  | 2.96  | 2.96  | 2.97  | 2.94  | 2.95  | 2.96  | 2.97  | 2.97  | 2.99  | 3.01  | 3.04  | 3.07  | 3.06  |
| ea-ed                      | Kpa       | 0.31  | 0.26  | 0.47  | 0.73  | 0.96  | 1.27  | 1.55  | 1.65  | 1.20  | 0.92  | 0.99  | 0.56  | 0.71  | 0.40  | 1.02  | 0.85  | 0.48  | 0.44  | 0.64  | 0.79  | 0.66  | 0.55  | 0.26  | 0.39  |
| ETaero                     | mm/day    | 0.2   | 0.2   | 0.3   | 0.5   | 0.6   | 1.1   | 1.4   | 1.8   | 1.2   | 0.9   | 0.8   | 0.5   | 0.4   | 0.2   | 0.6   | 0.4   | 0.2   | 0.2   | 0.2   | 0.2   | 0.1   | 0.1   | 0.1   | 0.2   |
| $\delta$                   | rad       | -0.39 | -0.34 | -0.28 | -0.20 | -0.10 | 0.01  | 0.16  | 0.21  | 0.29  | 0.36  | 0.40  | 0.41  | 0.39  | 0.35  | 0.28  | 0.20  | 0.10  | -0.01 | -0.11 | -0.21 | -0.30 | -0.36 | -0.40 | -0.41 |
| $\omega_s$                 | rad       | 1.37  | 1.40  | 1.43  | 1.47  | 1.52  | 1.57  | 1.65  | 1.67  | 1.71  | 1.75  | 1.77  | 1.78  | 1.77  | 1.75  | 1.71  | 1.67  | 1.62  | 1.56  | 1.52  | 1.47  | 1.42  | 1.39  | 1.37  | 1.36  |
| dr                         |           | 1.03  | 1.03  | 1.03  | 1.02  | 1.01  | 1.00  | 0.99  | 0.99  | 0.98  | 0.97  | 0.97  | 0.97  | 0.97  | 0.97  | 0.97  | 0.98  | 0.99  | 1.00  | 1.00  | 1.01  | 1.02  | 1.03  | 1.03  | 1.03  |
| Ra                         | MJ/m2/day | 23.0  | 24.5  | 26.5  | 28.9  | 31.6  | 34.2  | 37.3  | 38.1  | 39.3  | 40.1  | 40.5  | 40.6  | 40.4  | 39.9  | 38.9  | 37.6  | 35.7  | 33.4  | 30.9  | 28.2  | 25.8  | 23.9  | 22.7  | 22.3  |
| N                          | hr        | 10.5  | 10.7  | 10.9  | 11.3  | 11.6  | 12.0  | 12.6  | 12.8  | 13.1  | 13.4  | 13.5  | 13.6  | 13.5  | 13.4  | 13.1  | 12.7  | 12.3  | 12.0  | 11.6  | 11.2  | 10.9  | 10.6  | 10.5  | 10.4  |
| n/N                        |           | 0.58  | 0.37  | 0.55  | 0.68  | 0.68  | 0.67  | 0.61  | 0.60  | 0.55  | 0.61  | 0.53  | 0.31  | 0.36  | 0.39  | 0.45  | 0.41  | 0.50  | 0.46  | 0.62  | 0.67  | 0.85  | 0.80  | 0.54  | 0.60  |
| Rns                        | MJ/m2/day | 11.7  | 10.1  | 13.1  | 16.0  | 17.6  | 18.8  | 19.4  | 19.7  | 19.4  | 21.0  | 19.7  | 15.4  | 16.3  | 16.7  | 17.4  | 16.1  | 16.7  | 15.1  | 16.2  | 15.5  | 16.4  | 14.5  | 11.1  | 11.6  |
| f(n/N)                     |           | 0.62  | 0.44  | 0.60  | 0.71  | 0.71  | 0.70  | 0.65  | 0.64  | 0.59  | 0.65  | 0.58  | 0.38  | 0.42  | 0.45  | 0.50  | 0.47  | 0.55  | 0.52  | 0.65  | 0.70  | 0.87  | 0.82  | 0.58  | 0.64  |
| f(ed)                      |           | 0.16  | 0.17  | 0.16  | 0.15  | 0.14  | 0.15  | 0.13  | 0.12  | 0.11  | 0.10  | 0.09  | 0.08  | 0.08  | 0.08  | 0.08  | 0.08  | 0.08  | 0.08  | 0.09  | 0.11  | 0.13  | 0.14  | 0.15  | 0.15  |
| f(T)                       |           | 34.89 | 33.99 | 35.52 | 37.05 | 38.33 | 38.77 | 40.96 | 41.16 | 40.41 | 40.39 | 41.20 | 40.98 | 41.08 | 40.48 | 41.90 | 41.54 | 40.87 | 40.37 | 40.47 | 39.39 | 38.10 | 36.93 | 35.49 | 35.85 |
| Rnl                        | MJ/m2/day | -3.5  | -2.5  | -3.4  | -3.9  | -3.8  | -4.0  | -3.3  | -3.2  | -2.7  | -2.7  | -2.2  | -1.2  | -1.4  | -1.5  | -1.7  | -1.6  | -1.7  | -1.8  | -2.4  | -3.2  | -4.3  | -4.3  | -3.1  | -3.5  |
| Rn=Rns+Rnl                 | MJ/m2/day | 8.2   | 7.5   | 9.7   | 12.1  | 13.7  | 14.8  | 16.1  | 16.5  | 16.6  | 18.3  | 17.5  | 14.2  | 14.8  | 15.2  | 15.7  | 14.6  | 15.0  | 13.4  | 13.8  | 12.4  | 12.1  | 10.2  | 8.0   | 8.1   |
| $\Delta/(\Delta+\gamma^*)$ |           | 0.60  | 0.58  | 0.63  | 0.65  | 0.68  | 0.67  | 0.69  | 0.69  | 0.69  | 0.68  | 0.71  | 0.71  | 0.73  | 0.72  | 0.74  | 0.75  | 0.74  | 0.74  | 0.75  | 0.73  | 0.71  | 0.68  | 0.65  | 0.65  |
| E T rad                    | mm/day    | 2.0   | 1.8   | 2.5   | 3.2   | 3.8   | 4.0   | 4.6   | 4.6   | 4.7   | 5.1   | 5.0   | 4.1   | 4.4   | 4.5   | 4.8   | 4.5   | 4.0   | 4.2   | 3.7   | 3.5   | 2.8   | 2.1   | 2.1   |       |
| ET0                        | mm/day    | 2.2   | 2.0   | 2.8   | 3.7   | 4.4   | 5.2   | 6.0   | 6.4   | 5.8   | 6.0   | 5.9   | 4.5   | 4.8   | 4.7   | 5.3   | 4.8   | 4.7   | 4.2   | 4.4   | 3.9   | 3.6   | 3.0   | 2.2   | 2.3   |

Source: JICA Survey Team

## 2) Water Requirement of Crops

The crop water requirement is calculated by multiplying the evapotranspiration to the crop coefficient (Kc) given for each crop growth stage. The value of crop coefficients is adopted from the manual as indicated above.

## 3) Net Water Requirement

Net Water Requirement (NWR) is estimated using the following formula. The amount of water used for percolation, infiltration, and effective rainfall is based on the same manual.

### Paddy rice

$$NWR = \text{Water Requirement of Crop } (ET_{Crop}) + \text{Puddling Water} + \text{Vertical Percolation} - \text{Effective Rainfall}$$

## 4) Gross Water Requirement

The net water requirement shall be divided by the irrigation efficiency to calculate the gross water requirement. For irrigation efficiency, the following values given in the manual shall be used.

**Table 2-2-6 Irrigation efficiency**

| Category    | Field Efficiency<br>(1) | Conveyance efficiency |          | Irrigation Efficiency<br>(4) = (1) × (2) × (3) |
|-------------|-------------------------|-----------------------|----------|--|
|             |                         | Division (2)          | Loss (3) |  |
| Paddy field | 0.85                    | 0.80                  | 0.80     | 0.54   |
| Field       | 0.60                    | 0.80                  | 0.80     | 0.38   |

Sauce: JST

Gross water requirement per half-month (15 days) was calculated for 20 years from 2000 to 2019. Peak water requirement for 6,500 ha of irrigated area out of 9,000 ha of monsoon rice cultivation area at the occurrence of 1/5-year non-exceedance probability is as follows. Since 2016 corresponds to a 5-year probability, 2016 is used as the base year for planning.

**Table 2-2-7 Peak Gross Water Requirement**

| year | Peak Gross Water Requirement (m <sup>3</sup> /s) | Return period     | Ranking          |
|------|--|-------------------|------------------|
| 2000 | 7.792  | less than 2 years | 16 <sup>th</sup> |
| 2001 | 13.300   | 14 year           | 2 <sup>nd</sup>  |
| 2002 | 13.764   | 19 year           | 1 <sup>st</sup>  |
| 2003 | 8.768  | less than 2 years | 12 <sup>th</sup> |
| 2004 | 6.730  | less than 2 years | 20 <sup>th</sup> |
| 2005 | 11.132   | 4 year            | 6 <sup>th</sup>  |
| 2006 | 7.258  | less than 2 years | 19 <sup>th</sup> |
| 2007 | 8.037  | less than 2 years | 15 <sup>th</sup> |
| 2008 | 7.334  | less than 2 years | 18 <sup>th</sup> |
| 2009 | 9.596  | 2 year            | 9 <sup>th</sup>  |
| 2010 | 13.286   | 14 year           | 3 <sup>rd</sup>  |
| 2011 | 9.033  | less than 2 years | 11 <sup>th</sup> |
| 2012 | 8.434  | less than 2 years | 14 <sup>th</sup> |
| 2013 | 8.563  | less than 2 years | 13 <sup>th</sup> |
| 2014 | 11.831   | 6 year            | 4 <sup>th</sup>  |
| 2015 | 10.765   | 4 year            | 8 <sup>th</sup>  |
| 2016 | 11.441   | 5 year            | 5 <sup>th</sup>  |
| 2017 | 11.092   | 4 year            | 7 <sup>th</sup>  |
| 2018 | 9.252  | less than 2 years | 10 <sup>th</sup> |
| 2019 | 7.617  | less than 2 years | 17 <sup>th</sup> |

Source: JICA Survey Team

**Table 2-2-8 Gross water requirement calculation results (Project Base Year: 2016)**

| Year: 2016                   |               | Monsoon Rice 6500 ha         |       |       |       |       |       |       |       |       |       |       |       |        |       |       |       |       |       |       |       |       |       |       |       |      |
|------------------------------|---------------|------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
|                              |               | Gross Irrigation Requirement |       |       |       |       |       |       |       |       |       |       |       |        |       |       |       |       |       |       |       |       |       |       |       |      |
|                              |               | Jan-1                        | Jan-2 | Feb-1 | Feb-2 | Mar-1 | Mar-2 | Apr-1 | Apr-2 | May-1 | May-2 | Jun-1 | Jun-2 | Jul-1  | Jul-2 | Aug-1 | Aug-2 | Sep-1 | Sep-2 | Oct-1 | Oct-2 | Nov-1 | Nov-2 | Dec-1 | Dec-1 |      |
| Monsoon Paddy                |               | 15                           | 16    | 15    | 14    | 15    | 16    | 15    | 15    | 15    | 16    | 15    | 15    | 15     | 16    | 15    | 16    | 15    | 15    | 15    | 16    | 15    | 15    | 15    | 16    |      |
| ETo                          | mm/day        | 2.2                          | 2.0   | 2.8   | 3.7   | 4.4   | 5.2   | 6.0   | 6.4   | 5.8   | 6.0   | 5.9   | 4.5   | 4.8    | 4.7   | 5.3   | 4.8   | 4.7   | 4.2   | 4.4   | 3.9   | 3.6   | 3.0   | 2.2   | 2.3   |      |
| Cropping Pattern             |               |                              |       |       |       |       |       |       |       |       |       |       |       |        |       |       |       |       |       |       |       |       |       |       |       |      |
| Land Preparation             | mm/half month |                              |       |       |       |       |       |       |       |       | 55    | 55    | 50    | 50     |       |       |       |       |       |       |       |       |       |       |       |      |
| Kc                           |               |                              |       |       |       |       |       |       |       |       |       |       |       | 1.10   | 1.10  | 1.10  | 1.00  | 0.95  | 0.95  |       |       |       |       |       |       |      |
| ETcrop                       | mm/day        |                              |       |       |       |       |       |       |       |       |       |       |       | 5.3    | 5.2   | 5.8   | 4.8   | 4.5   | 4.0   |       |       |       |       |       |       |      |
| Percolation                  | mm/day        |                              |       |       |       |       |       |       |       |       |       |       | 2.5   | 2.0    | 1.5   | 1.0   | 1.0   | 1.0   | 2.5   | 2.5   |       |       |       |       |       |      |
| Crop Water Requirement       | mm/half month |                              |       |       |       |       |       |       |       |       |       | 92.5  | 85    | 152.2  | 148.9 | 102.6 | 93.04 | 104.9 | 97.18 |       |       |       |       |       |       |      |
| Effective Rainfall           | mm/half month | 0.0                          | 14.5  | 0.0   | 0.0   | 0.0   | 18.6  | 37.1  | 0.0   | 53.6  | 193.5 | 93.2  | 137.5 | 28.1   | 391.3 | 18.4  | 102.3 | 94.2  | 258.8 | 28.8  | 0.0   | 0.0   | 0.0   | 0.0   |       |      |
| Irrigation Requirement       | mm/half month | 0.0                          | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 124.1  | 0.0   | 84.2  | 0.0   | 10.7  | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   |       |      |
| Irrigation Requirement       | m3/s          | 0.0                          | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 6.2    | 0.000 | 4.2   | 0.000 | 0.5   | 0.000 | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   |       |      |
|                              |               | Spring Paddy 1000 ha         |       |       |       |       |       |       |       |       |       |       |       |        |       |       |       |       |       |       |       |       |       |       |       |      |
|                              |               | Jan-1                        | Jan-2 | Feb-1 | Feb-2 | Mar-1 | Mar-2 | Apr-1 | Apr-2 | May-1 | May-2 | Jun-1 | Jun-2 | Jul-1  | Jul-2 | Aug-1 | Aug-2 | Sep-1 | Sep-2 | Oct-1 | Oct-2 | Nov-1 | Nov-2 | Dec-1 | Dec-1 |      |
| Spring Paddy                 |               | 15                           | 16    | 15    | 14    | 15    | 16    | 15    | 15    | 15    | 16    | 15    | 15    | 15     | 16    | 15    | 16    | 15    | 15    | 15    | 16    | 15    | 15    | 15    | 16    |      |
| ETo                          | mm/day        | 2.2                          | 2.0   | 2.8   | 3.7   | 4.4   | 5.2   | 6.0   | 6.4   | 5.8   | 6.0   | 5.9   | 4.5   | 4.8    | 4.7   | 5.3   | 4.8   | 4.7   | 4.2   | 4.4   | 3.9   | 3.6   | 3.0   | 2.2   | 2.3   |      |
| Cropping Pattern             |               |                              |       |       |       |       |       |       |       |       |       |       |       |        |       |       |       |       |       |       |       |       |       |       |       |      |
| Land Preparation             | mm/half month |                              |       |       | 75    | 75    | 50    | 50    |       |       |       |       |       |        |       |       |       |       |       |       |       |       |       |       |       |      |
| Kc                           |               |                              |       |       |       |       | 1.10  | 1.10  | 1.10  | 1.00  | 0.95  | 0.95  |       |        |       |       |       |       |       |       |       |       |       |       |       |      |
| ETcrop                       | mm/day        |                              |       |       |       |       | 5.7   | 6.5   | 7.0   | 5.8   | 5.7   | 5.6   |       |        |       |       |       |       |       |       |       |       |       |       |       |      |
| Percolation                  | mm/day        |                              |       |       |       |       | 3.0   | 3.25  | 3.5   | 3.5   | 3.5   | 2.5   |       |        |       |       |       |       |       |       |       |       |       |       |       |      |
| Crop Water Requirement       | mm/half month |                              |       |       | 75.0  | 75.0  | 188.7 | 197.0 | 158.0 | 139.8 | 147.3 | 121.4 |       |        |       |       |       |       |       |       |       |       |       |       |       |      |
| Effective Rainfall           | mm/half month | 0.0                          | 14.5  | 0.0   | 0.0   | 0.0   | 18.6  | 37.1  | 0.0   | 53.6  | 193.5 | 93.2  | 137.5 | 28.1   | 391.3 | 18.4  | 102.3 | 94.2  | 258.8 | 28.8  | 0.0   | 0.0   | 0.0   | 0.0   |       |      |
| Irrigation Requirement       | mm/half month | 0.0                          | 0.0   | 0.0   | 75.0  | 75.0  | 170.1 | 159.9 | 158.0 | 86.2  | 0.0   | 28.3  | 0.0   | 0.0    | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   |       |      |
| Irrigation Requirement       | m3/s          | 0.000                        | 0.000 | 0.000 | 0.620 | 0.579 | 1.231 | 1.234 | 1.219 | 0.665 | 0.000 | 0.218 | 0.000 | 0.000  | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |       |      |
|                              |               | Wheat 6000 ha                |       |       |       |       |       |       |       |       |       |       |       |        |       |       |       |       |       |       |       |       |       |       |       |      |
|                              |               | Jan-1                        | Jan-2 | Feb-1 | Feb-2 | Mar-1 | Mar-2 | Apr-1 | Apr-2 | May-1 | May-2 | Jun-1 | Jun-2 | Jul-1  | Jul-2 | Aug-1 | Aug-2 | Sep-1 | Sep-2 | Oct-1 | Oct-2 | Nov-1 | Nov-2 | Dec-1 | Dec-1 |      |
| Spring Paddy                 |               | 15                           | 16    | 15    | 14    | 15    | 16    | 15    | 15    | 15    | 16    | 15    | 15    | 15     | 16    | 15    | 16    | 15    | 15    | 15    | 16    | 15    | 15    | 15    | 16    |      |
| ETo                          | mm/day        | 1.7                          | 1.5   | 2.2   | 3.0   | 3.6   | 4.2   | 5.0   | 5.4   | 4.8   | 4.9   | 4.9   | 3.7   | 4.0    | 3.8   | 4.4   | 3.9   | 3.8   | 3.4   | 3.5   | 3.0   | 2.8   | 2.3   | 1.6   | 1.7   |      |
| Cropping Pattern             |               |                              |       |       |       |       |       |       |       |       |       |       |       |        |       |       |       |       |       |       |       |       |       |       |       |      |
| Land Preparation             | mm/half month |                              |       |       |       |       |       |       |       |       |       |       |       |        |       |       |       |       |       |       |       |       |       |       |       |      |
| Kc                           |               | 1.05                         | 1.15  | 1.15  | 1.15  | 0.90  | 0.40  |       |       |       |       |       |       |        |       |       |       |       |       |       |       |       | 0.43  | 0.65  | 1.05  |      |
| ETcrop                       | mm/day        | 1.8                          | 1.8   | 2.5   | 3.4   | 3.2   | 1.7   |       |       |       |       |       |       |        |       |       |       |       |       |       |       |       | 1.0   | 1.1   | 1.8   |      |
| Percolation                  | mm/day        |                              |       |       |       |       |       |       |       |       |       |       |       |        |       |       |       |       |       |       |       |       |       |       |       |      |
| Crop Water Requirement       | mm/half month | 27.0                         | 28.2  | 37.2  | 47.7  | 48.0  | 27.1  |       |       |       |       |       |       |        |       |       |       |       |       |       |       |       |       | 14.6  | 16.1  | 29.4 |
| Effective Rainfall           | mm/half month | 0.0                          | 14.5  | 0.0   | 0.0   | 0.0   | 18.6  | 37.1  | 0.0   | 53.6  | 193.5 | 93.2  | 137.5 | 28.1   | 391.3 | 18.4  | 102.3 | 94.2  | 258.8 | 28.8  | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   |      |
| Irrigation Requirement       | mm/half month | 27.0                         | 13.7  | 37.2  | 47.7  | 48.0  | 8.5   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0    | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 14.6  | 16.1  | 29.4  |      |
| Irrigation Requirement       | m3/s          | 1.250                        | 0.595 | 1.722 | 2.366 | 2.221 | 0.368 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000  | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.676 | 0.744 | 1.274 |      |
|                              |               | Winter Vegetable 100 ha      |       |       |       |       |       |       |       |       |       |       |       |        |       |       |       |       |       |       |       |       |       |       |       |      |
|                              |               | Jan-1                        | Jan-2 | Feb-1 | Feb-2 | Mar-1 | Mar-2 | Apr-1 | Apr-2 | May-1 | May-2 | Jun-1 | Jun-2 | Jul-1  | Jul-2 | Aug-1 | Aug-2 | Sep-1 | Sep-2 | Oct-1 | Oct-2 | Nov-1 | Nov-2 | Dec-1 | Dec-1 |      |
| Spring Paddy                 |               | 15                           | 16    | 15    | 14    | 15    | 16    | 15    | 15    | 15    | 16    | 15    | 15    | 15     | 16    | 15    | 16    | 15    | 15    | 15    | 16    | 15    | 15    | 15    | 16    |      |
| ETo                          | mm/day        | 1.7                          | 1.5   | 2.2   | 3.0   | 3.6   | 4.2   | 5.0   | 5.4   | 4.8   | 4.9   | 4.9   | 3.7   | 4.0    | 3.8   | 4.4   | 3.9   | 3.8   | 3.4   | 3.5   | 3.0   | 2.8   | 2.3   | 1.6   | 1.7   |      |
| Cropping Pattern             |               |                              |       |       |       |       |       |       |       |       |       |       |       |        |       |       |       |       |       |       |       |       |       |       |       |      |
| Land Preparation             | mm/half month |                              |       |       |       |       |       |       |       |       |       |       |       |        |       |       |       |       |       |       |       |       |       |       |       |      |
| Kc                           |               | 0.95                         | 0.95  | 0.89  |       |       |       |       |       |       |       |       |       |        |       |       |       |       |       |       |       |       | 0.28  | 0.34  | 0.54  | 0.88 |
| ETcrop                       | mm/day        | 1.6                          | 1.5   | 1.9   |       |       |       |       |       |       |       |       |       |        |       |       |       |       |       |       |       |       | 0.8   | 0.9   | 1.5   |      |
| Percolation                  | mm/day        |                              |       |       |       |       |       |       |       |       |       |       |       |        |       |       |       |       |       |       |       |       |       |       |       |      |
| Crop Water Requirement       | mm/half month | 24.4                         | 23.3  | 28.8  | 0.0   | 0.0   | 0.0   |       |       |       |       |       |       |        |       |       |       |       |       |       |       |       | 11.5  | 13.4  | 24.6  |      |
| Effective Rainfall           | mm/half month | 0.0                          | 14.5  | 0.0   | 0.0   | 0.0   | 18.6  | 37.1  | 0.0   | 53.6  | 193.5 | 93.2  | 137.5 | 28.1   | 391.3 | 18.4  | 102.3 | 94.2  | 258.8 | 28.8  | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   |      |
| Irrigation Requirement       | mm/half month | 24.4                         | 8.8   | 28.8  | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0    | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 11.5  | 13.4  | 24.6  |      |
| Irrigation Requirement       | m3/s          | 0.019                        | 0.006 | 0.022 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000  | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.009 | 0.010 | 0.018 |      |
| Irrigation Requirement       | m3/s          | 1.269                        | 0.602 | 1.744 | 2.986 | 2.800 | 1.598 | 1.234 | 1.219 | 0.665 | 0.000 | 0.218 | 0.000 | 6.224  | 0.000 | 4.222 | 0.000 | 0.536 | 0.000 | 0.000 | 0.000 | 0.000 | 0.685 | 0.754 | 1.292 |      |
| Gross Irrigation Requirement | m3/s          | 3.304                        | 1.567 | 4.542 | 7.300 | 6.849 | 3.220 | 2.268 | 2.241 | 1.223 | 0.000 | 0.401 | 0.000 | 11.441 | 0.000 | 7.761 | 0.000 | 0.985 | 0.000 | 0.000 | 0.000 | 0.000 | 1.784 | 1.965 | 3.364 |      |

Source: JICA Survey Team

### 5) Comparing Flow Rate of Current Irrigation System and Calculated Value

According to the data from the Irrigation Management Office, the design flow rate for the current irrigation system is 11.8m<sup>3</sup>/s. The 1/5-year probable peak flow rate based on the current climatic conditions and cultivation conditions is 11.4 m<sup>3</sup>/s (to irrigate 6,500 ha of monsoon rice), which is almost the same as the design flow rate. The improvement of the facility will increase the conveyance efficiency and ensure the expansion of the irrigated area of monsoon rice even at the same flow rate. In a normal water year, 8,200 ha, the majority of the beneficiary area, can be irrigated with an intake rate of 11.8 m<sup>3</sup>/s. Therefore, the maximum design flow rate for the facility

in this design is the current design flow rate, which is 11.8 m<sup>3</sup>/s.

In addition, it was confirmed in the field survey that water was leaking from cracks in the CUPs (about 20% in total from eight locations). Based on the amount of leakage and the calculated gross water requirement, the irrigable area under the current conditions can be estimated to be 5,200ha and 6,500ha at peak (11.4m<sup>3</sup>/s) and normal year (11.8m<sup>3</sup>/s), respectively. By eliminating water leakage through the improvement of CUPs, the irrigated area will increase by 1,300ha (7,800-6,500ha) and 1,640ha (9,840-8,200ha), respectively.

- Peak period (water flow rate: 11.4m<sup>3</sup>/s): 6,500 × 1.2 = 7,800 ha
- Normal year (water flow rate: 11.8m<sup>3</sup>/s): 8,200 × 1.2 = 9,840 ha

#### 2-2-2-4 Amount of diverted water and Irrigable area

##### (1) River discharge as water resource

Since there is no flow observation point for the Trijuga River (Catchment Area = 709km<sup>2</sup>), the flow rate of Trijuga River as water resource of Chandra Canal Irrigation System (CCIS) is estimated from the existing observation data in the vicinity. The nearby Kankai Mai River observation point (Catchment Area = 1,148km<sup>2</sup>) is located about 100km east of the headworks and that river has observation data from 1972 to 2011, with similar basin area and topography. Therefore, the observation data of the Kankai Mai River shall be used for the design.

##### (2) River discharge in drought years

According to the observed data of Kankai Mai River, the annual runoff height in 1/5 drought year is 1,267mm (base year 1979). In accordance with this runoff condition, the discharge volume of Trijuga River at the intake point is estimated as follows in the 1/5 drought year.

**Table 2-2-9 Discharge of Trijuga River at the Intake Point (1/5 years drought)**

| Contents                            | Jan | Feb | Mar | Apr | May | Jan  | Jul  | Aug  | Sep  | Oct  | Nov  | Dec | Total |
|-------------------------------------|-----|-----|-----|-----|-----|------|------|------|------|------|------|-----|-------|
| Allocation of runoff (%)            | 1.6 | 1.2 | 1.2 | 1.5 | 2.8 | 8.7  | 26.0 | 26.1 | 17.2 | 8.2  | 3.3  | 2.1 | 100.0 |
| Height Runoff (mm)                  | 20  | 16  | 16  | 19  | 36  | 110  | 329  | 331  | 218  | 104  | 42   | 26  | 1,267 |
| River Discharge (m <sup>3</sup> /s) | 5.4 | 4.1 | 4.1 | 4.9 | 9.5 | 29.2 | 87.2 | 87.7 | 57.8 | 27.5 | 11.0 | 7.0 | -     |

Where, Trijuga River Catchment Area: 709km<sup>2</sup>

Allocation of runoff is calculated according to observation data of Kankai Mai River.

Height Runoff = Annual rate of Height Runoff × Allocation of rainfall

River discharge = Height Runoff × Catchment Area

Source: JICA Survey Team

The monsoon paddy farming which needs the peak irrigation water flow rate is from July to September. The minimum discharge of the Trijuga River during those period is estimated to be above 50m<sup>3</sup>/s. Therefore main irrigation canal's discharge 11.8m<sup>3</sup>/s can be regarded as the design discharge.

#### 2-2-2-5 Flood Analysis

##### (1) Considering Return period

According to the Design Manual "the Design Manual for Irrigation Project in Nepal, M3 Hydrology and

Agro-meteorology Manual”, the probability year of CDW for external drainage inflow is shown in the table below. Therefore, the planned probability year for CDW is 25 years, and 1/25 year is adopted as the planned probability year for hydrological events in drainage design.

**Table 2-2-10 Planning Probability Year in Nepal Irrigation Project Design Manual**

| Category of construction               | Details                    | Return period            |
|--|----------------------------|--------------------------|
| Irrigation plan                        |                            | 5 years                  |
| Scale of irrigation                    |                            | 5 years                  |
| Flood disaster prevention on headworks | Main river in Terai region | 100 years                |
|  | Other                      | 50 years                 |
| Discharge from outside                 | Canal, etc.                | 10 years                 |
|  | CDWs                       | <u>25years (adopted)</u> |
|  | Drain Ditch                | 10 years                 |
| Domestic discharge                     | Terai                      | 10 years                 |
|  | Hillside                   | 10 years                 |

Source: Irrigation Manual in Nepal.

## (2) Rainfall Data

The maximum rainfall per day had been collected from 1967 to 2018 at the weather station of Biratnagar as below. The highest rainfall is 405mm observed in 1974.

**Table 2-2-11 Maximum Rainfall per Day**

| year | Max. Rainfall | year | Max. Rainfall | year | Max. Rainfall | year | Max. Rainfall |
|------|---------------|------|---------------|------|---------------|------|---------------|
| 1967 | 142.5         | 1980 | 206.8         | 1993 | 114.0         | 2006 | 94.8          |
| 1968 | 137.2         | 1981 | 130.7         | 1994 | 60.8          | 2007 | 223.5         |
| 1969 | 103.6         | 1982 | 103.4         | 1995 | 132.0         | 2008 | 95.0          |
| 1970 | 121.2         | 1983 | 130.7         | 1996 | 146.6         | 2009 | 145.8         |
| 1971 | 137.2         | 1984 | 188.6         | 1997 | 155.0         | 2010 | 169.6         |
| 1972 | 142.0         | 1985 | 123.2         | 1998 | 167.5         | 2011 | 89.7          |
| 1973 | 144.7         | 1986 | 101.3         | 1999 | 90.7          | 2012 | 139.0         |
| 1974 | 405.0         | 1987 | 219.1         | 2000 | 203.5         | 2013 | 126.5         |
| 1975 | 159.0         | 1988 | 93.3          | 2001 | 194.1         | 2014 | 133.5         |
| 1976 | 128.3         | 1989 | 169.0         | 2002 | 150.3         | 2015 | 75.0          |
| 1977 | 154.6         | 1990 | 125.4         | 2003 | 181.3         | 2016 | 90.0          |
| 1978 | 148.0         | 1991 | 86.2          | 2004 | 155.5         | 2017 | 251.0         |
| 1979 | 145.6         | 1992 | 139.3         | 2005 | 112.7         | 2018 | 123.0         |

Unit: mm/day

Source: Weather station at Biratnagar

## (3) Probability Rainfall

The maximum daily rainfall shown in the table above is used to calculate the 1/25 year probability daily rainfall. The Gumbel method with extreme value distribution is used to calculate the probability year. The probable daily rainfall for 1/25th year is 266mm.

**Table 2-2-12 Probability Rainfall estimated by Gumbel distribution**

| Return Period | y: Extreme Value | x: Rainfall (mm) | Remarks   |
|---------------|------------------|------------------|---|
| 10            | 2.25037          | 222              | N = 52<br>x = 119.12+45.92y<br>y: Extreme Value |
| 25            | 3.19853          | 266 (applied)    |   |
| 50            | 3.90194          | 298              |   |

Source: JICA Survey Team

#### (4) Estimation of hourly rainfall

Since it is difficult to obtain hourly rainfall data in Nepal, we will estimate the hourly rainfall from Monobe's formula.

$$R_T = R_{24} / 24 \times (24 / t)^n$$

$R_T$  : Mean Time Rainfall (mm/hr)

$t$  : Duration of Rainfall (hr)

$n$  : Coefficient (Generally 1/3 ~ 2/3. 0.5 is applied in this estimation)

Therefore, the hourly rainfall with probability of 1/25 years is 54.3 (mm/hr).

The rainfall waveform at any given time is generated from the following equation based on the relationship between daily rainfall (266 mm) and hourly rainfall (54.3 mm).

$$R_t = A/(t + B)/24$$

$R_t$  : Average hourly rainfall in t hours (mm/hr)

$A$  : Constant obtained from data (=7687.1)

$B$  : Constant obtained from data (= 4.90)

The hyetograph ( $r=0.8$ ) obtained from the Talbot equation above is as follows;

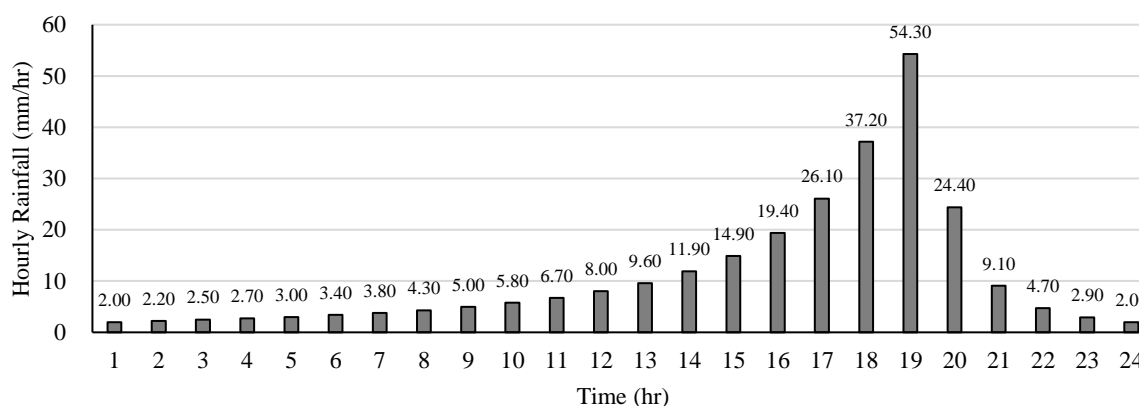


Figure 2-2-1 Hyetograph

#### (5) Time of flood concentration

Time of Flood concentration is estimated by Kakuya's formula, which can be applied to various land types.

$$T_p = C \times A^{0.22} (f_p \times R_t)^{-0.35}$$

$T_p$ : Time of flood concentration (hr)

$C$  : Land Use Coefficient

$A$  : Catchment Area (km<sup>2</sup>)

$f_p$  : Peak runoff rate

$R_t$ : Average hourly rainfall during the flood reach time (mm/hr)

#### (6) Model of Runoff

Although there are several runoff models available for calculating runoff volume, this project adopts the Rational Model, which is widely used and highly versatile, and is specialized for calculating peak runoff volume. As a result of comparing the flood volume between the storage function method, which is

widely used in Japan, and the rational equation, the calculation error is within 5%, which ensures the reliability of the model. The following table shows the results of flood discharge using the rational equation and the storage function method for the CUP works (IS06: A=71.4m<sup>2</sup>), which has the largest basin area.

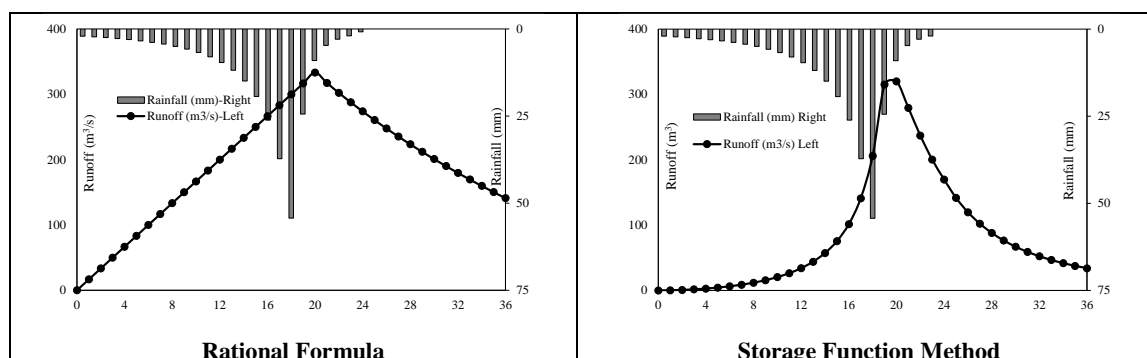


Figure 2-2-2 Runoff rate estimated by Rational Formula and Storage Function method

The 1/25 year probability flood specific discharge was recorded as  $q=4.2\text{m}^3/\text{s}/\text{km}^2$ . The specific discharge in this basin is  $q=4.7\text{m}^3/\text{s}/\text{km}^2$ , and the above formula is considered to be appropriate.

The calculation of flood volume by the Rational Formula is as follows

$$Q = 1/3.6 f_p \times R_t \times A$$

Q : Flood volume (m<sup>3</sup>/s)

$f_p$  : Peak runoff rate

$R_t$  : Average hourly rainfall during the flood reach time (mm/hr)

A : Catchment Area (km<sup>2</sup>)

The results of the calculations are shown in the following table.

Table 2-2-13 Runoff Volume and Specific Discharge

| Code                  | Catchment Area (km <sup>2</sup> ) | Land Category                    | Runoff Volume (m <sup>3</sup> /s) | Specific Discharge (m <sup>3</sup> /s/km <sup>2</sup> ) |
|-----------------------|-----------------------------------|----------------------------------|-----------------------------------|---|
| CUP-1                 | 7.3                               | Hillside and Paddy field         | 46.8                              | 6.4   |
| CUP-2                 | 1.5                               | Hillside and Paddy field         | 11.7                              | 7.8   |
| CUP-3                 | 22.1                              | Hillside and Paddy field         | 133.2                             | 6.0   |
| CUP-4                 | 7.6                               | Hillside and Paddy field         | 42.9                              | 5.6   |
| CUP-5                 | 23.1                              | Hillside and Paddy field         | 139.2                             | 6.0   |
| CUP-6                 | 71.4                              | Hillside and Paddy field         | 333.2                             | 4.7   |
| CUP-7                 | 17.9                              | Hillside and Paddy field         | 87.0                              | 4.9   |
| CUP-8                 | 4.6                               | Hillside and Paddy field         | 22.4                              | 4.9   |
| CDW-01                | 1.7                               | Hillside, Paddy field and houses | 15.2                              | 9.0   |
| CDW-02                | 5.4                               | Hillside, Paddy field and Field  | 37.5                              | 7.0   |
| CDW-03                | 3.2                               | Hillside, Paddy field and Field  | 26.2                              | 8.2   |
| CDW-04                | 1.0                               | Hillside and Paddy field         | 7.4                               | 7.4   |
| CDW-05                | 1.5                               | Hillside and Paddy field         | 9.0                               | 6.0   |
| CDW-06                | 2.0                               | Hillside and Paddy field         | 13.6                              | 6.8   |
| CDW-07                | 2.0                               | Hillside and Paddy field         | 12.1                              | 6.1   |
| CDW-08                | 0.3                               | Hillside and Paddy field         | 2.4                               | 8.0   |
| CDW-09                | 8.1                               | Hillside and Paddy field         | 48.8                              | 6.0   |
| CDW-10                | 0.2                               | Hillside and Paddy field         | 1.6                               | 8.0   |
| CDW-11                | 0.3                               | Paddy field                      | 2.4                               | 8.0   |
| CDW-12                | 2.0                               | Paddy field                      | 16.0                              | 8.0   |
| CDW-13                | 1.3                               | Paddy field                      | 10.7                              | 8.2   |
| CDW-14                | 0.2                               | Paddy field                      | 1.6                               | 8.0   |
| Intake, Trijuga River | 709.0                             |                                  |                                   |   |

Source: JICA Survey Team

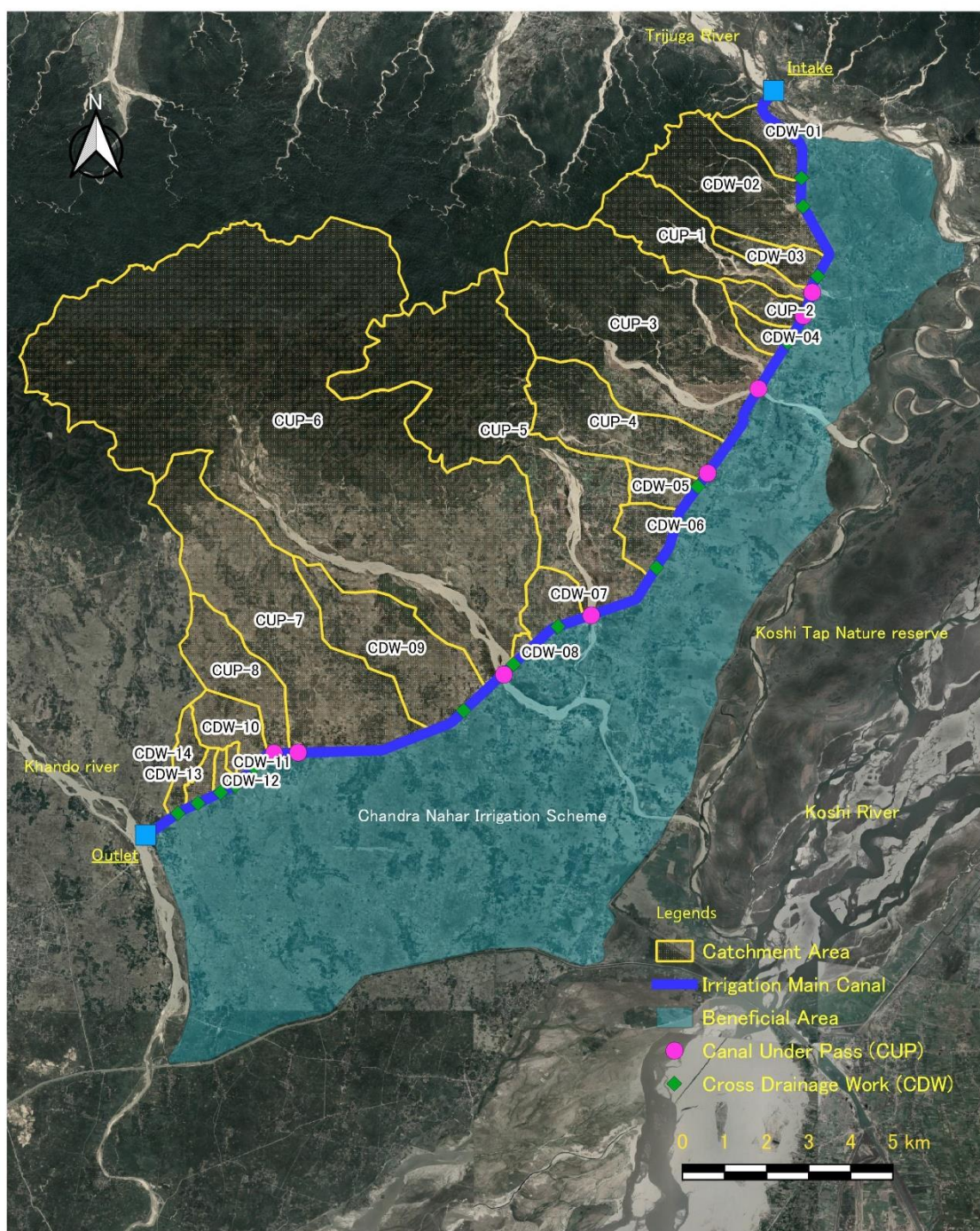


Figure 2-2-3 Flood Catchment Area

## 2-2-2-6 Design of Canal Under Pass (CUP)

### (1) Basic Policy

#### 1) Precondition

In the rehabilitation of CUPs, it is assumed that the main irrigation canal will cross the river and deliver the planned flow rate downstream, which is its original function. The design flow rate of each CUP and the width of the river to be crossed (i.e., the length of the culvert part), which are preconditions, are shown in the table below.

**Table 2-2-14 Design Discharge of CUPs and River width**

| Str. Code | Design Discharge (m <sup>3</sup> /s) | River width (m) |
|-----------|--------------------------------------|-----------------|
| CUP-1     | 10.77                                | 22.20           |
| CUP-2     | 10.77                                | 15.05           |
| CUP-3     | 10.11                                | 73.00           |
| CUP-4     | 9.43                                 | 48.10           |
| CUP-5     | 7.29                                 | 50.50           |
| CUP-6     | 6.99                                 | 152.90          |
| CUP-7     | 1.16                                 | 33.70           |
| CUP-8     | 1.16                                 | 25.00           |

Source: JICA Survey Team

#### 2) Consideration of Alternatives for structures crossing the river

In the rehabilitation of CUPs, the alternatives to the structures to cross the river are High Filling Canal, Canal Bridge, and Detour Canal. However, the alternatives would interrupt the flow of the rivers, cause to flood risks and high costs. On the other hand, the current structures, CUPs, do not interrupt the flow of rivers and cause to flood risk or high cost. Therefore, CUPs shall be adopted in the rehabilitation, following the shape of the existing facility.

#### 3) Issues and Solutions of Existing Structures

Common to all CUPs, the facilities do not fulfill their functions as irrigation canal due to aging or damage. The following sections point out the issues and solutions of the existing facilities for facility rehabilitation.

- a) The main material of the existing facilities in CUP-1, CUP-2, CUP-3, CUP-4, CUP-5 and CUP-6 is brick. The brick structure has a roughness coefficient of 0.017~0.030<sup>9</sup>, which is important for the hydraulic study. In order to meet the need to recover the conveyance efficiency and to convey the water inside the culvert downstream quickly, it is desirable to reduce the roughness coefficient. Therefore, concrete structures with roughness coefficients between 0.012~0.016<sup>10</sup> will be mainly used in the rehabilitation of this facility. Mainly using concrete structure is also judged to be more useful than brick structure in that it can be expected to maintain water tightness in the long term. On the other hand, the construction material used for the existing facilities in CUP-7 and CUP-8 is concrete structure, and concrete structure will be adopted in the reconstruction as well.
- b) In CUP-7 and CUP-8, scouring by river flow occurs at the locations of culvert structures. In the rehabilitation plan, the appropriate depth of culvert structure should be set assuming the progress of scouring. In addition, it should be noted that the backfilled soil in the rehabilitation of other facilities may not be stable and may be washed away by the river flow, so the structures

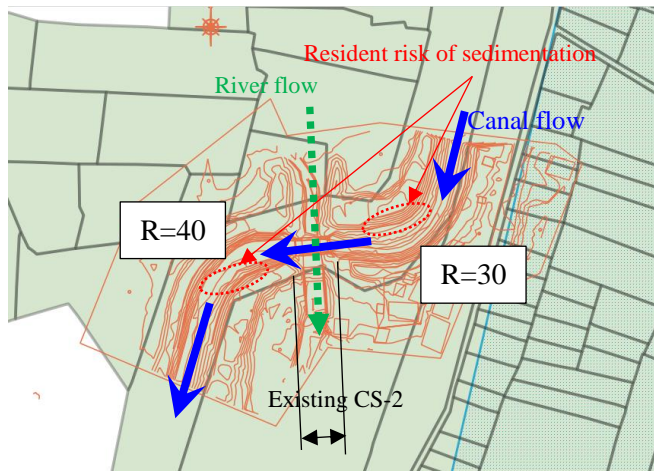
<sup>9</sup> The value of Masonry referring Design Policy of Irrigation Canal, Rural Development Bureau, MAFF in Japan

<sup>10</sup> The value of Concrete referring Design Policy of Irrigation Canal, Rural Development Bureau, MAFF in Japan

may come in contact with the river flow.

- c) Since all CUPs have a common problem of reduced water flow cross-section due to the inflow of trash, it is required to reduce the amount of trash inflow in the rehabilitated facility. Therefore, steel screens will be installed at the inlets of all CUPs.
- d) Common to all the CUPs, sediment is generated around the inlet and outlet. Therefore, when rehabilitating the CUP, the inlet and outlet sides should be shaped as vertical culvert in order to facilitate dredging work of the sediment from time to time. In addition, a maximum slope of 1/100 shall be provided for the culvert section to prevent sand from accumulating in the culvert parts.
- e) The existing CUP does not have enough width for vehicles and people to pass through the upper part of the culvert part (culvert length = river width). Therefore, vehicles are crossing the canal over the river slope. Therefore, when rehabilitating the CUP, the width of the upper part of the culvert section should be wide enough for vehicles and people to pass through.

- f) The CUP-2 has curved sections both upstream and downstream of the facility. In designing the culvert part of CUP, it is common to set the radius of curvature of the canal to 10 times the water surface width in order to minimize the change in flow velocity. Since the water surface width of the section is 12m, the radius of the curve is  $R=120\text{m}$ . However, the current curvature is  $R=40\text{m}$  upstream of the facility and  $R=30\text{m}$  downstream of the facility, and the flow velocity is not stable in the cross section of the curved section, resulting in significant sedimentation.



Therefore, the alignment of the irrigation canal will be modified as shown in the table below. In line with this modification, the location of CUP-2 will be relocated to the upstream side of the river.

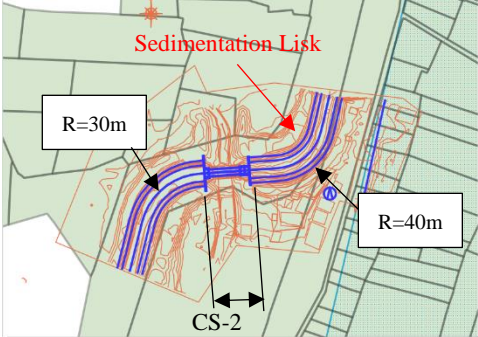
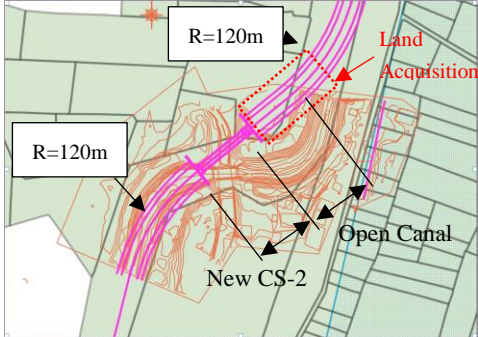


Upstream of CUP-2



Upstream of CUP-2

**Table 2-2-15 Modification plan of canal alignment on Up and Down stream of CUP-2**

| Alt.-1: Current route   | Alt.-2: Proposed route   |
|---|--|
| <p>The existing route shall be followed. It means that the existing CUP shall be removed and reconstructed.</p>    | <p>The radius of curvature shall be set at 10 times of the water surface width = 12m, and new CUP structure shall be built on the changed route.</p>   |
| <p>Demerit of Alt.-1</p> <ul style="list-style-type: none"> <li>♦ Uneven flow velocity in the canal cross section.</li> <li>♦ The risk of sediment accumulation increases inside the curved section where the flow velocity is slow.</li> <li>♦ The burden of maintenance work is increased.</li> </ul> <p>Merit of Alt.-1</p> <ul style="list-style-type: none"> <li>♦ No land acquisition.</li> </ul> | <p>Demerit of Alt.-2</p> <ul style="list-style-type: none"> <li>♦ Nesary to land acquisition.</li> </ul> <p>Merit of Alt.-2</p> <ul style="list-style-type: none"> <li>♦ The flow velocity in the canal will be generally uniform.</li> <li>♦ The risk of sediment deposition can be reduced.</li> <li>♦ The burden of maintenance work can be reduced.</li> </ul> |

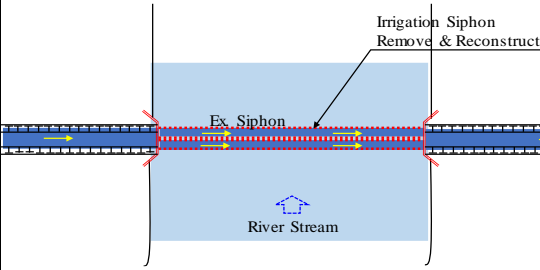
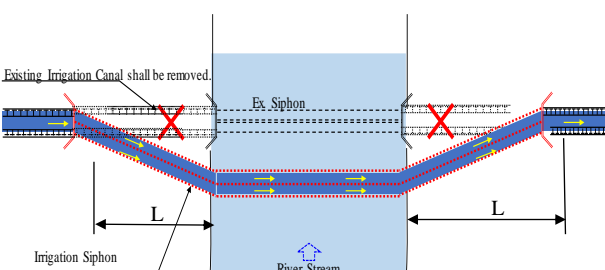
#### 4) Canal alignment Rehabilitation

The handling policy of the existing facilities for the rehabilitation of CUPs was compared and examined as shown in the Table 2-2-16 below.

Alt.-1: Since it can be considered to be advantageous in terms of conveyance efficiency and cost, Alt.-1 plan shall be adopted in principle for CUP-1, CUP-3, CUP-4, CUP-5, CUP-6, CUP-7, and CUP-8.

Alt.-2: CUP-2 changes the alignment of the curved sections upstream and downstream of the CUP in accordance with Table 2-2-15. Therefore, Alt.-2 is adopted for CUP-2 since it avoids the need to remove the existing facility.

**Table 2-2-16 Handling policy of the Existing Facilities for Rehabilitation**

|                     | Alternative-1<br>Remove and Re-construction of Existing CUP  | Alternative-2<br>Left in place existing CUP and constructing on renewal route   |
|---------------------|--|---|
| General             | Remove the existing CUP and install a new structure in the removed area.<br>  | No need to remove the existing CUP. And a CUP shall be installed at a new route where the canal route will be moved to the upstream side of the river.<br>  |
| Plan                | The planar alignment of the existing facility shall be followed. The length of the facility will be shorter than Alt.-2.   | In order to avoid the existing facilities, the alignment shall have the above detour section (L section). Since there is an assumption that no land acquisition will be done, this section will be a culvert section. Therefore, the length of the culvert will be 2~3 times longer than the current condition.                         |
| Existing Facilities | Remove   | Left in place   |
| Hydrology           | The basic structure of the new facility will remain basically the same as the current one. The roughness coefficient of the facility can be reduced by rehabilitating the facility as concrete structure.  | The roughness factor of the facility can be reduced by making the rehabilitated facility a concrete structure. But due to the longer length, the hydraulic head loss (friction loss) is larger than the current facility, which makes it hydraulically disadvantageous compared to Alt.-1.  |
| Maintenance         | The conventional function can be ensured by cleaning the inlet section on a regular basis.   | Since the length is longer than Alt.-1, both the required effort and cost shall be large.   |
| Construction        | The installation of a temporary irrigation canal and the demolition and removal of the existing CUPs are processes that require more steps than Alt.-2.  | The construction shall be done while the water is flowing into the existing facility (brick Canal with full water inside the target CUPs). Since it is unknown whether the existing CUPs have strong enough to stand to the internal water pressure, it is necessary to construct the CUP at an appropriate distance from the facility. |
| Borrowing Area      | It is necessary to lease land for the purpose of installing a temporary turnaround canal. The area of the land to be leased will be based on the area of the embankment of the temporary canal, but the area shall vary depending on the current ground level. | In the section where the new siphon is to be installed, the excavation area needs to be leased. The area to be leased for the excavation depends on the design conditions, so it will be compared with Plan 1. In addition, there is basically no land expropriation because the Canal on the modified route will be buried.            |
| Cost                | Smaller than Plan Alt.-2   | About three times as much as Alt.-1   |
| Conclusion          | Basically Alt.-1 shall be adopted, which is advantageous on technical and economic issues. However, CUP-2 is hydraulically unstable with the existing plan alignment, so Alt.-2 shall be adopted.  |   |

Sauce: JST

## 5) Ancillary structures

As ancillary structures common to all CUPs, (a) provision of transition section, (b) attachment of a main irrigation canal, (c) countermeasures against flooding of the river that crosses CUPs, and (d) safety measures are to be considered. An overview is given below.

- a) The transition section connecting the CUP to the irrigation canal will be lined with masonry to improve the need for unevenness and the vulnerability of the canal embankment. The design cross-section of the canal shall be a cross-section that allows the design flow rate based on the irrigation plan to flow down. Based on the field survey, a trapezoidal cross-section with

multiple cross-sections shall be used as in the original design. When connecting to the rehabilitated section, minor adjustments shall be made in the field.

- b) At the connection between the CUP and the irrigation canal, an appropriate length of transition is provided so that the cross-section does not change abruptly.
- c) For rivers crossing the CUPs, river revetments with masonry structures should be installed to the extent necessary to protect the CUPs from affected by river flood flows.
- d) At the inlet and outlet of the CUP, a 2.0 m high fence with barbed wire will be used to enclose the inlet/outlet of vertical culvert to prevent people from falling into it. Also, double safety measures will be taken by covering the opening of the vertical culvert with a net that prevent foreign material from falling into it.

## (2) Plan

Among the CUPs, CUP-1, CUP-3, CUP-4, CUP-5, CUP-6, CUP-7, and CUP-8 will follow the existing CUP plan alignment, while CUP-2 will be installed at an appropriate location after reviewing the plan alignment of the irrigation canal. On these facilities, in addition to the river width, the location of the inlet and outlet gutters can be examined to determine the length of the culvert section. The location of the inlet and outlet of CUP should be at the required distance from the bank of the river. The minimum top width of the river bank of 3.0m<sup>11</sup> or the design road width of 4.25m<sup>12</sup> and the width of the fence of 0.50m are considered as the required distance.

The table below shows the results of calculating the river width and the distance from the river bank to the inlet and outlet of the CUP.

**Table 2-2-17 Baseline of Culvert Length of CUP**

| Code  | Inlet side |       | River Width |      | Outlet Side |       | Total  | Remarks            |
|-------|------------|-------|-------------|------|-------------|-------|--------|--------------------|
|       | Bank/Road  | Fence | River       | Adj. | Bank/Road   | Fence |        |                    |
| CUP-1 | 4.25       | 0.50  | 22.20       | 0.30 | 4.25        | 0.50  | 32.00  |                    |
| CUP-2 | 3.00       | 0.50  | 18.40       | 0.10 | 3.00        | 0.50  | 25.50  | Modify canal route |
| CUP-3 | 4.25       | 0.0   | 73.00       | 0.00 | 4.25        | 0.50  | 82.50  |                    |
| CUP-4 | 4.25       | 0.50  | 48.10       | 0.40 | 4.25        | 0.50  | 58.00  |                    |
| CUP-5 | 4.25       | 0.50  | 50.50       | 0.00 | 4.25        | 0.50  | 60.00  |                    |
| CUP-6 | 4.25       | 0.50  | 152.90      | 0.10 | 4.25        | 0.50  | 162.50 |                    |
| CUP-7 | 3.00       | 0.50  | 33.70       | 0.05 | 4.25        | 0.50  | 42.00  |                    |
| CUP-8 | 3.00       | 0.50  | 25.00       | 0.00 | 3.00        | 0.50  | 32.00  |                    |

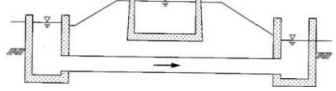
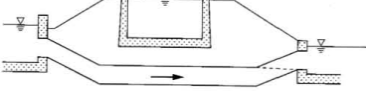
\*1 The river width was set equal to the culvert length of the existing CUP.

Source: JICA Survey Team

## (3) Profile

The shape of the siphon to be installed in this project act as a facility that helps the main canal cross a river. Since it is a facility that crosses under a river, the plan is to bury it in accordance with the current facility. The two types of shapes shown in the table below are common. Since there is a risk of sediment deposition in all of the target facilities, it is not appropriate to adopt type B. Therefore, type A shall be adopted for all CUPs.

**Table 2-2-18 Comparison for CUP type**

|                | Type-A  | Type-B   |
|----------------|---|--|
| Profile Image  |  |  |
| Culvert Length | Suitable for short routes.  | Can be applied to long routes.   |

<sup>11</sup>Design part I, Manual for River Works in Japan, 1997 (P.6)

<sup>12</sup>Nepal Rural Road Standards 2055 2nd Revision, 2071, December, 2014

|              | Type-A  | Type-B   |
|--------------|---|--|
| Flow Section | Can be applied in case of small section*2.                                      | Can be applied in case of wide section and easy to maintain.         |
| Burial Depth | Can be applied in case of shallow of burial depth and making inlet box smaller. | Can be applied when the culvert burial depth deeper.                 |
| Remarks      | Culvert shall be set 1~2% slope for maintenance.                                | Cannot be applied if there is much sedimentation in irrigation flow. |

Source: Design Policy of Irrigation Canal, Rural Development Bureau, MAFF in Japan

## 1) Depth of Culvert

### (a) Background of consideration

The depth of the culvert is generally 2.0m or more from the river bed to avoid the effect of scouring on the structure. However, in some location where the river bed intersects the CUP, there is no tendency of scouring, and in some cases the river bed rises due to deposition of sand. Therefore, it is not necessary to set the depth to 2.0m or more, but needs to consider it according to the site conditions.

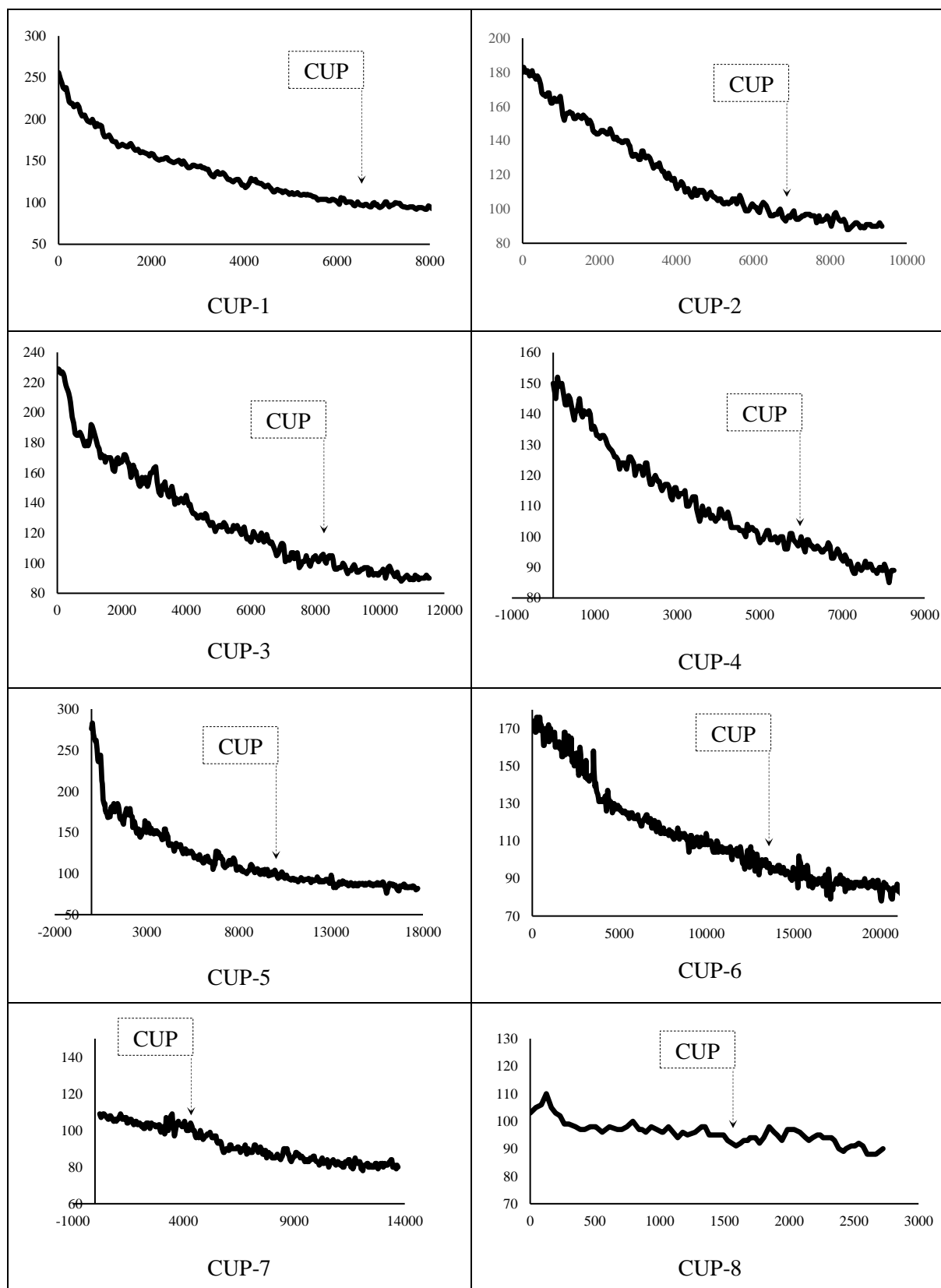
### (b) Fluctuations of river bed

As the result of the study by DTM<sup>13</sup>, it was confirmed that the slope of the river bed<sup>14</sup> was gradual at all locations where the CUPs were installed. Therefore, it was judged that the riverbed change including erosion would not proceed rapidly in those locations.

The gradient of the river bed where the river crosses the CUP is shown below.

<sup>13</sup> DTM: Digital Terrain Model

<sup>14</sup> The topographic information was created by tracing water lines in QGIS using the Shuttle Radar Topography Mission database. The topographic information was created by tracing water lines in QGIS using the database of the Shuttle Radar Topography Mission. Since the topography was not smoothed, extreme unevenness remained in the longitudinal section. Although the longitudinal section was not smoothed, it was judged that it would not interfere with obtaining an indication of the riverbed slope in sections of 1,000m or more.



\*1 the line graph represents the riverbed slope, where the vertical axis is the elevation and the horizontal axis is the longitudinal distance of the river.

\*2 the flagging of the CUP indicates where the CUP will cross.

\*3 Unevenness is shown in the figure, which is caused by mechanical work from DTM.

Source: JICA Survey Team

**Figure 2-2-4 Positioning between River beds and culvert of CUPs**

### (c) Scouring situation around existing facilities

From the field survey, it was confirmed that there are progressive riverbed scouring at CUP-7 and CUP-8. From the site conditions, it was inferred that the reason for this was not scouring related to the river flow but damage to the submerged bridge installed downstream of the CUP and the gabion protection installed around the submerged bridge.

At CUP-7, about 0.3m of scour was observed (photo). Since the facility was built in 1979 and the photo was taken in 2021, the riverbed was washed out by 0.3m in 42 years. Based on this result, it is assumed that 0.007m/year or 0.01m/year of scouring will occur.



Photo: JICA Survey Team

### (d) Combating Wear

After the installation of the CUP, it is necessary to make sure that the water from the river does not touch the facility. Therefore, an appropriate installation depth should be provided.

## 2) Determining the Minimum installation Depth

Based on the above study, the installation depth policy was categorized into CUP-1, CUP-2, CUP-3, CUP-4, CUP-5 and CUP-6 cases, and CUP-7 and CUP-8 cases.

- a) CUP-1, CUP-2, CUP-3, CUP-4, CUP-5 and CUP-6: A installation depth of 0.50 m shall be provided for all facilities to avoid abrasion of the facilities due to river water hitting the main body of the culvert section.
- b) CUP-7 and CUP-8: When planning on the premise that the general service life of concrete structures is 40 to 50 years, the target scour will progress by  $0.01\text{m years} \times 50 \text{ years} = 0.50\text{m}$  in 50 years after construction. The depth of installation is set to be 1.0m or more so that the structure will not affect the flow of the river even after 50 years of construction.
- c) Common items for all facilities: Based on the minimum installation depth shown above, the depth should be determined by examining the surfacing of the culvert structure. When considering surfacing, it is necessary to assume the thickness of membrane of the culvert. According to the Order for River Management Facilities, the minimum thickness of membrane of river structures is 350 mm or more. In this project, it is difficult to predict the movement of surface water in the riverbed, and in consideration of the risk of abrasion, the thickness is set at  $350 \text{ mm} + 50 \text{ mm}$ , making the planned membrane thickness to 400 mm.

### (4) Sectional Plan of Culvert

As a general rule, the current cross-section and number of culvert pipes of the CUP are used as a starting point for examination, and the following points are verified. If it is judged to be inadequate as an irrigation facility, the cross-section of the CUP shall be increased.

- a) The total head loss of the existing irrigation CUP is positioned as the "maximum allowable loss value," and the cross-section is designed so that the water head loss in the plan is within the allowable value.
- b) Consideration should be given to ensure sufficient flow velocity in the open canal to avoid sediment accumulation in the siphon. The approximate flow velocity is set based on the canal slope in the range of 2~3 km upstream and downstream of the siphon. It should be noted that the hydraulic head loss should not exceed the allowable value (above).

### 1) Allowable loss of water head

The head loss of a CUP is the sum of (a) Friction Loss ( $h_f$ ), (b) Inflow Loss ( $h_{en}$ ), (c) Outflow Loss ( $h_{ou}$ ), and (d) Screen Loss ( $h_r$ ). The cross-sectional shape of the siphon should be smaller than the head loss that occurs in the current condition.

#### (a) Friction Loss

The frictional loss head of the siphon can be determined by the following equation derived from the Manning formula

$$h_f = \frac{f'}{R} L = \frac{2g \cdot n^2}{R^{4/3}} - L = \left( \frac{n \cdot V}{R^{2/3}} \right)^2 L$$

$$f' = \frac{2g \cdot n^2}{R^{1/3}}$$

Where,

$h_f$  : Friction Head (m)

$n$  : Roughness Coefficient

Brick: 0.025 (same as Wat Masonry), Reinforced Concrete: 0.015

$L$  : Distance (m)

$V$  : Mean Velocity (m/s)

$f'$  : Darcy Friction Factor Formulae

$g$  : Earth Gravity Acceleration (9.8m/s<sup>2</sup>)

$R$  : Hydraulic Mean Depth = Sectional Area / Wetted Perimeter

#### (b) Inflow Loss

In this project, the siphon inflow flows into the inlet and then into the culvert, so the inflow area is a static surface where the velocity is negligible. The loss head due to the inflow from the static surface where the inflow velocity can be neglected and the change in water level due to this are calculated by the following equation.

$$h_{en} = f_e \cdot \frac{V^2}{2g}$$

$$\Delta h_{en} = h_{en} + \frac{V^2}{2g}$$

Where,

$h_{en}$  : Friction Head of Inlet (m)

$\Delta h_{en}$  : Changing of water level on inlet (m)

$V$  : Mean velocity after inlet (m/s)

$f'$  : Darcy Friction Factor Formulae

$g$  : Earth Gravity Acceleration (9.8m/s<sup>2</sup>)

$f_e$  : Loss factor of inlet = 0.5 (Accounting of corner)

#### (c) Outflow Loss

The head loss and change in water level at outlet is calculated as follows

$$h_{ou} = f_o \cdot \frac{V^2}{2g}$$

$$\Delta h_{ou} = h_o + \frac{V^2}{2g}$$

Where,

$h_{ou}$ : Friction head of outlet (m)

$\Delta h_{ou}$ : Changing of water level on outlet (m)

$V$ : Mean velocity after outlet (m/s)

$f'$ : Darcy friction factor formulae

$g$ : Earth gravity acceleration (9.8m/s<sup>2</sup>)

$f_o$ : Loss factor of outlet = 1.5 (It is assumed that all of the velocity energy in the canal is lost due to the outflow, which is usually 1.0.)

#### (d) Water head loss and water level change due to screen

The loss of hydraulic head due to the screen is calculated by using Kirschmer's formula.

$$h_r = f_r \cdot \frac{V_1^2}{2g} = \beta \cdot \sin \theta \left( \frac{t}{b} \right)^{4/3} \cdot \frac{V_1^2}{2g}$$

$$\Delta h_r = f_r \cdot \frac{V_1^2}{2g} + \frac{V_2^2}{2g} - \frac{V_1^2}{2g}$$

Where,

$h_r$ : Friction head of screen (m)

$\Delta h_r$ : Changing of water level on screen (m)

$V_1$ : Mean velocity at upstream of screen (m/s)

$V_2$ : Mean velocity at downstream of screen (m/s)

$b$ : Width of lattice (m)

$g$ : Earth gravity acceleration (9.8m/s<sup>2</sup>)

$f'$ : Darcy friction factor formulae

$\beta$ : Coefficients depending on the bar section shape of the lattice =1.67

$\theta$ : Inclination angle (°) = 73.3

$t$ : Thickness of grating bars (m)

From the above equation, the team calculated the head loss<sup>15</sup> of the existing CUP. This value is the allowable head loss used to determine the planned cross section of the CUP.

**Table 2-2-19 Head loss in existing CUPs**

| Items            | Unit              | CUP-1 | CUP-2 | CUP-3 | CUP-4 | CUP-5 | CUP-6  | CUP-7 | CUP-8 |
|------------------|-------------------|-------|-------|-------|-------|-------|--------|-------|-------|
| Design Flow Vol. | m <sup>3</sup> /s | 10.77 | 10.77 | 10.11 | 9.43  | 7.29  | 6.99   | 1.16  | 1.16  |
| Length           | m                 | 22.20 | 15.05 | 73.00 | 48.10 | 50.50 | 152.90 | 3.70  | 25.00 |
| Width            | m                 | 2.40  | 2.50  | 2.60  | 2.55  | 1.80  | 2.15   | 1.00  | 1.00  |
| Wall Height      | m                 | 1.30  | 1.30  | 1.30  | 1.30  | 1.30  | 1.30   | 1.00  | 1.00  |
| Barrels          | nos.              | 2     | 2     | 2     | 2     | 2     | 2      | 1     | 1     |
| Total Head Loss  | M                 | 0.36  | 0.29  | 0.49  | 0.35  | 0.48  | 0.62   | 0.29  | 0.25  |

Source: JICA Survey Team

## 2) Sectional plan of Culvert

The cross-section of the culvert of the CUP was examined by paying attention to the following

<sup>15</sup>The cross-sectional dimensions of the existing CUP could not be calculated based on accurate information because of the difficulty of drainage and the lack of remaining design data from the initial planning stage. Therefore, the loss hydraulic head was calculated using the results of field measurements as much as possible and the values calculated from the cross-sectional shape estimated from the wing shape and other factors.

points. The results are shown in the table below.

- a) The cross-section and number of culvert of the existing siphon are used as a starting point for the study.
- b) Do not exceed the allowable hydraulic head loss.
- c) As a countermeasure against sand deposition in the culvert, it is desirable to make the flow velocity in the CUP about 1.5 times the open canal flow velocity.
- d) The minimum width of the culvert should be 1,500 mm; if the width is less than 1,500 mm, use a concrete pipe ( $\phi$ 1,200 mm) that is easy to install.

**Table 2-2-20 Sectional Plan of CSs to be Rehabilitated**

|                                | unit              | CUP-1       | CUP-2       | CUP-3       | CUP-4       | CUP-5       | CUP-6       | CUP-7       |             | CUP-8       |             |
|--------------------------------|-------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
|                                |                   | Plan        | Plan        | Plan        | Plan        | Plan        | Plan        | Plan        | Pipe Plan   | Plan        | Pipe Plan   |
| Length                         | m                 | 32.00       | 25.50       | 82.50       | 58.00       | 60.00       | 162.50      | 42.00       | 42.00       | 32.00       | 32.00       |
| Setional Area                  | m <sup>2</sup>    | 6.48        | 6.48        | 6.48        | 6.48        | 4.50        | 4.50        | 2.25        | 1.13        | 2.25        | 1.13        |
| (a) Height                     | m                 | 1.80        | 1.80        | 1.80        | 1.80        | 1.50        | 1.50        | 1.50        |             | 1.50        |             |
| (b) Width                      | m                 | 1.80        | 1.80        | 1.80        | 1.80        | 1.50        | 1.50        | 1.50        |             | 1.50        |             |
| (c) $\phi$                     | m                 |             |             |             |             |             |             |             | 1.20        |             | 1.20        |
| (d) Barrel                     | nos               | 2           | 2           | 2           | 2           | 2           | 2           | 1           | 1           | 1           | 1           |
| Head Loss                      |                   |             |             |             |             |             |             |             |             |             |             |
| Desing Water Volume            | m <sup>3</sup> /s | 10.77       | 10.77       | 10.11       | 9.43        | 7.29        | 6.99        | 1.16        | 1.16        | 1.16        | 1.16        |
| Friction Loss                  | m                 | 0.06        | 0.05        | 0.13        | 0.08        | 0.13        | 0.33        | 0.01        | 0.05        | 0.01        | 0.04        |
| Screen Loss                    | m                 | 0.02        | 0.01        | 0.03        | 0.02        | 0.02        | 0.01        | 0.02        | 0.02        | 0.02        | 0.02        |
| Outlet Loss                    | m                 | 0.14        | 0.14        | 0.12        | 0.11        | 0.13        | 0.12        | 0.01        | 0.05        | 0.01        | 0.05        |
| Inlet Loss                     | m                 | 0.07        | 0.07        | 0.06        | 0.05        | 0.07        | 0.06        | 0.01        | 0.03        | 0.01        | 0.03        |
| <b>Total Head Loss</b>         | m                 | <b>0.29</b> | <b>0.27</b> | <b>0.35</b> | <b>0.26</b> | <b>0.35</b> | <b>0.52</b> | <b>0.05</b> | <b>0.15</b> | <b>0.05</b> | <b>0.14</b> |
| Allowable Loss                 | m                 | 0.36        | 0.29        | 0.49        | 0.35        | 0.48        | 0.62        | 0.29        | 0.29        | 0.25        | 0.25        |
| Judge                          |                   | OK          | OK          | OK          | OK          | OK          | OK          | OK          | OK          | OK          | OK          |
| Velocity                       |                   |             |             |             |             |             |             |             |             |             |             |
| (a) Velocity in Siphon         | m/s               | 1.66        | 1.66        | 1.56        | 1.46        | 1.62        | 1.55        | 0.52        | 1.03        | 0.52        | 1.03        |
| (b) Velocity of upstream canal | m/s               | 1.07        | 1.05        | 0.69        | 0.74        | 0.69        | 0.40        | 0.66        | 0.66        | 0.65        | 0.65        |
| <b>(a)/(b)*1</b>               |                   | <b>1.60</b> | <b>1.60</b> | <b>2.30</b> | <b>2.00</b> | <b>2.30</b> | <b>3.90</b> | <b>0.80</b> | <b>1.60</b> | <b>0.80</b> | <b>1.60</b> |
| Judge                          |                   | <u>good</u> | <u>good</u> | <u>good</u> | <u>good</u> | <u>good</u> | <u>good</u> | bad!        | <u>good</u> | bad!        | <u>good</u> |

\*1: Inside section (b) of culvert shall be more than 1.50m, considering construction workability.

\*2: Flow velocity of culvert shall be more than 1.5 times of the flow in the upstream canal. If not so, Concrete pipe shall be installed instead of the concrete culvert section to make sectional area small.

Source: JICA Survey Team

### 3) Surfacing Study

The installation depth of the CUP shall be set as follows considering minimum installation depth mentioned above. A surfacing study is conducted based on the minimum installation depth and result are mentioned in below table.

- a) CUP-1, CUP-2, CUP-3, CUP-4, CUP-5 and CUP-6: The depth of installation is set to be 0.50m
- b) CUP-7 and CUP-8: The depth of installation is set to be 1.0m.

**Table 2-2-21 Surfacing of culvert**

| Items                                 | Unit  | CUP-1 | CUP-2 | CUP-3 | CUP-4 | CUP-5 | CUP-6 | CUP-7 | CUP-8 |
|---------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| I. Side wall = $a*(b+c+d*e)*0.5$      | m2    | 1.04  | 1.04  | 1.04  | 1.04  | 0.86  | 0.86  | 0.48  | 0.48  |
| Side wall = $a*(b+c+d*e)$             | m2    | 2.07  | 2.07  | 2.07  | 2.07  | 1.73  | 1.73  | 0.96  | 0.96  |
| a. Height                             | m     | 1.80  | 1.80  | 1.80  | 1.80  | 1.50  | 1.50  | 1.20  | 1.20  |
| b. Thickness (Right wall)             | m     | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  |
| b. Thickness (Left wall)              | m     | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  |
| b. Thickness (Inside wall)            | m     | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  |
| e. Number of Inside wall              | nos   | 1     | 1     | 1     | 1     | 1     | 1     | 0     | 0     |
| II. Basement = $a*(b+c+d)$            | m2    | 0.95  | 0.95  | 0.95  | 0.95  | 0.95  | 0.95  | 0.52  | 0.52  |
| a. Thickness                          | m     | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  |
| b. Width                              | m     | 4.75  | 4.75  | 4.75  | 4.75  | 4.75  | 4.75  | 2.60  | 2.60  |
| c. Width $\times$ 0.5                 | m     | 2.38  | 2.38  | 2.38  | 2.38  | 2.38  | 2.38  | 1.30  | 1.30  |
| III. Top Beam = $a*(b+c+d)$           | m2    | 0.95  | 0.95  | 0.95  | 0.95  | 0.95  | 0.95  | 0.52  | 0.52  |
| a. Thickness                          | m     | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  |
| b. Width                              | m     | 4.75  | 4.75  | 4.75  | 4.75  | 4.75  | 4.75  | 2.60  | 2.60  |
| c. Width $\times$ 0.5                 | m     | 2.38  | 2.38  | 2.38  | 2.38  | 2.38  | 2.38  | 1.30  | 1.30  |
| IV. Hanch                             | m2    | 0.25  | 0.05  | 0.05  | 0.05  | 0.05  | 0.05  | 0.00  | 0.00  |
| a. Height                             | m     | 0.15  | 0.15  | 0.15  | 0.15  | 0.15  | 0.15  | 0.15  | 0.15  |
| b. Width                              | m     | 0.15  | 0.15  | 0.15  | 0.15  | 0.15  | 0.15  | 0.15  | 0.15  |
| c. Place Number                       | nos   | 4     | 4     | 4     | 4     | 4     | 4     | 0     | 0     |
| V. Footing                            | m2    | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  |
| VI. Load                              | kN    | 99.67 | 94.77 | 94.77 | 94.77 | 90.36 | 90.36 | 60.64 | 60.64 |
| a. Structure                          | kN    | 78.25 | 73.35 | 73.35 | 73.35 | 68.94 | 68.94 | 37.24 | 37.24 |
| b. Coil Covering                      | kN    | 21.42 | 21.42 | 21.42 | 21.42 | 21.42 | 21.42 | 23.40 | 23.40 |
| a. Structure                          | kN    | 78.25 | 73.35 | 73.35 | 73.35 | 68.94 | 68.94 | 37.24 | 37.24 |
| a-1. Total Sectional Area             | m2    | 3.19  | 2.99  | 2.99  | 2.99  | 2.81  | 2.81  | 1.52  | 1.52  |
| a-2. Weight of Unit Volume (RC)       | kN/m3 | 24.50 | 24.50 | 24.50 | 24.50 | 24.50 | 24.50 | 24.50 | 24.50 |
| b. Soil Covering                      | kN    | 21.42 | 21.42 | 21.42 | 21.42 | 21.42 | 21.42 | 23.40 | 23.40 |
| Depth (Culvert)                       | m     | 0.50  | 0.50  | 0.50  | 0.50  | 0.50  | 0.50  | 1.00  | 1.00  |
| Covering Area (Culvert)               | m2    | 1.19  | 1.19  | 1.19  | 1.19  | 1.19  | 1.19  | 1.30  | 1.30  |
| Covering Area (Total)                 | m2    | 1.19  | 1.19  | 1.19  | 1.19  | 1.19  | 1.19  | 1.30  | 1.30  |
| Weight of Unit Volume (Soil)          | kN/m3 | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 |
| VII. Buoyancy                         | kN    | 60.64 | 60.64 | 60.64 | 60.64 | 53.65 | 53.65 | 25.48 | 25.48 |
| Height from the bottom to water level | m     | 2.60  | 2.60  | 2.60  | 2.60  | 2.30  | 2.30  | 2.00  | 2.00  |
| Wall Height                           |       | 1.80  | 1.80  | 1.80  | 1.80  | 1.50  | 1.50  | 1.20  | 1.20  |
| Thickness of Base concrete            |       | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  |
| Thickness of top beam concrete        |       | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  |
| Total underside of bottom slab        | m     | 2.38  | 2.38  | 2.38  | 2.38  | 2.38  | 2.38  | 1.30  | 1.30  |
| Width $\times$ 0.5                    | m     | 2.38  | 2.38  | 2.38  | 2.38  | 2.38  | 2.38  | 1.30  | 1.30  |
| Weight of Unit Volume (Water)         | kN/m3 | 9.80  | 9.80  | 9.80  | 9.80  | 9.80  | 9.80  | 9.80  | 9.80  |
| Fs (VI. Load / VII. Buoyancy)         | -     | 1.64  | 1.56  | 1.56  | 1.56  | 1.68  | 1.68  | 2.38  | 2.38  |
| Fs reference value                    | -     | 1.20  | 1.20  | 1.20  | 1.20  | 1.20  | 1.20  | 1.20  | 1.20  |
| Judgement                             | -     | good  | good  | good  | good  | good  | good  | good  | good  |

\*1 CUP-7 and 8 are planned to use concrete pipes.

Source: JICA Survey Team

## (5) Inlet/Outlet Box

The vertical culvert is a facility to be installed on the inlet and outlet sides of the CUP that connect the irrigation canal to the culvert. The size of the vertical culvert was examined by paying attention to the following points. The dimensions are shown in following table.

- a) The width of the vertical gutter shall be the width of the culvert (including the middle wall). However, if the total width is less than 1.50m, it shall be set at 1.50m from the viewpoint of workability.
- b) For the height of the gutter, the top of the structure shall be set at +0.50m from the current height so that the existence of the structure can be confirmed from the surrounding area. The height of the bottom slab should be set at -0.50m from the bottom of the culvert so that gravel and sediment passing through the screen can accumulate.
- c) The length of the culvert is set at 2.0m in consideration of the entry of workers from the side of the irrigation canal during dredging work.

**Table 2-2-22 Inlet/Outlet Box Size**

|               | CUP-1 | CUP-2 | CUP-3 | CUP-4 | CUP-5 | CUP-6 | CUP-7 | CUP-8 |
|---------------|-------|-------|-------|-------|-------|-------|-------|-------|
| <b>Inlet</b>  |       |       |       |       |       |       |       |       |
| Width (W)     | 3.95  | 3.95  | 3.95  | 3.95  | 3.35  | 3.35  | 1.50  | 1.50  |
| Height (H1)   | 7.10  | 7.60  | 7.50  | 6.70  | 6.80  | 7.90  | 6.10  | 6.10  |
| Height (H2)   | 2.10  | 2.90  | 2.70  | 2.70  | 2.70  | 2.80  | 2.10  | 2.20  |
| Length (L)    | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  |
| <b>Outlet</b> |       |       |       |       |       |       |       |       |
| Width (W)     | 3.95  | 3.95  | 3.95  | 3.95  | 3.35  | 3.35  | 1.50  | 1.50  |
| Height (H1)   | 7.10  | 7.60  | 7.50  | 6.70  | 6.80  | 7.90  | 6.10  | 6.10  |
| Height (H2)   | 2.10  | 2.90  | 2.70  | 2.70  | 2.70  | 2.80  | 2.10  | 2.20  |
| Length (L)    | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  |

Unit: m

Source: JICA Survey Team

## (6) Screen

A screen will be installed at the upstream of the inlet side of the CUP. Existing CUP have trash such as plastic bottles floating in them, and this is one of the causes of water flow obstruction. In this design, a screen will be installed at the inlet of the CUP to prevent entry of debris.

