WEST BENGAL STATE ELECTRICITY DISTRIBUTION COMPANY LIMITED

BASIN STUDY FOR TEESTA BASIN
(WEST BENGAL PORTION)

Final Report

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INTRODUCTION

1.1 GENERAL

Basin study for any river basin can be defined as its ability to provide optimum support for various natural processes and allow sustainable activities undertaken by its inhabitants. The same is determined in terms of the following:

- Inventorization and analysis of the existing resource base and its production, consumption and conservation levels.
- Determination of regional ecological fragility/sensitivity based on geo-physical, biological, socio-economic and cultural attributes.
- Review of existing and planned developments as per various developmental plans.
- Evaluation of impacts on various facets of environment due to existing and planned development.

The basin study involves assessment of stress/load due to varied activities covering, e.g. exploitation of natural resources, industrial development, population growth which lead to varying degree of impacts on various facet of environment. The basin study also envisages a broad framework of environmental action plan to mitigate the adverse impacts on environment which could be in the form of:

- Preclusion of an activity
- Infrastructure development
- Modification in the planned activity
- Implementation of set of measures for amelioration of adverse impacts.

Thus, basin study is a step beyond the EIA, as it incorporates an integrated approach to assess the impacts due to various developmental projects. The present study basically assesses impacts on terrestrial and aquatic ecology due to development of various hydroelectric projects in the area to be studied as a part of the present study.

1.2 NEED FOR THE STUDY

The Study of Teesta Basin for West Bengal portion has been initiated at the instance of Ministry of Environment & Forests, Government of India while according prior Environmental Clearance to Teesta Low Dam –V hydroelectric project.

1.3 STUDY AREA

The Basin Study will focus on the various impacts resulting from implementation of hydro power projects in the Teesta basin in West Bengal. A total of 7 (seven) projects are envisaged in the study area to be covered in the Teesta basin and are listed in Table-1.1. The current status of projects in the Study Area is given in Table-1.2. The Teesta Basin Map and the Study Area Map are enclosed as Figures-1.1 and 1.2 respectively.

Table-1.1: Projects proposed in the Study Area

S. No.	Project Name	Proposed/Installed Capacity (MW)	Project Proponents
1	Teesta HEP Stage-VI	500	LANCO
2	Teesta Intermediate HEP	84	Project handed over to NHPC by West Bengal State Electricity Distribution Corporation Limited (WBSEDCL
3	Teesta Low Dam -I and HEP	81	Project handed over to NHPC by West Bengal State Electricity Distribution Corporation Limited (WBSEDCL
4	Teesta Low Dam -III HEP	132	NHPC Limited
5	Teesta Low Dam -IV HEP	160	NHPC Limited
6	Teesta Low Dam -V HEP	80	Project handed over to NHPC by West Bengal State Electricity Distribution Corporation Limited (WBSEDCL
7	Jorthang Loop HEP	96	Dans Energy Private Limited (DEPL)
	Total	**1133**	

Table-1.2: Current Status of Projects in the Study Area

S. No.	Project Name	Proposed/Installed Capacity (MW)	Current Status
1	Teesta HEP Stage-VI	500	Under Construction
2	Teesta Intermediate HEP	84	Scoping Clearance accorded by MoEF in October 2013
3	Teesta Low Dam -I and II HEP	81	Scoping Clearance accorded by MoEF in December 2013
4	Teesta Low Dam -III HEP	132	Commissioned
5	Teesta Low Dam -IV HEP	160	Commissioned
6	Teesta Low Dam -V HEP	80	Scoping Clearance accorded by MoEF in May 2013
7	Jorthang Loop HEP	96	Under Construction
	Total	**1133**	