## (7) Ancillary structures

### 1) Access with existing irrigation canal

The upstream and downstream of the CUP is connected to the standard cross-section of the main line of the irrigation canal across the transients.

### 2) Transition

The connection between the existing canal (trapezoidal cross-sectional earthen canal) and the CUP will be provided with open reinforced concrete transition canal. The transitions are provided to connect canal types with different cross sections to reduce hydraulic head loss. The extension (L) of the transients should be set so that the mounting angle ( $\theta$ ) is within 10 degrees, since it is said that the hydraulic head loss increases rapidly when the mounting angle ( $\theta$ ) is more than 10 degrees. Set an appropriate extension.

### 3) River Bank Protection

A revetment is installed to protect the irrigation facilities from the river flowing above the CUP. Based on the river conditions and the structure of the revetment adjacent to the river crossing bridge, the revetment is to be made of wet masonry.

### (8) Summarize of Specification

The facility plan of CUPs shall be summarized below.

| Name<br>(Facility Code)       | Summarized Specification   |
|-------------------------------|--|
| New Ganagajali CUP<br>(CUP-1) | Design Discharge: 10.33m <sup>3</sup> /s,<br>River stream volume crossing the CUP: 46.8m <sup>3</sup> /s<br>Facility Main Material: Reinforced Concrete<br>Structure type: A type Siphon<br>Barrels: Two box culvert (H1.8m × W1.8m)<br>Length: 32.0m<br>Depth of Culvert: 0.5m<br>In/Outlet box: W3.95m × H7.10m × L2.00m<br>Inlet side: Screen<br>Access with existing irrigation canal: Wet masonry and transition<br>River bank: Wet masonry<br>Others: Net fence and Safety net for fall prevention |
| Old Ganagajali CUP<br>(CUP-2) | Design Discharge: 10.33m <sup>3</sup> /s<br>River stream volume crossing the CUP: 11.7m <sup>3</sup> /s<br>Facility Main Material: Reinforced Concrete<br>Structure type: A type Siphon<br>Barrels: Two box culvert (H1.8m × W1.8m)<br>Length: 25.5m<br>Depth of Culvert: 0.5m<br>In/Outlet box: W3.95m × H7.60m × L2.00m<br>Inlet side: Screen<br>Access with existing irrigation canal: Wet masonry and transition<br>River bank: Wet masonry<br>Others: Net fence and Safety net for fall prevention  |
| Pauraha CUP<br>(CUP-3)        | Design Discharge: 9.93m <sup>3</sup> /s<br>River stream volume crossing the CUP: 133.2m <sup>3</sup> /s<br>Facility Main Material: Reinforced Concrete<br>Structure type: A type Siphon<br>Barrels: Two box culvert (H1.8m × W1.8m)<br>Length: 83.0m<br>Depth of Culvert: 0.5m<br>In/Outlet box: W3.95m × H7.50m × L2.00m<br>Inlet side: Screen<br>Access with existing irrigation canal: Wet masonry and transition<br>River bank: Wet masonry<br>Others: Net fence and Safety net for fall prevention  |
| Banra CUP<br>(CUP-4)          | Design Discharge: 9.43m <sup>3</sup> /s<br>River stream volume crossing the CUP: 42.9m <sup>3</sup> /s<br>Facility Main Material: Reinforced Concrete<br>Structure type: A type Siphon<br>Barrels: Two box culvert (H1.8m × W1.8m)<br>Length: 58.0m<br>Depth of Culvert: 0.5m<br>In/Outlet box: W3.95m × H6.70m × L2.00m<br>Inlet side: Screen<br>Access with existing irrigation canal: Wet masonry and transition<br>River bank: Wet masonry<br>Others: Net fence and Safety net for fall prevention   |
| Sundari CUP<br>(CUP-5)        | Design Discharge: 7.29m <sup>3</sup> /s<br>River stream volume crossing the CUP: 139.2m <sup>3</sup> /s<br>Facility Main Material: Reinforced Concrete<br>Structure type: A type Siphon<br>Barrels: Two box culvert (H1.5m × W1.5m)<br>Length: 60.0m   |

| Name<br>(Facility Code)       | Summarized Specification   |
|-------------------------------|--|
|                               | Depth of Culvert: 0.5m<br>In/Outlet box: W3.35m × H6.80m × L2.00m<br>Inlet side: Screen<br>Access with existing irrigation canal: Wet masonry and transition<br>River bank: Wet masonry<br>Others: Net fence and Safety net for fall prevention  |
| Mahuli CUP<br>(CUP-6)         | Design Discharge: 6.69m <sup>3</sup> /s<br>River stream volume crossing the CUP: 333.2m <sup>3</sup> /s<br>Facility Main Material: Reinforced Concrete<br>Structure type: A type Siphon<br>Barrels: Two box culvert (H1.5m × W1.5m)<br>Length: 162.5m<br>Depth of Culvert: 0.5m<br>In/Outlet box: W3.35m × H7.90m × L2.00m<br>Inlet side: Screen<br>Access with existing irrigation canal: Wet masonry and transition<br>River bank: Wet masonry<br>Others: Net fence and Safety net for fall prevention |
| Kailii I CUP<br>(CUP-7)       | Design Discharge: 1.16m <sup>3</sup> /s<br>River stream volume crossing the CUP: 87.0m <sup>3</sup> /s<br>Facility Main Material: Reinforced Concrete<br>Structure type: A type Siphon<br>Barrels: φ1.2m Reinforced Concrete Pipe<br>Length: 42.0m<br>Depth of Culvert: 1.0m<br>In/Outlet box: W1.50m × H6.10m × L2.00m<br>Inlet side: Screen<br>Access with existing irrigation canal: Wet masonry and transition<br>River bank: Wet masonry<br>Others: Net fence and Safety net for fall prevention    |
| Old Ganagajali CUP<br>(CUP-8) | Design Discharge: 1.16m <sup>3</sup> /s<br>River stream volume crossing the CUP: 11.7m <sup>3</sup> /s<br>Facility Main Material: Reinforced Concrete<br>Structure type: A type Siphon<br>Barrels: φ1.2m Reinforced Concrete Pipe<br>Length: 32.0m<br>Depth of Culvert: 1.0m<br>In/Outlet box: W1.50m × H6.10m × L2.00m<br>Inlet side: Screen<br>Access with existing irrigation canal: Wet masonry and transition<br>River bank: Wet masonry<br>Others: Net fence and Safety net for fall prevention    |

## 2-2-2-7 Design of CDW

### (1) Basic Policy

The following points shall be taken into consideration when planning the rehabilitation of the CDWs.

- a) The cross-section of the CDWs should be determined by calculating the flood discharge, but the planned cross-section should not be smaller than the current cross-section.
- b) In consideration of maintenance and management, the structure should be designed to prevent sediment from accumulating in the culvert.
- c) In order to protect the facilities to be rehabilitated and improved, revetments should be constructed to protect the slope of the lining, inflow, and outflow of the irrigation canal that crosses it.
- d) Most of the existing facilities are made of bricks, but reinforced concrete will be used to ensure strength and water tightness.

- e) The structural investigation was conducted in accordance with the "Technical Standard for River Erosion Control (Draft), Ministry of Construction, Commentary and Design Edition".

## (2) Plan and Drainage Flow Line

As there is no need to change the flow path to the target catchment area, the planar alignment of the cross-sectional CDWs is to follow the current condition. In other words, the existing facilities will be removed and reconstructed.

## (3) Design Profile

The installation height of the cross-sectional CDWs should be the same as that of the current facility, with the bottom of the irrigation canal and the top plate of the cross-sectional CDWs at the same height, so that the bottom of the canal is not altered as much as possible. The longitudinal slope should be set so that the canal gradient in the culvert matches the slope of the surrounding terrain.

## (4) Cross Sectional Area of Flow

A cross-section that can pass the flood discharge upstream of the CDWs should be secured. The cross-sectional area was calculated using the flood discharge, the canal slope obtained from the longitudinal cross-sectional plan, and the Manning's mean velocity's formula with a freeboard of 0.3m. The maximum flow velocity was set at 3.0m<sup>3</sup>/s because of the reinforced concrete structure, and the existing canal cross section was not reduced.

**Table 2-2-23 Cross Sectional Area of CDW's Flow**

| Code   | Prof. No | Flood volume (m <sup>3</sup> /s) | Section (Width × Height × Barrel, Length (m)) | Sloe    | Velocity (m/s) | Remarks (Section of Ex. CDWs) |
|--------|----------|----------------------------------|---|---------|----------------|-------------------------------|
| CDW-01 | 2+517    | 15.2                             | 2.4 × 1.8 × 2, 35.5m                          | 1/500   | 2.3            | 2.5 × 2.0 × 1                 |
| CDW-02 | 3+258    | 37.5                             | 3.0 × 2.0 × 3, 40.0m                          | 1/500   | 2.6            | 2.5 × 2.0 × 2                 |
| CDW-03 | 5+517    | 26.2                             | 2.8 × 2.0 × 2, 39.0m                          | 1/400   | 2.8            | 1.5 × 1.5 × 2                 |
| CDW-04 | 7+370    | 7.4                              | 1.6 × 1.5 × 2, 40.0m                          | 1/400   | 2.0            | 1.5 × 1.5 × 2                 |
| CDW-05 | 11+336   | 9.0                              | 2.4 × 1.5 × 2, 43.0m                          | 1/900   | 1.6            | 1.5 × 1.5 × 2 + 1.5 × 1.5 × 1 |
| CDW-06 | 13+772   | 13.6                             | 2.4 × 1.6 × 3, 46.0m                          | 1/1,000 | 1.5            | 2.4 × 1.6 × 2 + 2.4 × 1.6 × 2 |
| CDW-07 | 16+713   | 12.1                             | 2.2 × 1.6 × 3, 41.0m                          | 1/1,000 | 1.5            | 2.5 × 2.5 × 2*1               |
| CDW-08 | 18+178   | 2.4                              | 1.5 × 1.5 × 2, 34.5m                          | 1/1,000 | 1.3            | 1.5 × 1.5 × 2                 |
| CDW-11 | 26+135   | 2.4                              | 2.0 × 1.5 × 1, 25.0m                          | 1/1,000 | 1.4            | φ900 × 1 (RC-pipe)            |

\*1 CDW06: Two double culverts are currently in place, but since they were renovated and maintained after the collapse and only one (double) is functioning, they are referred to here as two.

## (5) Ancillary structures

### 1) Inlet and Outlet

The shape of the inlet/outlet works should be a catch basin type and made of reinforced concrete. The bottom height should be about 0.5m lower than the bottom height of the CDWs so that sediment can accumulate.

### 2) Water stop Wall

A water stop wall shall be installed to prevent waterlogging. The depth of the wall should be 1.0m.

### 3) Recovering of irrigation canal

In order to prevent water from flowing into the CDWs, and because of the significant unevenness in the bottom elevation of the irrigation canal at this location, the lining of the canal section will be carried out in conjunction with the repair and maintenance of the CDWs. The lining of the canal is basically 100m upstream and downstream from the location of CDWs. However, in the case where temporary structures such as sandbags etc., have been used for repair due to flood damage (CDW-02, CDW-06, CDW-08), the lining shall be extended to protect the CDWs since the same section is vulnerable. The lining of the canal shall be made of wet masonry.

#### **4) Protection of Inlet, Outlet and Embankment around CDW**

In order to protect the inlet and outlet works, protection works of about 10m upstream and downstream will be constructed. In addition, inlet and outlet canal sections will be protected in the same way. In addition, the flood-damaged embankments (CDW-02, CDW-06, and CDW-08) will be protected by protection works to protect the CDWs. The protection works will be made of wet masonry.

#### **5) Diversion (turnout)**

The diversion (which convey irrigation water to a secondary canal) adjacent to the CDWs (CDW-05) will be rehabilitated together with the CDWs reconstructed work.

### **2-2-2-8 Design of Canal Crossing Bridge (CCB)**

#### **(1) Manuals referring design**

The standards and guidelines to be followed are listed below.

##### Japanese Standard (Japan Road Association)

- Policy of Culvert on Guidelines for Road and Engineering, March 2010
- Policy of Embankment on Guidelines for Road and Engineering, April, 2010
- Specifications and Commentary of Road Bridge, March 2012
- Policy of Excavation, Slope and Stability on Guidelines for Road and Engineering, July 2009

##### Nepalese Standard

- Nepal Road Standard 2070, July 2013 (DOR)
- Nepal Road Standard 2070 (First Revision -2045) (DOR)
- Nepal Bridge Standards 2067 (DOR)
- Nepal Rural Road Standards 2055 2nd Revision, 2071, December, 2014 (DOLIDAR)

##### Indian Standard

- IRC-5-2015 (Standard Specifications and Code of Practice for Road Bridges Section -1, General Features of Design), June 2015
- IRC-6-2016 (Standard Specifications and Code of Practice for Road Bridges Section: Ii Loads And Load Combinations (Seventh Revision)), December, 2016
- IRC-SP-20 (Rural Road Manual), 2002

## (2) Design width

### 1) Design Manual

The width of CCB is required to be unchanged from the road plan surrounding the existing facility. Therefore, the current road width should be checked and the bridge should be planned according to the "Nepalese standard."

"The bridge design in Nepal is based on the Nepal Bridge Standards-2067 compiled by the Department of Road (DOR) and the Department of Local Infrastructure Development and Agricultural Road (DOLIDAR). And Agricultural Road (DOLIDAR) "Nepal Rural Road Standards (2055) 2nd Revision, 2071". The two sets of standards are used for different road classifications. For the Canal crossing bridge in this project, the "Nepal Rural Road Standards (2055) 2nd Revision, 2071" will be applied since the road classification is District Roads and Village Roads.

**Table 2-2-24 Road category and adopted design standard in Nepal**

| Road Category*1   | Nepal Bridge Standards-2067 | Nepal Rural Road Standards (2055) 2nd Revision, 2071 | Remarks            |
|-------------------|-----------------------------|--|--------------------|
| National Highways | ✓                           |  | Managed by DOR     |
| Feeder Roads      | ✓                           |  | - ditto -          |
| Urban Roads       | ✓                           |  | Managed by DOLIDAR |
| District Roads    | ✓                           | ✓  | - ditto -          |
| Village Roads     |                             | ✓  |                    |

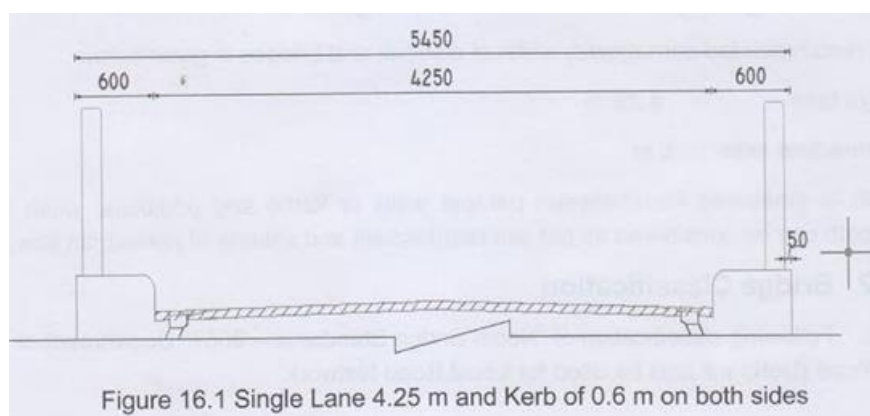
\*1 National Highways and Feeder Roads are called SPN (Strategic Road Network) and are under the jurisdiction of DoR, while Urban Roads and District Roads are called LRN (Local Road Network) and are under the jurisdiction of DOLIDAR.

\*2 There are different classifications for road planning, from Class-I to Class-IV, with the lowest Class-IV having an ADT (average daily planned traffic per year) of less than 2,000 vehicles per day and a design speed of 60 km/h.

Source: JICA Survey Team

### 2) Bridge Width

For the width of the CCB in this project, Nepal Rural Road Standards (2055) 2nd Revision, 2071 shall be applied, and the following cross-sections shall be standard. However, if the width of the road connecting to be rehabilitated is wider, 6.0m shall be applied. Sidewalks shall be provided at the necessary locations, taking into consideration the volume of vehicle and pedestrian traffic, and the existence and scale of residential areas around the canal crossing bridge. The width of sidewalks should be 1.0m.



Source: Nepal Rural Road Standards (2055) 2nd Revision, 2071

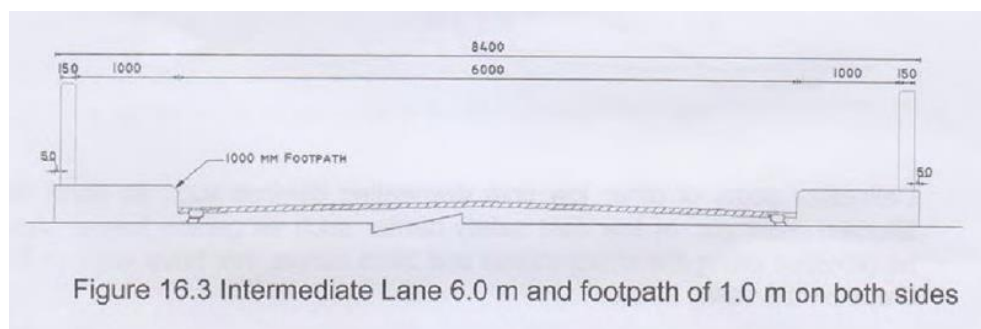


Figure 16.3 Intermediate Lane 6.0 m and footpath of 1.0 m on both sides  
Source: Nepal Rural Road Standards (2055) 2nd Revision, 2071

The following table shows the planned widths for each bridge.

**Table 2-2-25 Width of the Canal Crossing Bridges to be rehabilitated**

| Code   | Chainage | Planned roadway width | Foot Pass | Category of Ramp |
|--------|----------|-----------------------|-----------|------------------|
| CCB-02 | 0+420    | 4.25m                 | —         | Village road     |
| CCB-03 | 0+820    | 6.00m                 | ✓         | District Road    |
| CCB-04 | 1+280    | 4.25m                 | —         |                  |
| CCB-11 | 4+775    | 4.25m                 | —         | Village road     |
| CCB-13 | 8+005    | 4.25m                 | —         | Village road     |
| CCB-15 | 9+370    | 4.25m                 | —         | —                |
| CCB-16 | 10+035   | 4.25m                 | —         | Village road     |
| CCB-17 | 10+405   | 6.00m                 | —         | Village road     |
| CCB-19 | 12+460   | 6.00m                 | —         | Village road     |
| CCB-20 | 12+990   | 6.00m                 | —         | Village road     |
| CCB-22 | 14+865   | 4.25m                 | —         | Village road     |
| CCB-26 | 19+470   | 4.25m                 | —         | Village road     |
| CCB-27 | 20+715   | 4.25m                 | —         | Village road     |
| CCB-28 | 21+551   | 4.25m                 | —         | Village road     |
| CCB-31 | 24+605   | 4.25m                 | —         | Village road     |

Source: JICA Survey Team

### 3) Sectional Slope

The sectional slope of the CCB was set at 2.0% according to the table below.

**Table 2-2-26 Design standard of sectional slope**

| Pavement type | Cement Concrete | Bituminous | Gravel | Earthen |
|---------------|-----------------|------------|--------|---------|
| Camber, %     | 1.5 to 2.0      | 2.5        | 4.0    | 5.0     |

\*1 On straight sections of roads, shoulders should have a higher crossfall than that of the carriageway by 0.5%  
Source: Nepal Road Standard 2070

### 4) Bridge Surface Treatment

The surface of the CCB shall be treated with a concrete surface with a minimum thickness of 25 mm, following the descriptions in IRC-5 and the standard drawings for culverts and small bridges in IRC-20.

### (3) Bridge Plan

The bridge height of the CCB was set according to the results of the hydraulic analysis of the existing irrigation canal, taking into consideration the height of current bridge and the embankment, and the balance with the surrounding topography.

## 1) Freeboard in irrigation canal

The freeboard of the girder of the bridge across the planned canal was set at 0.3m, because the target canal is not a natural river but an irrigation canal and there is no need to consider debris flows.

## 2) Planned Height

The planned height of each CCB is shown in the table below, as well as the height of the irrigation canal at the location of installation, and the water depth and water level based on hydraulic analysis.

**Table 2-2-27 Positioning of the height among the CCB, Canal Bed and Water Level**

| Code   | Canal Bed El. (m) | Water Depth (m) | Water Level WEL.(m) | CCB Height (m) | Remarks  |
|--------|-------------------|-----------------|---------------------|----------------|--|
| CCB-02 | 97.157            | 1.346           | 98.503              | 99.430         | While securing the necessary water level of the Canal, set the water level in consideration of the surrounding topography. |
| CCB-03 | 97.033            | 1.252           | 98.285              | 100.120        | Follow the existing bridge height.   |
| CCB-04 | 96.293            | 0.935           | 97.228              | 98.670         | Set in consideration of the surrounding terrain. Slightly lower than the current bridge height.                            |
| CCB-11 | 94.597            | 1.858           | 96.455              | 97.370         | Securing the necessary water level in the Canal (slightly higher than the current bridge level)                            |
| CCB-13 | 93.183            | 1.963           | 95.146              | 95.960         | Secure the necessary water level in the Canal (at the level of the current bridge surface).                                |
| CCB-15 | 92.123            | 2.119           | 94.242              | 95.600         | Set in consideration of the surrounding terrain. Slightly lower than the current bridge height.                            |
| CCB-16 | 92.258            | 1.904           | 94.162              | 95.030         | Securing the necessary water level in the Canal (higher than the current bridge level)                                     |
| CCB-17 | 91.723            | 2.379           | 94.102              | 94.850         | Securing the necessary water level in the Canal (slightly higher than the current bridge level)                            |
| CCB-19 | 91.893            | 1.394           | 93.287              | 95.870         | Maintain the necessary water level in the Canal (at the level of the current bridge)                                       |
| CCB-20 | 91.420            | 1.670           | 93.090              | 94.090         | Set in consideration of the surrounding terrain. Slightly lower than the current bridge height.                            |
| CCB-22 | 90.976            | 1.673           | 92.649              | 93.450         | Maintain the necessary water level in the Canal (at the level of the current bridge)                                       |
| CCB-26 | 89.570            | 1.289           | 90.859              | 91.840         | Set in consideration of the surrounding terrain. The height of the current bridge surface.                                 |
| CCB-27 | 89.209            | 1.236           | 90.445              | 91.480         | Set in consideration of the surrounding terrain. The height of the current bridge surface.                                 |
| CCB-28 | 89.009            | 1.310           | 90.319              | 91.280         | Set in consideration of the surrounding terrain. The height of the current bridge surface.                                 |
| CCB-31 | 88.261            | 0.759           | 89.020              | 91.930         | Set in consideration of the surrounding terrain. The height of the bridge will be slightly lower than the current height.  |

Source: JICA Survey Team

## (4) Structural Consideration

### 1) Structural types

The CCB to be rehabilitated is based on a box culvert structure for the following reasons. In addition, depending on the width of the canal at the bridge location, a triple, double, or single type structure shall be used.

- a) The canal to be crossed shall be a managed canal, the width of the canal shall be set according to the amount of irrigation water, and the water level shall be controlled by gates.
- b) Culvert bridges can be used because of the scale of the facility (bridge length and height below the girders).

- c) Direct foundation is desirable due to the condition of the foundation and workability, and a culvert bridge is superior.

The structural type of each CCB established by the above is shown below.

**Table 2-2-28 Structural Form of the target CCBs**

| Code   | Profile No. | Barrels | Cross Sectional Area of Flow (Width × Height) | Canal Width at the target (m) |
|--------|-------------|---------|---|-------------------------------|
| CCB-02 | 0+420       | Triple  | 3.0×1.8                                       | 9.5                           |
| CCB-03 | 0+820       | ditto   | 3.0×2.6                                       | 10.6                          |
| CCB-04 | 1+280       | "       | 3.5×1.9                                       | 11.3                          |
| CCB-11 | 4+775       | "       | 3.5×2.3                                       | 10.7                          |
| CCB-13 | 8+005       | "       | 3.0×2.3                                       | 9.1                           |
| CCB-15 | 9+370       | "       | 3.5×3.0                                       | 10.7                          |
| CCB-16 | 10+035      | "       | 3.0×2.3                                       | 9.2                           |
| CCB-17 | 10+405      | "       | 3.0×2.7                                       | 9.2                           |
| CCB-19 | 12+460      | "       | 3.0×3.5                                       | 9.0                           |
| CCB-20 | 12+990      | "       | 3.0×2.2                                       | 9.4                           |
| CCB-22 | 14+865      | Double  | 3.0×2.0                                       | 6.5                           |
| CCB-26 | 19+470      | ditto   | 3.0×1.8                                       | 7.5                           |
| CCB-27 | 20+715      | "       | 3.0×1.8                                       | 6.5                           |
| CCB-28 | 21+551      | "       | 3.0×1.8                                       | 6.5                           |
| CCB-31 | 24+605      | Single  | 4.5×3.2                                       | 4.0                           |

Source: JICA Survey Team

## 2) Design Policy

The box culvert to be used for the CCB to be rehabilitated shall have a structure that ensures the necessary strength based on the "Guidelines for Road Construction Culvert Work (2009 Edition)". Although the target facility is planned as cast-in-place concrete due to local procurement conditions, verification shall be carried out under the condition of no covering, since the applicable covering of 0.5m or more for conventional box culverts in the Guidelines for Road Soil Engineering Culvert Construction cannot be secured.

Seismic verification is not considered because the Indian Road Congress-6 (IRC-6) states that box culverts and small bridges with span lengths of up to 10 m do not need to be verified for seismic action.

## 3) Design Load

The load combinations are as follows.

**Table 2-2-29 Combination of Loads in Structural Verification of Box Culverts**

| Load Category                             | Continuous-1 | Continuous-2 |
|---|--------------|--------------|
| Static Load (Own body)                    | ✓            | ✓            |
| Static Load (Water weight culvert inside) | ✓            |              |
| Dynamic Load                              | ✓            | ✓            |
| Earth Pressure                            | ✓            | ✓            |
| Effect of temperature change              | ✓            | ✓            |
| Effect of Earth-quack                     | —            | —            |

\*1 The dynamic load is verified for several cases of loading patterns according to the standards of the target structure.

\*2 For dynamic loads, the installation of tread plates should be considered.

**(a) Static Load:**

|                     |                               |
|---------------------|-------------------------------|
| Pavement            | $\gamma_a=22.50\text{kN/m}^3$ |
| Road Bed            | $\gamma_b=23.00\text{kN/m}^3$ |
| Soil (Moisture)     | $\gamma_s=20.00\text{kN/m}^3$ |
| Reinforced Concrete | $\gamma_c=24.50\text{kN/m}^3$ |
| Concrete            | $\gamma_t=23.00\text{kN/m}^3$ |
| Water               | $\gamma_w= 9.80\text{kN/m}^3$ |

**(b) Dynamic Load:**

|                       |  |
|-----------------------|--|
| Lead on driving wheel | T-14                                       |
| Direction of Load     | Right Angle to Culvert                     |
| Impact Coefficient    | $i = 0.3$ (covered by less than 4.0m soil) |

The above live load shall be T-14, which approximates the vehicle standards and axle weight as described in the Nepal Rural Road Standards (2055) 2nd Revision, 2071.

For the vertical load due to live load, the effect of the front wheels shall be considered. The distance between the front wheels and the rear wheels shall be 6.0 m, and the pattern of live load shall be set.

**(c) Earth Pressure:**

As deduced from the above, the condition settings related to earth pressure shall be as follows.

- a) Earth pressure in the horizontal direction (Static Load)
- b) Earth pressure in the vertical direction (No consideration cause of no soil cover.)

The earth pressure acting on the side walls due to the installation of the box culvert shall be less than the approximate value of the soil constant in the "Guidelines for Road Soil Engineering and Embankment Construction (2010 edition)" based on the results of the boring investigation and laboratory soil tests conducted in this work as backfilling with soil generated on site.

**Table 2-2-30 Soil Modulus**

| Category             | Condition                            | Unit Weight<br>( $\text{kN/m}^3$ ) | Angle of shearing<br>resistance (degrees) | Adhesive Force<br>( $\text{kN/m}^2$ ) |
|----------------------|--------------------------------------|------------------------------------|---|---------------------------------------|
| Embankment<br>(Sand) | Compacted (wide grain<br>size range) | 20                                 | 35  | 0                                     |

Source: Policy of Embankment on Guidelines for Road and Engineering, April, 2010

**(d) Water Pressure and Buoyancy**

Since the culvert is installed to cross an irrigation canal, the groundwater level shall be the planned irrigation water level. The water level inside and outside the box culvert shall be verified by the following two cases.

- a) CASE-1: Design Water Level (Depth)
- b) CASE-2: No water

**(e) Effect of temperature change and Shrinkage due to drying**

The effects of temperature change and shrinkage due to drying shall be considered. The reference temperature for temperature change shall be  $+20^\circ\text{C}$ . Refer to IRC-6, the temperature rise shall be  $20^\circ\text{C}$  and the temperature fall shall be  $25^\circ\text{C}$ .

#### 4) Material

- |                   |  |
|-------------------|--|
| Concrete          | ▪ Plain Concrete $\sigma_{ck}=18\text{N/mm}^2$             |
|                   | ▪ Reinforced Concrete $\sigma_{ck}=24\text{N/mm}^2$        |
| Reinforcement bar | ▪ Specification shall be comparable to SD345 <sup>16</sup> |

#### 5) Detail of Structure

##### (a) Approach Slab

An approach slab shall be installed between the box culvert and the connecting road for the CCB. The following items should be taken into consideration when planning the approach slab.

- The fulcrum reaction force acting on the approach slab is considered in the box culvert body. The reference strength is  $24\text{N/mm}^2$ , the same as that of the box culvert.
- The design strength is  $24\text{N/mm}^2$ , the same as that of the main body (box culvert), in consideration of workability. The reinforcing steel used shall be equivalent to SD345 (or similar specification).
- The length is basically 5 m.

##### (b) Wing wall

A wing wall shall be installed on the CCB to secure the connection between the box culvert and the slope of the irrigation canal. The following items should be taken into consideration when installing the wing wall.

- The length of the wing wall shall be determined by considering the slope of the irrigation canal upstream and downstream the planned canal crossing bridge, the existing facilities in the vicinity, and the height difference from the attachment road. The maximum length of the wing wall shall be 6.0m and the thickness of the wing wall shall not exceed the thickness of the box culvert side wall. The maximum length of the wing wall shall be determined in consideration of the earth pressure of the backfill and the placement of reinforcing bars on the box culvert side wall at the attachment point. The maximum length is determined by considering the effect of backfilling earth pressure and reinforcing bar placement on the box culvert side wall at the attachment point.
- 1.0m should be secured as a wall depth under the base.
- The thickness of the material should be equal to or less than the thickness of the side wall of the box culvert.
- The design strength shall be  $24\text{N/mm}^2$ , the same as that of the main body (box culvert), in consideration of workability. The steel bars used shall be equivalent to SD345 (or similar specification).

##### (c) Water stop wall

A water stop wall shall be installed at the downstream end to prevent scouring. The depth of the wall should be 1.0m or more than the depth of the revetment of the installation canal.

---

<sup>16</sup> SD345 is to set the strength of the structural study article. The steel bars to be used in this project will be BS (British Standard), not JIS standard, because they will be procured in the "Ne" country. This needs to be confirmed in the construction specifications.

**(d) Haunch**

In accordance with the "Culvert Construction Guidelines," p. 140, a haunch shall be provided. However, the bottom haunch shall not be provided. The size of the haunch should be about 0.4 to 0.5 T of the member thickness (T).

**6) Foundation**

The foundation structure was studied according to the following steps, and as a result, a standard gravel foundation (direct foundation) was used at all locations.

Step-1: Confirmation of soil type and N value at the location of the box culvert based on the results of the boring survey

Step-2: Check the allowable bearing capacity according to the Guidelines for Road Soil Engineering and Culvert Construction based on the confirmed soil type and N value.

Step-3: When the N value of the boring survey result does not meet the table in the Guidelines for Road Soil Engineering and Culvert Construction, calculate the bearing capacity.

The standard bearing capacity in Step-2 should be based on the following table from the Guidelines for Road Construction and Culvert Construction.

**Table 2-2-31 Approximate value of bearing capacity**

| Type of founded ground |                                   | Allowable Vertical Bearing Capacity $q_a$ (kN/m <sup>2</sup> ) | Reference Value  |         |
|------------------------|-----------------------------------|--|--|---------|
|                        |                                   |  | unconfined compression strength $q_u$ (kN/m <sup>2</sup> ) | N value |
| Bedrock layer          | Uniform hard rock with few cracks | 1000   | More than 10,000   | -       |
|                        | Hard rock with many cracks        | 600  | More than 10,000   | -       |
|                        | Soft shore and mudstone           | 300  | More than 1,000  | -       |
| Gravel layer           | Dense                             | 600  | -  | -       |
|                        | Not dense                         | 300  | -  | -       |
| Sandy layer            | Dense                             | 300  | -  | 30 ~ 50 |
|                        | Moderate                          | 200  | -  | 20 ~ 30 |
| Viscous layer          | Very hard                         | 200  | 200 ~ 400  | 15 ~ 30 |
|                        | Hard                              | 100  | 100 ~ 200  | 10 ~ 15 |

Source: Table 4-2, P.74~75, Japanese Guideline for Road and Culvert Engineering

The soil properties in Step-3 were set as follows, referring to the table on P.101 of the Guidelines for Road Construction and Embankment Construction.

**Table 2-2-32 Soil properties for soil type used in bearing capacity calculation**

| Type of Soil                    | Properties of Soil type          |  |                                     |
|---------------------------------|----------------------------------|--|-------------------------------------|
|                                 | Unit Weight (kN/m <sup>3</sup> ) | angle of shearing resistance (degrees) | Cohesive Force (kN/m <sup>2</sup> ) |
| (A) Clay soil, slightly soft    | 17kN/m <sup>3</sup>              | 20                                     | 30kN/m <sup>2</sup>                 |
| (B) Sandy soil, not dense fruit | 17kN/m <sup>3</sup>              | 25                                     | 0kN/m <sup>2</sup>                  |
| (C) Mixed sand, not dense fruit | 19kN/m <sup>3</sup>              | 30                                     | 0kN/m <sup>2</sup>                  |
| (D) Sand, not dense fruit       | 18kN/m <sup>3</sup>              | 35                                     | 0kN/m <sup>2</sup>                  |

The bearing capacity calculation in Step-3 is performed using the bearing capacity formula described in the "Specifications and Commentary for Road Bridges - Substructure Edition (H24.3)".

The following table shows the confirmation status of the subgrade at the location of the box culvert.

**Table 2-2-33 Foundation Status at the location target CCBs shall be installed**

| Code   | Survey No.                  | Step-1   | Step-2               | Step-3  | Remarks   |
|--------|-----------------------------|--|----------------------|---|---|
| CCB-02 | BR-1<br>(Right Bank side)   | Silt mixed with sand<br>N = 7                  | Confirmed as<br>good | Confirmed as good<br>(Calculated as soil type: A) |   |
| CCB-03 | BR-2<br>(Left Bank side)    | Sand mixed with silt<br>N = 11                 | Confirmed as<br>good | Confirmed as good<br>(Calculated as soil type: B) |   |
| CCB-04 |                             |  | Confirmed as<br>good |   | Using the value of BR-2 recent place, cause of no survey  |
| CCB-11 | BR-10<br>(Right Bank side)  | Silty sand<br>Average N value = 5              | Confirmed as<br>good | Confirmed as good<br>(Calculated as soil type: B) |   |
| CCB-13 | BR-11<br>(Left Bank side)   | Sand mixed with Gravel<br>Average N value = 12 | Confirmed as<br>good | Confirmed as good<br>(Calculated as soil type: C) | Using the value of BR-11 recent place, cause of no survey |
| CCB-15 | BR-14<br>(Right Bank side)  | Silt mixed with Sand<br>Average N value = 12   | Confirmed as<br>good |   |   |
| CCB-16 | BR-15A<br>(Left Bank side)  | Sandy soil<br>Average N value = 9              | Confirmed as<br>good | Confirmed as good<br>(Calculated as soil type: B) |   |
|        | BR-15B<br>(Right Bank side) | Sand mixed with Silt<br>Average N value = 11   | Confirmed as<br>good | Confirmed as good<br>(Calculated as soil type: B) |   |
| CCB-17 | BR-16A<br>(Left Bank side)  | Sand mixed with Gravel<br>Average N value = 9  | Confirmed as<br>good | Confirmed as good<br>(Calculated as soil type: C) |   |
|        | BR-16B<br>(Right Bank side) | Sand mixed with Gravel<br>Average N value = 11 | Confirmed as<br>good | Confirmed as good<br>(Calculated as soil type: C) |   |
| CCB-19 | BR-18A<br>(Left Bank side)  | Sand<br>Average N value = 12                   | Confirmed as<br>good | Confirmed as good<br>(Calculated as soil type: D) |   |
|        | BR-18B<br>(Right Bank side) | Sand mixed with Gravel<br>Average N value = 4  | Confirmed as<br>good | Confirmed as good<br>(Calculated as soil type: C) |   |
| CCB-20 | BR-19A<br>(Left Bank side)  | Sand mixed with Gravel<br>Average N value = 8  | Confirmed as<br>good | Confirmed as good<br>(Calculated as soil type: C) |   |
|        | BR-19B<br>(Right Bank side) | Sand mixed with Gravel<br>Average N value = 12 | Confirmed as<br>good | Confirmed as good<br>(Calculated as soil type: C) |   |
| CCB-22 | BR-21A<br>(Left Bank side)  | Sand<br>Average N value = 21                   | Confirmed as<br>good |   |   |
|        | BR-21B<br>(Right Bank side) | Sand mixed with Silt<br>Average N value = 9    | Confirmed as<br>good | Confirmed as good<br>(Calculated as soil type: B) |   |
| CCB-26 | BR-24A<br>(Left Bank side)  | Silty Sand<br>Average N value = 9              | Confirmed as<br>good | Confirmed as good<br>(Calculated as soil type: B) |   |
|        | BR-24B<br>(Right Bank side) | Sandy soil<br>Average N value = 15             | Confirmed as<br>good | Confirmed as good<br>(Calculated as soil type: B) |   |
| CCB-27 | BR-25A<br>(Left Bank side)  | Sand mixed with Silt<br>Average N value = 9    | Confirmed as<br>good | Confirmed as good<br>(Calculated as soil type: B) |   |
|        | BR-25B<br>(Right Bank side) | Silt mixed with Sand<br>Average N value = 6    | Confirmed as<br>good | Confirmed as good<br>(Calculated as soil type: A) |   |
| CCB-28 | BR-26A<br>(Left Bank side)  | Silt mixed with Sand<br>Average N value = 7    | Confirmed as<br>good | Confirmed as good<br>(Calculated as soil type: A) |   |
|        | BR-26B<br>(Right Bank side) | Silt mixed with Sand<br>Average N value = 7    | Confirmed as<br>good | Confirmed as good<br>(Calculated as soil type: A) |   |
| CCB-31 | BR-29<br>(Left Bank side)   | Silty Sand<br>Average N value = 10             | Confirmed as<br>good | Confirmed as good<br>(Calculated as soil type: C) |   |

## (5) Access Road

The width and geometry structure of the attachment road connecting to the CCB shall be determined based on the Nepal Rural Road Standards (2055) 2nd Revision, 2071 (hereinafter referred to as "NRS"), while taking into consideration the existing conditions.

### 1) Width of Road (cf.; Table 6.1- Carriageway, Shoulder, and Roadway width, NRS)

The planned widths are 7.5m, 6.75m, and 6.0m on level ground for District Road and 4.5m on level ground for Village Road, and were set as follows in consideration of the width of the current road and the width of the CCB to be installed.

**Table 2-2-34 Width of Access Road for each CCB**

| Code   | Profile No. | Road Category | Width Plan (m)     | Remarks                       |
|--------|-------------|---------------|--------------------|-------------------------------|
| CCB-02 | 0+420       | Village road  | 5.00 (0.5-4.0-0.5) | Ex pavement width = 4.0m      |
| CCB-03 | 0+820       | District Road | 7.00 (0.5-6.0-0.5) | Ex pavement width = 6.0m      |
| CCB-04 | 1+280       |               | 5.00 (0.5-4.0-0.5) |                               |
| CCB-11 | 4+775       | Village road  | 6.00 (0.5-5.0-0.5) | Ex pavement width = 5.1m      |
| CCB-13 | 8+005       | Village road  | 5.00 (0.5-4.0-0.5) | Ex road width = 3.7m and 4.0m |
| CCB-15 | 9+370       | —             | 5.00 (0.5-4.0-0.5) |                               |
| CCB-16 | 10+035      | Village road  | 5.00 (0.5-4.0-0.5) | Ex road width = 3.7m          |
| CCB-17 | 10+405      | Village road  | 6.00 (0.5-5.0-0.5) | Ex road width = 4.6m and 5.2m |
| CCB-19 | 12+460      | Village road  | 6.50 (0.5-5.5-0.5) | Ex pavement width = 5.5m      |
| CCB-20 | 12+990      | Village road  | 7.00 (0.5-6.0-0.5) | Ex pavement width = 6.0m      |
| CCB-22 | 14+865      | Village road  | 5.00 (0.5-4.0-0.5) | Ex road width = 4.2m          |
| CCB-26 | 19+470      | Village road  | 5.00 (0.5-4.0-0.5) | Ex road width = 4.0m          |
| CCB-27 | 20+715      | Village road  | 4.00 (0.5-3.0-0.5) | Ex road width = 3.0m          |
| CCB-28 | 21+551      | Village road  | 4.00 (0.5-3.0-0.5) | Ex road width = 2.8m          |
| CCB-31 | 24+605      | Village road  | 4.00 (0.5-3.0-0.5) | Ex pavement width = 3.0m      |

## 2) Design Speed (cf.: 5.4 Design Speed, NRS)

The design speed of District Road is 50km/h or 40km/h on level ground, and that of Village Road is 30km/h on level ground. Based on the above, the design speed of the access road connecting to CCB-03 is 40km/h because it is a District Road, and the design speed of the other access roads is 30km/h because they are Village Roads.

## 3) Steepest Vertical Slope (cf.: Table 12.1 Recommended gradients, NRS)

The maximum longitudinal slope shall be 7.0% on both District Road and Village Road.

## 4) Minimum length of vertical curve, (cf.: Table 12.2 Minimum length of vertical curve, NRS)

In order to minimize the influence of the surrounding topography and the installation of the CCB on the attachment road, the length of vertical curve for design speed of the District Road (40km/h) is 20m and for that of the design speed of the Village Road (30km/h) is 10m, with appropriate mitigation curves at the longitudinal slope change points.

## 5) Camber Cross Slope (cf.: Table 13.1 Recommended camber cross slope, NTS)

The basic cross slope is 4% for grave pavement and 3% for asphalt pavement, depending on the type of road surface, but since the construction of the access road is part of the section associated with the bridge attachment, the standard is 2%, the same as the bridge surface. The shoulder section will also have the same cross slope as the traffic surface.

## 6) Minimum Radius of Horizontal Radius (cf.: NRS/ Table 10.1 – Minimum Radius of Horizontal Radius, NRS)

The minimum radius of curvature shall be based on the current road alignment, while considering 60m for a design speed of 40km/h and 30m for a design speed of 30km/h.

## 7) Length of Linkage Road

The length of the linkage road was set as follows to ensure the water depth and water level based on the irrigation canal elevation and hydraulic analysis, and to minimize the impact on the surrounding area and houses along the road while taking into consideration the various criteria mentioned above.

**Table 2-2-35 Length of Linkage Road of each CCB**

| Code   | Left side (m) |             |        | Right side (m) |             |        | Remarks       |
|--------|---------------|-------------|--------|----------------|-------------|--------|---------------|
|        | BP.           | EP.         | Length | BP.            | EP.         | Length |               |
| CCB-02 | No.0+2.154    | No.1+18.270 | 36.116 | No.2+9.270     | No.3+13.770 | 24.500 |               |
| CCB-03 | No.0+9.000    | No.1+6.000  | 17.000 | No.1+17.000    | No.3+9.000  | 32.000 | District Road |
| CCB-04 | No.0+4.000    | No.1+11.500 | 27.500 | No.2+4.000     | No.2+13.196 | 9.196  |               |
| CCB-11 | No.0+6.500    | No.1+13.050 | 26.550 | No.2+5.550     | No.3+12.509 | 26.959 |               |
| CCB-13 | No.0-3.545    | No.1+16.930 | 40.475 | No.2+7.930     | No.3+12.430 | 24.500 |               |
| CCB-15 | No.0+2.000    | No.0+8.000  | 6.000  | No.1+0.050     | No.1+10.000 | 9.500  |               |
| CCB-16 | No.0-2.458    | No.0+10.500 | 8.042  | No.1+1.500     | No.2+6.000  | 24.500 |               |
| CCB-17 | No.0-14.605   | No.2+1.850  | 27.245 | No.2+12.850    | No.3+17.350 | 24.500 |               |
| CCB-19 | No.0+0.000    | No.1+4.500  | 24.500 | No.1+15.500    | No.2+10.000 | 14.500 |               |
| CCB-20 | No.0+1.300    | No.0+6.300  | 5.000  | No.0+17.300    | No.1+11.800 | 14.500 |               |
| CCB-22 | No.0+5.500    | No.0+11.300 | 5.800  | No.0+18.500    | No.2+5.200  | 26.700 |               |
| CCB-26 | No.0+3.900    | No.0+8.900  | 5.000  | No.0+16.100    | No.2+0.000  | 23.900 |               |
| CCB-27 | No.0+0.000    | No.2+2.782  | 42.782 | No.2+9.982     | No.4+5.705  | 35.723 |               |
| CCB-28 | No.0+1.400    | No.0+6.400  | 5.000  | No.0+13.600    | No.1+10.000 | 16.400 |               |
| CCB-31 | No.0+0.000    | No.1+2.366  | 22.366 | No.1+7.666     | No.2+10.000 | 22.334 |               |

## 8) Slope of earth work

In order to connect the linkage road to the existing ground, the slope at both ends was based on the following

- Embankment: 1:1.8 as poorly graded sand, referring to the Guidelines for Road Earthwork Cuttings and Slope Stability Work.
- Excavation: 1:1.5 as poorly graded sand, referring to the Guidelines for Road Earthwork Cuttings and Slope Stability Work.

## (6) Ancillary Facilities

Ancillary facilities for the CCB include transition and check gates in addition to the above-mentioned attachment roads.

### 1) Transition

Since the culvert bridge will be constructed across the irrigation canal, which has a trapezoidal cross-section, transition canal will be provided to avoid sudden changes in the flow conditions of the irrigation canal.

### 2) Check Gate

The check gates attached to the CCBs (CCB-10, CCB-19 and CCB-24) need to be demolished for the improvement and maintenance of this project, so the check gates will also be improved and maintained.

### 2-2-3 Outline Design Drawing

The Drawings of Outline Design are shown below,

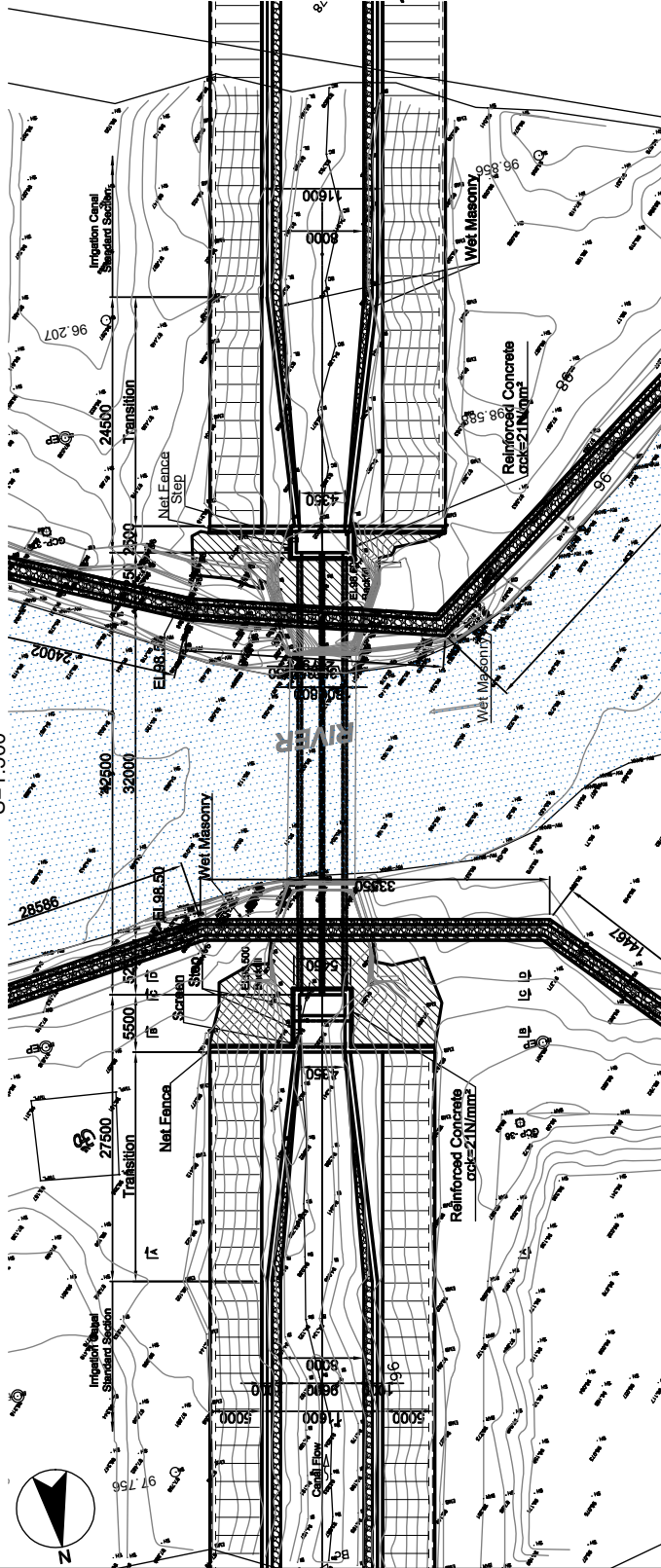
**Table 2-2-36 List of Drawing of Outline design**

| DWG No                             | Drawing Title   | Pages |
|------------------------------------|---|-------|
| <b>Canal Siphon (CSCS)</b>         |   |       |
| CUP-1                              | New Ganagajali CUP (CUP-1) Plan/Profile/Section           | 1/1   |
| CUP-2                              | Old Ganagajal CUP (CUP-2) Plan/Profile/Section            | 1/1   |
| CUP-3                              | Pauraha CUP (CUP-3) Plan/Profile/Section                  | 1/1   |
| CUP-4                              | Banra CUP (CUP-4) Plan/Profile/Section                    | 1/1   |
| CUP-5                              | Sundari CUP (CUP-5) Plan/Profile/Section                  | 1/1   |
| CUP-6                              | Mahuli CUP (CUP-6) Plan/Profile/Section                   | 1/1   |
| CUP-7                              | Kailii I CUP (CUP-7) Plan/Profile/Section                 | 1/1   |
| CUP-8                              | Kailii II CUP (CUP-8) Plan/Profile/Section                | 1/1   |
| <b>CDW (CDW)</b>                   |   |       |
| CDW-1                              | CDW No.1 (CDW-01) Plan/Profile/Section                    | 1/1   |
| CDW-2                              | CDW No.2 (CDW-02) Plan/Profile/Section                    | 1/1   |
| CDW -3                             | CDW No.3 (CDW-03) Plan/Profile/Section                    | 1/1   |
| CDW -4                             | CDW No.4 (CDW-04) Plan/Profile/Section                    | 1/1   |
| CDW -5                             | CDW No.5 (CDW-05) Plan/Profile/Section                    | 1/1   |
| CDW -6                             | CDW No.6 (CDW-06) Plan/Profile/Section                    | 1/1   |
| CDW -7                             | CDW No.7 (CDW-07) Plan/Profile/Section                    | 1/1   |
| CDW -8                             | CDW No.8 (CDW-08) Plan/Profile/Section                    | 1/1   |
| CDW -9                             | CDW No.11 (CDW-11) Plan/Profile/Section                   | 1/1   |
| <b>Canal Crossing Bridge (CCB)</b> |   |       |
| CCB-1                              | Canal Crossing Bridge No.1 (CCB-02) Plan/Profile/Section  | 1/1   |
| CCB-2                              | Canal Crossing Bridge No.2 (CCB-03) Plan/Profile/Section  | 1/1   |
| CCB-3                              | Canal Crossing Bridge No.3 (CCB-04) Plan/Profile/Section  | 1/1   |
| CCB-4                              | Canal Crossing Bridge No.4 (CCB-11) Plan/Profile/Section  | 1/1   |
| CCB-5                              | Canal Crossing Bridge No.6 (CCB-13) Plan/Profile/Section  | 1/1   |
| CCB-6                              | Canal Crossing Bridge No.7 (CCB-15) Plan/Profile/Section  | 1/1   |
| CCB-7                              | Canal Crossing Bridge No.8 (CCB-16) Plan/Profile/Section  | 1/1   |
| CCB-8                              | Canal Crossing Bridge No.9 (CCB-17) Plan/Profile/Section  | 1/1   |
| CCB-9                              | Canal Crossing Bridge No.10 (CCB-19) Plan/Profile/Section | 1/1   |
| CCB-10                             | Canal Crossing Bridge No.11 (CCB-20) Plan/Profile/Section | 1/1   |
| CCB-11                             | Canal Crossing Bridge No.12 (CCB-22) Plan/Profile/Section | 1/1   |
| CCB-12                             | Canal Crossing Bridge No.13 (CCB-26) Plan/Profile/Section | 1/1   |
| CCB-13                             | Canal Crossing Bridge No.18 (CCB-27) Plan/Profile/Section | 1/1   |
| CCB-14                             | Canal Crossing Bridge No.24 (CCB-28) Plan/Profile/Section | 1/1   |
| CCB-15                             | Canal Crossing Bridge No.24 (CCB-31) Plan/Profile/Section | 1/1   |

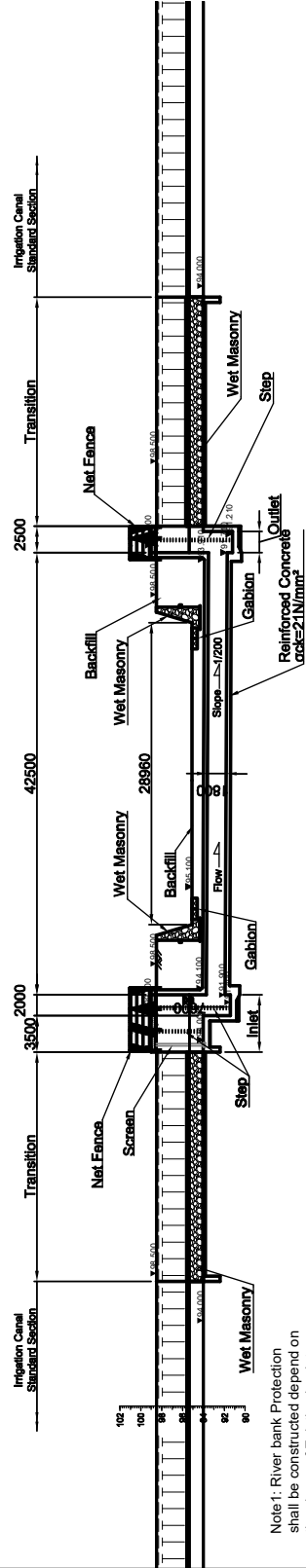
Note: The scale of the drawings is shown on the basis of A3 size paper.

# New Ganagajali CUP (CUP-1)

**Plan**  
S=1:500



**Profile**  
S=1:500

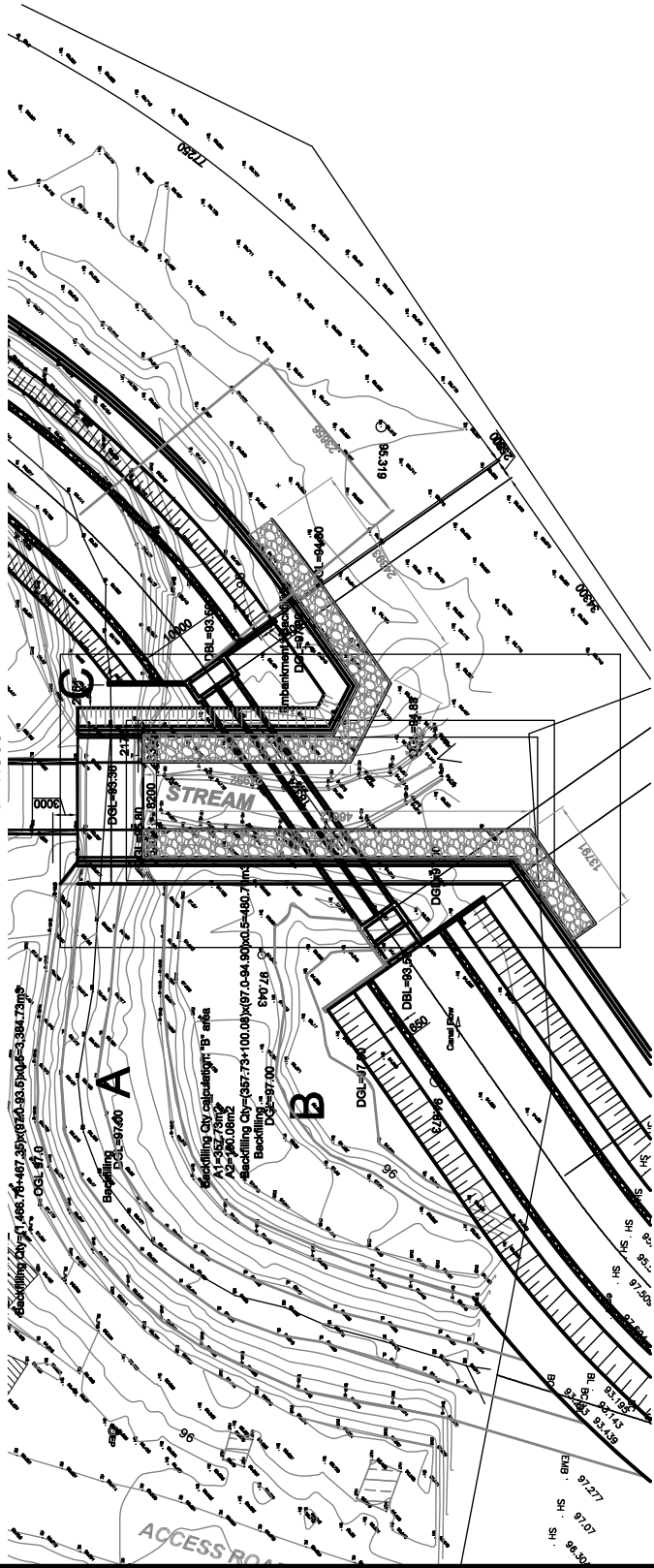


Note 1: River bank Protection shall be constructed depend on the shape of Existing bank top.

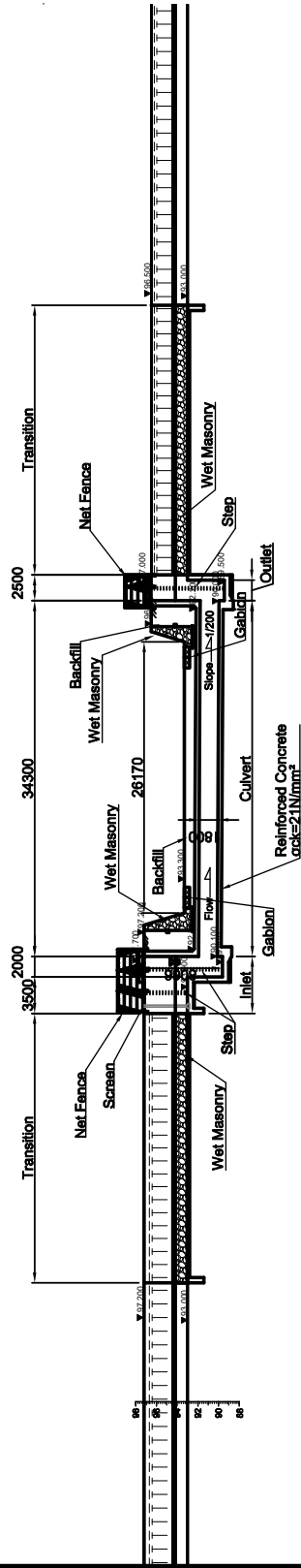
|  |  |  |                   |                            |                        |
|--|--|--|-------------------|----------------------------|------------------------|
| PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM<br>IN EASTERN TERAI AREA IN NEPAL | DWG. TITLE<br>New Ganagajali CUP (CUP-1)<br>Plan, Profile, Section |  | DATE<br>As Shown  | DESIGNED BY<br>APPROVED BY | DWG. NO.<br>SERIAL NO. |
|  | JAPAN INTERNATIONAL<br>COOPERATION AGENCY                          |  | SCALE<br>As Shown | APPROVED BY<br>As Shown    | DWG. NO.<br>SERIAL NO. |

# Old Ganagajal CUP (CUP-2)

**Plan**  
S=1:500



**Profile**  
S=1:500

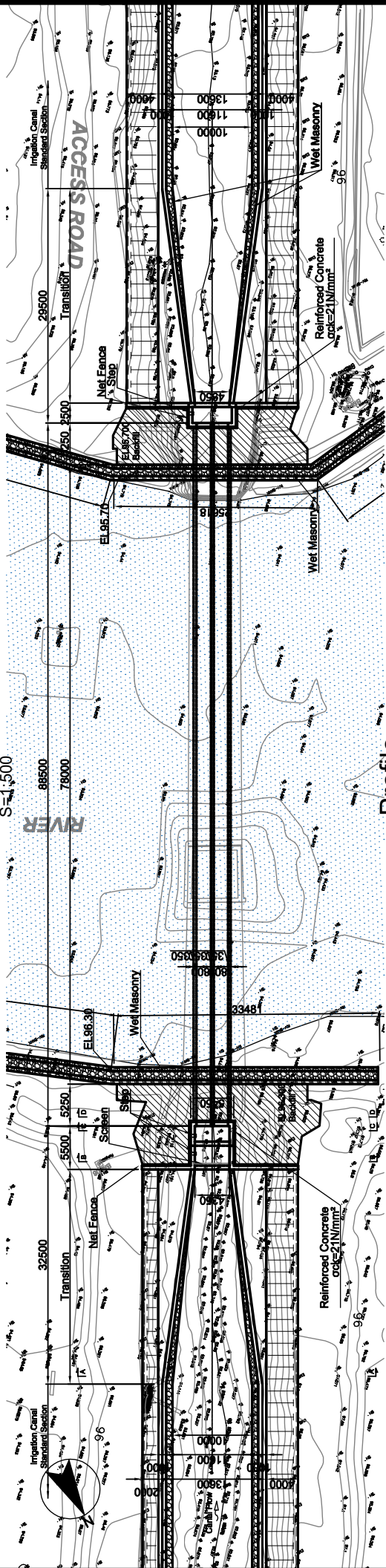


Note 1: River bank Protection shall be constructed depend on the shape of Existing bank top.

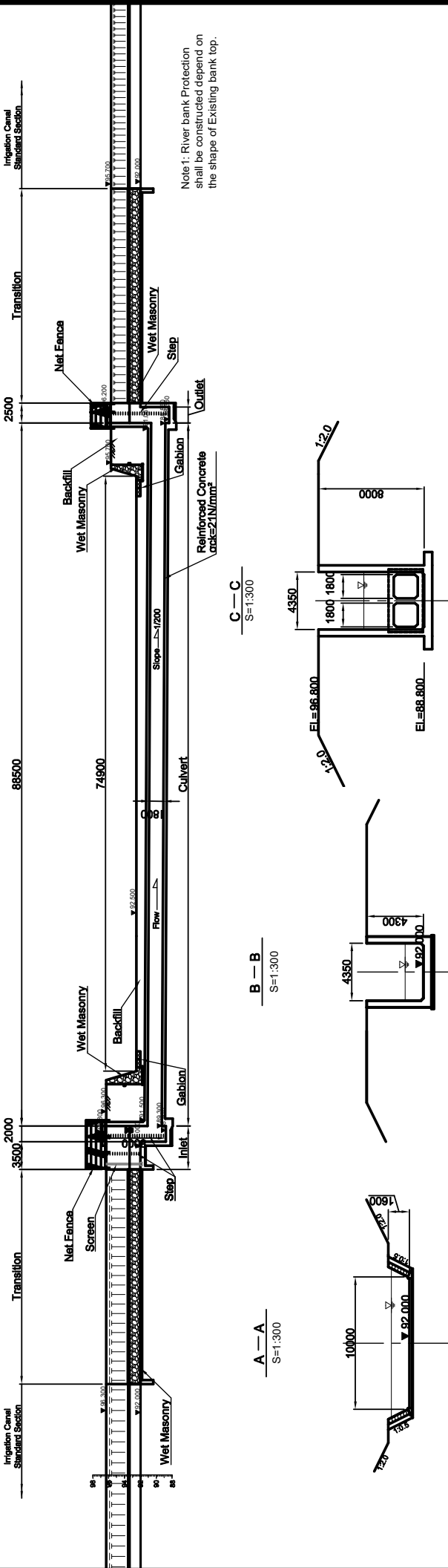
|  |  |  |                   |                      |            |
|--|--|--|-------------------|----------------------|------------|
| PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM<br>IN EASTERN TERAI AREA IN NEPAL | DWG. TITLE<br>Old Ganagajal CUP (CUP-2)<br>Plan, Profile, Section                                  |  | DATE<br>As Shown  | DESIGNED BY<br>CUP-2 | DWG. NO.   |
|  | MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION,<br>DEPARTMENT OF WATER RESOURCES AND IRRIGATION |  | SCALE<br>As Shown | APPROVED BY<br>CUP-2 | SERIAL NO. |

# Pauraha CUP (CUP-3)

**Plan**  
S=1:500



**Profile**  
S=1:500



Note 1: River bank Protection shall be constructed depend on the shape of Existing bank top.

**A-A**  
S=1:300

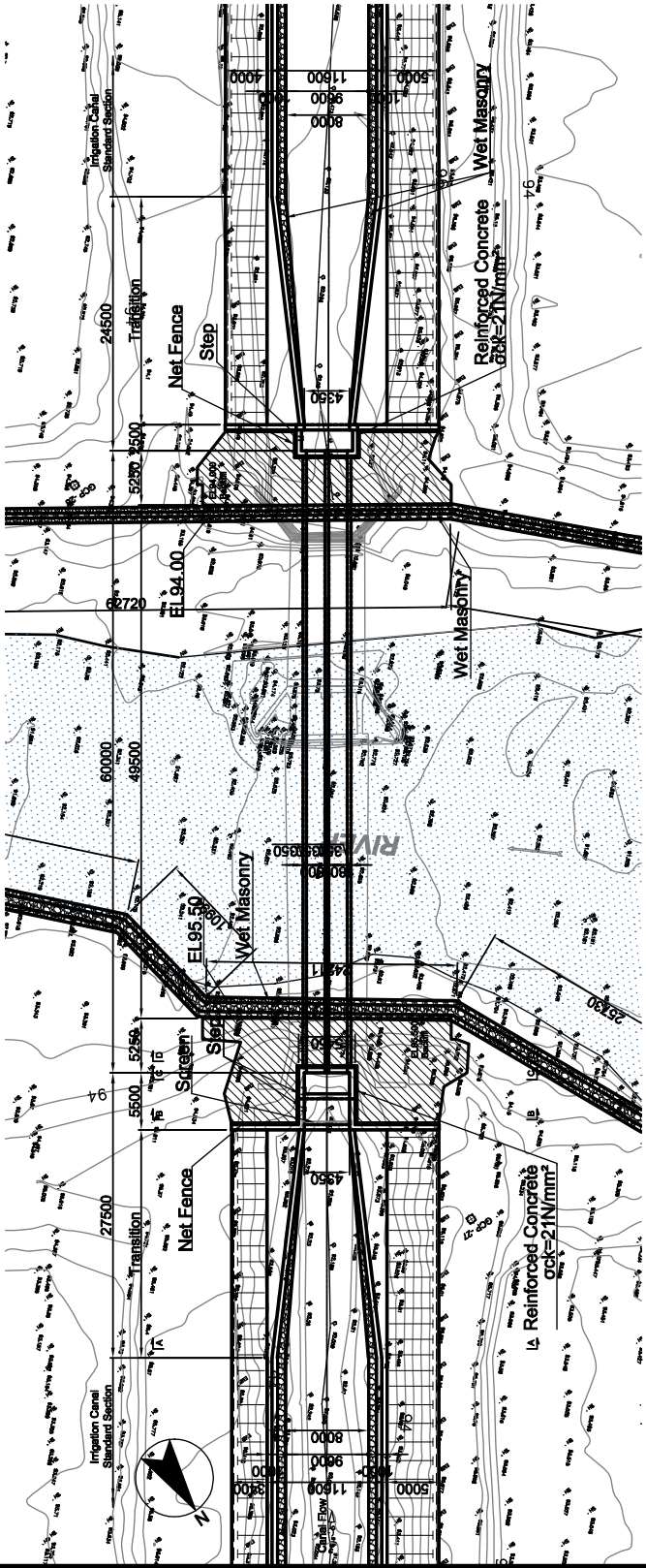
**B-B**  
S=1:300

**C-C**  
S=1:300

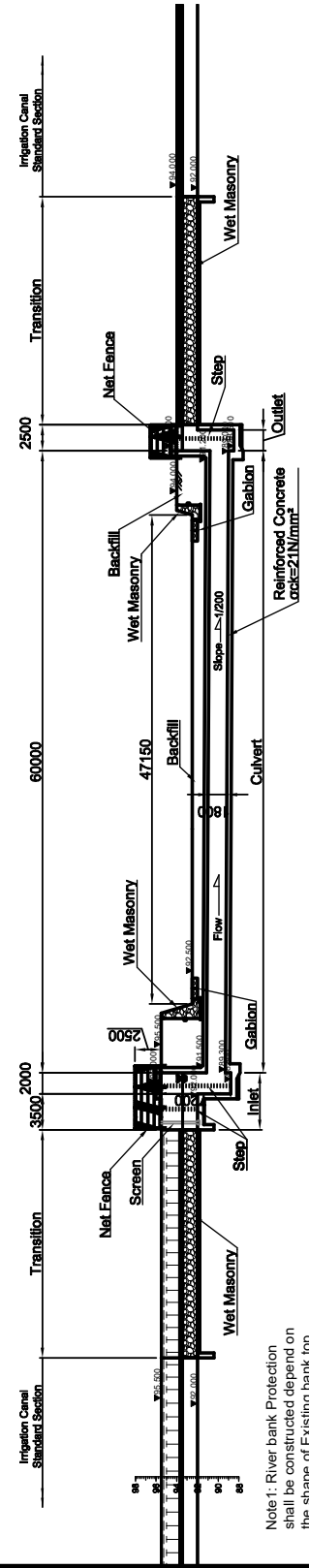
|   |   |  |                   |                           |
|---|---|--|-------------------|---------------------------|
| PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM<br>IN EASTERN TERAI AREA IN NEPAL<br><br>MINISTRY OF ENERGY, WATER RESOURCES AND IRRIGATION,<br>DEPARTMENT OF WATER RESOURCES AND IRRIGATION | DWG. TITLE<br>Pauraha CUP (CUP-3)<br>Plan, Profile, Section |  | DATE<br>As Shown  | DESIGNED BY<br>CUP-3      |
|   | JAPAN INTERNATIONAL<br>COOPERATION AGENCY                   |  | SCALE<br>As Shown | APPROVED BY<br>SERIAL NO. |

# Banra CUP (CUP-4)

Plan  
S=1:500

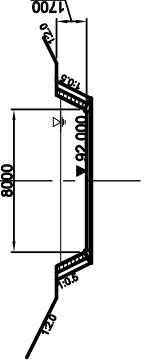


Profile  
S=1:500

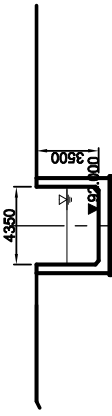


Note 1: River bank Protection shall be constructed depend on the shape of Existing bank top.

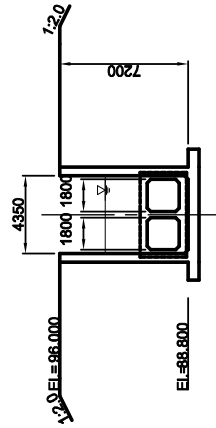
A-A  
S=1:300



B-B  
S=1:300



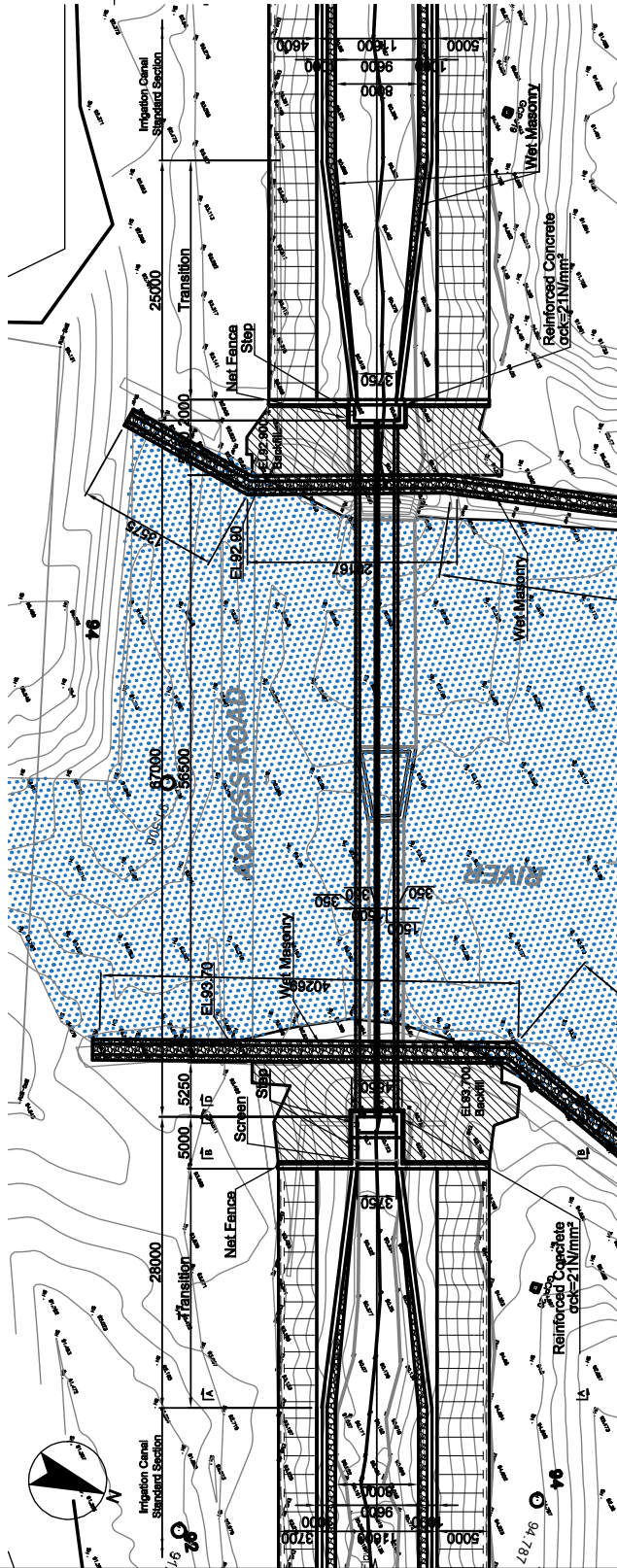
C-C  
S=1:300



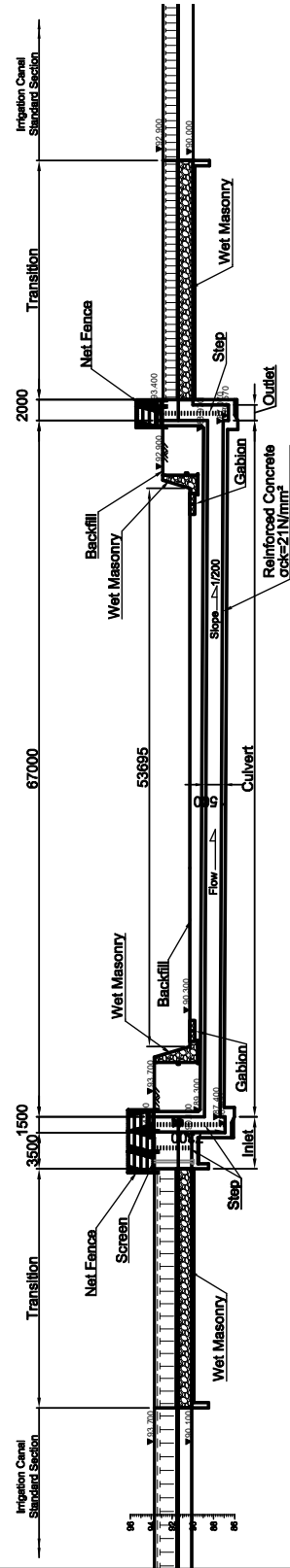
|  |       |   |       |
|--|-------|---|-------|
| PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM<br>IN EASTERN TERAI AREA IN NEPAL |       | DWG. TITLE                                  |       |
| MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION,<br>DEPARTMENT OF WATER RESOURCES AND IRRIGATION           |       | Banra CUP (CUP-4)<br>Plan, Profile, Section |       |
| DESIGNED BY  | DATE  | APPROVED BY                                 | SCALE |
|  |       | As Shown                                    |       |
| DWG NO.  | CUP-4 | SERIAL NO.                                  |       |

# Sundari CUP (CUP-5)

Plan  
S=1:500

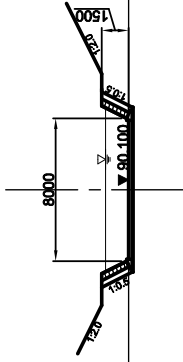


Profile  
S=1:500

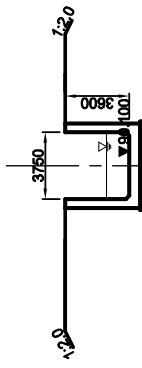


Note 1: River bank Protection shall be constructed depend on the shape of Existing bank top.

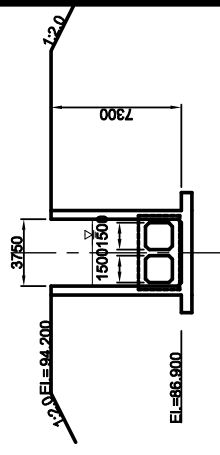
A-A  
S=1:300



B-B  
S=1:300



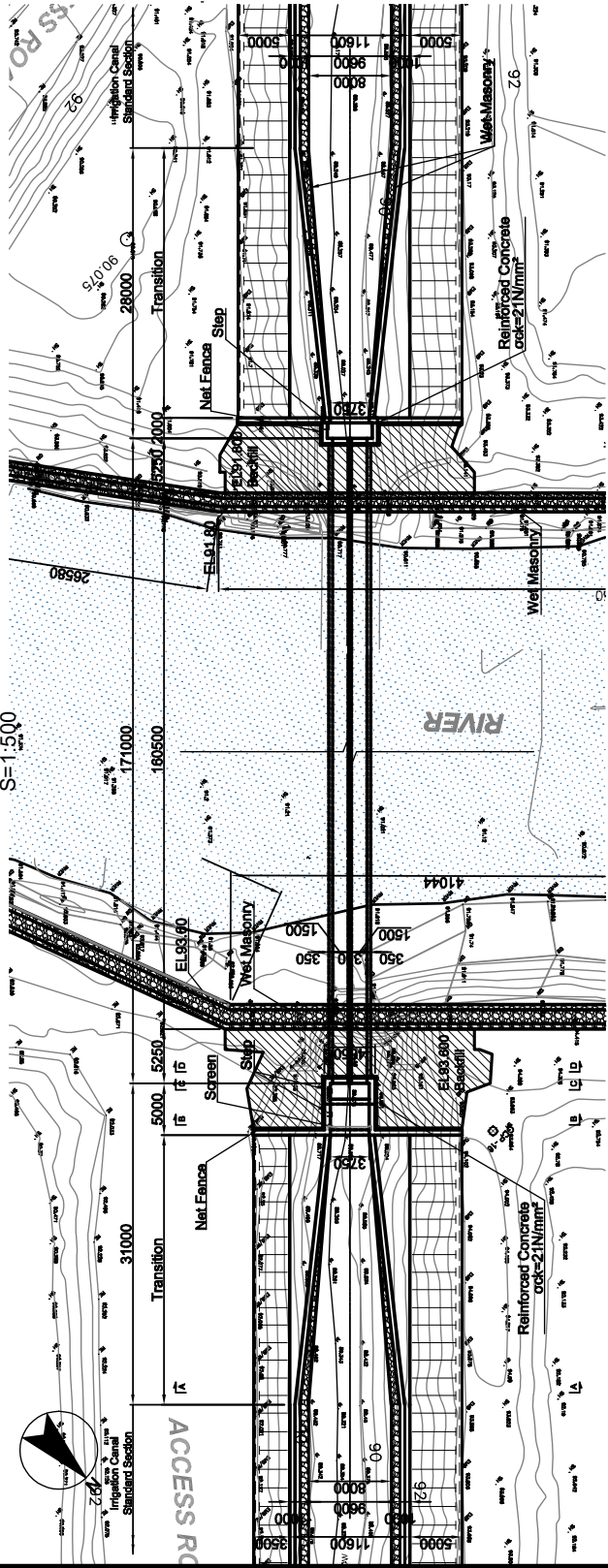
C-C  
S=1:300



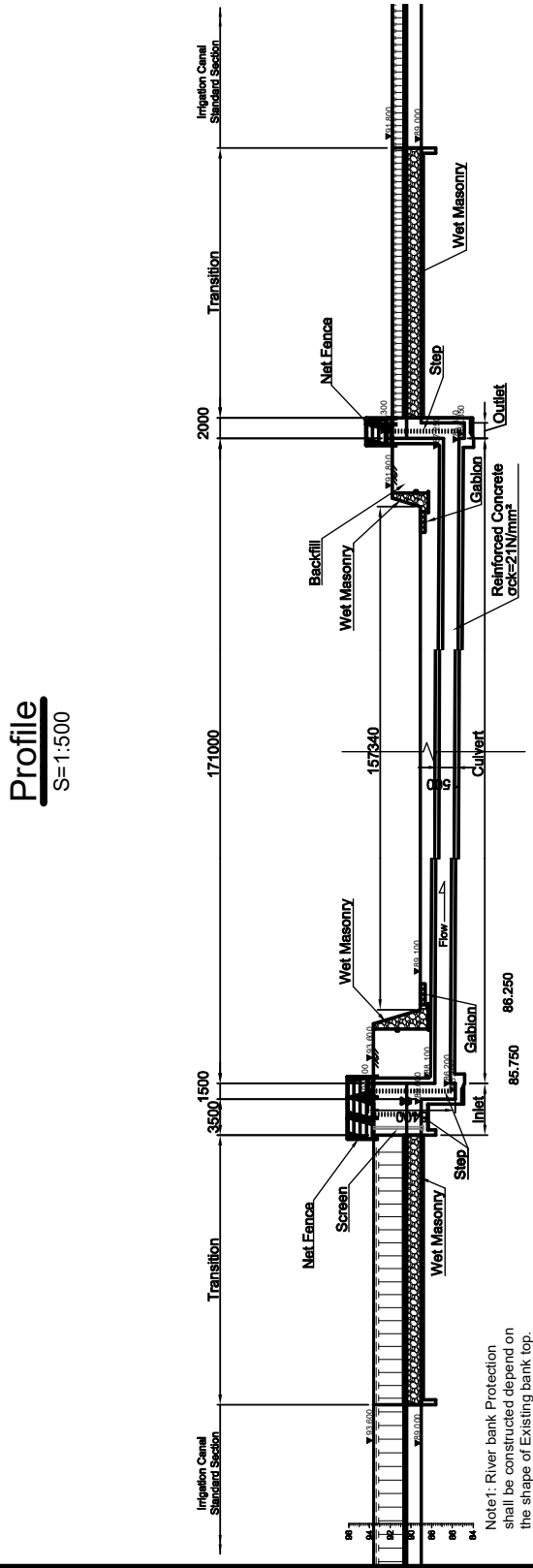
|   |          |             |                     |
|---|----------|-------------|---------------------|
| DWG. TITLE<br>Sundari CUP (CUP-5)<br>Plan, Profile, Section   | DATE     | DESIGNED BY | DWG NO.             |
|   | SCALE    | APPROVED BY | CUP-5<br>SERIAL NO. |
| PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM<br>IN EASTERN TERAI AREA IN NEPAL<br>MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION,<br>DEPARTMENT OF WATER RESOURCES AND IRRIGATION<br>JAPAN INTERNATIONAL<br>COOPERATION AGENCY | As Shown |             |                     |

# Mahuli CUP (CUP-6)

**Plan**  
S=1:500

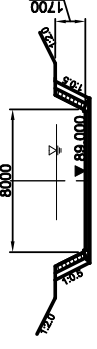


**Profile**  
S=1:500

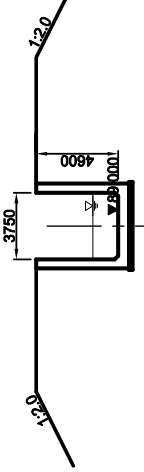


Note: River bank Protection shall be constructed depend on the shape of Existing bank top.