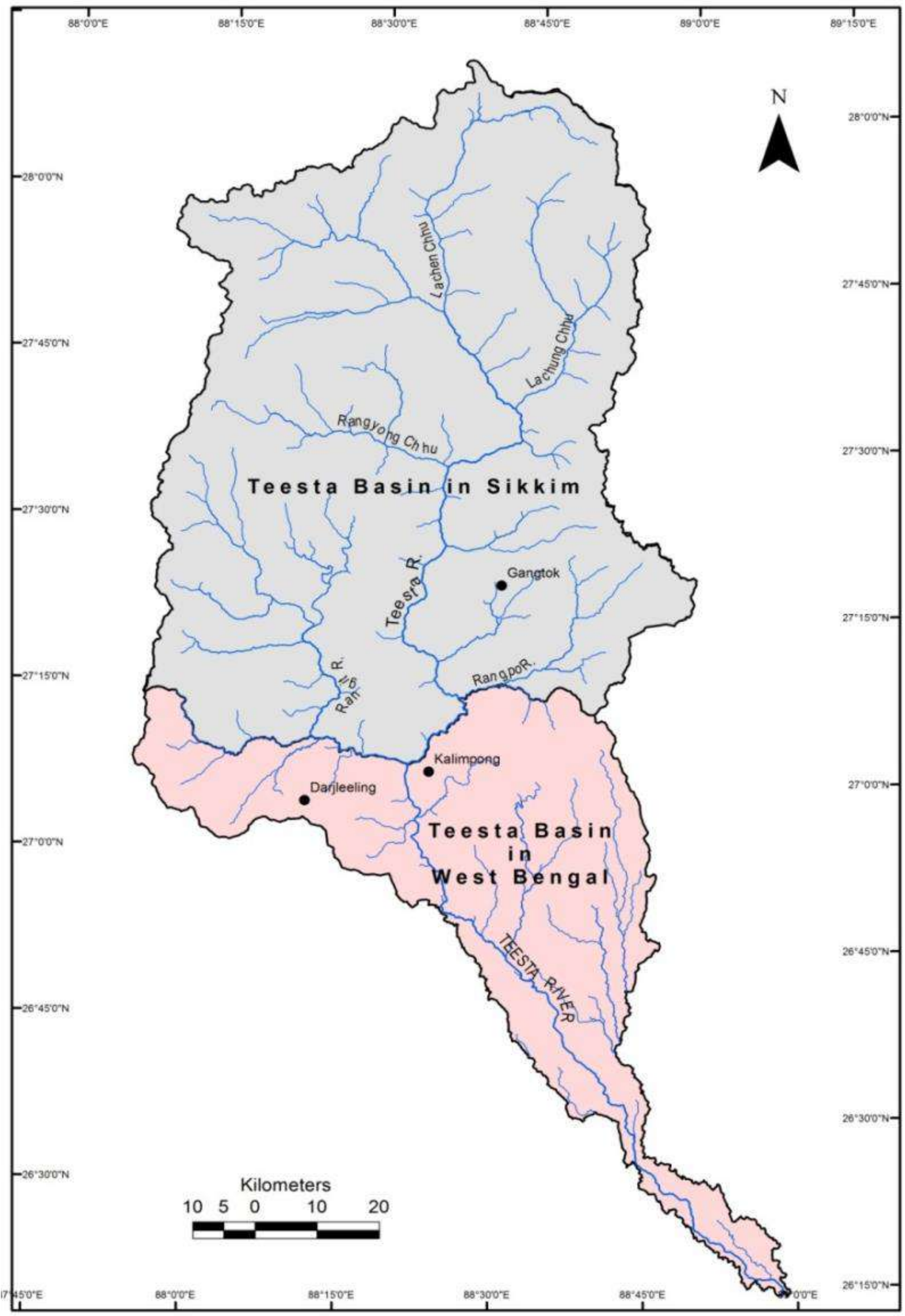


Figure 1.1 Basin map of Teesta river highlighting Teesta basin in West Bengal

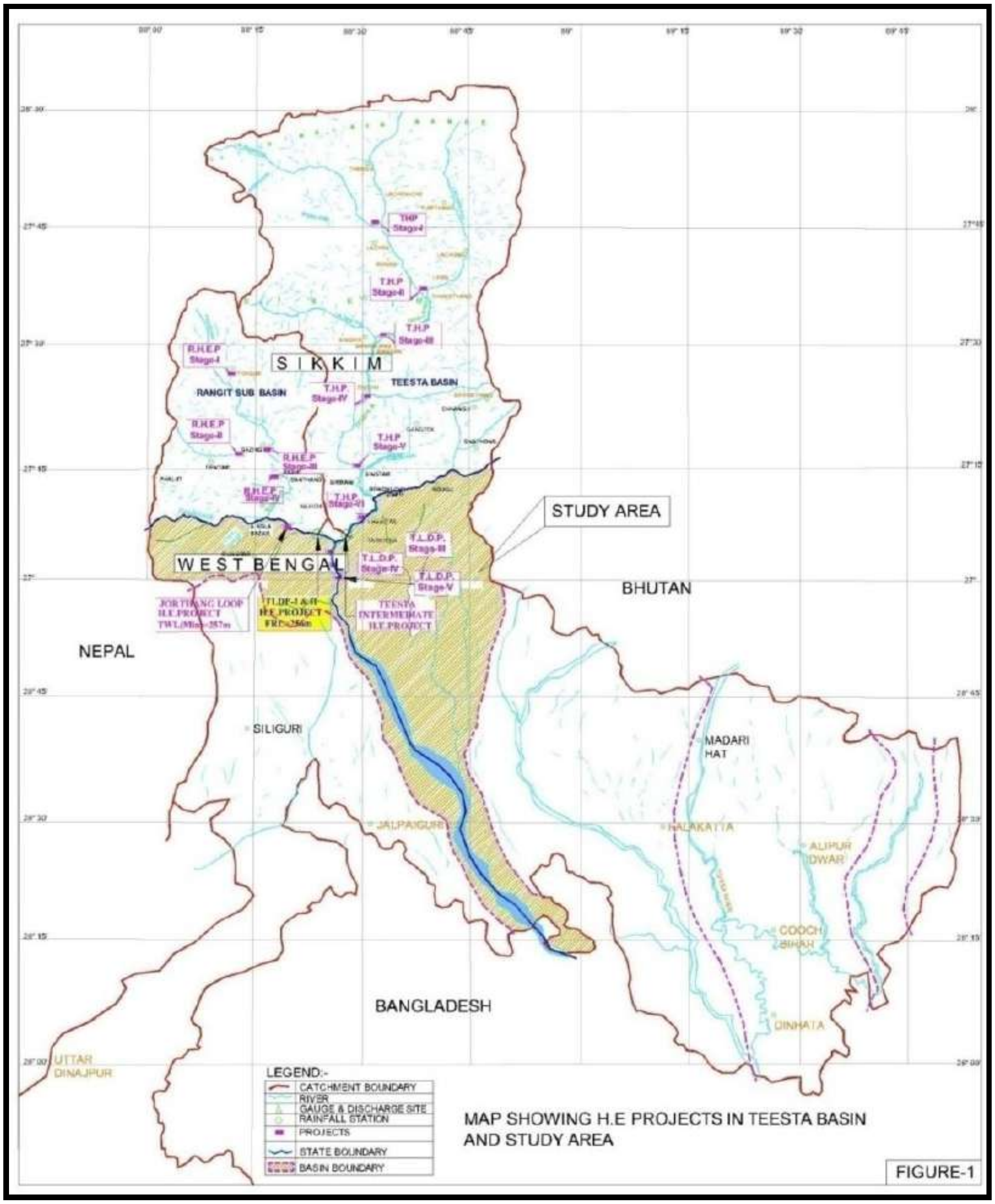


Figure-1.2: Study Area Map for Teesta Basin Study

Geographically, Teesta sub basin in West Bengal is located between 26^0 14' – 27^0 13' N Latitude and 87^0 59' - 88^0 59' E longitude. Teesta basin in West Bengal forms its boundary with Sikkim state in North through RamamKhola, Rangit and Teesta rivers. It shares its border with Nepal and Mahananda river basin in West, Jaldhaka river basin in East and Bangladesh in south. The basin's relief varies nearly from 40 m to 3600 masl. Teesta sub-basin in West Bengal covers an area of 3225 sq. Km. which comprises of hilly terrain of Darjeeling district (approximately 1121 sq. km) and plains of Jalpaiguri district (2104 sq. km). The hilly terrain especially in Sikkim and Darjeeling is highly prone to the landslides, flood and earthquakes. Throughout its course in the hilly terrain of West Bengal and Sikkim, it traverses through deep gorges and narrow valleys.

In the 96th Meeting of EAC of MoEF&CC for River Valley and Hydroelectric Projects held on 11th and 12th August 2016, the projects on Rammam river is also to be included. The details of Hydroelectric Projects on river Rammam are given in Table-1.3.