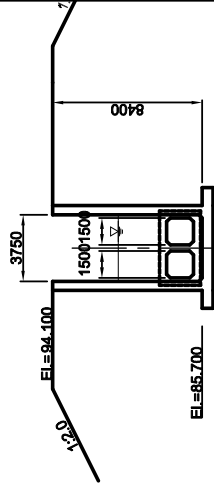
**A-A**  
S=1:300



**B-B**  
S=1:300



**C-C**  
S=1:300



|             |            |
|-------------|------------|
| DESIGNED BY | DWG NO.    |
| APPROVED BY | CUP-6      |
| SCALE       | SERIAL NO. |
| DATE        | As Shown   |

DWG. TITLE  
Mahuli CUP (CUP-6)  
Plan, Profile, Section

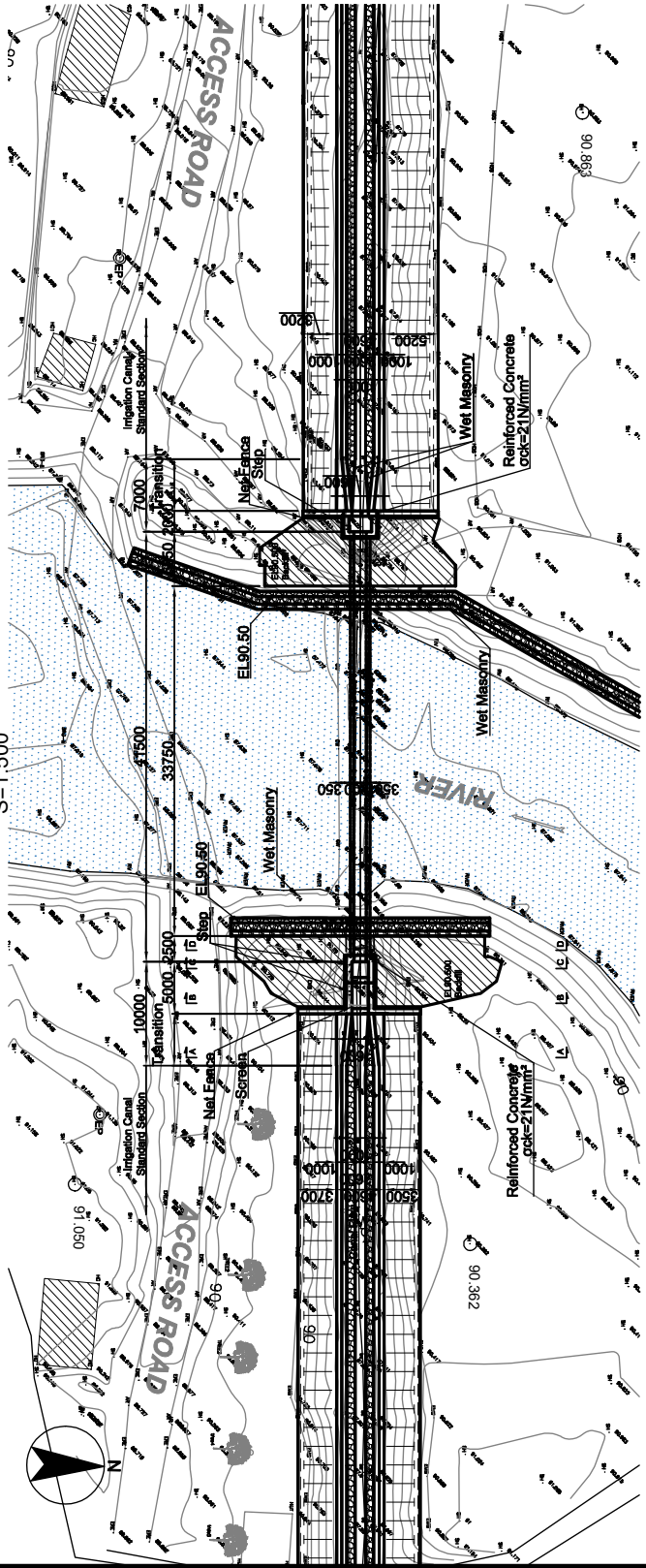
PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM  
IN EASTERN TERAI AREA IN NEPAL

MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION,  
DEPARTMENT OF WATER RESOURCES AND IRRIGATION

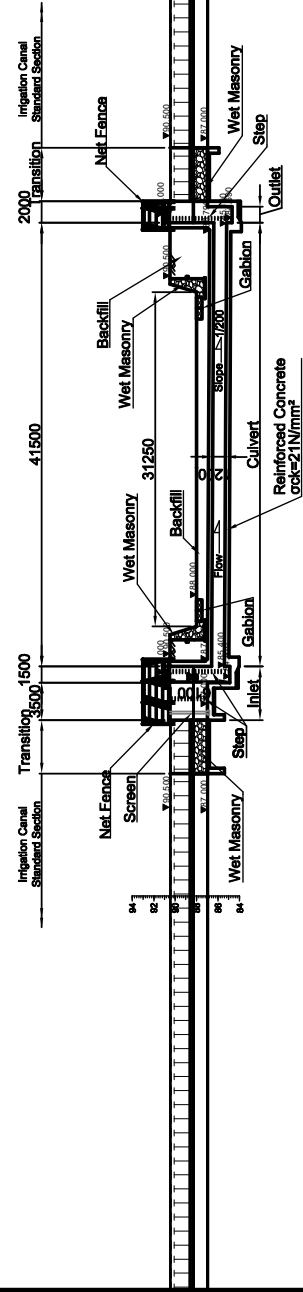
JAPAN INTERNATIONAL  
COOPERATION AGENCY

# Kailii I CUP (CUP-7)

**Plan**  
S=1:500

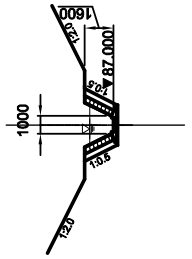


**Profile**  
S=1:500

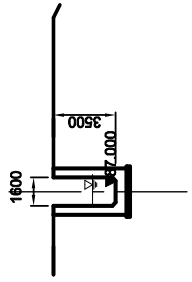


Note 1: River bank Protection shall be constructed depend on the shape of Existing bank top.

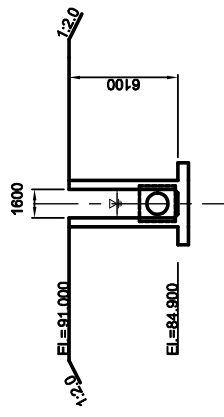
**A-A**  
S=1:300



**B-B**  
S=1:300



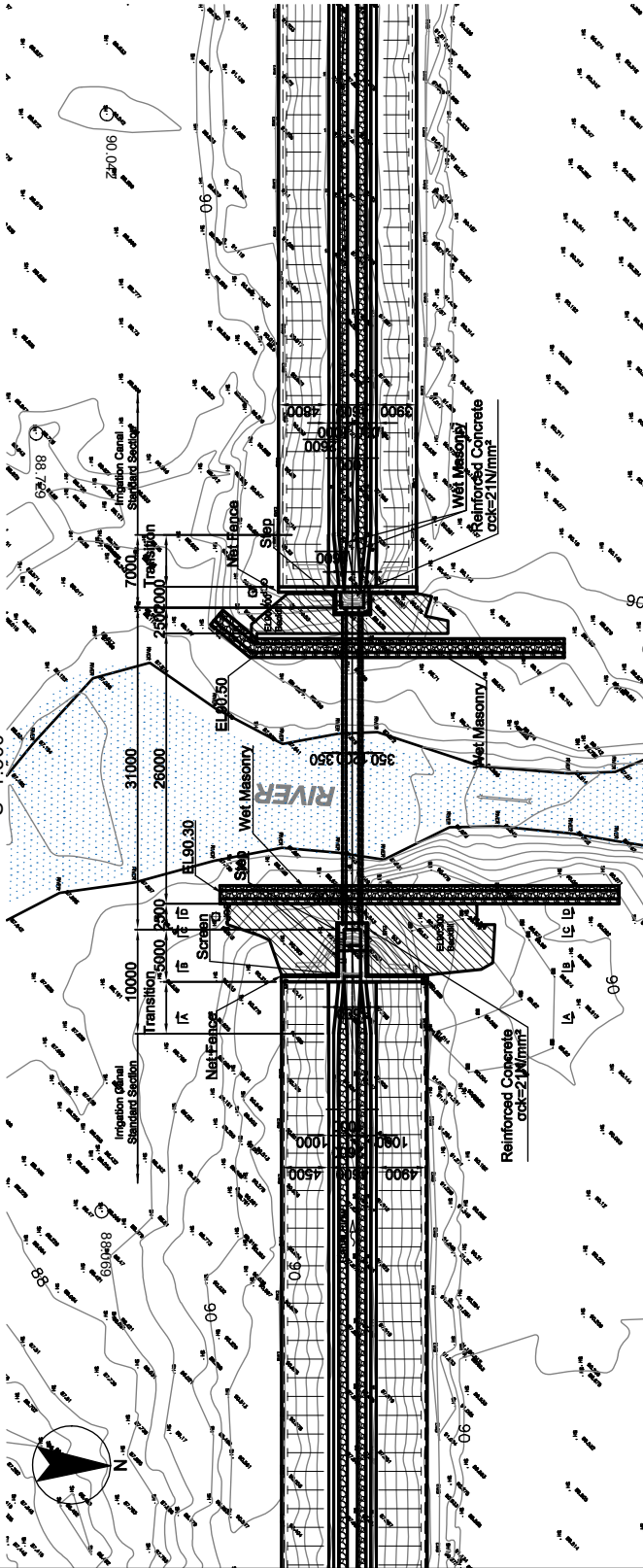
**C-C**  
S=1:300



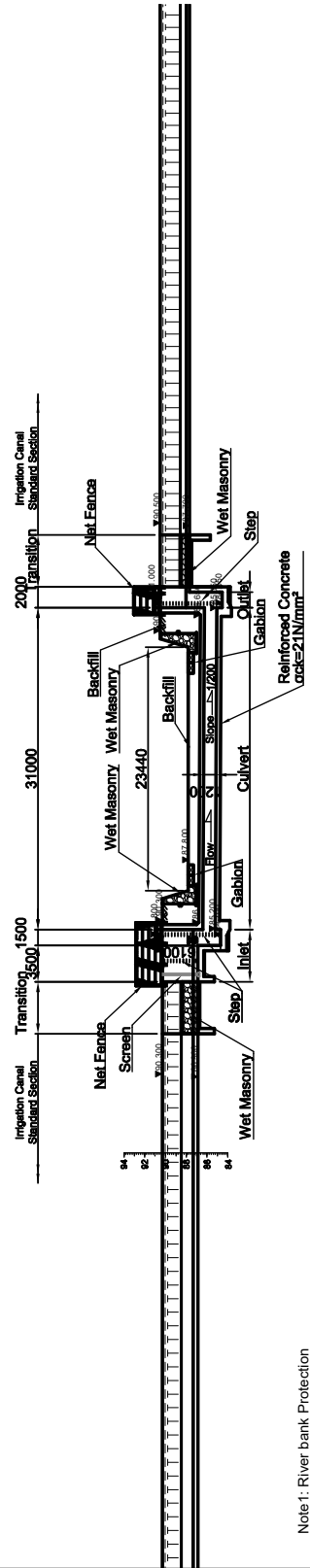
|  |       |  |            |
|--|-------|--|------------|
| PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM<br>IN EASTERN TERAI AREA IN NEPAL |       | DWG. TITLE<br>Kailii I CUP (CUP-7)<br>Plan, Profile, Section |            |
| MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION,<br>DEPARTMENT OF WATER RESOURCES AND IRRIGATION           |       | JAPAN INTERNATIONAL<br>COOPERATION AGENCY                    |            |
| DESIGNED BY  | DATE  | DWG. NO.   | CUP-7      |
| APPROVED BY  | SCALE | As Shown   | SERIAL NO. |

# Kailii II CUP (CUP-8)

**Plan**  
S=1:500

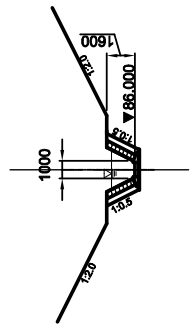


**Profile**  
S=1:500

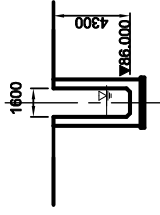


Note 1: River bank Protection shall be constructed depend on the shape of Existing bank top.

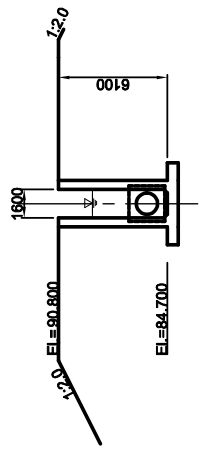
**A-A**  
S=1:300



**B-B**  
S=1:300

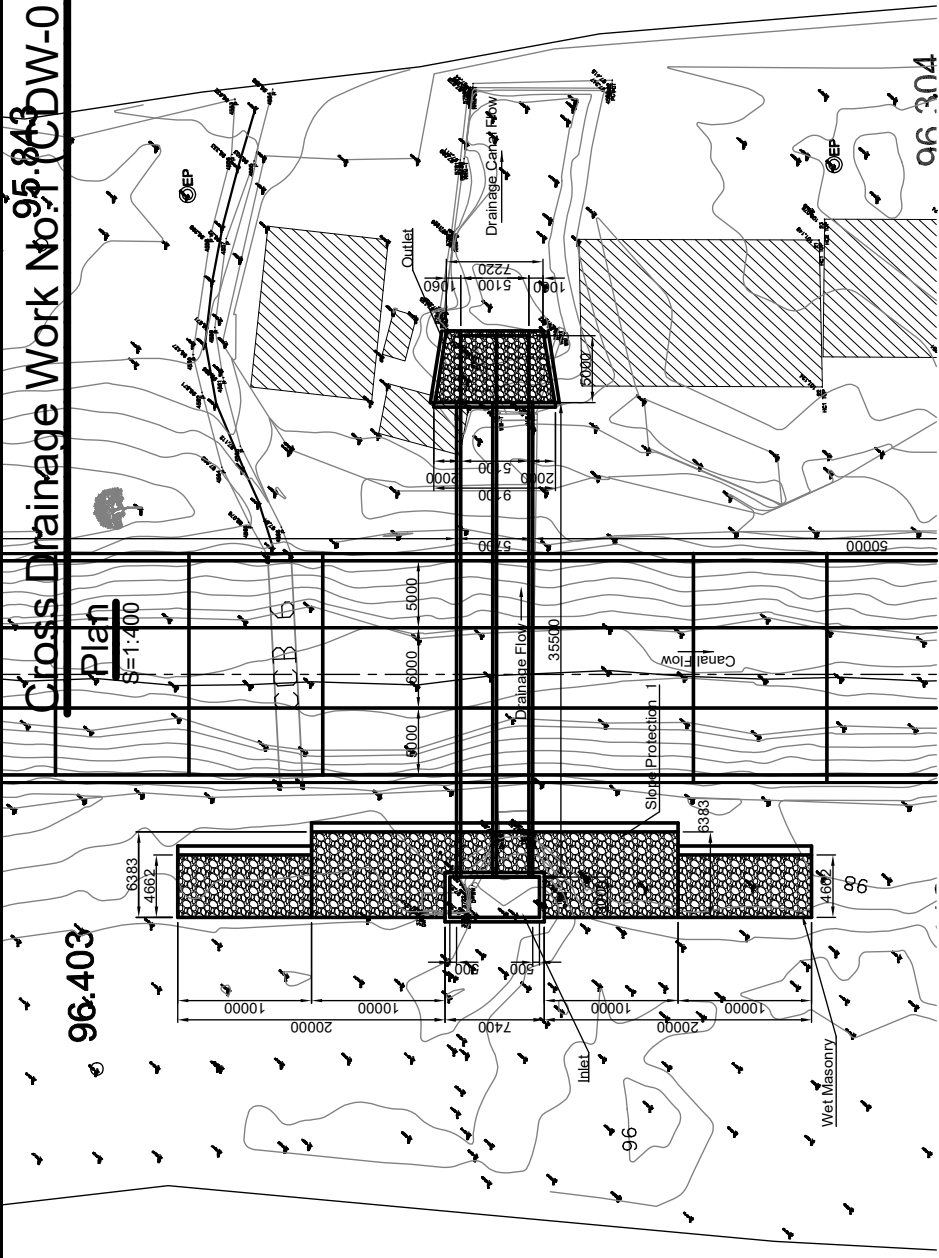


**C-C**  
S=1:300

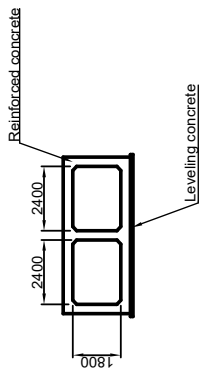


|  |   |  |                           |                      |            |
|--|---|--|---------------------------|----------------------|------------|
| PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM<br>IN EASTERN TERAI AREA IN NEPAL<br><br>MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION,<br>DEPARTMENT OF WATER RESOURCES AND IRRIGATION | DWG. TITLE<br>Kailii II CUP (CUP-8)<br>Plan, Profile, Section |  | DATE<br>As Shown          | DESIGNED BY<br>CUP-8 | DWG NO.    |
|  | SCALE<br>As Shown   |  | APPROVED BY<br>SERIAL NO. | CUP-8                | SERIAL NO. |

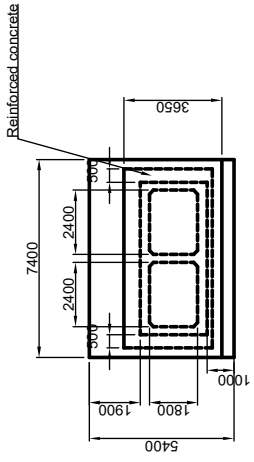
# Cross Drainage Work No. 1 (CDW-01)



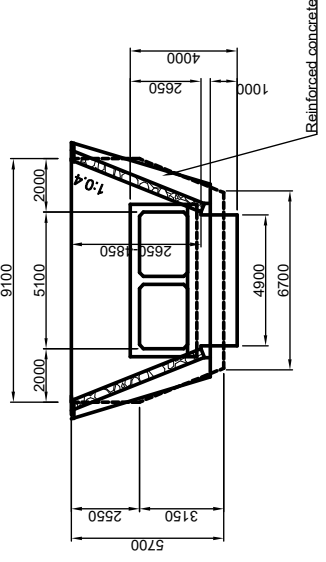
**Drainage Culvert**  
S=1:200



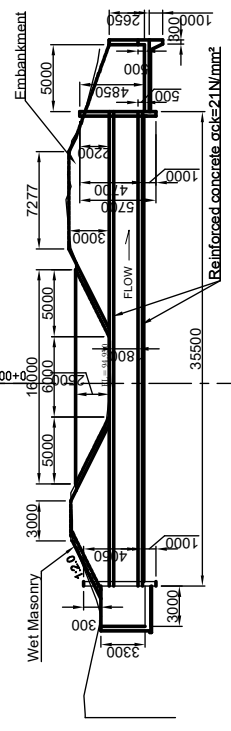
**Inlet**  
S=1:200



**Outlet**  
S=1:200

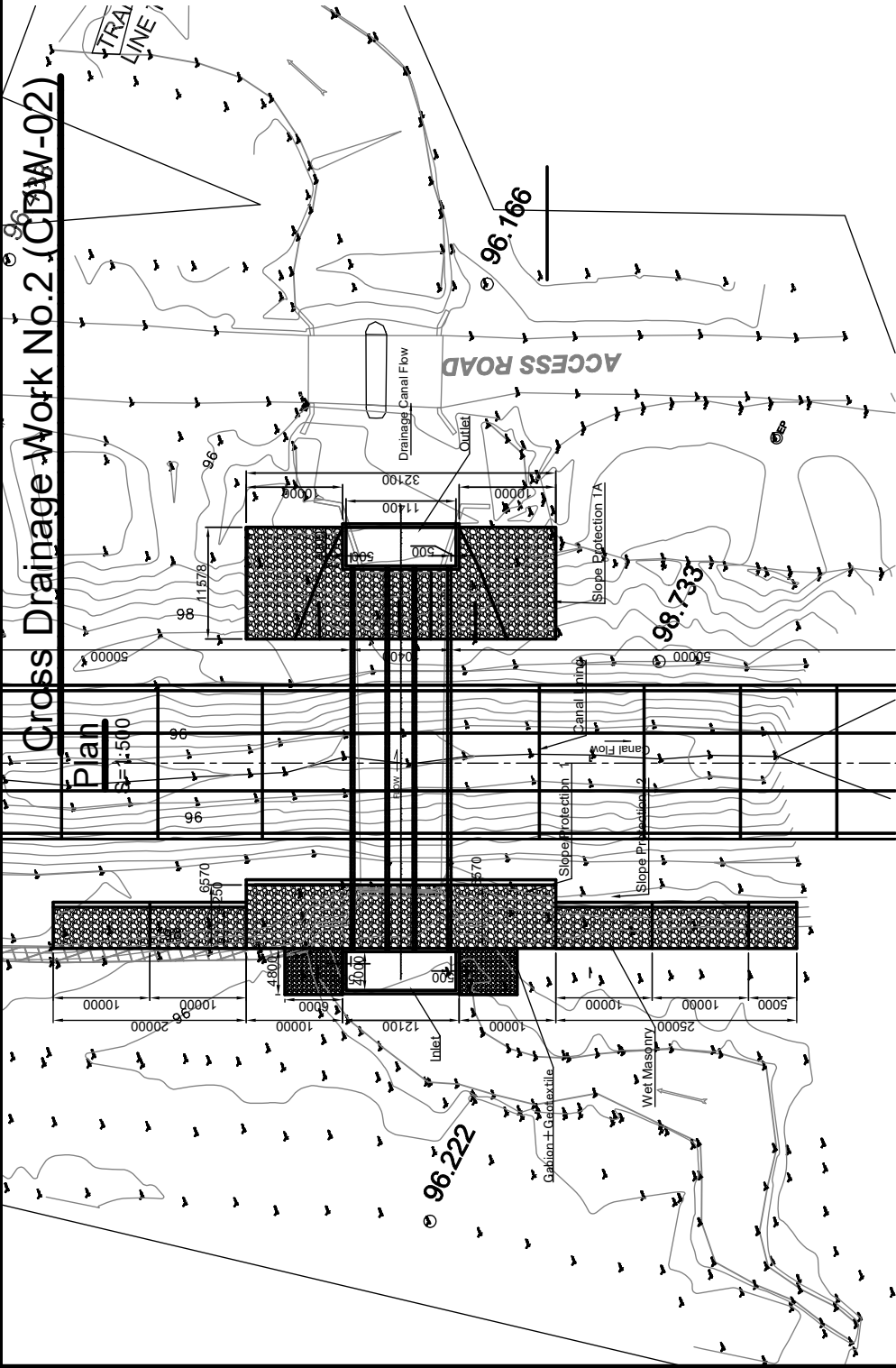


**Profile**  
S=1:400

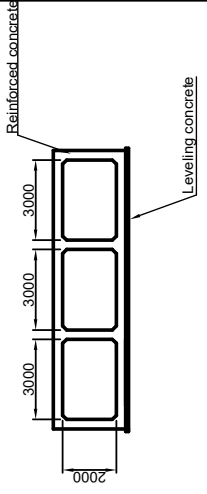


|  |  |              |                    |                   |
|--|--|--------------|--------------------|-------------------|
| <b>DWG. TITLE</b>  |  | <b>DATE</b>  | <b>DESIGNED BY</b> | <b>DWG. NO.</b>   |
| Preparatory Survey for the Project for Rehabilitation of Irrigation System<br>in Eastern Terai Area in Nepal |  |              |                    | CDW-1             |
| Cross Drainage Work No. 1 (CDW-01)<br>Plan, Profile, Section   |  | <b>SCALE</b> | <b>APPROVED BY</b> | <b>SERIAL NO.</b> |
| MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION,<br>DEPARTMENT OF WATER RESOURCES AND IRRIGATION           |  | As Shown     |                    |                   |
| JAPAN INTERNATIONAL<br>COOPERATION AGENCY  |  |              |                    |                   |

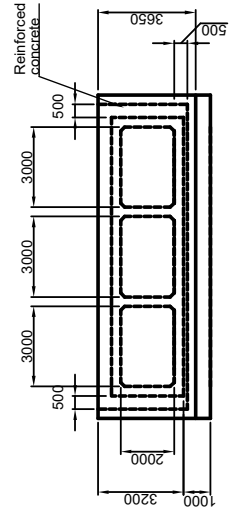
# Cross Drainage Work No.2 (CDW-02)



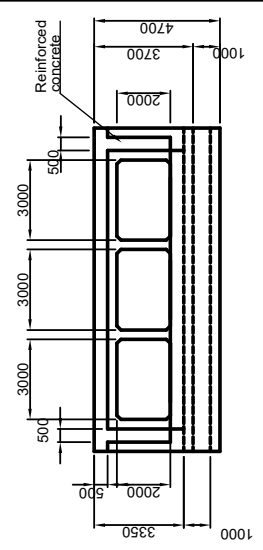
**Drainage Cuvvert**  
S=1:200



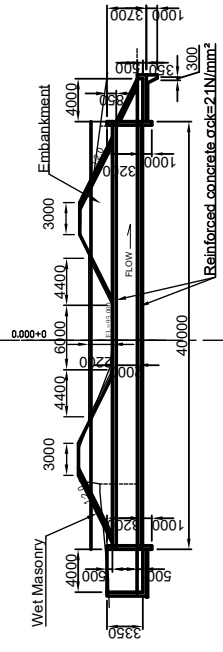
**Inlet**  
S=1:200



**Outlet**  
S=1:200

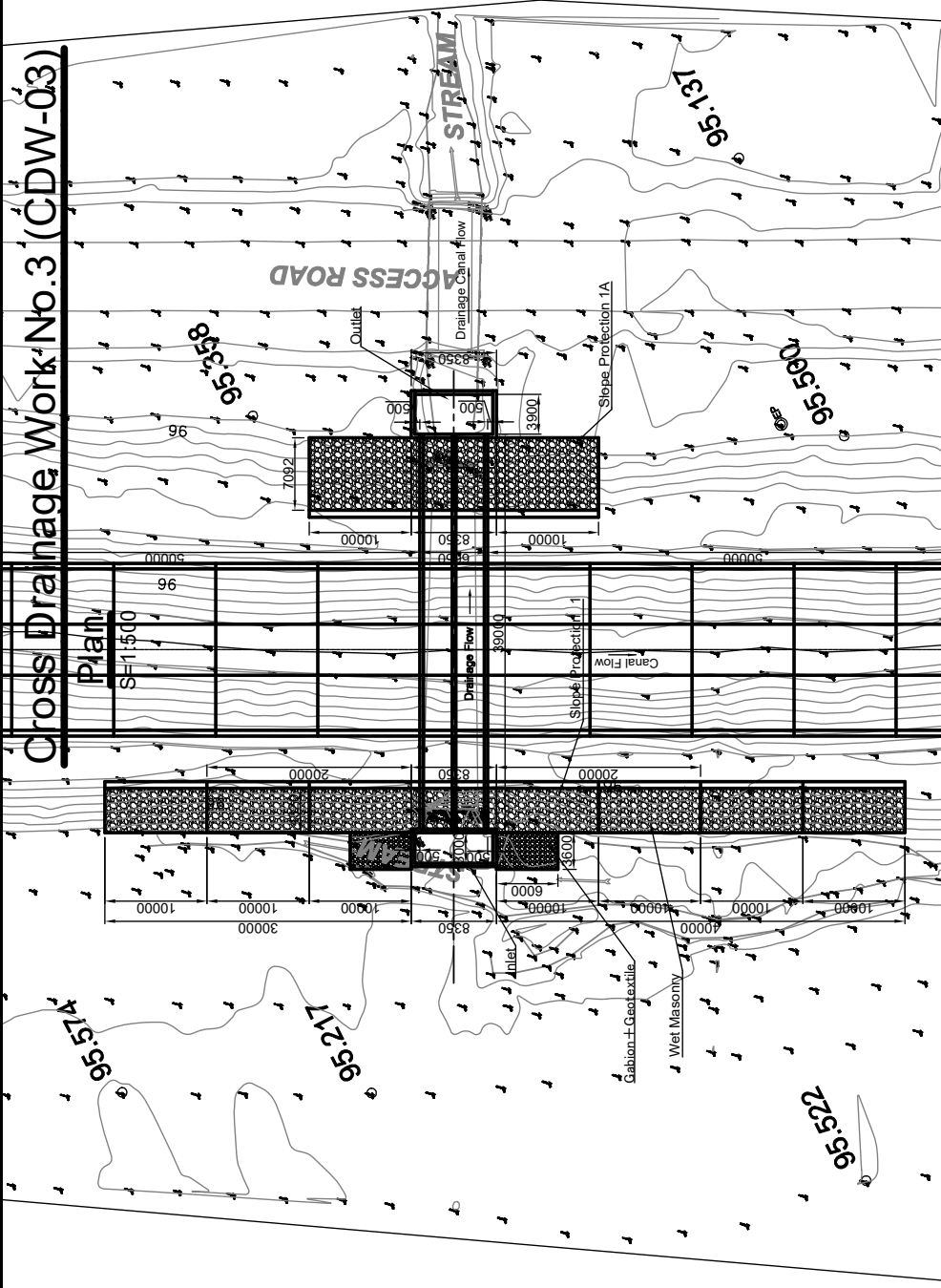


**Profile**  
S=1:500

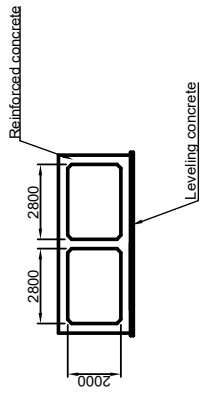


|  |       |   |          |
|--|-------|---|----------|
| DWG. TITLE<br>Cross Drainage Work No.2 (CDW-02)<br>Plan, Profile, Section  | DATE  | DESIGNED BY                               | DWG. NO. |
|  | SCALE | APPROVED BY                               | CDW-2    |
| PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM<br>IN EASTERN TERAI AREA IN NEPAL<br>MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION,<br>DEPARTMENT OF WATER RESOURCES AND IRRIGATION |       | JAPAN INTERNATIONAL<br>COOPERATION AGENCY |          |
|  |       | As Shown                                  |          |

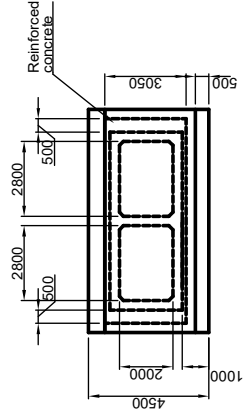
# Cross Drainage Work No.3 (CDW-03)



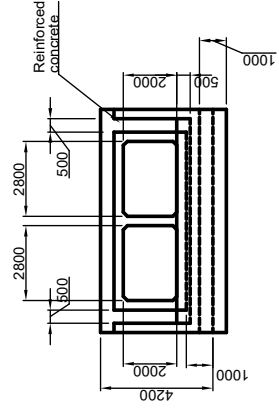
**Drainage Cuvert**  
S=1:200



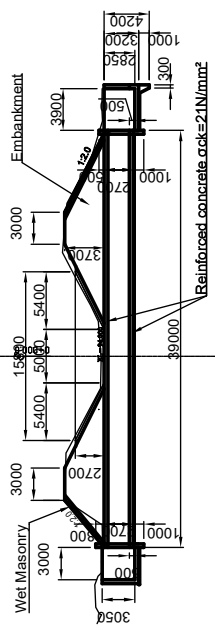
**Inlet**  
S=1:200



**Outlet**  
S=1:200

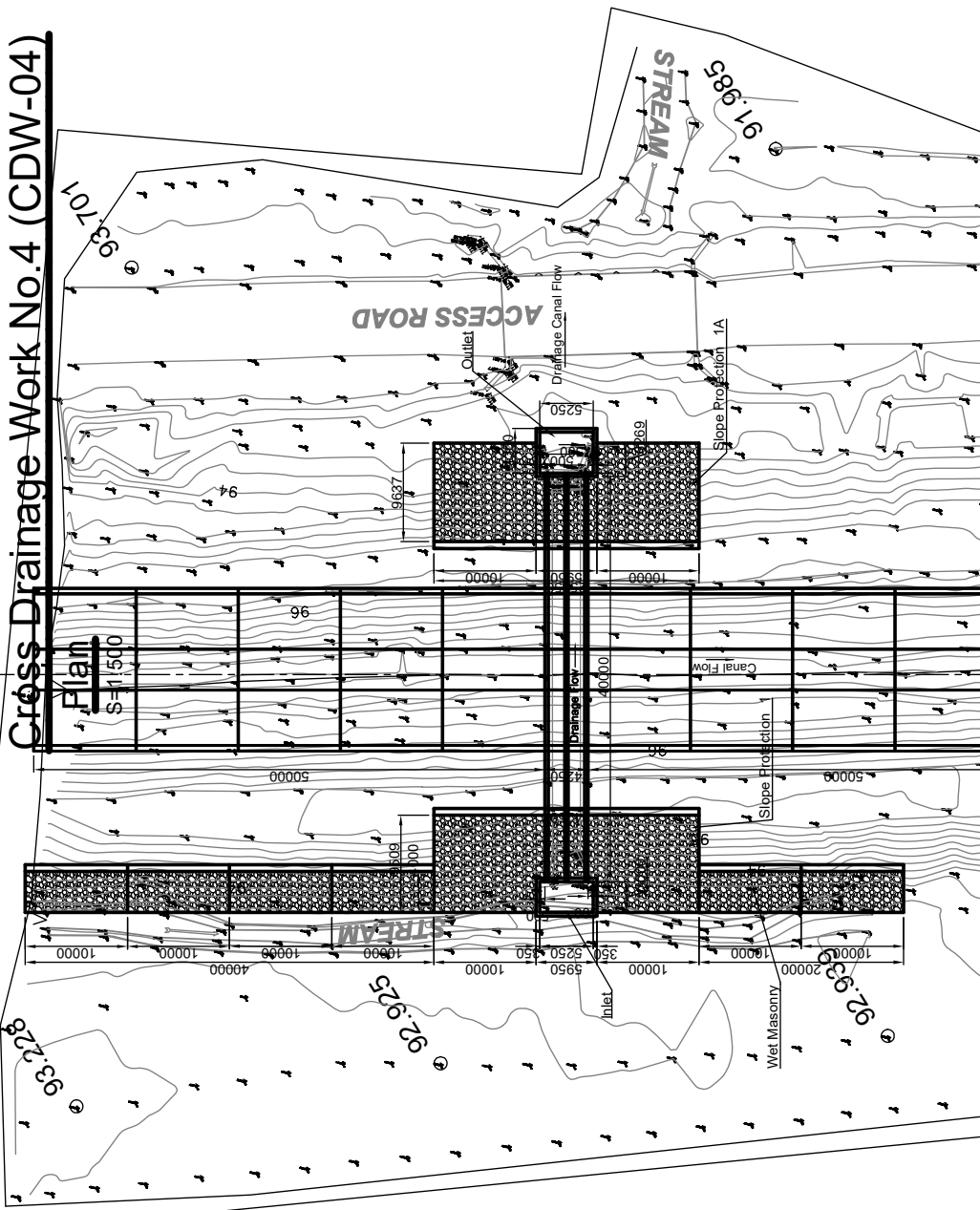


**Profile**  
S=1:500

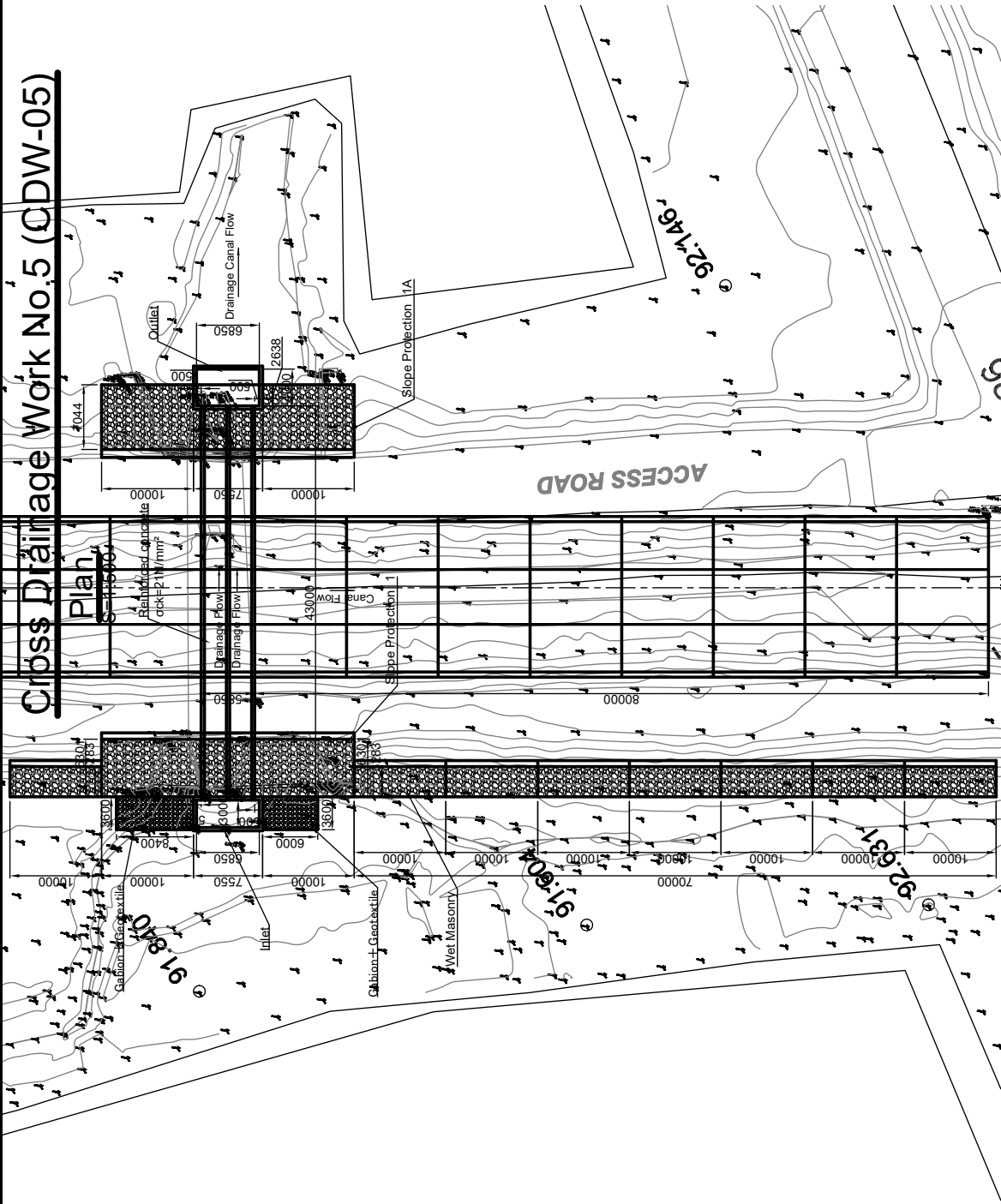


|  |   |  |                   |                            |                                |
|--|---|--|-------------------|----------------------------|--------------------------------|
| PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM<br>IN EASTERN TERAI AREA IN NEPAL<br><br>MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION,<br>DEPARTMENT OF WATER RESOURCES AND IRRIGATION | DWG. TITLE<br>Cross Drainage Work No.3 (CDW-03)<br>Plan, Profile, Section |  | DATE<br>As Shown  | DESIGNED BY<br>APPROVED BY | DWG NO.<br>CDW-3<br>SERIAL NO. |
|  | JAPAN INTERNATIONAL<br>COOPERATION AGENCY                                 |  | SCALE<br>As Shown | APPROVED BY                | SERIAL NO.                     |

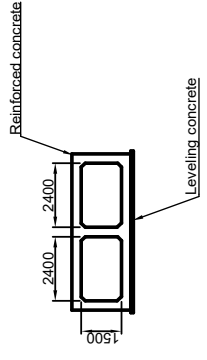
# Cross Drainage Work No.4 (CDW-04)



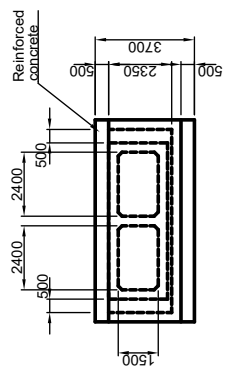
# Cross Drainage Work No.5 (CDW-05)



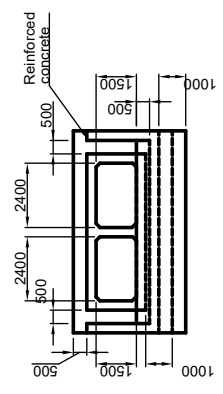
**Drainage Cuvert**  
S=1:200



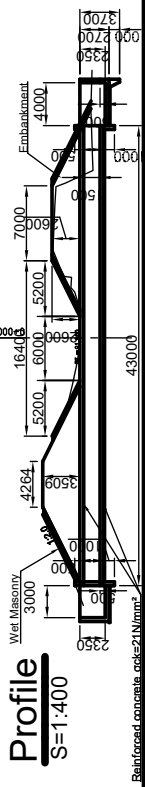
**Inlet**  
S=1:200



**Outlet**  
S=1:200

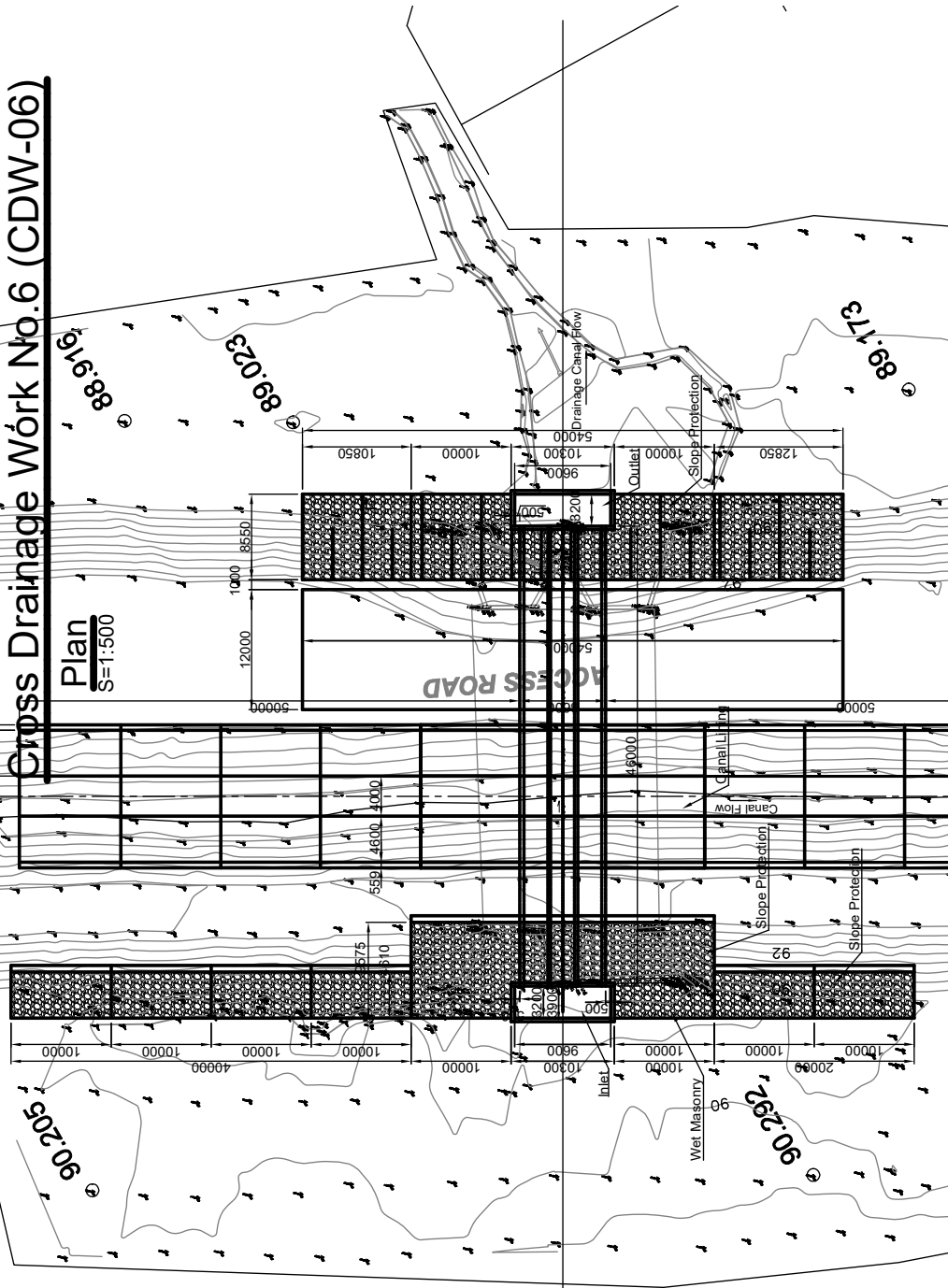


**Profile**  
S=1:400

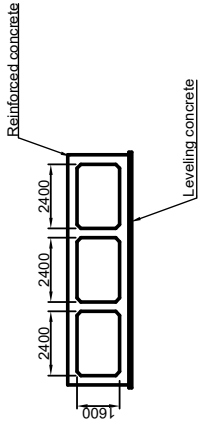


|  |                 |   |                |
|--|-----------------|---|----------------|
| <p>PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM<br/>IN EASTERN TERAI AREA IN NEPAL</p> |                 | <p>DWG. TITLE</p>   |                |
| <p>MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION,<br/>DEPARTMENT OF WATER RESOURCES AND IRRIGATION</p>           |                 | <p>Cross Drainage Work No.5 (CDW-05)<br/>Plan, Profile, Section</p> |                |
| <p>DESIGNED BY</p>   | <p>DATE</p>     | <p>APPROVED BY</p>  | <p>DWG NO.</p> |
| <p>SCALE</p>   | <p>As Shown</p> | <p>SERIAL NO.</p>   | <p>CDW-5</p>   |

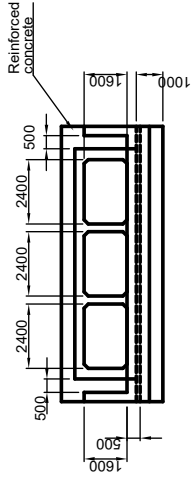
# Cross Drainage Work No.6 (CDW-06)



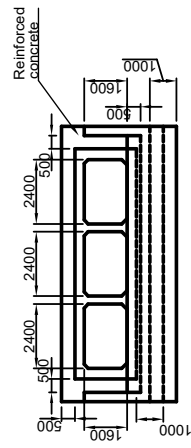
**Drainage Cuvart**  
S=1:200



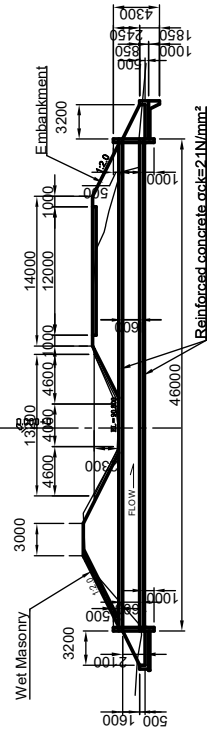
**Inlet**  
S=1:200



**Outlet**  
S=1:200



**Profile**  
S=1:500



DWG. TITLE

Cross Drainage Work No.6 (CDW-06)  
Plan, Profile, Section

DATE

DESIGNED BY

DWG NO.

JAPAN INTERNATIONAL  
COOPERATION AGENCY

PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM  
IN EASTERN TERAI AREA IN NEPAL

MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION,  
DEPARTMENT OF WATER RESOURCES AND IRRIGATION

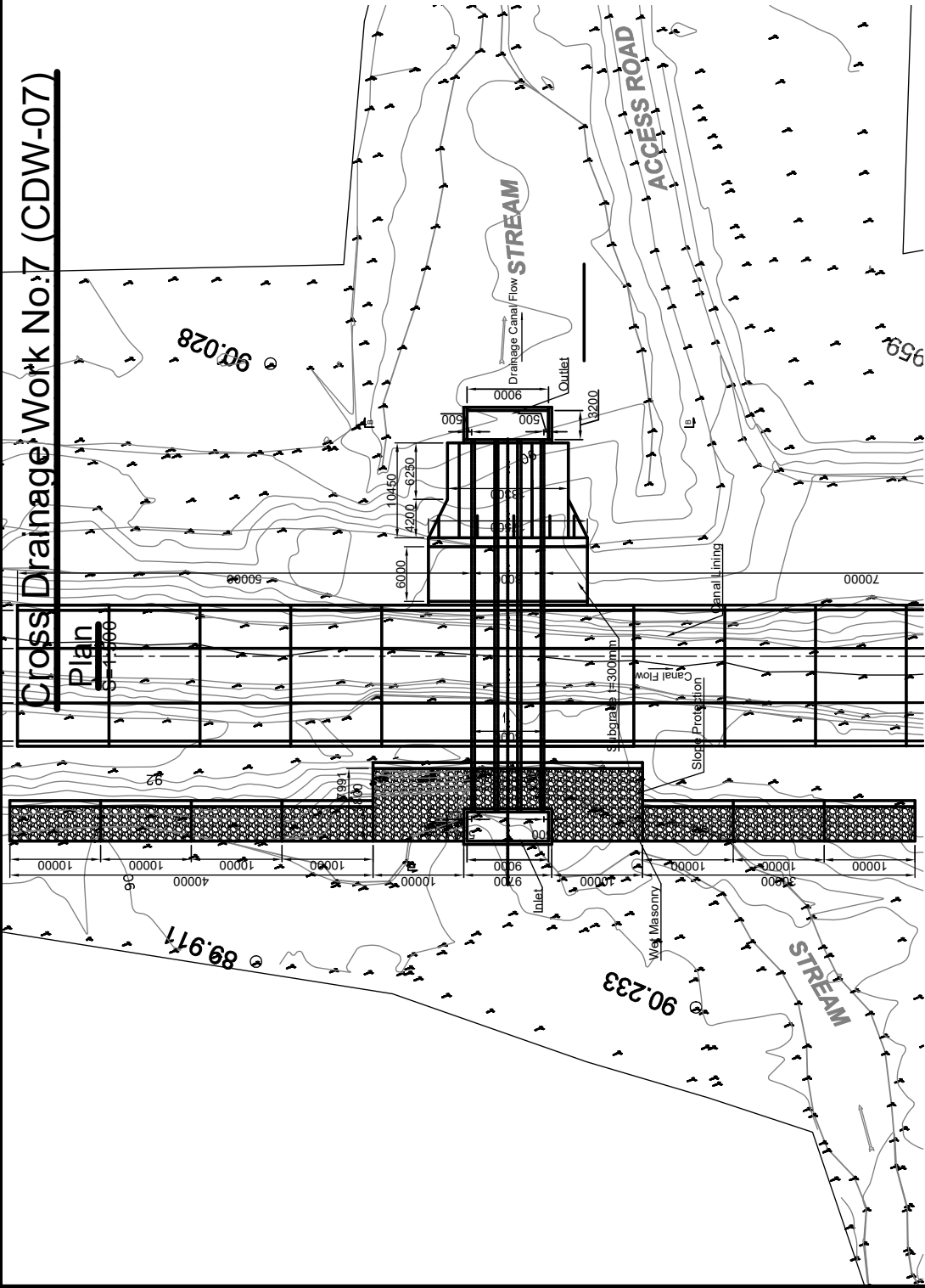
SCALE

APPROVED BY

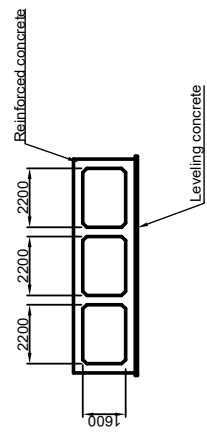
SERIAL NO.

As Shown

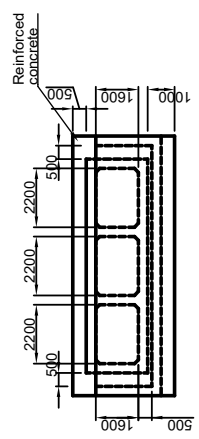
# Cross Drainage Work No.7 (CDW-07)



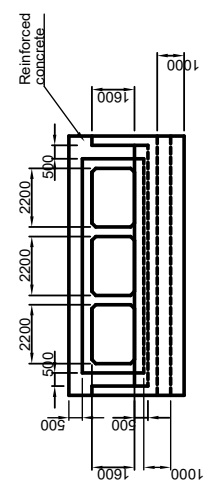
**Drainage Cuvert**  
S=1:200



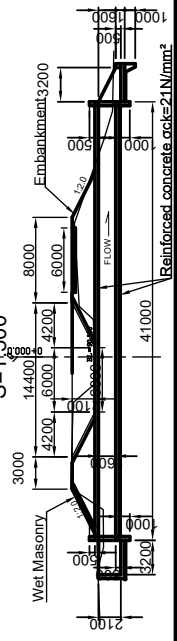
**Inlet**  
S=1:200



**Outlet**  
S=1:200

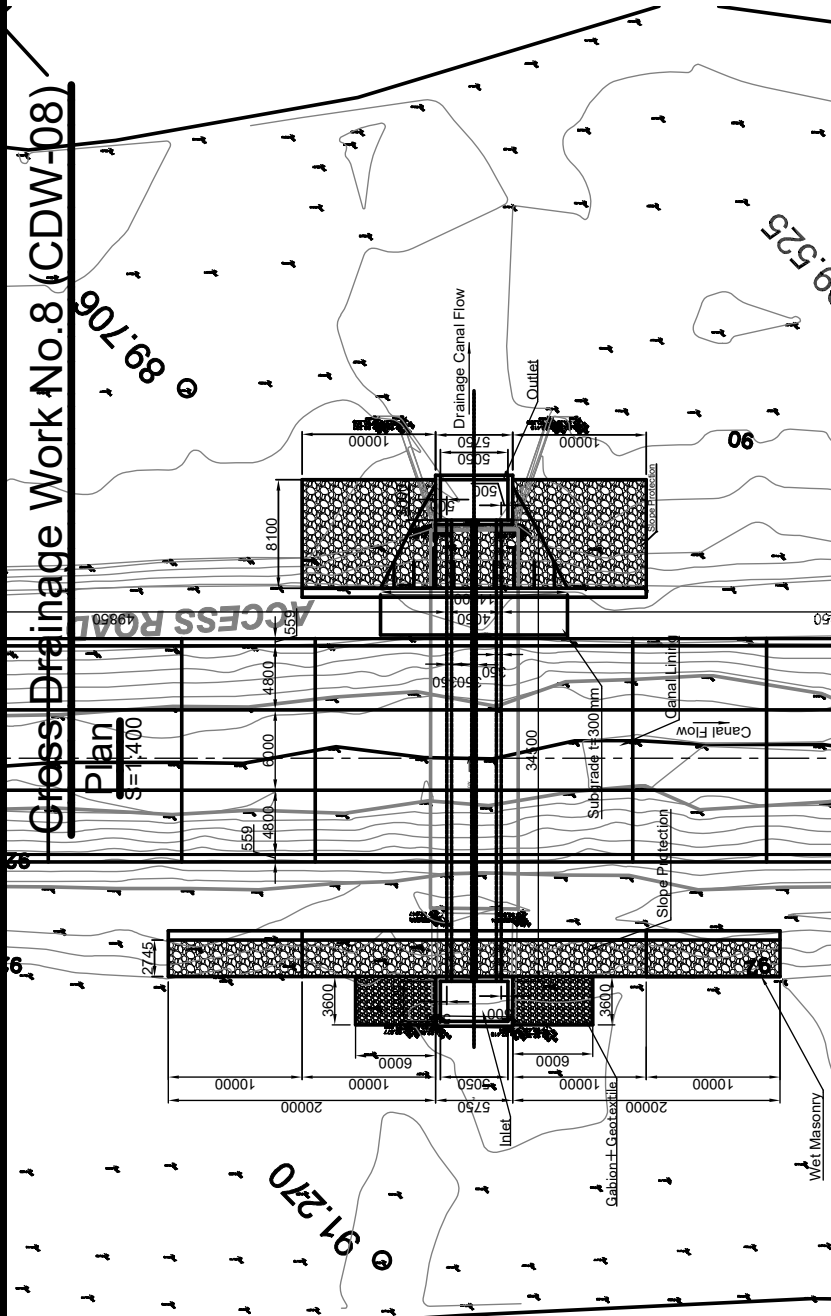


**Profile**  
S=1:500

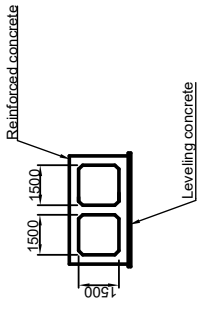


|  |   |  |                   |                            |                  |
|--|---|--|-------------------|----------------------------|------------------|
| PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM<br>IN EASTERN TERAI AREA IN NEPAL<br><br>MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION,<br>DEPARTMENT OF WATER RESOURCES AND IRRIGATION | DWG. TITLE<br>Cross Drainage Work No.7 (CDW-07)<br>Plan, Profile, Section |  | DATE<br>As Shown  | DESIGNED BY<br>APPROVED BY | DWG NO.<br>CDW-7 |
|  | JAPAN INTERNATIONAL<br>COOPERATION AGENCY                                 |  | SCALE<br>As Shown | SERIAL NO.                 | SERIAL NO.       |

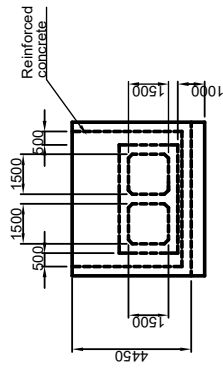
# Gross Drainage Work No.8 (CDW-08)



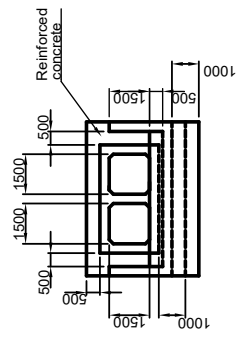
**Drainage Cuvert**  
S=1:200



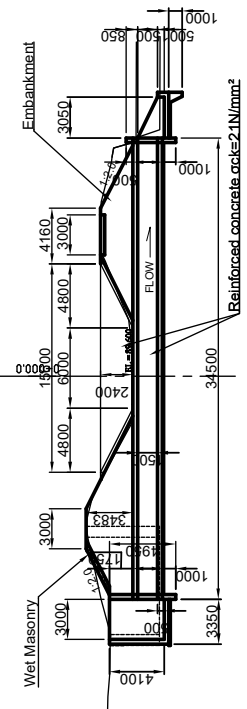
**Inlet**  
S=1:200



**Outlet**  
S=1:200



**Profile**  
S=1:400



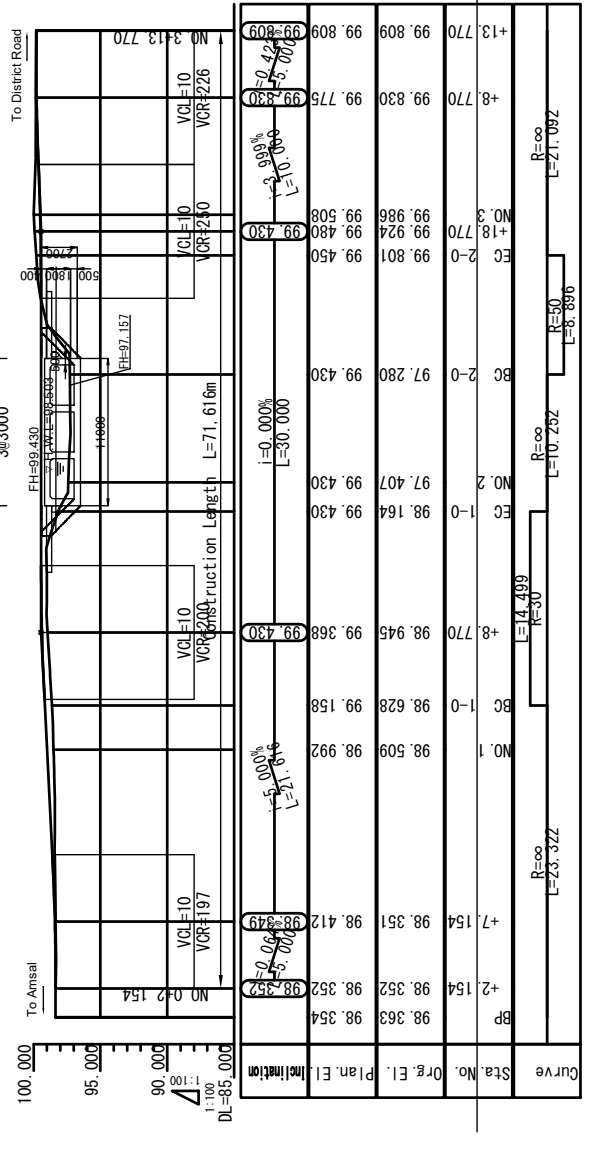
|  |   |  |                  |                      |                           |
|--|---|--|------------------|----------------------|---------------------------|
| PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM<br>IN EASTERN TERAI AREA IN NEPAL<br><br>MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION,<br>DEPARTMENT OF WATER RESOURCES AND IRRIGATION | DWG. TITLE<br>Cross Drainage Work No.8 (CDW-08)<br>Plan, Profile, Section |  | DATE<br>As Shown | DESIGNED BY<br>CDW-8 | APPROVED BY<br>SERIAL NO. |
|  | DWG. NO.  |  | SCALE            | APPROVED BY          | SERIAL NO.                |



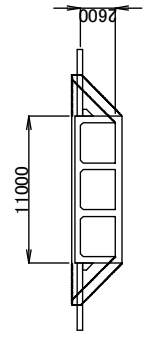
# Canal Crossing Bridge No.2 (CCB-02)

【Design Condition of Road】

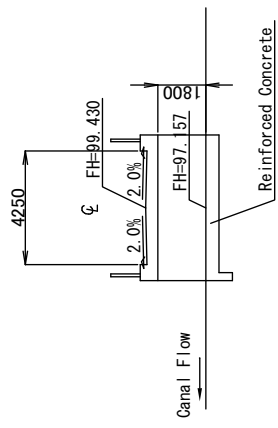
|                     |              |
|---------------------|--------------|
| Road Category       | Village Road |
| Design Speed        | V=30km/h     |
| Min. Curve Radius   | R=30m        |
| Max Inclination     | i=7.0%       |
| Min. Vertical Curve | VCL=10m      |



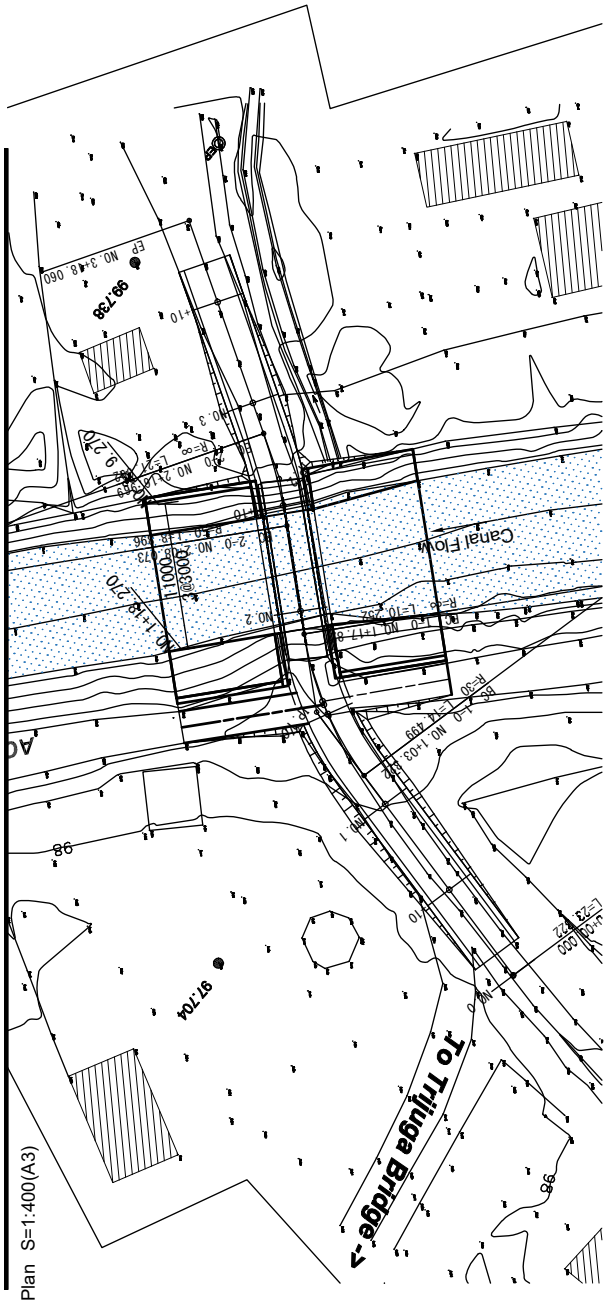
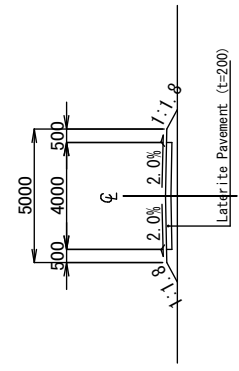
Box Culvert Section  
S=1:400(A3)



Box Culvert Profile  
S=1:200(A3)



Road Section [Village Road]  
S=1:200(A3)



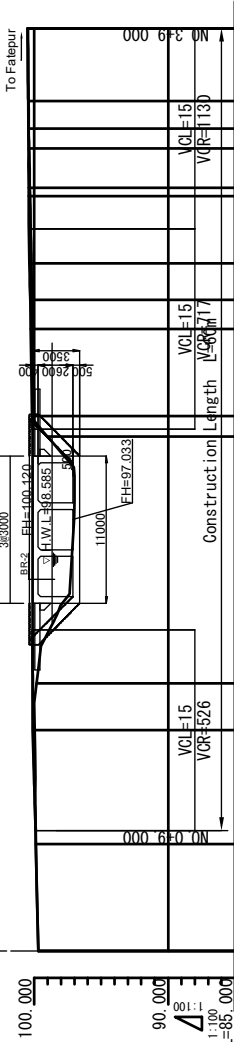
Plan S=1:400(A3)

|   |             |          |  |
|---|-------------|----------|--|
| DATE  | DESIGNED BY | DWG. NO. | CCB-1                                  |
|   |             |          | SERIAL NO.                             |
| SCALE   | APPROVED BY | As Shown |  |
| DWG. TITLE  |             |          | Canal Crossing Bridge No.2 (CCB-02)    |
|   |             |          | Plan, Profile, Section                 |
| PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM IN EASTERN TERAI AREA IN NEPAL |             |          | JAPAN INTERNATIONAL COOPERATION AGENCY |
| MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION, DEPARTMENT OF WATER RESOURCES AND IRRIGATION           |             |          |  |

# Canal Crossing Bridge No.3 (CCB-03)

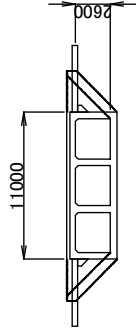
**【Design Condition of Road】**

|                     |               |
|---------------------|---------------|
| Road Category       | District Road |
| Design Speed        | V=40km/h      |
| Min. Curve Radius   | R=30m         |
| Max Inclination     | i=7.0%        |
| Min. Vertical Curve | VCL=15m       |

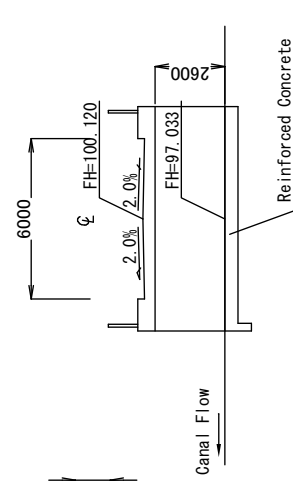


| Curve  | Sta. No. | Org. El. | Plan. El. | Int. Inclination | Construction Length | Int. Inclination |
|--------|----------|----------|-----------|------------------|---------------------|------------------|
| BP     | 99.691   | 99.691   | 99.691    | 99.878           | 100.000             | 99.878           |
|        | +8.000   | 99.878   | 99.878    | 99.878           | 100.000             | 99.878           |
|        | +16.500  | 99.971   | 100.067   | 100.067          | 100.000             | 100.067          |
| NO.1   | 99.824   | 100.105  | 100.105   | 100.105          | 100.000             | 100.105          |
| BC 1-0 | 99.029   | 100.120  | 100.120   | 100.120          | 100.000             | 100.120          |
| EC 1-0 | 100.311  | 100.185  | 100.185   | 100.185          | 100.000             | 100.185          |
| BC 2-0 | 100.364  | 100.228  | 100.228   | 100.228          | 100.000             | 100.228          |
| EC 2-0 | 100.415  | 100.325  | 100.325   | 100.325          | 100.000             | 100.325          |
| BC 3-0 | 100.420  | 100.337  | 100.337   | 100.337          | 100.000             | 100.337          |
| EC 3-0 | 100.424  | 100.387  | 100.387   | 100.387          | 100.000             | 100.387          |
| NO.3   | 100.424  | 100.387  | 100.387   | 100.387          | 100.000             | 100.387          |
| EC 3-0 | 100.448  | 100.436  | 100.436   | 100.436          | 100.000             | 100.436          |
| NO.3   | 100.448  | 100.436  | 100.436   | 100.436          | 100.000             | 100.436          |
| EC 3-0 | 100.491  | 100.491  | 100.491   | 100.491          | 100.000             | 100.491          |

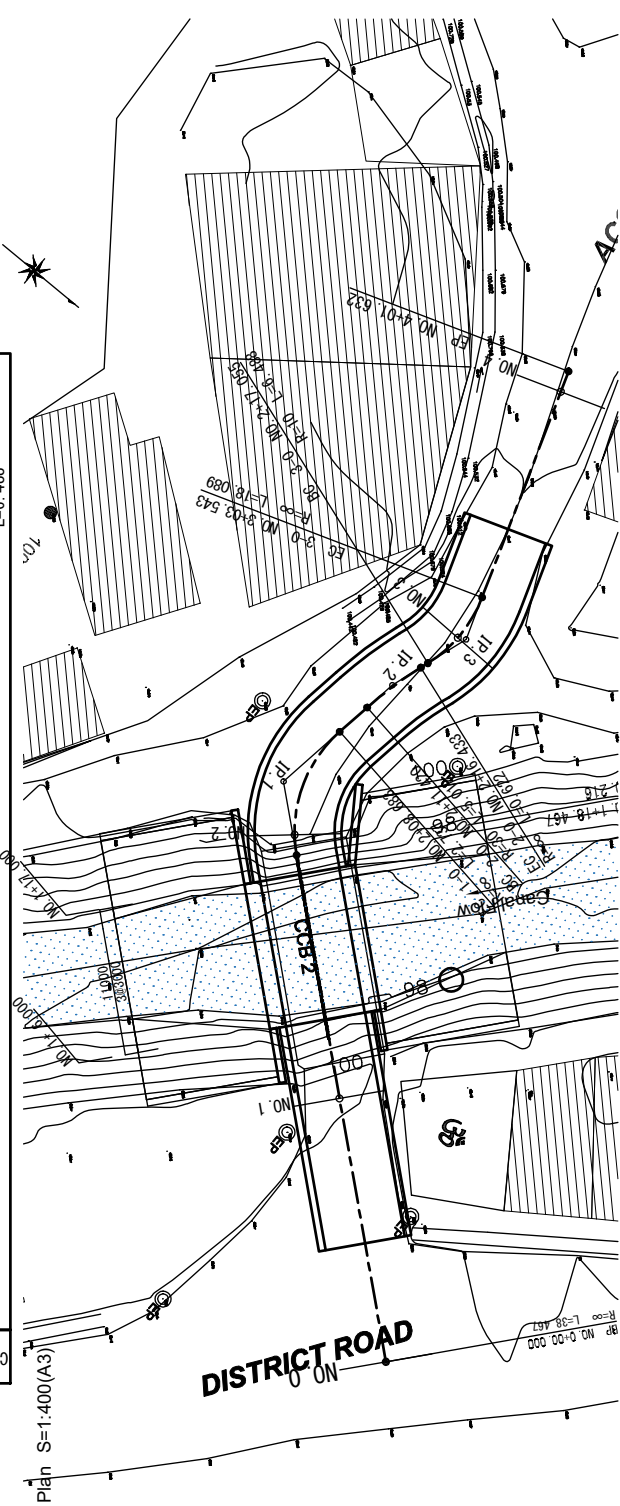
Box Culvert Section S=1:400(A3)



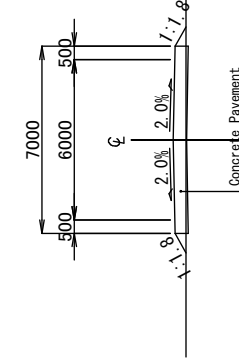
Box Culvert Profile S=1:200(A3)



DISTRICT ROAD



Road Section [District Road] S=1:200(A3)



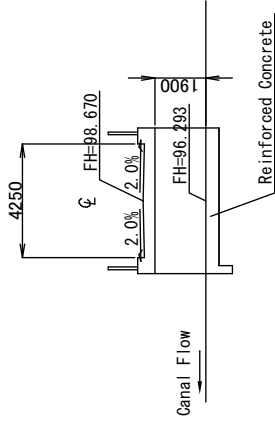
|  |   |  |                   |                            |                     |
|--|---|--|-------------------|----------------------------|---------------------|
| PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM<br>IN EASTERN TERAI AREA IN NEPAL<br>MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION,<br>DEPARTMENT OF WATER RESOURCES AND IRRIGATION | DWG. TITLE<br>Canal Crossing Bridge No.3 (CCB-03)<br>Plan, Profile, Section |  | DATE<br>As Shown  | DESIGNED BY<br>APPROVED BY | DWG NO.<br>CCB-2    |
|  | SERIAL NO.<br>As Shown  |  | SCALE<br>As Shown | APPROVED BY<br>As Shown    | SERIAL NO.<br>CCB-2 |

# Canal Crossing Bridge No.4 (CCB-04)

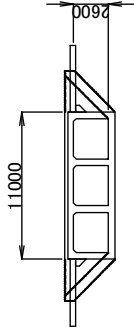
**【Design Condition of Road】**

|                     |              |
|---------------------|--------------|
| Road Category       | Village Road |
| Design Speed        | V=30km/h     |
| Min. Curve Radius   | R=30m        |
| Max. Inclination    | i=7.0%       |
| Min. Vertical Curve | VC L=10m     |

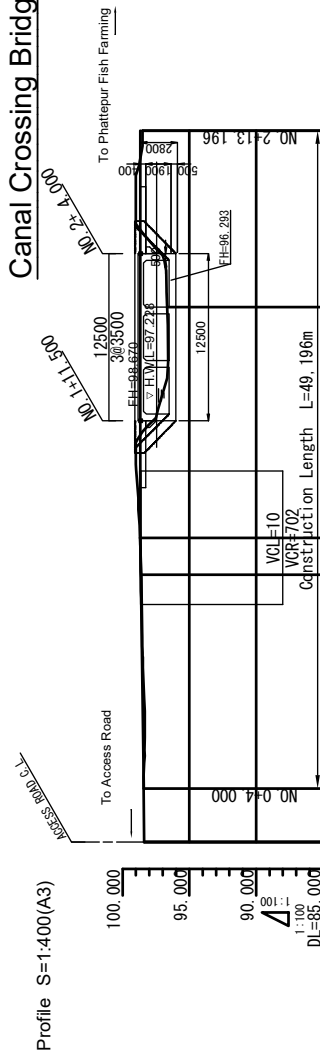
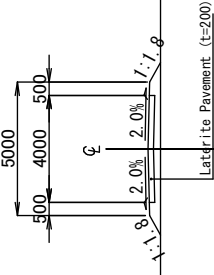
Box Culvert Profile  
S=1:200(A3) Upstream



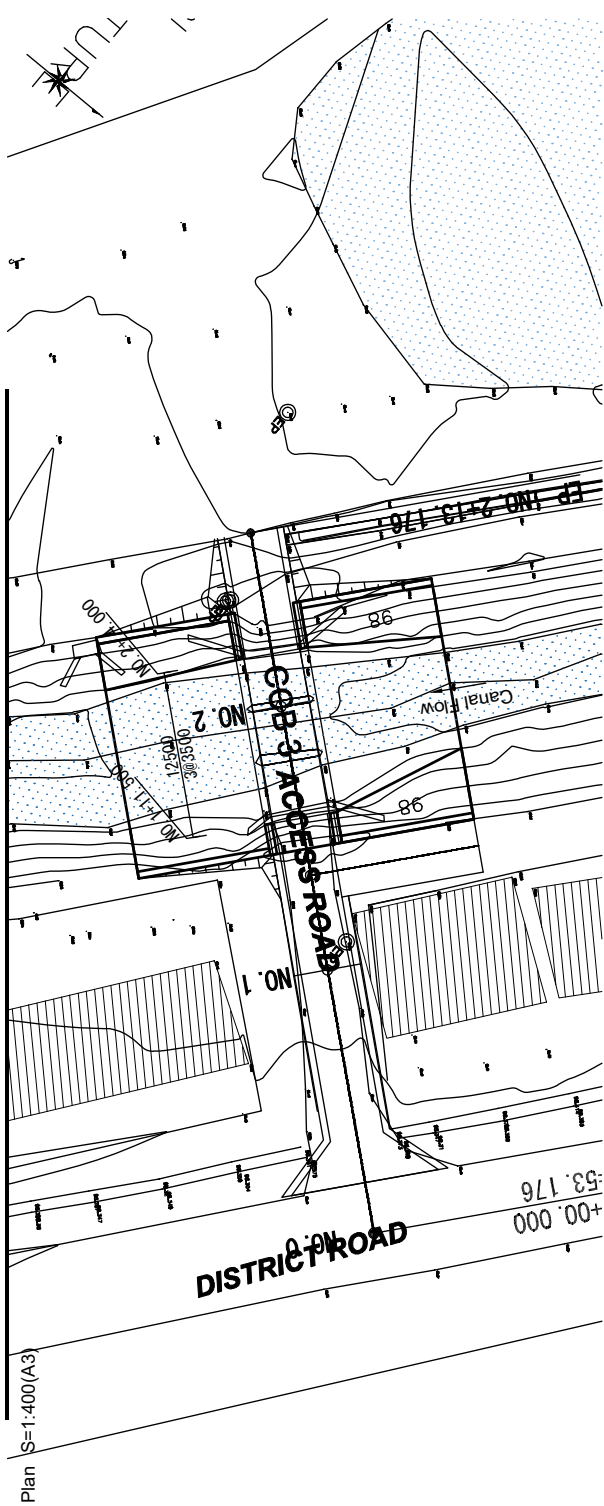
Box Culvert Section  
S=1:400(A3)



Road Section [Village Road]  
S=1:200(A3)



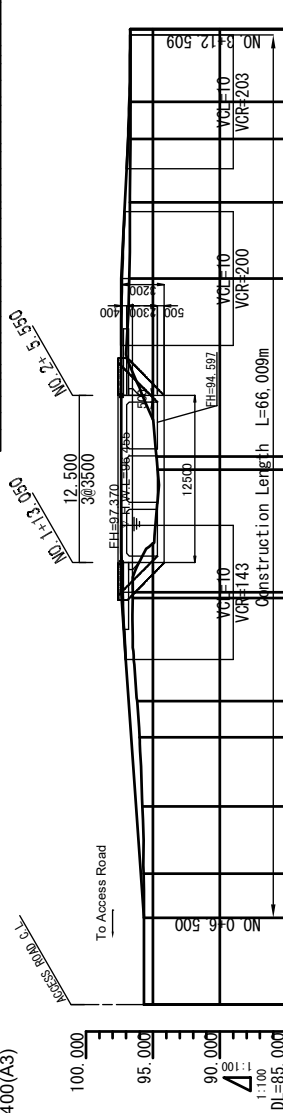
| Curve | Sta. No. | Org. El. | Plan. El. | Inclination         |
|-------|----------|----------|-----------|---------------------|
|       | BP       | 98.366   | 98.403    |                     |
|       | NO. 1    | 98.584   | 98.627    | -1.425%<br>L=10.196 |
|       |          | 98.683   | 98.652    |                     |
|       | NO. 2    | 96.659   | 98.670    | -0.000%<br>L=30.446 |
|       |          | 98.500   | 98.670    |                     |
|       | EP       | +13.196  | 98.670    |                     |



|  |   |       |             |                   |
|--|---|-------|-------------|-------------------|
| PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM<br>IN EASTERN TERAI AREA IN NEPAL | DWG. TITLE<br>Canal Crossing Bridge No.4 (CCB-04)<br>Plan, Profile, Section | DATE  | DESIGNED BY | DWG. NO.<br>CCB-3 |
| MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION,<br>DEPARTMENT OF WATER RESOURCES AND IRRIGATION           | JAPAN INTERNATIONAL<br>COOPERATION AGENCY                                   | SCALE | APPROVED BY | SERIAL NO.        |
|  |   |       |             | As Shown          |

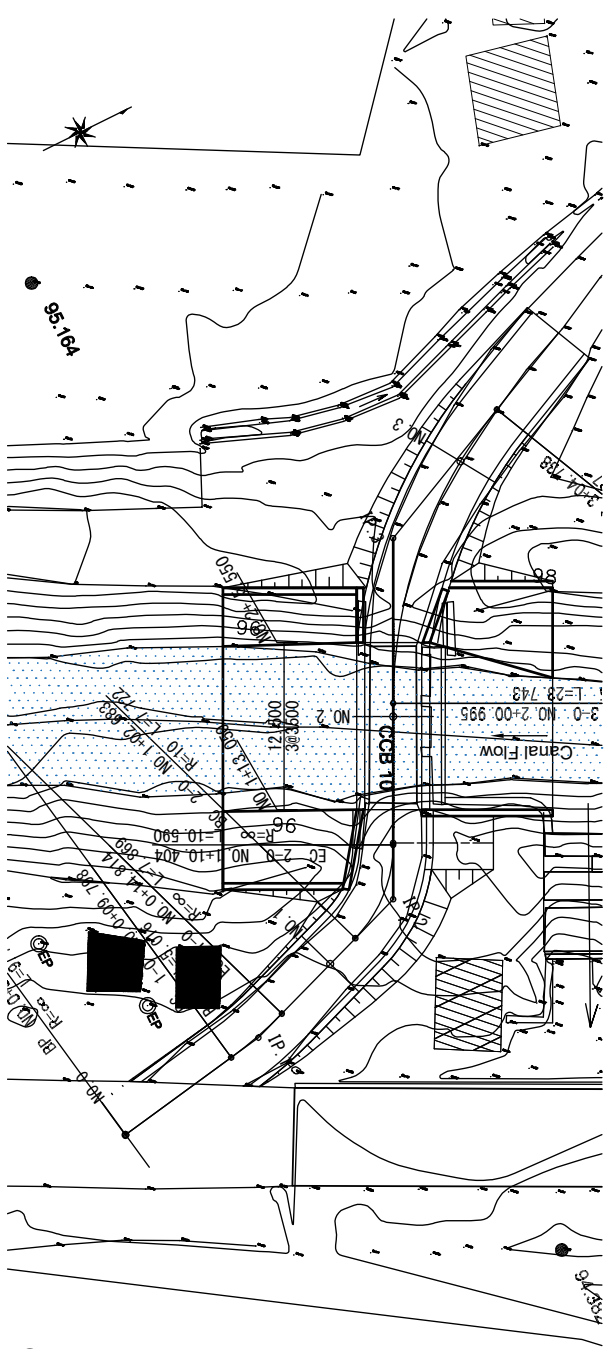
# Canal Crossing Bridge No. 11 (CCB-11)

Profile S=1:400(A3)



| Station | Org. El. | Plan. El. | Inclination |
|---------|----------|-----------|-------------|
| 95.672  | 95.672   | 95.667    | $i=0.000\%$ |
| 95.785  | 95.785   | 95.783    | $i=0.000\%$ |
| 96.009  | 96.009   | 96.283    | $i=0.000\%$ |
| 96.186  | 96.186   | 97.283    | $i=0.000\%$ |
| 96.829  | 96.829   | 97.283    | $i=0.000\%$ |
| 94.653  | 97.370   | 97.370    | $i=0.000\%$ |
| 94.742  | 97.370   | 97.370    | $i=0.000\%$ |
| 96.688  | 96.688   | 97.370    | $i=5.000\%$ |
| 96.718  | 96.718   | 97.370    | $i=5.000\%$ |
| 96.684  | 96.684   | 96.771    | $i=0.062\%$ |
| 96.509  | 96.509   | 96.771    | $i=0.062\%$ |
| 96.706  | 96.706   | 96.771    | $i=0.062\%$ |

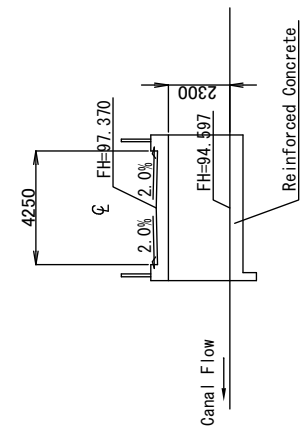
Plan S=1:400(A3)



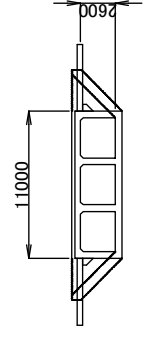
**【Design Condition of Road】**

|                     |              |
|---------------------|--------------|
| Road Category       | Village Road |
| Design Speed        | V=30km/h     |
| Min. Curve Radius   | R=30m        |
| Max Inclination     | i=7.0%       |
| Min. Vertical Curve | VC=L=10m     |

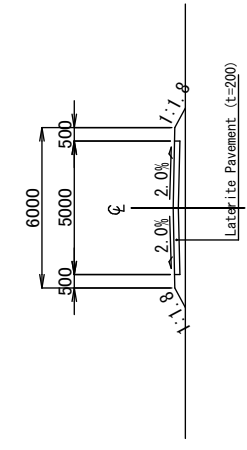
Box Culvert Profile  
S=1:200(A3)



Box Culvert Section  
S=1:400(A3)



Road Section [Village Road]  
S=1:200(A3)



Note: Check Gate shall be restored at upstream side of Culvert.