Table-1.3: Details of HEPs on Rammam River

S. No.	Name of Project	Capacity (MW)	Status
1	Rammam Stage-I HEP	48	Project handed over to NHPC Ltd. By WBSEDCL
2	Rammam Intermediate Small HEP	12	Project handed over to NHPC Ltd. By WBSEDCL
3	Rammam Stage-II HEP	51	Project under operation by WBSEDCL
4	Rammam Stage-III HEP	120	Under construction by NTPC Ltd.
	Total	**231**	

1.4 PROFILE OF THE STUDY AREA

The climate of Teesta basin in West Bengal is sub-tropical humid. In the Northern part of the state that includes the mountain region (Himalayas), temperature ranges from 0 °C to 10°C in winter while it increases to around 12°C to 18°C in the plains. January is the coldest month. The summer season begins from the month of March and temperature starts rising up to June. May is the hottest month. The temperature reaches 20°C in hills to >40°C in the plains (State Forest Report, 2010-11; http://www.westbengalforest.gov.in/publication_pdf/sfr-2010-2011.pdf). The average rainfall for 5 years (2009 – 2013) in the Darjeeling hills ranges from 1.48 mm to 889 mm with minimum in February and maximum in July (http://www.imd.gov.in/section/hydro/ distrainfall/webrain/wb/darjeeling.txt).

The total population of the Teesta basin in West Bengal is nearly 80,00,000, of which maximum lie in the foothills and plains. It is about 27% of the total population of basin including Bangladesh and Sikkim (http://www.strategicforesight.com/publication pdf/22345riversofpeace-website.pdf).

The river Teesta is one of the main Himalayan rivers and originates as ChhomboChhu from a glacial lake KhangchungChho at 5,280 m. The river rises in mountainous terrain in extreme north as ChhomboChhu, which flows eastward and then southward to be joined by various tributaries in Sikkim, viz. ZemuChhu at Zemu, LachungChhu at Chungthang, RangyongChhu at Mangan, DikChhu at Dikchu, Rani Khola at Singtam, RangpoChhu at Rangpo and Rangitriver at Teesta Bazar. From Teesta Bazar downstream, the river leaves Sikkim and enters the hilly terrains of West Bengal and leaves hilly terrains at Sevoke near Siliguri, West Bengal. Teesta river ultimately drains into Brahmaputra at Teesta much Ghat (Kamarjani-Bahadurabad in Rangpu district of Bangladesh) and traverses a distance of about 400 km from its origin.

Teesta river is lifeline of people of Sikkim and North West Bengal. It has a great socio-economic and cultural importance in this landscape. More than 80% of the total population inhabit plains and foothills of the catchment, where agricultural practices are predominant and local communities rely strongly on the river water for irrigation and domestic consumption. The problem lies in lean season when water flow in Teesta river decreases 10 times from average flow. All hydro-electric projects are based on the run of the river scheme and impacts on the downstream flow are foreseen as major challenge. In general hilly terrains in Himalaya are sparsely populated, having good forest cover and stand for relatively pristine ecosystems. The whole landscape is the main source of ecosystem services to local people.

1.5 SCOPE OF WORK

1.5.1 Data Collection

In the present study emphasis should be laid on terrestrial and aquatic ecology. The estimation of supportive capacity of the basin should involve the preparation of the existing scenario i.e., the preparation of detailed data base of the basins. This should be accomplished through the steps outlined in following sections.

Meteorology

The information on various meteorological aspects is to be collected from India Meteorological Department (IMD) for meteorological stations located within the basin area or in vicinity to the basin boundary. The information on various aspects such as rainfall, temperature wind, humidity, etc. will be collected.

Water Resources

The information on following aspects should be collected:

- Review of drainage characteristics of the basin, including various surface water bodies like rivers and lakes.
- Data collection and review of past studies/reports/data etc.
- Review of existing water sharing agreements for meeting various need-based existing and future demands viz. municipal, irrigation, power generation and industrial.
- Analysis of all, past assessment of the water availability and assessing the water availability, as per updated data for the system as a whole and at existing ongoing/proposed project locations on annual/monsoon/non-monsoon and monthly basis.

- Estimation of sediment load at various points in the basin based on available secondary data.
- Identification of perennial sources of water and their designated usages.

Water Quality

As a part of the study, secondary data is to be collected for water quality in the study area. In addition to above, information on human settlement, sewage generated and mode of collection, conveyance treatment and disposal of sewage should also be collected.

The water quality monitoring shall be conducted at 14 (fourteen locations @ (2 locations per project) in the study area. The frequency of sampling shall be once per month for 12 months. The various parameters include pH, Dissolved Oxygen (DO), Electrical conductivity (EC), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Total Alkalinity, Total Hardness, Biochemical Oxygen Demand(BOD), Chemical Oxygen Demand(COD), Nitrates, Chlorides, Sulphates, Phosphates, Sodium, Calcium, Magnesium, Potassium, Iron, Manganese, Zinc, Cadmium, Lead, Copper, Mercury, Total Chromium, Total Coliform.

Flora

The following data should be collected from various secondary sources for river Teesta and its tributaries in the basin area **:**

- Characterization of forest types in the study area and extent of each forest type.
- Information on general vegetation pattern and floral diversity.
- Presence of economically important species in the study area.
- Presence of Rare, Endangered and Threatened floral species as per the categorization Botanical Survey of India's Red Data list in the basin area.
- Presence of endemic floral species found in the study area, if any should be assessed as a part of the study.
- Location of wild life sanctuaries, national parks, biosphere reserves if any, in the study area

The field studies should be conducted for sampling 14 (fourteen locations @ (2 locations per project) to collect primary data on terrestrial ecology in the study area. The monitoring should be conducted for three seasons namely pre-monsoon, monsoon and post-monsoon. The following should be covered as a part of the EIA study.

- Identification of forest type and density, bio-diversity in the study area.
- Preparation of comprehensive checklist of flora (Angiosperms, Gymnosperms, Lichens, Orchids, Pteridophytes, Bryophytes, Fungi, Algae etc.) with Botanical and local names.

- Importance Value Index of the dominant vegetation at various sampling locations.
- Frequency, Abundance and density of each species of Trees, Shrubs and Herbs at representative sampling sites should be estimated.
- Identification and listing of plants of genetically, biologically, economical and medicinal importance.
- Details on presence of Endemics and RET species in the Study Area
- Major forest produce, if any, and dependence of locals on the same in the forests observed in the study area.
- Standard survey method for sampling methodology needs to be adopted for Flora.

In addition, based on the published literature including various research papers, the information on forest types, presence of various species, biological diversity etc. should be collected for the study area.

Fauna

The following data to be collected from various secondary sources for the study area:

- Inventory of Birds (resident, migratory), land animals including mammals, reptiles, amphibians, fishes etc reported & surveyed in the basin area should be prepared.
- Presence of RET faunal species as per the categorization of IUCN Red Data list and as per different schedules of Indian Wildlife Protection Act, 1972 in the Study Area.
- Presence of endemic faunal species found in the basin area, if any should be assessed as a part of the Study.
- Existence of barriers and corridors for wild animals, if any in the basin area should be covered as a part of the study.
- Identification of threats to wildlife in the Study Area.
- Presence of National Park, Sanctuary, Biosphere, Reserve Forest etc. in the basin area should be assessed.

During ecological survey, identification of faunal species shall be carried out simultaneously. Indirect observations of mammals should be carried out by identification of tracks, droppings (scal), claw marks and calls, etc. The listing of faunal species by direct observation techniques should be carried out. The detailed list of faunal species should be formulated based on forest records and published literature.

Aquatic Flora and Fauna

The following data should be collected from various secondary sources for river Teesta and its tributaries in the basin area **:**

- Presence of major fish species
- Inventory of migratory fish species & migratory routes of various fish species
- Presence of major breeding and spawning sites.

The field studies should be conducted for sampling at 14 (fourteen locations @ (2 locations per project) in the study area to collect primary data on aquatic ecology & fisheries in the study area. The density and diversity of phytoplanktons, zooplanktons should be estimated. In addition, primary productivity should be monitored at various locations to be covered as a part of the study.

The diversion of water for hydropower generation leads to reduction in flow downstream to the dam site up to disposal of tail race outfall. This leads to diverse impacts on riverine ecology. The dam could also act as a barrier for migration of fishes. The data on prevailing fish species should be collected from the Fisheries Department. To augment the existing data, a fisheries survey should be conducted at 14 (fourteen locations @ (2 locations per project) in the study area. The survey should be conducted once per month for 12 months. The details of the monitoring work should be carried out as per the following:

- Assessment of biotic resources with special reference to primary productivity, zooplanktons, phytoplanktons, benthos, macrophytes, macro-invertebrates and fishes in the study area.
- Population densities and diversities of phytoplanktons, zooplanktons, benthos, macrophytes, macro-invertebrates and fish shall be estimated. Diversity indices of these ecological groups should also be calculated separately.
- Fish composition
- Migratory route of migratory fishes
- Spawning & breeding grounds of fish species, if any, should be identified.

1.5.2 Impacts due to Hydropower Development

The impacts on terrestrial and aquatic ecology should be studied. The scenario to be considered for assessment in the present study should be based on the hydropower projects presented in Table-1.1. The key aspects to be covered are listed as below:

- Modification in hydrologic regime due to diversion of water for hydropower generation.

- Depth of water available in river stretches during lean season and its assessment of its adequacy vis-a-vis various fish species.
- Length of river stretches with normal flow due to commissioning of various hydroelectric projects due to diversion of flow for hydropower generation.
- Impacts on discharge in river stretches during monsoon and lean seasons due to diversion of flow for hydropower generation.
- Impacts on water users in terms of water availability and quality
- Impacts on aquatic ecology including riverine fisheries as a result of diversion of flow for hydropower generation.
- Assessment of maintaining minimum releases of water during lean season to sustain riverine ecology, maintain water quality and meet water requirement of downstream users.
- Impact due to loss of forests
- Impact on RET species & impacts on economically important plant species.
- Impacts due to increased human interference
- Impacts due to agricultural practices.
- Study the impact of cascade development and make recommendations on the requirement of free flowing stretch between two projects. Ecological inventory and geomorphology for different stretches of river to be delineated.
- Information on river stretch affected and forest area affected by each project needs to be modified to include additional details of catchment area; total forest area of the sub basin and the area getting affected and total river length, stretch affected and free flowing.
- Undertake environmental flow release assessment for the entire year i.e. covering lean, non-lean non- monsoon and monsoon periods, based on methodology such as BBM and make recommendations for each stretch.
- Hydro Dynamic Study for assessment of Environmental flow release should be linked with the fauna, habitat requirement for assessment of environmental flowreleases for entire year.
- Modelling study carried out to assess the impact of peaking discharge should be concluded with recommendations for mitigation of such impacts.
- Sampling sites, forest cover and forest type should be listed and illustrated sub basin wise. Endemic species of fishes in Teesta basin shall be tabulated.

- The main objective of the study is to bring out the impacts of dams being planned on the main river and its tributaries. At the end of the Report there should be a separate Chapter synthesizing the results of each component so that a holistic picture of impacts could be emerged which should lead to Recommendations
- Impact on overall balance of sediment due to construction of a number of projects needs to be included in the report.
- Impact of sand mining, boulder mining, etc need to be included in the study
- Impact assessment should also include "Impacts due to construction of approach roads for the HEPs".
- Source of secondary information used in the report/to be used in the report should be revealed and credit given accordingly.
- Detailed maps of each Sub-Basin have to be provided separately for each parameter such as forest cover, forest type, vegetation, location of sampling sites, etc. For each forest type it will be appropriate to give altitudinal range (for some it is given), its location in the study area in separate maps.
- For betterment of analysis, it may be appropriate to categorize dams as Operational/ Under Construction/ EC, Scoping, Not Allotted yet, This will facilitate decision making on dropping of any dam, if it is required from environmental angle.

1.5.3 Outcomes of the Study

The key outcomes of the study should be to:

- Provide sustainable and optimal ways of hydropower development of Teesta river in the Study Area, keeping in view of the environmental setting of the basin
- Assess requirement of environmental flow for the entire year i.e. covering lean, non-lean non- monsoon and monsoon periods with actual flow, depth and velocity at different level.

The study may be linked as Cumulative Impact Assessment on account of development of various hydropower projects in the Study Area and should cover the following aspects :

- Flow regime
- Flood plain including wetlands
- Aquatic ecology
- River morphology
- Sediment transport/erosion and deposition

- Impact on human activities and livelihood
- Considering the total length of the main river in the basin and the HEPs already existing and planned for future development, how many more HEPs may be allowed
- to come up. In other words, how much of the total length of the river that may be tunneled inclusive of the tunneling requirement of all the projects that have been planned for development so that the integrity of the river is not grossly undermined.
- What may be criteria for downstream impact study in terms of length of the river downstream to the tail water discharge point and what may be the parameters of such a study. Currently the norm is 10 km radius area, which is inadequate for major projects.
- If the states do not change their policy of allotting elevation-wise river reaches for hydropower development, what criteria the EAC may adopt in restricting the river reach for hydropower development. Alternatively, what should be the clear river length of uninterrupted flow between the reservoir tip at FRL of a downstream project and the tail water discharge point of the immediate upstream project.
- What will be the scientific procedure to decide on the minimum lean season flow that must be maintained in the downstream of a dam/barrage and based on such a procedure, what minimum lean season flow must be ensured by the hydropower developer in various reaches of a long river in relation to the aquatic lives and downstream water use.
- For peaking stations, what extent of diurnal flow variation may be considered safe for the aquatic life. There are examples where the release is drastically reduced during the long time for reservoir filling and the huge discharge flows through the river during the few hours of peak power generation. This is detrimental to the aquatic environment of the downstream stretch of the river.
- For muck disposal, what may be minimum distance that must be maintained between the outer boundary of the muck disposal sites and the river bank. If such a site is not available at the indicated distance and long haulage of muck may be involved for safe muck disposal at sites further away, what may be the pros and cons of including the enhanced cost of muck disposal in the project budget. Thus, the study may highlight on the existing norms, cost of haulage per tonne-

kilometer, the percentage of the haulage cost of the total project cost and the extent to which the power may be more expensive to generate.