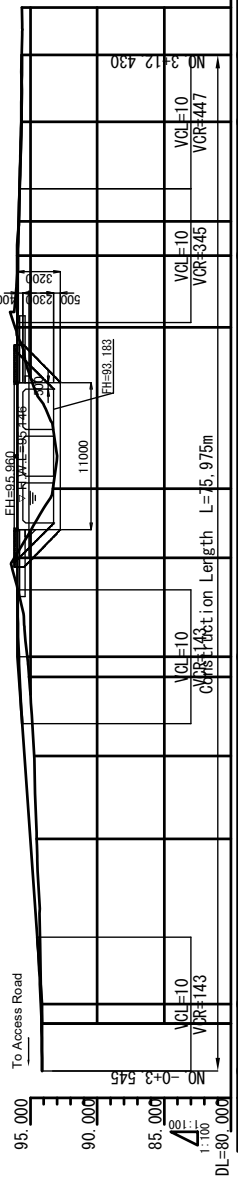
|  |  |       |            |
|--|--|-------|------------|
| PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM<br>IN EASTERN TERAI AREA IN NEPAL | DESIGNED BY  | DATE  | DWG. NO.   |
|  | APPROVED BY  | SCALE | CCB-4      |
| MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION,<br>DEPARTMENT OF WATER RESOURCES AND IRRIGATION           | Canal Crossing Bridge No.11 (CCB-11)<br>Plan, Profile, Section |       | SERIAL NO. |
|  | JAPAN INTERNATIONAL<br>COOPERATION AGENCY                      |       | As Shown   |

# Canal Crossing Bridge No.13(CCB-13)

## 【Design Condition of Road】

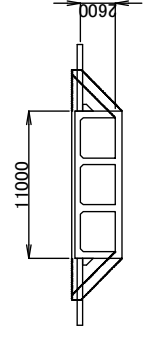
|                     |              |
|---------------------|--------------|
| Road Category       | Village Road |
| Design Speed        | V=30km/h     |
| Min. Curve Radius   | R=30m        |
| Max Inclination     | i=7.0%       |
| Min. Vertical Curve | VC=L=10m     |

Profile S=1:400(A3)

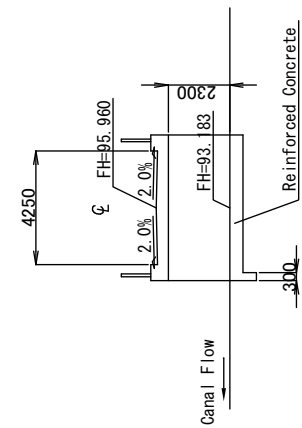


| Curve   | Sta.    | Org. El. | Plan. El. | Inclination | Length | Grade  |
|---------|---------|----------|-----------|-------------|--------|--------|
| BP      | +1.455  | 94.181   | 94.181    | 94.142      | 94.142 | 94.142 |
| EC -2-0 | +7.430  | 95.106   | 95.242    | 95.873      | 95.960 | 95.960 |
| NO. 1   | 94.710  | 94.440   | 94.440    | 94.142      | 94.523 | 95.006 |
| EC -3-0 | 96.214  | 95.960   | 96.214    | 95.873      | 95.960 | 95.960 |
| NO. 2   | 93.322  | 95.960   | 93.322    | 95.960      | 95.960 | 95.960 |
| EC -4-0 | 96.143  | 95.960   | 96.143    | 95.960      | 95.960 | 95.960 |
| NO. 3   | 95.859  | 95.877   | 95.877    | 95.960      | 95.960 | 95.960 |
| EC -7-0 | +7.430  | 95.670   | 95.698    | 95.960      | 95.960 | 95.960 |
| NO. 4   | 95.643  | 95.637   | 95.637    | 95.637      | 95.637 | 95.637 |
| EP      | +12.430 | 95.613   | 95.613    | 95.613      | 95.613 | 95.613 |

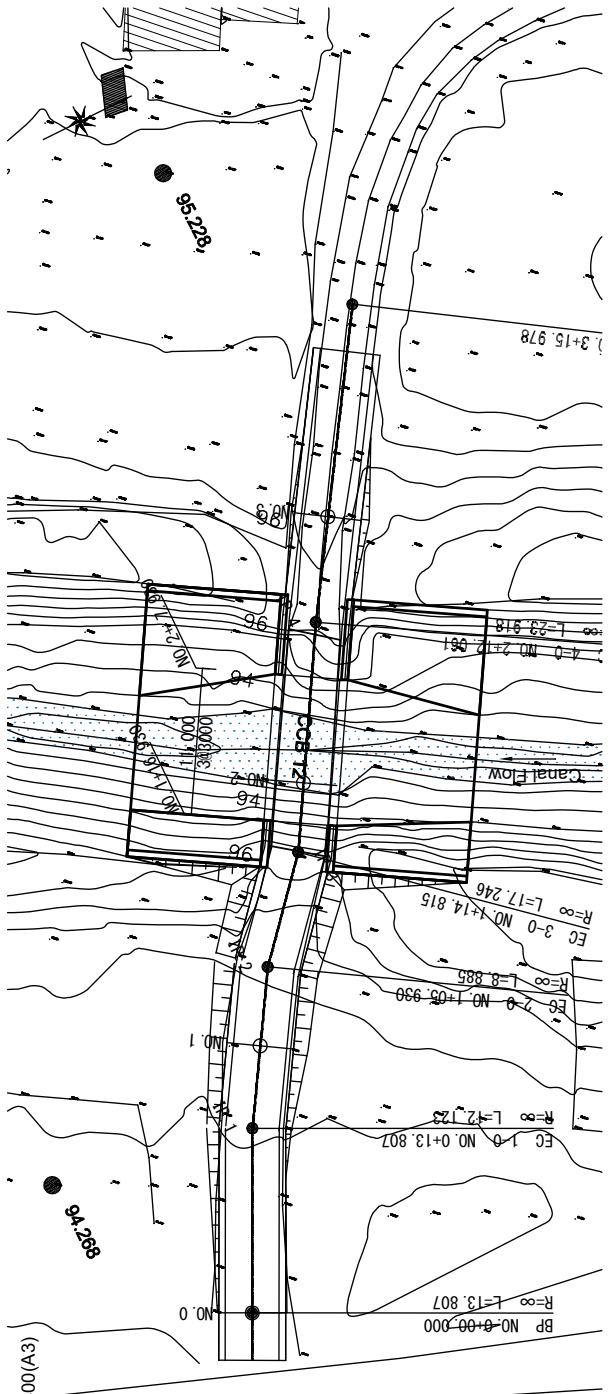
Box Culvert Section S=1:400(A3)



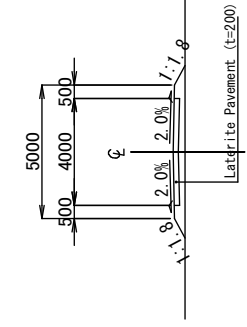
Box Culvert Profile S=1:200(A3)



Plan S=1:400(A3)



Road Section [Village Road] S=1:200(A3)



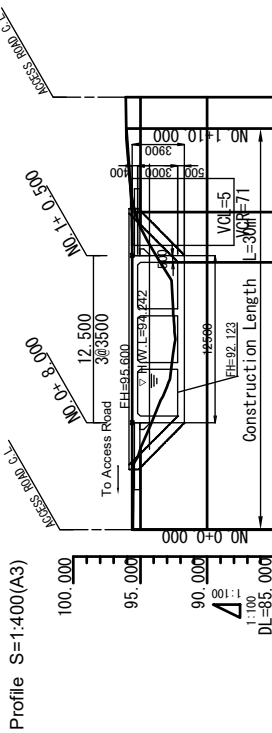
PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM  
IN EASTERN TERAI AREA IN NEPAL

MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION,  
DEPARTMENT OF WATER RESOURCES AND IRRIGATION

Canal Crossing Bridge No.13 (CCB-13)  
Plan, Profile, Section

|          |             |            |
|----------|-------------|------------|
| DATE     | DESIGNED BY | DWG NO.    |
| SCALE    | APPROVED BY | CCB-5      |
| As Shown |             | SERIAL NO. |

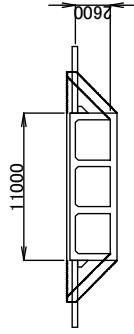
# Canal Crossing Bridge No. 15 (CCB-15)



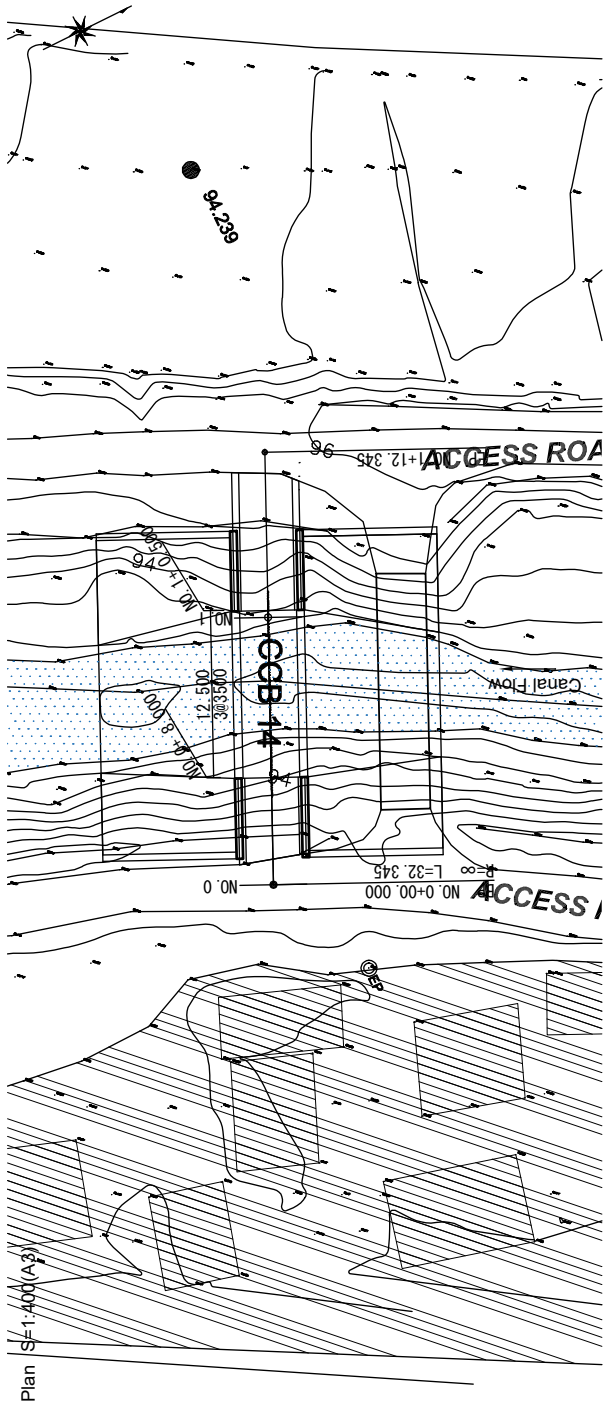
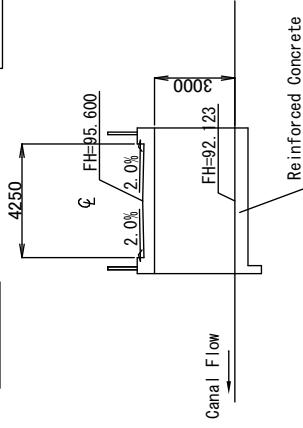
| Sta. No. | Org. El. | Plan. El. | Inclination |
|----------|----------|-----------|-------------|
| BP       | 95.556   | 95.600    | 95.600      |
|          |          |           | 95.644      |
|          |          |           | 95.644      |
|          |          |           | 96.037      |
|          |          |           | 96.037      |
| EP       | 96.086   | 96.000    | 96.000      |

| 【Design Condition of Road】 |              |
|----------------------------|--------------|
| Road Category              | Village Road |
| Design Speed               | V=30km/h     |
| Min. Curve Radius          | R=30m        |
| Max Inclination            | i=7.0%       |
| Min. Vertical Curve        | VCL=10m      |

Box Culvert Section  
S=1:400(A3)

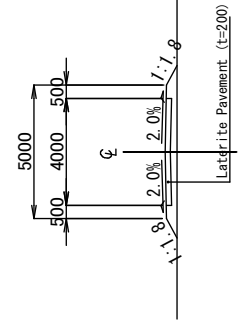


Box Culvert Profile  
S=1:200(A3)



Plan  
S=1:400(A3)

Road Section [Village Road]  
S=1:200(A3)

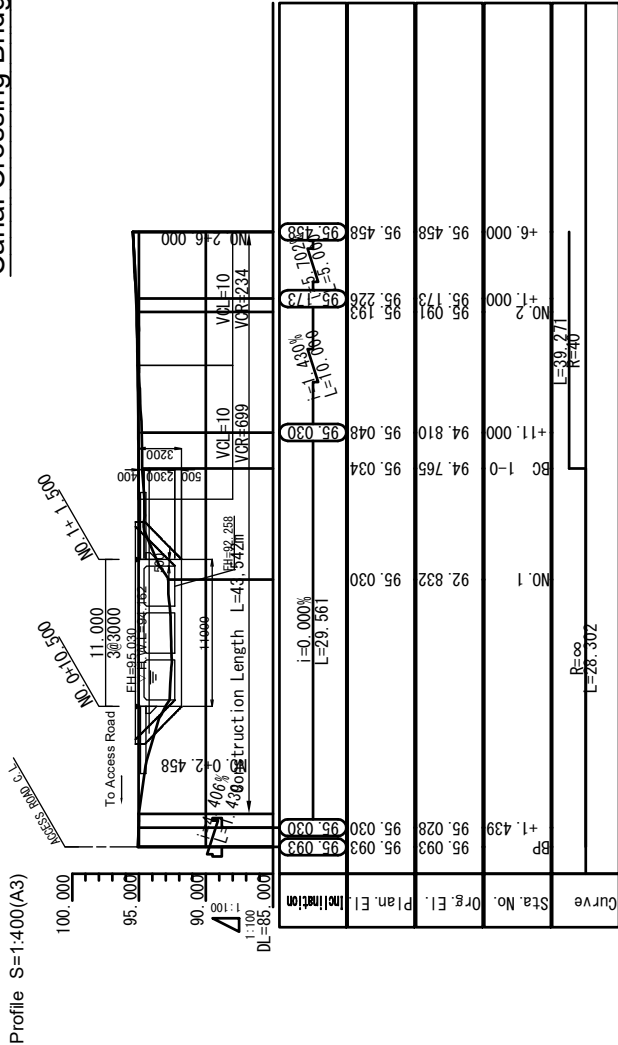


|  |             |            |       |
|--|-------------|------------|-------|
| DATE   | DESIGNED BY | DWG. NO.   | CCB-6 |
| SCALE  | APPROVED BY | SERIAL NO. | CCB-6 |
| As Shown   |             |            |       |
| DWG. TITLE<br>Canal Crossing Bridge No. 15 (CCB-15)<br>Plan, Profile, Section                                |             |            |       |
| PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM<br>IN EASTERN TERAI AREA IN NEPAL |             |            |       |
| JAPAN INTERNATIONAL<br>COOPERATION AGENCY  |             |            |       |
| MINISTRY OF ENERGY, WATER RESOURCES AND IRRIGATION,<br>DEPARTMENT OF WATER RESOURCES AND IRRIGATION          |             |            |       |

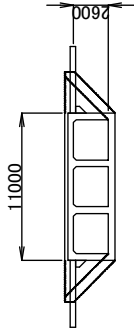
# Canal Crossing Bridge No. 16 (CCB-16)

**【Design Condition of Road】**

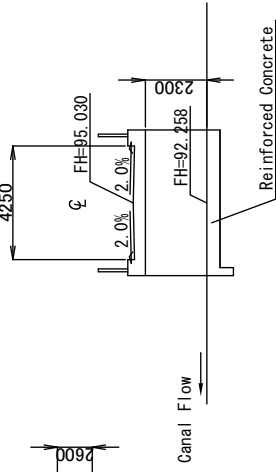
|                     |              |
|---------------------|--------------|
| Road Category       | Village Road |
| Design Speed        | V=30km/h     |
| Min. Curve Radius   | R=30m        |
| Max Inclination     | i=7.0%       |
| Min. Vertical Curve | VC L=10m     |



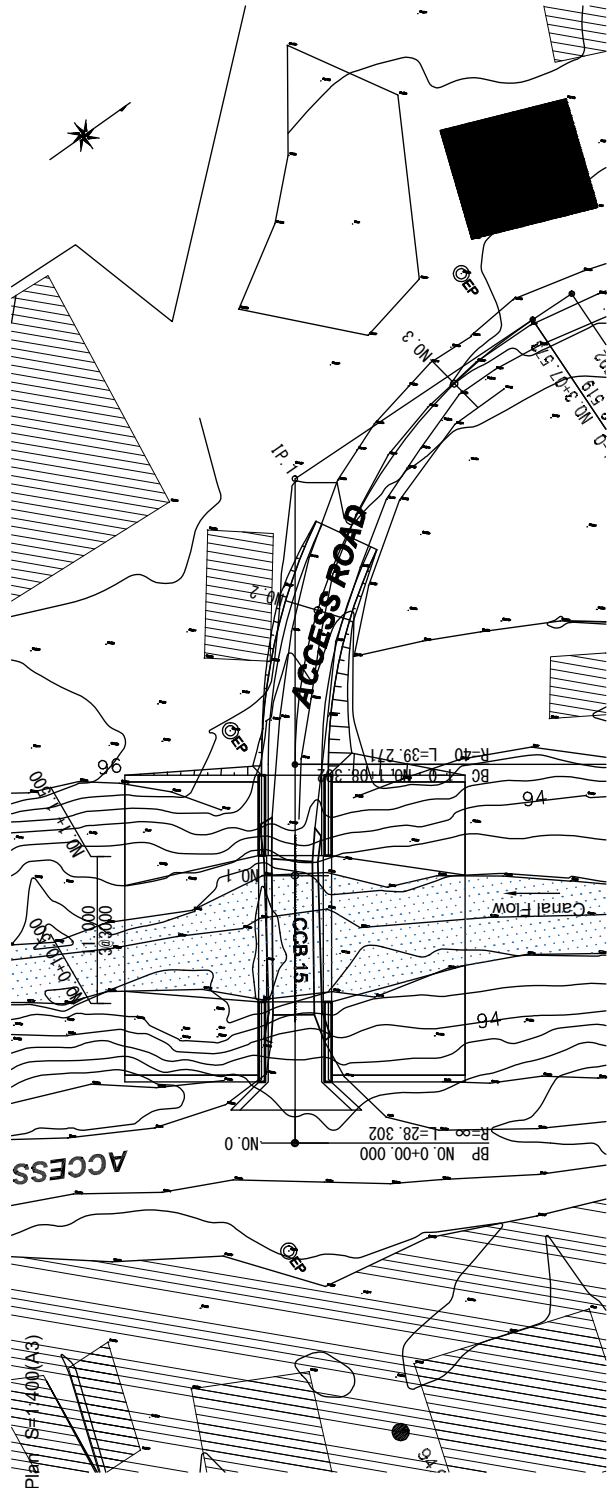
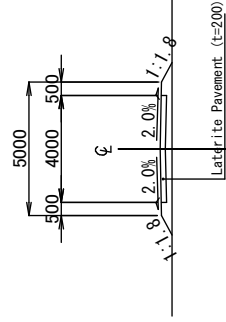
Box Culvert Section  
S=1:400(A3)



Box Culvert Profile  
S=1:200(A3)



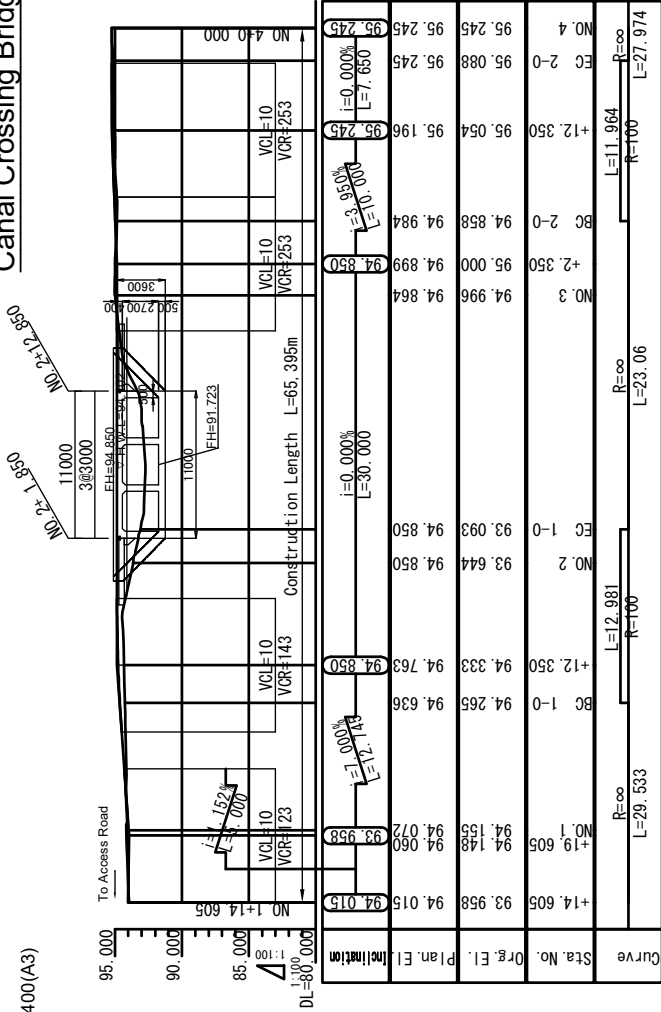
Road Section [Village Road]  
S=1:200(A3)



|  |   |                 |                    |
|--|---|-----------------|--------------------|
| <b>PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM<br/>IN EASTERN TERAI AREA IN NEPAL</b> | <b>DWG. TITLE</b>   | <b>DATE</b>     | <b>DESIGNED BY</b> |
| MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION,<br>DEPARTMENT OF WATER RESOURCES AND IRRIGATION                   | Canal Crossing Bridge No. 16 (CCB-16)<br>Plan, Profile, Section |                 |                    |
| JAPAN INTERNATIONAL<br>COOPERATION AGENCY  |   | <b>SCALE</b>    | <b>APPROVED BY</b> |
|  |   | As Shown        |                    |
|  |   | <b>DWG. NO.</b> | <b>SERIAL NO.</b>  |
|  |   | CCB-7           |                    |

# Canal Crossing Bridge No.17 (CCB-17)

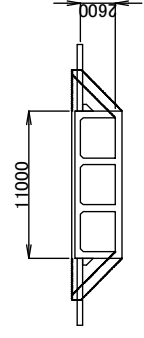
Profile S=1:400(A3)



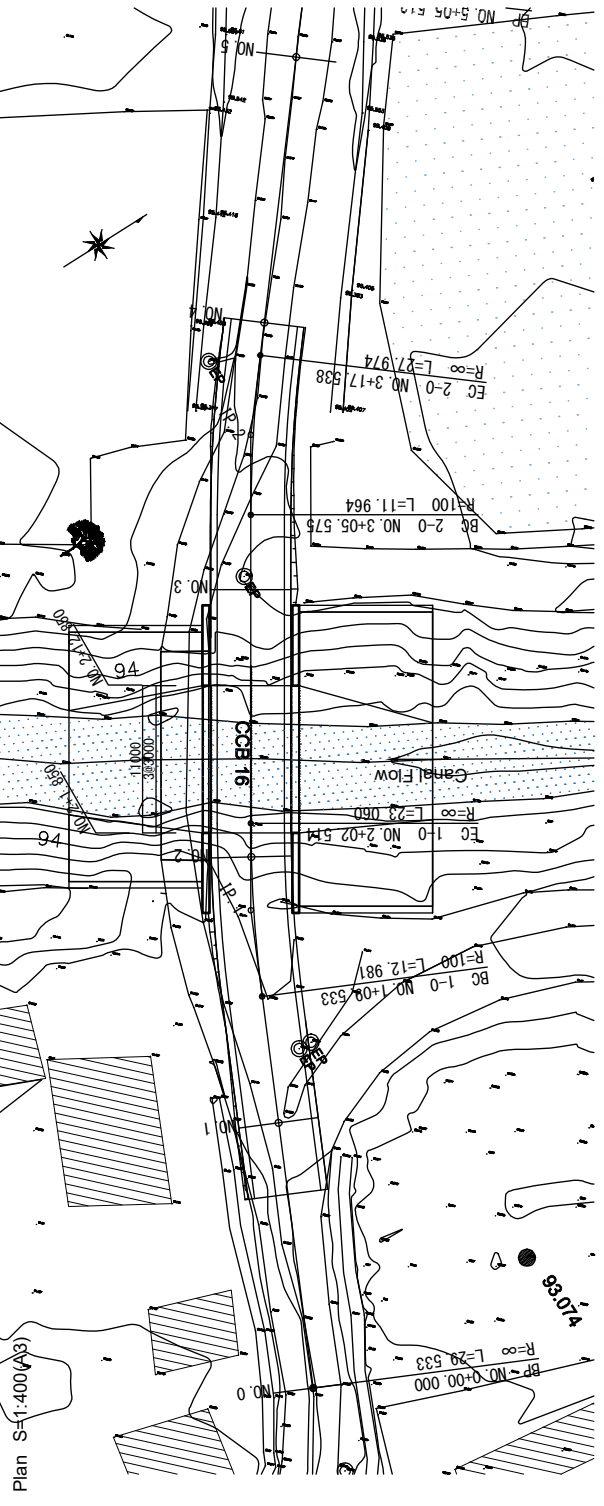
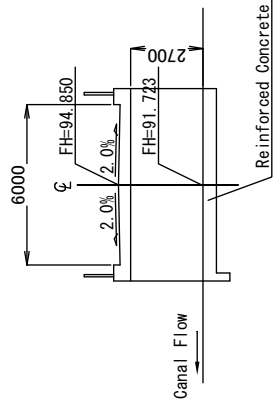
**【Design Condition of Road】**

|                     |              |
|---------------------|--------------|
| Road Category       | Village Road |
| Design Speed        | V=30km/h     |
| Min. Curve Radius   | R=30m        |
| Max. Inclination    | i=7.0%       |
| Min. Vertical Curve | VCL=10m      |

Box Culvert Section S=1:400(A3)

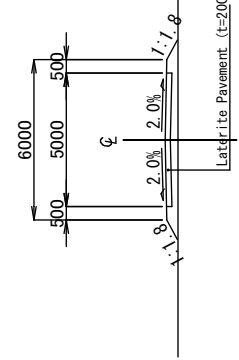


Box Culvert Profile S=1:200(A3)



Plan S=1:400(A3)

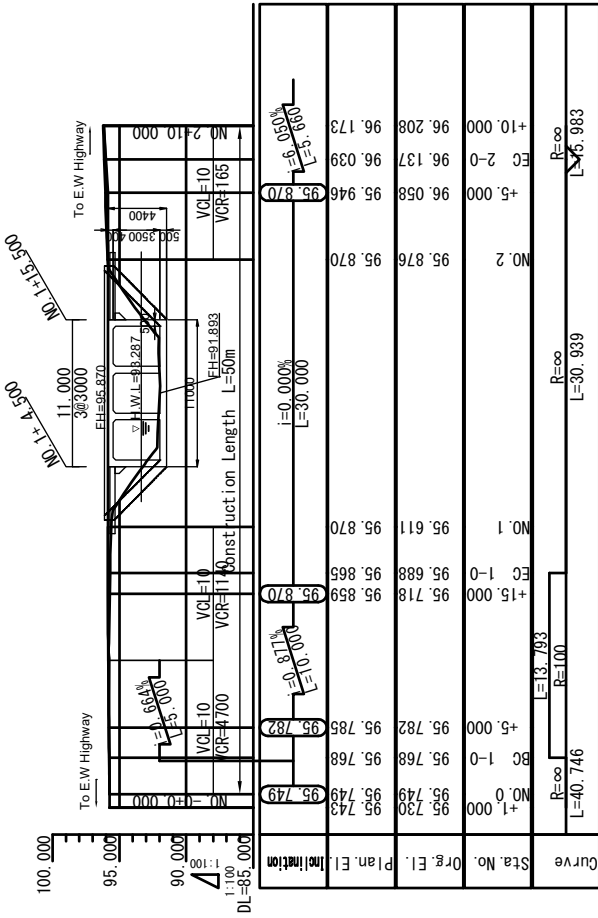
Road Section [Village Road] S=1:200(A3)



|   |             |          |  |
|---|-------------|----------|--|
| DATE  | DESIGNED BY | DWG. NO. | CCB-8                                  |
|   |             |          | SERIAL NO.                             |
| SCALE   | APPROVED BY | As Shown | CCB-8                                  |
|   |             |          | SERIAL NO.                             |
| DWG. TITLE  |             |          | Canal Crossing Bridge No.17 (CCB-17)   |
| PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM IN EASTERN TERAI AREA IN NEPAL |             |          | JAPAN INTERNATIONAL COOPERATION AGENCY |
| MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION, DEPARTMENT OF WATER RESOURCES AND IRRIGATION           |             |          |  |
| Canal Crossing Bridge No.17 (CCB-17)  |             |          |  |
| Plan, Profile, Section  |             |          |  |

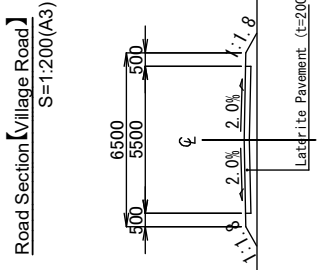
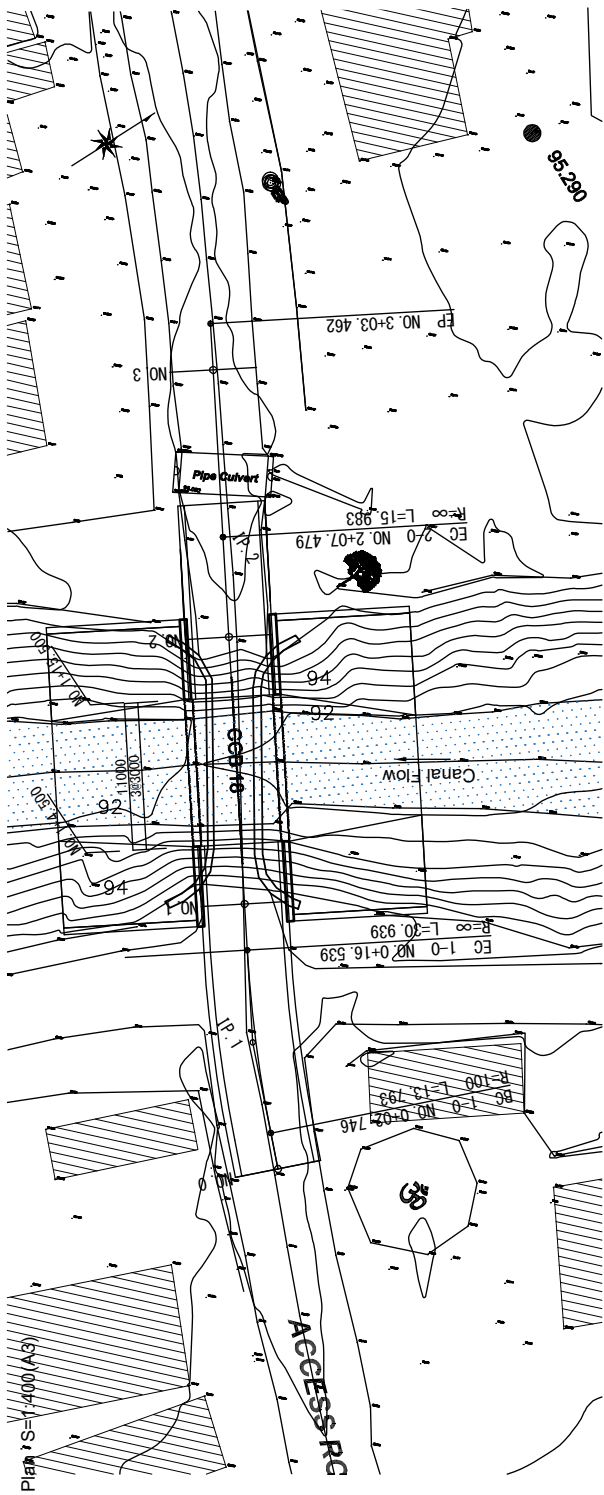
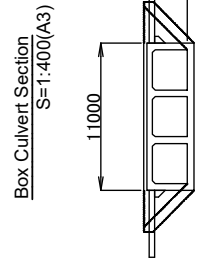
# Canal Crossing Bridge No. 19 (CCB-19)

Profile S=1:400(A3)



**【Design Condition of Road】**

|                     |              |
|---------------------|--------------|
| Road Category       | Village Road |
| Design Speed        | V=30km/h     |
| Min. Curve Radius   | R=30m        |
| Max Inclination     | i=7.0%       |
| Min. Vertical Curve | VCL=10m      |



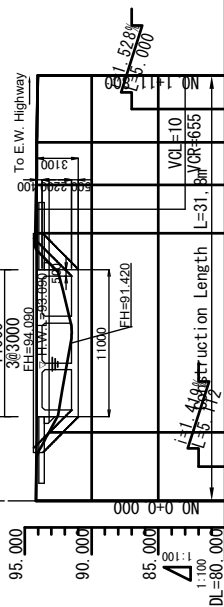
|  |             |          |            |
|--|-------------|----------|------------|
| DATE   | DESIGNED BY | DWG. NO. | CCB-9      |
|  |             |          | SERIAL NO. |
| SCALE  | APPROVED BY | As Shown |            |
| <p><b>DWG. TITLE</b></p> <p>Canal Crossing Bridge No. 19 (CCB-19)<br/>Plan, Profile, Section</p>                     |             |          |            |
| <p>PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM<br/>IN EASTERN TERAI AREA IN NEPAL</p> |             |          |            |
| <p>MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION,<br/>DEPARTMENT OF WATER RESOURCES AND IRRIGATION</p>           |             |          |            |
| <p>JAPAN INTERNATIONAL<br/>COOPERATION AGENCY</p>  |             |          |            |

# Canal Crossing Bridge No. 20 (CCB-20)

Profile S=1:400(A3)

**【Design Condition of Road】**

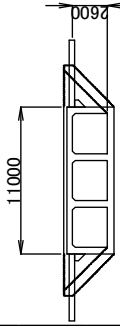
|                     |              |
|---------------------|--------------|
| Road Category       | Village Road |
| Design Speed        | V=30km/h     |
| Min. Curve Radius   | R=30m        |
| Max Inclination     | i=7.0%       |
| Min. Vertical Curve | VCL=10m      |



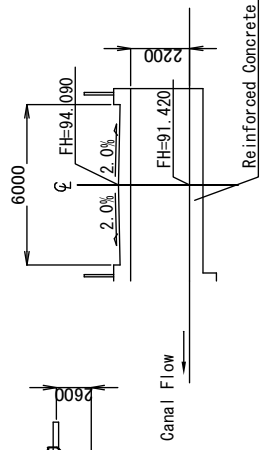
| Sta. No. | Org. El. | Plan. El. | Inclination |
|----------|----------|-----------|-------------|
| BP       | 94.163   | 94.163    | 94.163      |
| BC 1-0   | 94.127   | 94.087    | 94.071      |
| NO. 1    | 94.205   | 94.090    | 94.090      |
|          |          |           | 94.014      |
|          |          |           | 94.014      |
|          |          |           | 94.014      |

$R=100$   
 $L=23.627$   
 $R=100$   
 $L=11.97$   
 $R=100$   
 $L=11.97$

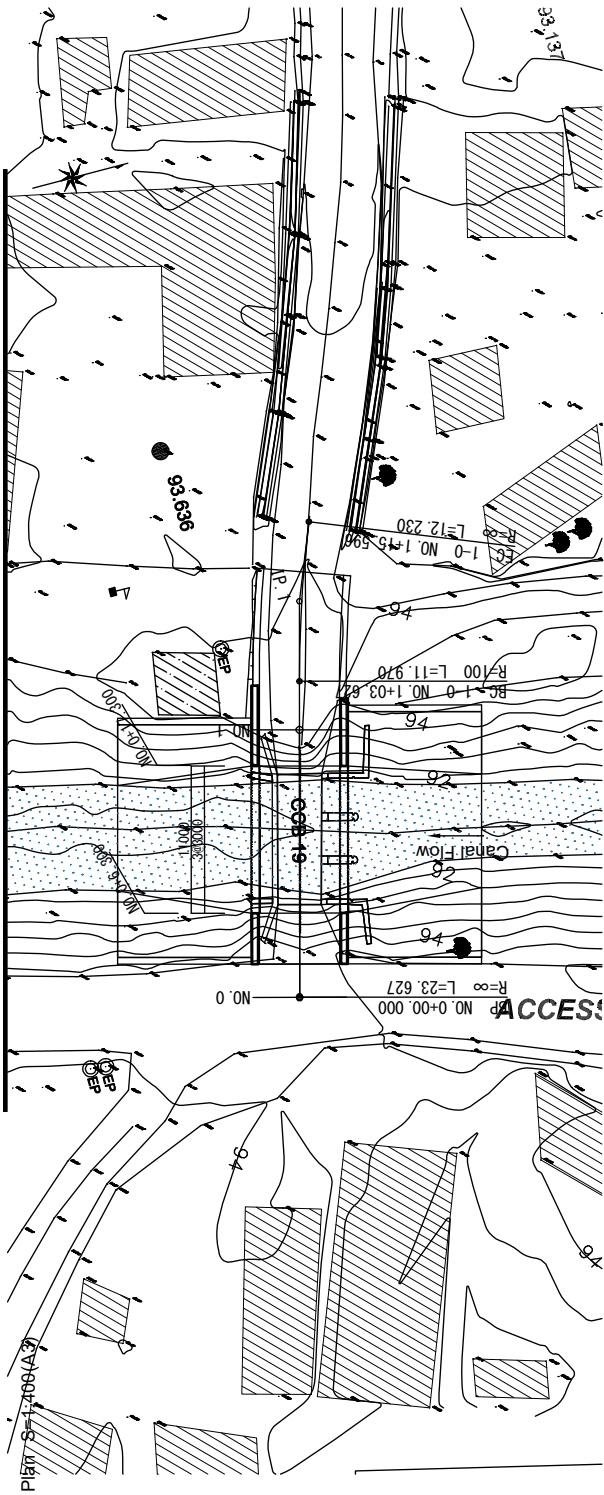
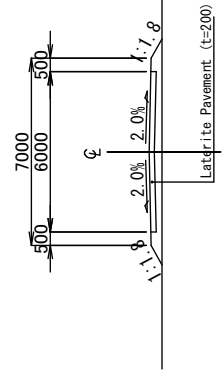
Box Culvert Section S=1:400(A3)



Box Culvert Profile S=1:200(A3)



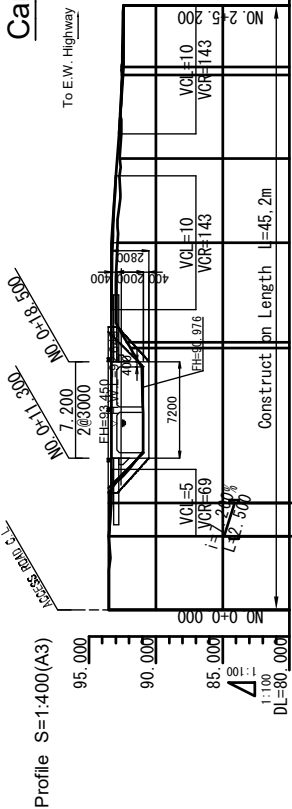
Road Section [Village Road] S=1:200(A3)



Note: Check Gate shall be restored at upstream side of Culvert.

|   |   |  |             |             |                   |
|---|---|--|-------------|-------------|-------------------|
| PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM<br>IN EASTERN TERAI AREA IN NEPAL<br>MINISTRY OF ENERGY, WATER RESOURCES AND IRRIGATION,<br>DEPARTMENT OF WATER RESOURCES AND IRRIGATION | DWG. TITLE<br>Canal Crossing Bridge No. 20 (CCB-20)<br>Plan, Profile, Section |  | DATE        | DESIGNED BY | DWG NO.<br>CCB-10 |
|   | SCALE<br>As Shown   |  | APPROVED BY | SERIAL NO.  | SERIAL NO.        |

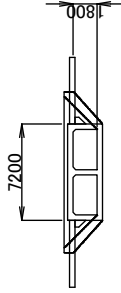
# Canal Crossing Bridge No.22 (CCB-22)



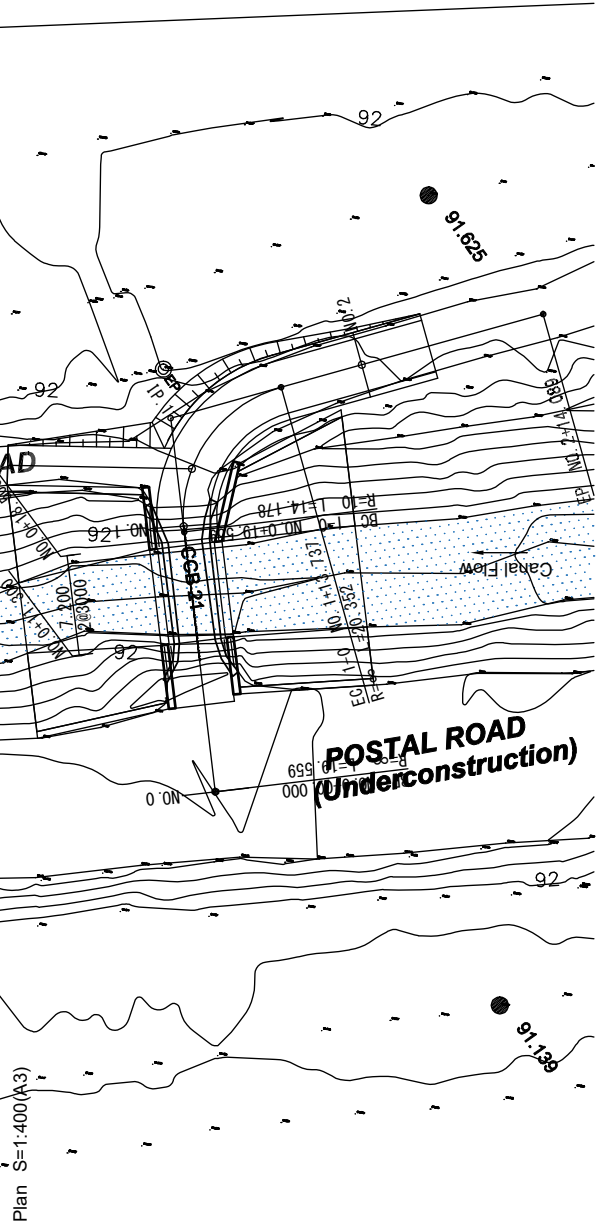
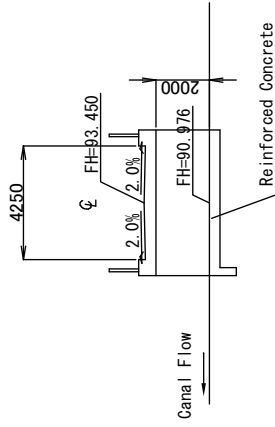
| Curve | Sta. No. | Org. El. | Plan. El. | Inclination |
|-------|----------|----------|-----------|-------------|
| BP    | 93.500   | 93.500   | 93.500    | 0.000%      |
|       | 93.500   | 93.500   | 93.320    | 0.000%      |
| EC    | 92.880   | 92.880   | 92.880    | 7.00%       |
|       | 92.400   | 92.400   | 92.401    | 0.00%       |

| 【Design Condition of Road】 |              |
|----------------------------|--------------|
| Road Category              | Village Road |
| Design Speed               | V=30km/h     |
| Min. Curve Radius          | R=30m        |
| Max Inclination            | i=7.0%       |
| Min. Vertical Curve        | VCL=10m      |

Box Culvert Section  
S=1:400(A3)

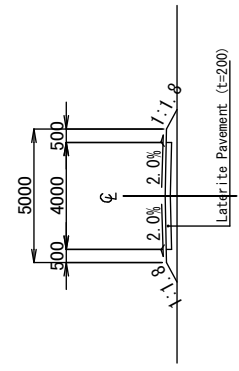


Box Culvert Profile  
S=1:200(A3)



Plan S=1:400(A3)

Road Section [Village Road]  
S=1:200(A3)



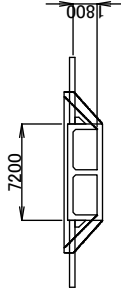
|  |                                      |                    |                 |                   |
|--|--------------------------------------|--------------------|-----------------|-------------------|
| <b>DWG. TITLE</b>  | Canal Crossing Bridge No.22 (CCB-22) | <b>DESIGNED BY</b> | <b>DWG. NO.</b> | <b>CCB-11</b>     |
| <b>DATE</b>  |                                      | <b>APPROVED BY</b> | <b>SCALE</b>    | <b>SERIAL NO.</b> |
|  |                                      |                    | As Shown        |                   |
| <b>PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM<br/>IN EASTERN TERAI AREA IN NEPAL</b> |                                      |                    |                 |                   |
| MINISTRY OF ENERGY, WATER RESOURCES AND IRRIGATION,<br>DEPARTMENT OF WATER RESOURCES AND IRRIGATION                  |                                      |                    |                 |                   |
| JAPAN INTERNATIONAL<br>COOPERATION AGENCY  |                                      |                    |                 |                   |

# Canal Crossing Bridge No.26 (CCB-26)

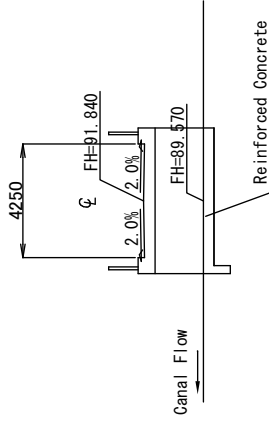
## 【Design Condition of Road】

|                     |              |
|---------------------|--------------|
| Road Category       | Village Road |
| Design Speed        | V=30km/h     |
| Min. Curve Radius   | R=30m        |
| Max Inclination     | i=7.0%       |
| Min. Vertical Curve | VCL=10m      |

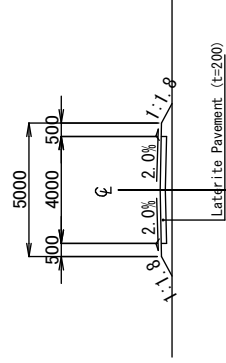
Box Culvert Section  
S=1:400(A3)



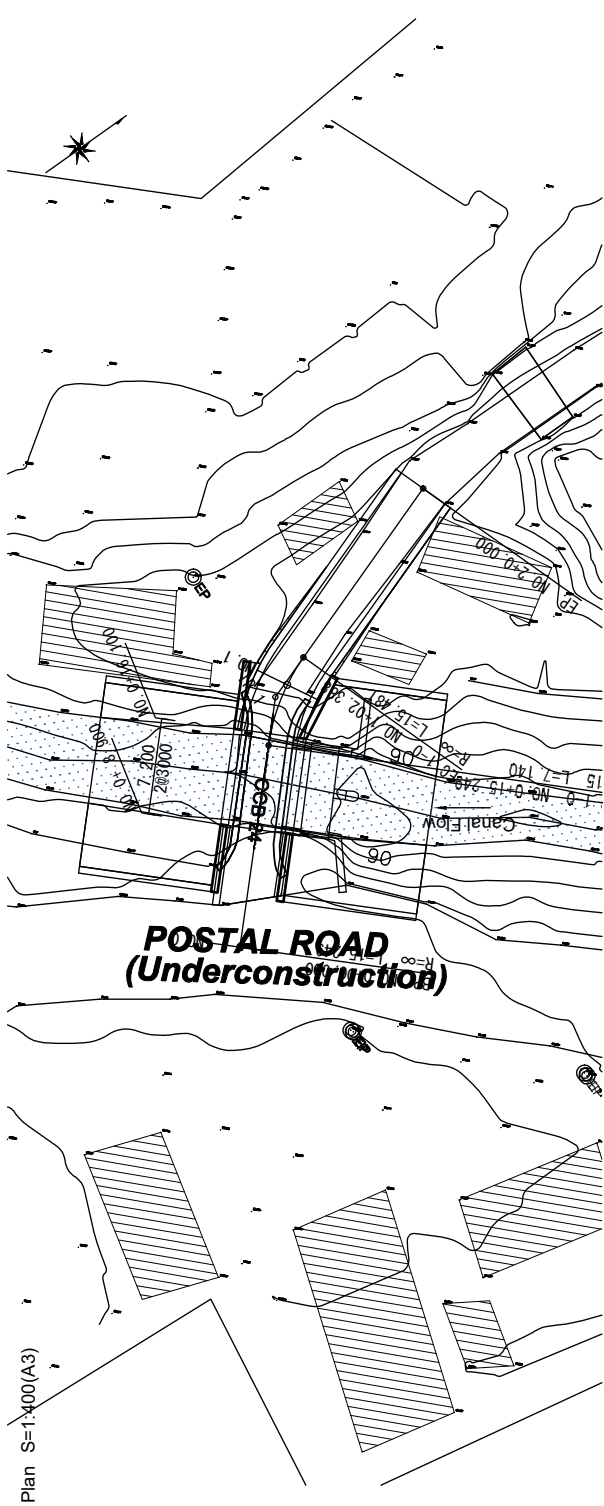
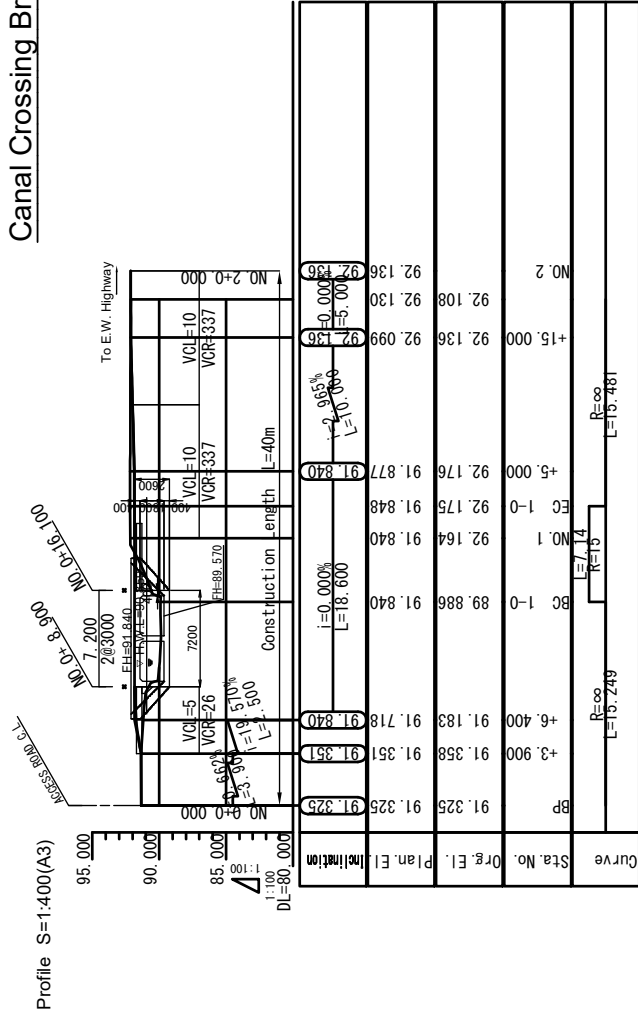
Box Culvert Profile  
S=1:200(A3)



Road Section [Village Road]  
S=1:200(A3)



Note: Check Gate shall be restored at upstream side of Culvert.



**DWG. TITLE**

PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM  
IN EASTERN TERAI AREA IN NEPAL

JAPAN INTERNATIONAL  
COOPERATION AGENCY

MINISTRY OF ENERGY, WATER RESOURCES AND IRRIGATION,  
DEPARTMENT OF WATER RESOURCES AND IRRIGATION

Canal Crossing Bridge No.26 (CCB-26)  
Plan, Profile, Section

As Shown

SCALE

APPROVED BY

DESIGNED BY

DATE

DWG NO.

CCB-12

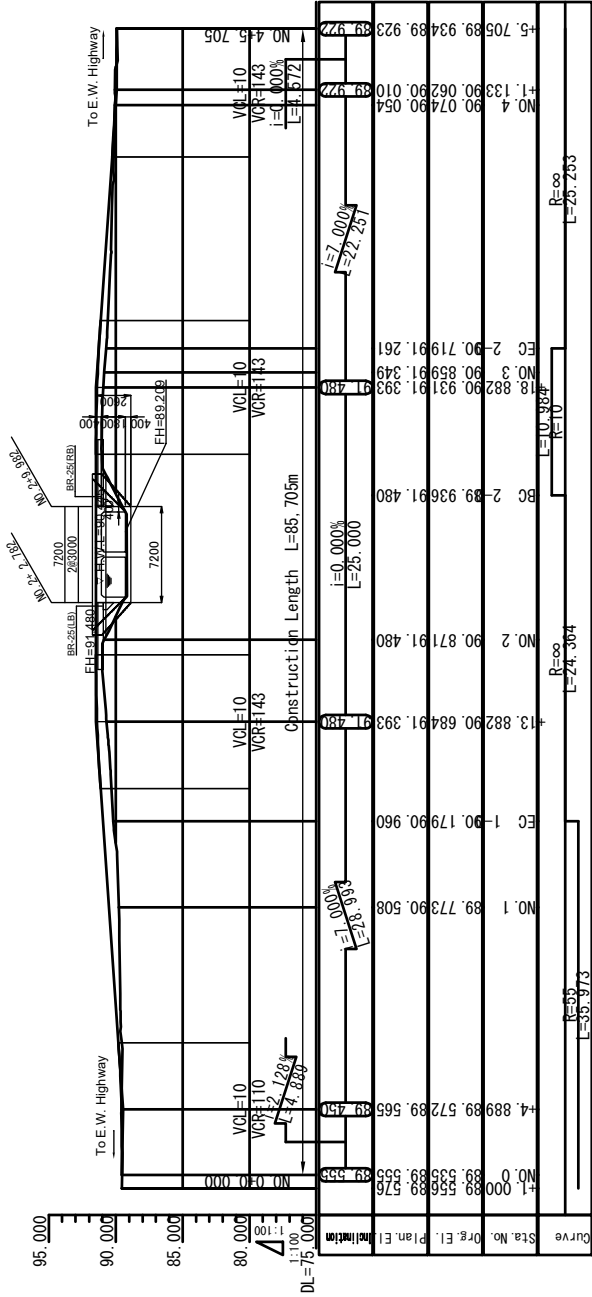
SERIAL NO.

# Canal Crossing Bridge No.27 (CCB-27)

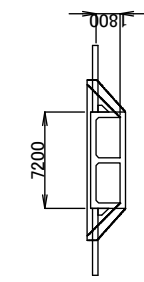
【Design Condition of Road】

|                     |              |
|---------------------|--------------|
| Road Category       | Village Road |
| Design Speed        | V=30km/h     |
| Min. Curve Radius   | R=30m        |
| Max Inclination     | i=7.0%       |
| Min. Vertical Curve | VCL=10m      |

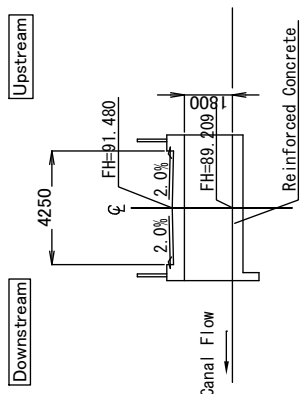
Profile S=1:400(A3)



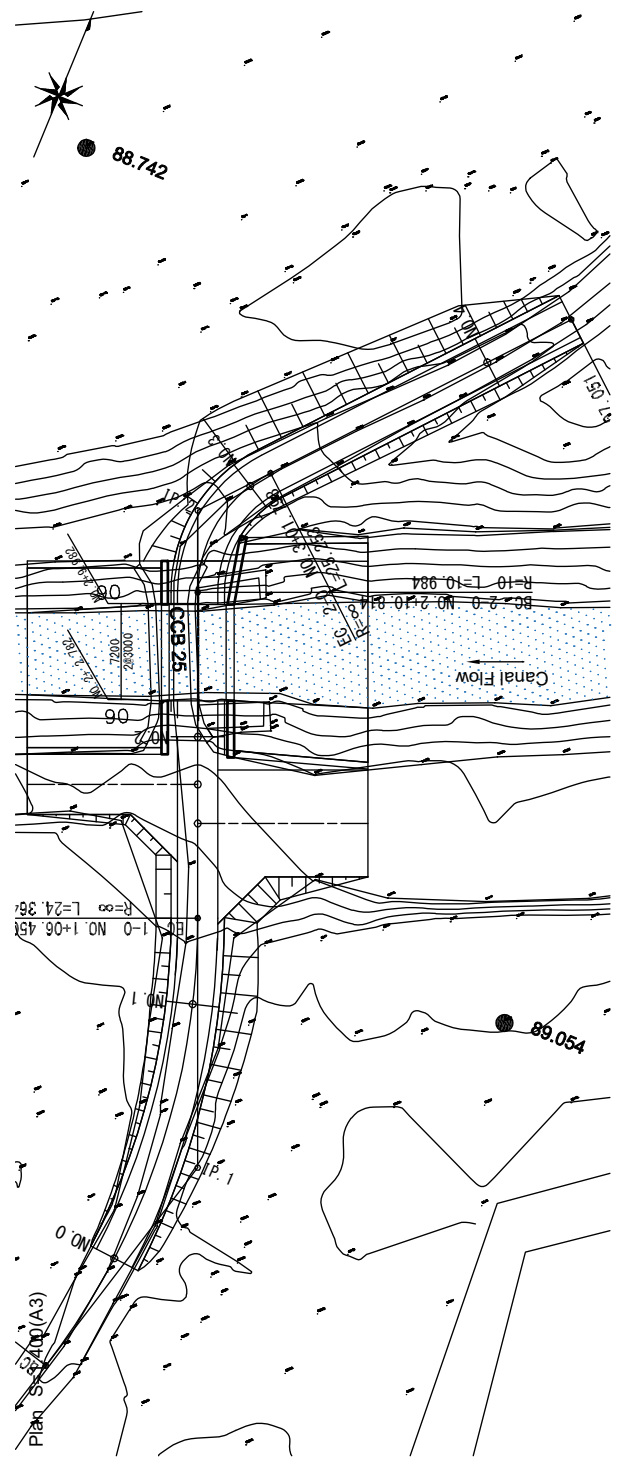
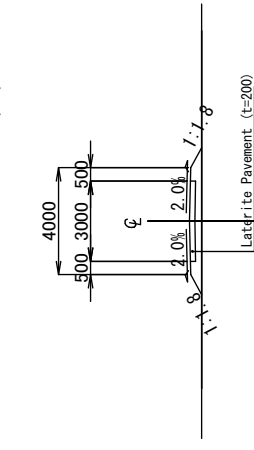
Box Culvert Section  
S=1:400(A3)



Box Culvert Profile  
S=1:200(A3)



Road Section [Village Road]  
S=1:200(A3)



DWG. TITLE

PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM  
IN EASTERN TERAI AREA IN NEPAL

MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION,  
DEPARTMENT OF WATER RESOURCES AND IRRIGATION

JAPAN INTERNATIONAL  
COOPERATION AGENCY

DATE

DESIGNED BY

DWG NO.

SCALE

APPROVED BY

SERIAL NO.

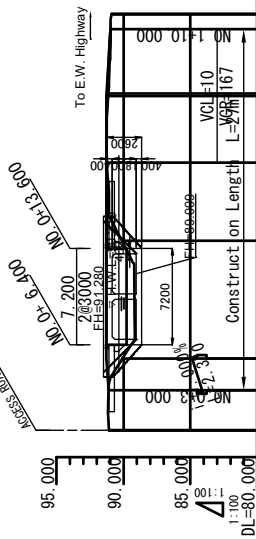
As Shown

Canal Crossing Bridge No.27 (CCB-27)  
Plan, Profile, Section

CCB-13

# Canal Crossing Bridge No. 28 (CCB-28)

Profile S=1:400(A3)

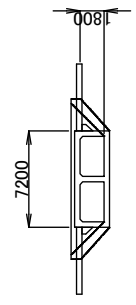


**【Design Condition of Road】**

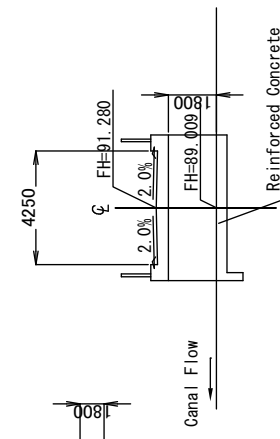
|                     |              |
|---------------------|--------------|
| Road Category       | Village Road |
| Design Speed        | V=30km/h     |
| Min. Curve Radius   | R=30m        |
| Max. Inclination    | i=7.0%       |
| Min. Vertical Curve | VCL=10m      |

| Curve                                   | Sta. No. | Org. El. | Plan. El. | Inclination |
|---|----------|----------|-----------|-------------|
| BP                                      | 91.101   | 91.114   | 91.114    | 91.114      |
| BC                                      | 90.74    | 90.74    | 91.280    | 91.280      |
| EC                                      | 91.235   | 91.235   | 91.280    | 91.280      |
| EP                                      | 90.000   | 90.980   | 90.980    | 90.980      |
| R=∞ L=14.175<br>R=∞ L=30<br>R=∞ L=5.917 |          |          |           |             |

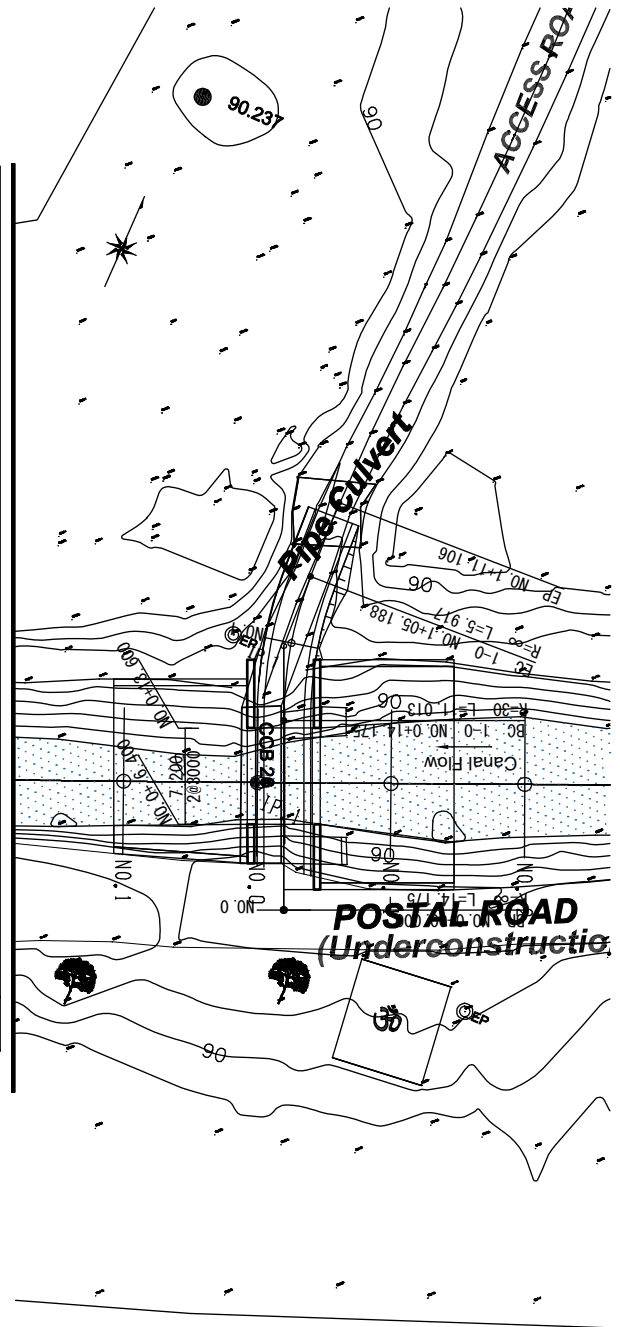
Box Culvert Section  
S=1:400(A3)



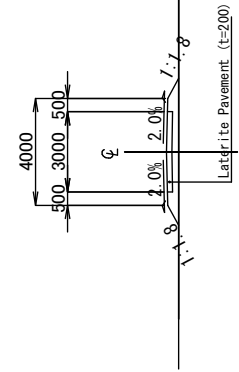
Box Culvert Profile  
S=1:200(A3)



Plan S=1:400(A3)



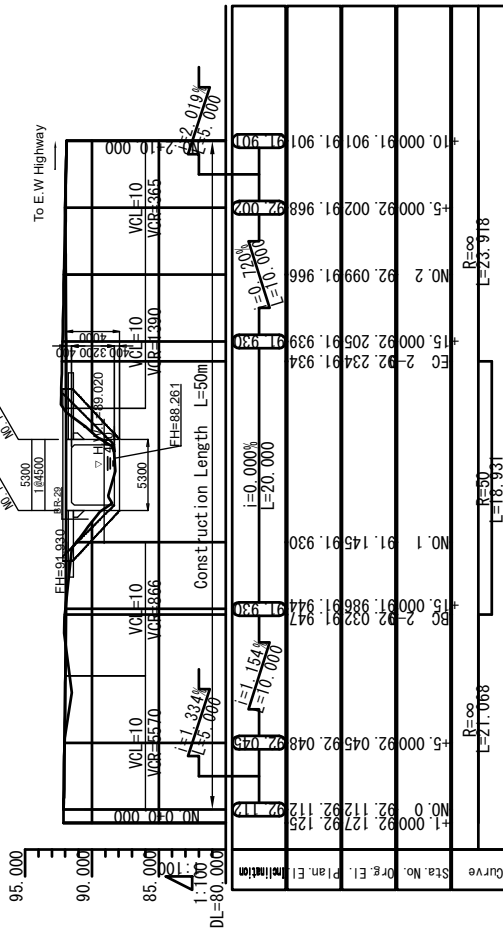
Road Section [Village Road]  
S=1:200(A3)



|  |             |          |            |
|--|-------------|----------|------------|
| DATE   | DESIGNED BY | DWG. NO. | CCB-14     |
|  |             |          | SERIAL NO. |
| SCALE  | APPROVED BY | As Shown |            |
| DWG. TITLE   |             |          |            |
| PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM<br>IN EASTERN TERAI AREA IN NEPAL |             |          |            |
| MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION,<br>DEPARTMENT OF WATER RESOURCES AND IRRIGATION           |             |          |            |
| JAPAN INTERNATIONAL<br>COOPERATION AGENCY  |             |          |            |
| Canal Crossing Bridge No. 28 (CCB-28)<br>Plan, Profile, Section  |             |          |            |

# Canal Crossing Bridge No.31 (CCB-31)

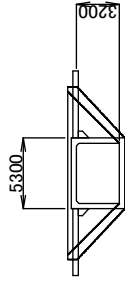
Profile S=1:400(A3)



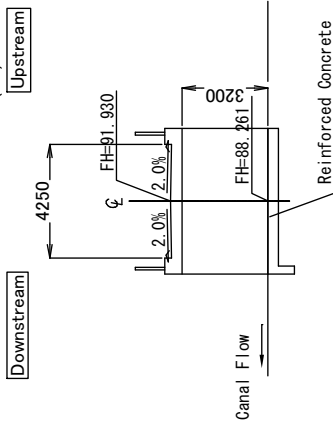
**【Design Condition of Road】**

|                     |              |
|---------------------|--------------|
| Road Category       | Village Road |
| Design Speed        | V=30km/h     |
| Min. Curve Radius   | R=30m        |
| Max Inclination     | i=7.0%       |
| Min. Vertical Curve | VCL=10m      |

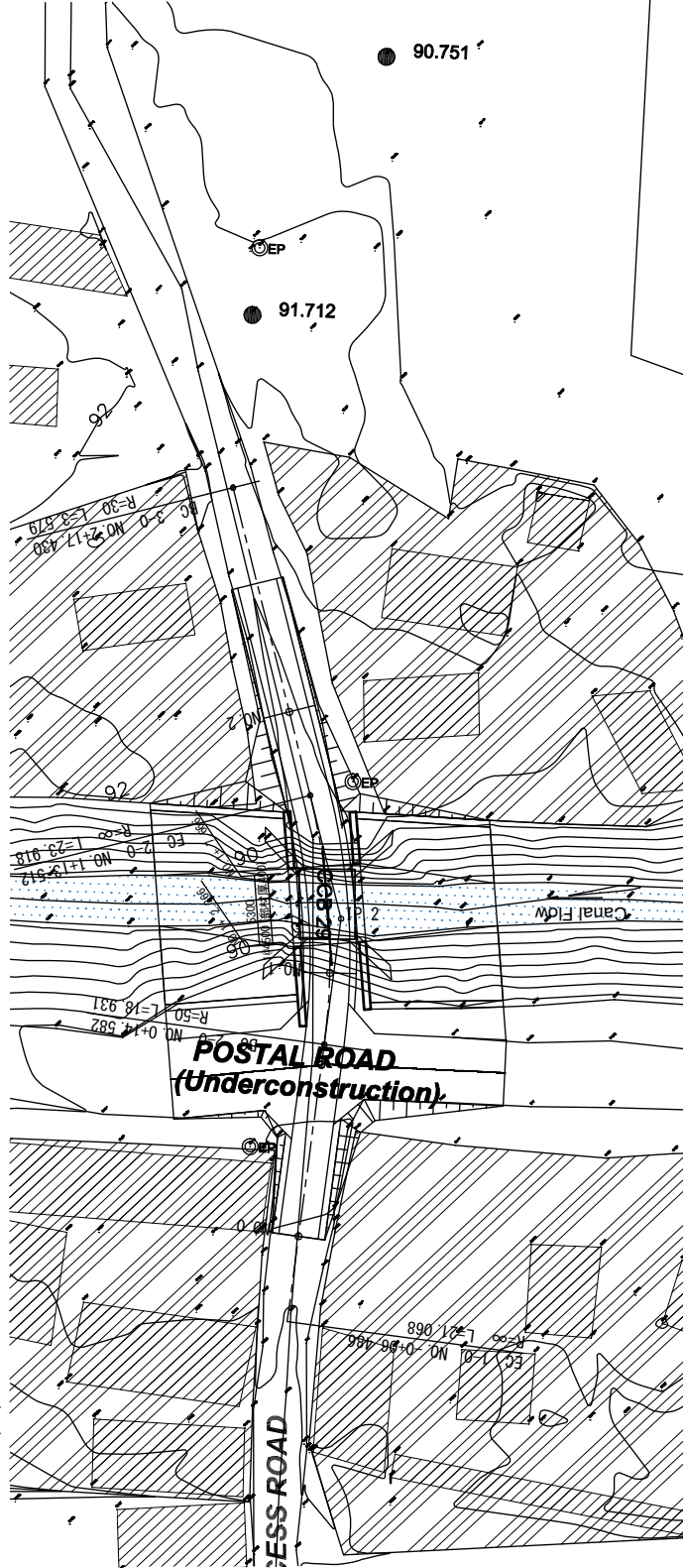
Box Culvert Section S=1:400(A3)



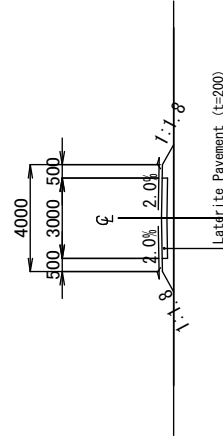
Box Culvert Profile S=1:200(A3)



Plan S=1:400(A3)



Road Section [Village Road] S=1:200(A3)



|   |             |          |  |
|---|-------------|----------|--|
| DATE  | DESIGNED BY | DWG. NO. | CCB-15                                 |
|   |             |          | SERIAL NO.                             |
| SCALE   | APPROVED BY | As shown | CCB-15                                 |
|   |             |          | SERIAL NO.                             |
| DWG. TITLE  |             |          | Canal Crossing Bridge No.31 (CCB-31)   |
| PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEM IN EASTERN TERAI AREA IN NEPAL |             |          | JAPAN INTERNATIONAL COOPERATION AGENCY |
| MINISTRY OF ENERGY, WATER RESOURCE AND IRRIGATION, DEPARTMENT OF WATER RESOURCES AND IRRIGATION           |             |          |  |
| Canal Crossing Bridge No.31 (CCB-31)  |             |          | Plan, Profile, Section                 |

## **2-2-4 Implementation Plan**

### **2-2-4-1 Implementation Policy**

The main implementing authority of this project is the Ministry of Energy, Water Resources and Irrigation (MoEWRI) and the Executing Agency is the Department of Water Resources and Irrigation (DWRI). MoEWRI will approve and issue the approval document regarding Authorization to Pay (A/P) for a consultants and a contractor in accordance with each implementation stage. On the other hand, DWRI will have the responsibility of Operation and Maintenance (O&M) of the facilities rehabilitated by this project.

Detail Design, Bidder documents and supervision of the construction and procurement shall be implemented by Japanese consultant. Therefore, MoEWRI and the consultant will sign a contract after signing Exchanged Note (E/N) and Grant Agreement (G/A) of Grant Aid for this project. The contract style is a lump sum contract. MoEWRI will approval and issue the approval document regarding Authorization to Pay (A/P) according to the proceeding stage of construction and procurement.

The construction of this project will be implemented by Japanese Construction Company. Most of this construction work is general civil engineering. But the construction consists the consideration of farming during dry season, so that the construction company has to set temporary irrigation canal instructed by DWRI and supervisor. Therefore, it is recommended that the construction company should have a lot of career on likely situation to implement this project. The selection of contractors will be conducted by public tender and the qualifications and selection criteria required of the contractors will be determined during the tender preparation stage, after consultation and confirmation with MoEWRI and DWIR.

### **2-2-4-2 Implementation Conditions**

#### **(1) Key consideration for construction**

##### **1) Construction of Canal Under Passes**

- a) Canal Under Passes (CUPs) will be constructed during dry season when the target rivers have little flow because construction work of CUPs is installed under the river.
- b) The contractor has to pay attention always to river flow whether the river has little flow, and they have to make a space to run a flush flow using multi-stage diversion method.
- c) Sump pit and pump-drain should be set, because the construction area has to be protected from ground water coming which will be happen on the excavation work.
- d) Temporary irrigation canal shall be set since irrigation water of 1.6m<sup>3</sup>/s has to be secured for farming on dry season.

##### **2) Construction of Cross Drainage Works**

- a) Cross Drainage Works (CDWs) shall be constructed under place of irrigation canal foundation. Sump pit and pump-drain should be set, because the construction area has to be protected from ground water coming which will be happen on the excavation work.
- b) Temporary irrigation canal shall be set since irrigation water of 1.6m<sup>3</sup>/s has to be secured for farming on dry season. Temporary irrigation canal shall be installed with large size sand bags setting at the middle of irrigation canal. Therefore, during the construction work of CDWs, the construction works shall be implemented halfway each based on the centerline of irrigation canal.
- c) Embankment Protection as an ancillary facility shall be constructed during rainy season. The contractor, always, have to pay attention and take safety measure to water, because rain water

will gather into some part of construction area as drainage water.

- d) A part of CDWs' construction shall be implemented near houses. The construction work must ensure safety to the surrounding houses.

### 3) Construction of Canal Crossing Bridges

- a) Canal Crossing Bridges (CCBs) shall be constructed under the irrigation canal foundation. Sump pit and pump-drain should be set, because the construction area has to be protected from ground water coming which will be happen on the excavation work.
- b) The situation of foundation of CCBs shall be checked because there is vehicle traffic on them. During the Preparatory Survey, boring was conducted near the target CCB but not under the existing structures. Therefore, when the existing bridges removed, the foundation condition have to be confirmed and judged as appropriateness by a Geotechnical Engineer.
- c) Temporary irrigation canal shall be set since irrigation water of 1.6m<sup>3</sup>/s has to be secured for farming on dry season. The temporary irrigation canal shall be made with large size sand bags setting at the middle of irrigation canal. Therefore, on construction works of CCBs, the construction works shall be implemented halfway each based of centerline of irrigation canal.
- d) Most of CCBs' construction shall be implemented near the existing houses and presence of traffic flow. The construction work must not disturb the traffic flow, the contractor shall establish temporary bridge in the irrigation canal to make transportation smooth during CCB construction.

## (2) Key consideration for setting implementation schedule

### 1) National Holidays in Nepal

National Holidays in Nepal for setting implementation schedule are listed herein below. Especially, it is necessary to consider to (b) and (c) below. Almost public transportation and stores will get day-off for two (2) ~ three (3) weeks and sometimes many people (including labours) will leave the site to return to their hometown. However, holidays excluding (b) and (c) is total approximately 10 days and these holidays will not affect the implementation schedule.

- a) Friday PM and Saturday on every week
- b) DASHAIN: 7 days and before and after total 10 days of the festival on October (17 days in total)
- c) TIHAR: 4 days and before and after total 7 days of the festival on October (11 days in total)

### 2) Weather Condition

Precondition regarding rainfall and river streams around the target sites are below.

- a) Rainy season: April to September
- b) Dry season: October to March
- c) River stream situation: All river crossing irrigation canal have no water flow during November to April, since they are seasonal river.

### 3) Farming and Irrigation Schedule

The Peak flow of irrigation around target area happens during rainy season and there is constant flow during dry season as well. Precondition regarding farming and irrigation are presented below referring past result.

- a) Flow peak for paddy: June to October (5 months),  $Q_{max}=11.8m^3/s$
- b) Flow peak for wheat: January to February (2 months),  $Q_{max}=1.6m^3/s$
- c) No demand of peak flow from farmers: March to May and November to December

**Table 2-2-37 Timing for construction considering precondition in target area**

|   | Jan                            | Feb       | Mar       | Apr    | May    | Jun                   | Jul    | Aug    | Sep    | Oct                            | Nov       | Dec       |
|---|--------------------------------|-----------|-----------|--------|--------|-----------------------|--------|--------|--------|--------------------------------|-----------|-----------|
| Rain fall (mm)  | 28.00                          | 12.00     | 24.00     | 73.00  | 122.00 | 209.00                | 385.00 | 282.00 | 267.00 | 23.00                          | 0.00      | 1.00      |
| Quantity of irrigation *1                             | 2.08                           | 1.11      | 0.00      | 0.09   | 0.33   | 2.87                  | 2.32   | 6.84   | 5.61   | 4.09                           | 0.27      | 0.17      |
| Temp. Irrigation ( $m^3/s$ )                          | 1.6 $m^3/sec$                  |           | exist.    | exist. | exist. | 11.8 $m^3/sec$        |        |        |        |                                | exist.    | exist.    |
| River stream*1  | non-exist                      | non-exist | non-exist | exist. | exist. | exist.                | exist. | exist. | exist. | exist.                         | non-exist | non-exist |
| Schedules that can be constructed in a general method |                                |           |           |        |        |                       |        |        |        |                                |           |           |
| Canal Under Pass                                      |                                |           |           |        |        |                       |        |        |        |                                |           |           |
|   | 1                              | 2         | 3         |        |        |                       |        |        |        |                                | 4         | 5         |
| Cross Drainage Work                                   | Main construction/canal inside |           |           |        |        | Embankment protection |        |        |        | Main construction/canal inside |           |           |
|   | 1                              | 2         | 3         | 4      | 5      | 6                     | 7      | 8      | 9      | 10                             | 11        | 12        |
| Canal Crossing Bridge                                 |                                |           |           |        |        |                       |        |        |        |                                |           |           |
|   | 1                              | 2         | 3         | 4      | 5      |                       |        |        |        | 6                              | 7         | 8         |




\*1 Unit:  $m^3/s$ , the values are referred from the results of gate control record.

Source: JICA Survey Team

### (3) Consideration for the Community around Target Area

The construction work shall be implemented considering the following issues.

- a) Consideration for Religion: If the pruning or transplanting of branches or foliage of trees of religious significance is required, the Ward Office should be consulted before the work is carried out to prevent unnecessary conflicts with local residents (Cf.: photo below).
- b) Accident prevention: Falling accidents into the irrigation canal of residents and livestock had reported. On the other hand, the project includes CCB used as school route. Therefore, safety net and net fence around the target facilities should be included in facility design and assigning traffic officer and announcement of construction schedule must be done on the construction stage.
- c) Consideration for Beneficiaries: Temporary irrigation canal shall be set to secure the irrigation water for farming, so that it avoids negative effect to beneficiaries' farming.

|   |   |  |
|---|---|--|
|  <p>Ficus religiosa which is transplanting required with a utility pole (around road connection between CCB16 and left bank)</p> |  <p>Examples of sites where safety considerations are required (upstream of CUP-1)</p> |  <p>Beneficial area (buffer-zone)</p> |
|---|---|--|

#### **(4) Respect for labour Policy**

- a) Daily work at most construction sites in Nepal starts at 8 am and finish around 5 pm including a lunchbreak of 1 hour.
- b) Labor transportation is commonly used in Nepal.

#### **(5) Safety Management**

Security-related information in Saptari district and its surrounding areas shall be collected from JICA Nepal Office, Embassy of Japan and other organizations. Security measures shall be taken with attention to the following items:

- a) Advice for safe and smooth work implementation shall be obtained from Nepalese counterpart organizations.
- b) Close contact should be maintained with aid agencies working around Saptari District, if any, to share security-related information. Generally, Saptari District and its surrounding area are relatively safer.
- c) Traffic conditions in Nepal are poor and it may be unsafe for foreigners to drive a car. Commuting shall be by car with a local driver.
- d) Construction Plan shall be established according to “The Guidance for the Management of Safety for Construction Works on Japanese ODA Projects”

#### **(6) Procurement**

##### **1) Concrete**

Ready mixed concrete is manufacturing at the factory in Biratnagar and Janakpul around a target site. But transporting to the sites is difficult because the duration of the transport is at least two hours. Furthermore, these plants would also have to provide concrete to other construction works, and it may be difficult to get enough ready-mixed concrete timely during the construction period of the Project. Therefore, a concrete batcher plant shall be installed at the construction site or in its vicinity.

##### **2) Reinforcement bar, Iron, Steel**

Reinforcing bars satisfying British Standards (BS) are widely distributed in Nepal and can be procured in Nepal.

##### **3) Tax**

The Nepalese authority agreed to take necessary measures to exempt taxes, including Value Added Tax (hereinafter referred to as “VAT”), custom duty, corporate tax, income tax, and any other taxes which are to be arisen from the Project activities in Nepal. According to Japan’s Grant Aid regulations, if there is any taxes and levies imposed on the Project, MoEWRI will have to allocate necessary budget for the payment of taxes and levies.

- a) It is necessary to pay plus 13% when purchase of the equipment in Nepal. VAT will be refunded at later date (after 3 months to 6 months) for a Grant Aid projects. MoEWRI requests Inland Revenue Department for refund.
- b) Custom duty: After MoEWRI sends a confirmation letter to the customs office, customs duties will not be levied. MoEWRI needs to pay necessary fee to the custom.
- c) Corporate income tax, Personal income tax: As described in the Exchange of Notes, it is confirmed by the Nepal Ministry of Finance that any income tax for consultants, contractors and its staffs will be exempted

## **(7) Impact of COVID-19 to implementation and procurement**

### **1) Impact of COVID-19 to other Grant Aid projects in Nepal**

#### **(a) Impact to construction work**

Impact of COVID-19 to construction works in Nepal are below.

- a) Lack of Labor: Most of labor had leaved from the site when the number of infected patient was increased. And after the COVID-19 infection situation settled down, it took time and effort to arrange for workers who had left to be reassigned to the site. In addition, without the workers returning to the site, it is not possible to keep the team formation on schedule, which is causing delays in construction. According to a construction contractor, in the worst case scenario, there was a case where the work was scheduled to be done in 10 teams, but only one team could be formed.
- b) Labor health management: Purchase of thermometers and blood oxygen meters for labor health management, PCR testing, and purchase and stockpiling of oxygen cylinders, oxygen inhalers, protective clothing, and medical supplies for emergencies.
- c) Soaring costs of procuring materials and equipment: The number of cases of procuring materials and equipment at a premium to the original cost has been increasing because there is no longer any prospect of procuring materials and equipment as planned.
- d) Process delays due to procurement of materials and equipment: Due to the effects of the lockdown and restrictions on movement, there have been obstacles to the procurement of materials and equipment due to restrictions on vehicle traffic and movement, as well as shortages in the supply of materials (e.g., production of some materials has been suspended due to a shortage of industrial oxygen in order to secure medical oxygen). In addition, for the same reason, suppliers in India, China, and Thailand have been slow to respond, affecting the entire process.
- e) Stoppage of government agencies: In the capital city Kathmandu, although government agencies continued to operate even after the lockdown was imposed, they operated with a minimum number of staff and did not interrupt construction procedures, so contractors decided to continue with construction. On the other hand, due to the small number of people operating the various government agencies, there were delays in the approval of import customs clearance documents, visa applications, and other operations.

#### **(b) Impact to Procurement of Materials and equipment**

The Nepal Bureau of Statistics is organizing official data on major materials, but updates have ceased since January 2020. Therefore, the team interviewed construction companies in Nepal about the prices of construction materials to be procured before and after the spread of COVID-19. The unit prices of cement and rebar/steel were compared between December 2019 and April 2021. This unit price increase is presumed to be one of the effects of the expansion of COVID-19 infection on global logistics.

#### **(c) Impact to Procurement of Labor**

With regard to labor (labor cost), no steep rise was observed due to the impact of COVID-19. As mentioned above, with regard to labor procurement, difficulties have arisen not in unit costs but in procurement itself.

### **2) Impact of the spread of COVID-19 infection in countries other than Nepal**

As an impact of the spread of COVID-19 infection in countries other than Nepal, many projects have been "reimbursed" for necessary expenses as "design change" procedures since February 2020 when the spread of the infection became clear. Examples of specific items are shown below.

Purchase of thermometers and blood oxygen meters for health management; purchase and stockpiling of oxygen cylinders, oxygen inhalers, protective clothing, medicines, etc. for PCR examinations and emergencies; compensation for the cost of returning home for staff and laborers when construction is temporarily suspended, and so on.

### 3) Impact of the spread of COVID infection on project implementation

The impacts of COVID-19 described above can be summarized as (1) impact on schedule and (2) impact on cost. Therefore, it is difficult to take concrete measures against the impact of the spread of COVID infection on the implementation of the project.

The following are the details that should be assumed in advance during the preparatory survey for cooperation.

- a) With regard to the schedule, a sufficient preparation period shall be provided, assuming that the period required for procurement of materials after the signing of the contract will be long. The preparation period assumes the logistic work for procurement, and is distinguished from the preparation period for work such as temporary storage of materials and equipment at the site and groundbreaking event.
- b) As for the cost, the cost of the new corona quarantine measures based on the JICA notification is included in the project cost estimate.

#### 2-2-4-3 Scope of Works

In the case of implementation of this project, the classification of the scope of work by Japan's side and Nepal's side is summarized as follows.

**Table 2-2-38 Construction Classification / Procurement and Installation Classification**

| Japan  | Nepal   |
|--|---|
| Canal Under Pass × 8 units<br>Cross Drainage Work × 9 units<br>Canal Crossing Bridge × 15 units<br><br><i>Total: 32 Facilities</i> | <ul style="list-style-type: none"> <li>◆ Securing land for construction</li> <li>◆ Free provision of land for use and lease for construction</li> <li>◆ Preparation of EMP (Environmental Management Plan) and submission to the Ministry of Forests and Environment</li> <li>◆ Restoration of infrastructures such as electric lines, water and sewage lines that are temporarily disrupted during construction</li> </ul> |

#### 2-2-4-4 Consultant Supervision

##### (1) Project Implementation Structure

The project will be implemented by Japanese consultants contracted with the Responsible Authority of Nepal after the signing of the Exchange of Notes (E/N) between the Governments of the two countries and the Grant Agreement (G/A) between JICA and the Government of Nepal following the Cabinet Decision. The consultant will implement detailed design, bid assistance, construction supervision and soft component.