The key outcomes of the study should be to:

- Provide sustainable and optimal ways of hydropower development of teesta river in the Study Area river, keeping in view of the environmental setting of the Study Area.
- Assess requirement of environmental flow for the entire year i.e. covering lean, non-lean non- monsoon and monsoon periods with actual flow, depth and velocity at different levels.
- Downstream impacts on Assam up to Guwahati due to hydropower development in the Study Area Management of impact and mitigation measures.

1.6 OUTLINE OF THE REPORT

The present report outlines the findings of Interim Report. The outline of the Report is given as below:

Chapter-1 covers the need for the basin study, study area to be covered as a part of the study. The scope of work and brief profile of the study area is also summarized in the Chapter.

Chapter-2 outlines the methodology adopted for conducting the Basin study.

Chapter-3 presents the brief description of projects within the Study Area.

Chapter-4 delineates the hydrological aspects of the projects within the Study Area.

Chapter-5 summarizes the water quality characteristics of the area.

Chapter-6 presents the findings the floral survey conducted as a part of the study.

Chapter-7 presents the findings the faunal studies conducted as a part of the study.

Chapter-8 presents the aquatic ecological aspects of environment. The findings of the chapter are based on collection of data from primary as well as secondary data sources.
Chapter-9 presents the findings the fisheries survey conducted as a part of the study.

Chapter-10 gives a brief description of the environmental sensitive areas within the Study Area.

Chapter-11 delineates the prediction of impacts likely to accrue as a result of construction and operation phases of various projects on the tributaries of Teesta Basin.

Chapter-12 delineates the Environmental Audit of Teesta Low Dam III and Teesta Low Dam IV HEP.

Chapter-13 delineates an Environmental Management Plan (EMP) for amelioration of anticipated adverse impacts likely to accrue as a result of commissioning of various projects in the study area. The approach adopted for formulation of the Environmental Management Plan (EMP) has been to maximize the positive environmental impacts and minimize the negative ones.

Chapter-14 presents the recommendation of Teesta Basin study alongwith Environmental Flows to be released for sustaining the riverine ecology

CHAPTER 2
METHODOLOGY ADOPTED FOR THE STUDY

CHAPTER-2

METHODOLOGY ADOPTED FOR THE STUDY

The present study was carried out in view of the developmental activities, which are likely to be supported by Lower Teesta basin in West Bengal within natural resources limits and minimum degradation of social, cultural and economic environments. The activities include the construction of ongoing and proposed hydroelectric projects on Teesta river in West Bengal; such activities can have a large number of impacts on the flora, fauna, river flow, river geomorphology, hydrology, social, cultural and economic environments. This contribution deals with the biological elements of terrestrial and aquatic ecosystem of the surrounding areas of all proposed project. The main scope of the study is to carry out ecological surveys in the surroundings of the proposed projects in Teesta basin of West Bengal.

2.1 STUDY AREA

The Study Area comprises of surroundings of a total of 7 proposed/under construction/ commissioned hydroelectric projects located on Teesta and Rangit rivers within the boundary of West Bengal. The primary surveys were carried out at various locations in the surroundings of proposed projects as per scope of the study.

2.2 FLORA

The detail accounts on forest types and forest cover in the catchment area were based on our primary surveys in the area supplemented with the working plans and records of Darjeeling and Jalpaiguri district Forest Divisions. The major forest types encountered in the area were described based on the classification of Champion and Seth (1968), Negi, (1989, 1996), Hazara and Verma (1996), Mudgal and Hajra (1999).

The description of vegetation of the project areas proposed along the Teesta and the Rangitrivers has been presented in terms of zones which correspond to topographic/ elevational classes within the 10 km radius as influence zones of the projects. The important sites for the primary surveys were:

i) Area between Siliguri and Sevok
ii) Sevok, Riyang, Kalizora and Teesta Bazar
iii) Teesta-Melle, Jorethang, Sombaria- Kitam Wildlife Sanctuary and Rangit river catchment
iv) Teesta-Lapchu, Lamta-Jorbanglow, Darjeeling and Senchal Wildlife Sanctuary.

v) Area between Teesta and 3rd Mile, on way to Kalimpong area
vi) Melle-Rangpo, Singtam, up to Sherwani

2.2.1 Community Structure

To understand the community structure, vegetation sampling was carried out at different locations of proposed projects and catchment area along the Teesta and Rangit river sub basins. These surveys were undertaken during different seasons (pre-monsoon, monsoon and post-monsoon) of the year to account for most of the floral elements found in the area. For floral survey fourteen sites were selected for vegetation structure study in the Study Area. The sampling was conducted for three seasons (i.e. pre-monsoon, monsoon and post-monsoon). In order to calculate the Importance Value Index (IVI) and Shanon-Wiener diversity index' Modified-Whittaker nested vegetation plot design for sampling various vegetation types (Stohlgren*et al.,* 1995a) was used. At each of the site, a 200 m long and 5 m wide belt transect was laid perpendicular to the forest edge. Along each transect, ten contiguous 20 m x 5 m plots were set for tree layer. Within each 20 m x 5 m plot, ten nested subplots, each of 5 m x 2 m size were established for analysing saplings and shrubs. The herbs were analysed by placing ten subplots, each of 1m x 1 m size randomly on each site. Tree species were counted as those individuals in 20 m x 5 m plots whose circumference at breast height (cbh) was greater than 30 cm (> 30 cm). All individuals with 10 – 30 cm cbh were listed as shrubs and saplings. Herbs (< 10 cm cbh) were analyzed in 1 m x 1m subplots randomly laid within same 20 m x 5 m plots.

Each individual species belonging to one of the three vegetation layers (i.e. trees, shrubs/saplings or and herbs) was quantitatively analyzed for three variables, (i) density, (ii) total basal area (TBA) for trees and total basal cover for shrubs and herbs and (iii) Importance Value Index (IVI) using the methodology of Curtis &McIntosh (1950) with minor modifications. Density represents the numerical strength of the species in a community. TBA/TCA value is positively correlated with the dominance of a species while IVI expresses the dominance and ecological success of any species in a single value.

Density was obtained as a ratio of total number of individuals of a particular species found to the total number of sampling plots studied.

The TBA value for tree species was measured by the formula:

$$\text{TBA} = \text{Mean Basal Area} \times \text{Density}$$

where, Mean Basal Area = (Average circumference at breast height)$^2/4\pi$

The cover value (for herb layer) was measured by the formula:

$$\text{Mean basal cover} = \pi \times (\text{average diameter of species})^2 \times 0.25$$

IVI value (Phillips, 1959) of a species was measured by the following formula:

IVI = Relative frequency +Relative density + Relative dominance

where,

Relative frequency = (Frequency of a particular species/Frequency of all species) ×100

Relative density = (Density of a particular species/Density of all species) ×100

Relative dominance = (TBA of a particular species/TBA of all species) ×100

Species diversity of each vegetation layer (trees, saplings, shrubs and herbs) in each forest fragment was calculated by using 'Shanon-Wiener diversity index' (Shanon Wiener, 1963) as:

$$H' = -\Sigma\ (ni/n) \times \ln\ (ni/n)$$

where, in is individual density of a species, n is total density of all the species and ln = natural logarithm

2.3 FAUNA

Information on different faunal taxa like mammals, avifauna, reptiles, amphibian, butterflies and other invertebrates commenced with secondary literature and primary surveys. The secondary information was gathered from the study area as well as adjacent areas with the help of Mallick, 2012; Chettri and Bhupathi, 2007; Sengupta et. al, 2014; Ghorai and Sengupta, 2014; Chettri, 2007 etc. Secondary information was strengthened by the primary surveys for three seasons, which were carried out at all sites mentioned for floral surveys. Primary surveys for the fauna in the study area were conducted during April 2014, July 2014 and October 2014, which correspond to the pre-monsoon, monsoon and post-monsoon seasons. Primary surveys include direct and indirect evidences. During the primary surveys, species belonging to mammals, birds, reptiles, amphibia, butterflies and other insects were spotted at the various sites study area. The avifauna and butterflies of the study sites have been documented through Direct Observations, Random Walks and Opportunistic Observations during early morning (6:00 to 10:00 hrs.) and evening (17:00 to 19:00 hrs) for birds using a pair of binoculars and noon (11:00 to 14:00) for butterflies were carried out. The field guides - Grewal et al. (2002) and Harbal (1992) were used to identify birds and butterflies species, respectively. For mammals both direct and indirect methods have been applied to sample mammals present in the study area. Indirect evidences like tracks and signs (e.g. footprints/pugmarks, calls, signs and scats) along with Visual Encounter Surveys have been used. In addition, the presence of species was confirmed indirectly with the help of species' calls, presence of trophies and hides and by interviewing the local people.

After preparation of an inventory using all available sources, each species was assessed for its conservation profile using IUCN redlist (2015) and Wildlife (Protection) Act (1970, amended in 2002).

2.4 WATER QUALITY & AQUATIC ECOLOGY

The study was carried out in Teesta river and its tributaries flowing in the hilly terrain of West Bengal. The sampling was conducted at 15 sites in Teesta, Rangit and Riyang Khola rivers. The sampling was carried out at a monthly interval at all sites from April 2014 to March 2015. Details of sampling sites are given in Table 2.1 and **Figure 2.1**. The elevation of sampling sites covered as a part of the study ranged from 134 m to 281 m.

Table 2.1: Details of sampling locations in Teesta basin of West Bengal

Site	Coordinates Lat/Long	River	Elevation (m)	Description of sites
S1	$27^0$09'59"N $88^0$31'43"E	Teesta	281	Upstream of Powerhouse of Teesta Stage VI
S2	$27^0$07'55"N $88^0$30'05"E	Teesta	245	Proposed Powerhouse of Teesta Stage VI
S3	$27^0$07'12"N $88^0$28'31"E	Teesta	223	Upstream of Teesta Intermediate dam
S4	$27^0$05'42"N $88^0$27'42"E	Teesta	219	Downstream of Teesta Intermediate dam
S5	$27^0$07'13"N $88^0$19'10"E	Rangit	270	Upstream of Proposed Powerhouse of Jorethang Loop HEP
S6	$27^0$05'44"N $88^0$23'06"E	Rangit	227	Downstream powerhouse of Jorethang Loop HEP
S7	$27^0$05'23"N $88^0$24'10"E	Rangit	220	Upstream of Teesta Low Dam I & II
S8	$27^0$04'52"N $88^0$25'50"E	Rangit	209	Downstream of Teesta Low Dam I & II
S9	$27^0$02'59"N $88^0$25'36"E	Teesta	208	Upstream of Teesta Low Dam III
S10	$26^0$59'53"N $88^0$26'10"E	Teesta	188	Downstream of Teesta Low Dam III
S11	$26^0$56'10"N $88^0$27'05"E	Teesta	158	Upstream of Teesta Low Dam IV
S12	$26^0$55'16"N $88^0$27'41"E	Teesta	150	Downstream of Teesta Low Dam IV
S13	$26^0$53'19"N $88^0$28'28"E	Teesta	144	Teesta Low dam V
S14	$26^0$52'50"N $88^0$28'36"E	Teesta	134	Downstream of Teesta Low dam stage V (near Sevok)
S15	$26^0$59'36"N $88^0$25'42"E	Riyang	187	Riyang is a tributary of Teesta, joins on left bank downstream Teesta Low dam III