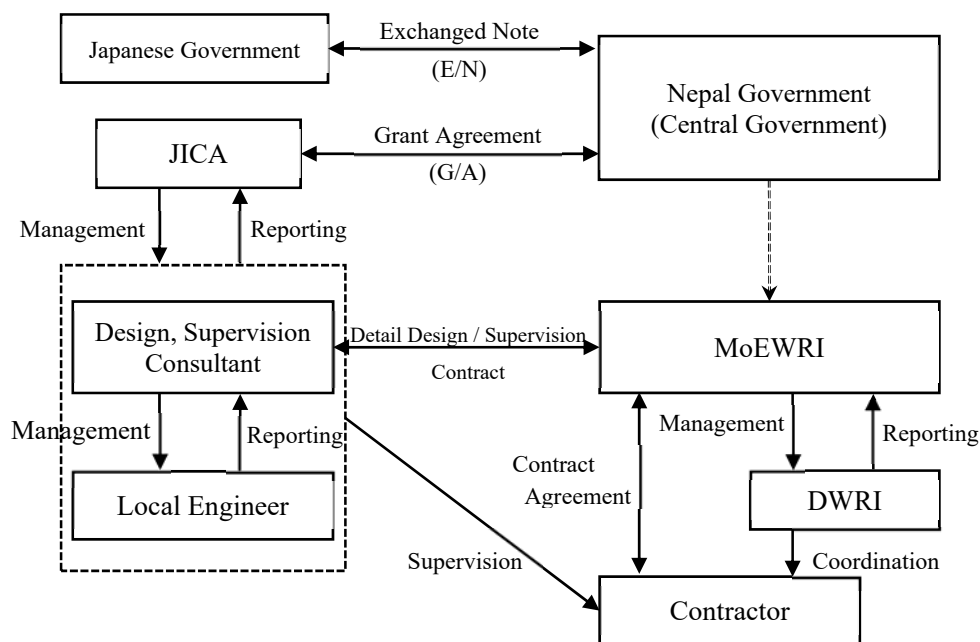


Figure 2-2-5 Implementation Structure

## (2) Detail Design and Supervisor

### 1) Structure

The Japanese consultant recommended by JICA will sign a contract with the organization responsible for the project in Nepal, and will be responsible for detailed design, bidding assistance and construction supervision. In the construction supervision stage, the Japanese consultant will supervise the construction and liaise and coordinate with the related organizations. The resident construction supervisor is mainly stationed in Saptari District or neighboring Sunsari District, and travel to the site. If necessary, local engineers are hired to support the work and transfer technology. The local engineer is a civil engineer who also serves as an interpreter, and supports communication with local residents and construction supervision.

The roles of the design and construction supervision consultants (Japanese and local engineers) are as follows

#### (a) Detail Design Stage

- a) A detailed status survey of the project site will be conducted to supplement and add to the contents of the basic design.
- b) Prepare detailed drawings.
- c) The design is reviewed by reconfirming the basic conditions, checking the validity of the specifications, and scrutinizing the bill of quantities.
- d) Prepare the bidding documents.
- e) Prepare detailed design drawings, specifications, and bills of quantities as bid documents

#### (b) Bidding Stage

- a) Obtain approval from the supervising/implementing agency for the bidding documents.
- b) Support the technical aspects of bidding, bid evaluation and contract negotiations conducted

by the supervising and implementing agencies.

- c) Report the results of the bidding to JICA.

**(c) Supervision Stage**

- a) Confirmation of the quality assurance, progress and safety management of the works as described in the specifications shall be carried out and reported to the implementing agency/JICA on a regular basis.
- b) When payment is requested by the contractor, the workmanship inspection is carried out and the results are reported to the implementing agency and JICA.
- c) Upon completion of the project, the completion inspection will be carried out and the results will be reported to the implementing agency and JICA.
- d) One year after the completion of the project, a defect inspection will be conducted and the results will be reported to the implementing agency and JICA.

**2) Assignment plan**

**(a) Detail Design Stage**

The team composition of Japanese engineers of the Japanese Consultant are consists of 7 persons, which include the chief engineer, irrigation and drainage facility design, gate design, bridge design, facility foundation investigation, and construction planning and cost estimation.

**(b) Preparing stage for Bidding**

The work will be carried out by three persons in total: the Chief Engineer, the Irrigation and Drainage Facility Designer, and the Construction Planning and Cost Estimator. The chief engineer and the person in charge of the design of irrigation and drainage facilities will go to the counterpart country to obtain the approval of the bid documents.

**(c) Bidding Stage**

Bidding will be carried out in Japan. The bidding work will be mainly handled by a team of three persons: a chief engineer, an irrigation and drainage facility designer, and a construction planner and estimator.

**(d) Supervision Stage**

Japanese resident construction management engineers shall be stationed in the target country and supervise the construction. The resident construction supervising engineer should visit the construction site every day and supervise the construction. They also report the progress to JICA office in Kathmandu and DRWI once a month. In this project, two engineers are dispatched as spot engineers; one is a geological engineer to check the ground condition after removal of the existing facilities, and the other is an irrigation engineer to adjust the temporary irrigation plan. In addition, the resident construction supervisor will employ a local engineer to support the construction supervision.

In addition, personnel engaged in the soft component shall be dispatched to engage in work based on the soft component plan.

### (e) Completion inspection and defect inspection

The completion and defect inspections shall be carried out by one Japanese consultant and the implementing agency in Nepal. Both the completion inspection and the defect inspection shall be carried out using a check sheet and the results shall be reported to JICA.

#### 2-2-4-5 Quality Control Plan

The Consultant shall instruct the Construction Contractor to carry out the analyses and tests shown in the table below and reflect the results in the quality control.

**Table 2-2-39 Quality Control Plan**

| Items                  | Contents                       | Method   | Frequency                        | Application Criteria                                    |
|------------------------|--------------------------------|--|----------------------------------|---|
| Foundation             | Bearing Capacity               | Load Test  | per Site                         | Japanese Standard                                       |
| Concrete               | Aggregate                      | Particle size analysis, abrasion test, surface water content, density test, water absorption rate test   | per Sampling location            | Japanese Standard                                       |
|                        | Cement                         | Check the ingredient list  | Once a month                     | Nepal Standard  |
|                        | Concrete                       | Slump test, air volume test, unit volume mass test, wash analysis test, and Compressive strength test, bending strength test                     | per day                          | Japanese Standard                                       |
| Reinforcement Bar      | Strength Reinforcement         | Check the mill sheet tensile strength dimensional inspection   | At each time of on-site delivery | Japanese Standard<br>Nepal Standard<br>British Standard |
| Formwork Supporting    | Installation Location Strength | Fixing position and method Design calculation sheet  | per part as necessary            | Japanese Standard                                       |
| Earthwork (Excavation) | Material                       | Density test of soil particles, particle size test, liquid limit test, plastic limit test, water content test, soil compaction test by thrusting | per major part                   | Japanese Standard                                       |
|                        | Construction Site              | Particle size distribution water content ratio test, penetration test, density test  |                                  |   |
| Wet Masonry            | Gravels                        | Taking measurements  | per site                         | Japanese Standard                                       |
|                        | Mortar                         | Sand-cement mixing ratio   |                                  |   |
| Structural Form        | Dimensions                     | dimensional inspection   | per Part                         | Japanese Standard                                       |

Source: JICA Survey Team

#### 2-2-4-6 Procurement Plan for Equipment and Materials

As for construction equipment, concrete plants, concrete mixer trucks, and generators are listed as materials and equipment that are difficult to procure in the Nepal. From the viewpoint of quality and stability of procurement schedule, it is considered appropriate to procure these materials and equipment from Japan. Other materials and equipment for the project can be basically procured in Nepal.

#### 2-2-4-7 Plan for guidance of operation and maintenance of facilities

As for the CUP, it is necessary to dispatch Japanese engineers and provide them with basic knowledge and guidance on work methods necessary for regular maintenance and management work, which is planned to be implemented under the soft component described below.

## 2-2-4-8 Soft Component

This project aims to improve the efficient and stable utilization of irrigation water by rehabilitating the irrigation canal facilities which are severely deteriorated due to aging in Chandra Nahar Irrigation Scheme. Therefore, the soft component activities are planned to provide technical guidance on maintenance and management work of the rehabilitated CUPs, aiming to ensure sustainable and efficient use of the rehabilitated facilities. The background is presented as follows.

### (1) Background to the technical guidance for the maintenance and management work of CUP

In the Canal Under Pass to be rehabilitated in this project, the flow velocity is higher than that in the earthen canal (open canal) section, and sediment deposition is relatively low. The flow in the vertical culvert (inflow side) is in the vertical downward direction. The flow in the horizontal culvert has a relatively long flow time, and sediment tends to accumulate in the culvert section. In addition, when trash such as plastic bottles and the like is piled up on the upstream side, it obstructs the flow and reduces the efficiency of irrigation water conveyance. Although this situation can be mitigated through the establishment of a maintenance management system, it is pointed out that, at present, the cleaning of CUPs by the Koshi Pump and Chandra Nahar Irrigation Management Office (hereinafter referred to as the Irrigation Management Office), which is the organization responsible for the operation and maintenance of the trunk canal, is not sufficient.

Therefore, in order to utilize the facilities rehabilitated in this project sustainably and efficiently, it is important to prepare a specific work plan and implementation plan for the removal of trash and sediment around the inflow area of the CUP, and to implement regular maintenance and management activities based on the plan.

In addition, this project proposes a form of CUP that minimizes sedimentation in the culvert pipe. This format facilitates the maintenance and management of the CUP, but the method of maintenance and management will be changed from the conventional facility. Therefore, it is necessary for the irrigation management office to learn the maintenance and management techniques of the new type of CUP.

### (2) Objective, outcomes and methods for verifying achievement of outcomes

| Result  | Activities   | Method of confirmation of results (indicators)   |
|---|--|--|
| Irrigation management office staff will learn how to properly maintain the Canal Under Pass after renovation. | Support for irrigation management office to acquire knowledge and skills for maintenance and management of CUP after rehabilitation. Assist Irrigation Management Office staff in developing draft maintenance work guidelines. Conduct practical work based on the draft maintenance work guidelines. | The percentage of correct answers by participants on the comprehension test pertaining to the knowledge and skills required for maintenance work will be **%. Draft working guidelines for the maintenance of CUPs will be developed. Cleaning work will be carried out by the Irrigation Management Office in accordance with the draft work guidelines for the maintenance of CUPs |

### (3) Activities

The activities required for the maintenance of the project-granted facilities are mainly as follows.

- a) Daily inspection and repair: Visually inspect the facilities through daily water management operations. If any defects are found, emergency repairs should be made.
- b) Annual Periodic Inspection and Repair: A periodic inspection shall be conducted once every year before the monsoon season by visually inspect the facilities. If any defects are found, repairs shall be carried out. The cleaning of trash attached to the screen and the sediment deposited in

the upstream and downstream vertical sections shall be carried out. The cross sectional drainage works will be dredged to remove the accumulated sediment in the cross-sectional small stream canal as necessary.

- c) Long-term periodic inspection and repair: Diagnose the soundness of the structure every five years as a guide. If there is a problem with the soundness, repair should be carried out. When inspecting the inside of a siphon pit in a canal, measure the oxygen concentration and provide sufficient ventilation to avoid oxygen deprivation and the danger to life caused by toxic gases.

In the soft component activities, the irrigation management office will learn the contents and methods of maintenance and management of the CUP to be developed in the project (maintenance and management techniques of new type of CUP), which will enable them to properly maintain the irrigation facilities.

#### (4) Activities to establish for appropriate maintenance and management of CUPs after rehabilitation

The maintenance work of the CUP can be carried out efficiently when the flow rate in the canal is low. Therefore, the maintenance work will be carried out in February to March, which is the period when the water flow in the target area is the lowest. The work is divided into two stages, i.e., (a) removal of screen trash and (b) removal of sediment in the inlet, and the outline of the work is assumed. In the soft component activities, the staff of Irrigation Management Office will prepare the draft work guideline which includes the following arrangements.

- a) Removal of screen trash: After the water in the canal is drained, workers enter the canal and remove the trash accumulated on the screen by hand. The removed garbage will be transported by truck to the waste disposal site designated by the local government for disposal.
- b) Removal of soil and sand from the CUP: After draining the water in the inlet and outlet of the CUP, the soil and sand is removed from the inside of the inlet to the outside. About three workers load the earth and sand into buckets inside the inlet and remove them by the workers outside. The removed sediment is returned to the canal because it was originally in the canal.

In order to establish the above siphon maintenance management system, the following activities will be implemented.

| Activities  | Consultants  |  | Input from Nepal Government   |
|---|--|--|---|
|   | Input  | Activity   |   |
| The irrigation management office will acquire knowledge and skills for the maintenance and management of CUPs after renovation. | Japanese : 0.25 man-months<br>Implementation of training<br>Provision of training instructors, training venues and teaching materials  | Provide classroom instruction and on-the-job training to irrigation management office staff on maintenance of retrofitted siphons. | Venue for classroom training<br>Irrigation Management Office staff: 2<br>Participation in training and compilation of training attendance records |
| Irrigation Management Office staff will develop draft maintenance work guidelines.  | Japanese:0.25 man-months<br>Support for preparation of draft work guidelines   | Assist the Irrigation Management Office in the development of draft work guidelines.   | Irrigation Management Office staff: 2<br>Preparation of draft working guidelines  |
| Conduct work practice based on the draft maintenance work guidelines  | Japanese: 1.0 person-months (1.0 person-months)<br>Civil engineer: 1 person (1.0 man-month)<br>Work caretaker: 1 person (1.0 person-month)<br>Workers: 5 (1.0 man-month)<br>Technical support for maintenance work | Provide technical guidance in the practice of maintenance work.  | Irrigation Management Office staff: 2<br>Equipment (tractor)  |

The following is a summary schedule and description of the soft component activities that form the basis

for the inputs.

### Activity-1: 0.25Months

|       |   |
|-------|---|
| Day-1 | A meeting is held with the director of Irrigation Management Office to discuss the implementation policy, and the trainees from Irrigation Management Office are selected. After that, the training site is prepared.                   |
| Day-2 | Test the trainees' baseline knowledge on maintenance of CUPs. Prepare classroom materials based on the test results.  |
| Day-3 | AM classroom lecture and PM site visit and training will be conducted. In the classroom lecture, basic knowledge about irrigation distribution, hydraulics about siphon, and machinery and labor about maintenance work will be taught. |
| Day-4 | Ditto   |
| Day-5 | The test of basic knowledge (revised version) conducted on the second day will be conducted again to check the status of picking up the knowledge. If there is insufficient mastery of the knowledge, it will be repaired.              |

Note: For consultant activities, 2.5 days will be added to the above schedule for overseas travel, intra-Nepal travel and preparation for activities.

### Activity-2: 0.25Monthes

|       |  |
|-------|--|
| Day-1 | Confirm the design policy and design (construction) drawings, and check the situation surrounding the CUP, the movement of sediment, garbage, etc. at the site.  |
| Day-2 | Organizing the situation at the site, etc. After that, check the case studies, prepare, confirm and discuss the draft work guidelines. Including on-site confirmation.   |
| Day-3 | Reviewing, preparing, confirming, and discussing examples of draft work guidelines. Including on-site confirmation.  |
| Day-4 | Preparation, review and discussion of draft working guidelines. After that, report to the Director of Irrigation Management Office and discussion.   |
| Day-5 | Refinement and finalization of the draft working guidelines.<br>Procedures such as ordering and contracting. In preparation for dredging work, we accompany contractors to check sites and discuss work policies. (4 CUPs) |

Note: 2.5 days will be added to the above schedule for the Consultant's activities to organize the design information and to compile the results of activities 1) and 2).

### Activity-3: 1.00Month

The following process is carried out for four cycles (for four facilities).

|              |   |
|--------------|---|
| Day-1~2      | Preparation, pump drainage and screen waste   |
| Day-3~4      | Removal of soil and sand from vertical gutter |
| Day-5        | Demobilization                                |
| Total 5 days | × 4 facilities = 20 days                      |

Note: As for the consultant's activities, 6 days for compiling the results of activities at each facility, reporting to responsible organizations, implementing agencies, JICA office, etc. in Kathmandu, 2 days for overseas and domestic travel, and 2 days for reserve days will be added to the above schedule.

## (5) Procurement of soft component implementation resources

The soft component support of the project is based on providing technical assistance to the irrigation management offices in charge so that they can practice maintenance and management on their own initiative.

In the implementation of the soft component activities, it is necessary to clarify the method of maintenance and the role of the Irrigation Management Office so that the maintenance can be carried out continuously. For this purpose, it is planned to be implemented under the guidance of experts using the resources of Nepal, including the Irrigation Management Office.

In this soft component activity, it is important for the irrigation management office technicians to acquire the skills. Two mid-level technicians with 10 to 15 years of experience will be selected from the members of the technical department assigned in the irrigation management office. The two trainees will learn specific arrangements in terms of work by observing the field work while acquiring supervisory techniques.

Regarding the materials and equipment for the soft component activities, a tractor will be used to remove the dredged material to the neighbourhood. Tractors can be utilized through the Irrigation Management Office with machinery owned by the Water Users Association.

### (6) Implementation plan for Soft Component Activity

The timing of the soft component activities should be after the completion of the facility maintenance and at a time when the amount of irrigation water is low, because the maintenance and management will be carried out in the field in view of the timing of the facility repair works and the use of irrigation water. Therefore, the project will be implemented for the completed facilities before the irrigation water for rainy season crops is fully supplied.

| Month                           | Aug                   | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr              | May | Jun | Jul | Aug | Sep | Oct                        | Nov | Dec | Jan       | Feb | Mar | Apr | May |  |
|---------------------------------|-----------------------|-----|-----|-----|-----|-----|-----|-----|------------------|-----|-----|-----|-----|-----|----------------------------|-----|-----|-----------|-----|-----|-----|-----|--|
| Conut.                          | 1                     | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9                | 10  | 11  | 12  | 13  | 14  | 15                         | 16  | 17  | 18        | 19  | 20  | 21  | 22  |  |
| Events                          | Start of construction |     |     |     |     |     |     |     | Irrigation Start |     |     |     |     |     | Completion of Construction |     |     |           |     |     |     |     |  |
| Guidance of Maintenance         |                       |     |     |     |     |     |     |     |                  |     |     |     |     |     |                            |     |     | 1.5months |     |     |     |     |  |
| Atc. 1: Guidance                |                       |     |     |     |     |     |     |     |                  |     |     |     |     |     |                            |     |     |           |     |     |     |     |  |
| Act. 2: Making a Working Policy |                       |     |     |     |     |     |     |     |                  |     |     |     |     |     |                            |     |     |           |     |     |     |     |  |
| Act. 3: Practical training      |                       |     |     |     |     |     |     |     |                  |     |     |     |     |     |                            |     |     |           |     |     |     |     |  |

Rainy Season

### (7) Output of Soft component

- Overall: Completion Report of Soft Component
- Result: Draft Guidelines for Maintenance and Management of CUPs  
Records of maintenance and management of CUPs

### (8) Responsibilities of the Government of Nepal

- a) Coordination of government officials and participants in the implementation of soft component activities
- b) Organizing, managing, and coordinating training and meetings related to soft component activities
- c) Preparation of draft guidelines for maintenance and management of CUPs
- d) Cleaning of CUP

### 2-2-4-9 Implementation Schedule

The weather in the target areas are divided into the dry season from April to late October and the wet season from early November to late March. The target components in this project are 8 CUPs, 9 CDWs and 15 CCBs, which brings the total number of construction sites to 32. All the structures are planned to be constructed in the dry season because the main body is concrete work. On the other hand, the bank protection works, which is a supplementary structure to the cross drainage works, can be carried out during the rainy season because it is masonry works.

The construction of the project at 32 locations should be carried out utilizing two dry seasons and one

rainy season from the viewpoint of workability. As for the preparatory works, 1.5 months will be set aside in the latter half of the rainy season in order to establish a system to start the main construction work immediately after the beginning of the dry season, and about 4 months will be set aside for the preparation of documents such as tariff procedures.

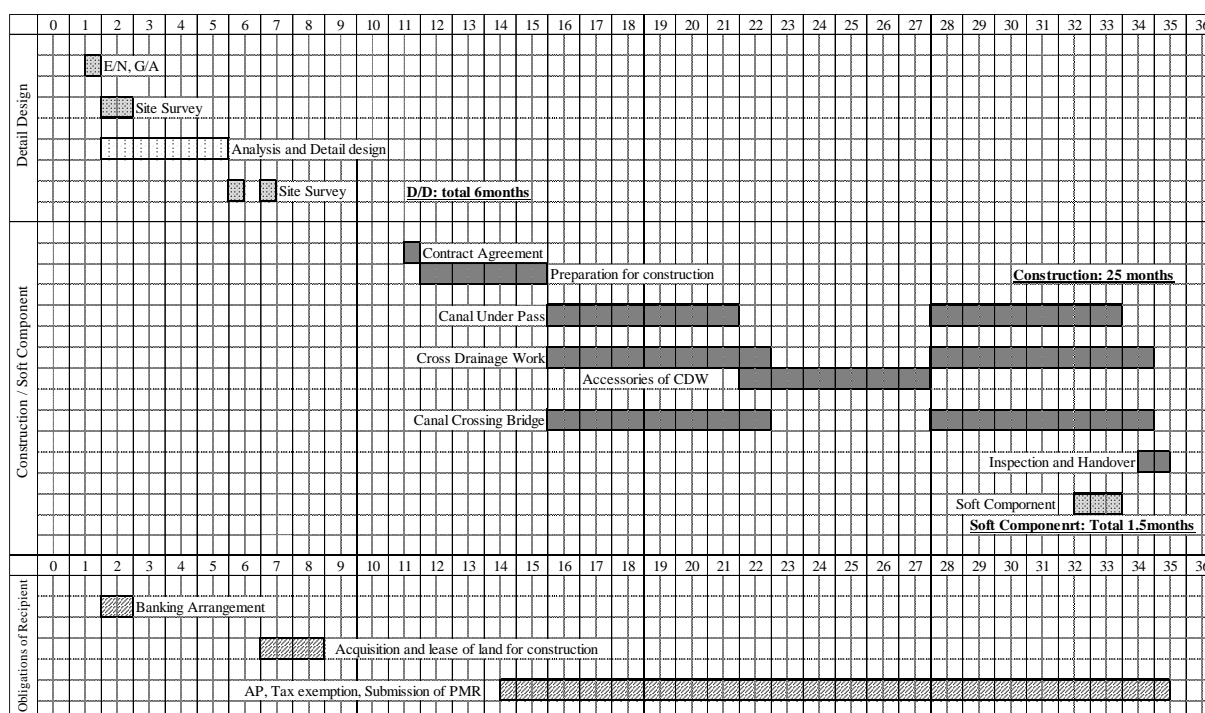
On the other hand, JST has been confirmed in discussions with the government of Nepal that obtaining a construction permit is not conducting for the start of construction. Instead of a construction permit, the implementing agency shall inform the local government and other relevant agencies as appropriate before the start of construction.

For this project, it is assumed that the E/N will be signed in July 2022 and then the contract will be signed in March 2023. This will result in an overall duration of 36 months.

**Table 2-2-40 Duration and number of months for design, construction supervision and construction work**

| Stage                               | Period  | Number of Months |
|-------------------------------------|---|------------------|
| Design and Construction Supervision | Mid-July 2022 – Mid-May 2025  | 36 months        |
| Construction Work                   | Mid-May 2023 – Mid-May 2025<br>(March to August 2023 is a preparation period) | 25 Months        |
| Defect Check                        | May 2026  | 0.23 Months      |

Source: JICA Survey Team



**Figure 2-2-6 Implementation Schedule for Whole Project (Tentative)**

### 2-3 Security Plan

No specific security threat risks have been identified around the project site. However, it shall be recommended that a security plan be put in place within the scope of work of the project, such as the installation of fences and barricades, appropriate deployment of security guards, and the establishment of a monitoring and communication structure, while sharing information among the related parties concerned as needed, because of the need to deal with unforeseen circumstances.

## 2-4 Obligations of Recipient Country

Nepalese side is responsible for following undertakings:

**Table 2-4-1 Obligations of recipient country**

| Item  | Summary  |
|---|--|
| Securing of land  | Secure the necessary land for the project.<br>Since this project is for the rehabilitation and maintenance of existing facilities, and the rehabilitation and maintenance will basically be carried out at the current location, the land will be within the canal site. However, some of the facilities (irrigation canal siphons) will require the acquisition of land due to changes in the planar alignment. The local residents have already been consulted and have agreed to the provision of land. The government of Nepal will ensure the smooth securing of land for implementation.   |
| Submission and approval of EMP  | Since the 2020 amendment to the Environmental Management Regulation (EPR), the project implementing agency has been designated as the reviewing and approving agency for the IEE and Brief Environmental Report.<br>The main purpose of the monitoring is to ensure that the compensation and support planned in the RAP have been provided to the affected people in a timely manner and that their livelihoods have been restored to at least the same or better level than before the project was implemented. DWRI, the implementing agency of the project, will prepare the monitoring form and submit it to JICA with the cooperation of the Land Acquisition and Compensation Committee in the county.  |
| Refund of VAT on the purchase of construction materials and equipment | In order to obtain a refund of VAT, construction companies need to request a tax registration form from the local tax office and register. After the registration, they will be able to apply for the refund. Specifically, you need to electronically enter your refund request on the local tax office website and submit an Invoice with a refund recommendation request letter from the implementing agency. After the registration information and required documents are verified by the tax agency, the refund will be made by check.   |
| Import tax exemption  | Import taxes incurred at the time of import shall be dealt with through prior exemption procedures.<br>The builder sends a request for approval of the master list to the implementing agency. After the master list is approved by the relevant ministries and agencies of the implementing agency, the application is submitted to the Ministry of Finance, the approval is granted by the Ministry of Taxation, and the implementing agency and tax bureau are notified.<br>The builder must apply for a duty-free import permit for each import. The builder submits the necessary documents to the implementing agency, the implementing agency submits the duty exemption letter to the customs bureau, and after the master list is verified, the duty exemption letter is sent to the relevant customs office. |

## 2-5 Project Operation Plan

### 2-5-1 Proprietary Right and Operation and Maintenance

All the project target structures are on the Main canal. Property rights belongs to the Nepal Government and Koshi Pump, Chandra Nahar Irrigation Management Office (KPCNIMD) is responsible for maintenance.

### 2-5-2 Operation Plan

Target facilities of the Project are Canal Under Passes (CUPs), Cross Drainage Works (CDWs) and Canal Crossing Bridges (CCBs). Operation plan is not prepared as none of the target facilities need operation.

### **2-5-3 Maintenance Plan**

#### **(1) Activity**

The following maintenance activities are proposed.

- a) Ordinary check and maintenance:  
Facilities will be checked through day-to-day O&M works. Immediate amendment will be made as need arises.
- b) Annual regular inspection and maintenance:  
Outer appearance of facilities will be inspected annually by visual means. Reparation will be made if it is necessary. Rubbish trapped by inlet screen of CUPs and sludge/sedimentation accumulated in inlet/outlet of CUP should be removed. Sedimentation in the irrigation canal should also be removed especially at points of CDWs as need arises.
- c) Five-year regular inspection and maintenance:  
Soundness of structures will be checked and evaluated about once in five years. Structural rehabilitation will be made as necessity requires. It should be noted that measurement of oxygen density and provision of appropriate air ventilation are required for inspection inside the CUP tunnels to avoid life-threatening trouble caused by oxygen deficiency or toxic gas.

#### **(2) Economic Feasibility**

O&M cost of project target facilities is estimated 399,360 NRs. Considering that annual O&M budget of the IMD for Chandra Nahar irrigation is about 39 million NRs, it is possible for the IMD to secure maintenance budget of project target facilities.

#### **(3) Technical Feasibility**

The IMD has been maintained aging Chandra Nahar irrigation system for nearly 100 years. This fact shows that the IMD has certain level of technical capacity to maintain project target facilities. However, there are a few concerns as described below.

##### **1) Maintenance of new type CUP**

The Project proposes to change the type of CUPs to make its O&M easy. Although O&M of CUPs will become easy, process of O&M works will be different from the previous one. It is necessary for the IMD staff to learn and master the new O&M method to maintain new CUPs.

To combat this issue, “technical training on new type CUP” is proposed as a of soft component activities. Maintenance of new type CUPs by the IMD becomes possible, if the IMD staff could learn appropriate maintenance method of new type CUP.

##### **2) Information management of irrigation system maintenance**

The Koshi Pump, Chandra Nahar Irrigation Management Office is taking measures to deal with problems such as repairing collapsed parts of embankments and improving river revetments.

However various types of important information on irrigation system maintenance, such as canal layout and record of maintenance, are not stored in the office of IMD. Hence, it is necessary to improve information management of the IMD and make important information available even in the future.

## 2-6 Project Cost Estimation

### 2-6-1 Initial Cost Estimation

#### (1) Cost borne by Japanese side

As for the initial cost born by the Japanese side, it is confidential until the bidding for construction is carried out. Among the overall project costs, Nepalese side shall bear the costs partially according to the work sharing between both governments.

**Table 2-6-1 Cost borne by Japanese side**

|                     |
|---------------------|
| <u>Confidential</u> |
|---------------------|

#### (2) Cost borne by Nepalese side

**Table 2-6-2 Costs borne by the Government of Nepal**

| Items   | Estimated Cost<br>(1,000 NRs) | Converted Price<br>(1,000 JPY) |
|---|-------------------------------|--------------------------------|
| To secure the necessary budget and implement land acquisition and resettlement and compensation with full replacement cost in accordance with RAP   | 3,799                         | 3,498                          |
| To implement environmental & social monitoring, and to submit the monitoring results to JICA  | 248                           | 228                            |
| To secure and clear the following lands for widening and replacing by rehabilitation of facilities temporary construction yard and stock yard   | 277                           | 255                            |
| To clear, level and reclaim the sites, and remove utilities such as power poles, power and water pipe or other public facilities, if necessary.   | 1,300                         | 1,197                          |
| To bear the following commissions to the Agent Bank for the banking services based upon B/A   | 5,000                         | 4,605                          |
| To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the country of the Recipient with respect to the purchase of the products and/or the services be exempted | 238,000                       | 219,174                        |
| To implement social monitoring, and to submit the monitoring results to JICA  | 308                           | 284                            |
| Total   | 248,932                       | 229,241                        |

#### (3) Conditions for cost estimation

- a) Base month of estimation: May, 2021
- b) Exchange rate: 1US\$=108.85JP¥, 1NRs=0.9209JP¥
- c) Period of construction: Refer to implementation schedule for detail
- d) Others : This project cost estimation is to be completed in accordance with the guidelines for Grant Aid assistance of Japanese government. The rate for the grant for contingencies will be determined later by the Ministry of Foreign Affairs, Japan.

## 2-6-2 Operation and Maintenance Cost

The cost for maintenance of the project facilities is expected to be NRs399,360/year. The breakdown is shown in the table.

In the calculation of operation and maintenance cost, routine maintenance such as periodic inspection, dredging of sediment in the channel, removal of garbage, etc. have been carried out in the past. However, it is difficult to say that the repair of structures has been properly carried out. Therefore, it is necessary for concrete structures to be repaired as needed to maintain their functions in a sustainable manner.

Periodic inspections and routine maintenance should be carried out before and after the rainy season, and repairs should be carried out once before the rainy season and three times when the need is confirmed by periodic inspections, for a total of four times.

Considering that the annual maintenance budget of the Irrigation Management Office for Chandra Nahar Irrigation is 39 million NRs, the maintenance cost of the facilities provided by the Irrigation Management Office for the project can be paid without any problem.

**Table 2-6-3 Annual Cost of Maintenance for the target facilities**

| Facility   | Inspection item  | frequency                                      | Qty. of engineer | Necessary equipment                            | Qty.                | Cost (NRs) |
|--|--|--|------------------|--|---------------------|------------|
| <b>(1) Daily Inspection</b>  |  |  |                  |  |                     |            |
| CUP, CDW, CCB<br>- Main Facility<br>- Bank Protection<br>- Inlet and Outlet                        | Deterioration/damage, sedimentation<br>Deformation/damage<br>Sediment accumulation, waste accumulation | Twice a year<br><br>Duration:<br>3days/set     | 2 persons        | Shovel<br>Sickle<br>Small truck                | 12 PD/year          | 18,720     |
| <b>(2) Daily Maintenance</b>   |  |  |                  |  |                     |            |
| CUP, CDW, CCB<br>- Main Facility<br>- Inlet and Outlet   | Cleaning, removal of sediment and miscellaneous materials, grass cutting                               | Once a year<br><br>Duration:<br>5days/set      | 6 persons        | Shovel<br>Sickle<br>Small truck<br>Broom       | total<br>60PD/year  | 93,600     |
| <b>(3) Repairing</b>   |  |  |                  |  |                     |            |
| CUP, CDW, CCB<br>- Main Facility,<br>Inlet and Outlet<br>- Protection works<br>- Bridges<br>- Gate | Repairing damaged parts<br>Repair damaged parts<br>Repair guardrails<br>Paint on steel parts           | 4 times per year<br><br>Duration:<br>1 day/set | 6 persons        | Handy hummer<br>Mortar and etc.<br>Small truck | total<br>24PD/year  | 37,440     |
| <b>(4) Cleaning</b>  |  |  |                  |  |                     |            |
| CUP × 8  | Removal of garbage   | 10 days/facility*3                             | 2 persons        | Winch<br>Small truck                           | total<br>160PD/year | 249,600    |
| <b>Total</b>   |  |  |                  |  | 256PD               | 399,360    |

\*1 PD = Pearson Day

\*2 labor cost =1,560NRs/day

\*3 Monsoon season 2days/month × 4 months + winter season 1day/month × 2 months = total 10 days.

## **Chapter 3 Project Evaluation**



## **Chapter 3 Project Evaluation**

### **3-1 Preconditions**

The preconditions for the implementation of this project, which require special attention, are as follows.

#### **(1) Acquisition of environmental certification**

Environmental assessment in Nepal requires an Initial Environmental Examination (IEE) to be conducted and environmental permits to be obtained under the revised Environmental Protection Rule (2020).

#### **(2) Land Acquisition**

This project is for the rehabilitation and improvement of existing facilities, and since the rehabilitation is to be carried out at the current location, it will be carried out within the canal site, but since some parts of the canal alignment will have to be changed, it is necessary for the Nepal side to secure a smooth site for implementation.

#### **(3) Tax Exemption**

Value-added tax refunds, import tax exemptions, etc. MoEWRI must work with the relevant government agencies to expedite the implementation of these exemptions.

### **3-2 Necessary Input by Recipient Country**

#### **(1) Cooperation with stockholders and assignment of C/P**

The project will be led by the Ministry of Energy and Water Resources and the Irrigation, which are the implementing agencies. And at the field level, the Koshi Pump Chandra Irrigation Management Office, which operates and manages the Chandra irrigation system, will be directly involved in the project.

In the rehabilitation and maintenance of the irrigation system, temporary canals and detours are planned to be constructed so as not to affect the year-round farming activities. In order to implement the project, it is important to understand the irrigation water supply plan for the Main canal in advance and to inform the local residents of the details and timing of the project. For this purpose, it is essential to share information with the WUA, which is composed of farmers.

Therefore, for the smooth implementation of this project, it is necessary to cooperate with the WUA in addition to the implementing agencies, namely the Ministry and Department and the Koshi Pump Chandra Irrigation Management Office.

#### **(2) Soft Component Activity**

The soft component of the project plans to provide guidance on how to maintain and manage the irrigation CUPs to be rehabilitated and improved. Regular maintenance and management of the CUP is necessary to operate the facility without interfering with its functions, and the participation of engineers from the Koshi Pump and Chandra Irrigation Management Office during implementation is necessary to achieve the results of the soft component.

### **(3) Assistance to the Chandra Canal Irrigation System (CCIS)**

The staff and budget of the Koshi Pump and Chandra Irrigation Management Office, which is responsible for the operation and maintenance of the said irrigation system, should be continuously allocated to continue the operation and maintenance of the Main canal, disaster recovery work and support to farmers.

### **3-3 Important Assumptions**

The external conditions for the implementation of the project are as follows.

#### **(1) Economic Disruption**

With an average economic growth rate of 4.6% over the past decade, the country was expected to be removed from the LDC designation in 2021, as it surpassed the criteria for LDC recognition. However, the impact of the coronavirus (COVID-19) since the beginning of 2020 has been significant, resulting in a negative growth rate (-1.88%) in year 2019/20. Therefore, it is estimated that it will take about another five more years to be removed from the LDC designation. The impact of COVID-19 is an external condition for project implementation that the number of staff and budget amount of the Irrigation Management Office will not be significantly reduced due to the disruption caused by the low growth.

#### **(2) Non-large Scale Natural Disasters**

Although the project area has been affected by earthquakes and floods in the past, the facilities have been rehabilitated and improved in each case. The impacts of such disasters were resulted in the localized damage to the facilities. The external condition for project implementation is that there will be no large-scale natural disasters that would affect most of the facilities in the irrigation system.

#### **(3) Public Safety**

Currently, there is no significant issue in the security situation in the project site, and the local security situation is stable with no major security concerns. However, in March 2021, a bombing of a government facility occurred by a rebel group in the adjacent Siraha District (9 people injured). In implementing the project, it is necessary to confirm the latest security information through C/P and other related parties. Since such a deterioration of security could seriously impede the activities of project-related personnel, an external condition for project implementation is that the security situation does not deteriorate significantly.

#### **(4) Restriction of travel and local activity due to spreading COVID-19**

As of May 2022, the infection of COVID-19 in Nepal has not serious and life has returned to the similar situation as before the beginning of pandemic. However, it is necessary to understand the possibility that restrictions of travel and local activity if variant of COVID-19 would discover and spread. If such a restrictions are issued, the progress of the project may be severely compromised. Therefore, an external factor in the implementation of the project is that the infection situation of the COVID-19 does not worsen.

### **3-4 Project Evaluation**

#### **3-4-1 Relevance**

This project is considered to have validity to be implement as a Japanese Grant Aid project because of the following reasons.

##### **(1) Beneficial Target of the Project**

The 35,000 beneficiary households of the Chandra Irrigation System, depend on the system for their livelihood. By upgrading the major components of the 100-year-old irrigation system, sustainable irrigated agriculture will be possible. And by reducing water leakage and improving conveyance efficiency, irrigated agriculture will be possible as originally planned, directly benefiting 35,000 households. Indirectly, the increase in crop production will benefit agriculture-related facilities such as rice mills and collection and shipping centres, and service sector such as stores inside and outside of the irrigation system.

##### **(2) Development Plan in Nepal**

In the 15th Five-Year Plan, the latest national development plan, "Prosperous Nepal, Happy Nepal" is set as the long-term vision, and "Sustainable High Production and Productivity" is set as one of the 10 major items to achieve the vision. One of the 10 main goals of the plan is to achieve "sustainable high production and productivity." The specific goals for "sustainable high production and productivity" are to increase productivity through irrigated agriculture and to secure farmland that can be cultivated year-round, and the renewal of the aging irrigation system will contribute to achieving such goals.

##### **(3) Japanese Aid Policy**

The government of Nepal has set a goal of "shifting from being the poorest country in the world by 2022" and is working on the task of stabilizing society by promoting economic growth and spreading the benefits to the entire population. Against this background, four priority areas have been identified and support is being provided in order to encourage the efforts of the government of Nepal. This project is positioned as one of such priority areas, "Poverty Alleviation and Quality of Life Improvement," and aims to support poverty alleviation and quality of life improvement by increasing agricultural productivity and income through the dissemination of agricultural technologies, and improving the level of health care, education, and other services. Support for the stable irrigated agriculture, rather than unstable rain-fed agriculture, is required.

#### **3-4-2 Effectiveness**

This Project is judged to possess effectiveness due to the following quantitative and qualitative effects.

##### **(1) Quantitative effects**

Quantitative effects to be expected are shown in the table herein below.

**Table 3-4-1 Indicator for Quantitative Effects**

| Index                        | Baseline (2021) | Target value*1 | Remarks                                  |
|------------------------------|-----------------|----------------|--|
| Irrigable Area               |                 |                |  |
| (a) Rainy Season Crop (Rice) | 6,500 ha        | 7,800 ha       | Irrigable Area will increase by 1,300ha. |
| (b) Dry Season Crop (Wheat)  | 4,320 ha        | 5,200 ha       | Irrigable Area will increase by 880ha.   |
| Yield                        |                 |                |  |
| (c) Rainy Season Crop (Rice) | 30,900 ton      | 32,850 ton     | Yield will increase by 1,950ton.         |
| (d) Dry Season Crop (Wheat)  | 8,900 ton       | 10,700 ton     | Yield will increase by 1,800ton.         |

\*1: Target means 3 years after the completion of the project  
Where,

- (a) Irrigable area (Rainy season crop: Rice): Increase 20% irrigable area by improving the leakage of CUP.
- (a)-1 Baseline 6,500ha (Current irrigated area according to the interview with irrigation management office.)
- (a)-2 Target value 7,800ha (in the case of improving 20% leakage of CUP.  $6,500 \times 1.2 = 7,800$ ha)
- (a)-3 1,300ha can be irrigated by improving 20% leakage of CUP. ( $7,800 - 6,500 = 1,300$ )
- (b) Irrigable area (Dry season crop: Wheat): Since dry-season crops are grown under irrigation, the increase in flow rate directly affects into an increase in the area.
- (b)-1 Baseline 4,320ha (Planting rate  $48\% \times 9,000$ ha. Note: 48%: is referred from Table2-2-6. 9,000ha is referred from table 2-2-2.)
- (b)-2 Target Value 5,200ha (in the case of improving 20% leakage of CUP.  $4,320 \times 1.2 = 5,184$ ha  $\approx 5,200$ ha)
- (b)-3 880ha can be irrigated by improving 20% leakage of CUP. ( $5,200 - 4,320 = 880$ )
- (a) Yield (Rainy season crop): the value is on Cropping Area 9,000ha
- (c)-1 Baseline:  $3.85\text{ton/ha} \times 6,500 + 2.35\text{ton/ha} \times 2,500\text{ha} = 30,900\text{ton}$
- (c)-2 Target Value:  $3.85\text{ton/ha} \times 7,800 + 2.35\text{ton/ha} \times 1,200\text{ha} = 32,850\text{ton}$
- Where,
- (c)-3 Each area: referring to index (a). Total are 9,000ha is referred from Table 2-2-2.
- (c)-4 Yield of irrigated paddy 3.85ton/ha. (the yield of Irrigation Paddy is referred from the middle rate between 3.5 ~4.2ton/ha.
- (c)-5 Yield of rained cropping paddy 2.35ton/ha (cf. table 2-2-2)
- (c)-6 The yield of the increase in irrigated area (1,300 ha) is 1,950 tons ( $32,850 - 30,900 = 1,950$ )
- (b) Yield (Dry season crops): 2.05ton/ha
- (d)-1 Baseline:  $4,320\text{ha} \times 2.05\text{ton/ha} = 8,856 \approx 8,900\text{ton}$
- (d)-2 Target value:  $5,200\text{ha} \times 2.05\text{ton/ha} = 10,660 \approx 10,700\text{ton}$
- Where,
- (d)-3 Each Are: referring to index (b).
- (d)-4 Yield of wheat 2.05ton/ha (cf. Table 2-2-2)
- (d)-5 The yield of the increase in irrigated area (880ha) is 1,800 tons. ( $10,700 - 8,900 = 1,800$ )

Source: JICA Survey Team

## **(2) Qualitative Effects**

Qualitative effects to be expected are as follow.

### **a) Stable Supplying of Irrigation Water through Preventing of the collapses of the Target Facilities**

**Canal Under Passes and Cross Drainage Works:** Collapse of the facilities will make irrigation water supply to the beneficiary areas impossible. As a result, rainy-season crops will be depend solely on rain and unit yield will be reduced from the current 3.42 tons/ha to 2.35 tons/ha and production from 30,900 tons to 21,150 tons. In the dry season, cultivation of wheat equivalent to 4,320 hectares will be impossible due to lack of irrigation water. Therefore, rehabilitation and maintenance of the facilities will enable more efficient farming activities to be sustained.

**Canal Crossing Bridge:** Collapse of the facility will significantly reduce the conveyance efficiency in supplying irrigation water to the beneficiary areas. As a result, the irrigable area for both rainy and dry season will be reduced, and the farming will become more dependent on rain water, resulting in a decrease in yield to values close the case of collapse of the CUPs and CDWs. Therefore, more efficient farming activities can be sustained by rehabilitating and improving the facilities.

### **b) Ensure Safety and Convenience of Access through Rehabilitation of Bridge as of Rural and Domestic Roads..**

**Canal Crossing Bridge:** Collapse of an existing bridge can be a major disaster for smooth traffic movement within the Chandra Nahar irrigation system and neighboring residents. Even if there is few traffic movement, due to the collapse of the bridge, people will be forced to bypass the adjacent bridge, which will increasing the access distance to the collection and shipping area and rice mill by about 1.9 km (the average bypass distance of 15 bridges in the case of a bridge collapse). Therefore, the rehabilitation and maintenance of this facility will prevent congestion and accidents from occurring and secure access to the road, which is used not only as an agricultural road but also as a community road.



## **Appendix**



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- Appendix-2 Survey Schedule
- Appendix-3 List of Parties concerned in the Recipient country
- Appendix-4 Minutes of Discussion
- Appendix-5 Soft Component Plan



## Appendix-1 Member List of the Survey Team

### (1)The First Preparatory Survey (March 2021 ~ May 2021)

| Name              | Assignment   | Occupation         | Remote |
|-------------------|--|--------------------|--------|
| Azechi Tomohiro   | Team Leader  | Director, JICA HQ  | ✓      |
| Nagayo Narihideo  | Member   | Advisor, JICA HQ   | ✓      |
| Matsui Hayao      | Member   | JICA HQ            | ✓      |
| Sato Fusashige    | Consultant Leader<br>Irrigation and Drainage Plan & Facility Designing (1)     | NTCI* <sup>1</sup> |        |
| Shukuya Kazuaki   | Vice Consultant Leader<br>Cana Crossing Bridge Plan & Facility Designing (1)-1 | NTCI               | ✓      |
| Nishi Mototaka    | Irrigation and Drainage Plan & Facility Designing (2)                          | NTCI               |        |
| Inoue Toru        | Cana Crossing Bridge Plan & Facility Designing (1)-2                           | NTCI               |        |
| Takeda Yoshimi    | Cana Crossing Bridge Plan & Facility Designing (2)                             | NTCI               | ✓      |
| Mitsui Ayako      | Farming / Instructional management (1)   | NK* <sup>2</sup>   |        |
| Tsurui Jun        | Water Management / Facility O&M<br>/ Instructional management (2)              | NK                 |        |
| Koyama Tomoaki    | Construction Plan (1) / Cost Estimation  | NTCI               |        |
| Wakabayashi Keita | Natural Condition Survey / Construction Plan (2)                               | NTCI               |        |
| Nakamura Kenji    | Environmental and Social Safeguard   | NTCI               |        |

\*<sup>1</sup> NTC International Co., Ltd. (Consultant Firm)

\*<sup>2</sup> Nippon Koei Co., Ltd. (Consultant Firm)

### (2)The Second Preparatory Survey (December 2021)

| Name            | Assignment   | Occupation         | Remote |
|-----------------|--|--------------------|--------|
| Sato Katsumasa  | Team Leader  | Advisor, JICA HQ   | ✓      |
| Mano Sachiko    | Member   | JICA HQ            | ✓      |
| Sato Fusashige  | Consultant Leader<br>Irrigation and Drainage Plan & Facility Designing (1)     | NTCI* <sup>1</sup> |        |
| Shukuya Kazuaki | Vice Consultant Leader<br>Cana Crossing Bridge Plan & Facility Designing (1)-1 | NTCI               | ✓      |
| Koyama Tomoaki  | Construction Plan (1) / Cost Estimation  | NTCI               |        |
| Nakamura Kenji  | Environmental and Social Safeguard   | NTCI               |        |

\*<sup>1</sup> NTC International Co., Ltd. (Consultant Firm)

## Appendix-2 Survey Schedule

### (1)The First Preparatory Survey (March 2021 ~ May 2021)

#### Activity Category

Site Survey: Inspection of each facility condition, Confirmation of surrounding condition around the target site, etc.

Meeting (\*): Meeting with Government such as central and/or local office. Spelling the organization name in (\*).

Cf; MoEWRI: Ministry of Energy, Water Resources and Irrigation, DWRI: Department of Water Resources and Irrigation, IMO: Irrigation Management Office of DWRI in Rajibiraji, WUA: Water Users Association

Reporting: Reporting, Organizing Information, and Administration and logistic work

Move 1-1: International movement (Narita – Doha (transit) - Kathmandu)

Move 1-2: International movement (Kathmandu - Doha (transit) - Narita)

Move 1-3: International movement (Kathmandu - Narita)

Move 2-1: Domestic movement (from Kathmandu to Itahari (Accommodate point near the site))

Move 2-2: Domestic movement (from Itahari to Kathmandu)

Q: Quarantine for COVID-19

O: Others

| Date     | Sato                         | Nishi        | Inoue        | Mitsui | Tsurui       | Koyama                                     | Wakabayashi  | Nakamura     |
|----------|------------------------------|--------------|--------------|--------|--------------|--|--------------|--------------|
| 2021     |                              |              |              |        |              |  |              |              |
| 12-March | Move 1-1                     |              |              |        |              | Move 1-1                                   |              |              |
| 13-March | Move 1-1 / Q                 |              |              |        |              | Move 1-1 / Q                               |              |              |
| 14-March | Reporting / Q                |              |              |        |              | Reporting / Q                              |              |              |
| 15-March | Reporting / Q                |              |              |        |              | Reporting / Q                              |              |              |
| 16-March | Reporting / Q                |              |              |        |              | Reporting / Q                              |              |              |
| 17-March | Reporting / Q                |              |              |        |              | Reporting / Q                              |              |              |
| 18-March | Reporting / Q                |              |              |        |              | Reporting / Q                              |              |              |
| 19-March | Reporting / Q                |              |              |        |              | Reporting / Q                              |              |              |
| 20-March | Reporting / Q                |              |              |        |              | Reporting / Q                              |              |              |
| 21-March | Reporting / Q                |              |              |        |              | Reporting / Q                              |              |              |
| 22-March | Reporting / Q                |              |              |        |              | Reporting / Q                              |              |              |
| 23-March | Reporting                    |              |              |        |              | Reporting                                  |              |              |
| 24-March | Reporting                    |              |              |        |              | Reporting                                  |              |              |
| 25-March | Meeting (DWRI)               |              |              |        |              | Meeting (DWRI)                             |              |              |
| 26-March | Meeting (MoEWRI)             |              |              |        |              | Meeting (MoEWRI)                           |              |              |
| 27-March | Move 2-1                     |              |              |        |              | Move 2-1                                   |              |              |
| 28-March | Meeting (IMO)<br>Site Survey |              |              |        |              | Meeting (IMO)<br>Site Survey               |              |              |
| 29-March | Site Survey                  |              |              |        |              | Site Survey                                |              |              |
| 30-March | Site Survey                  |              |              |        |              | Site Survey                                |              |              |
| 31-March | Site Survey                  |              |              |        |              | Site Survey                                |              |              |
| 1-April  | Move 2-2                     | Move 1-1     | Move 1-1     |        |              | M2-2                                       | Move 1-1     |              |
| 2-April  | Reporting                    | Move 1-1 / Q | Move 1-1 / Q |        |              | Reporting                                  | Move 1-1 / Q |              |
| 3-April  | Reporting                    | Q            | Q            |        |              | Reporting                                  | Q            |              |
| 4-April  | Reporting                    | Q            | Q            |        |              | Reporting                                  | Q            |              |
| 5-April  | Reporting                    | Q            | Q            |        |              | O (Study trip of Nagdhunga Tunnel Project) | Q            |              |
| 6-April  | M2-1                         | Q            | Q            |        |              | M2-1                                       | Q            | Move 1-1     |
| 7-April  | Site Survey                  | Q            | Q            |        |              | Site Survey                                | Q            | Move 1-1 / Q |
| 8-April  | Site Survey                  | Q            | Q            |        |              | Site Survey                                | Q            | Q            |
| 9-April  | Site Survey                  | Q            | Q            |        |              | Site Survey                                | Q            | Q            |
| 10-April | Site Survey                  | Q            | Q            |        | Move 1-1     | Site Survey                                | Q            | Q            |
| 11-April | Site Survey                  | Q            | Q            |        | Move 1-1 / Q | Site Survey                                | Q            | Q            |
| 12-April | Site Survey                  | Move 2-1     | Move 2-1     |        | Q            | Site Survey                                | Move 2-1     | Q            |

| Date     | Sato                         | Nishi                        | Inoue                        | Mitsui                                       | Tsurui  | Koyama                       | Wakabayashi                  | Nakamura  |
|----------|------------------------------|------------------------------|------------------------------|--|---|------------------------------|------------------------------|---|
| 2021     |                              |                              |                              |  |   |                              |                              |   |
| 13-April | Meeting (IMO)<br>Site Survey | Meeting (IMO)<br>Site Survey | Meeting (IMO)<br>Site Survey |  | Q   | Meeting (IMO)<br>Site Survey | Meeting (IMO)<br>Site Survey | Q   |
| 14-April | Site Survey                  | Site Survey                  | Site Survey                  |  | Q   | Site Survey                  | Site Survey                  | Q   |
| 15-April | Site Survey                  | Site Survey                  | Site Survey                  |  | Q   | Site Survey                  | Site Survey                  | Q   |
| 16-April | Site Survey                  | Move 2-2                     | Site Survey                  |  | Q   | Move 2-2                     | Site Survey                  | Q   |
| 17-April | Site Survey                  | Reporting                    | Site Survey                  |  | Q   | Reporting                    | Site Survey                  | Move 2-1  |
| 18-April | Site Survey                  | Reporting                    | Site Survey                  | Move 1-1                                     | Q   | Reporting                    | Site Survey                  | Site Survey   |
| 19-April | Reporting                    | Move 1-2                     | Site Survey                  | Move 1-1 / Q                                 | Q   | Move 1-2                     | Site Survey                  | Site Survey   |
| 20-April | Reporting                    | Move 1-2                     | Site Survey                  | Q  | Q   | Move 1-2                     | Site Survey                  | Site Survey   |
| 21-April | Move 2-2                     |                              | Site Survey                  | Q  | Move 2-1                                      |                              | Flow velocity survey         | Site Survey   |
| 22-April | Meeting (DWRD)               |                              | Site Survey                  | Q  | Site Survey                                   |                              | Flow velocity survey         | Site Survey   |
| 23-April | Meeting (MoEWRI)             |                              | Site Survey                  | Q  | Site Survey                                   |                              | Flow velocity survey         | Site Survey   |
| 24-April | Move 1-2                     |                              | Site Survey                  | Q  | Meeting (IMO)<br>Site Survey                  |                              | Flow velocity survey         | Site Survey   |
| 25-April | Move 1-2                     |                              | Site Survey                  | Q  | Reporting                                     |                              | Flow velocity survey         | Meeting with rerated parsons environment and social |
| 26-April |                              |                              | Site Survey                  | Q  | Reporting                                     |                              | Reporting                    | Meeting with rerated parsons environment and social |
| 27-April |                              |                              | Meeting (IMO)                | Q  | Town office Meeting<br>Village office Meeting |                              | Meeting (IMO)                | Meeting with rerated parsons environment and social |
| 28-April |                              |                              | Move 2-2                     | Q  | WUA Meeting                                   |                              | Move 2-2                     | Meeting with rerated parsons environment and social |
| 29-April |                              |                              | Reporting                    | Reporting Meeting (local consultant company) | Reporting                                     |                              | Reporting                    | Meeting with rerated parsons environment and social |
| 30-April |                              |                              | Reporting                    | Reporting Meeting (local consultant company) | Town office Meeting<br>Village office Meeting |                              | Reporting                    | Meeting with rerated parsons environment and social |
| 1-May    |                              |                              | Move 1-2                     | Move 1-2                                     | Reporting                                     |                              | Move 1-2                     | Reporting   |
| 2-May    |                              |                              | Move 1-2                     | Move 1-2                                     | Reporting                                     |                              | Move 1-2                     | Reporting   |
| 3-May    |                              |                              |                              |  | Move 2-2                                      |                              |                              | Move 2-2  |
| 4-May    |                              |                              |                              |  | Reporting                                     |                              |                              | Reporting   |
| 5-May    |                              |                              |                              |  | Reporting                                     |                              |                              | Reporting   |
| 6-May    |                              |                              |                              |  | Move 1-3                                      |                              |                              | Move 1-3  |

## (2)The Second Preparatory Survey (December 2021)

| Date        | Sato K.   | Mano | Sato F.             | Shukuya | Koyama              | Nakamura |
|-------------|---|------|---------------------|---------|---------------------|----------|
| 2021        |   |      |                     |         |                     |          |
| 9-December  |   |      | Move 1-1            |         | Move 1-1            |          |
| 10-December |   |      | Move 1-1            |         | Move 1-1            |          |
| 11-December |   |      | Move 2-1            |         | Move 2-1            |          |
| 12-December |   |      | Meeting (IMO)       |         | Meeting (IMO)       |          |
| 13-December |   |      | Move 2-2            |         | Move 2-2            |          |
| 14-December |   |      | Meeting (DWRI)      |         | Meeting (DWRI)      |          |
| 15-December |   |      | Meeting<br>(MoEWRI) |         | Meeting<br>(MoEWRI) |          |
| 16-December | Discussion of Outline Design (DOD)<br>JICA Nepal Office Meeting |      |                     |         |                     |          |
| 17-December | Courtesy call to Japanese Embassy in Nepal                      |      |                     |         |                     |          |
| 18-December |   |      | Reporting           |         | Reporting           |          |
| 19-December |   |      | Move 1-2            |         | Move 1-2            |          |
| 20-December |   |      | Move 1-2            |         | Move 1-2            |          |

## Appendix-3 List of Parties concerned in the Recipient country

### (1)The First Preparatory Survey (March 2021 ~ May 2021)

#### ◇ Ministry of Energy, Water Resources and Irrigation

- ◆ Madhu Sudan Adhikari, Secretary
- ◆ Sarita Dawadi Joint Secretary

#### ◇ Department of Water Resources and Irrigation

- ◆ Madhukar Rajbhandari, Director General,
- ◆ Krishna Nepal Deputy Director General
- ◆ Hari Shankar Jha Environment Inspector

#### ◇ Management office of Koshi Pump, Chandra Nahar Irrigation Scheme

- ◆ Rajendra Prasad Sah Office Chief
- ◆ Suresh Sah Engineer
- ◆ Keshav Das Engineer
- ◆ Kabita Mehta Engineer
- ◆ Ram Pati Sah Sub- Engineer
- ◆ Surya Narayan Chaudhary Association Organizer
- ◆ Ranjan Sharma Supervisor

- 
- ◇ Water Users Association of Chandra canal
    - ◆ Badri Narayan Mahatma Yadav Chairperson of the Main Canal Committee
    - ◆ Ram Dev Sah, Vice chairperson of the Main Canal Committee
    - ◆ Shiv Persad Yadav, Chairperson of Odraha Branch Canal Committee
    - ◆ Ashram Chaidhari, Treasurer of Odraha Branch Canal Committee
    - ◆ Nanda Sankar Lagwa, Chairperson of New Hanumannagar Branch Canal Committee
    - ◆ Shailendra Gohit, Beneficiary farmer of New Hanumannagar Branch Canal
    - ◆ Om Narayan Mandal, Chairperson of Banauli Branch Canal Committee
    - ◆ Domni Devi Mandal, Member of Banauli Branch Canal Committee
  
  - ◇ Koshi Tappu Wildlife Reserve Office
    - ◆ Ashok Ram Chief Warden, Kosi Tapu Wildlife Reserve (KTWR)
    - ◆ Ankit Poudel Ranger, Buffer Zone Section, KTWR
    - ◆ Hare Ram Yadav Ranger, Pathari Sector Post, KTWR
    - ◆ Keshor Raut Gamescout, Pathari Sector Post, KTWR
    - ◆ Binda Sardar Gamescout, Pathari Sector Post, KTWR
  
  - ◇ Buffer zone user committee
    - ◆ Birendra Yadav Chairperson, Council of Kosi Tappu Buffer Zone User Committee/ Chairperson, Odraha-Kamalpur Buffer Zone User Committee
    - ◆ Bachhu Lal Chaudhari Chairperson, Purbapipra-Dharampur-Ghoganpur Buffer Zone User Committee
  
  - ◇ District Forest Office in Saptraï
    - ◆ Luxman Safi District Forest Officer
  
  - ◇ Department of Road
    - ◆ Aasutosh Karna, Site Engineer, Postal Highway Project Office
  
  - ◇ Agricultural Information Center , Ministry of Land Management, Agriculture, Cooperative
    - ◆ Rajendra Pra. Yadav, Chief
  
  - ◇ Terafit Village office
    - ◆ Bachan Yadav, Chief of Agricultural Development Unit
-

❖ Sapta Koshi Town office

- ♦ Amit Chidhari, Chief of Agricultural Development Unit

❖ Ward Number 1

- ♦ Narayan Aharya Ward Chairperson
- ♦ Raj Kumar Das Health Section Officer

**(2)The Second Preparatory Survey (December 2021)**

Ministry of Energy, Water Resources and Irrigation

- ♦ Sarita Dawadi Joint Secretary
- ♦ Amar Bahadur Chand

Department of Water Resources and Irrigation

- ♦ Susheel Chandra Acharya Director General
- ♦ Krishna Nepal Deputy Director General, Engineering Sector
- ♦ Niaz Waris Deputy Director General, Water management sector
- ♦ Mukesh Pathak

Management office of Koshi Pump, Chandra Nahar Irrigation Scheme

- ♦ Rajendra Shah Office Chief
  - ♦ Ram Pati Sah
-

## **Appendix-4 Minutes of Discussion**

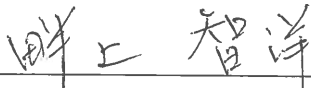
### **(1) Minutes of Discussion of the First Preparatory Survey**



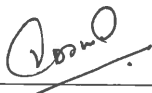
**Minutes of Discussions  
on the Preparatory Survey for the Project for  
Rehabilitation of Irrigation System in Eastern Terai Area**

Based on the several preliminary discussions between the Government of Nepal (hereinafter referred to as “Nepal”) and preliminary survey mission of Japan International Cooperation Agency (hereinafter referred to as “JICA”), JICA organized the Preparatory Survey Team for the Outline Design (hereinafter referred to as “the Team”) of the Project for Rehabilitation of Irrigation System in Eastern Terai Area (hereinafter referred to as “the Project”) to Nepal. The Team held a series of discussions with the officials of the Government of Nepal. In the course of the discussions, both sides have confirmed the main items described in the attached sheets.

Kathmandu and Tokyo, 23 December, 2020

  
\_\_\_\_\_

Mr. Tomohiro AZEGAMI  
Leader  
Preparatory Survey Team  
Japan International Cooperation Agency  
Japan

  
\_\_\_\_\_

Ms. Sarita DAWADI  
Joint Secretary  
Ministry of Energy, Water Resources and Irrigation  
Government of Nepal

## ATTACHMENT

1. Objective of the Project

The objective of the Project is to achieve appropriate water distribution in Chandra Nahar Irrigation Scheme by rehabilitating irrigation facilities, thereby contributing to improve agricultural productivity.

2. Title of the Preparatory Survey

Both sides confirmed the title of the Preparatory Survey as “the Preparatory Survey for the Project for Rehabilitation of Irrigation System in Eastern Terai Area”.

3. Project site

Both sides confirmed that the site of the Project is in Chandra Nahar Irrigation Scheme, which is shown in Annex 1.

4. Responsible authority for the Project

Both sides confirmed the authorities responsible for the Project are as follows:

The Department of Water Resource and Irrigation, Ministry of Energy, Water Resource and Irrigation will be the executing agency for the Project (hereinafter referred to as “the Executing Agency”). The Executing Agency shall coordinate with all the relevant authorities to ensure smooth implementation of the Project and ensure that the undertakings for the Project shall be managed by relevant authorities properly and on time. The organization charts are shown in Annex 2.

5. Items requested by the Government of Nepal

5-1. As a result of discussions, both sides confirmed that the items and number requested by the Government of Nepal are as follows:

**【Rehabilitation of facilities】**

Irrigation siphon culvert (8 facilities)

Drainage culvert (approximately 20 facilities)

Canal crossing bridge (approximately 50 facilities)

**【Consulting service】**

Detailed Design

Bidding Assistance

Construction Supervision

**【Soft Component】**

Capacity Development of WUAs for irrigation water management

- 5-2. JICA will assess the feasibility of the above requested items through the survey and will report the findings to the Government of Japan. The final scope of the Project will be decided by the Government of Japan in coordination with Government of Nepal.
- 5-3. The Government of Nepal shall submit an official request to the Government of Japan through a diplomatic channel before the appraisal of the Project, which is scheduled in August, 2021.

6. Procedures and Basic Principles of Japanese Grant

- 6-1. The Nepal side agreed that the procedures and basic principles of Japanese Grant (hereinafter referred to as “the Grant”) as described in Annex 3 shall be applied to the Project.

As for the monitoring of the implementation of the Project, JICA requires Nepal side to submit the Project Monitoring Report, the form of which is attached as Annex 4.

- 6-2. The Nepal side agreed to take the necessary measures, as described in Annex 5, for smooth implementation of the Project. The contents of the Annex 5 will be elaborated and refined during the Preparatory Survey and be agreed in the mission dispatched for explanation of the Draft Preparatory Survey Report.  
The contents of Annex 5 will be updated as the Preparatory Survey progresses, and eventually, will be used as an attachment to the Grant Agreement.

7. Schedule of the Survey

- 7-1. The Team will implement remote survey in Japan until March, 2021. Then the Team will proceed with further survey in Nepal until May, 2021.
- 7-2. An official request to the Government of Japan will be submitted before August, 2021.
- 7-3. JICA will prepare a draft Preparatory Survey Report in English and dispatch a mission to Nepal in order to explain its contents around August, 2021.
- 7-4. If the contents of the draft Preparatory Survey Report is accepted and the undertakings for the Project are fully agreed by the Nepal side, JICA will finalize the Preparatory Survey Report and send it to Nepal around November, 2021.
- 7-5. The above schedule is tentative and subject to change in response to the situation of COVID-19.

A

Qp.

## 8. Environmental and Social Considerations

8-1. The Nepal side confirmed to give due environmental and social considerations before and during implementation, and after completion of the Project, in accordance with the JICA Guidelines for Environmental and Social Considerations (April, 2010).

8-2. The Project is categorized as “B” from the following considerations:

The project is not considered to be a large-scale agriculture project, is not located in a sensitive area, and has none of the sensitive characteristics under the JICA guidelines for environmental and social considerations (April 2010), it is not likely to have a significant adverse impact on the environment.

(In case the necessity arises) The Nepal side confirmed to conduct the necessary procedures concerning the environmental assessment (including stakeholder meetings, Environmental Impact Assessment (EIA) /Initial Environmental Examination (IEE) and information disclosure, etc.) and make EIA/IEE report of the Project. The EIA/IEE approval shall be received from the responsible authorities and submitted to JICA by January, 2022.

8-3. (In case the Project result in involuntary resettlement) For the Project that will result in involuntary resettlement, the Nepal side confirmed to prepare a Resettlement Action Plan (RAP)/Abbreviated Resettlement Action Plan (ARAP) and make it available to the public. In addition, the Nepal side confirmed to provide the affected people with sufficient compensation and/or support in accordance with RAP/ARAP, which is consistent with JICA Guidelines for Environmental and Social Considerations (April, 2010), in a timely manner.

## 9. Other Relevant Issues

9-1. Due to the pandemic of COVID-19, JICA survey team (the Consultant) conducts remote survey hiring local consultants until the Team is able to enter the Nepal. The Nepal side agreed to take necessary arrangement for the smooth implementation of the survey. In addition, schedule of the survey which is mentioned in 7 might be delayed due to COVID-19.

9-2. JICA survey team (the Consultant) and executing agency of Nepal will prioritize facilities to be rehabilitated based on the field survey, and confirm by exchanging the Technical Note by the end of April, 2021. Government of Japan will decide the target and number of facilities based on the prioritization and the result of the preparatory survey.

9-3. The Nepal side will provide to JICA survey team (the Consultant) existing



necessary information for facilities' plan and design such as geographical data, meteorological data, design standard, policy manual and etc.

- 9-4. The Nepal side agreed that they submit the draft budget plan for operation and maintenance and enhancement of WUAs by the end of April, 2021, which is going to be finalized by the end of July, 2021. This plan is utilized to implement improved water distribution even after the project completion.

Annex 1 Project Site

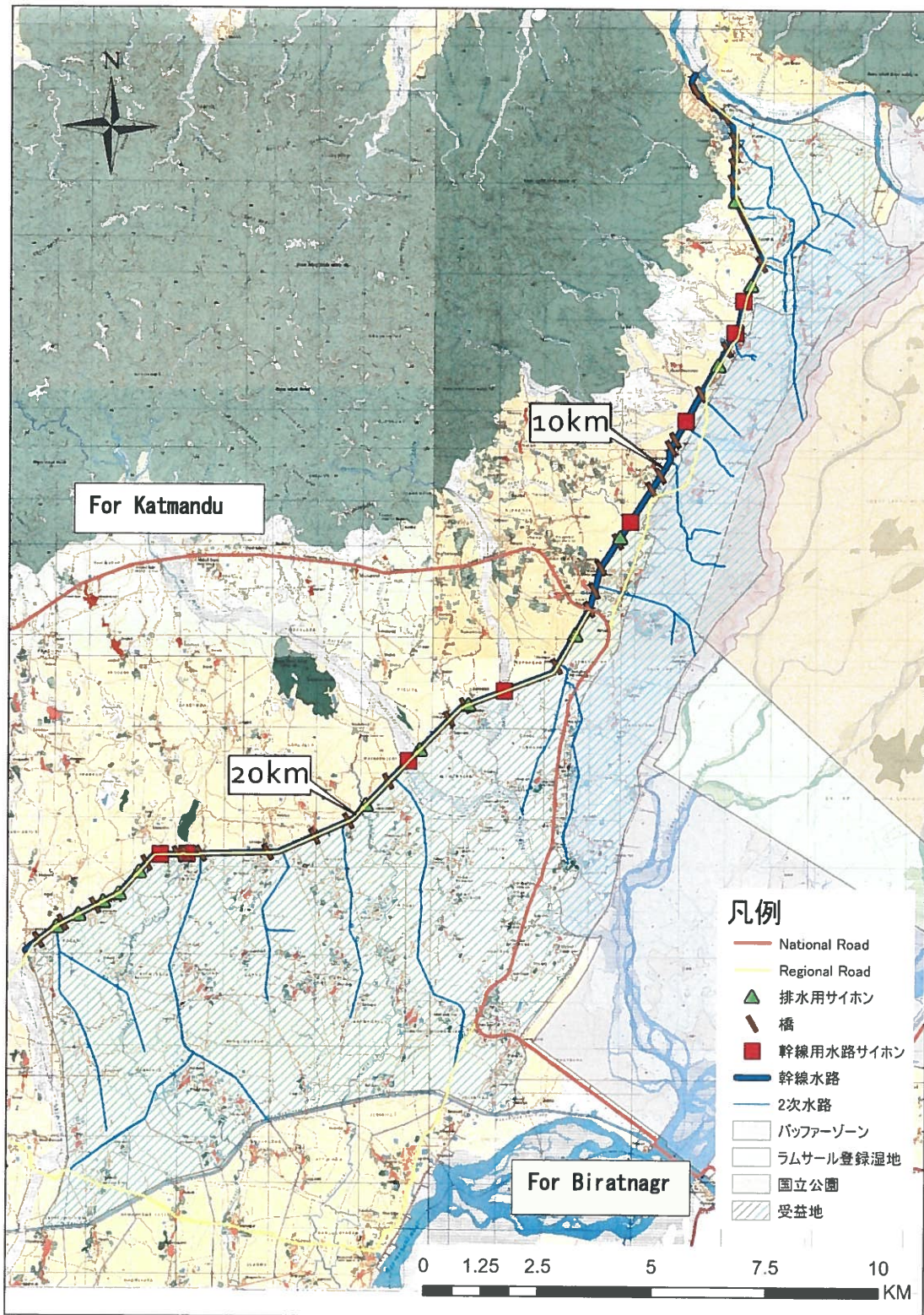
Annex 2 Organization Chart

Annex 3 Japanese Grant

Annex 4 Project Monitoring Report (template)

Annex 5 Major Undertakings to be taken by the Government of Nepal



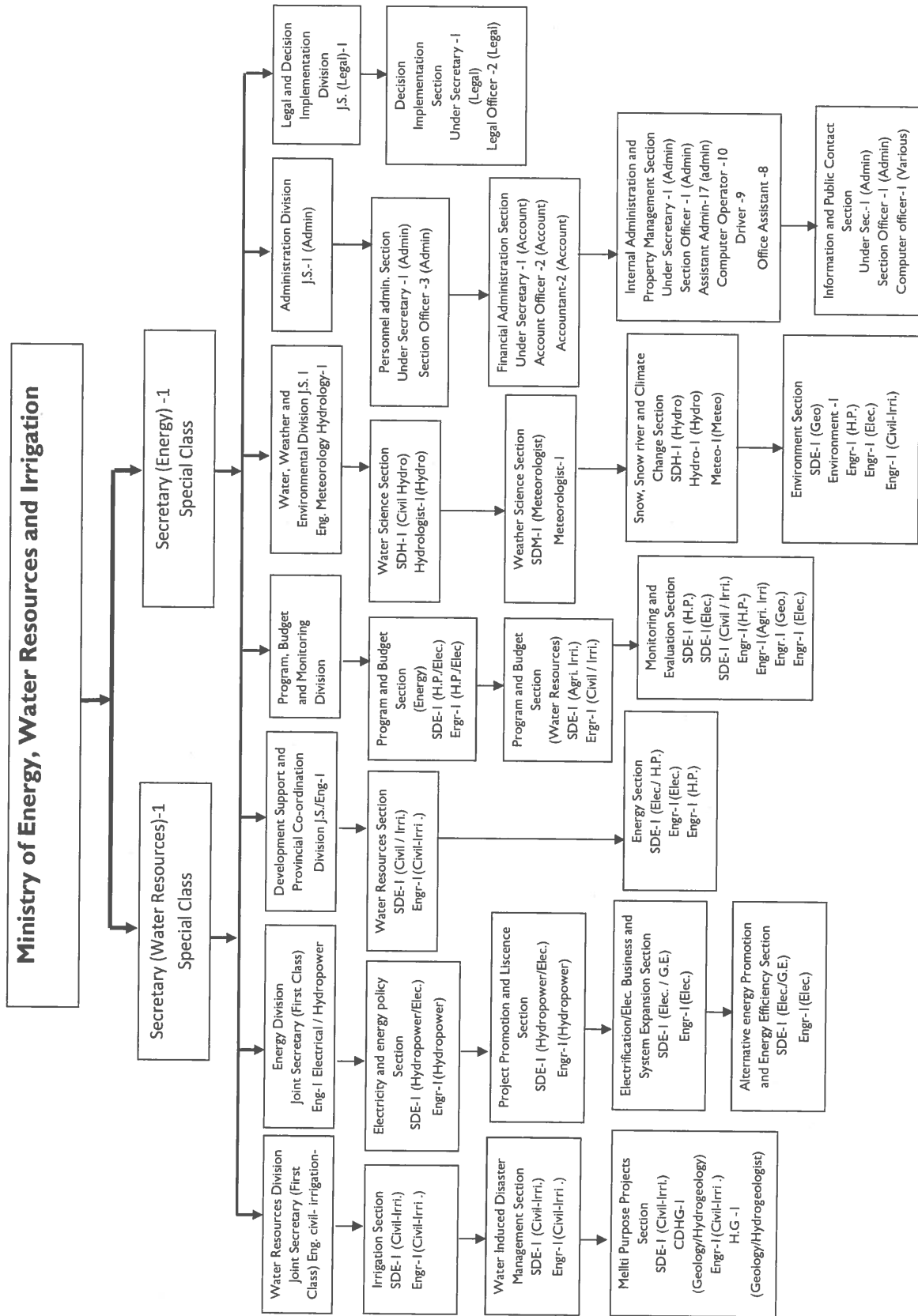


※Locations and type of structure are provisional.

*a*

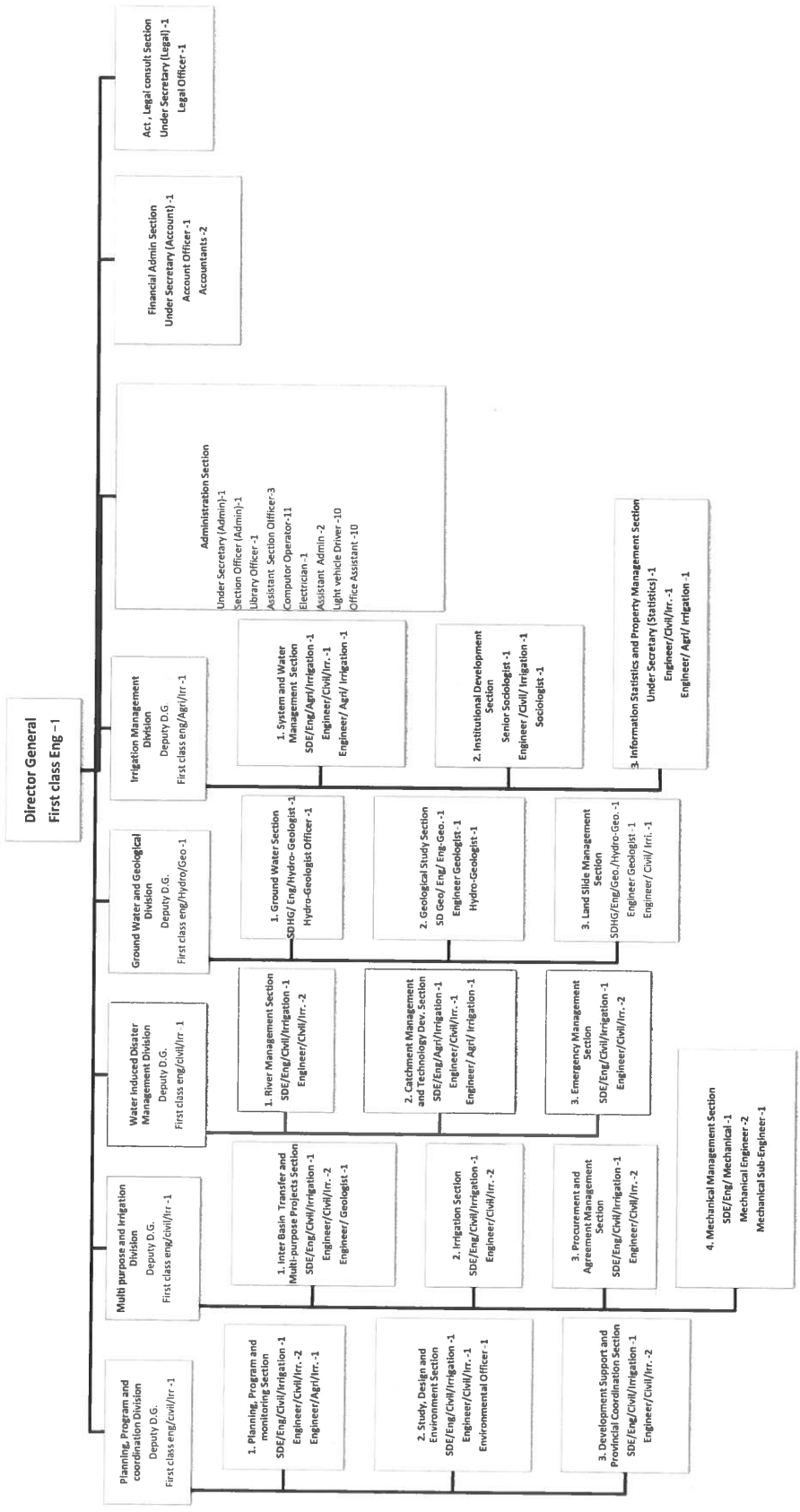
*Be.*

Organogram - Ministry of Energy, Water Resource and Irrigation



Organogram - Department of Water Resource and Irrigation

Department of Water Resources and Irrigation



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## JAPANESE GRANT

The Japanese Grant is non-reimbursable fund provided to a recipient country (hereinafter referred to as “the Recipient”) to purchase the products and/or services (engineering services and transportation of the products, etc.) for its economic and social development in accordance with the relevant laws and regulations of Japan. Followings are the basic features of the project grants operated by JICA (hereinafter referred to as “Project Grants”).

### 1. Procedures of Project Grants

Project Grants are conducted through following procedures (See “PROCEDURES OF JAPANESE GRANT” for details):

(1) Preparation

- The Preparatory Survey (hereinafter referred to as “the Survey”) conducted by JICA

(2) Appraisal

-Appraisal by the government of Japan (hereinafter referred to as “GOJ”) and JICA, and Approval by the Japanese Cabinet

(3) Implementation

Exchange of Notes

-The Notes exchanged between the GOJ and the government of the Recipient

Grant Agreement (hereinafter referred to as “the G/A”)

-Agreement concluded between JICA and the Recipient

Banking Arrangement (hereinafter referred to as “the B/A”)

-Opening of bank account by the Recipient in a bank in Japan (hereinafter referred to as "the Bank") to receive the grant

Construction works/procurement

-Implementation of the project (hereinafter referred to as “the Project”) on the basis of the G/A

(4) Ex-post Monitoring and Evaluation

-Monitoring and evaluation at post-implementation stage

### 2. Preparatory Survey

(1) Contents of the Survey

The aim of the Survey is to provide basic documents necessary for the appraisal of the the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of




relevant agencies of the Recipient necessary for the implementation of the Project.

- Evaluation of the feasibility of the Project to be implemented under the Japanese Grant from a technical, financial, social and economic point of view.
- Confirmation of items agreed between both parties concerning the basic concept of the Project.
- Preparation of an outline design of the Project.
- Estimation of costs of the Project.
- Confirmation of Environmental and Social Considerations

The contents of the original request by the Recipient are not necessarily approved in their initial form. The Outline Design of the Project is confirmed based on the guidelines of the Japanese Grant.

JICA requests the Recipient to take measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the executing agency of the Project. Therefore, the contents of the Project are confirmed by all relevant organizations of the Recipient based on the Minutes of Discussions.

#### (2) Selection of Consultants

For smooth implementation of the Survey, JICA contracts with (a) consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

#### (3) Result of the Survey

JICA reviews the report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the feasibility of the Project.

### 3. Basic Principles of Project Grants

#### (1) Implementation Stage

##### 1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the Exchange of Notes (hereinafter referred to as “the E/N”) will be signed between the GOJ and the Government of the Recipient to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Recipient to define the necessary articles, in accordance with the E/N, to implement the Project, such as conditions of disbursement, responsibilities of the Recipient, and procurement conditions. The terms and conditions generally applicable to the Japanese Grant are stipulated in the “General Terms and Conditions for Japanese Grant (January 2016).”



2) Banking Arrangements (B/A) (See “Financial Flow of Japanese Grant (A/P Type)” for details)

- a) The Recipient shall open an account or shall cause its designated authority to open an account under the name of the Recipient in the Bank, in principle. JICA will disburse the Japanese Grant in Japanese yen for the Recipient to cover the obligations incurred by the Recipient under the verified contracts.
- b) The Japanese Grant will be disbursed when payment requests are submitted by the Bank to JICA under an Authorization to Pay (A/P) issued by the Recipient.

3) Procurement Procedure

The products and/or services necessary for the implementation of the Project shall be procured in accordance with JICA’s procurement guidelines as stipulated in the G/A.

4) Selection of Consultants

In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the Recipient to continue to work on the Project’s implementation after the E/N and G/A.

5) Eligible source country

In using the Japanese Grant disbursed by JICA for the purchase of products and/or services, the eligible source countries of such products and/or services shall be Japan and/or the Recipient. The Japanese Grant may be used for the purchase of the products and/or services of a third country as eligible, if necessary, taking into account the quality, competitiveness and economic rationality of products and/or services necessary for achieving the objective of the Project. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm, which enter into contracts with the Recipient, are limited to "Japanese nationals", in principle.

6) Contracts and Concurrence by JICA

The Recipient will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be concurred by JICA in order to be verified as eligible for using the Japanese Grant.

7) Monitoring

The Recipient is required to take their initiative to carefully monitor the progress of the Project in order to ensure its smooth implementation as part of their responsibility in the G/A, and to regularly report to JICA about its status by using the Project Monitoring Report (PMR).

8) Safety Measures

The Recipient must ensure that the safety is highly observed during the implementation of the Project.

9) Construction Quality Control Meeting

Construction Quality Control Meeting (hereinafter referred to as the “Meeting”) will be held for quality assurance and smooth implementation of the Works at each stage of the Works. The member of the Meeting will be composed by the



Recipient (or executing agency), the Consultant, the Contractor and JICA. The functions of the Meeting are as followings:

- a) Sharing information on the objective, concept and conditions of design from the Contractor, before start of construction.
- b) Discussing the issues affecting the Works such as modification of the design, test, inspection, safety control and the Client's obligation, during of construction.

(2) Ex-post Monitoring and Evaluation Stage

- 1) After the project completion, JICA will continue to keep in close contact with the Recipient in order to monitor that the outputs of the Project is used and maintained properly to attain its expected outcomes.
- 2) In principle, JICA will conduct ex-post evaluation of the Project after three years from the completion. It is required for the Recipient to furnish any necessary information as JICA may reasonably request.

(3) Others

1) Environmental and Social Considerations

The Recipient shall carefully consider environmental and social impacts by the Project and must comply with the environmental regulations of the Recipient and JICA Guidelines for Environmental and Social Considerations (April, 2010).

2) Major undertakings to be taken by the Government of the Recipient

For the smooth and proper implementation of the Project, the Recipient is required to undertake necessary measures including land acquisition, and bear an advising commission of the A/P and payment commissions paid to the Bank as agreed with the GOJ and/or JICA. The Government of the Recipient shall ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the Recipient with respect to the purchase of the Products and/or the Services be exempted or be borne by its designated authority without using the Grant and its accrued interest, since the grant fund comes from the Japanese taxpayers.

3) Proper Use

The Recipient is required to maintain and use properly and effectively the products and/or services under the Project (including the facilities constructed and the equipment purchased), to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Japanese Grant.