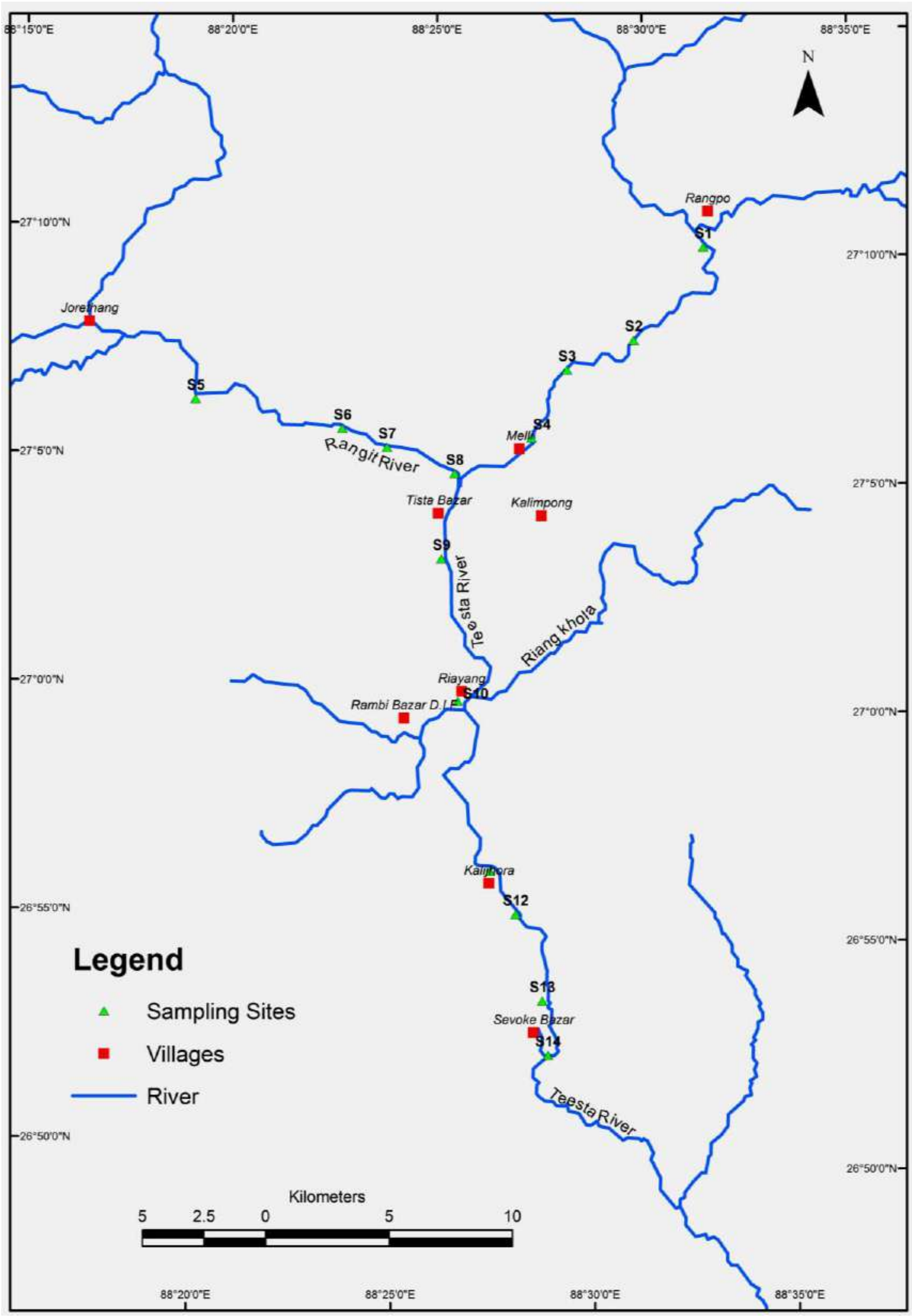


Figure-2.1: Map showing aquatic sampling sites at different places in Teesta, Rangit and Riyang Khola

2.4.1 Physical and Chemical Characteristics

For each physical and chemical parameter, three replicates were obtained and averaged for the final results. Water temperature was recorded with the help of graduated mercury thermometer. In case of water, care was taken in measuring the temperature as it was recorded from surface, column and near the bottom of the river. Average values of these readings were computed for final results. The water current velocity at all sites was measured with the help of float method. A 20 m stretch of the river was measured and marked at both ends. A float was thrown at upper end and the time taken by the float to travel the marked distance, was recorded by a stop watch.

The pH was recorded with the help of pH Scan (Eutech) and pH meter (EI – 132 E) in the field. For the turbidity of water, samples were collected in sampling bottles from different sites in the field and brought to the laboratory for analysis. The turbidity was recorded with the help of digital turbidity meter (TN 100; Eutech). The total dissolved solids were measured with the help of TDScan 1 (Eutech) at each site. Similarly, Electrical conductivity was recorded with the help of TDScan 3 (Eutech) at the sites. Dissolved oxygen was measured by iodometric titration method using Oxygen test kit (Aquamerck). Total alkalinity, alkalinity as carbonates and bicarbonates, total hardness, Ca and Mg contents, and chloride were measured with the help of APHA (2005) and Adoni (1985). Nitrate (NO_3 – N) and phosphate (PO_4 – P) were measured by photometric method using UV/visible spectrophotometer (Ultrospec 3000). Other ions like Na, and K and a few heavy metals (Iron, Cu) were detected by Atomic Absorption Spectrometry (AAS 6300).

2.4.2 Biological Characteristics

Four biotic communities namely phytoplankton, Zooplankton, Phytobenthos and Macro-invertebrates were sampled to assess the aquatic richness. Phytoplankton and Zooplankton were collected by filtering 50 liters (in high turbid condition, only 20 litre was filtered at each site) of water at each site using a sieve of 25μ mesh size. The residue left in the sieve was collected in a 50 ml vial. Three replicates were taken for each community and pooled for further analysis. Phytoplankton samples were preserved using Lugol’s solution. No preservative were added in zooplankton samples. Benthos samples were collected from each site by scraping the boulder surfaces of known quadrat area (5cm x 5 cm). These samples were then preserved and analyzed in the same way as described for the plankton. The macro-invertebrates were obtained with the help of a square feet Surber’s sampler. The substrate, mainly stones are disturbed and immediately transferred to a bucket kept under water and later rinsed thoroughly to dislodge all the attached macro-invertebrates. For the phytobenthos and macro-invertebrates three replicates for each community were obtained and pooled for further analysis. To count the organisms the procedure described by Pennak (1953) and Edmondson (1959) were followed.

Further analysis was conducted in laboratory. The volume of zooplankton, phytoplankton, and benthos were made up to 100 ml. The total density of zooplankton and phytoplankton were calculated using 'Drop-count' method, described by Adoni (1983). Macro-invertebrates samples retrieved from the sampling sites were brought to the laboratory all individuals were counted. The final densities of macro-invertebrates were expressed in the individuals per m^2.

The relative abundance of algal species was calculated as:

(Number of cells of a species / Total number of cells counted) x 100.

Identification of planktonic and benthic algae was carried out using permanent slide mounts of samples from all the sites. The samples are acid digested, centrifuged and thoroughly rinsed to get the cleared samples. For treatment of samples, the standard method was followed (APHA, 2005). The permanent slides were prepared by mounting the medium in Euparol. These slides were examined using standard literature (Lange- Bertalot & Krammer 2000, 2001, 2002; Hustedt and Jenson 1985; Sarod and Kamat, 1983).