4) Export and Re-export

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



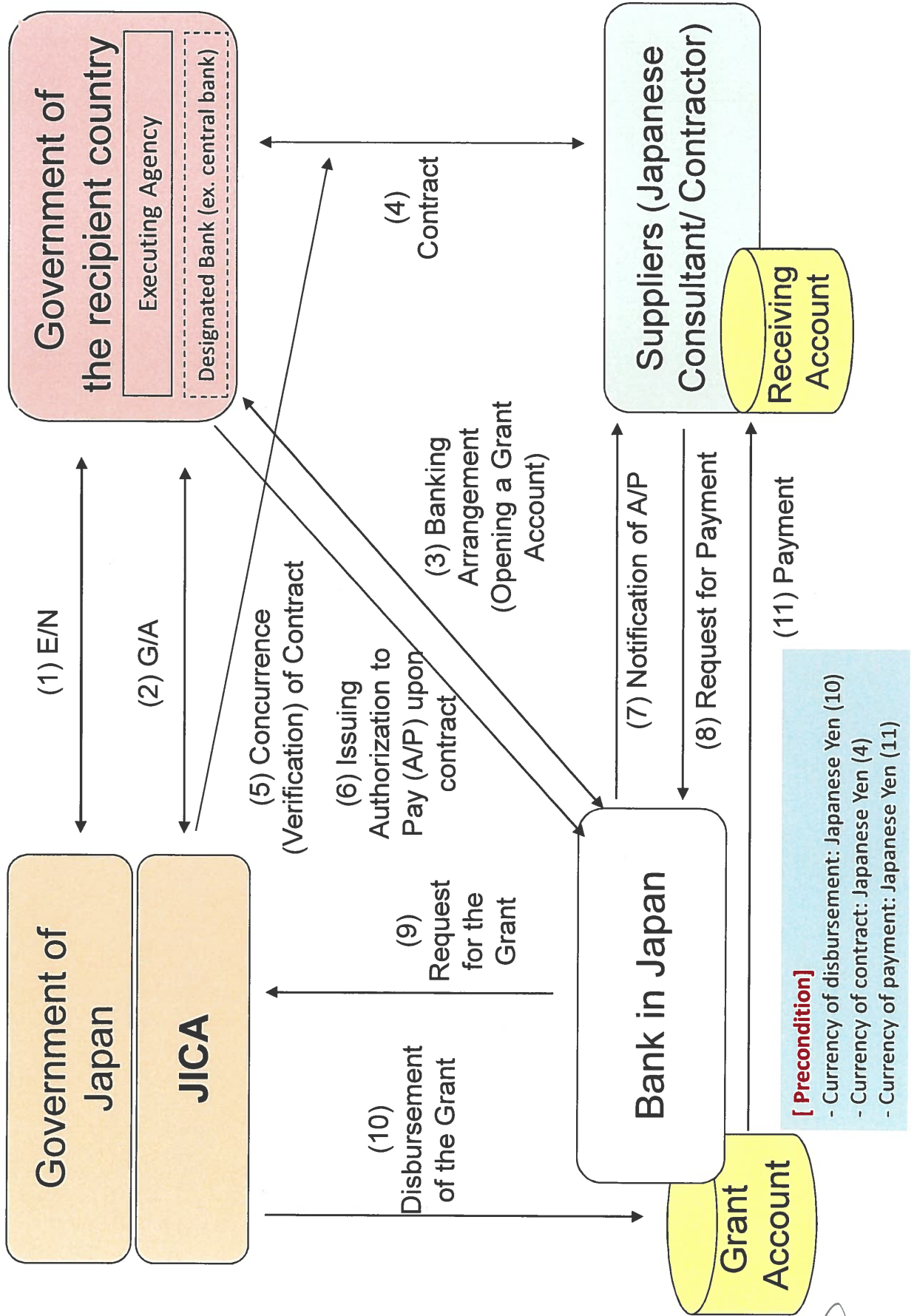
PROCEDURES OF JAPANESE GRANT

| Stage                              | Procedures   | Remarks  | Recipient Government | Japanese Government | JICA    | Consultants | Contractors | Agent Bank |
|------------------------------------|--|--|----------------------|---------------------|---------|-------------|-------------|------------|
| Official Request                   | Request for grants through diplomatic channel  | Request shall be submitted before appraisal stage.   | x                    | x                   |         |             |             |            |
| 1. Preparation                     | (1) Preparatory Survey<br>Preparation of outline design and cost estimate                                  |  | x                    |                     | x       | x           |             |            |
| 2. Appraisal                       | (2) Preparatory Survey<br>Explanation of draft outline design, including cost estimate, undertakings, etc. |  | x                    |                     | x       | x           |             |            |
|                                    | (3) Agreement on conditions for implementation   | Conditions will be explained with the draft notes (E/N) and Grant Agreement (G/A) which will be signed before approval by Japanese government. | x                    | x (E/N)             | x (G/A) |             |             |            |
|                                    | (4) Approval by the Japanese cabinet   |  |                      | x                   |         |             |             |            |
| 3. Implementation                  | (5) Exchange of Notes (E/N)  |  | x                    | x                   |         |             |             |            |
|                                    | (6) Signing of Grant Agreement (G/A)   |  | x                    |                     | x       |             |             |            |
|                                    | (7) Banking Arrangement (B/A)  | Need to be informed to JICA  | x                    |                     |         |             |             | x          |
|                                    | (8) Contracting with consultant and issuance of Authorization to Pay (A/P)                                 | Concurrence by JICA is required  | x                    |                     |         | x           |             | x          |
|                                    | (9) Detail design (D/D)  |  | x                    |                     |         | x           |             |            |
|                                    | (10) Preparation of bidding documents  | Concurrence by JICA is required  | x                    |                     |         | x           |             |            |
|                                    | (11) Bidding   | Concurrence by JICA is required  | x                    |                     |         | x           | x           |            |
|                                    | (12) Contracting with contractor/supplier and issuance of A/P  | Concurrence by JICA is required  | x                    |                     |         |             | x           | x          |
|                                    | (13) Construction works/procurement  | Concurrence by JICA is required for major modification of design and amendment of contracts.   | x                    |                     |         | x           | x           |            |
| (14) Completion certificate        |  | x  |                      |                     | x       | x           |             |            |
| 4. Ex-post monitoring & evaluation | (15) Ex-post monitoring  | To be implemented generally after 1, 3, 10 years of completion, subject to change  | x                    |                     | x       |             |             |            |
|                                    | (16) Ex-post evaluation  | To be implemented basically after 3 years of completion  | x                    |                     | x       |             |             |            |

notes:

1. Project Monitoring Report and Report for Project Completion shall be submitted to JICA as agreed in the G/A.
2. Concurrence by JICA is required for allocation of grant for remaining amount and/or contingencies as agreed in the G/A.

# Financial Flow of Japanese Grant (A/P Type)



**Project Monitoring Report**  
**on**  
**Project Name**  
**Grant Agreement No. XXXXXXX**  
20XX, Month

**Organizational Information**

|  |  |
|--|--|
| <b>Signer of the G/A<br/>(Recipient)</b> | Person in Charge (Designation) _____<br>Contacts                      Address: _____<br>Phone/FAX: _____<br>Email: _____ |
| <b>Executing<br/>Agency</b>              | Person in Charge (Designation) _____<br>Contacts                      Address: _____<br>Phone/FAX: _____<br>Email: _____ |
| <b>Line Ministry</b>                     | Person in Charge (Designation) _____<br>Contacts                      Address: _____<br>Phone/FAX: _____<br>Email: _____ |

**General Information:**

|                          |   |
|--------------------------|---|
| <b>Project Title</b>     |   |
| <b>E/N</b>               | Signed date:<br>Duration:   |
| <b>G/A</b>               | Signed date:<br>Duration:   |
| <b>Source of Finance</b> | Government of Japan: Not exceeding JPY _____ mil.<br>Government of (_____): _____ |




**1: Project Description**

**1-1 Project Objective**

|  |
|--|
|  |
|--|

**1-2 Project Rationale**

- Higher-level objectives to which the project contributes (national/regional/sectoral policies and strategies)
- Situation of the target groups to which the project addresses

|  |
|--|
|  |
|--|

**1-3 Indicators for measurement of "Effectiveness"**

| Quantitative indicators to measure the attainment of project objectives |                      |                    |
|---|----------------------|--------------------|
| Indicators  | Original (Yr . . . ) | Target (Yr . . . ) |
|   |                      |                    |
|   |                      |                    |
| Qualitative indicators to measure the attainment of project objectives  |                      |                    |
|   |                      |                    |

**2: Details of the Project**

**2-1 Location**

| Components | Original<br><i>(proposed in the outline design)</i> | Actual |
|------------|---|--------|
| 1.         |   |        |

**2-2 Scope of the work**

| Components | Original*<br><i>(proposed in the outline design)</i> | Actual* |
|------------|--|---------|
| 1.         |  |         |
|            |  |         |
|            |  |         |

Reasons for modification of scope (if any).

|       |
|-------|
| (PMR) |
|-------|

**2-3 Implementation Schedule**

| Items | Original                                |   | Actual |
|-------|---|---|--------|
|       | <i>(proposed in the outline design)</i> | <i>(at the time of signing the Grant Agreement)</i> |        |
|       |   |   |        |

Reasons for any changes of the schedule, and their effects on the project (if any)

|  |
|--|
|  |
|--|

**2-4 Obligations by the Recipient**

**2-4-1 Progress of Specific Obligations**  
 See Attachment 2.

**2-4-2 Activities**  
 See Attachment 3.

**2-4-3 Report on RD**  
 See Attachment 11.

**2-5 Project Cost**

**2-5-1 Cost borne by the Grant(Confidential until the Bidding)**

| Components |   |  | Cost<br>(Million Yen)  |        |
|------------|---|--|--|--------|
|            | Original<br><i>(proposed in the outline design)</i> | Actual<br><i>(in case of any modification)</i> | Original <sup>1),2)</sup><br><i>(proposed in the outline design)</i> | Actual |
|            | 1.  |  |  |        |
|            |   |  |  |        |
|            |   |  |  |        |
| Total      |   |  |  |        |

Note: 1) Date of estimation:  
 2) Exchange rate: 1 US Dollar = Yen

**2-5-2 Cost borne by the Recipient**

| Components |   |  | Cost<br>(1,000 Taka)   |        |
|------------|---|--|--|--------|
|            | Original<br><i>(proposed in the outline design)</i> | Actual<br><i>(in case of any modification)</i> | Original <sup>1),2)</sup><br><i>(proposed in the outline design)</i> | Actual |
|            | 1.  |  |  |        |
|            |   |  |  |        |
|            |   |  |  |        |
|            |   |  |  |        |

- Note: 1) Date of estimation:  
2) Exchange rate: 1 US Dollar =

Reasons for the remarkable gaps between the original and actual cost, and the countermeasures (if any)

(PMR)

**2-6 Executing Agency**

- Organization's role, financial position, capacity, cost recovery etc,
- Organization Chart including the unit in charge of the implementation and number of employees.

|   |
|---|
| <b>Original</b> (at the time of outline design)<br>name:<br>role:<br>financial situation:<br>institutional and organizational arrangement (organogram):<br>human resources (number and ability of staff): |
| <b>Actual</b> (PMR)   |

**2-7 Environmental and Social Impacts**

- The results of environmental monitoring based on Attachment 5 (in accordance with Schedule 4 of the Grant Agreement).
- The results of social monitoring based on in Attachment 5 (in accordance with Schedule 4 of the Grant Agreement).
- Disclosed information related to results of environmental and social monitoring to local stakeholders (whenever applicable).

**3: Operation and Maintenance (O&M)**

**3-1 Physical Arrangement**

- Plan for O&M (number and skills of the staff in the responsible division or section, availability of manuals and guidelines, availability of spareparts, etc.)

|   |
|---|
| <b>Original</b> (at the time of outline design) |
| <b>Actual</b> (PMR)                             |

**3-2 Budgetary Arrangement**

- Required O&M cost and actual budget allocation for O&M

|   |
|---|
| <b>Original</b> (at the time of outline design) |
|---|

**Actual (PMR)**

**4: Potential Risks and Mitigation Measures**

- Potential risks which may affect the project implementation, attainment of objectives, sustainability
- Mitigation measures corresponding to the potential risks

**Assessment of Potential Risks (at the time of outline design)**

| Potential Risks          | Assessment                                       |
|--------------------------|--|
| 1. (Description of Risk) | Probability: High/Moderate/Low                   |
|                          | Impact: High/Moderate/Low                        |
|                          | Analysis of Probability and Impact:              |
|                          |  |
|                          | Mitigation Measures:                             |
|                          |  |
|                          | Action required during the implementation stage: |
| 2. (Description of Risk) | Probability: High/Moderate/Low                   |
|                          | Impact: High/Moderate/Low                        |
|                          | Analysis of Probability and Impact:              |
|                          |  |
|                          | Mitigation Measures:                             |
|                          |  |
|                          | Action required during the implementation stage: |
| 3. (Description of Risk) | Probability: High/Moderate/Low                   |
|                          | Impact: High/Moderate/Low                        |
|                          | Analysis of Probability and Impact:              |
|                          |  |
|                          | Mitigation Measures:                             |
|                          |  |
|                          | Action required during the implementation stage: |

*li*

*De*

|   |                                   |
|---|-----------------------------------|
|   | Contingency Plan (if applicable): |
|   |                                   |
| <b>Actual Situation and Countermeasures</b> |                                   |
| (PMR)                                       |                                   |

**5: Evaluation and Monitoring Plan (after the work completion)**

**5-1 Overall evaluation**

Please describe your overall evaluation on the project.

|  |
|--|
|  |
|--|

**5-2 Lessons Learnt and Recommendations**

Please raise any lessons learned from the project experience, which might be valuable for the future assistance or similar type of projects, as well as any recommendations, which might be beneficial for better realization of the project effect, impact and assurance of sustainability.

|  |
|--|
|  |
|--|

**5-3 Monitoring Plan of the Indicators for Post-Evaluation**

Please describe monitoring methods, section(s)/department(s) in charge of monitoring, frequency, the term to monitor the indicators stipulated in 1-3.

|  |
|--|
|  |
|--|



Attachment

1. Project Location Map
  2. Specific obligations of the Recipient which will not be funded with the Grant
  3. Monthly Report submitted by the Consultant
- Appendix - Photocopy of Contractor's Progress Report (if any)
- Consultant Member List
  - Contractor's Main Staff List
4. Check list for the Contract (including Record of Amendment of the Contract/Agreement and Schedule of Payment)
  5. Environmental Monitoring Form / Social Monitoring Form
  6. Monitoring sheet on price of specified materials (Quarterly)
  7. Report on Proportion of Procurement (Recipient Country, Japan and Third Countries) (PMR (final) only)
  8. Pictures (by JPEG style by CD-R) (PMR (final) only)
  9. Equipment List (PMR (final) only)
  10. Drawing (PMR (final) only)
  11. Report on RD (After project)



Monitoring sheet on price of specified materials

1. Initial Conditions (Confirmed)

| Items of Specified Materials |        | Initial Volume<br>A | Initial Unit Price (¥)<br>B | Initial total Price<br>C=A×B | 1% of Contract Price<br>D | Condition of payment       |                            |
|------------------------------|--------|---------------------|-----------------------------|------------------------------|---------------------------|----------------------------|----------------------------|
|                              |        |                     |                             |                              |                           | Price (Decreased)<br>E=C-D | Price (Increased)<br>F=C+D |
| 1                            | Item 1 | ●●t                 | ●                           | ●                            | ●                         | ●                          | ●                          |
| 2                            | Item 2 | ●●t                 | ●                           | ●                            |                           |                            |                            |
| 3                            | Item 3 |                     |                             |                              |                           |                            |                            |
| 4                            | Item 4 |                     |                             |                              |                           |                            |                            |
| 5                            | Item 5 |                     |                             |                              |                           |                            |                            |

2. Monitoring of the Unit Price of Specified Materials

(1) Method of Monitoring : ●●

(2) Result of the Monitoring Survey on Unit Price for each specified materials

| Items of Specified Materials |        | 1st month, 2015 | 2nd month, 2015 | 3rd month, 2015 | 4th | 5th | 6th |
|------------------------------|--------|-----------------|-----------------|-----------------|-----|-----|-----|
| 1                            | Item 1 | ●               | ●               | ●               |     |     |     |
| 2                            | Item 2 |                 |                 |                 |     |     |     |
| 3                            | Item 3 |                 |                 |                 |     |     |     |
| 4                            | Item 4 |                 |                 |                 |     |     |     |
| 5                            | Item 5 |                 |                 |                 |     |     |     |

(3) Summary of Discussion with Contractor (if necessary)

Report on Proportion of Procurement (Recipient Country, Japan and Third Countries)  
 (Actual Expenditure by Construction and Equipment each)

|                             | Domestic Procurement<br>(Recipient Country)<br>A | Foreign Procurement<br>(Japan)<br>B | Foreign Procurement<br>(Third Countries)<br>C | Total<br>D |
|-----------------------------|--|-------------------------------------|---|------------|
| Construction Cost           | (A/D%)   | (B/D%)                              | (C/D%)  |            |
| Direct Construction Cost    | (A/D%)   | (B/D%)                              | (C/D%)  |            |
| others                      | (A/D%)   | (B/D%)                              | (C/D%)  |            |
| Equipment Cost              | (A/D%)   | (B/D%)                              | (C/D%)  |            |
| Design and Supervision Cost | (A/D%)   | (B/D%)                              | (C/D%)  |            |
| Total                       | (A/D%)   | (B/D%)                              | (C/D%)  |            |

## Major Undertakings to be taken by the Government of Nepal

**1. Specific obligations of the Government of Nepal which will not be funded with the Grant****(1) Before the Bidding**

| NO | Items   | Deadline  | In charge | Estimated Cost | Ref. |
|----|---|---|-----------|----------------|------|
| 1  | To sign the banking arrangement (B/A) with a bank in Japan (the Agent Bank) to open bank account for the Grant  | within 1 month after the signing of the G/A         | MOF       |                |      |
| 2  | To issue A/P to the Agent Bank for the payment to the consultant  | within 1 month after the signing of the contract(s) | MOEWRI    |                |      |
| 3  | To bear the following commissions to the Agent Bank for the banking services based upon B/A   |   |           |                |      |
|    | 1) Advising commission of A/P   | within 1 month after the signing of the contract(s) | MOEWRI    |                |      |
|    | 2) Payment commission for A/P   | every payment                                       | MOEWRI    |                |      |
| 4  | To approve IEE/EIA(Conditions of approval should be fulfilled, if any) and secure the necessary budget for implementation for EMP and EMoP (and fulfilling conditions of approval, if any).   | within 1 month after the signing of the G/A         | MOEWRI    |                |      |
| 5  | To secure the necessary budget and implement land acquisition and resettlement (including preparation of resettlement sites), and compensation with full replacement cost in accordance with RAP  | before notice of the bidding documents              | MOEWRI    |                |      |
| 6  | To implement social monitoring, and to submit the monitoring results to JICA, by using the monitoring form, on a quarterly basis as a part of Project Monitoring Report   | until land acquisition and resettlement complete    | MOEWRI    |                |      |
| 7  | To secure and clear the following lands<br>1) land for widening and replacing by rehabilitation of facilities<br>2) temporary construction yard and stock yard near the Project area<br>3) borrow pit and disposal site near the Project area | before notice of the bidding documents              | MOEWRI    |                |      |
| 8  | To obtain the planning, zoning, building permit   | before notice of the bidding documents              | MOEWRI    |                |      |
| 9  | To clear, level and reclaim the following sites<br>1) remove utilities such as power poles, power and water pipe or other public facilities, if necessary.  | before notice of the bidding documents              | MOEWRI    |                |      |
| 10 | To submit Project Monitoring Report (with the result of Detailed Design)  | before preparation of the bidding documents         | MOEWRI    |                |      |

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

**(2) During the Project Implementation**

| NO | Items | Deadline | In charge | Estimated Cost | Ref. |
|----|-------|----------|-----------|----------------|------|
|----|-------|----------|-----------|----------------|------|

a

Cg.

Appx.4 (1) Minutes of Discussion of the First Preparatory Survey

|    |   |  |        |  |  |
|----|---|--|--------|--|--|
| 1  | To issue A/P to the Agent Bank for the payment to the supplier and the contractor   | within 1 month after the signing of the contract(s)  | MOEWRI |  |  |
| 2  | To bear the following commissions to the Agent Bank for the banking services based upon the B/A   |  |        |  |  |
|    | 1) Advising commission of A/P   | within 1 month after the signing of the contract(s)  | MOEWRI |  |  |
|    | 2) Payment commission for A/P   | every payment  | MOF    |  |  |
| 3  | To ensure prompt customs clearance and to assist the Supplier(s) with internal transportation in the country of the Recipient   | during the Project   | MOEWRI |  |  |
| 4  | To accord Japanese physical persons and/or physical persons of third countries whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the country of the Recipient and stay therein for the performance of their work         | during the Project   | MOEWRI |  |  |
| 5  | To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the country of the Recipient with respect to the purchase of the products and/or the services be exempted   | during the Project   | MOEWRI |  |  |
| 6  | To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project  | during the Project   | MOEWRI |  |  |
| 7  | To notify JICA promptly of any incident or accident, which has, or is likely to have, a significant adverse effect on the environment, the affected communities, the public or workers.   | during the construction  | MOEWRI |  |  |
| 8  | 1) To submit Project Monitoring Report  | every month  | MOEWRI |  |  |
|    | 2) To submit Project Monitoring Report (final) (including as-built drawings, equipment list, photographs, etc.)   | within 1 month after issuance of Certificate of Completion for the works under the contract(s) | MOEWRI |  |  |
| 9  | To submit a report concerning completion of the Project   | within 6 months after completion of the Project  | MOEWRI |  |  |
| 10 | To construct access roads   | 3 months before completion of the construction   | MOEWRI |  |  |
|    | 1) Outside the site   |  |        |  |  |
| 11 | To provide facilities for distribution of electricity, water supply and drainage and other incidental facilities necessary for the implementation of the Project outside the site(s)  |  | MOEWRI |  |  |
| 12 | To provide office, equipment, furniture and facilities necessary for the implementation of the Project in the site(s)   | before start of the construction   | MOEWRI |  |  |
|    | 1) Office space   |  |        |  |  |
|    | 2) General furniture for office works   |  |        |  |  |
|    | 2) Equipment for office works   | before start of the construction   | MOEWRI |  |  |
| 13 | To take measure necessary for security and safety of the Project<br>- maintaining the safety of workers and the general public by thorough implementation of safety measures and immediate action in the case of accident<br>- traffic control around the site(s) and on transportation routes of construction materials<br>- | during the construction  | MOEWRI |  |  |

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*(Handwritten signature)*

Appx.4 (1) Minutes of Discussion of the First Preparatory Survey

|    |   |   |        |  |  |
|----|---|---|--------|--|--|
| 14 | To implement EMP and EMoP   | during the construction   | MOEWRI |  |  |
| 15 | To submit results of environmental monitoring to JICA, by using the monitoring form, on a quarterly basis as a part of Project Monitoring Report  | during the construction   | MOEWRI |  |  |
| 16 | To implement RAP (livelihood restoration program)   | for a period based on livelihood restoration program  | MOEWRI |  |  |
| 17 | To implement social monitoring, and to submit the monitoring results to JICA, by using the monitoring form, on a quarterly basis as a part of Project Monitoring Report<br>- Period of the monitoring may be extended if affected persons' livelihoods are not sufficiently restored. Extension of the monitoring will be decided based on agreement between MOEWRI and JICA. | - until the end of livelihood restoration program (In case that livelihood restoration program is provided)<br>- for 2 years after land acquisition and resettlement complete (In case that livelihood restoration program is not provided) | MOEWRI |  |  |

(3) After the Project

| NO | Items   | Deadline                             | In charge | Estimated Cost | Ref. |
|----|---|--------------------------------------|-----------|----------------|------|
| 1  | To implement EMP and EMoP   | for a period based on EMP and EMoP   | MOEWRI    |                |      |
| 2  | To submit results of environmental monitoring to JICA, by using the monitoring form, semiannually<br>- The period of environmental monitoring may be extended if any significant negative impacts on the environment are found. The extension of environmental monitoring will be decided based on the agreement between MOEWRI and JICA. | for 3 years after the Project        | MOEWRI    |                |      |
| 3  | To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid<br>1) Allocation of maintenance cost<br>2) Operation and maintenance structure<br>3) Routine check/Periodic inspection   | After completion of the construction | MOEWRI    |                |      |

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2. Other obligations of the Government of Nepal funded with the Grant

| NO | Items  | Deadline     | Amount<br>(Million Japanese Yen)* |     |
|----|--|--------------|-----------------------------------|-----|
| 1  | To rehabilitate irrigation siphon culvert /drainage culvert/ canal crossing bridge (or To procure equipment)<br>- Rehabilitation of irrigation siphon culvert<br>1) To conduct the following transportation<br>a) Marine(Air) transportation of the products from Japan to the country of the Recipient<br>b) Internal transportation from the port of disembarkation to the project site<br>2) To construct access roads<br>a) Within the site<br>3) To construct the temporary building<br>4) To provide facilities for the distribution of electricity, water supply, drainage and other incidental facilities<br>a) Electricity<br>- The drop wiring and internal wiring within the site<br>- The main circuit breaker and transformer<br>b) Water Supply<br>- The supply system within the site (receiving and/or elevated tanks)<br>c) Drainage<br>- The drainage system (for toilet sewer, ordinary waster, storm drainage and others) within the site<br>d) Furniture and Equipment<br>- Project equipment | August, 2024 |                                   |     |
| 2  | Contingencies  |              |                                   |     |
|    | Total  |              |                                   | XXX |

\*The Amount is provisional. This is subject to the approval of the Government of Japan.

**(2) Minutes of Discussion of the Second Preparatory Survey**



**Minutes of Discussions**  
**on the Preparatory Survey for the Project for**  
**Rehabilitation of Irrigation System in Eastern Terai Area**  
**(Explanation on Draft Preparatory Survey Report)**

With reference to the minutes of discussions signed between the Ministry of Energy, Water Resources and Irrigation (hereinafter referred to as "MoEWRI") and the Japan International Cooperation Agency (hereinafter referred to as "JICA") on 23 December, 2020 and in response to the request from the Government of Nepal (hereinafter referred to as "Nepal") dated on 17 November 2021, JICA dispatched the Preparatory Survey Team (hereinafter referred to as "the Team") for the explanation of Draft Preparatory Survey Report (hereinafter referred to as "the Draft Report") for the Project for Rehabilitation of Irrigation System in Eastern Terai Area (hereinafter referred to as "the Project").

As a result of the discussions, both sides agreed on the main items described in the attached sheets.

Kathmandu and Tokyo, 16 December, 2021



Dr. Katsumasa SATO  
Leader  
Preparatory Survey Team  
Japan International Cooperation Agency  
Japan



Ms. Sarita DAWADI  
Joint Secretary  
Ministry of Energy, Water Resources and Irrigation  
Government of Nepal  
Nepal







## ATTACHEMENT

1. Objective of the Project

The objective of the Project is to achieve appropriate water distribution in Chandra Nahar Irrigation Scheme by rehabilitating irrigation facilities, thereby contributing to increase agricultural production.

2. Title of the Preparatory Survey

Both sides confirmed the title of the Preparatory Survey as “the Preparatory Survey for the Project for Rehabilitation of Irrigation System in Eastern Terai Area”.

3. Project site

Both sides confirmed that the site of the Project is in Chandra Nahar Irrigation Scheme, which is shown in Annex 1.

4. Responsible authority for the Project

Both sides confirmed the authorities responsible for the Project are as follows:  
The Department of Water Resource and Irrigation, Ministry of Energy, Water Resource and Irrigation will be the executing agency for the Project (hereinafter referred to as “the Executing Agency”). The Executing Agency shall coordinate with all the relevant authorities to ensure smooth implementation of the Project and ensure that the undertakings for the Project shall be taken care by relevant authorities properly and on time. The organization charts are shown in Annex 2.

5. Contents of the Draft Report

After the explanation of the contents of the Draft Report by the Team, the Nepal side agreed to its contents. JICA will finalize the Preparatory Survey Report based on the confirmed items. The report will be sent to the Nepal side around May, 2022.

6. Cost estimate

Both sides confirmed that the cost estimate including the contingency explained by the Team is provisional and will be examined further by the Government of Japan for its approval. The contingency would cover the additional cost against natural disaster, unexpected natural conditions, etc.

7. Confidentiality of the cost estimate and technical specifications

Both sides confirmed that the cost estimate and technical specifications of the Project should never be disclosed to any third parties until all the contracts under the Project are concluded.

8. Procedures and Basic Principles of Japanese Grant

The Nepal side agreed that the procedures and basic principles of Japanese Grant (hereinafter referred to as "the Grant") as described in Annex 3 shall be applied to the Project. In addition, the Nepal side agreed to take necessary measures according to the procedures.

9. Timeline for the project implementation

The Team explained to the Nepal side that the expected timeline for the project implementation is as attached in Annex 4.

10. Expected outcomes and indicators

Both sides agreed that key indicators for expected outcomes are as follows. The Nepal side will be responsible for the achievement of agreed key indicators targeted in year 2028 and shall monitor the progress for Ex-Post Evaluation based on those indicators.

[Quantitative indicators]

| Index                        | Baseline (2021) | Target year (2028)<br>(years after the project completion) |
|------------------------------|-----------------|--|
| Irrigable Area               |                 |  |
| (a) Rainy Season Crop (Rice) | 6,500 ha        | 7,800 ha   |
| (b) Dry Season Crop (Wheat)  | 4,320 ha        | 5,200 ha   |
| Yield                        |                 |  |
| (c) Rainy Season Crop (Rice) | 30,900 ton      | 32,850 ton   |
| (d) Dry Season Crop (Wheat)  | 8,900 ton       | 10,700 ton   |

[Qualitative indicators]

- To ensure stable supplying of irrigation water through preventing of the collapses of the target
- To ensure safety and convenience within the Chandra Nahar Irrigation Scheme and for nearby Residents through the Provision of Rural and Domestic Roads.

11. Ex-Post Evaluation

JICA will conduct ex-post evaluation after three (3) years from the project completion, in principle, with respect to five evaluation criteria (Relevance, Effectiveness,

Efficiency, Impact, Sustainability). The result of the evaluation will be publicized. The Nepal side is required to provide necessary support for the data collection.

12. Technical assistance (“Soft Component” of the Project)

Considering the sustainable operation and maintenance of the products and services granted through the Project, following technical assistance is planned under the Project. The Nepal side confirmed to deploy necessary number of counterparts who are appropriate and competent in terms of its purpose of the technical assistance as described in the Draft Report.

13. Undertakings of the Project

Both sides confirmed the undertakings of the Project as described in Annex 5. With regard to exemption of customs duties, internal taxes and other fiscal levies as stipulated in (2) 5 of Annex 5, both sides confirmed that such customs duties, internal taxes and other fiscal levies, which shall be clarified in the bid documents by Nepal during the implementation stage of the Project.

The Nepal side assured to take the necessary measures and coordination including allocation of the necessary budget which are preconditions of implementation of the Project. It is further agreed that the costs are indicative, i.e. at Outline Design level. More accurate costs will be calculated at the Detailed Design stage.

Both sides also confirmed that the Annex 5 will be used as an attachment of G/A.

Both sides confirmed that MoEWRI shall take necessary measures to ensure and maintain the security of the Project site and the persons related to the implementation of the Project, in cooperation with relevant authorities during the Project period. Such security measures shall reasonably reflect needs of the Consultant/the Contractor engaging in the Project, as shown in Annex 5.

Both sides agreed that in case the additional security measures would be necessary for the implementation of the Project, such a case shall be secured by the Recipient without using the Grant.

14. Monitoring during the implementation

The Project will be monitored by the Executing Agency and reported to JICA by using the form of Project Monitoring Report (PMR) attached as Annex 6. The timing of submission of the PMR is described in Annex 5.

15. Project completion

Both sides confirmed that the project completes when all the facilities constructed by the Grant are in operation. The completion of the Project will be reported to JICA promptly by the Executing Agency, but in any event not later than six months after completion of the Project.

16. Environmental and Social Considerations

16-1 General Issues

16-1-1 Environmental Guidelines and Environmental Category

The Team explained that 'JICA Guidelines for Environmental and Social Considerations (April 2010)' (hereinafter referred to as "the Guidelines") is applicable for the Project. The Project is categorized as B because the Project is not considered to be a large-scale agricultural project, has none of the sensitive characteristics under the Guidelines, it is not likely to have a significant adverse impact on the environment.

16-1-2 Environmental Checklist

The environmental and social considerations including major impacts and mitigation measures for the Project are summarized in the Environmental Checklist attached as Annex 7. Both sides confirmed that in case of major modification of the content of the Environmental Checklist, the Nepal side shall submit the modified version to JICA in a timely manner.

16-2 Environmental Issues

16-2-1 Initial Environmental Examination (IEE)

Both sides confirmed the IEE report will be approved by MoEWRI in January, 2022.

16-2-2 Environmental Management Plan and Environmental Monitoring Plan

Both sides confirmed Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP) of the Project is as Annex 8, respectively. Both side agreed that environmental mitigation measures and monitoring shall be conducted based on the EMP and EMoP, which may be updated during the detailed design stage.

16-3 Social Issues

16-3-1 Land Acquisition and Resettlement

Both sides confirmed the 0.83 ha of land would be acquired and 22 Households /142 people would be relocated/affected due to the implementation of the Project.

Such land acquisition and resettlement shall be implemented based on the (Abbreviated) Resettlement Action Plan (RAP) as Annex 9 which was prepared in line with the Guidelines and will be confirmed by the Nepal side in January/2022. Nepal side confirmed to provide the affected people with sufficient compensation and/or support in accordance with RAP.

#### 16-4 Environmental and Social Monitoring

##### 16-4-1 Environmental Monitoring

Both sides agreed that the Nepal side will submit results of environmental monitoring to JICA with PMR by using the monitoring form attached as Annex 10. The timing of submission of the monitoring form is described in Annex 5.

##### 16-4-2 Social Monitoring

Both sides confirmed that the Nepal side will implement social monitoring about land acquisition plan proposed in the RAP. The Nepal side and the Team agreed that MoEWRI will submit results of social monitoring to JICA with PMR by using the monitoring form attached as Annex 10.

##### 16-4-3 Information Disclosure of Monitoring Results

Both sides confirmed that the Nepal side will disclose results of environmental and social monitoring to local stakeholders through their website / in their field offices. The Nepal side agreed JICA will disclose results of environmental and social monitoring submitted by the Nepal side as the monitoring forms attached as Annex 10 on its website.

#### 17. Other Relevant Issues

##### 17-1 Disclosure of Information

Both sides confirmed that the Preparatory Survey Report from which project cost is excluded will be disclosed to the public after completion of the Preparatory Survey. The comprehensive report including the project cost will be disclosed to the public after all the contracts under the Project are concluded.

##### 17-2 Gender Mainstreaming

Both sides confirmed that gender mainstreaming should be duly practiced for the Project implementation as the project is categorized as GIS (Gender Integrated Project). In particular, Both sides agreed on implementation of soft-component activities that promote women's participation in case female staffs are in the targeted position.

### 17-3 Climate change adaptation

Both side confirmed that this project contributes to climate change adaptation to cope with floods caused by sudden rainfall due to the effects of climate change.

### 17-4 Collaboration with technical cooperation projects

It is important that maintenance and management including secondary and tertiary canals are properly implemented after the rehabilitation of the facilities covered by the project. JICA is implementing a technical cooperation project named "Project for the Promotion of Irrigated Agriculture in Terai Plain" in Kankai Irrigation Scheme, Province No.1. The project purpose is that the model of irrigated agriculture is formed by the collaboration among the Federal, Provincial, Local Governments and Water Users Associations (WUAs).

The technical cooperation project is planning to provide trainings to the Government officials and the members of the irrigation office and WUAs in Chandra Nahar Irrigation Scheme too. The training is expected to cover implementation of appropriate facility maintenance, improvement of water distribution planning and its implementation. The specific activities and schedule will be discussed with Nepal and JICA.

Annex 1 Project Site

Annex 2 Organization Chart

Annex 3 Japanese Grant

Annex 4 Project Implementation Schedule

Annex 5 Major Undertakings to be taken by the Government of Nepal

Annex 6 Project Monitoring Report (template)

Annex 7 Environmental Check List

Annex 8 Environmental Management Plan/Environmental Monitoring Plan

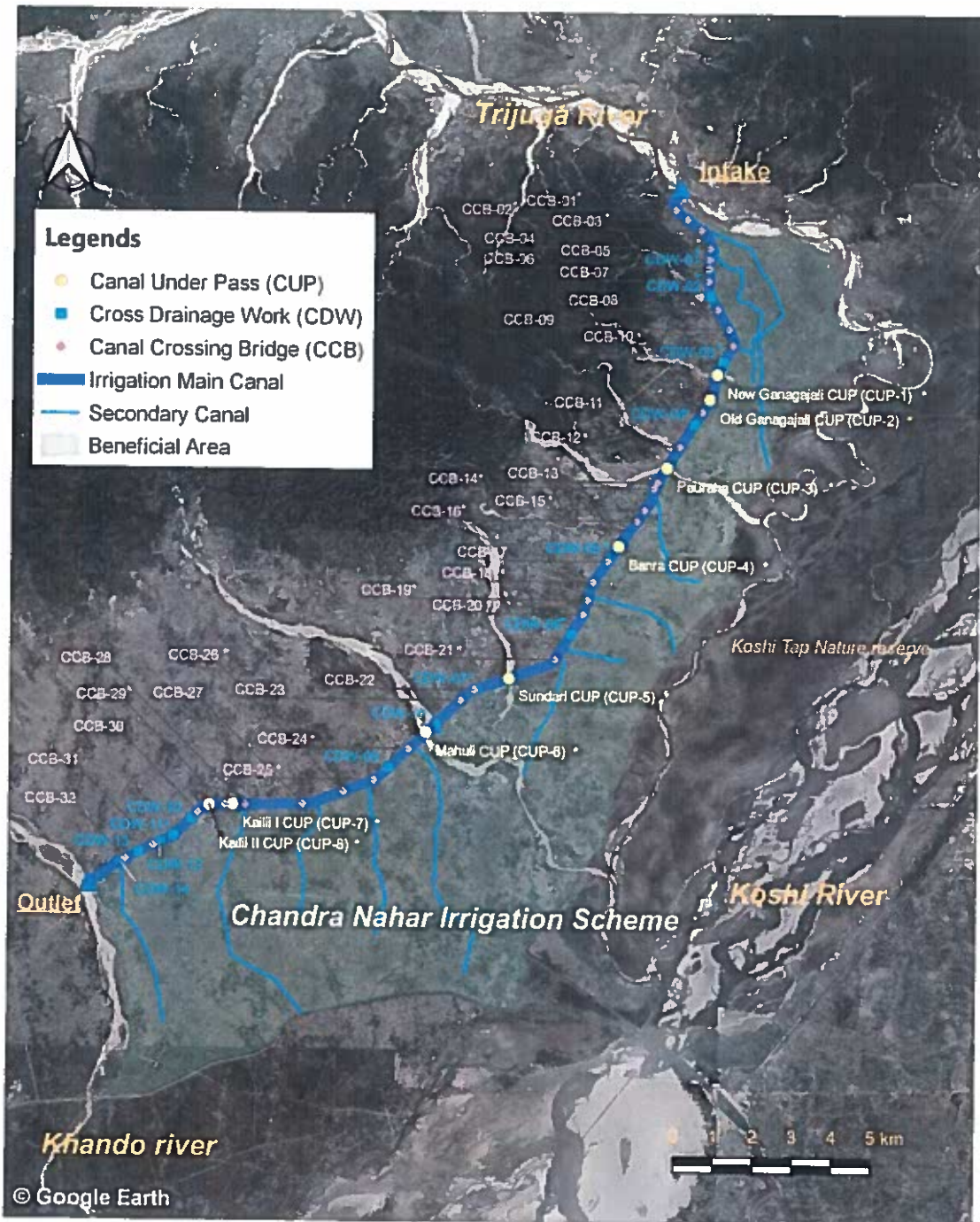
Annex 9 (Abbreviated) Resettlement Action Plan

Annex 10 Environmental and Social Monitoring Form



Project Site

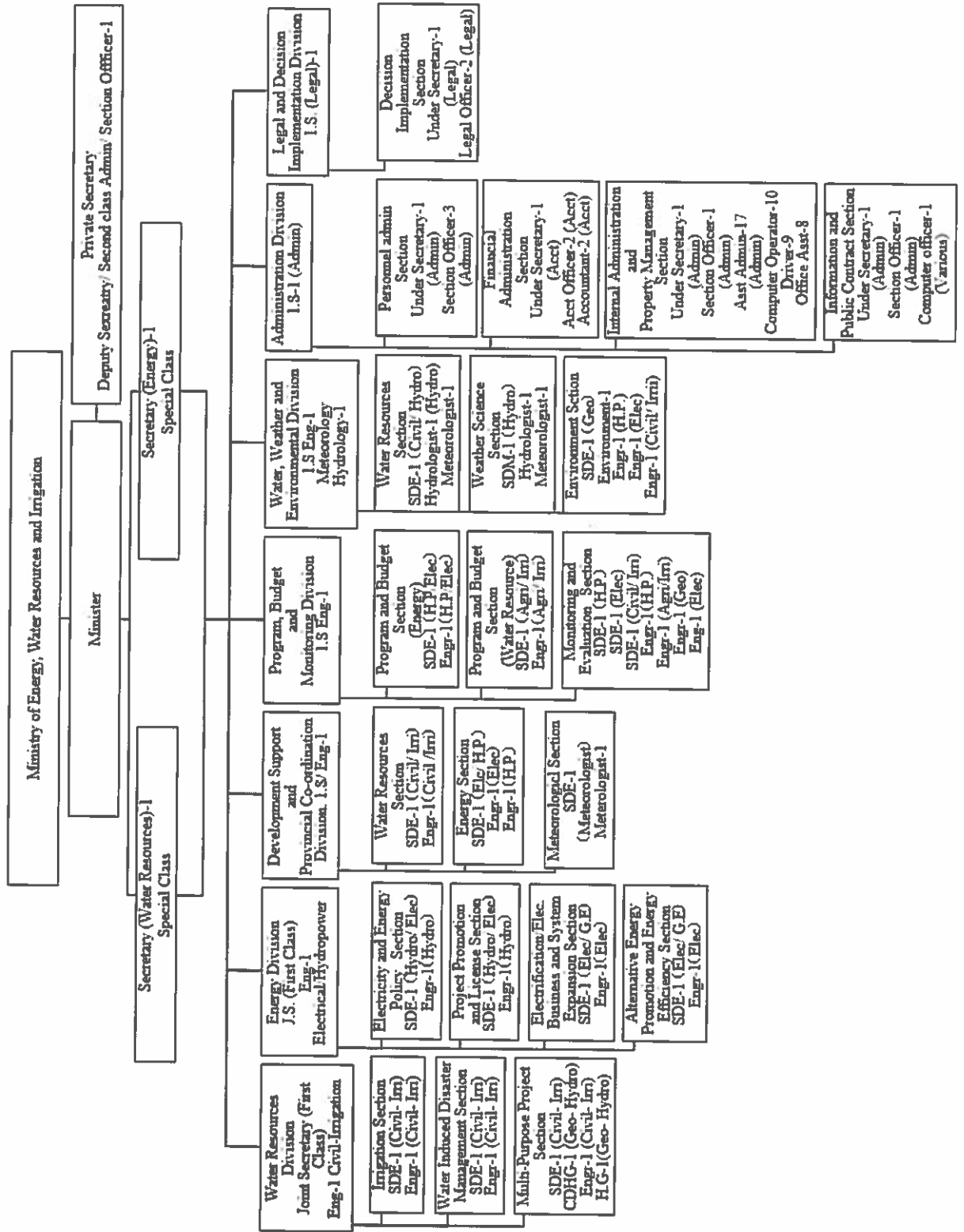
### Location Map (Target Facilities)



\* Facilities to be Rehabilitated

A.O.

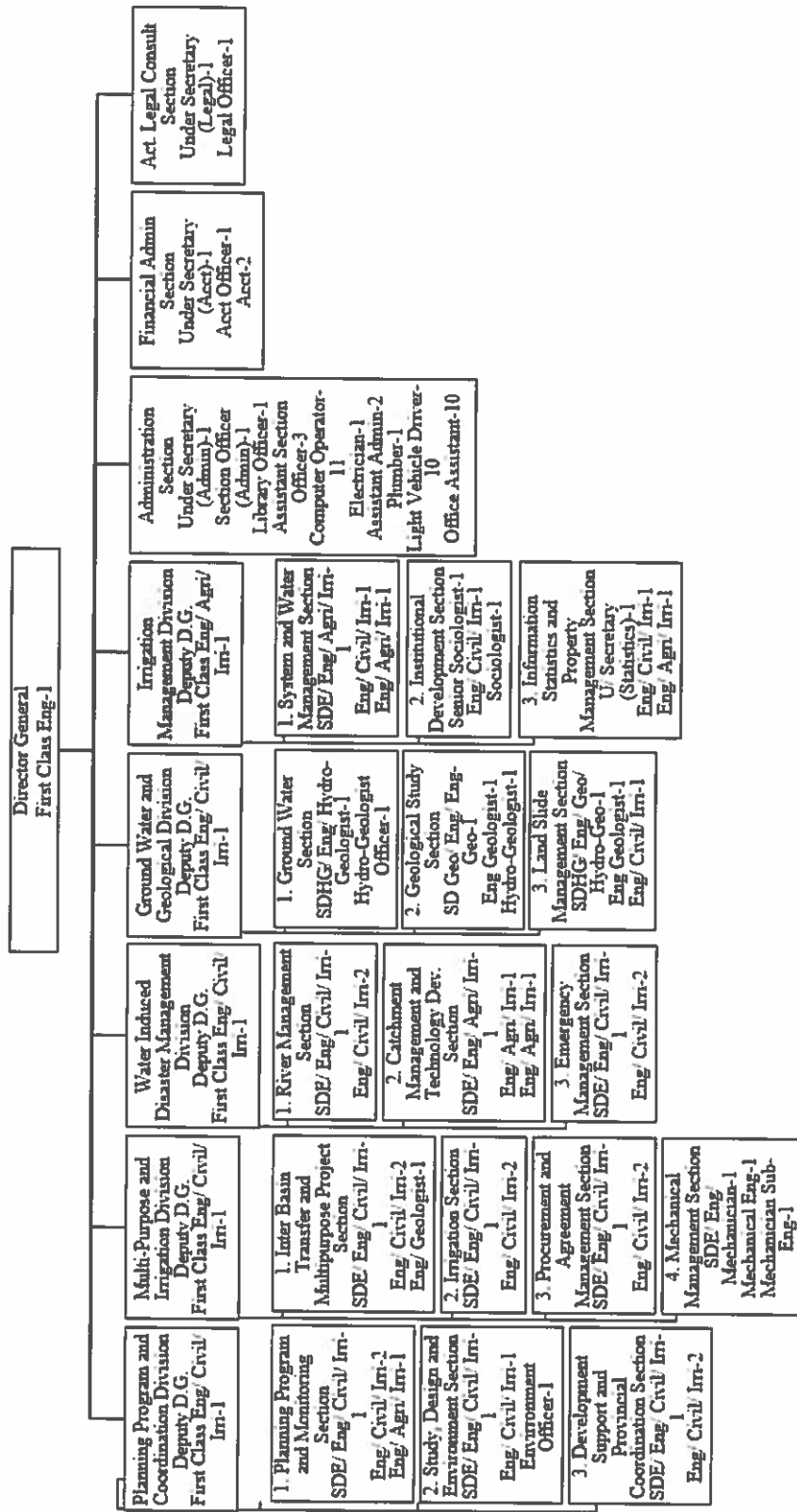
Organization Chart - Ministry of Energy, Water Resource and Irrigation



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Organization Chart - Department of Water Resource and Irrigation



## JAPANESE GRANT

The Japanese Grant is non-reimbursable fund provided to a recipient country (hereinafter referred to as "the Recipient") to purchase the products and/or services (engineering services and transportation of the products, etc.) for its economic and social development in accordance with the relevant laws and regulations of Japan. Followings are the basic features of the project grants operated by JICA (hereinafter referred to as "Project Grants").

### 1. Procedures of Project Grants

Project Grants are conducted through following procedures (See "PROCEDURES OF JAPANESE GRANT" for details):

(1) Preparation

- The Preparatory Survey (hereinafter referred to as "the Survey") conducted by JICA

(2) Appraisal

- Appraisal by the government of Japan (hereinafter referred to as "GOJ") and JICA, and Approval by the Japanese Cabinet

(3) Implementation

Exchange of Notes

- The Notes exchanged between the GOJ and the government of the Recipient

Grant Agreement (hereinafter referred to as "the G/A")

- Agreement concluded between JICA and the Recipient

Banking Arrangement (hereinafter referred to as "the B/A")

- Opening of bank account by the Recipient in a bank in Japan (hereinafter referred to as "the Bank") to receive the grant

Construction works/procurement

- Implementation of the project (hereinafter referred to as "the Project") on the basis of the G/A

(4) Ex-post Monitoring and Evaluation

- Monitoring and evaluation at post-implementation stage

### 2. Preparatory Survey

(1) Contents of the Survey

The aim of the Survey is to provide basic documents necessary for the appraisal of the the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of

relevant agencies of the Recipient necessary for the implementation of the Project.

- Evaluation of the feasibility of the Project to be implemented under the Japanese Grant from a technical, financial, social and economic point of view.
- Confirmation of items agreed between both parties concerning the basic concept of the Project.
- Preparation of an outline design of the Project.
- Estimation of costs of the Project.
- Confirmation of Environmental and Social Considerations

The contents of the original request by the Recipient are not necessarily approved in their initial form. The Outline Design of the Project is confirmed based on the guidelines of the Japanese Grant.

JICA requests the Recipient to take measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the executing agency of the Project. Therefore, the contents of the Project are confirmed by all relevant organizations of the Recipient based on the Minutes of Discussions.

#### (2) Selection of Consultants

For smooth implementation of the Survey, JICA contracts with (a) consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

#### (3) Result of the Survey

JICA reviews the report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the feasibility of the Project.

### 3. Basic Principles of Project Grants

#### (1) Implementation Stage

##### 1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the Exchange of Notes (hereinafter referred to as "the E/N") will be signed between the GOJ and the Government of the Recipient to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Recipient to define the necessary articles, in accordance with the E/N, to implement the Project, such as conditions of disbursement, responsibilities of the Recipient, and procurement conditions. The terms and conditions generally applicable to the Japanese Grant are stipulated in the "General Terms and Conditions for Japanese Grant (January 2016)."

2) Banking Arrangements (B/A) (See "Financial Flow of Japanese Grant (A/P Type)" for details)

- a) The Recipient shall open an account or shall cause its designated authority to open an account under the name of the Recipient in the Bank, in principle. JICA will disburse the Japanese Grant in Japanese yen for the Recipient to cover the obligations incurred by the Recipient under the verified contracts.
- b) The Japanese Grant will be disbursed when payment requests are submitted by the Bank to JICA under an Authorization to Pay (A/P) issued by the Recipient.

3) Procurement Procedure

The products and/or services necessary for the implementation of the Project shall be procured in accordance with JICA's procurement guidelines as stipulated in the G/A.

4) Selection of Consultants

In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the Recipient to continue to work on the Project's implementation after the E/N and G/A.

5) Eligible source country

In using the Japanese Grant disbursed by JICA for the purchase of products and/or services, the eligible source countries of such products and/or services shall be Japan and/or the Recipient. The Japanese Grant may be used for the purchase of the products and/or services of a third country as eligible, if necessary, taking into account the quality, competitiveness and economic rationality of products and/or services necessary for achieving the objective of the Project. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm, which enter into contracts with the Recipient, are limited to "Japanese nationals", in principle.

6) Contracts and Concurrence by JICA

The Recipient will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be concurred by JICA in order to be verified as eligible for using the Japanese Grant.

7) Monitoring

The Recipient is required to take their initiative to carefully monitor the progress of the Project in order to ensure its smooth implementation as part of their responsibility in the G/A, and to regularly report to JICA about its status by using the Project Monitoring Report (PMR).

8) Safety Measures

The Recipient must ensure that the safety is highly observed during the implementation of the Project.

(2) Ex-post Monitoring and Evaluation Stage

- 1) After the project completion, JICA will continue to keep in close contact with the Recipient in order to monitor that

the outputs of the Project is used and maintained properly to attain its expected outcomes.

2) In principle, JICA will conduct ex-post evaluation of the Project after three years from the completion. It is required for the Recipient to furnish any necessary information as JICA may reasonably request.

(3) Others

1) Environmental and Social Considerations

The Recipient shall carefully consider environmental and social impacts by the Project and must comply with the environmental regulations of the Recipient and JICA Guidelines for Environmental and Social Considerations (April, 2010).

2) Major undertakings to be taken by the Government of the Recipient

For the smooth and proper implementation of the Project, the Recipient is required to undertake necessary measures including land acquisition, and bear an advising commission of the A/P and payment commissions paid to the Bank as agreed with the GOJ and/or JICA. The Government of the Recipient shall ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the Recipient with respect to the purchase of the Products and/or the Services be exempted or be borne by its designated authority without using the Grant and its accrued interest, since the grant fund comes from the Japanese taxpayers.

3) Proper Use

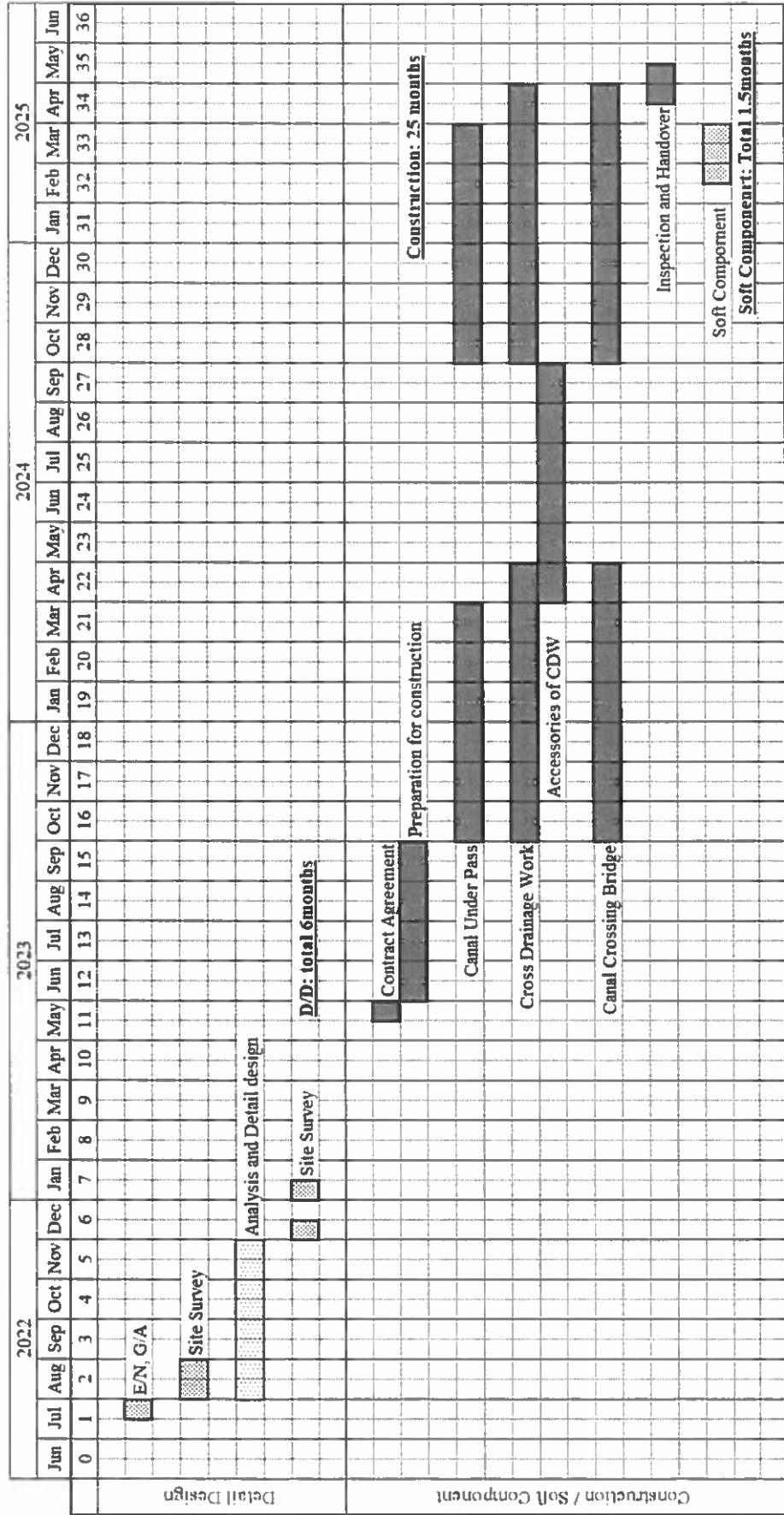
The Recipient is required to maintain and use properly and effectively the products and/or services under the Project (including the facilities constructed and the equipment purchased), to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Japanese Grant.

4) Export and Re-export

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

Annex4

Project Implementation Schedule



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## Annex 5

## Major Undertakings to be taken by the Government of Nepal

## 1. Specific obligations of the Government of Nepal which will not be funded with the Grant

## (1) Before the Bidding

| NO | Items   | Deadline  | In charge | Estimated Cost (NRs) | Ref. |
|----|---|---|-----------|----------------------|------|
| 1  | To sign the banking arrangement (B/A) with a bank in Japan (the Agent Bank) to open bank account for the Grant  | within 1 month after the signing of the G/A         | MOF       |                      | -    |
| 2  | To issue A/P to the Agent Bank for the payment to the consultant  | within 1 month after the signing of the contract(s) | MOEWRI    |                      | -    |
| 3  | To bear the following commissions to the Agent Bank for the banking services based upon B/A   |   |           |                      | -    |
|    | 1) Advising commission of A/P   | within 1 month after the signing of the contract(s) | MOEWRI    |                      |      |
|    | 2) Payment commission for A/P   | every payment                                       | MOF       |                      |      |
| 4  | To approve IEE(Conditions of approval should be fulfilled, if any) and secure the necessary budget for implementation for EMP and EMoP (and fulfilling conditions of approval, if any).   | within 1 month after the signing of the G/A         | MOEWRI    |                      |      |
| 5  | To secure the necessary budget and implement land acquisition and resettlement (including preparation of resettlement sites), and compensation with full replacement cost in accordance with RAP  | before notice of the bidding documents              | MOEWRI    |                      |      |
| 6  | To implement environmental & social monitoring, and to submit the monitoring results to JICA, by using the monitoring form, on a quarterly basis as a part of Project Monitoring Report   | until land acquisition and resettlement complete    | MOEWRI    |                      |      |
| 7  | To secure and clear the following lands<br>1) land for widening and replacing by rehabilitation of facilities<br>2) temporary construction yard and stock yard near the Project area<br>3) borrow pit and disposal site near the Project area | before notice of the bidding documents              | MOEWRI    |                      |      |
| 8  | To clear, level and reclaim the following sites<br>1) remove utilities such as power poles, power and water pipe or other public facilities, if necessary.  | before notice of the bidding documents              | MOEWRI    |                      |      |
| 9  | To submit Project Monitoring Report (with the result of Detailed Design) to JICA  | before preparation of the bidding documents         | MOEWRI    |                      |      |

(B/A: Banking Arrangement. A/P: Authorization to pay. N/A: Not Applicable)

(MOF: Ministry of Finance. MOEWRI: Ministry of Energy, Water Resource and Irrigation)

(2) During the Project Implementation

| NO | Items   | Deadline   | In charge | Estimated Cost | Ref. |
|----|---|--|-----------|----------------|------|
| 1  | To issue A/P to the Agent Bank for the payment to the contractor  | within 1 month after the signing of the contract(s)  | MOF       |                |      |
| 2  | To bear the following commissions to the Agent Bank for the banking services based upon the B/A   |  |           |                |      |
|    | 1) Advising commission of A/P   | within 1 month after the signing of the contract(s)  | MOEWRI    |                |      |
|    | 2) Payment commission for A/P   | every payment  | MOF       |                |      |
| 3  | To ensure prompt customs clearance and to assist the Supplier(s) with internal transportation in the country of the Recipient   | during the Project   | MOEWRI    |                |      |
| 4  | To accord Japanese physical persons and/or physical persons of third countries whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the country of the Recipient and stay therein for the performance of their work | during the Project   | MOEWRI    |                |      |
| 5  | To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the country of the Recipient with respect to the purchase of the products and/or the services be exempted   | during the Project   | MOEWRI    |                |      |
| 6  | To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project  | during the Project   | MOEWRI    |                |      |
| 7  | To notify JICA promptly of any incident or accident, which has, or is likely to have, a significant adverse effect on the environment, the affected communities, the public or workers.   | during the construction  | MOEWRI    |                |      |
| 8  | To ensure the safety of persons engaged in the implementation of the project  | during the construction  | MOEWRI    |                |      |
| 9  | To take necessary measures for security and safety of the Project site i.e. traffic control around the site(s) and on transportation routes of construction materials   | during the construction  | MOEWRI    |                |      |
| 10 | 1) To submit Project Monitoring Report to JICA  | every month  | MOEWRI    |                |      |
|    | 2) To submit Project Monitoring Report (final) (including as-built drawings, equipment list, photographs, etc.)   | within 1 month after issuance of Certificate of Completion for the works under the contract(s) | MOEWRI    |                |      |
| 11 | To submit a report concerning completion of the Project   | within 6 months after completion of the Project  | MOEWRI    |                |      |
| 12 | To implement EMP and EMoP   | during the construction  | MOEWRI    |                |      |
| 13 | To submit results of environmental monitoring to JICA, by using the monitoring form, on a quarterly basis as a part of Project Monitoring Report  | during the construction  | MOEWRI    |                |      |
| 14 | To implement social monitoring, and to submit the monitoring results to JICA, by using the monitoring form, on a quarterly basis as a part of Project Monitoring Report   | during the Project   | MOEWRI    |                |      |

*Qe*      *A.S*

(3) After the Project

| NO | Items   | Deadline                             | In charge | Estimated Cost | Ref. |
|----|---|--------------------------------------|-----------|----------------|------|
| 1  | To implement EMP and EMoP   | for a period based on EMP and EMoP   | MOEWRI    |                |      |
| 2  | To submit results of environmental monitoring to JICA, by using the monitoring form, semiannually<br>- The period of environmental monitoring may be extended if any significant negative impacts on the environment are found. The extension of environmental monitoring will be decided based on the agreement between MOEWRI and JICA. | for 3 years after the Project        | MOEWRI    |                |      |
| 3  | To maintain and use properly and effectively the facilities constructed under the Grant Aid<br>1) Allocation of maintenance cost<br>2) Operation and maintenance structure<br>3) Routine check/Periodic inspection  | After completion of the construction | MOEWRI    |                |      |

2. Other obligations of the Government of Nepal funded with the Grant

| NO    | Items   | Deadline  | Amount<br>(Million<br>Japanese Yen)* |
|-------|---|-----------|--------------------------------------|
| 1     | To rehabilitate Canal Under Pass / Cross Drainage Work / Canal Crossing Bridge<br>•Canal Under Pass<br>•Cross Drainage Work<br>•Canal Crossing Bridge | May, 2025 |                                      |
| 2     | To implement detailed design, bidding support and construction supervision (Consulting Service)   |           |                                      |
| 3     | Contingencies   |           |                                      |
| Total |   |           |                                      |

\*The Amount is provisional. This is subject to the approval of the Government of Japan.

*De*      *AC*

**Project Monitoring Report**  
**on**  
**Project Name**  
**Grant Agreement No. XXXXXXX**  
20XX, Month

**Organizational Information**

|  |   |
|--|---|
| <b>Signer of the G/A<br/>(Recipient)</b> | _____<br>Person in Charge ( <u>Designation</u> )<br>_____<br>Contacts <u>Address:</u> _____<br><u>Phone/FAX:</u> _____<br><u>Email:</u> _____ |
| <b>Executing Agency</b>                  | _____<br>Person in Charge ( <u>Designation</u> )<br>_____<br>Contacts <u>Address:</u> _____<br><u>Phone/FAX:</u> _____<br><u>Email:</u> _____ |
| <b>Line Ministry</b>                     | _____<br>Person in Charge ( <u>Designation</u> )<br>_____<br>Contacts <u>Address:</u> _____<br><u>Phone/FAX:</u> _____<br><u>Email:</u> _____ |

**General Information:**

|                          |   |
|--------------------------|---|
| <b>Project Title</b>     |   |
| <b>E/N</b>               | Signed date:<br>Duration:   |
| <b>G/A</b>               | Signed date:<br>Duration:   |
| <b>Source of Finance</b> | Government of Japan: Not exceeding JPY _____ mil.<br>Government of (_____): _____ |

|                               |  |
|-------------------------------|--|
| <b>1: Project Description</b> |  |
|-------------------------------|--|

**1-1 Project Objective**

|  |
|--|
|  |
|--|

**1-2 Project Rationale**

- Higher-level objectives to which the project contributes (national/regional/sectoral policies and strategies)
- Situation of the target groups to which the project addresses

|  |
|--|
|  |
|--|

**1-3 Indicators for measurement of "Effectiveness"**

| Quantitative indicators to measure the attainment of project objectives |                |              |
|---|----------------|--------------|
| Indicators  | Original (Yr ) | Target (Yr ) |
|   |                |              |
|   |                |              |
| Qualitative indicators to measure the attainment of project objectives  |                |              |
|   |                |              |

|                                  |
|----------------------------------|
| <b>2: Details of the Project</b> |
|----------------------------------|

**2-1 Location**

| Components | Original<br><i>(proposed in the outline design)</i> | Actual |
|------------|---|--------|
| 1.         |   |        |

**2-2 Scope of the work**

| Components | Original*<br><i>(proposed in the outline design)</i> | Actual* |
|------------|--|---------|
| 1.         |  |         |
|            |  |         |
|            |  |         |

Reasons for modification of scope (if any).

|       |
|-------|
| (PMR) |
|-------|




**2-3 Implementation Schedule**

| Items | Original                                |   | Actual |
|-------|---|---|--------|
|       | <i>(proposed in the outline design)</i> | <i>(at the time of signing the Grant Agreement)</i> |        |
|       |   |   |        |

Reasons for any changes of the schedule, and their effects on the project (if any)

|  |
|--|
|  |
|--|

**2-4 Obligations by the Recipient**

**2-4-1 Progress of Specific Obligations**  
 See Attachment 2.

**2-4-2 Activities**  
 See Attachment 3.

**2-4-3 Report on RD**  
 See Attachment 11.

**2-5 Project Cost**

**2-5-1 Cost borne by the Grant(Confidential until the Bidding)**

| Components |   |  | Cost (Million Yen)   |        |
|------------|---|--|--|--------|
|            | Original<br><i>(proposed in the outline design)</i> | Actual<br><i>(in case of any modification)</i> | Original <sup>1),2)</sup><br><i>(proposed in the outline design)</i> | Actual |
|            | 1.  |  |  |        |
|            |   |  |  |        |
|            |   |  |  |        |
| Total      |   |  |  |        |

Note: 1) Date of estimation:  
 2) Exchange rate: 1 US Dollar = Yen

**2-5-2 Cost borne by the Recipient**

| Components |   |  | Cost (1,000 Taka)  |        |
|------------|---|--|--|--------|
|            | Original<br><i>(proposed in the outline design)</i> | Actual<br><i>(in case of any modification)</i> | Original <sup>1),2)</sup><br><i>(proposed in the outline design)</i> | Actual |
|            | 1.  |  |  |        |
|            |   |  |  |        |
|            |   |  |  |        |
|            |   |  |  |        |

- Note: 1) Date of estimation:  
 2) Exchange rate: 1 US Dollar =

Reasons for the remarkable gaps between the original and actual cost, and the countermeasures (if any)

(PMR)

**2-6 Executing Agency**

- Organization's role, financial position, capacity, cost recovery etc,
- Organization Chart including the unit in charge of the implementation and number of employees.

|   |
|---|
| <b>Original</b> (at the time of outline design)<br>name:<br>role:<br>financial situation:<br>institutional and organizational arrangement (organogram):<br>human resources (number and ability of staff): |
| <b>Actual</b> (PMR)   |

**2-7 Environmental and Social Impacts**

- The results of environmental monitoring based on Attachment 5 (in accordance with Schedule 4 of the Grant Agreement).
- The results of social monitoring based on in Attachment 5 (in accordance with Schedule 4 of the Grant Agreement).
- Disclosed information related to results of environmental and social monitoring to local stakeholders (whenever applicable).

**3: Operation and Maintenance (O&M)**

**3-1 Physical Arrangement**

- Plan for O&M (number and skills of the staff in the responsible division or section, availability of manuals and guidelines, availability of spareparts, etc.)

|   |
|---|
| <b>Original</b> (at the time of outline design) |
| <b>Actual</b> (PMR)                             |

**3-2 Budgetary Arrangement**

- Required O&M cost and actual budget allocation for O&M

|   |
|---|
| <b>Original</b> (at the time of outline design) |
|---|

Actual (PMR)

**4: Potential Risks and Mitigation Measures**

- Potential risks which may affect the project implementation, attainment of objectives, sustainability
- Mitigation measures corresponding to the potential risks

**Assessment of Potential Risks (at the time of outline design)**

| Potential Risks          | Assessment                                       |
|--------------------------|--|
| 1. (Description of Risk) | Probability: High/Moderate/Low                   |
|                          | Impact: High/Moderate/Low                        |
|                          | Analysis of Probability and Impact:              |
|                          |  |
|                          | Mitigation Measures:                             |
|                          |  |
|                          | Action required during the implementation stage: |
| 2. (Description of Risk) | Probability: High/Moderate/Low                   |
|                          | Impact: High/Moderate/Low                        |
|                          | Analysis of Probability and Impact:              |
|                          |  |
|                          | Mitigation Measures:                             |
|                          |  |
|                          | Action required during the implementation stage: |
| 3. (Description of Risk) | Probability: High/Moderate/Low                   |
|                          | Impact: High/Moderate/Low                        |
|                          | Analysis of Probability and Impact:              |
|                          |  |
|                          | Mitigation Measures:                             |
|                          |  |
|                          | Action required during the implementation stage: |

|   |                                   |
|---|-----------------------------------|
|   | Contingency Plan (if applicable): |
|   |                                   |
| <b>Actual Situation and Countermeasures</b> |                                   |
| (PMR)                                       |                                   |
|   |                                   |

**5: Evaluation and Monitoring Plan (after the work completion)**

**5-1 Overall evaluation**

Please describe your overall evaluation on the project.

**5-2 Lessons Learnt and Recommendations**

Please raise any lessons learned from the project experience, which might be valuable for the future assistance or similar type of projects, as well as any recommendations, which might be beneficial for better realization of the project effect, impact and assurance of sustainability.

**5-3 Monitoring Plan of the Indicators for Post-Evaluation**

Please describe monitoring methods, section(s)/department(s) in charge of monitoring, frequency, the term to monitor the indicators stipulated in 1-3.

Attachment

1. Project Location Map
2. Specific obligations of the Recipient which will not be funded with the Grant
3. Monthly Report submitted by the Consultant
- Appendix - Photocopy of Contractor's Progress Report (if any)
  - Consultant Member List
  - Contractor's Main Staff List
4. Check list for the Contract (including Record of Amendment of the Contract/Agreement and Schedule of Payment)
5. Environmental Monitoring Form / Social Monitoring Form
6. Monitoring sheet on price of specified materials (Quarterly)
7. Report on Proportion of Procurement (Recipient Country, Japan and Third Countries) (PMR (final) only)
8. Pictures (by JPEG style by CD-R) (PMR (final) only)
9. Equipment List (PMR (final) only)
10. Drawing (PMR (final) only)
11. Report on RD (After project)



Monitoring sheet on price of specified materials

1. Initial Conditions (Confirmed)

| Items of Specified Materials | Initial Volume<br>A | Initial Unit Price (¥)<br>B | Initial total Price<br>C=A×B | 1% of Contract Price<br>D | Condition of payment<br>Price (Increased)<br>E=C-D | Price (Increased)<br>F=C+D |
|------------------------------|---------------------|-----------------------------|------------------------------|---------------------------|--|----------------------------|
| Item 1                       | ●●t                 | ●                           | ●                            | ●                         | ●  | ●                          |
| Item 2                       | ●●t                 | ●                           | ●                            | ●                         |  |                            |
| Item 3                       |                     |                             |                              |                           |  |                            |
| Item 4                       |                     |                             |                              |                           |  |                            |
| Item 5                       |                     |                             |                              |                           |  |                            |

2. Monitoring of the Unit Price of Specified Materials

(1) Method of Monitoring : ●●

(2) Result of the Monitoring Survey on Unit Price for each specified materials

| Items of Specified Materials | 1st month, 2015 | 2nd month, 2015 | 3rd month, 2015 | 4th | 5th | 6th |
|------------------------------|-----------------|-----------------|-----------------|-----|-----|-----|
| Item 1                       | ●               | ●               | ●               |     |     |     |
| Item 2                       |                 |                 |                 |     |     |     |
| Item 3                       |                 |                 |                 |     |     |     |
| Item 4                       |                 |                 |                 |     |     |     |
| Item 5                       |                 |                 |                 |     |     |     |

(3) Summary of Discussion with Contractor (if necessary)

Attachment 7

Report on Proportion of Procurement (Recipient Country, Japan and Third Countries)  
 (Actual Expenditure by Construction and Equipment each)

|                             | Domestic Procurement<br>(Recipient Country)<br>A | Foreign Procurement<br>(Japan)<br>B | Foreign Procurement<br>(Third Countries)<br>C | Total<br>D |
|-----------------------------|--|-------------------------------------|---|------------|
| Construction Cost           | (A/D%)   | (B/D%)                              | (C/D%)  |            |
| Direct Construction Cost    | (A/D%)   | (B/D%)                              | (C/D%)  |            |
| others                      | (A/D%)   | (B/D%)                              | (C/D%)  |            |
| Equipment Cost              | (A/D%)   | (B/D%)                              | (C/D%)  |            |
| Design and Supervision Cost | (A/D%)   | (B/D%)                              | (C/D%)  |            |
| Total                       | (A/D%)   | (B/D%)                              | (C/D%)  |            |

A. U

Annex 7

**Environmental Checklist:(No.16 Agriculture, Irrigation, and Livestock)**

| Category                  | Environmental Item                   | Main Check Items   | Yes: Y<br>No: N                  | Confirmation of Environmental Considerations<br>(Reasons, Mitigation Measures)  |
|---------------------------|--------------------------------------|--|----------------------------------|---|
| 1 Permits and Explanation | (1) EIA and Environmental Permits    | (a) Have EIA reports been already prepared in official process?<br>(b) Have EIA reports been approved by authorities of the host country's government?<br>(c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied?<br>(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<br>(b) N<br>(c) N<br>(d) N | (a) IEE Report has been prepared and submitted to MOEWRI which is the authoritative agency of approving IEE in this project in Nepal.<br>(b) IEE Report will be reviewed by MOEWRI and expected to be approved after the review.<br>(c) Condition will be informed by MOEWRI after review.<br>(d) No particular other environmental permits are required.                                 |
|                           | (2)Explanation to 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?<br>(b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?   | (a) Y<br>(b) Y                   | (a) Project information disclosure and consensus building were done through multiple public consultation meeting, stakeholder meeting, and one to one meeting, etc with local and central stakeholders. Understanding from the local stakeholders has been obtained.<br>(b) The comment from the local residents obtained during above meetings has been reflected to the project design. |
|                           | (3)Examination of alternatives       | (a) Have alternative plans of the project been examined with social and environmental considerations?  | (a) Y                            | (a) Plural alternative plans (including the zero option) have been examined comprehensively with social and environmental considerations.   |

A.O.

Annex 7

| Category            | Environmental Item     | Main Check Items  | Yes: Y<br>No: N         | Confirmation of Environmental Considerations<br>(Reasons, Mitigation Measures)  |
|---------------------|------------------------|---|-------------------------|---|
| 2 Pollution Control | (1) Water Quality      | (a) Are considerations given to water pollution of the surrounding water bodies, such as rivers and groundwater by effluents or leachates from agricultural lands? Are adequate use/disposal standards for fertilizers, agrochemicals, and livestock wastes established? Is a framework established to increase awareness of the standards among farmers?<br>(b) Is a monitoring framework established for water pollution of rivers and groundwater? | (a) Y<br>(b) Y          | (a) Existing water quality of the river and the groundwater is analyzed base on the baseline survey, and prevent measures towards the water pollution was established in the mitigation measures and the monitoring plan.<br>(b) Monitoring items, frequency, implementation entity, and responsible organization are indicated in the monitoring plan.   |
|                     | (2) Wastes             | (a) Are wastes properly treated and disposed of in accordance with the country's regulations?   | (a) Y                   | (a) First of all, project will reuse excavated soil as refilling material as much as possible. Assumed wastes (other excavated soil, demolished bricks and concrete and garbage from camping site) will be processed according to the regulation of Nepal and the related local government.   |
|                     | (3) Soil Contamination | (a) Is there a possibility that impacts in irrigated lands, such as salinization of soils will result?<br>(b) Are adequate measures taken to prevent soil contamination of irrigated lands by agrochemicals, heavy metals, and other hazardous substances?<br>(c) Are any agrochemicals management plans prepared? Are any usages or any implementation structures organized for proper use of the plans?   | (a) N<br>(b) Y<br>(c) Y | (a) The source of salinization of soils has not been confirmed and it is not expected by the project implementation.<br>(b) Soil contamination by the hazardous waste and heavy metals are not expected because the project doesn't have a plan to use them.<br>(c) Soil contamination by the spilt oil from construction machines and vehicles during construction period is anticipated, but to be prevented by mitigation measures and monitoring. |
|                     | (4) Subsidence         | (a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?  | (a) N                   | (a) Subsidence is not expected because extraction of a large volume of ground water will not be done during the construction and operation period by the  |

Annex 7

| Category              | Environmental Item  | Main Check Items  | Yes: Y<br>No: N                           | Confirmation of Environmental Considerations<br>(Reasons, Mitigation Measures)   |
|-----------------------|---------------------|---|---|--|
|                       |                     |   |   | project.   |
|                       | (5) Odor            | (a) Are there any odor sources? Is there a possibility that odor problems will occur to the inhabitants?  | (a) N                                     | (a) Activities generate odor is not expected.  |
| 3 Natural Environment | (1) Protected Areas | (a) Is the project site or discharge area 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) Project site is outside of wildlife reserve and Ramsar site. Discharge into these area by the project is not expected. It was confirmed with local stakeholder including KTWR that impact by the project is not expected like other ongoing project (Postal Road Project). Moreover, Koshi Tappu Wildlife Reserve and Buffer Zone Management Plan (2018) aims to achieve both sustainable ecosystem services and community prosperity, and is consistent with this project, as the document clearly states the need to rehabilitate Chandra Nahar irrigation facilities. |
|                       | (2) Ecosystem       | (a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)?<br>(b) Does the project site or discharge area encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions?<br>(c) Is there a possibility that the project will result in the loss of breeding and feeding grounds for valuable wildlife? If they are lost, are there substitutes for the grounds near the original | (a) N<br>(b) Y<br>(c) N<br>(d) N<br>(e) Y | (a) Not encompass such sites but a draw (seasonal river) where canal under pass crossing is used as corridor by Asian elephant.<br>(b) According to the IEE survey, species listed in the country's protected list and IUCN are confirmed and mitigation measures are established.<br>(c) Based on the consultation with KTWR experts, construction is planned to minimize disturbance to wildlife access. Since the project is rehabilitation of existing facilities, significant loss of breeding and feeding grounds is not expected.                                     |

Annex 7

| Category             | Environmental Item | Main Check Items  | Yes: Y<br>No: N  | Confirmation of Environmental Considerations<br>(Reasons, Mitigation Measures)  |
|----------------------|--------------------|---|--|---|
|                      |                    | locations?<br>(d) Is there a possibility that overgrazing will cause ecological degradation, such as impacts on wildlife habitats and desertification?<br>(e) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem?   |  | (d) Overgrazing is not planned.<br>(e) Since the project mainly work for rehabilitation of existing facilities, such overgrazing or significant impact is not expected.   |
| 4 Social Environment | (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?<br>(b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement?<br>(c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement?<br>(d) Is the compensation going to be paid prior to the resettlement?<br>(e) Is the compensation policies prepared in document?<br>(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?<br>(g) Are agreements with the affected | (a) Y<br>(b) Y<br>(c) Y<br>(d) Y<br>(e) Y<br>(f) Y<br>(g) Y<br>(h) Y<br>(i) Y<br>(j) Y | (a) Small number of resettlement of structures and land acquisition are expected.<br>(b) Community consultation meetings and workshops will be held to explain about compensation and measures of livelihood restoration and to get agreement from the community people before project.<br>(c) ARAP was developed based on socio-economic studies as well as a number of meetings with various stakeholders.<br>(d) Compensation will be paid prior to the resettlement according to the both Nepal laws and JICA guidelines.<br>(e) Entitlement Matrix is included in ARAP report.<br>(f) Vulnerable persons and/or his/her family will be assisted during the compensation process, and be given priority of job opportunity during the construction period.<br>(g) Agreements with the affected people will be obtained and compensation will be paid prior to resettlement.<br>(h) ARAP organization framework was suggested according to related Nepali laws and JICA guidelines /WB OP 4.12 in the RAP. And also budget for preparation, implementation, and monitoring of ARAP |

Annex 7

| Category | Environmental Item        | Main Check Items  | Yes: Y<br>No: N  | Confirmation of Environmental Considerations<br>(Reasons, Mitigation Measures)  |
|----------|---------------------------|---|--|---|
|          |                           | <p>people obtained prior to resettlement?</p> <p>(h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan?</p> <p>(i) Are any plans developed to monitor the impacts of resettlement?</p> <p>(j) Is the grievance redress mechanism established?</p>   |  | <p>was estimated and the schedule of compensation and resettlement was discussed and presented in the report.</p> <p>(i) Monitoring plan was developed in ARAP report.</p> <p>(j) According to the Nepali law, the grievance redress mechanism is proposed and will be established. Necessary cost for grievance redress mechanism is also calculated and presented in the ARAP.</p>  |
|          | (2) Living and Livelihood | <p>(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary?</p> <p>(b) Is proper allotment made for rights to agricultural land use? Is there a possibility that the allotment will result in inequitable distribution or usurpation of land and available resources?</p> <p>(c) Are proper allotments, such as water rights allotment in the project area made? Is there a possibility that the allotments will result in inequitable distribution or usurpation of water rights and available resources?</p> | <p>(a) N</p> <p>(b) N</p> <p>(c) N</p> <p>(d) N</p> <p>(e) N</p> | <p>(a) The project will improve irrigation efficiency and agricultural production. Some adverse impacts anticipated will be mitigated with compensation and livelihood restoration measures.</p> <p>(b) Alternative land was considered but to be compensated in cash based on the discussion with PAPs.</p> <p>(c) Not related because this project targets just rehabilitation of existing irrigation canal and bridges.</p> <p>(d) Impact on current spring water facilities used by community will be mitigated by construction of alternative facilities at each site. Hence, the community will be able to use the water constantly.</p> <p>(e) Though significant is not anticipated, DWRI will work together with other agencies like</p> |

Annex 7

| Category | Environmental Item                           | Main Check Items   | Yes: Y<br>No: N | Confirmation of Environmental Considerations<br>(Reasons, Mitigation Measures)  |
|----------|--|--|-----------------|---|
|          |  | (d) Is there a possibility that the amount of water used (surface water, groundwater) by the project will adversely the downstream fisheries and water uses?<br>(e) Is there a possibility that water-borne or water-related diseases (e.g., schistosomiasis, malaria, filariasis) will be introduced? Is adequate consideration given to public health education, if necessary? |                 | Ministry of Health to sensitize community and provide necessary services like mosquito net etc as necessary.          |
|          | (3) Heritage                                 | (a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?  | (a) N           | (a) No such facilities are identified in the project area.  |
|          | (4) Landscape                                | (a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?   | (a) N           | (a) Impact on landscape is not anticipated; rather it will be improved through the rehabilitation of aged facilities. |
|          | (5) Ethnic Minorities and Indigenous Peoples | (a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples?<br>(b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?   | (a) N<br>(b) N  | (a) Not confirmed in the Project area.<br>(b) Same as above.  |

Annex 7

| Category | Environmental Item              | Main Check Items  | Yes: Y<br>No: N                  | Confirmation of Environmental Considerations<br>(Reasons, Mitigation Measures)  |
|----------|---------------------------------|---|----------------------------------|---|
|          | (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?<br>(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?<br>(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.?<br>(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<br>(b) Y<br>(c) Y<br>(d) Y | (a) Securing of working condition is implemented according to the related Nepali laws and international rules such as OHSAS.<br>(b) Measures to prevent industrial accidents are secured by mitigation measures such as obligation of wearing safety boots and a helmet during the construction work and the monitoring, which includes countermeasures for the accidents.<br>(c) Safety education through measures such as a morning gathering, a toolbox meeting, a motto, or signboard will be given to construction workers. Construction contractor will prepare a safety and sanitation plan.<br>(d) Setting of the reputation to promote an invasion prevention fence and danger around the construction area is set up. Construction plan and schedule will be informed to the community through signboard or direct announcement in advance. It is assumed that a guard worker for the purpose of prevention of ensuring safety and theft is to be placed. |
| 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)?<br>(b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts?<br>(c) If construction activities adversely affect the social environment, are adequate measures considered to   | (a) Y<br>(b) Y<br>(c) Y          | (a) Noise, dust, water pollution are assumed. Mitigation measures and monitoring plan are established through IEE Study.<br>(b) Though move of Asian elephant across canal underpass is expected, adequate mitigation measures was considered through consultation with KTWR, rangers, municipality, and ward offices concerned.<br>(c) Land acquisition, resettlement, are assumed. Mitigation measures and monitoring plan are established through IEE  |

Annex 7

| Category | Environmental Item | Main Check Items  | Yes: Y<br>No: N                  | Confirmation of Environmental Considerations<br>(Reasons, Mitigation Measures)   |
|----------|--------------------|---|----------------------------------|--|
|          |                    | reduce impacts?   |                                  | and ARAP.  |
|          | (2) Monitoring     | (a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts?<br>(b) What are the items, methods, and frequencies of the monitoring program?<br>(c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)?<br>(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<br>(b) -<br>(c) Y<br>(d) Y | (a) Monitoring plan has been made in the IEE process.<br>(b) The monitoring items were decided considering the present condition survey results and impact evaluation. Monitoring methods were decided considering implementation practicability of Nepal government and securing accuracy. Frequency was decided considering types of work, local situation, and health damage.<br>(c) Monitoring framework has been suggested in the monitoring plan of both IEE and ARAP. This framework has to be adapted reflecting the present condition of Nepal as possible. DWRI will designate one staff who will specifically work for the liaison with other organizations and a core actor of supervising the monitoring.<br>(d) Monitoring report on ARAP shall be submitted by DWRI in pre/post construction stage while Environmental Monitoring Report shall be prepared by Contractor and DWRI during the construction period. |

Annex 7

| Category | Environmental Item                      | Main Check Items   | Yes: Y<br>No: N | Confirmation of Environmental Considerations<br>(Reasons, Mitigation Measures)   |
|----------|---|--|-----------------|--|
| 6 Note   | Reference to Checklist of Other Sectors | (a) Where necessary, pertinent items described in the Forestry checklist should also be checked.<br>(b) For the projects including construction of large-scale weirs, reservoirs, and dams, where necessary, pertinent items described in the Hydropower, Dams, and Reservoirs checklist should also be checked. | (a) N<br>(b) N  | (a) Forest is out of the project object.<br>(b) Construction of large-scale weirs, reservoirs, and dams are not targeted in 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) Y           | (a) It is anticipated that the rehabilitation of aged irrigation facilities will enhance the resilience against flood and heavy rain to be happened due to climate change in future. |

Environmental Management Plan/Environmental Monitoring Plan

1. Environmental Management Plan

Environmental Management Plan and costs are shown in the table below.

**Environmental Management Plan(EMP)**

| No.                                      | Impact Category  | Mitigation  | Implementation  | Responsibility          | Cost (USD)      |
|--|--|---|---|-------------------------|-----------------|
| Before Construction/ During Construction |  |   |   |                         |                 |
| 1  | Air Pollution  | <ul style="list-style-type: none"> <li>Watering of road surfaces and areas to be demolished.</li> <li>Provide training to construction vehicle drivers and workers to avoid idling vehicles and equipment</li> <li>Properly maintain construction equipment and prevent abnormal black or white smoke from the machine</li> </ul>                           | Contractor  | DWRI                    | Included in BOQ |
| 2  | Water Pollution  | <ul style="list-style-type: none"> <li>Turbid water associated with the construction will be drained downstream after precipitation of sediment by using a temporary cofferdam.</li> <li>Discharge of alkaline drainage from concrete work site should be gradual so as not to have a sudden impact downstream.</li> </ul>                                  | Contractor  | DWRI                    | Included in BOQ |
| 3  | Solid Wastes   | <ul style="list-style-type: none"> <li>Reuse excavated soil and other materials as much as possible.</li> <li>Old bricks, concrete rubble, and earth and sand resulting from the demolition of existing structures should be disposed of in locations designated by the local government.</li> </ul>  | Contractor  | DWRI                    | Included in BOQ |
|  |  | <ul style="list-style-type: none"> <li>Guide the prevention and management of littering of refuse into canals.</li> </ul>   | Soft Component  | DWRI                    | Soft Component  |
| 4  | Soil Contamination   | <ul style="list-style-type: none"> <li>Use a drip tray when working with potential oil spills.</li> <li>Regularly inspect and maintain heavy machinery and equipment to prevent oil leaks.</li> </ul>   | Contractor  | DWRI                    | Included in BOQ |
| 5  | Noise and Vibration  | <ul style="list-style-type: none"> <li>Perform regular maintenance of equipment to prevent abnormal noise and vibration.</li> <li>Workers working near noisy equipment should be provided with ear protection.</li> <li>In the vicinity of facilities that require special consideration, we will devise a schedule and set up temporary fences.</li> </ul> | Contractor  | DWRI                    | Included in BOQ |
| 10                                       | Ecosystem  | <ul style="list-style-type: none"> <li>Provide education to avoid the unnecessary killing of wildlife at construction sites</li> <li>Secure the migration routes of Asian Elephants and assign night guards to ensure a system that enables necessary communication with rangers.</li> <li>Implementation of monitoring of wildlife.</li> </ul>             | Contractor  | DWRI                    | Included in BOQ |
| 14                                       | Land Acquisition   | Land acquisition and compensation or assistance in accordance with the ARAP   | DWRI, DCD (District Compensation Determination Committee) | DWRI                    | ARAP Cost       |
| 15                                       | Vulnerable social groups,  | ditto   | ditto   | DWRI (with MoWC and SW) | ARAP Cost       |
| 16 & 26                                  | Local economy (employment, livelihoods, etc.), children's rights | <ul style="list-style-type: none"> <li>Adherence to the minimum age set by the Child Labor Law</li> <li>Securing movement routes for vehicles and pedestrians during construction by installing temporary roads</li> </ul>  | Contractor  | DWRI                    | Included in BOQ |
| 18                                       | Water Use  | <ul style="list-style-type: none"> <li>Construction of alternative wells.</li> <li>After construction, the results will be compared with WHO drinking water quality standards.</li> <li>During construction, a constant volume of water will be discharged downstream.</li> </ul>   | DWRI  | DWRI                    | ARAP Cost       |

|                           |   |  |                             |      |                 |
|---------------------------|---|--|-----------------------------|------|-----------------|
| 27 & 28                   | Infectious Disease Control. Working environment (including occupational safety) | <ul style="list-style-type: none"> <li>Take preventive measures in accordance with declarations and action regulations related to the prevention of the spread of COVID-19</li> <li>Thoroughly implement general infection prevention measures, such as masks, hand disinfection, and temperature checks.</li> <li>Appropriate occupational safety equipment (helmets, shoes, etc.) will be provided according to the nature of the work.</li> <li>Conduct a safety convention for workers.</li> </ul> | Contractor                  | DWRI | Included in BOQ |
| 29                        | Accidents   | <ul style="list-style-type: none"> <li>Perform routine maintenance on heavy machinery and equipment.</li> <li>Take measures to prevent water-related accidents at the CUP.</li> </ul>  | Contractor                  | DWRI | Included in BOQ |
| 30                        | Climate Change  | <ul style="list-style-type: none"> <li>Perform routine maintenance on heavy machinery and equipment.</li> <li>Prevents unnecessary idling.</li> </ul>  | Contractor                  | DWRI | Included in BOQ |
|                           |   | <ul style="list-style-type: none"> <li>Tree planting for cut down trees.</li> </ul>  | DWRI (with DFO)             | DWRI | GON admin. cost |
| <b>After Construction</b> |   |  |                             |      |                 |
| 3                         | Waste   | <ul style="list-style-type: none"> <li>Conduct monitoring and educational activities related to the prevention of waste littering.</li> </ul>  | DWRI (with local community) | DWRI | GON admin. cost |
| 10                        | Ecosystem   | <ul style="list-style-type: none"> <li>Confirm that Asian Elephants migration impediments are not occurring.</li> </ul>  | DWRI (with KTWR)            | DWRI | GON admin. cost |
| 29                        | Accidents   | <ul style="list-style-type: none"> <li>Organize records of the occurrence of accidents and take measures to prevent a recurrence.</li> </ul>   | DWRI (with local community) | DWRI | GON admin. cost |

Source: JICA Survey Team

## 2. Environmental Monitoring Plan

An environmental monitoring plan as described in the table below will be implemented during the pre-construction, construction, and operation phases to mitigate impacts. The implementing agency will be different depending on the monitoring items, but all the supervising agencies will be DWRI as a project proponent in collaboration with local stakeholders.

### Environmental Monitoring Plan(EMoP)

| Category  | Monitoring Item   | Frequency                                      | Indicator  | Place  | Implementer                                       |
|---|---|--|--|--|---|
| <b>&lt; Before Construction / During Construction</b> |   |  |  |  |   |
| 0. Common   | Record of Complain and Grievance management   | Once a Week                                    | Presence of complaints and grievance handling record   | DWRI Office, Land acquisition and compensation committee                       | DWRI, Land acquisition and compensation committee |
|   | Maintenance and inspection records of equipment   | Daily / 1 time<br>Periodic: Optional           | Presence of maintenance records                        | Project Site   | Contractor  |
| 1. Air Pollution                                      | Status of water sprinkling implementation   | Once a Month                                   | Presence of implementation record                      | Project Site   | Contractor  |
|   | Abnormal actuation of machine and equipment   | Once a Month                                   | Presence of white/dark smoke                           | Project Site   | Contractor  |
|   | Dust generation status by visual inspection   | Once a Month                                   | Presence of dust spread                                | Project Site   | Contractor  |
| 2. Water Pollution                                    | Water quality (turbidity, pH) of irrigation Canals as baseline values                         | One time before construction in the dry season | Test record  | Locations where the discharge of muddy water and concrete effluent is expected | Contractor  |
|   | Water quality of treated wastewater   | Once a Week                                    | Less than baseline                                     |  | Contractor  |
| 3. Solid Waste  | Status of reuse of soil generated on-site   | Once a Month                                   | Presence of reuse record                               | Project Site   | Contractor  |
|   | Status of disposal of concrete rubble, formwork, waste oil, etc. at designated disposal sites | Once a Month                                   | Presence of record of disposal at the appropriate site | Disposal site  | Contractor  |

|   |   |  |  |   |   |
|---|---|--|--|---|---|
|   | Training for workers on waste and waste disposal  | Once a Month                                       | Presence of record   | Project Site  | Contractor                              |
| 4 Soil Contamination                                    | Drip tray usage   | Once a Month                                       | Presence of record   | Project Site  | Contractor                              |
| 10 Ecosystem  | Implementation of environmental education for workers   | Beginning and Once a Month                         | Presence of record   | Project Site  | Contractor                              |
|   | Wildlife Crossing Status  | Once a Month                                       | Presence of record   | Project Site  | Contractor                              |
|   | Monitoring on wildlife  | Once a Month                                       | Presence of record, species and number of wildlife monitored | Project Site  | Contractor                              |
| 14 Land Acquisition                                     | Status of final valuation assessment  | Once at the time of implementation                 | Presence of record   | PAHs (PAFs)   | DWRI/CDC                                |
|   | Status of land acquisition and compensation payments based on the resettlement plan   | Once a month during the ARAP implementation period | Deviation from ARAP, presence of receipts                    | PAHs (PAFs)   | DWRI/CDC                                |
| 15 Socially vulnerable people                           | Status of Support for Households with Socially Vulnerable Members   | Once a month during the ARAP implementation period | Deviation from resettlement plan, whether support            | PAHs (PAFs)   | DWRI/CDC                                |
| 18. Water Use   | Construction status of alternative water intake facilities  | Once per completed month                           | Presence of record   | Well construction site                              | DWRI                                    |
|   | Water quality at alternative intake facilities  | Once upon completion of good drilling              | WHO water quality standards, Nepali standards                | ditto   | DWRI                                    |
| 26 Children's Right                                     | (Confirmation of Underage Workers in the Worker Register)   | Once a Month                                       | Employment record under 16 years old.                        | Project Site  | Contractor                              |
| 27. Working environment (including occupational safety) | Status of distribution of helmets, protective goggles, ear protection, etc. to workers  | Month of execution                                 | Presence of implementation record                            | Project Site  | Contractor                              |
|   | Implementation of countermeasures against new coronary infections   | Once a Month                                       | Presence of implementation record                            | Project Site  | Contractor                              |
|   | First Aid Kits installation (FAK) deployment status   | Once a Month                                       | Presence of deployment record                                | Project Site  | Contractor                              |
|   | Preparation of accident and emergency response manual and dissemination to workers  | Month of execution                                 | Presence of manual and record of dissemination to workers    | Project Site  | Contractor                              |
| 29. Accidents   | Status of prior notification of construction sections to surrounding municipalities   | Once a Month                                       | Record of notice   | Project Site  | Contractor                              |
|   | Status of signage, guides, and night patrols  | Once a Month                                       | Presence of record   | Project Site  | Contractor                              |
|   | Confirmation of records describing the extent, frequency, causes, and future countermeasures for accidents that have occurred | Once a Month                                       | Presence of record   | Project Site  | Contractor                              |
| <Operation phase>                                       |   |  |  |   |   |
| 3. Waste  | Garbage disposal situation  | Twice a year                                       | Presence of record   | Project Site  | DWRI                                    |
| 10. Ecosystem   | Confirmation of wildlife migration  | Twice a year                                       | Presence of record   | Project Site  | DWRI (with KTR and ranger if necessary) |
| 29. Accidents   | Accident occurrence records (including measures to prevent future accidents)  | Once a year  | Presence of record of accident occurrence                    | Traffic police, interviewing residents if necessary | DWRI                                    |

Source: JICA Survey Team

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**ABBREVIATED RESETTLEMENT ACTION PLAN  
(ARAP)  
FOR THE PREPARATORY SURVEY FOR THE PROJECT  
FOR REHABILITATION OF  
CHANDRA NAHAR IRRIGATION SYSTEM  
IN  
EASTERN TERAI AREA**

**December 2021  
Kathmandu, Nepal**

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**KEY DEFINITIONS**

1. **Affected Area:** means such area as may be notified by the appropriate Government for the purposes of land acquisition
2. **Agricultural Land:** Means land used for the purpose of: (i) agriculture or horticulture; (ii) dairy farming, poultry farming, pisciculture, sericulture, seed farming breeding of livestock or nursery growing medicinal herbs; (iii) raising of crops, trees, grass or garden produce, and (iv) land used for the grazing of cattle;
3. **Building:** Means a house or other roofed structure of any material whatsoever but does not include a tent or other portable and temporary shelter;
4. **Compensation:** The payment in cash or kind for private property acquired by the Chandra Nahar Irrigation Project, based on replacement value as defined by the Compensation Determination Committee (CDC).
5. **Compensation Determination Committee (CDC):** The district-level committee established under Section 13 (2) of the Land Acquisition Act 2034 (1977) to determine replacement value and compensation rates for property acquired under the Act.
6. **Encroacher:** A person who has extended their building, agricultural lands, business premises or work places into public/government land without authority;
7. **Income:** Income of the PAP shall mean the amount prior to the cut-off date from all occupations taken together calculated by an objective assessment;
8. **Land:** "land" includes benefits to arise out of land, and things attached to the earth or permanently fastened to anything attached to the earth
9. **Project Affected Family:** The Project Affected Family (PAF) includes the following:
  - family whose land or other immovable property has been acquired;
  - family which does not own any land but a member or members of such family may be agricultural laborers, tenants including any form of tenancy or holding of usufruct right, share-croppers or artisans or who may be working in the affected area for three years prior to the acquisition of the land, whose primary source of livelihood stand affected by the acquisition of land;
  - indigenous people and other traditional forest dwellers who have lost any of their forest rights recognized under the operational plan of community forest
  - family whose primary source of livelihood for three years prior to the acquisition of the land is dependent on forests or water bodies and includes gatherers of forest produce, hunters, fisher folk and boatmen and such livelihood is affected due to acquisition of land;
  - member of the family who has been assigned land by the State Government or the Central Government under any of its schemes and such land is under acquisition;
  - family residing on any land in the urban areas for preceding three years or more prior to the acquisition of the land or whose primary source of livelihood for three years prior to the acquisition of the land is affected by the acquisition of such land;
10. **Project Affected Person (PAP)** is any person affected either directly or indirectly by the project and/or project related activity, irrespective of the legal status and would include the following.
  - Title holders,
  - Encroachers,
  - Squatters,
  - Tenants, Leaseholders, Sharecroppers,
  - Employees, Landless laborers,

11. **Project Affected Household (PAH):** A social unit consisting of a family and/or non-family members living together, and is affected by the project negatively and/or positively;
12. **Rehabilitation:** The measures taken to mitigate identified social impacts, including compensation, resettlement and rehabilitation and transition allowances where required.
13. **Replacement Cost:** With regard to land and structures, "replacement cost" is defined as follows: For agricultural land, it is the pre-project or pre-displacement, whichever is higher, market value of land of equal productive potential or use located in the vicinity of the affected land, plus the cost of preparing the land to levels similar to those of the affected land, plus the cost of any registration and transfer taxes. For houses and other structures, it is the market cost of the materials to build a replacement structure with an area and quality similar to or better than those of the affected structure, or to repair a partially affected structure, plus the cost of transporting building materials to the construction site, plus the cost of any labor and contractors' fees, plus the cost of any registration and transfer taxes.
14. **Titleholder:** The person in whose name the project-affected land and/or building is registered and the person who is authorized by law to receive the compensation granted for the acquisition of land.
15. **Shop:** Means any premises where any trade or business is carried on and where services are rendered to customers;
16. **Squatter:** A person who has settled on public/government land, land belonging to institutions, trust, etc., and or someone else's land illegally for residential, business and or other purposes and/or has been occupying land and building/asset without authority;
17. **Temporary Impact:** Impact expected during implementation of the project in the form of earth spoil, tremors and vibrations, etc. affecting land and structure
18. **Tenant:** A person who holds/occupies land-/structure of another person and (but for a special contract) would be liable to pay rent for that land/structure. This arrangement includes the predecessor and successor-in-interest of the tenant but does not include mortgage of the rights of a landowner or a person to whom holding has been transferred; or an estate/holding has been let in farm for the recovery of an arrear of land revenue; or of a sum recoverable as such an arrear or a person who takes from Government a lease of unoccupied land for the purpose of subletting it. A person occupying/using land of a titleholder according to the stipulations of the Land Act, 2021 (1964).
19. **Vulnerable Households/PAPs:** Vulnerable households/PAPs are those defined in the Entitlement Matrix (see next section)
20. **Cut-off date:** In the cases of land acquisition affecting legal titleholders, the cut-off date will be the date of issuing the preliminary notice under the Land Acquisition Act 2034. In cases where people lack title, the cutoff-date shall be the start date when the census survey was undertaken by the project authority

## 1.0. INTRODUCTION

### 1.1. Project Background

Chandra Nahar Irrigation System was designed and constructed during 1922 to 1926 AD by the British Engineers, during the Chandra Samsher Jung Bahadur Rana reign to irrigate the low lands of Terai region of currently Saptari district's right bank side of Sapta Koshi River. The irrigation system draws water from the perennial river of Trijuga rathrough a diversion dam constructed across the Trijuga River. The irrigation system has a total irrigable area of 10,500 ha. The estimated beneficiary households served by the canal are approximately 30,000. This irrigation system lies under the jurisdiction of Koshi Pump Chandra Nahar Irrigation Management Division Office of Saptari.

The Chandra Nahar Irrigation System underwent a major renovation and rehabilitation, completed in 1987, through a grant assistance of Government of India. Irrigation Management Transfer Project (IMTP) under the financial assistance of Asian Development Bank (ADB) was launched as a participatory approach in irrigation system in 1993/94 that was instrumental in its involvement in Operation and Maintenance, institutional development and water management works in the irrigation system. Presently the major parts of the irrigation system are deteriorated and not functioning properly. The malfunctioning is mainly due to aging and lack of periodic operation and maintenance. Defective canal lining, sedimentation, de-silting problems, water leakages, deterioration of water control facilities and sluice gates are the major problems of the system. Even though the Chandra Nahar's Water Users Associations (WUAs) have had a long history, the collection of irrigation service fees, periodic cleaning and maintenance works have not been conducted, resulting in under functioning of the system. Thus, the entire system is in urgent need for overall system rehabilitation and WUAs' strengthening and capacity building.

### 1.2. Description of the Project

The Chandra Nahar Irrigation system is located on the west bank of the Saptakosi River in Saptari district. Geographically, it is located in north-eastern part of Saptari district. It lies in 26-31° N to 26-44° N latitude and 86-47° E to 86-59° E longitude. Koshi Tappu Wildlife Reserve (KTWR) and Ramsar Site are located eastward of the Project site.

The project starts at Saptakoshi municipality and traverses through Kanchanrup municipality, Tirahut municipality, Agnisair Krishna Savaram Rural Municipality (RM), Mahadeva RM and ends at Rajbiraj municipality. The Reduced Level (RL) between the intake and the farthest service canal is 21.0 m, with highest elevation at intake being 120 masl and at canal end being 99.0 masl.

The whole command area lies to the right side of the Trijuga River and same is the source of water for irrigation through Chandarnahar scheme. The Chandra canal's main canal is 27 km in length, starting at the side-intake at Trijuga River at Fhattepur, (at about 12 km northwards from East-West Highway intersection) and ending at Khado River (at about 5 km westwards from the centre of Rajbiraj town). The elevation varies between 171 m and 136 m amsl. There are 15 Branch canals off-setting from the main canal and each branch canal has a network of Tertiary canals. The main canal also has additionally 30 direct outlets that irrigate farm lands adjacent to the main canal. Activities that causes land acquisition and resettlement and its size

#### (1) Land acquisition

As described above, since this project is a construction project within the existing irrigation canal ROW, the land acquisition range will be limited to two locations: Irrigation siphon No. 2 (CUP-02), which is to be changed its alignment, and a concrete plant yard for construction purpose.

ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area

Needless to say but it is up to the contractor to decide where to secure the concrete plant yard, but the Preparatory Survey could not confirm a sufficiently wide government-owned land in the vicinity of the facility to be rehabilitated, so the confirmation was carried out as a temporary construction site for the purpose of securing the estimated budget. The total land acquisition area is 0.83 ha. Affected vendors will be relocated as per their willingness to relocate in area on their own. Since, affected vendor don't have land entitle certificate, Government of Nepal and international practices provide full replacement value and transportation cost of structures. The area breakdown and location chart are shown in Table 1.1 and Figure 1.1.

Table 1.1: Breakdown of the area

| Category                            | Temporary land acquisition |                   | Permanent land acquisition |                   | Total       |                   |
|-------------------------------------|----------------------------|-------------------|----------------------------|-------------------|-------------|-------------------|
|                                     | Area (ha)                  | PAHs (households) | Area (ha)                  | PAHs (households) | Area (ha)   | PAHs (households) |
| Changing alignment of CUP-02        | 0.02                       | 1                 | 0.11                       | 1                 | 0.13        | 2                 |
| Construction of concrete plant yard | 0.70                       | 2                 | 0                          | 0                 | 0.70        | 2                 |
| <b>Total</b>                        | <b>0.72</b>                | <b>3</b>          | <b>0.11</b>                | <b>1</b>          | <b>0.83</b> | <b>4</b>          |

Source: JICA Survey Team, 2021

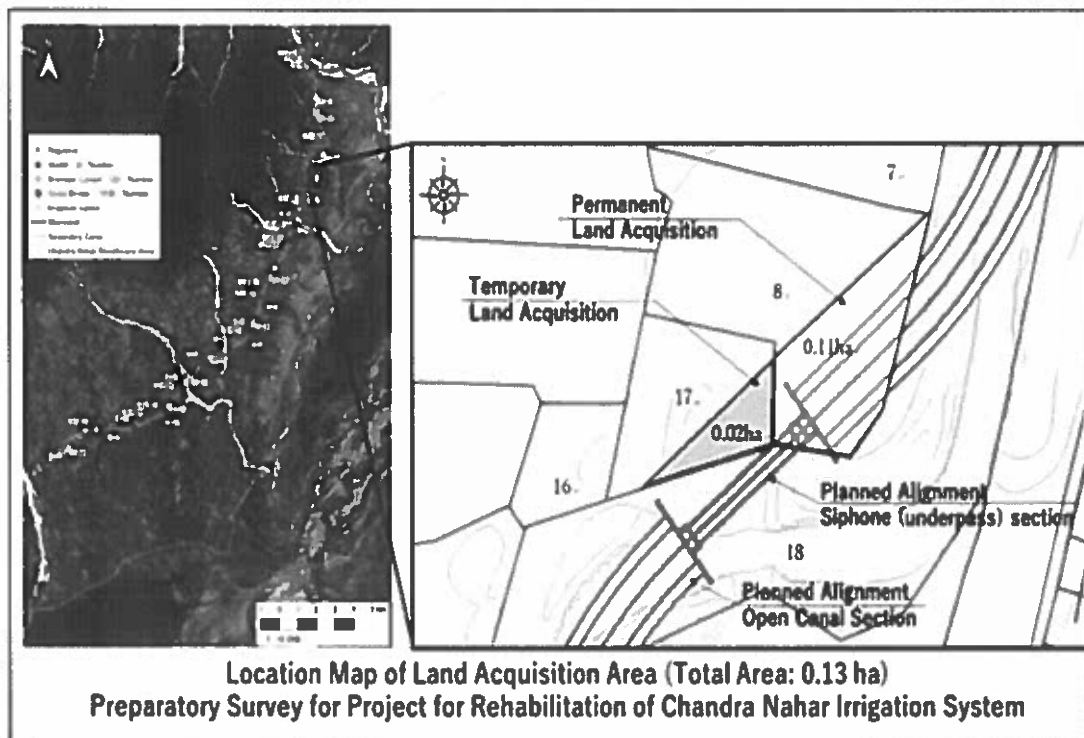


Figure 1.1: Land acquisition area for changing alignment of CUP-02

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ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area

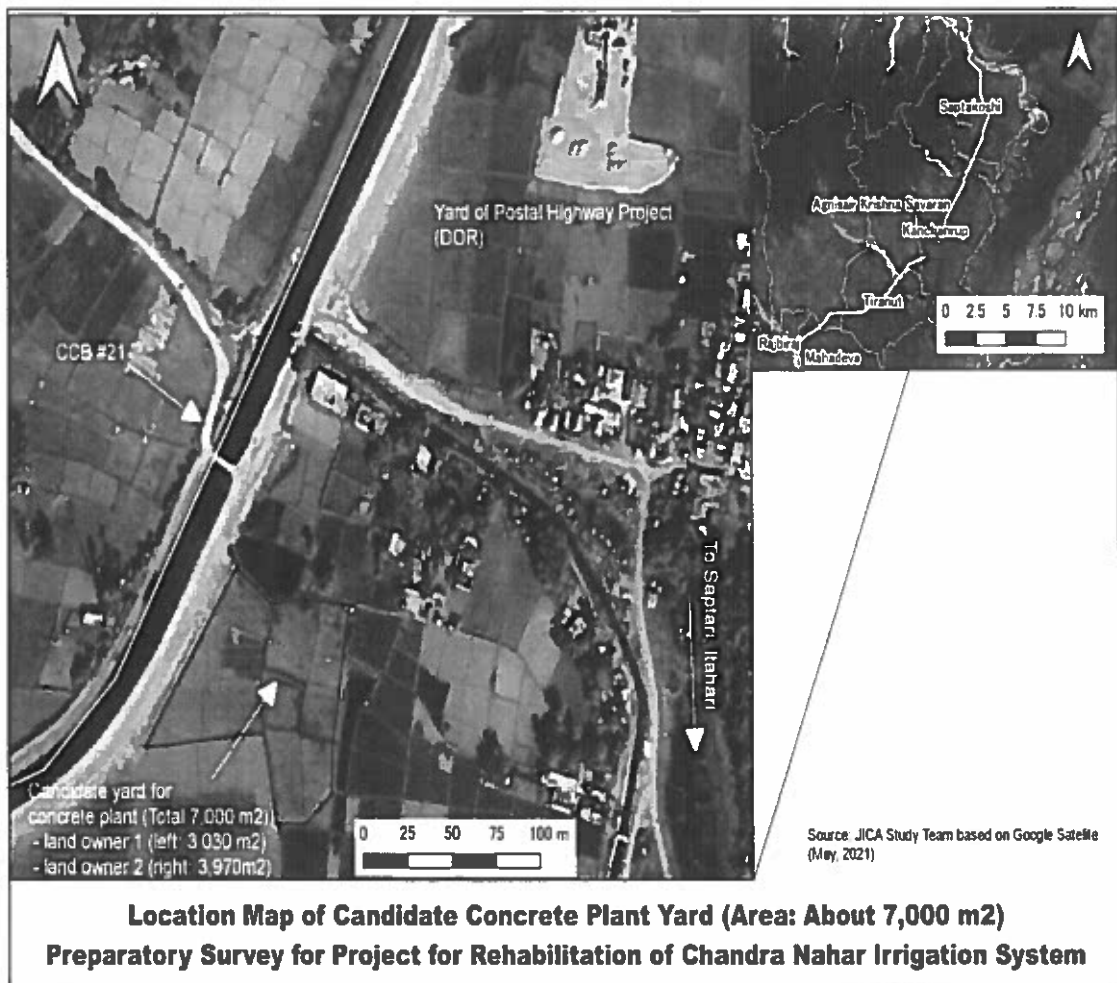


Figure 1.2: Land acquisition area for construction of concrete plant yard

**1.2.1. Project Affected Family / Persons**

Total numbers of PAF are shown in Table 1.2.

Table 1.2: List of Project Affected Family / Persons

| Category   | Land ownership | PAFs | PAPs |
|--|----------------|------|------|
| Relocation of properties within Canal ROW                | Government     | 18   | 125  |
| Land acquisition for changing canal alignment CUP-02     | Private        | 2    | 8    |
| Land acquisition for construction of concrete plant yard | Private        | 2    | 9    |
|  | Total          | 22   | 142  |

**1.2.2. Affected facilities**

Total number of PAF and PAP are shown in Table 1.3.

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Table 1.3: List of Project Affected Facilities

| Category     | Description and the number of facilities | Total Number of PAFs who own the properties |
|--------------|--|---|
| Animal shed  | 5  | 4   |
| Hen coop     | 2  | 2   |
| Water well   | 5  | 5   |
| Straw mound  | 3  | 2   |
| Vendor       | 12                                       | 12  |
| Kitchen      | 1  | 1   |
| Fruit Tree   | Banana: 34                               | 3   |
|              | Mango: 2                                 | 2   |
|              | Citrus: 1                                | 1   |
|              | Papaya: 3                                | 1   |
| Clump bamboo | 1  | 1   |
| Other trees  | 9  | 3   |

Note: The total number of PAFs in this table and Table 1.3 is not equal because there are PAFs who have multiple properties to be affected by the project (for example, one farmer has both animal shed and fruit tree to be affected).

## 2.0. Resettlement and Compensation Practices: Government of Nepal and JICA

### 2.1. GoN Law and Regulations

#### 2.1.1. Land Acquisition Act (1977)

The Land Acquisition Act, 1977 (2034 BS), has been enacted to integrate the laws for Acquisition of Land, 1962, and partially updated in 1993 by its subsequent amendment. The section 3 of the Act empowers the government to acquire land at any place, for the purpose of public works by providing the required compensation to its owners. The Act obliges the government to consider the compensation for acquisition of land for the benefit of the local people. Article 12 established Compensation Fixed (Determination) Committee as a leading organization for fixing compensation unit price. Steps of Land Acquisition plan as per Land Acquisition Act 1977 are presented in Figure 2.1.



Figure 2.1: Steps of Land Acquisition plan

#### 2.1.2. Land Acquisition Guidelines (1989)

The Land Acquisition Guidelines and guidelines pursuant to section 16 and 17 of the Land Acquisition Act 1977 specify two categories of affected families, namely Project Affected Families (PAF) and Seriously Project Affected Family (SPAF). A PAF consists of the members of a household including elderly dependents and minor children (under 18 years) residing under one roof and operating as a single economic unit, who are adversely affected by the project. SPAF is defined as a family who loses over 25% of its total land holdings or whose land is reduced to an uneconomic holding (less than 5.0 katha, 1 katha equivalent to 338.63 square meter) or who is being displaced).

Under these guidelines the concerned officials, with the assistance of the project team, are to carry out assessments of project affected families to identify their standard of living and types of assets.

Valuation of land and asset lost were to be based on comparative market values of similar assets in the vicinity. The guidelines also included arrangements for rehabilitation of project-affected families. For PAF's, the compensation package includes cash for assets acquired or damaged by the project and a rehabilitation grant (assistance allowance) to cover any suffering and hardship. For SPAF's, the compensation additionally include employment for one family member and provision of skill training.

The Guidelines specify the establishment of an Acquisition and Rehabilitation Committee (also known as Compensation Determination Committee, "CDC") consisting of the concerned Chief District Officer (Chair), Land Revenue Officer, representative of the District Coordination Committee (DCC) and the Project Manager and others as deemed necessary. The Committee is responsible for acquiring land and paying compensation. In 1993, a second set of guidelines reduced the Acquisition and Rehabilitation Committee to a four-member Compensation Fixation/Determination and Rehabilitation Management Committee by dropping the Land Revenue Officer and other governmental appointees. The functions and powers of the committee were clarified, as were methods of payment and means of ensuring fair valuation of land quality.

### **2.1.3. Land Acquisition, Resettlement and Rehabilitation Policy**

The Government of Nepal, Ministry of Land Reform, has prepared Land Acquisition, Resettlement, and Rehabilitation Policy under technical assistance with ADB, however, the policy has not yet been enacted in Nepalese Gazette. The drafted policy emphasizes scientific standards for land valuation and extension of compensation equivalent to minimum market value of land. A provision in the policy allows the government to take action against those who try to disrupt land acquisition process or create hurdles for the project. In this regard, the policy has stressed on the need to first assessment of socio-economic impacts of a project. All expenses related to land acquisition, compensation and implementation of resettlement and rehabilitation plans should be considered as a project cost.

## **3.0. JICA's Policy on Involuntary Resettlement**

The policy provisions on involuntary resettlement of JICA is shown in the JICA's Environmental Guidelines. And item 3 of Article 2.6 in this guideline describes that "JICA confirms that projects do not deviate significantly from the World Bank's Safeguard Policies". Therefore, the main documents relevant to the land acquisition and resettlement of the Project are:

- JICA Guidelines for Environmental and Social Considerations (2010)
- The World Bank's Safeguard Policies (Operational Policy / Bank Policy 4.12 and its Annex in particular
- Involuntary Resettlement Sourcebook (the World Bank)

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**Table 3.1: Gap Analysis of GoN and World Bank Policies: Involuntary Resettlement and Loss of Asset**

| Theme                            | Provision within the Land Acquisition Act (LAA), 1977  | Requirements under WBG ESS5  | Gaps and How it is to be addressed  |
|----------------------------------|--|--|---|
| Avoidance or impact minimization | The LAA allows land acquisition for "public purposes". It does not specify avoiding or minimizing resettlement   | ESS 5 requires avoidance / minimizing of involuntary resettlement by exploring project design alternatives   | The Project will avoid and minimize impacts associated with land acquisition and resettlement wherever possible. An alternative analysis will be carried out as a part of ESIA/IEE or project's social assessment to minimize involuntary resettlement exploring all viable alternative project designs                                     |
| Impact Mitigation                | The LAA provides for compensation of land and assets and in certain cases of landlessness, for provision of replacement land. The CDC chaired by the Chief District Officer (CDO) determines criteria. | Provision of compensation at replacement cost along with rehabilitation assistance and commitment to improve and / or restore livelihoods to pre-project levels.   | A negotiation process with affected PAPs will take place in a group under the supervision of CDC to reach at a mutually acceptable compensation. If it fails, an independent assessment of replacement cost will be conducted and provided this Report for the CDC's consideration  |
| Timing of Compensation           | Executing agency may acquire land by depositing money with the competent authority for compensation determination  | Possession of acquired land and related assets will be taken up by the project only after compensation has been made available and, where applicable, resettlement sites and moving allowances have been provided to the displaced persons in addition to compensation | Land access will be initiated only after payment of full compensation (except in case of legally disputed cases, if any). Forced evictions will not be carried out. PAFs will be given reasonable time (up to 12 months) to identify temporary accommodation within project area until they are able to build their new replacement houses. |

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|  |  |   |  |
|--|--|---|--|
| Informed Consultation and Participation      | During the LA process, the CDO is the appellate authority. Otherwise, the LAA does not require on-going consultations with affected persons and other stakeholders.  | Disclosure of relevant information, meaningful consultations with affected persons, communities, and other stakeholders, consultations must be on-going and inclusive.  | PAPs will be informed about the intended acquisition of their land and consulted multiple times in the process of preparation of RAP. Their preferences for resettlement and rehabilitation options will be incorporated in RAP. |
| Livelihood Restoration                       | The legal frameworks for resettlement provide for rehabilitation of displaced settlements and compensation to affected persons through land-based resettlement strategies. However, land-based livelihood is not used as a criterion for application of such land-based resettlement strategies wherever possible.                           | Provision of compensation at replacement cost along with rehabilitation assistance and commitment to improve and / or restore livelihoods and standard of living to pre-project levels.   | Both nonland and land-based livelihood restoration strategies will be considered during the preparation of RAP.  |
| Grievance Redress Mechanism                  | The affected entities may approach the CDO and/or the Ministry of Home Affairs within a defined period for compulsory expropriation. Under Clause 25.7, appeal against the compensation may be directly filed with the Ministry of Home Affairs. However, entities other than legally registered land owners and tenants are not considered. | The project is required to establish a grievance redress mechanism, which should seek to resolve concerns promptly, using an understandable and transparent consultative process that is culturally appropriate and readily accessible. | The project has established a GRM which will be used for this purpose as well. The GRM also includes access to legal redress at any stage in the process.  |
| Special assistance for vulnerable households | The landless families with legal ownership can get additional compensation at the discretion of the CDC.   | Particular attention will be paid to the needs of the poor and the vulnerable as a part of the resettlement process, however no specific package or entitlement for vulnerable groups.  | Guidelines to identify vulnerable PAFs and specific benefits to be included in the RAP are considered.   |
| Support during transition                    | No such provision in the LAA.  | Transitional support should be provided as necessary to all economically displaced persons, based on a reasonable estimate of the time required to restore their income-earning capacity, production levels, and standards of living.   | The RPF makes provisions for transitional support for all PAFs who are physically displaced.   |

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**Part I: Matrix Entitlement Policy Matrix (Guiding Notes)**

### **Entitlement Policy Matrix (Guiding Notes)**

The Entitlement Policy Matrix is prepared with a view to provide assistance and support to those who need some support and assistance following the process of land acquisition, even in instances where land donations are voluntary.

#### **4.0. Entitlements for Project Affected Persons (PAPs)**

The entitlement for different categories of impacts is explained in the following entitlement matrix. Briefly, the entitlement matrix presents the entitlements for different impact categories in the following order:

1. Impact to titleholders which cover
  - a. Loss of land
  - c. Loss of commercial structures
2. Impact to tenants and leaseholders
  - a. Commercial
3. Impacts to non-title holders
  - a. residential squatters
  - b. commercial squatters
  - c. encroachers
4. Impacts to trees, plants and standing crops
5. Loss of livelihoods (Permanent loss and Temporary disruption to income)
  - a. Owners
  - b. Employees in shops, agricultural laborers, sharecroppers etc
6. Impacts to Vulnerable Households
7. Impacts to Community Assets
8. Loss of Access to Residences/place of business
9. Unidentified impacts

The exact value of compensation and replacement cost will be project specific. An indicative entitlement matrix for Chandra Nahar Irrigation Project is furnished in the Table 1 below.

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**Table 4.1: Entitlement Matrix Applicable for the Project**

| Type of Loss  | Entitlement Unit      | Description of Entitlement  | Implementation procedures   |
|---|-----------------------|---|---|
| <b>Agricultural, Residential, Commercial, Pasture and Forestry Land</b> |                       |   |   |
| Loss of Private land under any form of tenure                           | Titleholder           | <ul style="list-style-type: none"> <li>• Provide compensation at full replacement cost based on market rate, or provide full title to land of equal area and productivity acceptable to owner in the vicinity.</li> <li>• In the case of farmland, compensation for cultivation disruption allowance equal to one-year production.</li> <li>• In case of vulnerable groups, give preference for land-for-land compensation</li> <li>• Ensure that resettlement assistance in addition of compensation for land occupied (land, other assets, employment) at least restore their livelihoods and standards of living to pre-displacement levels.</li> <li>• If remaining land becomes unusable as a result of land acquisition, option provided to landowner to relinquish unusable remaining portion of land and receive similar benefits to those losing all their land parcel(s)</li> </ul> | <ul style="list-style-type: none"> <li>• A list of affected and entitled persons and the area of land loss is required.</li> <li>• Notice to vacate the land should be served at least a month prior to acquisition date.</li> <li>• To ensure fair compensation, determination of rates will be established not more than one year prior to property acquisition.</li> <li>• Land registration in the name of both land owner and spouse (in case of land for land compensation)</li> <li>• In case of cash compensation, deposited into a joint account in the name of both land owner and spouse.</li> </ul> |
| Loss of Tenancy Land  | Landowners<br>Tenants | <ul style="list-style-type: none"> <li>• Both the Land owner &amp; the tenant will be entitled for 50 percent of land compensation amount each (As per 2058 B.S. amendment in Land Reform Act).</li> <li>• Non-registered tenant/renter/lease holder does not qualify for compensation for land losses; however they will be entitled to compensation for standing crops and any other assets built by them. Any upfront cost for the tenancy agreement will be reimbursed.</li> </ul>  | <ul style="list-style-type: none"> <li>• Where a renter/leaseholder has a share cropping arrangement, the compensation payable should be apportioned according to the arrangement.</li> <li>• An advance prior notice will be provided to landlord and tenant.</li> </ul>   |

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| Type of Loss                          | Entitlement Unit   | Description of Entitlement   | Implementation procedures   |
|---------------------------------------|--|--|---|
| <b>Temporary Loss of Private Land</b> | Titleholder Tenants and landlord<br>(As both are the owners of equal (i.e. 50 %) share, hence treated as private land holder.  | <ul style="list-style-type: none"> <li>• Compensation for crop, land productivity and other property losses for the duration of temporary occupation.</li> <li>• Compensation for other disturbances &amp; damages caused to property.</li> <li>• Project and the municipalities to ensure that persons other than the owner affected as a result of temporary acquisition are compensated for the temporary period.</li> <li>• Land should be returned to the owner at the end of temporary acquisition period, restored to its original condition or improved as agreed with owner.</li> </ul> | <ul style="list-style-type: none"> <li>• Advance notice for crop harvesting</li> <li>• The owner/entitled party will sign a temporary occupation contract specifying:                             <ol style="list-style-type: none"> <li>I. Period of occupancy,</li> <li>II. The terms and conditions for calculation of production losses,</li> <li>III. The frequency of compensation payment, and</li> <li>IV. Annual inflation adjustment, and</li> <li>V. Land protection and rehabilitation measures.</li> </ol> </li> <li>• Advance notice to vacate the land before civil works start</li> <li>• Compensation for any losses crops / structures</li> </ul> |
| <b>Land donations</b>                 | Voluntary donation is accepted only if: <ul style="list-style-type: none"> <li>• AP is direct project beneficiary and is fully consulted and informed about rights and choices available to them;</li> <li>• AP doesn't fall below poverty line after land donation;</li> <li>• No household relocation is involved.</li> <li>• All adult family members have agreed to donate;</li> <li>• AP is freely willing to donate, is aware that refusal is an option (with an agreement, including</li> </ul> | <ul style="list-style-type: none"> <li>• No compensation for the donated land, but entitled for compensation of other assets such as minor structure, trees, crops, allowances, etc.</li> <li>• Transfer of land ownership</li> <li>• Free of any transfer costs, registration fees or charges</li> <li>• Preferential employment in project construction</li> </ul>   | <ul style="list-style-type: none"> <li>• Verify the requirements of the donation</li> <li>• Carry out due diligence on the owners and users of land donated: identify rightful owner(s); any competing claims of ownership or use; structures and assets on the land; any encumbrances on the land.</li> <li>• Ensure appropriate consultation and disclosure</li> <li>• Establish informed consent of the person donating land</li> <li>• Sign written commitment; local witness or third party verification to the commitment letter</li> <li>• Maintain a transparent record of all consultations and agreements reached.</li> </ul>                             |

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| Type of Loss  | Entitlement Unit   | Description of Entitlement  | Implementation procedures   |
|---|--|---|---|
|   | a "no coercion" verified by a third party); and<br>• Impact limited to less than 10% of landholding and minor assets<br>• Land is free from disputes regarding ownership or tenure |   |   |
| <b>Trees and Crops</b>  |  |   |   |
| <b>Loss of Trees &amp; Crops (Perennial/ Non-perennial)</b>                 | Owner of affected trees, fruits and crops  | <ul style="list-style-type: none"> <li>• Advance notice to harvest crops</li> <li>• Net value of existing crops where harvesting is not possible.</li> <li>• The crops, which live, in short time will be paid in accordance with one-year output value. The crops which have lived for several years will be compensated at market value on the basis of loss of future production, based on 5 years annual net production for fruit &amp; fodder trees &amp; 3 years annual net production for timber/ fuel wood trees &amp; other perennial crops</li> </ul> | <ul style="list-style-type: none"> <li>• Inventory of the tree and plant species list</li> <li>• List of owners, non-perennial crops and the area (if applicable) of cultivation</li> <li>• The APs will get notice 2 months in advance regarding crop harvesting. Crops grown after the issue of the notice will not be compensated.</li> <li>• The work schedule for construction works will be adjusted considering the crop seasons for avoiding crop damage.</li> <li>• Crop/trees/bamboo market values will be determined by the CDCs in consultation with Agriculture Knowledge Centre and Division Forest Office of the concerned district.</li> <li>• Where a tenant/renter/lessee &amp; landowner have a share cropping arrangement, the compensation payable will be apportioned according to the lease arrangement.</li> <li>• Materials may be salvaged with no deduction from compensation</li> </ul> |
| <b>Structures and Other basic facilities</b>                                |  |   |   |
| <b>Loss of privately owned structures ( commercial and other structure)</b> | Titleholder /non-titleholder   | <ul style="list-style-type: none"> <li>• Compensation for full or partial loss of structures at full replacement cost of materials and labor according to structure type, with no deduction for depreciation.</li> </ul>  | <ul style="list-style-type: none"> <li>• Replacement cost at market value of structures will be determined by the municipalities in consultation with the Malpot (Land Revenue Office), local experts and</li> </ul>  |

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| Type of Loss   | Entitlement Unit                                | Description of Entitlement  | Implementation procedures   |
|--|---|---|---|
|  |   | <ul style="list-style-type: none"> <li>Resettlement assistance (rental, dislocation and transportation allowances) for residential and commercial structures.</li> <li>Households losing residential structures entitled to receive additional training or benefits for the households losing more than 10% of their land.</li> </ul>   | <ul style="list-style-type: none"> <li>compensation prices will be finalized with participation of AP representatives.</li> <li>Other structures that will be considered for compensation if affected under the project include: toilet, sheds, walls, fences, water mills, workshop etc.</li> <li>Materials may be salvaged with no deduction from compensation.</li> <li>Notice to vacate at least 90 days prior to acquisition.</li> <li>Renter/lessee holder will not be entitled for compensation of structures. However, if the structures are made by them, they will be entitled to compensation or the nature of compensation will be in accordance to the lessee agreement</li> </ul> |
| <b>Community and Cultural Assets/ Facilities</b>                                 |   |   |   |
| <b>Loss of land and structures</b>   | Local community user's group                    | <ul style="list-style-type: none"> <li>Restoration of affected structures by DoWRI leaving such facilities in a better condition than they were before; or cash compensation at full replacement cost.</li> <li>Restoration of access to community resources.</li> <li>The land revenue office in the district and concerned Rural Municipality/Municipality will be requested to assist communities for land replacement identifying the area nearby.</li> </ul> | <ul style="list-style-type: none"> <li>The land revenue office in the district and concerned Municipality will be requested to assist communities for land replacement identifying the area nearby.</li> </ul>  |
| <b>Loss of community forests and other natural resources due to construction</b> | Forest users group (FUG)/Other Concerned Groups | <ul style="list-style-type: none"> <li>Mitigation measures should be initiated to control erosion caused by tree cutting, and to stabilize and rehabilitate the slopes with suitable bioengineering works and vegetation.</li> </ul>  | <ul style="list-style-type: none"> <li>List of plant and tree species lost and an assessment for maintaining the same kind of vegetation.</li> <li>Compensation for trees calculated on the basis of type, age, and productive value of affected trees in consultation with concerned Division Forest Office (DFO) and FUG.</li> </ul>  |

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| Type of Loss   | Entitlement Unit                   | Description of Entitlement  | Implementation procedures   |
|--|------------------------------------|---|---|
|  |                                    | <ul style="list-style-type: none"> <li>Community forestland lost due to construction activities should be replaced and reforested.</li> <li>Advance notice to harvest resources from affected community forest areas.</li> <li>Compensation for trees to the FUG</li> </ul>   | <ul style="list-style-type: none"> <li>To minimize damage, the concerned forest office will be requested to take necessary action.</li> </ul>   |
| <b>Rehabilitation Assistance</b>                             |                                    |   |   |
| <b>Displacement of household</b>                             | Titleholders<br>Tenants            | <ul style="list-style-type: none"> <li>Housing displacement allowance for loss of own residential accommodation</li> <li>House rental allowance</li> <li>Transportation allowance</li> </ul>  | <ul style="list-style-type: none"> <li>Displaced households will receive a house rent allowance for 6 months</li> <li>Allowances will be paid at the time of serving the notice to vacate.</li> </ul> |
| <b>Loss of Income</b>  | AP from Vulnerable groups          | <ul style="list-style-type: none"> <li>One time financial assistance in case of loss of business/livelihood; or</li> <li>Skills training and income generation support</li> <li>Preferential access to employment opportunities in project-related construction works</li> </ul>  |   |
| <b>Damages caused during Construction – temporary losses</b> |                                    |   |   |
| <b>Any kind of private and public properties</b>             | All categories of entitled persons | <ul style="list-style-type: none"> <li>Extreme care will be taken by municipalities and their contractors to avoid damaging public and private property.</li> <li>Where damages do occur to public or private property as a result of construction works, the affected parties shall be compensated immediately for damages to crops and trees, damaged land, structure and infrastructure shall be restored immediately to their former conditions.</li> <li>Compensation at market price for the loss of income, damaged crops, trees etc.</li> </ul> |   |

## 5.0. Socio-Economic Condition in the Project Areas (PAs)

### 5.1. Introduction

The Chandranahar irrigation project lies in Saptari district (project district) of Province 2 of Nepal. The project covers 3 Municipalities and 3 Rural Municipalities of Saptari District. The coverage of the project (project area) is presented in Table 5.1.

Table 5.1: Coverage of the Chandranahar IP

| S.N.                      | Municipality/Rural Municipality | Ward no       |
|---------------------------|---------------------------------|---------------|
| <b>Municipality</b>       |                                 |               |
| 1.                        | Saptakoshi                      | 1,2,4,5,10,11 |
| 2.                        | Kanchanrup                      | 6,7,8,9       |
| 3                         | Rajbiraj                        | 10            |
| <b>Rural Municipality</b> |                                 |               |
| 1                         | Tirahut                         | 2,3,4         |
| 2                         | Agnisair Krishna Savaran        | 4             |
| 3                         | Mahadewa                        | 1             |

Source: Project Report, 2021

### 5.2. Households and Population of the Project District and Project Areas

Table 5.2 presents the population distribution in the Project Areas (PAs). Population and spatial population distribution in the project area vary from place to place with some level of difference in the sex ratio and household size. The Project Areas constitute only 0.83% of the national population and about 34.49% of the Project district -Saptari (hereafter in PD). The average household size in the project area is 5.12 in is quite smaller than PD. An average sex ratio is 96.33 in project areas which are 96.44 in PDs and 94.2 in Nepal.

Table 5.2: Population Distribution in Project Areas (PAs)

| Project Area           | Household | Population |            |            | Average household size | Sex ratio |
|------------------------|-----------|------------|------------|------------|------------------------|-----------|
|                        |           | Total      | Male       | Female     |                        |           |
| Project Area (PAs)     | 42976     | 220496     | 109037     | 111459     | 5.12                   | 96.33     |
| Project Districts (PD) | 121098    | 639284     | 313846     | 325438     | 5.28                   | 96.44     |
| Nepal                  | 5,427,302 | 26,494,504 | 12,849,041 | 13,645,463 | 4.88                   | 94.2      |

Source: CBS, 2011

### 5.3. Caste and Ethnicity of the Project Areas

Project Areas of the Chandranahar IP are of multiethnic in nature and comprise of more than 50 castes of which Yadav is more dominant one. Yadav is the major ethnic group of the PAs which accounts 16.87 % of the total population. The other major ethnic groups are Tharu (10.32%), Muslim (9.59 %), Mushahar (6.56 %), Khatwe (5.16 %) and others like Amat, Bantaba, Byasi/Sanka, Lepcha etc which contributes less than one percent of the total population. The various type of caste and ethnicity in the PAs are shown in Table 5.3.

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Table 5.3: Distribution of Population by Caste and Ethnic Groups in the PAs

| Caste/ Ethnicity    | Project Areas |      | Caste/ Ethnicity | Project Areas |       |
|---------------------|---------------|------|------------------|---------------|-------|
|                     | Total         | %    |                  | Total         | %     |
| Amat                | 95            | 0.04 | Kumal            | 268           | 0.12  |
| Badhaee             | 851           | 0.39 | Kumhar           | 1,252         | 0.57  |
| Badi                | 30            | 0.01 | Kurmi            | 222           | 0.10  |
| Bahing              | 169           | 0.08 | Lepcha           | 35            | 0.02  |
| Bangali             | 893           | 0.40 | Limbu            | 135           | 0.06  |
| Bantaba             | 24            | 0.01 | Lohar            | 221           | 0.10  |
| Bantar/Sardar       | 6595          | 2.99 | Magar            | 1,390         | 0.63  |
| Baraee              | 1782          | 0.81 | Majhi            | 53            | 0.02  |
| Brahman - Hill      | 5680          | 2.58 | Mali             | 319           | 0.14  |
| Brahman - Tarai     | 3020          | 1.37 | Mallaha          | 3,244         | 1.47  |
| Byasi/Sanka         | 38            | 0.02 | Marwadi          | 532           | 0.24  |
| Chamar/Harijan/Ram  | 8092          | 3.67 | Musahar          | 14,473        | 6.56  |
| Chhetree            | 6209          | 2.82 | Musalman         | 21,150        | 9.59  |
| Damai/Dholi         | 678           | 0.31 | Nachhiring       | 11            | 0.00  |
| Danuwar             | 355           | 0.16 | Newar            | 1,886         | 0.86  |
| Dev                 | 938           | 0.43 | Nuniya           | 661           | 0.30  |
| Dhanuk              | 11565         | 5.24 | Others           | 347           | 0.16  |
| Dhimal              | 38            | 0.02 | Punjabi/Shikh    | 376           | 0.17  |
| Dhobi               | 1873          | 0.85 | Rai              | 949           | 0.43  |
| Dom                 | 499           | 0.23 | Rajbansi         | 63            | 0.03  |
| Dura                | 14            | 0.01 | Rajbhar          | 763           | 0.35  |
| Dusadh/Pasawan/Pasi | 2062          | 0.94 | Rajdhob          | 4,307         | 1.95  |
| Foreigner           | 109           | 0.05 | Rajput           | 1,048         | 0.48  |
| Ghale               | 376           | 0.17 | Sanyasi/Dashnami | 570           | 0.26  |
| Gharti/Bhujel       | 587           | 0.27 | Sarbaria         | 55            | 0.02  |
| Gurung              | 98            | 0.04 | Sarki            | 211           | 0.10  |
| Hajam/Thakur        | 3312          | 1.50 | Sonar            | 1,046         | 0.47  |
| Halkhor             | 113           | 0.05 | Sudhi            | 1,243         | 0.56  |
| Haluwai             | 4356          | 1.98 | Sunuwar          | 244           | 0.11  |
| Kalar               | 37            | 0.02 | Tamang           | 1,004         | 0.46  |
| Kalwar              | 424           | 0.19 | Tatma/Tatwa      | 1,852         | 0.84  |
| Kami                | 1,613         | 0.73 | Teli             | 11,695        | 5.30  |
| Kanu                | 42            | 0.02 | Terai Others     | 1,664         | 0.75  |
| Kathbaniyan         | 7,826         | 3.55 | Thakuri          | 44            | 0.02  |
| Kayastha            | 1,065         | 0.48 | Tharu            | 22,745        | 10.32 |
| Kewat               | 838           | 0.38 | Thulung          | 13            | 0.01  |
| Khatwe              | 11,370        | 5.16 | Undefined Others | 520           | 0.24  |
| Khawas              | 17            | 0.01 | Yadav            | 37,193        | 16.87 |
| Koiri/Kushwaha      | 2,934         | 1.33 | Yakkha           | 22            | 0.01  |

Source: CBS, 2011

#### 5.4. Language of the Project Areas

In the PAs, the percentage of Nepali language speakers is only 7.7% whereas the percentage of the Maithali speakers is 74.79% which are followed by Tharu speakers that is 10.44%. The various kinds of languages spoken in the PAs are listed in the Table 5.4.

*De* *A.O.*

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**Table 5.4: Distribution of Population speaking different language in the Project Areas**

| Language     | Project Areas |       |
|--------------|---------------|-------|
|              | Population No | %     |
| Bahing       | 169           | 0.08  |
| Bangla       | 121           | 0.05  |
| Bantawa      | 16            | 0.01  |
| Bhojpuri     | 155           | 0.07  |
| Bhujel       | 184           | 0.08  |
| Danuwar      | 299           | 0.14  |
| Doteli       | 64            | 0.03  |
| Gurung       | 11            | 0.00  |
| Hindi        | 383           | 0.17  |
| Lapcha       | 34            | 0.02  |
| Limbu        | 95            | 0.04  |
| Magahi       | 419           | 0.19  |
| Magar        | 332           | 0.15  |
| Maithili     | 164,912       | 74.79 |
| Musalman     | 285           | 0.13  |
| Nepali       | 16,969        | 7.70  |
| Newar        | 395           | 0.18  |
| Not Reported | 1,474         | 0.67  |
| Others       | 379           | 0.17  |
| Rai          | 358           | 0.16  |
| Rajsthani    | 403           | 0.18  |
| Sunuwar      | 237           | 0.11  |
| Tamang       | 814           | 0.37  |
| Tharu        | 23,009        | 10.44 |
| Thulung      | 20            | 0.01  |
| Urdu         | 8,603         | 3.90  |
| Yakkha       | 22            | 0.01  |

Source: CBS, 2011

### 5.5. Age Groups in the Project Areas

In the PAs, the percent of population below 9 years is 22.13 whereas the percent of population above 60 years is 7.86 %. Table 5.5 shows the distribution of population by age and sex in PAs and Project District (PD).

**Table 5.5: Distribution of Population by Age and Sex in PAs and PD**

| Place | Gender | Age Group |       |         |       |        |      | Total   |
|-------|--------|-----------|-------|---------|-------|--------|------|---------|
|       |        | 0-9       |       | 10-59   |       | 60>    |      |         |
|       |        | Number    | %     | Number  | %     | Number | %    |         |
| PD    | Both   | 149,390   | 23.37 | 438,440 | 68.58 | 51,454 | 8.05 | 639,284 |
|       | Male   | 76,557    | 24.39 | 210,998 | 67.23 | 26,291 | 8.38 | 313,846 |
|       | Female | 72,833    | 22.38 | 227,442 | 69.89 | 25,163 | 7.73 | 325,438 |
| PAs   | Both   | 47035     | 22.13 | 148839  | 70.02 | 16702  | 7.86 | 212576  |
|       | Male   | 24080     | 23.07 | 71585   | 68.57 | 7975   | 7.64 | 104392  |
|       | Female | 22955     | 21.22 | 77254   | 71.41 | 8727   | 8.07 | 108184  |

Source: CBS, 2011

### 5.6. Education Level in the Project Areas

According to CBS 2011, 55.85% population above the age of 5 years have basic level of education (1-8 grades) whereas 33.63% population have school level (8-12 or intermediate)

education in the project area. Only 4.85% populations have higher level of education. Table 5.6 shows that educational status of population varies in the PAs.

**Table 5.6: Level of Educational Level Attained in PAs among Literate Population**

| Education Level  | Project Areas |            |
|------------------|---------------|------------|
|                  | Population    | %          |
| Beginner         | 3089          | 2.60       |
| Basic Level      | 66300         | 55.85      |
| School Level     | 39918         | 33.63      |
| Graduate & above | 5755          | 4.85       |
| Others           | 3648          | 3.07       |
| <b>Total</b>     | <b>118710</b> | <b>100</b> |

Source: CBS, 2011

### 5.7. Ownership of House in the Project Areas

About 94.04% families lived in own house whereas 4.83% live in rented house in the PAs. Table 5.7 presents the ownership of house in the PAs.

**Table 5.7: Ownership of house in the Project Areas**

| Ownership     | Project Areas |              |
|---------------|---------------|--------------|
|               | Households No | %            |
| Owned         | 40415         | 94.04        |
| Rented        | 2077          | 4.83         |
| Institutional | 208           | 0.48         |
| Others        | 546           | 1.27         |
| <b>Total</b>  | <b>42976</b>  | <b>100.0</b> |

Source: CBS, 2011

### 5.8. House Structure in the Project Areas

The census survey 2011 recorded the house structure of Nepal based on three fundamental characteristics i.e. material used in foundation, walls and roofs. Indeed, house structure is one of the indicators of well beings of household.

### 5.9. Foundation of the Housing

Foundation of more than 60 % house in the project areas are made by wooden follow by cement bonded bricks/stone (about 23%). Only few houses foundation are made by RCC with pillar. Table 5.8 shows the distribution of housing structures by foundation type in PAs.

**Table 5.8: Distribution of Housing Structures by Types of Foundation**

| Foundation                 | Project Areas |            |
|----------------------------|---------------|------------|
|                            | Household No  | %          |
| Mud bonded bricks/stone    | 3089          | 7.19       |
| Cement Bonded bricks/stone | 9871          | 22.97      |
| RCC with pillar            | 2047          | 4.76       |
| Wooden pillar              | 26143         | 60.83      |
| Others                     | 898           | 2.09       |
| Not stated                 | 928           | 2.16       |
| <b>Total</b>               | <b>42976</b>  | <b>100</b> |

Source: CBS, 2011

### 5.10. House Wall and Roof

About 64 % of the household's walls are made by bamboo follow by cement bonded bricks/stone (about 27%). Only few houses walls are made by wood/planks and mud bonded bricks/stone.

Table 5.9 shows the distribution of households by wall structure in the PAs.

**Table 5.9: Distribution of households by Wall Structure in PAs**

| Types of walls             | Project Area |              |
|----------------------------|--------------|--------------|
|                            | Household No | %            |
| Mud bonded bricks/stone    | 2169         | 5.05         |
| Cement bonded bricks/stone | 11575        | 26.93        |
| Wood/planks                | 600          | 1.40         |
| Bamboo                     | 27491        | 63.97        |
| Unbaked Brick              | 42           | 0.10         |
| Others                     | 42           | 0.10         |
| Not stated                 | 10574        | 24.60        |
| <b>Total</b>               | <b>42976</b> | <b>100.0</b> |

Source: CBS, 2011

Likewise, about 43 % of the households roof are made by thatch/straw whereas about 32% houses have galvanized iron roof. Table 5.10 presents the distribution of housing structures by roof type.

**Table 5.10: Distribution of Household by Material's used in Roof in the PAs**

| Roof            | Project Area |            |
|-----------------|--------------|------------|
|                 | Household No | %          |
| Thatch/straw    | 18618        | 43.32      |
| Galvanized iron | 13802        | 32.12      |
| Tile/slate      | 2472         | 5.75       |
| RCC             | 6827         | 15.89      |
| Wood/planks     | 176          | 0.41       |
| Others          | 72           | 0.17       |
| Not stated      | 1009         | 2.35       |
| <b>Total</b>    | <b>42976</b> | <b>100</b> |

Source: CBS, 2011

### 5.11. Access to Drinking Water in the Project Area

In the PAs, Tube well/hand pump water supply is the main source of supply of drinking water at household level. More than 93% households use tap/piped water for drinking water. Only few households use tap/piped water, uncovered well/kuwa etc. Details of the sources of drinking water in PAs is presented in Table 5.11.

**Table 5.11: Distribution of Drinking Water Supply Sources by Types of Sources in PAs**

| Sources of drinking water | Project Area |              |
|---------------------------|--------------|--------------|
|                           | Household No | %            |
| Tap/piped water           | 1207         | 2.81         |
| Tube well/hand pump       | 40156        | 93.44        |
| Covered well/kuwa         | 93           | 0.22         |
| Uncovered well/kuwa       | 482          | 1.12         |
| Spout water               | 43           | 0.10         |
| River/stream              | 21           | 0.05         |
| Others                    | 305          | 0.71         |
| Not stated                | 669          | 1.56         |
| <b>Total</b>              | <b>42976</b> | <b>100.0</b> |

Source: CBS, 2011

**5.12. Cooking Energy in the Project Area**

Firewood, guitha (cow dung), LP gas are commonly used cooking energy at household in the PD and PAs. In PAs, about 48% households use firewood for cooking followed by santhi/guitha (about 38%). Only few household uses LP gas, kerosene, biogas etc. The details of sources of cooking energy in PAs is presented in the Table 5.12.

**Table 5.12: 5Distribution of Household by Sources of Cooking Energy**

| Cooking energy | Project Areas |              |
|----------------|---------------|--------------|
|                | Household No  | %            |
| Firewood       | 20638         | 48.02        |
| Kerosene       | 751           | 1.75         |
| LP Gas         | 4263          | 9.92         |
| Santhi/Guitha  | 16325         | 37.99        |
| Bio-gas        | 190           | 0.44         |
| Electricity    | 23            | 0.05         |
| Others         | 97            | 0.23         |
| Not stated     | 689           | 1.60         |
| <b>Total</b>   | <b>42976</b>  | <b>100.0</b> |

Source: CBS, 2011

**5.13. Use of Energy of Lighting at Household in the Project Area**

Table 5.13 shows the sources of lighting energy at household in the PAs. In the PAs, electricity is the main source of energy for lighting at household (60.66%). Other sources of lighting in PAs are kerosene, biogas, solar etc.

**Table 5.13: Distribution of HHs by Types of Lighting Energy Usage in the Project Areas**

| Lighting energy | Project Areas |              |
|-----------------|---------------|--------------|
|                 | Household No  | %            |
| Electricity     | 26068         | 60.66        |
| Kerosene        | 15689         | 36.51        |
| Biogas          | 120           | 0.28         |
| Solar           | 340           | 0.79         |
| Other           | 72            | 0.17         |
| Not stated      | 687           | 1.60         |
| <b>Total</b>    | <b>42976</b>  | <b>100.0</b> |

Source: CBS, 2011

**5.14. Sanitation Facility at Household in the Project Area**

According to CBS 2011, about 66% households in the PAs have no toilet facilities. Only 22% households have toilet facilities that means sanitation facilities in the PA is poor. Details of distribution of households by toilet facilities in PAs are shown in Table 5.14.

**Table 5.14: Distribution of Household by Toilet Facilities in the project Area**

| Toilet Facility | Project Area |              |
|-----------------|--------------|--------------|
|                 | Household No | %            |
| Without Toilet  | 28256        | 65.75        |
| Flush Toilet    | 9512         | 22.13        |
| Ordinary Toilet | 4551         | 10.59        |
| Not stated      | 657          | 1.53         |
| <b>Total</b>    | <b>42976</b> | <b>100.0</b> |

Source: CBS, 2011

**5.15. Communication facilities in the Project Area**

In the project area, there are several means of communication. Table 5.15 shows the main means of communication are mobile, radio, television, cable television, telephone etc. According to CBS report 2011, the largest proportion of household has access to mobile (53%) and follow to radio (39%) and television (34.18%).

**Table 5.15: Distribution of Household percentage with means of Communication**

| Area         | Total household | Radio | Television | Cable Television | Computer | Internet | Telephone | Mobile phone |
|--------------|-----------------|-------|------------|------------------|----------|----------|-----------|--------------|
| Project area | 42976           | 16805 | 14688      | 3822             | 1284     | 293      | 2047      | 22840        |
| Percent (%)  | 100             | 39.10 | 34.18      | 8.89             | 2.99     | 0.68     | 4.76      | 53.15        |

Source: CBS, 2011

**5.16. Religion in the Project Area**

The largest population in the PA follow Hindu religion. The second largest proportion of population (3.7%) is the believers of Christianity. Most of Christian households are Tharu and Hill Dalits (source: CBS, 2011).

**5.17. Cultural Sites in the Project Area**

During the consultation meeting for ToR of Chandra Nahar Irrigation Project, local people reported that there are few temples such as Hanuman temple, Ganesh temple, Devi temple, Ram temple etc. Details of the list of cultural sites around the project area are shown in Table

**Table 5.16: List of Cultural Sites in the PAs**

| S.N | Name                                     | Location  |
|-----|--|---|
| 1   | Hanuman Temple                           | Saptakoshi Municipality, ward no.4, Balardaha     |
| 2   | Durga Temple                             | Saptakoshi Municipality, ward no.10, Bhagani      |
| 3   | Shree 108 MaaDurga Bhagwati Temple       | Saptakoshi Municipality, ward no.-1, Fattepur     |
| 4   | Ganesh Temple                            | Kanchanrup Municipality, Saptari                  |
| 5   | Shivalaye Temple                         | Tirahut RM, ward no. 4, Diman                     |
| 6   | Kamala Temple                            | Tirahut RM, ward no. 4,                           |
| 7   | Hanuman Temple                           | Tirahut RM, ward no. 4,                           |
| 8   | Shree Ramjanaki Temple                   | Agmisair Krishna Sabaran RM, ward no. 4, Parswani |
| 9   | Ram Temple                               | Agmisair Krishna Sabaran RM, ward no. 4, Parswani |
| 10  | Devi Temple                              | Agmisair Krishna Sabaran RM, ward no. 4, Parswani |
| 11  | Saangcholing Ghumba (under Construction) | Saptakoshi Municipality, ward no-1, Fattepur      |

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| S.N | Name                                  | Location   |
|-----|---------------------------------------|--|
| 12  | Bholenath Temple (under construction) | Saptakoshi Municipality, ward no-1, Fattepur     |
| 13  | Hanuman Temple                        | Saptakoshi Municipality, ward no-1, Fattepur     |
| 14  | Hanuman Temple                        | Saptakoshi Municipality, ward no-10, Bhagini     |
| 15  | Rajaji Temple                         | Saptakoshi Municipality, ward no-10, Kamalpur    |
| 16  | Santoshi Temple                       | Kanchanrup Municipality, ward no.-6, Ghoghanpur  |
| 17  | Hanuman Temple                        | Kanchanrup Municipality, ward no.-6, Baluwachowk |
| 18  | Sideshwornath Temple                  | Tirahut RM, Ward no. 2, MAinakareri              |

Source: Field Survey, 2021



Shree 108 Maa Durga Bhwati Temple



Shiva Temple



Hanuman Temple



Ganesh Mandir

Figure 5.1: Cultural Sites around the PAs (Source: Field Survey, 2021)

## 6.0. Results of the Household Survey

A detail social-economic survey households occupying/living in the RoW of the Chandranahar IP was carried out to identify socio-economic characteristics of the households including landholding size, ownership on physical structure and its types, livestock, livelihood pattern, income and expenditure of households, standing crops and trees on land to identify vulnerable groups (Table). The possible loss and affect on the asset like land, structure and livelihood due to the rehabilitation of the project was also assessed during the survey.

Table 6.1: Distribution of the surveyed Households

| SN           | Municipality/Rural Municipality | Settlements                     | Surveyed Households (No) |
|--------------|---------------------------------|---------------------------------|--------------------------|
| 1.           | Saptakoshi Municipality         | Fattepur, Parsaha               | 3                        |
| 2.           | Kanchanrup Municipality         | Baluwa, Ghoghanpur, Kanchanpur, | 4                        |
| 3.           | Tirahut Rural Municipality      | Mainakaderi, Piparahi, Diban    | 5                        |
| 4            | Agnisair Krishna Savaran        | Banauli                         | 3                        |
| <b>Total</b> |                                 |                                 | <b>15</b>                |

Source: Field Survey, 2021

### 6.1. Caste, Ethnicity and Family size of the Surveyed households

Major castes and ethnicities of the surveyed households are Yadav, Raut, Mukhiya, Hills Chetry, Hills Janjatis, Sah, Muslim and Terai dalits. Most of the surveyed households are terai origin and socially disadvantaged. Source: Field survey, 2021).

More than half of the households in the surveyed households live in joint family and the rest in single family (Table 5.18) and average family size is 7.6. Maximum number of family member in the surveyed household is 14 whereas 4 is the smallest size (Table 6.2).

Table 6.2: Distribution of household by family structure of direct affected households

| By Family Type | Surveyed Households (No) | %          |
|----------------|--------------------------|------------|
| Single Family  | 9                        | 60         |
| Joint Family   | 6                        | 40         |
| <b>Total</b>   | <b>15</b>                | <b>100</b> |

Source: Household Survey, 2021

Table 6.3: Family size of the Surveyed Households

| S.N.         | Name of the House Head | Address                                 | Family size (Number of Family members) |
|--------------|------------------------|---|--|
| 1            | Rajendra Sadaa         | Saptakoshi-1, Fattepur                  | 14                                     |
| 2            | Indra Bahadur Bista    | Saptakoshi-2, Parsaha                   | 4                                      |
| 3            | Surya Bahadur Bista    | Saptakoshi-2, Parsaha                   | 4                                      |
| 4            | Umesh Raut             | Kanchanrup-7, Baluwa Chowk (Left Side)  | 7                                      |
| 5            | Santosh Sah            | Kanchanrup-8, Baluwa Chowk (right side) | 8                                      |
| 6            | Bhuwan Thapa           | Kanchanrup-8, Baluwa Chowk (right side) | 8                                      |
| 7            | Bouwa Raut             | Kanchanrup-9                            | 4                                      |
| 8            | Bihari Mukhiya         | Tirahut-2, Mainakaderi                  | 10                                     |
| 9            | Narayan Khang          | Tirahut-2, Mainakaderi                  | 4                                      |
| 10           | Sita Devi              | Tirahut-2, Mainakaderi                  | 11                                     |
| 11           | Jibachha Mukhiya       | Tirahut-2, Mainakaderi                  | 12                                     |
| 12           | Dabud Miyan            | Tirahut-2, Mainakaderi                  | 4                                      |
| 13           | Ramdev Yadav           | Agnisair Krishna Savaran—4, Banauli     | 6                                      |
| 14           | Rajkumar Yadav         | Agnisair Krishna Savaran—4, Banauli     | 8                                      |
| 15           | Rambhanaj Yadav        | Agnisair Krishna Savaran—4, Banauli     | 10                                     |
| <b>Total</b> |                        |   | <b>114</b>                             |

Source: Household Survey, 2021

## 6.2. Major Livelihoods Sources of the Surveyed Households

Major livelihoods sources of the surveyed households is agriculture followed by daily wages and small business. Most of the surveyed households adopt multiple livelihoods sources for their living (Table 6.4). Share cropping is one of the major agriculture practices in the project area and surveyed households.

Table 6.4: Major Livelihoods Sources of the Surveyed Households

| S.N. | Name of the House Head | Address                                 | Major Livelihoods Sources                        |
|------|------------------------|---|--|
| 1    | Rajendra Sadaa         | Saptakoshi-1, Fattepur                  | Daily Wages Works                                |
| 2    | Indra Bahadur Bista    | Saptakoshi-2, Parsaha                   | Security Guard                                   |
| 3    | Surya Bahadur Bista    | Saptakoshi-2, Parsaha                   | Security Guard                                   |
| 4    | Umesh Raut             | Kanchanrup-7, Baluwa Chowk (Left Side)  | Agriculture Farming and shop                     |
| 5    | Santosh Sah            | Kanchanrup-8, Baluwa Chowk (right side) | Agriculture Farming, Cycle Repairing Shop Centre |
| 6    | Bhuwan Thapa           | Kanchanrup-8, Baluwa Chowk (right side) | Fast Food and Tea Shop                           |
| 7    | Bouwa Raut             | Kanchanrup-9                            | Agriculture Farming and Foreign Employment       |
| 8    | Bihari Mukhiya         | Tirahut-2, Mainakaderi                  | Small Shop, Fishing and Agriculture Farming      |
| 9    | Narayan Khang          | Tirahut-2, Mainakaderi                  | Mobile shop and Daily Wage Work                  |
| 10   | Sita Devi              | Tirahut-2, Mainakaderi                  | Mobile Shop                                      |
| 11   | Jibachha Mukhiya       | Tirahut-2, Mainakaderi                  | Agriculture Farming, Mobile Shop                 |
| 12   | Dabud Miyan            | Tirahut-2, Mainakaderi                  | Cycle Repairing Centre                           |
| 13   | Ramdev Yadav           | Agnisair Krishna Savaran—4, Banauli     | Daily Wage Work, Tea Shop                        |
| 14   | Rajkumar Yadav         | Agnisair Krishna Savaran—4, Banauli     | Agriculture Farming and Business                 |
| 15   | Rambhanaj Yadav        | Agnisair Krishna Savaran—4, Banauli     | Agriculture Farming and Business                 |

Source: Household Survey, 2021

## 6.3. Monthly Income of the Surveyed Households

Most of the surveyed households have very less income than the national income. Average monthly income of the surveyed households is NRs 21,200. Table 6.5 presents the monthly income of the surveyed households. NRs 35,000 and NRs 13,000 is the highest and lowest income of the surveyed households respectively.

Table 6.5: Monthly income of the surveyed households

| S.N. | Name of the House Head | Address                                 | Monthly Income (NRs) |
|------|------------------------|---|----------------------|
| 1    | Rajendra Sadaa         | Saptakoshi-1, Fattepur                  | 13,000               |
| 2    | Indra Bahadur Bista    | Saptakoshi-2, Parsaha                   | 35,000               |
| 3    | Surya Bahadur Bista    | Saptakoshi-2, Parsaha                   | 35,000               |
| 4    | Umesh Raut             | Kanchanrup-7, Baluwa Chowk (Left Side)  | 20,000               |
| 5    | Santosh Sah            | Kanchanrup-8, Baluwa Chowk (right side) | 17,000               |
| 6    | Bhuwan Thapa           | Kanchanrup-8, Baluwa Chowk (right side) | 23,000               |
| 7    | Bouwa Raut             | Kanchanrup-9                            | 25,000               |
| 8    | Bihari Mukhiya         | Tirahut-2, Mainakaderi                  | 15,000               |
| 9    | Narayan Khang          | Tirahut-2, Mainakaderi                  | 20,000               |
| 10   | Sita Devi              | Tirahut-2, Mainakaderi                  | 15,000               |
| 11   | Jibachha Mukhiya       | Tirahut-2, Mainakaderi                  | 30,000               |

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| S.N. | Name of the House Head | Address                             | Monthly Income (NRs) |
|------|------------------------|-------------------------------------|----------------------|
| 12   | Dabud Miyan            | Tirahut-2, Mainakaderi              | 15,000               |
| 13   | Ramdev Yadav           | Agnisair Krishna Savaran—4, Banauli | 15,000               |
| 14   | Rajkumar Yadav         | Agnisair Krishna Savaran—4, Banauli | 20,000               |
| 15   | Rambhanaj Yadav        | Agnisair Krishna Savaran—4, Banauli | 20,000               |

Source: Household Survey, 2021

#### 6.4. Education level of the Surveyed Households

Literacy rate of the surveyed households is 78.94% which is higher than the national average (67.9%). However, only about 8 % have attended +2 level.

Table 6.6: Literacy rate of the surveyed households

| SN | Level of Education | Individual (No) | %           |
|----|--------------------|-----------------|-------------|
| 1. | Literate           | 90              | 78.94       |
| 2. | SEE                | 15              | 13.15       |
| 3. | +2                 | 9               | 7.89        |
|    | <b>Total</b>       | <b>114</b>      | <b>100%</b> |

Source: Household Survey, 2021

#### 6.5. Land holding size of the Surveyed Households

Land holding size of the surveyed households is 5 Kattha per family which is mostly irrigated agriculture land. The maximum and minimum land holding size of the surveyed households is 40 Kattha and 1 Kattha respectively. (Source: Household Survey, 2021)

### 7.0. Monitoring and Reporting of RAP

#### 7.1. Monitoring and Evaluation

Monitoring and Evaluation is the tools for ensuring effective ARAP implementation of rehabilitation of Chandra Nahar Irrigation Project. The ARAP implementation activities need to be monitored in different stages of the project cycle. The frequency and nature of monitoring and evaluation may vary in different phases.

Two types of monitoring, internal, and external will be administered in three levels: (i) process level (ii) output level and (iii) impact level of: (a) record and assess the project inputs and the number of persons affected and compensated and (b) confirm that former subsistence levels and living standards are being reestablished.

#### 7.2. Internal Monitoring (IM)

The internal monitoring (IM) of the project implementation will be carried out by DoWRI in coordination with the project level management office (i.e PMO) in regular basis with the help of Social Officer and Resettlement Specialists from the Project consultant. A quarterly report of IM will be prepared by Social Officer of PMO in consultation with consultants and submitted to DoWRI and JICA.

The PMO will maintain a record of all transaction in their resettlement database, followed by entitlement records signed by PAPs, and survey-based monitoring of resettlement and land acquisition progress.

Project field offices will be responsible for monitoring the day-to-day resettlement activities. The local social mobilizers under resettlement experts will play an important role to assist the project field office in course of regular monitoring. The field-level monitoring will be carried out through:

- Review of census information for PAPs
- Consultation and informal interview with PAPs
- Informal sample survey of PAPs
- Key informants interview
- Public consultation meeting

**Table 7.1: Proposed Monitoring for Internal Monitoring**

| S.N  | Particulars  | Procedures   | Timing   | Responsibility  |
|--|--|--|--|---|
| <b>Output Level</b>  |  |  |  |   |
| Land Acquisition   | Encroachment in to public and private land   | Visit to public and private land with local people, photographs                                    | Quarterly  | Social Mobilizers   |
|  | Acquisition of land  | Project records  | Quarterly  | Social safeguard/resettlement officers                          |
|  | Compensation payment of structures, land and trees   | Project's record, site visit and consultation with PAP   | Quarterly  | PMO/social safeguard/resettlement officer                       |
|  | RAP disclosures  | Project records, interview with public,  | Within 15 days after the Proposed disclosed date | PMO/social safeguard/resettlement officer                       |
|  | Grievances related to compensation payment, land acquisition                                 | Interviews with the PAP, project records   | Monthly for 3 months and then quarterly basis    | PMO/Social Safeguard or resettlement officer                    |
| <b>Impact Level</b>  |  |  |  |   |
| Change in household level income and economic                  | Changes in the land price, land use and agricultural practices, productivity and crop export | Discuss with farmers and extension workers, agricultural statistics of district agriculture office | Annually   | Koshi Pump Chandra Nahar Irrigation Management Office (KPCNIMO) |
| Betterment and improvement in availability of irrigation water | Water availability and quantity of water for irrigation improved                             | Interview with farmers   | Annually   |   |

## 8.0. Grievance Redress Mechanism

### 8.1. Grievance Redress Mechanism

#### 8.1.1. *Grievance Redress Mechanism Overview*

A grievance redress mechanism is established to allow stakeholders including PAPs to raise any concerns or complaints, or to appeal any disagreeable decisions, practices and activities arising from the project including compensation for land and assets. Stakeholders will be made fully aware of their rights and the procedures.

As part of the implementation stage the project implementation office under the DoWRI will directly interact and consult with the project affected persons. These would comprise of consultations towards acquisition of land, compensation and relocation of structures, compensation of trees, addressing the impacts on common property resources such as places of religious importance, community buildings, trees, etc. For the implementation of ARAP, consultations and information dissemination will be undertaken to let the affected persons about ARAP details, and the progress made. Implementation stage also involves redress of grievances in case of rehabilitation aspects as well as relocation of common property resources through the grievance redress mechanisms.

The affected persons and groups identified in ARAP matrix above will be able to raise any grievances related the land acquisition , relocation of the assets with the subproject grievance redress mechanism (GRM), to help ensure the successful implementation of resettlement measures. At first instance, the project-affected grievant should raise their grievance with the information officer of the project management office formed by the DoWRI of the project, and the information officer will determine whether it can be resolved within the project, at the ward level, or whether another mechanism should be used. PAPs will be exempt from all administrative fees incurred, pursuant to the grievance redressed procedures except for cases filed in court. More details regarding the GRM are provided under:

#### 8.1.2. *Proposed Grievance Redress Mechanism*

Existing mechanisms for grievance redress at the local level will be drawn upon under the project to enable grievant to lodge issues, complaints and requests for information, to help support and build the capacity of local governments.

#### 8.1.3. *Structure of the GRM*

The grievant should first raise any project-related grievances with the information officer (or any to a designated position to receive and act on grievances related issues by the project) of Project Management Office (formed by DoWRI ) at site. The person will refer the cases according to the nature of grievances to the concerned entities. The records shall be kept properly. There may be different types of grievances namely general and grievances related to land acquisition and compensation. The GRM of general grievances and land related grievances are elaborated below:

#### General types of Grievances (except land acquisition and compensation)

##### **A. First level of Grievance:**

At the first, any grievance related the project should be handled and addressed at the project level grievance redress unit as relevant and possible. The staffing of the grievance redress unit comprises of grievance /information officer, Environmental and Social Officer, and Project Manager.

**B. Second Level of Grievances**

If the grievances related to the land acquisition and compensation couldn't be resolved at project level, then it will be forwarded to the district administration office.

For other grievances except the land acquisition and resettlement, the grievances if not able to resolve at the local level will be forwarded to the DoWRI for the decision.

**C. Third Level of Grievances:**

If the grievances except the land acquisition and resettlement couldn't be resolved at DoWRI level then, then it will be forwarded to MoEWRI through DoWRI

**8.1.4. Processes of the GRM**

Grievances shall be submitted through various mediums, including in person, in written form to a noted address, through a phone line or through direct calls to concerned officials, and emails.. The complainant will follow up based that unique number at the time of registration. All complaints will be responded within two weeks at any level. In case response is not received from 1st level within 15 days, the complaint will be escalated to next level. If complaint remains unaddressed at 1st and 2nd within maximum 30 days after registering the compliant, it will be elevated to 3rd level. The third level within 7 days of time should instruct the concerned person at PMO (project level) level to arrange for a hearing within maximum 5 days of time. Effort will be given by all levels of GRCs to conduct hearing and resolve the concern at their level up to the satisfaction of complainant within the stipulated timeframe. In case 1st and 2nd level GRCs are unable to resolve the concern up to the satisfaction of complainant, these GRCs' or Complainant may approach to 3rd level of GRC at MoEWRI Level. After conducting hearing at any level of GRC, the decision will be communicated to complainant within maximum 15 Days of time.

**8.1.5. Grievance Redress Process**

All local contact information and options for complaint submission will be available on site, on Toles, Wards, municipality office/rural municipality office. A half yearly report on Grievance Redress by the subproject project will be prepared and will be sent to the DoWRI. The DoWRI will forward it to JICA.

**8.1.6. Further details of the GRM**

The functions of grievance mechanism include redressing grievances of community/beneficiaries/project affected persons in all project respects, providing rehabilitation and resettlement assistance and related activities, and hearing grievances from workers involved in the project at any level or phase. The system should be established to report back to the concerned community or persons regarding the decision on the complaint. The grievances related to women should be dealt by women officer. As required, the social mobilizers will be recruited. GRC will deal/hear the issues related to Environment, Rehabilitation & Resettlement (R&R) and individual grievances and will give its decision/verdict within 15 days after hearing the aggrieved person. The final verdict of the GRC will be given by the Head of GRC in consultation with other members of the GRCs and will be binding to all other members. Potential grievances which may need to be addressed are listed below:

- Rehabilitation & Resettlement and Compensation issue
- Loss of livelihood
- Access to resource /utility/facility
- Ambient air and noise Quality
- Impact on water quality/resource
- Grievance from vulnerable community

- Gender related issues
- Grievances from workers
- Safety and risk repeated to project development

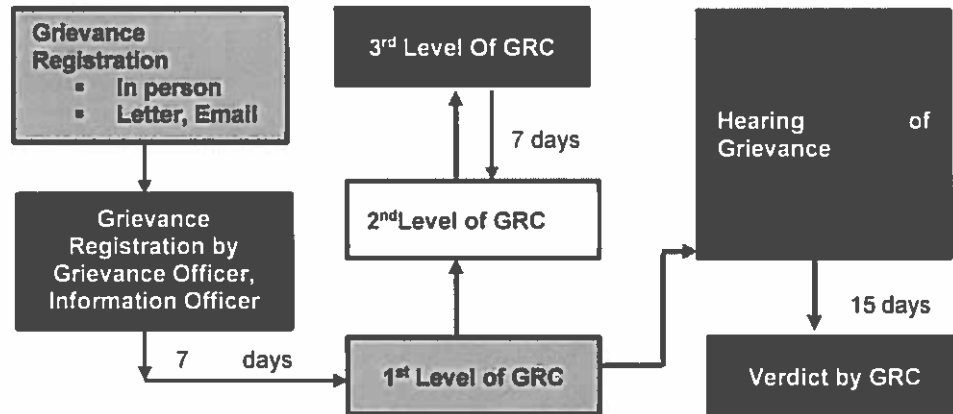


Figure 8.1: GRM Details

**8.1.7. Grievances related to land acquisition and compensation**

There is the potentiality for two main types of grievances: grievances related to land acquisition and resettlement requirements, and grievances related to compensation or entitlement. The PAPs will have access to both locally constructed grievances redress committees specified above, i.e. Project Management Office (PMO) and formal courts of appeal system. Under the latter system every PAP can appeal to the court if they feel that they are not compensated appropriately. They may appeal to appellate court within 35 days of the public notice given to them.

Proposed mechanism for grievance resolution is given below:

**Stage 1:**

Complaints of PAPs on any aspect of compensation, relocation, or unaddressed losses shall in first instance be settled verbally or in written form in field-based project office (or PMO). The complaint can be discussed in an informal meeting with the PAP by the concerned personnel to settle the issues at the local level. The community consultation, involvement of social/resettlement experts will be helpful in this regard. It will be the responsibility of Project In-charge to resolve the issue within 15 days from the date of the complaint received.

**Stage 2:**

If no understanding or amicable solution reached or no response from the project office, the PAP can appeal to CDC. While lodging the complaint, the PAP must produce documents to support his/her claim. CDC will provide the decision within 15 days of registering the appeal.

**Stage 3:**

If the PAP is not satisfied with the decision of CDC or in absence of any response of its representatives, within 35 days of the complaint, the PAP, in his/her last resort, may submit its case to the court.

*Qe* *AO*

**9.0. Institutional framework and responsibility for ARAP**

The following institutional framework and responsibility are proposed for implementation of ARAP.

**Table 9.1: Institutional framework and responsibility**

| S.N. | Activities  | Responsibility                             | Role  | Remarks |
|------|---|--|---|---------|
| 1    | Preparation of ARAP report                        | DoWRI                                      | Survey and preparation of ARAP                        |         |
| 2    | Disclosure of RAP Findings                        | DoWRI                                      | Main role   |         |
| 3    | Final Cut-Off-Date                                | DoWRI                                      | Main role   |         |
| 4    | Formation of Compensation Determination Committee | District Administrative Office (Saptari)   | Lead role: CDO office<br>Facilitation role: PMO/DoWRI |         |
| 5    | Final Asset Valuation                             | Compensation Determination Committee (CDC) | Lead: CDC<br>Facilitation: PMO/DoWRI                  |         |
| 6    | Compensation Agreement                            | DoWRI                                      | Lead: PMO/DoWRI                                       |         |
| 7    | Compensation Payment                              | CDC  | Lead: CDC<br>Facilitation: PMO/DoWRI                  |         |
| 8    | Monitoring of Grievance Redress                   | PMO/DoWRI                                  | Lead: PMO<br>Supervision: DoWRI                       |         |
| 9    | RAP Disclosure Report                             | PMO/DoWRI                                  | Lead: PMO   |         |

Note: PMO: Project Management Office (PMO) at site to be formed by DoWRI. The name and structure of PMO may be different but the function and responsibilities mentioned above remains the same.

**10.0. Cost****(1) RAP Implementation Cost**

| No                               | Item description  | Unit | QTY       | Unit cost (NRs.) | Total (NRs.)     | Source             |
|----------------------------------|---|------|-----------|------------------|------------------|--------------------|
| <b>I.RAP Implementation Cost</b> |   |      |           |                  |                  |                    |
| <b>1</b>                         | <b>Compensation (pvt.)<sup>*1</sup></b>                           |      |           |                  |                  |                    |
| 1-1                              | Temporary loss of private land (CUP-02)                           | Ha/y | 0.02      | 100,000          | 2,000            | DWRI               |
| 1-2                              | Temporary loss of private land (Concrete plant yard)              | Ha/y | 0.70 x 2y | 180,000          | 630,180          | DWRI               |
| 1-3                              | Permanent loss of private land (CUP-02)                           | Ha   | 0.11      | 12,000,000       | 1,320,000        | DWRI               |
| 1-4                              | Loss of means of livelihood and damage on properties (relocation) | HHs  | 18        | <sup>*2</sup>    | 1,681,520        | DWRI               |
| <b>2</b>                         | <b>Compensation (public)</b>                                      |      |           |                  |                  |                    |
| 2-1                              | Relocation of electric pole                                       | Pcs  | 10        | 10,000~8,000     | 111,000          | NEA                |
| 2-2                              | Reconstruction of water well                                      | Pcs. | 5         | 20,000           | 100,000          | DWRI               |
| 2-3                              | Cutting and relocating trees                                      | Pcs. | 22        | LS               | 100,000          | DWRI <sup>*3</sup> |
| 2-4                              | Replanting tree (1:10)  | Pcs. | 220       | 3,960            | 871,000          | DWRI <sup>*3</sup> |
| <b>3</b>                         | <b>Other operation cost</b>                                       |      |           |                  |                  |                    |
| 3-1                              | Staffing (social env. officer)                                    | Nos. | 1         | LS               | ---              | DWRI <sup>*4</sup> |
| 3-2                              | Final assets valuation  | Set  | 1         | 200,000          | 200,000          | CDC/DWRI           |
| 3-3                              | Grievance Handling  | Set  | 1         | LS               | 150,000          | DWRI/GCRM          |
| 3-4                              | Reporting   | Set  | 1         | LS               | 100,000          | DWRI               |
|                                  | <b>Sub-Total (from 1 to 3 )</b>                                   |      |           |                  | <b>4,887,520</b> |                    |
|                                  | Contingencies (10% of sub-total )                                 |      |           |                  | 488,700          |                    |
|                                  | <b>Total</b>  |      |           |                  | <b>5,376,520</b> |                    |

Note:

\*1: Figures mentioned in above is provisional amount based on the consultation with PAPs. The final amount shall be determined by compensation determination committee.

\*2: See ARAP report for detail of provisional calculation of valuation for each affected assets.

\*3: Transportation of felling trees will be consulted with DFO.

\*4: Deputed directly from DoWRI

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## (2) RAP Monitoring Cost

| Activity   | Indicator                   | Qty          | Unit cost (NRs.) | Total Cost (NRs.) |
|--|-----------------------------|--------------|------------------|-------------------|
| Meeting for set up compensation determination committees | Established committee       | 4            | 20,000.00        | 80,000.00         |
| Follow up valuation and compensation process             | Field report                | Complete set | LS               | 100,000.00        |
| Meetings for grievance redress                           | Meetings/grievance resolved | 5            | 15,000.00        | 75,000.00         |
| PAPs Livelihoods assessment                              | Assessment report           | LS           |                  | 250,000.00        |
| <b>Sub -total</b>  |                             |              |                  | <b>505,000.00</b> |
| Contingency (10%)  |                             |              |                  | 50,500.00         |
| <b>Total</b>   |                             |              |                  | <b>555,500.00</b> |

11.0. RAP Implementation Schedule

Table 11.1: Rap Implementation Schedule for Project for Rehabilitation of Irrigation System

Proposed Implementation Schedule

| Year   | 1st Year |   |   |   |   |   |   |    |    |    |   |   | 2nd Year |   |   |   |   |   |   |    |    |    |   |   | 3rd Year |   |   |   |   |   |   |    |    |    |   |   | 4th Year |   |   |   |  |  |  |  |  |  |  |  |
|--|----------|---|---|---|---|---|---|----|----|----|---|---|----------|---|---|---|---|---|---|----|----|----|---|---|----------|---|---|---|---|---|---|----|----|----|---|---|----------|---|---|---|--|--|--|--|--|--|--|--|
| Month  | 3        | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3        | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3        | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3        | 4 | 5 | 6 |  |  |  |  |  |  |  |  |
| <b>Event</b>   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |  |  |  |  |  |  |  |  |
| <b>E/N, G/A</b>  |          |   |   |   |   | ▼ |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |  |  |  |  |  |  |  |  |
| <b>Detailed Design &amp; Tender Assistance (DD/TA)</b> |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |  |  |  |  |  |  |  |  |
| Procurement of consultant for DD/TA and Tender         |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |  |  |  |  |  |  |  |  |
| Detailed Design  |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |  |  |  |  |  |  |  |  |
| Preparation of Tender Document and Tender Assistance   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |  |  |  |  |  |  |  |  |
| <b>RAP Implementation</b>                              |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |  |  |  |  |  |  |  |  |
| 1 Disclosure of RAP study findings                     |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |  |  |  |  |  |  |  |  |
| 2 Final Cut-off date                                   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |  |  |  |  |  |  |  |  |
| 3 Formation of compensation determination committee    |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |  |  |  |  |  |  |  |  |
| 4 Final asset valuation                                |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |  |  |  |  |  |  |  |  |
| 5 Compensation Agreement                               |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |  |  |  |  |  |  |  |  |
| 6 Compensation   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |  |  |  |  |  |  |  |  |
| 7 Monitoring and Grievance Redress                     |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |  |  |  |  |  |  |  |  |
| 8 RAP disclosure Report                                |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |  |  |  |  |  |  |  |  |
| <b>Construction Work</b>                               |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |  |  |  |  |  |  |  |  |
| Signing of Contract                                    |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |  |  |  |  |  |  |  |  |
| Mobilization and Preparation Work                      |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |  |  |  |  |  |  |  |  |
| Canal Under Pass (CUP) / Irrigation Siphon 8 locations |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |  |  |  |  |  |  |  |  |
| Drainage Facilities 9 locations                        |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |  |  |  |  |  |  |  |  |
| Canal Crossing Bridges 15 locations                    |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |  |  |  |  |  |  |  |  |
| Handover to client                                     |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |   |   |   |    |    |    |   |   |          |   |   |   |  |  |  |  |  |  |  |  |

**Part II: Rehabilitation of Chandra Nahar IP cash compensation matrix**



ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area

12.0. Cash Compensation Matrix

| SN                                 | Particular   | Location                                  | Types of Impact                         | Unit | Quantity of Impact | Unit costs (NRs)  | Total Costs (NRs)  | Remarks   |
|------------------------------------|--|---|---|------|--------------------|---|--|---|
| <b>1. LAND</b>                     |  |   |   |      |                    |   |  |   |
| <b>A. Private Land – Temporary</b> |  |   |   |      |                    |   |  |   |
| 1.                                 | Private land acquisition<br><br>(Temporary lease)<br><br>(Parcel no 17 near CUP 2) | Saptakoshi Municipality, Saptari district | Temporary land acquisition is required. | Ha   | 0.02 Ha            | Unit land price for lease to be decided by the Compensation Determination Committee (CDC) formed under the Chairperson of Saptari CDO as per the district norms | Total compensation amount Land price for lease to be decided by the Compensation Determination Committee (CDC) formed under the Chairperson of Saptari Chief District Officer (CDO), As per the local consultation the cost of land price is NRs 12,000,000/ha | Land acquisition is required for lease during the construction stages of the project. This includes cultivation disruption allowances equal to one year of production. The land belongs to Mrs. Semani Devi Mandal Ph no - 9819969521 |
| 2.                                 | Private land acquisition<br><br>(Temporary lease)<br><br>(Concrete plant yard)     |   | Temporary land acquisition is required. | Ha   | 0.70 Ha            | Unit land price for lease to be decided by the Compensation Determination Committee (CDC) formed under the Chairperson of Saptari CDO as per the district norms | Total compensation amount Land price for lease to be decided by the Compensation Determination Committee (CDC) formed  | Land belongs to Om Prakash Yadav (9817784123) and Kirpa Nanda Goit Yadav (9817784123)   |

ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area

| SN  | Particular  | Location                                       | Types of Impact                         | Unit | Quantity of Impact | Unit costs (NRs)  | Total Costs (NRs)   | Remarks  |
|---|---|--|---|------|--------------------|---|---|--|
|   |   |  |   |      |                    |   | under the Chairperson of Saptari CDO As per consultation with local, the price of land lease per hectare per year is NRs. 100,000 |  |
| <b>Sub-Total</b>                                    |   |  |   |      |                    |   |   |  |
| <b>Private Land – Permanent (CUP 2)</b>             |   |  |   |      |                    |   |   |  |
| 1.  | Private land acquisition<br>(Permanent acquisition)<br>(Parcel no 8)                    | Saptakoshi Municipality, Saptari district      | Permanent land acquisition is required. | Ha   | 0.11 Ha            | Unit land price to be decided by the Compensation Determination Committee (CDC) formed under the Chairperson of Saptari CDO based on the certain criteria such as GoN (land Revenue Office) rates and market rates etc. Generally 70 % weightage is given to GoN rates and 30 % to market rates | Total land price to be decided by the Compensation Determination Committee (CDC) formed under the Chairperson of Saptari CDO      | Permanent land acquisition is required for the project.<br><br>The land belongs to Mr Kedar Mandal, Ph no - 9819969521 |
| <b>2. STRUCTURES</b>                                |   |  |   |      |                    |   |   |  |
| <b>B. Structures at the targeted facility sites</b> |   |  |   |      |                    |   |   |  |
| 1.  | Temporary and permanent houses (including cattle sheds, movable shops, stores & fences) | Different places of the targeted facility site |   | HHS  | 18                 | Unit cost for each structure affected to be decided by the Compensation Determination Committee (CDC) formed under the Chairperson of Saptari CDO based on the certain criteria such as GoN rates, market rates etc   | Total compensation amount for each structure affected to be decided by the Compensation Determination Committee (CDC) formed      | Please see detail of the structures affected in Annex 1  |

ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area

| SN   | Particular                                | Location                                       | Types of Impact  | Unit | Quantity of Impact | Unit costs (NRs)     | Total Costs (NRs)  | Remarks   |
|--|---|--|--|------|--------------------|----------------------|--|---|
|  |   |  |  |      |                    |                      | under the Chairperson of Saptari CDO based on the certain criteria such as GoN rates, market rates etc |   |
|  | <b>Sub-Total</b>                          |  |  |      |                    |                      |  |   |
| <b>3. ELECTRICITY AND TELEPHONE POLES</b>                                |   |  |  |      |                    |                      |  |   |
| <b>C. Electricity and Telephone Poles at the targeted facility sites</b> |   |  |  |      |                    |                      |  |   |
| 1.   | <b>Electricity Poles</b>                  | Different places of the targeted facility site | Relocation of Electricity Poles                          | No   | 7                  | 10,000 per pole      | 70,000   | Consultation with Er. Sanjib Sah, NEA chief Kanchapur branch, Saptari |
| 2.   | <b>Telephone Poles with optical fibre</b> | Different places of the targeted facility      | Relocation of optical fibre                              | No   | 1                  | 5,000 per pole       | 5,000  | Consultation with Telecom Office chief Er. Rajdev Prasad Sah, Saptari |
| 3.   |   |  |  |      |                    |                      |  |   |
| <b>4. HAND PUMPS</b>   |   |  |  |      |                    |                      |  |   |
| <b>D. Hand Pumps at the targeted facility sites</b>                      |   |  |  |      |                    |                      |  |   |
| 1.   | <b>Community Well (Hand pump)</b>         | Different places of the targeted facility      | Relocation of Hand pump                                  | No   | 5                  | 20,000 per hand pump | 100,000  |   |
| <b>5. TREES</b>  |   |  |  |      |                    |                      |  |   |
| <b>E. Trees and vegetation at the targeted facility sites</b>            |   |  |  |      |                    |                      |  |   |
| 1.   | No of trees affected due to the           | Targeted facility sites of the IP              | To be removed/relocated from the targeted facility sites | No   | 22                 | -                    | -  | Please see Annex 2 for the coordinates of                             |

ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area

| SN | Particular                                    | Location   | Types of Impact  | Unit | Quantity of Impact | Unit costs (NRs)     | Total Costs (NRs) | Remarks  |
|----|---|--|--|------|--------------------|----------------------|-------------------|--|
|    | rehabilitation of the IP                      |  |  |      |                    |                      |                   | the affected tree  |
| 2. | Felling of trees, storage and handover        | Targeted facility sites (coordinates of the affected trees to be removed/relocated is included in Annex) | To be removed/relocated from the targeted facility sites | No   | 21                 |                      |                   | Will coordinate with the DFO Saptari while feeling and transporting the felled trees             |
| 3. | Relocation of a Peepal tree                   | Kancharup Municipality - 4, PaluwaGhoghanpur   | Relocation in nearby area of the existing site           | No   | 1                  |                      |                   |  |
| 4. | Compensation plantation of the affected trees | Along the RoW of the Chandranahar IP   | -  | No   | 220                | 39,600 per seedlings | 871,200           | To be coordinated with the DFO Saptari during the plantation for seedlings and technical support |

ANNEXES



*ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area*

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**Annex 1: Private Structures Adjacent to Targeted Facilities Which are likely to be Removed/Relocated**



ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area

Following 21 structures are likely to be affected during the construction of the targeted facilities of the IP

| S.N. | Name of the House Head    | Address                                 | Personal Assets/Properties   | Number of Families | Monthly Income (Unit: NPR) | Occupation   |
|------|---------------------------|---|--|--------------------|----------------------------|--|
| 1    | Rajendra Sadaa            | Saptakoshi-1, Fatepur                   | 2 animal sheds, 1 hen coop, 8 banana trees, and 1 pump                                 | 14                 | 15,000                     | Daily Wages Worker                                 |
| 2.   | Indra Bahadur Bista       | Saptakoshi-2, Parsaha                   | 1 cattle shed, 1 straw mound and 1 hen coop  | 4                  | 35,000                     | Security Guard                                     |
| 3    | Surya Bahadur Bista       | Saptakoshi-2, Parsaha                   | 1 buffalo shed, 12 banana and 1 citrus trees, and other 5 trees on the canal alignment | 4                  | 35,000                     | Security Guard                                     |
| 4    | RameshwarMandal           | Saptakoshi-4, Balardaha                 | 1 Moringa tree, 14 banana trees, 1 clump of bamboos and 2 rice straw mound             | 6                  | 12,000                     | Business   |
| 5    | Mr. Miya                  | Kanchanrup-8, Baluwa Chowk (right side) | 1 mango tree and 1 water pump (well)   | 8                  | 30,000                     | Foreign Employment in Gulf Country and Mobile Shop |
| 6    | Bhuwan Thapa              | Kanchanrup-8, Baluwa Chowk (right side) | 1 Movable vendor shop  | 5                  | 30,000                     | Mobile Shop  |
| 7    | Bouwa Raut                | Kanchanrup-9                            | 1 Movable vendor shop  | 4                  | 30,000                     | Farming and Foreign Employment                     |
| 8    | Bihari Mukhiya            | Tirahut-2, Mainakaderi                  | 1 Movable vendor shop  | 10                 | 25,000                     | Fishing and Farming                                |
| 9    | Narayan Khang             | Tirahut-2, Mainakaderi                  | 1 Movable vendor shop  | 4                  | 20,000                     | Daily Wage Work                                    |
| 10   | Sita Devi                 | Tirahut-2, Mainakaderi                  | 1 Movable vendor shop  | 6                  | 10,000                     | Shop   |
| 11   | Jibachha (Mukhiya) Maiaha | Tirahut-2, Mainakaderi                  | 1 Store  | 13                 | 30,000                     | Farming, Mobile Shop                               |
| 12   | Ramananda Yadav           | Agnisair Krishna Savaran—4, Banauli     | 1 Hand Pump, 1 movable vendor shop with 1 kitchen                                      | 6                  | 10,000                     | Daily Wage Work, Tea Shop                          |

ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area

| S.N.  | Name of the House Head     | Address                                 | Personal Assets/Properties                     | Number of Families | Monthly Income (Unit: NPR)                    | Occupation             |
|---|----------------------------|---|--|--------------------|---|------------------------|
| 13  | Rajkumar Yadav             | Agnisair Krishna Savaran—4, Banauli     | 1 Cattle shed and 1 movable vendor shop        | 8                  | 20,000  | Farming and Business   |
| 14  | Rambhajan Yadav            | Agnisair Krishna Savaran—4, Banauli     | 1 Movable vendor shop                          | 10                 | 15,000  | Farming and Business   |
| 15  | Jiban Yadav                | Agnisair Krishna Savaran—4, Banauli     | 1 mango tree, 3 papaya trees and 2 local trees | 4                  | 10,000  | Farming and Business   |
| 16  | Mr. Dabud Miyan            | Tirahut-2, Mainakaderi                  | 1 Movable vendor shop                          | 4                  | 15,000  | Cycle repairing centre |
| 17  | Mr. Santosh Sah            | Kanchanrup-8, Baluwa Chowk (right side) | 1 Movable vendor shop                          | 8                  | 17,000  | Farming and Business   |
| 18  | Mr. Umesh Raut             | Kanchanrup-8, Baluwa Chowk (right side) | 1 Movable vendor shop                          | 7                  | 20,000  | Farming and Business   |
| Private land likely to be affected due to land acquisition by the project |                            |   |  |                    |   |                        |
| S.N.  | Name of the House Head     | Address                                 | Personal Assets/Properties                     | Number of Families | Details                                       | Occupation             |
| 19  | Mr Kedar Mandal            | Saptakoshi Municipality                 | farm land (0.11 ha)                            | 7                  | Land for changing canal alignment             | agriculture            |
| 20  | Mrs Semani Devi Mandal     | Saptakoshi Municipality                 | farm land (0.03 ha)                            | 1                  | Land for changing canal alignment             | agriculture            |
| 21  | Mr. Om Prakash Yadav       | Kanchanrup                              | farm land (0.3 ha)                             | 6                  | Land for construction of plant yard temporary | Civil servant          |
| 22  | Mr. Kirpa Nanda Goit Yadav | Kanchanrup                              | farm land (0.4 ha)                             | 3                  | Land for construction                         | Farmer                 |

ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area

| S.N. | Name of the House Head | Address | Personal Assets/Properties | Number of Families | Monthly Income (Unit: NPR) | Occupation |
|------|------------------------|---------|----------------------------|--------------------|----------------------------|------------|
|      |                        |         |                            |                    | of plant yard temporary    |            |






**Annex 2: Coordinates of the affected trees to be removed/relocated**



ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area



Details of affected trees

| S N | Species | X-Coordinate | Y-coordinate | Girth (cm?) | Height (m) | Grade | Palika                  | Photo  | Remarks  |
|-----|---------|--------------|--------------|-------------|------------|-------|-------------------------|--|--|
| 1   | Pipal   | 492982       | 2957399      | 410         | 14         | 2     | Saptakoshi Municipality |   | A part of the branches will be cut only for securing necessary clearance for traffic |
| 2   | Moringa | 493889       | 2956064      | 34          | 7          | 3     |                         |  |  |

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| S<br>N | Species | X-<br>Coordinat<br>e | Y-<br>coordinat<br>e | Girth<br>(cm?) | Heigh<br>t<br>(m) | Grad<br>e | Palik<br>a | Photo  | Remarks |
|--------|---------|----------------------|----------------------|----------------|-------------------|-----------|------------|--|---------|
| 3      | Moringa | 493888               | 2956065              | 45             | 7                 | 3         |            |   |         |
| 4      | Moringa | 494255               | 2953171              | 85             | 6                 | 3         |            |  |         |






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| S N | Species | X-Coordinate | Y-coordinate | Girth (cm?) | Height (m) | Grade | Palika | Photo  | Remarks |
|-----|---------|--------------|--------------|-------------|------------|-------|--------|--|---------|
| 5   | Masala  | 493921       | 2952115      | 90          | 8          | 3     |        |   |         |
| 6   | Kadam   | 493920       | 2952117      | 75          | 7          | 2     |        |  |         |

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| S N | Species | X-Coordinate | Y-coordinate | Girth (cm?) | Height (m) | Grade | Palika                  | Photo  | Remarks |
|-----|---------|--------------|--------------|-------------|------------|-------|-------------------------|--|---------|
| 7   | Kadam   | 492307       | 2949004      | 160         | 10         | 1     | Kanchanrup Municipality |   |         |
| 8   | Aap     | 492202       | 2949030      | 120         | 9          | 2     |                         |  |         |






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| S N | Species | X-Coordinate | Y-coordinate | Girth (cm?) | Height (m) | Grade | Palika | Photo   | Remarks |
|-----|---------|--------------|--------------|-------------|------------|-------|--------|---|---------|
| 9   | Aap     | 492202       | 2949030      | 110         | 9          | 2     |        |  |         |
| 10  | Aap     | 492202       | 2949030      | 137         | 9          | 2     |        |   |         |

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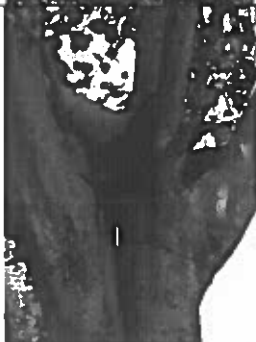
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| S N | Species | X-Coordinate | Y-coordinate | Girth (cm?) | Height (m) | Grade | Palika | Photo  | Remarks |
|-----|---------|--------------|--------------|-------------|------------|-------|--------|--|---------|
| 11  | Pipal   | 492113       | 2948691      | 89          | 4          | 3     |        |   |         |
| 12  | Siris   | 491438       | 2947619      | 62          | 6          | 3     |        |  |         |






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| S<br>N | Specie<br>s | X-<br>Coordinat<br>e | Y-<br>coordinat<br>e | Girth<br>(cm?<br>) | Heigh<br>t<br>(m) | Grad<br>e | Palik<br>a | Photo  | Remarks |
|--------|-------------|----------------------|----------------------|--------------------|-------------------|-----------|------------|--|---------|
| 13     | Siris       | 491438               | 2947619              | 66                 | 6                 | 3         |            |   |         |
| 14     | Pipal       | 491008               | 2946976              | 140                | 8                 | 2         |            |  |         |






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| S N | Species | X-Coordinate | Y-coordinate | Girth (cm?) | Height (m) | Grade | Palika | Photo  | Remarks |
|-----|---------|--------------|--------------|-------------|------------|-------|--------|--|---------|
| 15  | Bar     | 491005       | 2946975      | 107         | 7          | 2     |        |   |         |
| 16  | Kadam   | 490979       | 2946981      | 91          | 9          | 3     |        |  |         |



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| S N | Species | X-Coordinate | Y-coordinate | Girth (cm?) | Height (m) | Grade | Palika                     | Photo  | Remarks |
|-----|---------|--------------|--------------|-------------|------------|-------|----------------------------|--|---------|
| 17  | Kadam   | 490845       | 2946455      | 130         | 8          | 2     |                            |   |         |
| 18  | pipal   | 484712       | 2941013      | 360         | 16         | 2     | Tirthut Rural Municipality |  |         |






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| S N | Species | X-Coordinate | Y-coordinate | Girth (cm?) | Height (m) | Grade | Palika                             | Photo  | Remarks |
|-----|---------|--------------|--------------|-------------|------------|-------|------------------------------------|--|---------|
| 19  | pithari | 481719       | 2940624      | 94          | 9          | 2     |                                    |   |         |
| 20  | Bakaino | 481720       | 2940625      | 80          | 7          | 3     | Krishna Sumiran Rural Municipality |  |         |




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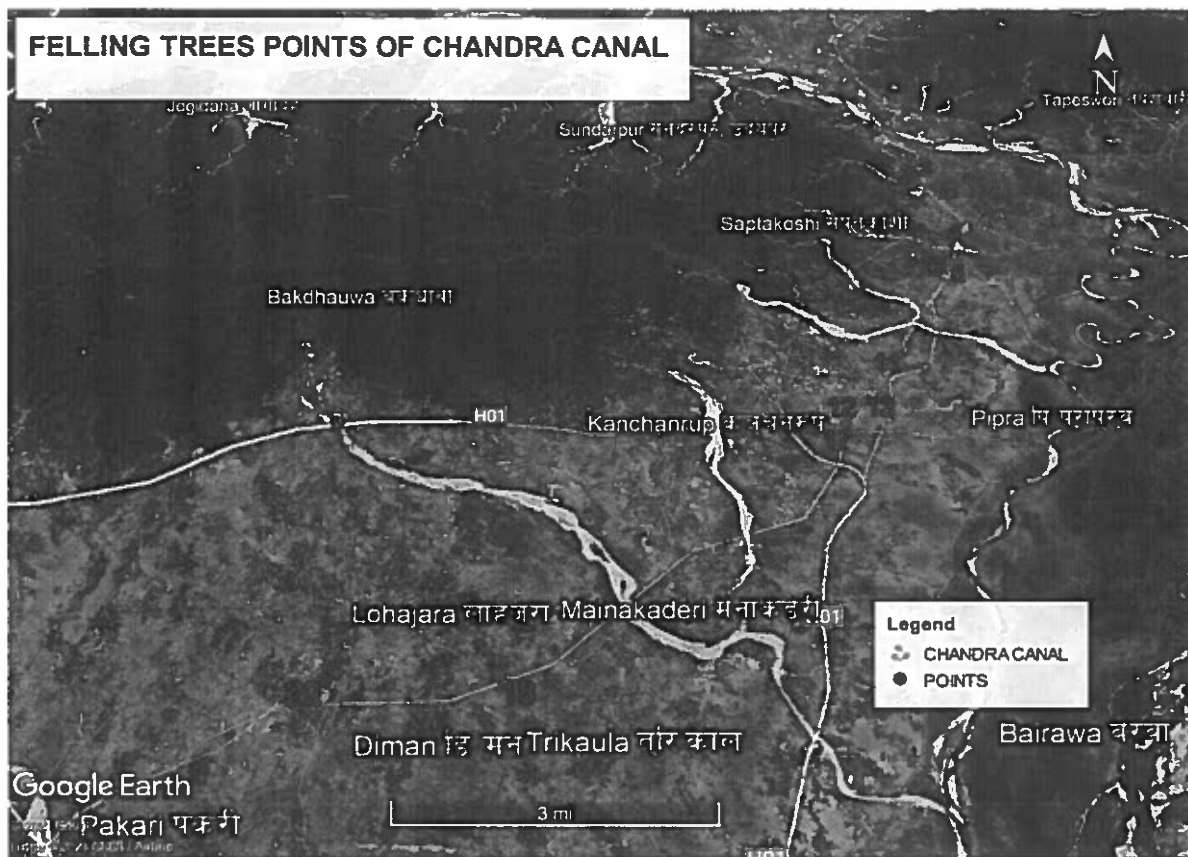
| S N | Species | X-Coordinate | Y-coordinate | Girth (cm?) | Height (m) | Grade | Palika | Photo  | Remarks |
|-----|---------|--------------|--------------|-------------|------------|-------|--------|--|---------|
| 21  | Aap     | 481720       | 2940611      | 185         | 10         | 2     |        |   |         |
| 22  | Kadam   | 481718       | 2940610      | 65          | 6          | 3     |        |  |         |

Note: Grade of a tree is defined as the quality of tree, quality of stem and quantity of timber obtained from particular tree under 3 categories (1,2 and 3) as per the bylaws of Government of Nepal (Forest Regulations, 2051 BS).

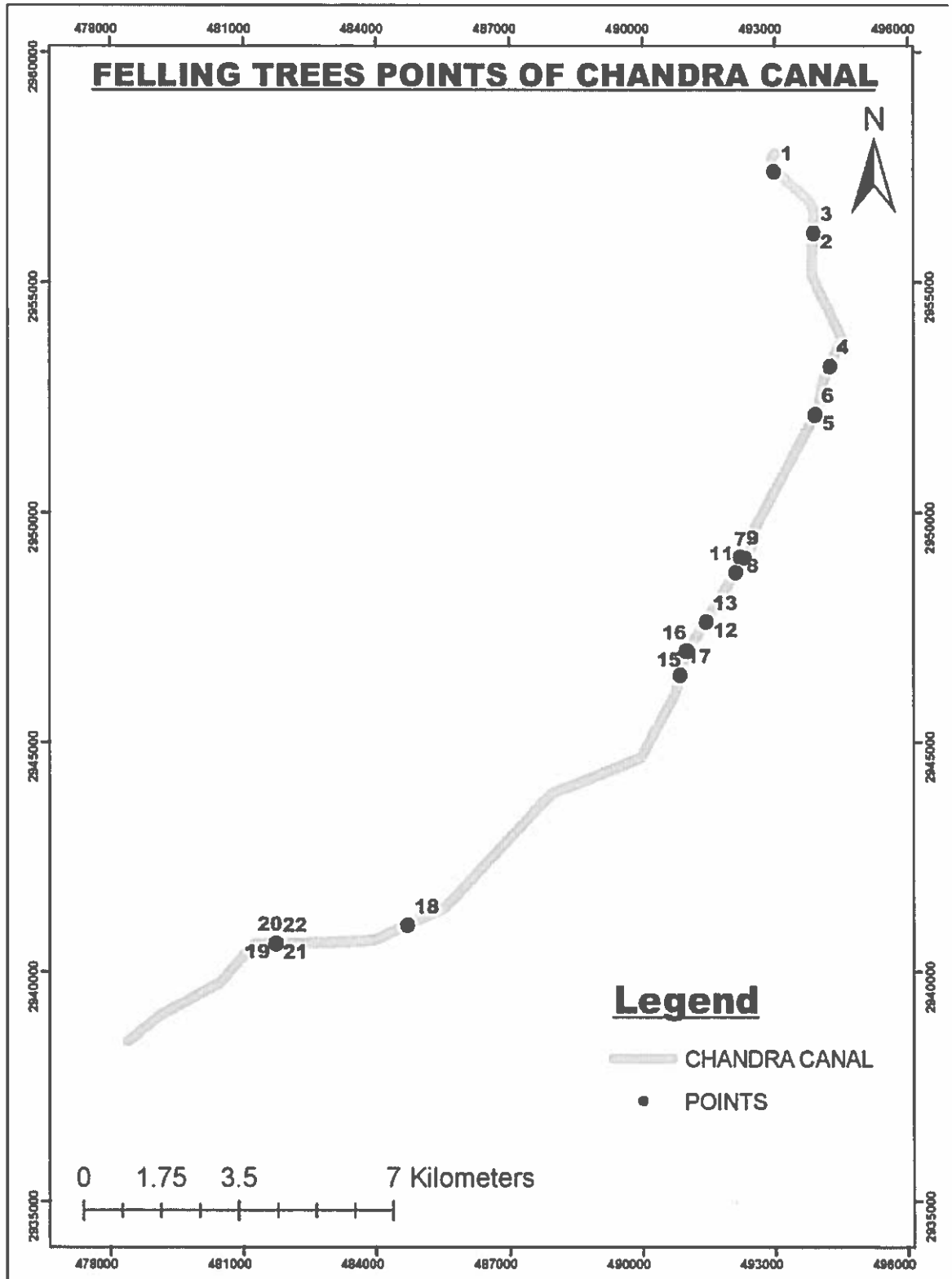



**Annex 3: Location maps of the affected trees**





ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area



**Annex 4: Details of the Losses and Compensation**



## Replacement Cost Calculation of Losses and compensation for Chandra Nahar Irrigation System

A method of valuation of assets (including land, shelter, , structures, trees, etc.) that helps determine the amount of compensation sufficient to replace lost assets, covering transaction costs, which may include taxes, fees, transportation, labor, etc.

With regard to land and structures, "replacement cost" is defined as follows:

For agricultural land, it is the pre-project or pre-displacement, whichever is higher, market value of land of equal productive potential or use located in the vicinity of the affected land, plus the cost of preparing the land to levels similar to those of the affected land, plus the cost of any registration and transfer taxes.

For houses and other structures, it is the market cost of the materials to build a replacement structure with an area and quality similar to or better than those of the affected structure, or to repair a partially affected structure, plus the cost of transporting building materials to the construction site, plus the cost of any labor and contractors' fees, plus the cost of any registration and transfer taxes. In determining the replacement cost, depreciation of the asset and the value of salvage materials are not taken into account, nor is the value of benefits to be derived from the project deducted from the valuation of an affected asset.

Resettlement The RAP, in accordance with JICA's Guidelines for Environmental and Social Considerations and World Bank's Operational Policy on Involuntary Resettlement (OP 4.12), covers the involuntary taking of land that results in (i) relocation or loss of shelter, (ii) loss of assets or access to assets; or (iii) loss of income sources or means of livelihood, whether or not the affected persons must move to another location.

The valuation of losses for compensation is based on the above understandings of replacement cost. The cost of the compensation is based on the actual transaction records at site and addition of all the above benefits. Each of the land and structures to be compensated are calculated on the item wise basis for material (inclusive of additional allowances and labor). The calculations for compensation determination are shown in an item wise basis.



**Basis of Calculations:**

Construction of 10 feet X12 feet shop with CGI sheet and other features as per site conditions




| S.N          | Particulars              | Quantity Required | Unit Rate(Rs) | Total (Rs)       | Remarks               |
|--------------|--------------------------|-------------------|---------------|------------------|-----------------------|
| 1            | 3 " pole                 | 2 no              | 3000.00       | 6000.00          | 6 meter long          |
| 2            | 1 ½" pipe                | 8 no              | 1100.00       | 8800.00          | " "                   |
| 3            | 1" iron bar              | 2 no              | 1000.00       | 2000.00          |                       |
| 4            | Angle 1 ½"               | 1 no              | 1000.00       | 1000.00          |                       |
| 5            | CGI roofing              | 13 piece          | 2000.00       | 26000.00         | 7 foot long CGI sheet |
| 6            | CGI sheet to use in wall | 18 piece          | 2000          | 36000.00         |                       |
| 7            | For flooring<br>Cement   | 10 bags           | 800.00        | 8000.00          |                       |
|              | Sand                     | 1 trip            | 12000.00      | 12000.00         |                       |
| 8            | Miscellaneous item       | LS                |               | 5000.00          |                       |
| 9            | Labor                    |                   |               | 30000.00         |                       |
| <b>Total</b> |                          |                   |               | <b>136600.00</b> |                       |

Tentative 1 square feet construction with material and labor = Rs 1150.00. The proposed compensation are higher than the replacement cost.

**Annex 4: Details of the Impacts from the Site**





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| SN | Facility/Location | Details  | Cost (NRs.)  | Photographs   |
|----|-------------------|--|--|---|
| 1  | CCB01/ Saptakoshi | Need to cut branch of Pipal ( <i>Ficus religiosa</i> ) tree<br>(26°44'16.32"N, 86°55'45.79"E)            | NRs. 3000.00   |    |
|    |                   | Need relocation of Electric pole of NEA for securing appropriate width<br>(26°44'19.26"N, 86°55'49.25"E) | NRs. 10,000 (Including purchase, uprooting, trenching and installation of the electric pole) |   |
| 2  | CCB02/ Saptakoshi | Relocation of the electric pole of NEA<br>(26°44'09.4"N, 86°55'58.32"E)                                  | NRs. 10,000 (Including purchase, uprooting, trenching and installation of the electric pole) |  |






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| SN | Facility/Location | Details   | Cost (NRs.)  | Photographs  |
|----|-------------------|---|--|--|
|    |                   | Relocation of the Nepal Telecom optical cable<br>(26°44'09.1"N, 86°55'57.8"E) | NRs. 5,000 (For the temporary mgmt. of the cable)  |   |
| 3  | CCB03/ Saptakoshi | Relocation of 1 electric pole of NEA<br>(26°44'16.32"N, 86°55'45.79"E)        | NRs. 10,000 (Including purchase, uprooting, trenching and installation of the electric pole) |  |







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| SN | Facility/Location | Details  | Cost (NRs.)  | Photographs  |
|----|-------------------|--|--|--|
| 4  | DC01/ Saptakoshi  | 2 animal sheds, 1 hen coop and 8 banana trees of Mr. RajendraSada needs relocation. (26°43'44"N, 86°56'19.7"E) | 2 Animal shed= NRs. 100,000<br>1 Hen coop= NRs. 5,000<br>8 banana trees= NRs. 8,000<br>1 pump = 20,000 |   |
| 5  | DC02/ Saptakoshi  | 1 cattle shed and 1 straw mound of the IndraBahadurBista needs relocation (26°43'23.9"N, 86°56'18.6"E)         | 1 cattle shed= NRs. 76800.00 (64 sq foot @Rs 1200/square foot)<br>1 straw mound= Nrs. 10,000.00        |  |
|    |                   | 1 hen coop needs relocation (26°43'23.9"N, 86°56'18.6"E)   | 1 hen coop (20 square foot @ Rs 1200/sq foot) =NRs. 24000.00   |  |

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| SN | Facility/Location | Details  | Cost (NRs.)  | Photographs   |
|----|-------------------|--|--|---|
|    |                   | 1 buffalo shed of Surya Bahadur Bista needs relocation<br>(26°43'24.1"N, 86°56'18.5"E) | 1 buffalo shed (120 sq foot @ Rs 1200/sq foot = NRs. 144000.00 |    |
|    |                   | 12 banana and 1 citrus trees needs to be cleared away                                  | 12 banana trees= NRs. 12,000<br>1 citrus tree= NRs. 20,000     |   |
|    |                   | 5 trees on the canal alignment needs relocation  | 5 trees=NRs. 198,000   |  |

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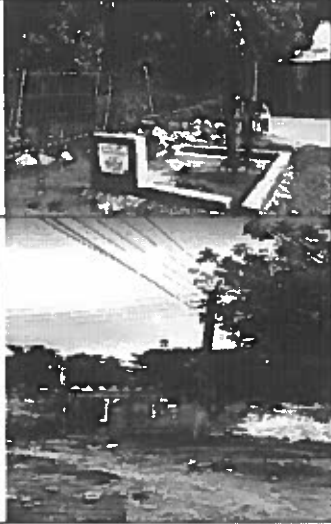
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| SN | Facility/Location | Details  | Cost (NRs.)  | Photographs   |
|----|-------------------|--|--|---|
| 6  | CCB10/ Saptakoshi |  |  |   |
| 7  | DC03/ Saptakoshi  | 1 Moringa tree, 14 banana trees, 1 clump of bamboos and 2 rice straw mound gets affected   | 1 trees=NRs. 39,720<br>14 banana trees= NRs. 14,000<br>1 clump bamboo= NRs. 5,000<br>2 rice straw mound = 14,000     |    |
| 8  | IS01/ Saptakoshi  | 1 tree on the outlet of the siphon gets affected   | 1 tree= NRs 39,600   |   |
| 9  | IS02/Saptakoshi   | A tree impacted that is on the non-title holding land near the birth center (26°41'24.5"N, 86°56'20"E) 2 wooden poles needs relocation | Cost of acquisition of 0.11 ha of land =NRs. 1,100,000<br>Cost of tree=39,600<br>Cost of 2 wooden poles= NRs. 16,000 |  |
| 10 | CCB12/ Kanchanrup |  |  |   |
| 11 | IS03/ Kanchanrup  | Elephant corridor to be secured for Asian elephants coming through the KoshiTappu wildlife reserve (26°40'20.9"N, 86°55'40.6"E)        | Included in Contractor document  |   |
| 12 | CCB14/ Kanchanrup | (26°40'02.5"N, 86°55'29.6"E)   |  |   |





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| SN | Facility/Location | Details   | Cost (NRs.)  | Photographs  |
|----|-------------------|---|--|--|
| 13 | CCB15/ Kanchanrup | 1 mango tree and well needs to be relocated<br>(26°39'43.9"N, 86°55'20.3"E)             | Mango tree = NRs. 39,600<br><br>Hand Pump= NRs. 20,000                                       |  |
|    |                   | 1 electric pole of NEA with cable needs relocation<br>(26°39'43.5"N, 86°55'20.6"E)      | NRs. 10,000 (Including purchase, uprooting, trenching and installation of the electric pole) |  |
| 14 | CCB16/ Kanchanrup | 1 electric pole of NEA needs relocation with Pipal tree<br>(26°39'33.2"N, 86°55'14.8"E) | NRs. 10,000 (Including purchase, uprooting, trenching and installation of the electric pole) |  |
| 15 | IS04/ Kanchanrup  |   |  |  |
| 16 | DC05/ Kanchanrup  | N/A   |  |  |



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| SN | Facility/Location | Details   | Cost (NRs.)  | Photographs  |
|----|-------------------|---|--|--|
| 17 | CCB18/ Kanchanrup | Movable vendor shop on left side of canal of Mr. UmeshRaut needs relocation<br>(26°38'36.5"N, 86°54'34.5"E) | Vendor Shop (approximately 96 sq foot @ Rs 1200/sq foot= NRs 115200.00 |  |






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| SN | Facility/Location | Details  | Cost (NRs.)   | Photographs   |
|----|-------------------|--|---|---|
|    |                   | Movable vendor shop on left side of canal of Mr. SantoshSah needs relocation<br>(26°38'36.6"N, 86°54'34.7"E) | Vendor Shop (approximately 40 sq foot @Rs 1200/square foot= NRs. 48000.00 |   |
|    |                   | Movable vendor shop on right side of canal of Mr. BauwaRaut needs relocation<br>(26°38'37.3"N, 86°54'33.4"E) | Vendor Shop (approximately 36 square foot @Rs 1200/s foot= NRs. 43200.00  |  |

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| SN | Facility/Location | Details   | Cost (NRs.)                     | Photographs   |
|----|-------------------|---|---------------------------------|---|
|    |                   | Community well on the left side of the canal needs relocation<br>(26°38'37.3"N, 86°54'34.6"E)         | Hand pump = NRs. 20,000         |   |
|    |                   | Relocation of the electric pole near the vendor shop of Mr. UmeshRaut<br>(26°38'36.5"N, 86°54'34.5"E) | Two electric pole = NRs. 20,000 |  |

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| SN | Facility/Location | Details  | Cost (NRs.)  | Photographs  |
|----|-------------------|--|--|--|
| 18 | CCB19/ Kanchanrup | Movable vendor shop on left side of canal of Mr. BhuwanThapa needs relocation (26°38'20.2"N, 86°54'28.3"E) | Vendor Shop (approximately 36 sq foot= NRs. 43200 00 |  |
| 19 | DC06/ Kanchanrup  | N/A  |  |  |
| 20 | CCB21/ Kanchanrup | N/A  |  |  |
| 21 | IS05/ Kanchanrup  | N/A  |  |  |
| 22 | DC07/ Tirahut     | N/A  |  |  |
| 23 | DC08/ Tirahut     | N/A  |  |  |
| 24 | IS06/ Tirahut     | N/A  |  |  |






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| SN | Facility/Location | Details   | Cost (NRs.)   | Photographs   |
|----|-------------------|---|---|---|
| 25 | CCB24/ Tirahut    | Movable vendor shop on left side of canal of Ms. Sitadevi needs relocation<br>(26°36'02.7"N, 86°51'46.5"E)      | Vendor Shop= (approximate 48 sq foot @ Rs 1200/square foot) = NRs. 57600.00 |   |
|    |                   | Movable vendor shop on left side of canal of Mr. Narayan Khang needs relocation<br>(26°36'02.8"N, 86°51'46.5"E) | Vendor Shop= (36 square foot) @ Rs 1200/square foot = NRs. 43200.00         |  |

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| SN | Facility/Location | Details   | Cost (NRs.)  | Photographs  |
|----|-------------------|---|--|--|
|    |                   | Movable vendor shop on left side of canal of Mr. BihariMukhiya needs relocation<br>(26°36'02.9"N, 86°51'46.5"E) | Vendor Shop (approximate 42 square foot) = NRs. 50400.00 |   |
|    |                   | Movable vendor shop on left side of canal of Mr. DabudMiyan needs relocation<br>(26°36'03"N, 86°51'46.5"E)      | Vendor Shop (42 square foot)= NRs. 50400.00              |  |

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| SN | Facility/Location | Details   | Cost (NRs.)   | Photographs   |
|----|-------------------|---|---|---|
|    |                   | House and store on the right side of the canal of Mr. Jiwamukhiya needs relocation (26°36'03.3"N, 86°51'45.9"E) | Cost of House + store (100 square foot) = 120000.00 |   |
| 26 | DC09/ Tirahut     | N/A   |   |   |
| 27 | CCB25/ Tirahut    | N/A   |   |   |
| 28 | CCB26/ Tirahut    | Electric pole on the right side of the canal needs relocation (26°35'24.1"N, 86°50'47.2"E)                      | Electric pole = NRs. 10,000                         |  |

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ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area

| SN | Facility/Location               | Details  | Cost (NRs.)  | Photographs   |
|----|---------------------------------|--|--|---|
| 29 | IS07/ Agnisair Krishna Savaran  | Hand Pump on the premise of the movable vendor shop and kitchen of Mr. RamanandaYadav needs relocation<br>26°35'10.2"N, 86°49'04.7"E | Pump = NRs. 20,000<br>Vendor shop (72 square foot= NRs. 86400.00<br>Kitchen (25 sq foot) = NRs. 30,000 |   |
| 30 | CCB29/ Agnisair Krishna Savaran | Cattle shed and movable vendor shop of MrRajkumarYadav needs to be relocated<br>(26°35'10.03"N, 86°48'59.58"E)                       | Vendor and cattle shed (120 sq foot = NRs) = Rs. 144000  |  |


*Qe* *A.S*

ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area

| SN | Facility/Location | Details  | Cost (NRs.)                                     | Photographs   |
|----|-------------------|--|---|---|
|    |                   | Movable vendor shop of Mr. Ram bhajanYadav needs relocation (26°35'10.09"N, 86°48'59.21"E) | Vendor shop (36 square foot)= NRs. 43200.00     |   |
|    |                   | An electric pole of NEA needs relocation   | Electric pole = NRs. 10,000                     |   |
|    |                   | 1 mango, 3 papaya and 2 local trees needs to be cleared away.                              | 3 tree = 118,800<br>3 papaya trees = NRs. 3,000 |  |

*De* *A.O*

ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area

| SN | Facility/Location                 | Details   | Cost (NRs.)       | Photographs  |
|----|-----------------------------------|---|-------------------|--|
| 31 | IS08/ Agnisair Krishna Savaran    | N/A   |                   |  |
| 32 | DC11/<br>Agnisair Krishna Savaran | 3 trees on the left side of the canal<br>needs cleared away | 3 trees = 118,800 |  |

*De.*

*A.S.*

*ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area*

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**Hearing of IEE Report of Chandranahar IP, Saptari, Nepal**

ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area

**Executive Summary of Consultation Meetings- Public Hearing of IEE Report of Chandranahar IP, Saptari, Nepal**

| SN | Date          | Venue  | Name of organizations interviewed/ participated                                      | Number of participants |      |        | Key Agenda   | Reference Number | Remarks              |
|----|---------------|--|--|------------------------|------|--------|--|------------------|----------------------|
|    |               |  |  | Total                  | Male | Female |  |                  |                      |
| 1  | 2021 April 09 | Koshi Tappu Wildlife Reserve Office                | Koshi Tappu Wildlife Reserve (KTWR) Chief Warden, Chairman of Buffer zone user group | 2                      | 1    | 0      | Brief about the preparatory of Chandra Nahar, concern and opinion of reserve, any prevention measures, rule and regulation of reserve and organogram of Koshi Tappu Wildlife reserve |                  | Consultation meeting |
| 2  | 2021 April 10 | Buffer Zone office of Koshi Tappu Wildlife Reserve | Ranger of Buffer Zone of KTWR, Cheirman of Buffer zone user group                    | 1                      | 1    | 0      | Brief about the preparatory of Chandra Nahar, concern and opinion of reserve, any prevention measures, rule and regulation of reserve and organogram of Koshi Tappu Wildlife reserve |                  | Consultation meeting |
| 3  | 2021 April 12 | Home of Chairman                                   | PurbaPipra-Dharampur-GhoganPur Buffer Zone User Committee (Western)                  | 1                      | 1    | 0      | Brief about the preparatory of Chandra Nahar, stakeholder's concern and opinion as much as possible. Any mitigation measures or prevention measures to the project proponent.        |                  | Consultation meeting |

Handwritten signatures and initials, including a circular stamp with 'V.S.' and a signature 'A.V.'.

ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area

| SN | Date          | Venue                                  | Name of organizations interviewed/ participated | Number of participants |      |        | Key Agenda   | Reference Number | Remarks              |
|----|---------------|--|---|------------------------|------|--------|--|------------------|----------------------|
|    |               |  |   | Total                  | Male | Female |  |                  |                      |
| 4  | 2021 April 21 | Ranger Office, Sitapur                 | District Forest Office, Rajbira, Saptari        | 1                      | 1    | 0      | Brief about the survey of Chandra Nahar rehabilitation project, Tree cutting and plantation  |                  | Consultation meeting |
| 5  | 2021 April 21 | Postal Highway Project Office, Itahari | Postal Highway Project Office                   | 1                      | 1    | 0      | Brief about the survey of Chandra Nahar rehabilitation which is besides the Postal Highway, Construction status of the Postal Highway, Construction Period, Construction Company and Fund (Construction), Reason behind the time extension of construction period, Concrete plant yard rent, Drawing of the road project, DPR, IEE and Cadastral Map, Disposal site, Quarry site, Cutting tree |                  | Consultation meeting |

## ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area

| SN | Date         | Venue                             | Name of organizations Interviewed/ participated | Number of participants |      |        | Key Agenda  | Reference Number | Remarks |
|----|--------------|-----------------------------------|---|------------------------|------|--------|---|------------------|---------|
|    |              |                                   |   | Total                  | Male | Female |   |                  |         |
| 6  | 2021 July 07 | Gangajali-4, Saptakoshi Na Paa.   | Province Member of Province 2                   | 1                      | 1    | 0      | commitment to support to rehabilitation of this project, reduce the deforestation in catchment area, Bridge reconstruction and make wide, Drainage Mixed in the canal should be stopped |                  | KII     |
| 7  | 2021 July 08 | Kanchanrup Na Paa                 | ward Adhyaksha                                  | 1                      | 1    | 0      | Focused on regular maintainance   |                  | KII     |
| 8  | 2021 July 08 | Saptakoshi Na Paa                 | Mayor, Saptakoshi Municipality                  | 1                      | 1    | 0      | consideration of time and deadline for project completion, access road for canal, drainage and pollution reduction  |                  | KII     |
| 9  | 2021 July 09 | Saptakoshi Na.Paa-1, Fattepur     | Ward President, ward no 1                       | 1                      | 1    | 0      | relocation of the affected household should managed during the construction   |                  | KII     |
| 10 | 2021 July 09 | Kanchanrup Na. Paa -6, Ghoghanpur | Main Officer, Kanchanrup municipality           | 1                      | 1    | 0      | Focused on the coordination with local stakeholder  |                  | KII     |
| 11 | 2021 July 09 | Telecom-Fattepur sub Branch       | linemen TelecomFattepur sub Branch              | 1                      | 1    | 0      | priority should be given to optical fiber during rehabilitation   |                  | KII     |

ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area

| SN | Date         | Venue                         | Name of organizations interviewed/ participated                     | Number of participants |      |        | Key Agenda  | Reference Number | Remarks |
|----|--------------|-------------------------------|---|------------------------|------|--------|---|------------------|---------|
|    |              |                               |   | Total                  | Male | Female |   |                  |         |
| 12 | 2021 July 10 | Kanchanrup Na. Paa            | Mayor, kanchanrup municipality                                      | 1                      | 1    | 0      | Emphasis the on the coordination during the rehabilitation, concern about human wildlife conflict   |                  | KII     |
| 13 | 2021 July 10 | Kanchanrup Na. Paa            | Nimitta Administration Officer                                      | 1                      | 1    | 0      | Focused on the plantation ad conservation of wildlife.  |                  | KII     |
| 14 | 2021 July 10 | Kanchanrup Na Paa -Kanchanpur | Khandar   | 1                      | 1    | 0      | Focused on regular maintainance   |                  | KII     |
| 15 | 2021 July 10 | Koshi Pamp Nahar Irmgation    | Branch Office Head, Nepal Bidhyut                                   | 1                      | 1    | 0      | The cost to relocate of pole shoule be eared by project   |                  | KII     |
| 16 | 2021 July 10 | Tirahut Ga Paa - 2            | Engineer  | 1                      | 1    | 0      | Focused on emproved of agriculture production   |                  | KII     |
| 17 | 2021 July 07 | Saptakoshi Municipality,      | Women group, water user association, vegitable seller group         | 47                     | 28   | 19     | Water distribution should be equal, local worker should be prioritized during rehabilitation, Agriculture program should be launch along with rehabilitation of canal |                  | FGD     |
| 18 | 2021 July 08 | Kanchanrup Municipality,      | Women group, water user association, vegitable seller group, muslim | 25                     | 21   | 4      | Demand of skill development training  |                  | FGD     |

*Cye* *A.O*

ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area

| SN | Date         | Venue                              | Name of organizations interviewed/ participated   | Number of participants |      |        | Key Agenda  | Reference Number | Remarks        |
|----|--------------|------------------------------------|---|------------------------|------|--------|---|------------------|----------------|
|    |              |                                    |   | Total                  | Male | Female |   |                  |                |
| 19 | 2021 July 09 | Rajbiraj                           | District Forest Rajbiraj  | 3                      | 3    | 0      | focused on the reduction of environmental impact and river protection   |                  | FGD            |
| 20 | 2021 July 09 | Pathan                             |   | 4                      | 4    | 0      | People concerned about the human wildlife conflict and agriculture promotion  |                  | FGD            |
| 21 | 2021 July 09 | Tirahut Municipality               | Women group and male group  | 6                      | 6    | 0      | Focused on regular maintainance   |                  | FGD            |
| 22 | 2021 July 10 | Agnisair Municipality              |   | 7                      | 7    | 0      | Focused on agricultural promotion program   |                  | FGD            |
| 23 | 2021 July 10 | Rajbiraj                           |   | 6                      | 6    | 0      | People thought rehabilitation is necessary  |                  | FGD            |
| 24 | 2021 Sept 28 | Saptakoshi Municipality, Ward no 4 | Mayor, chariman of ward no 4, NGO representative, local leaders, Water Users Association (WUA) Chairperson, Health Post, affected communities of the RM, representatives of political parties, local school teachers, representative from DoWRI, Koshi Pump Chandra | 66                     | 31   | 35     | Disclosure of the IEE report (Methodology, baseline information, likely impacts and issues, proposed mitigation measures etc), collection of feedback and suggestions from the participants |                  | Public Hearing |

ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area

| SN | Date         | Venue                                     | Name of organizations interviewed/ participated   | Number of participants |      |        | Key Agenda  | Reference Number | Remarks        |
|----|--------------|---|---|------------------------|------|--------|---|------------------|----------------|
|    |              |   |   | Total                  | Male | Female |   |                  |                |
|    |              |   | Nahar Irrigation Management Office, Local Businessman.  |                        |      |        |   |                  |                |
| 25 | 2021 Sept 28 | Tirhut Rural Municipality (RM), Ward no 3 | Tiruhath RM (Chairperson), Tiruhath RM affected Wards (Chairperson), local leaders, Water Users Association (WUA) Chairperson, Health Post, affected communities of the RM, representatives of political parties, local school teachers | 36                     | 34   | 2      | Disclosure of the IEE report (Methodology, baseline information, likely impacts and issues, proposed mitigation measures etc), collection of feedback and suggestions from the participants |                  | hers           |
| 26 | 2021 Sept 28 | Kanchanrup Municipality, Ward no 7        | Mayor of Kanchanrup municipality, deputy mayor of Kanchanrup municipality, ward chairman of ward 6, and 7, local people, business man, School Teachers, environment expert from DoWRI   | 46                     | 34   | 12     | Disclosure of the IEE report (Methodology, baseline information, likely impacts and issues, proposed mitigation measures etc), collection of feedback and suggestions from the participants |                  | Public Hearing |

ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area

| SN | Date         | Venue  | Name of organizations interviewed/ participated   | Number of participants |      |        | Key Agenda  | Reference Number | Remarks        |
|----|--------------|--|---|------------------------|------|--------|---|------------------|----------------|
|    |              |  |   | Total                  | Male | Female |   |                  |                |
| 27 | 2021 Sept 28 | Agnisar Krishnasabaran Rural Municipality, Ward no 4 | Agnisar Krishnasabaran Rural Municipality (Chairperson of the affected Wards), affected communities of the Agnisar Krishnasabaran Rural Municipality, local leaders, local school teachers, Health Post, representatives of political parties, Koshi Pump Chandranahar Irrigation Management Office, Department of Water Resources and Irrigation | 48                     | 42   | 6      | Disclosure of the IEE report (Methodology, baseline information, likely impacts and issues, proposed mitigation measures etc), collection of feedback and suggestions from the participants |                  | Public Hearing |
| 28 | 2021 Sept 29 | Mahadeva Rural Municipality, Ward no 1               | Mahadeva Rural Municipality (Chairperson of the affected Wards), Division Forest Office (DFO), Health Post, local leader, local school teachers, representatives of political parties, affected communities of the  | 29                     | 28   | 1      | Disclosure of the IEE report (Methodology, baseline information, likely impacts and issues, proposed mitigation measures etc), collection of feedback and suggestions from the participants |                  |                |

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ARAP for the Preparatory Survey for the Project for Rehabilitation of Chandra Nahar Irrigation System in Eastern Terai Area

| SN | Date         | Venue                                     | Name of organizations interviewed/ participated      | Number of participants |      |        | Key Agenda  | Reference Number | Remarks              |
|----|--------------|---|--|------------------------|------|--------|---|------------------|----------------------|
|    |              |   |  | Total                  | Male | Female |   |                  |                      |
|    |              |   | Mahadeva Rural Municipality and Rajbira Municipality |                        |      |        |   |                  |                      |
| 29 | 2021 Sept 27 | Koshitappu Wildlife Reserve (KTWR) Office | Koshitappu Wildlife Reserve (KTWR) Chief Warden      | 1                      | 1    | 0      | Sharing key issues and findings of the IEE report related to biological environment, sharing of the proposed mitigation measures of likely biological impact, Disclosure of the IEE report, informing about the public hearing and handing over the invitation letter, suffix of the public notice in KYWR office, invitation to the public hearing |                  | Consultation meeting |

Note: IEE: Initial Environmental Examination, WUA: Water Users Association, KTWR: Koshi Tappu Wildlife Reserve, DFO: Division Forest Office, RM: Rural Municipality.

Annex10

**Environmental Monitoring Form**

**Monthly Environmental Monitoring Form**

Site Environmental Compliance Inspection and Monitoring Form

Form-1 for Pre-Construction Phase

Provided below is a sample form which may be utilized and adapted as needed to record the results of a compliance inspection or ambient monitoring at a project site. DWRI submits this monitoring form to DD/SV consultant and JICA monthly and quarterly respectively.

**Project Name** : Project for Rehabilitation of Irrigation System in Federal Democratic Republic of Nepal      **Implementing Agency** : DWRI

**Location** : Saptari district      **Monitoring Agency** : N/A

**Date Reported** : DD/MM/YYYY      **Enforcement Agency** : DWRI / CDC

**Reporting Period** : XX Quarter of YYYY

(Monthly)

**1. Project Proponent**

| DWRI's Environmental Awareness         | Yes/No | Actions required |
|--|--------|------------------|
| DWRI aware of mitigation requirements? |        |                  |
| DWRI has a copy of EMP?                |        |                  |

Handwritten signatures and initials, including a large 'Q' and 'A.O.'.

Annex 10

**2. Land Acquisition and Compensation**

| Resettlement Activities   | Planned Total | Unit  | Progress in Quantity |               | Expected date of completion | Responsible organization |
|---|---------------|-------|----------------------|---------------|-----------------------------|--------------------------|
|   |               |       | Progress as of _____ | Issues if any |                             |                          |
| <b>1 Set up of RAP Implementation Structure</b>   |               |       |                      |               |                             |                          |
| 1-1 Formation of Compensation Determination Committee   |               | Times |                      |               |                             | DWRI                     |
| 1-2 Appointment of social environmental officer from DWRI   |               | Times |                      |               |                             | DWRI                     |
| 1-3 Key stakeholders such as Municipalities, DFO, WUA, CDC are informed about RAP schedule          |               | Times |                      |               |                             | DWRI                     |
| 1-4 Kickoff meeting with DWRI and CDC   |               | Times |                      |               |                             |                          |
| <b>2. Update PAPs list and Final Asset Valuation</b>  |               |       |                      |               |                             |                          |
| 2-1 Identification of final PAHs  |               | PAHs  |                      |               |                             | DWRI                     |
| 2-2 Announcement to affected people   |               | times |                      |               |                             | DWRI                     |
| 2-3 Final Asset Valuation   |               | Times |                      |               |                             | DWRI                     |
| 2-4 Consultation meeting  |               | times |                      |               |                             | DWRI                     |
| 2-5 Revise RAP and signing compensation agreement based on the feedback at the consultation meeting |               | set   |                      |               |                             | DWRI                     |
| <b>3 Progress of paying compensation</b>  |               |       |                      |               |                             |                          |
| 3-1. PAHs in ROW  |               | PAHs  |                      |               |                             | DWRI                     |
| 3-2. PAHs outside of ROW (Concrete plant yard)  |               | PAHs  |                      |               |                             | DWRI                     |
| 3-3. PAHs outside of ROW (Canal alignment CUP-02)   |               | PAHs  |                      |               |                             | DWRI                     |
| <b>4 Progress of evacuation from the site</b>   |               |       |                      |               |                             |                          |
| 4-1. PAHs in ROW  |               | PAHs  |                      |               |                             | DWRI                     |
| 4-2. PAHs outside of ROW (Concrete plant yard)  |               | PAHs  |                      |               |                             | DWRI                     |
| 4-3. PAHs outside of ROW (Canal alignment CUP-02)   |               | PAHs  |                      |               |                             | DWRI                     |
| <b>5 Progress of relocation of obstacles</b>  |               |       |                      |               |                             |                          |
| 5-1. Electric poles and wires   |               | Pcs   |                      |               |                             | DWRI                     |
| 5-2. Optic fibre cable  |               | Pcs   |                      |               |                             | DWRI                     |
| 5-3. Cutting trees and replanting   |               | Pcs   |                      |               |                             | DWRI                     |
| 5-4. Others if any  |               | Pcs   |                      |               |                             | DWRI                     |
| <b>6. Construction of alternative facilities</b>  |               |       |                      |               |                             |                          |
| 6-1 Shallow well  |               | Pcs   |                      |               |                             | DWRI                     |
| <b>7. Complain and Grievance Redress</b>  | N/A           | Cases |                      |               |                             |                          |
| 7-1 Nos of solved cases by committee  | N/A           | Cases |                      |               |                             | DWRI                     |
| 7-2 Nos. of unsolved cases by committee   | N/A           | Cases |                      |               |                             | DWRI                     |

**3. Record of Complain and Grievance Management**

| No | Date | Complain and Grievance from PAPs | Solution / Result / Any actions to be taken |
|----|------|----------------------------------|---|
|----|------|----------------------------------|---|

Annex10

|   |  |  |  |
|---|--|--|--|
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 4 |  |  |  |

4. Notes;

Inspected by: \_\_\_\_\_

Date: \_\_\_\_\_

*Qe*      *AO*

Annex10

**Monthly Environmental Monitoring Form**

Site Environmental Compliance Inspection and Monitoring Form

**Form-2 for Construction Phase**

Provided below is a sample form which may be utilized and adapted as needed to record the results of a compliance inspection or ambient monitoring at a project site. Contractor submits this monitoring form to DD/SV consultant and JICA monthly and quarterly respectively.

|                         |          |  |                            |          |                       |
|-------------------------|----------|--|----------------------------|----------|-----------------------|
| <b>Project Name</b>     | <b>:</b> | <b>Project for Rehabilitation of Irrigation System in Federal Democratic Republic of Nepal</b> | <b>Implementing Agency</b> | <b>:</b> | <b>DWRI</b>           |
| <b>Location</b>         | <b>:</b> | <b>Saptari district</b>  | <b>Monitoring Agency</b>   | <b>:</b> | <b>NA</b>             |
| <b>Date Reported</b>    | <b>:</b> | <b>DD/MM/YYYY</b>  | <b>Enforcement Agency</b>  | <b>:</b> | <b>Contractor(s)</b>  |
| <b>Reporting Period</b> | <b>:</b> | <b>XX Month of YYYY</b>  | <b>Contractor(s)</b>       | <b>:</b> | <b>XXXX Co., Ltd.</b> |

**(Monthly)**

**1. Mitigation Compliance Inspection**



Annex10

| Impact / Mitigation Measures (From EMMP)  | Mitigations Implemented? (Yes/No) | Mitigation Effective? (Yes/No) | Impact Observed/ Location | Action Required? (Yes/No) Describe if Yes: | Any remarks |
|---|-----------------------------------|--------------------------------|---------------------------|--|-------------|
| - Community is aware of construction schedule   |                                   |                                |                           |  |             |
| - Community is aware of contact address of complain and grievance redress mechanism                           |                                   |                                |                           |  |             |
| - A sign of machine trouble (abnormal noise, vibration, white/dark smoke, etc.) are not observed              |                                   |                                |                           |  |             |
| - Water is sprinkled before on the dirt / unpaved road against dust   |                                   |                                |                           |  |             |
| - Moisture is given to the facilities before demolition as needed   |                                   |                                |                           |  |             |
| - Drip trays are used when refuelling or maintenance  |                                   |                                |                           |  |             |
| - Reuse excavated material as much as possible  |                                   |                                |                           |  |             |
| - Solid waste are disposed at designated dumping site   |                                   |                                |                           |  |             |
| - Temporary fence is installed at construction site where residence or hospitals etc. are adjacent            |                                   |                                |                           |  |             |
| - Necessary protection measures against COVID-19 is implemented (such as wearing masks, put sanitizers, etc.) |                                   |                                |                           |  |             |
| - Safety Assemblage was held for workers  |                                   |                                |                           |  |             |
| - Safety tools (helmet, goggle, glove, etc) are provided to workers   |                                   |                                |                           |  |             |

Handwritten signatures in blue ink, appearing to be initials or names, located at the bottom right of the page.

Annex10

|   |  |  |  |  |  |
|---|--|--|--|--|--|
| - Workers younger than 14/16 years old are not employed                 |  |  |  |  |  |
| - First-aid kits (FAK) are available at all construction sites and yard |  |  |  |  |  |
| - An accident and emergency response manual is available                |  |  |  |  |  |

**2. Water Quality at Outlet of Discharge from Construction Site and Concrete Waste Water**

| Item             | Unit | Baseline Data <sup>*1</sup> |          |                 | Monitoring Result |          |                 | Model of Equipment used | Standards max. Limits <sup>*2</sup> | Action Required (Yes/No) Describe if Yes: | Any remarks |
|------------------|------|-----------------------------|----------|-----------------|-------------------|----------|-----------------|-------------------------|-------------------------------------|---|-------------|
|                  |      | Date                        | Location | Amount measured | Date              | Location | Amount measured |                         |                                     |   |             |
| pH               | -    |                             |          |                 |                   |          |                 | <6.5-8.5 <sup>3</sup>   |                                     |   |             |
| TSS or Turbidity | mg/L |                             |          |                 |                   |          |                 | <50 <sup>4</sup>        |                                     |   |             |

\*1: Range of pH was 7.3 - 7.7 and TSS was 98 - 424 mg/l in baseline survey in 2021  
 \*2: GON. Guidelines for Irrigation Water Quality, 2065  
 \*3: It is recommend that the amount of alkali discharge water from the concrete work site should not exceed 25% to 30% of the canal water flow  
 \*4 In case if TSS of baseline data was already exceed the set standards, the figure measured by baseline data shall be used as maximum tolerance limit.  
 \*5. In case Contractor(s) prefer Turbidity to TSS, the Contractor measure TSS and Turbidity in the Baseline survey and identify the turbidity level at pre-construction stage which shall be used as maximum tolerance limit.

**3. Natural Environment**

| Item  | Monitoring Result |                                 |                             | Action Required (Yes/No) Describe if Yes: | Any remarks |
|---|-------------------|---------------------------------|-----------------------------|---|-------------|
|   | Date              | Mitigations Implemented? Yes/No | If yes, describe in details |   |             |
| KTWR and BZMC is informed of construction schedule/progress regularly |                   |                                 |                             |   |             |

Annex10

|  |  |  |  |  |  |
|--|--|--|--|--|--|
| Workers are trained not to kill/hunt protected wildlife                                    |  |  |  |  |  |
| Passable space for elephant migration is secured   |  |  |  |  | (applicable only when rehabilitate CUP-03) |
| Any wildlife is observed during the construction (species and number of wildlife observed) |  |  |  |  |  |

**4. Record of Complain and Grievance Management**

| No | Date | Complain and Grievance from Communities or other stakeholders | Solution / Result / Any actions to be taken |
|----|------|---|---|
| 1  |      |   |   |
| 2  |      |   |   |
| 3  |      |   |   |
| 4  |      |   |   |

**5. Notes;**

Inspected by: \_\_\_\_\_

Date: \_\_\_\_\_



Annex10

**Biannual Environmental Monitoring Form**

Site Environmental Compliance Inspection and Monitoring Form

Form-3 for Operation Phase

Provided below is a sample form which may be utilized and adapted as needed to record the results of a compliance inspection or ambient monitoring at a project site. DWRI submits this monitoring form to JICA biannually.

**Project Name** : Project for Rehabilitation of Irrigation System in Federal Democratic Republic of Nepal  
**Implementing Agency** : DWRI

**Location** : Saptari district  
**Monitoring Agency** : NA

**Date Reported** : DD/MM/YYYY  
**Enforcement Agency** : DWRI

**Reporting Period** : X th Report in YYYY  
**Contractor(s)** : NA

(Biannual)

**1. Mitigation Compliance Inspection**

Annex10

| Impact / Mitigation Measures (From EMMP)   | Mitigations Implemented? (Yes/No) | Impact Observed/ Location | Action Required? (Yes/No) Describe if Yes: | Any Comment |
|--|-----------------------------------|---------------------------|--|-------------|
| - enlightenment to community not to dispose waste in irrigation canal is conducted         |                                   |                           |  |             |
| -Waste in canal is regularly collected   |                                   |                           |  |             |
| -Wildlife movement especially Asian Elephant is confirmed as it was                        |                                   |                           |  |             |
| -No significant change on wildlife is observed based on hearing from ranger and BZMC, etc. |                                   |                           |  |             |
| -Accident cases are recorded and countermeasures are addressed                             |                                   |                           |  |             |

2. Record of Complain and Grievance Management

| No | Date | Complain and Grievance from Communities or other stakeholders | Solution / Result / Any actions to be taken |
|----|------|---|---|
| 1  |      |   |   |
| 2  |      |   |   |
| 3  |      |   |   |
| 4  |      |   |   |

3. Notes;

Inspection Completed by: \_\_\_\_\_

Date: \_\_\_\_\_

*Qe*

*AG*

## **Appendix-5 Soft Component Plan**



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# **The Preparatory Survey on the Project for Rehabilitation of Irrigation System in Eastern Terai Area in Nepal**

## **Soft Component Plan**

### **Contents**

|  |   |
|--|---|
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| 7. Cost of Soft Component .....  | 5 |
| 8. Obligation of the Government of Nepal .....                                 | 5 |

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## **1. Back ground**

This project aims to improve the efficient and stable utilization of irrigation water by rehabilitating the irrigation canal facilities which are severely deteriorated due to aging in Chandra Nahar Irrigation Scheme, Saptari District, eastern Terai Plain, Nepal. Therefore, the soft component activities are planned to provide technical guidance on maintenance and management work of the rehabilitated Canal Under Pass (CUP), aiming to ensure sustainable and efficient use of the rehabilitated facilities. The background is presented as follows.

### **(1) Background to the technical guidance for the maintenance and management work of CS**

In the Canal Under Pass (CUP) to be rehabilitated in this project, the flow velocity is higher than that in the earthen Canal (open Canal) section, and sediment deposition is relatively low. The flow in the vertical culvert (inflow side) is in the vertical downward direction. The flow in the horizontal culvert has a relatively long flow time, and sediment tends to accumulate in the culvert section. In addition, when trash such as plastic bottles and the like is piled up on the upstream side, it obstructs the flow and reduces the efficiency of irrigation water conveyance. Although this situation can be mitigated through the establishment of a maintenance management system, it is pointed out that, at present, the cleaning of CUPs by the Koshi Pump and Chandra Nahar Irrigation Management Office (hereinafter referred to as the Irrigation Management Office), which is the organization responsible for the operation and maintenance of the trunk canal, is not sufficient.

Therefore, in order to utilize the facilities rehabilitated in this project sustainably and efficiently, it is important to prepare a specific work plan and implementation plan for the removal of trash and sediment around the inflow area of the CS, and to implement regular maintenance and management activities based on the plan.

In addition, this project proposes a form of CS that minimizes sedimentation in the culvert pipe. This format facilitates the maintenance and management of the CS, but the method of maintenance and

management will be changed from the conventional facility. Therefore, it is necessary for the irrigation management office to learn the maintenance and management techniques of the new type of CUP.

## 2. Objective, outcomes and methods for verifying achievement of outcomes

| Result   | Activities  | Method of confirmation of results (indicators)   |
|--|---|--|
| Irrigation management office staff will learn how to properly maintain the CUP after renovation. | Support for irrigation management office to acquire knowledge and skills for maintenance and management of CUPs after rehabilitation. Assist Irrigation Management Office staff in developing draft maintenance work guidelines. Conduct practical work based on the draft maintenance work guidelines. | The percentage of correct answers by participants on the comprehension test pertaining to the knowledge and skills required for maintenance work will be **%. Draft working guidelines for the maintenance of CSs will be developed. Cleaning work will be carried out by the Irrigation Management Office in accordance with the draft work guidelines for the maintenance of CSs |

## 3. Activities

The activities required for the maintenance of the project-granted facilities are mainly as follows.

- a) Daily inspection and repair: Visually inspect the facilities through daily water management operations. If any defects are found, emergency repairs should be made.
- b) Annual Periodic Inspection and Repair: A periodic inspection shall be conducted once every year before the monsoon season by visually inspect the facilities. If any defects are found, repairs shall be carried out. The cleaning of trash attached to the screen and the sediment deposited in the upstream and downstream vertical sections shall be carried out. The cross sectional drainage works will be dredged to remove the accumulated sediment in the cross-sectional small stream canal as necessary.
- c) Long-term periodic inspection and repair: Diagnose the soundness of the structure every five years as a guide. If there is a problem with the soundness, repair should be carried out. When inspecting the inside of a CUP, measure the oxygen concentration and provide sufficient ventilation to avoid oxygen deprivation and the danger to life caused by toxic gases.

In the soft component activities, the irrigation management office will learn the contents and methods of maintenance and management of the CUP to be developed in the project (maintenance and management techniques of new type of CUP), which will enable them to properly maintain the irrigation facilities.

### (1) Activities to establish for appropriate maintenance and management of Canal Under Passes (CUPs) after rehabilitation

The maintenance work of the CS can be carried out efficiently when the flow rate in the canal is low. Therefore, the maintenance work will be carried out in February to March, which is the period when the water flow in the target area is the lowest. The work is divided into two stages, i.e., (a) removal of screen trash and (b) removal of sediment in the inlet, and the outline of the work is assumed.. In the soft component activities, the staff of Irrigation Management Office will prepare the draft work guideline which includes the following arrangements.

- a) Removal of screen trash: After the water in the canal is drained, workers enter the canal and remove the trash accumulated on the screen by hand. The removed garbage will be transported by truck to the waste disposal site designated by the local government for disposal.

- b) Removal of soil and sand from the CUP: After draining the water in the inlet and outlet of the CUP, the soil and sand is removed from the inside of the inlet to the outside. About three workers load the earth and sand into buckets inside the inlet and remove them by the workers outside. The removed sediment is returned to the canal because it was originally in the canal.

In order to establish the above facility maintenance management system, the following activities will be implemented.

| Activities  | Consultants  |   | Input from Nepal Government   |
|---|--|---|---|
|   | Input  | Activity  |   |
| The irrigation management office will acquire knowledge and skills for the maintenance and management of CUPs after renovation. | Japanese : 0.25 man-months<br>Implementation of training<br>Provision of training instructors, training venues and teaching materials  | Provide classroom instruction and on-the-job training to irrigation management office staff on maintenance of retrofitted CUPs. | Venue for classroom training<br>Irrigation Management Office staff: 2<br>Participation in training and compilation of training attendance records |
| Irrigation Management Office staff will develop draft maintenance work guidelines.  | Japanese:0.25 man-months<br>Support for preparation of draft work guidelines   | Assist the Irrigation Management Office in the development of draft work guidelines.  | Irrigation Management Office staff: 2<br>Preparation of draft working guidelines  |
| Conduct work practice based on the draft maintenance work guidelines  | Japanese: 1.0 person-months (1.0 person-months)<br>Civil engineer: 1 person (1.0 man-month)<br>Work caretaker: 1 person (1.0 person-month)<br>Workers: 5 (1.0 man-month)<br>Technical support for maintenance work | Provide technical guidance in the practice of maintenance work.   | Irrigation Management Office staff: 2<br>Equipment (tractor)  |

The following is a summary schedule and description of the soft component activities that form the basis for the inputs.

#### Activity-1: 0.25Months

|       |  |
|-------|--|
| Day-1 | A meeting is held with the director of Irrigation Management Office to discuss the implementation policy, and the trainees from Irrigation Management Office are selected. After that, the training site is prepared.                |
| Day-2 | Test the trainees' baseline knowledge on maintenance of CSs. Prepare classroom materials based on the test results.  |
| Day-3 | AM classroom lecture and PM site visit and training will be conducted. In the classroom lecture, basic knowledge about irrigation distribution, hydraulics about CUP, and machinery and labor about maintenance work will be taught. |
| Day-4 | Ditto  |
| Day-5 | The test of basic knowledge (revised version) conducted on the second day will be conducted again to check the status of picking up the knowledge. If there is insufficient mastery of the knowledge, it will be repaired.           |

Note: For consultant activities, 2.5 days will be added to the above schedule for overseas travel, intra-Nepal travel and preparation for activities.

#### Activity-2: 0.25Monthes

|       |  |
|-------|--|
| Day-1 | Confirm the design policy and design (construction) drawings, and check the situation surrounding the CS, the movement of sediment, garbage, etc. at the site.         |
| Day-2 | Organizing the situation at the site, etc. After that, check the case studies, prepare, confirm and discuss the draft work guidelines. Including on-site confirmation. |
| Day-3 | Reviewing, preparing, confirming, and discussing examples of draft work guidelines. Including on-site confirmation.  |
| Day-4 | Preparation, review and discussion of draft working guidelines. After that, report to the Director of Irrigation Management Office and discussion.                     |

|       |  |
|-------|--|
| Day-5 | Refinement and finalization of the draft working guidelines. Procedures such as ordering and contracting. In preparation for dredging work, we accompany contractors to check sites and discuss work policies. (4 CSs) |
|-------|--|

Note: 2.5 days will be added to the above schedule for the Consultant's activities to organize the design information and to compile the results of activities 1) and 2).

### Activity-3: 1.00Month

The following process is carried out for four cycles (for four facilities).

|              |   |
|--------------|---|
| Day-1~2      | Preparation, pump drainage and screen waste   |
| Day-3~4      | Removal of soil and sand from vertical gutter |
| Day-5        | Demobilization                                |
| Total 5 days | × 4 facilities = 20 days                      |

Note: As for the consultant's activities, 6 days for compiling the results of activities at each facility, reporting to responsible organizations, implementing agencies, JICA office, etc. in Kathmandu, 2 days for overseas and domestic travel, and 2 days for reserve days will be added to the above schedule.

## 4. Procurement of soft component implementation resources

The soft component support of the project is based on providing technical assistance to the irrigation management offices in charge so that they can practice maintenance and management on their own initiative.

In the implementation of the soft component activities, it is necessary to clarify the method of maintenance and the role of the Irrigation Management Office so that the maintenance can be carried out continuously. For this purpose, it is planned to be implemented under the guidance of experts using the resources of Nepal, including the Irrigation Management Office.


In this soft component activity, it is important for the irrigation management office technicians to acquire the skills. Two mid-level technicians with 10 to 15 years of experience will be selected from the members of the technical department assigned in the irrigation management office. The two trainees will learn specific arrangements in terms of work by observing the field work while acquiring supervisory techniques.

Regarding the materials and equipment for the soft component activities, a tractor will be used to remove the dredged material to the neighbourhood. Tractors can be utilized through the Irrigation Management Office with machinery owned by the Water Users Association.

## 5. Implementation plan for Soft Component Activity

The timing of the soft component activities should be after the completion of the facility maintenance and at a time when the amount of irrigation water is low, because the maintenance and management will be carried out in the field in view of the timing of the facility repair works and the use of irrigation water. Therefore, the project will be implemented for the completed facilities before the irrigation water for rainy season crops is fully supplied.

| Month                           | Aug                   | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr              | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb                        | Mar | Apr | May |  |
|---------------------------------|-----------------------|-----|-----|-----|-----|-----|-----|-----|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|----------------------------|-----|-----|-----|--|
| Conut.                          | 1                     | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9                | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19                         | 20  | 21  | 22  |  |
| Events                          | Start of construction |     |     |     |     |     |     |     | Irrigation Start |     |     |     |     |     |     |     |     |     | Completion of Construction |     |     |     |  |
| Guidance of Maintenance         |                       |     |     |     |     |     |     |     |                  |     |     |     |     |     |     |     |     |     |                            |     |     |     |  |
| Act. 1: Guidance                |                       |     |     |     |     |     |     |     |                  |     |     |     |     |     |     |     |     |     |                            |     |     |     |  |
| Act. 2: Making a Working Policy |                       |     |     |     |     |     |     |     |                  |     |     |     |     |     |     |     |     |     |                            |     |     |     |  |
| Act. 3: Practical training      |                       |     |     |     |     |     |     |     |                  |     |     |     |     |     |     |     |     |     |                            |     |     |     |  |
|                                 |                       |     |     |     |     |     |     |     |                  |     |     |     |     |     |     |     |     |     |                            |     |     |     |  |

 Rainy Season

## **6. Output of Soft component**

- Overall: Completion Report of Soft Component  
Result: Draft Guidelines for Maintenance and Management of CSs  
Records of maintenance and management of CSs

## **7. Cost of Soft Component**

Cost of soft component is estimated as JPY 5,835,000.

- Remuneration JPY1,218,000
- Direct cost JPY2,084,000
- Indirect cost JPY2,533,000 (Other Cost JPY1,461,000 + Overhead JPY1,072,000)

## **8. Obligation of the Government of Nepal**

- a) Coordination of government officials and participants in the implementation of soft component activities
- b) Organizing, managing, and coordinating training and meetings related to soft component activities
- c) Preparation of draft guidelines for maintenance and management of CSs
- d) Cleaning of CS