2.5 FISH & FISHERIES

Present study on various aspects like species composition, fish migration, fisheries etc was primarily focused in and around the zone of influence area of all hydro-electric projects located in lower Teesta basin in West Bengal. Data was collected with the help of primary as well as secondary sources. In order to prepare a detail list of fish fauna in the Teesta basin under discussion Acharjee and Barat (2013) was consulted particularly for hilly region while data was taken from Patra et al. (2011) in plain area. Monthly survey was carried out to record the fish catch from different locations. Fish were recorded from fishermen spotted during their fishing hours. In addition, fishermen were also hired to land fish from different sampling locations. Fish were landed with the help of cast net and hook and rods. Each species was subjected to IUCN red list (2015) to assess its conservation status.

CHAPTER 3
PROJECT DESCRIPTION

CHAPTER-3
PROJECT DESCRIPTION

3.1 INTRODUCTION

A total of 7 (seven) projects are envisaged in the study area to be covered in the Teesta basin. The installed capacity of various projects proposed in the study area is given as below:

- Teesta Stage-VI HEP(500 MW)
- Teesta Intermediate HEP(84 MW)
- Teesta Low Dam –I and II HEP(81 MW)
- Teesta Low Dam –III HEP(132 MW)
- Teesta Low Dam –IV HEP(160MW)
- Teesta Low Dam –V HEP(80 MW)
- Jorethang Loop HEP(96 MW)

As per the direction of 96th Expert Appraisal Committee (EAC) meeting, the projects on river Rammam are also to be included. The following projects have been included:

- Rammam Stage-I HEP(48 MW)
- Rammam Intermediate HEP(12 MW)
- Rammam Stage-II HEP(51 MW)
- Rammam Stage-III HEP(120 MW)

The total number of hydroelectric projects (under operation, under construction and proposed) has been finalized and freezed in consultation with the Government of West Bengal. A letter from Commissioner, Department of Power & NES is enclosed as Annexure-I. A brief description of the above referred projects is given in the following sections.

3.2 TEESTA STAGE-VI HEP

The proposed Teesta stage-VI hydroelectric project is located at a distance of 5 km from Rangpoo Bazar which is located at a distance of about 40 km from Gangtok. The project is a run off the river Hydro Electric Project, having Installed capacity of (125 X 4) 500 MW with firm power generation of 77.69 MW an annual generation of 2441 Gwh in 90% dependable Year. The key components of Teesta stage-VI HEP are

- Barrage comprising 6 (Six) waterways and 105 m length, 4 nos. intakes, 4 nos. desilting chambers, gate operation chamber, 2 nos . silt flushing tunnels.
- Power house comprising of Head Race Tunnels, Surge shaft, Pressure shafts, Power house cavern, Transformer cavern, Tail race surge chamber, tunnels and pot head yard.

Barrage

Diversion barrage has been proposed on river Teesta about 500 m downstream of L.D. Kazi bridge at Sirwani. The adequate pondage downstream of Teesta Stage – V is available and it also avoids the submergence of houses, roads and other facilities. The river profile is considerably straight therefore the suitable location for intake structure and desilting chambers is available.

The barrage structure with 6 (six) nos. spillway of 12.5 m each along with 5 (Five) nos of 6 m thick piers have been provided making total width as 105 m of the barrage. The average bed level of river is 338 m, to facilitate the flushing of river load. The crest level of the spillway bays is proposed at 338 m, the top level of barrage has been kept as 361.5 m. The barrage is designed to cater a flood of 7103 cumec. The high flood level for design flood works out to be EL 345.20 m. The FRL and MDDL are proposed as EL 360 m and EL 354 m respectively.

Diversion Arrangement during Construction

The construction of barrage has been considered during non-monsoon season only and the diversion of 700 cumec non-monsoon flow has been considered for seasonal diversion to construct the barrage. The diversion channel and earth/rockfill coffer dams shall be constructed to divert the water during non-monsoon period.

Water Conductor System

The water conductor system located on the right bank of river Teesta has been designed to carry a discharge of 531 cumec. The layout of water conductor system and power house complex has been finalized on the basis of available topographical conditions. All the structures are underground.

Intake Structure

4 (Four) nos of intake structures shall be located at the right of barrage with an inclination of 15° from barrage axis. Each intake straight type intake has been designed to pass a discharge of about 159.3 cumec and shall have centre to centre distance of 24 m. The intake structure invert shall be at EL 341 m which is 3 m above the crest level. The bell mouth entry on upper hall of the intake has been proposed. The size of the intake is 3.5m (W) X 8.85m (H) having top EL 349.85m to avoid any vortex formation.

Desilting Chambers

4 (Four) nos of desilting chambers with a clear distance of 31.5 m between the chambers have been proposed to remove the silt particles of size 0.2 mm and above. The length of the desilting chamber has been proposed as 550 m and 18.5 m width X 28.5 m deep (including hopper) to provide an average flow velocity of 0.324 m/sec. The

silt settled in the desilting chamber shall be collected by silt flushing tunnels through 4 (Four) nos silt flushing conduits further through 2 (Two) nos desilting tunnels. The size of the silt flushing tunnels shall be varying from 0.9m X 1.5m to 1.4m X 1.5m along the length of chamber. Ultimately merging with D shaped tunnel of size 5.5m X 6.0m. The outfall of silt flushing tunnel is about 1.4 km distance of barrage near the adit I area.

Head Race Tunnel

2 (Two) nos of head race tunnel to cater the discharge of 531 cumec having modified horse shoe dia of 9.5 m with a slope of 1 in 350 m has been proposed.

Surge Shaft

2 (Two) nos underground restricted orifice type surge shaft of 28m (D) X 115m (H). The orifice area of 15.39 m^2 including area of gate grooves has been provided.

Pressure Shaft

4 (Four) no of steel lined pressure shafts of 5.4m dia each with length varying from 150 to 226 m has been provided.

Power House Complex

The power house is proposed to be located underground within the rocky hill slope comprising of following components:

- Power house Cavern
- Transformer Cavern
- Down Stream Surge Cavern
- Draft Tube Tunnels, one for each unit
- Main Access Tunnels
- Ventilation / Cable Tunnel
- Interconnecting Gallery
- Drainage cum Escape Tunnel

4 (Four) generating units of 125 MW capacity each have been proposed to be installed in the power house. Vertical Francis Type Turbine has been chosen. The overall size of the cavern is 140m (L), 22m (W) and 50m (H). At one end service bay is provided at floor level of EL 249m.

The salient features of Teesta Stage-VI HEP are given in Table-3.1.

Table-3.1: Salient Features of Teesta Stage-VI HEP

Access to the Project	
By road	Through NH – 31 A from Tarkhola to Singtam
By air	Bagdogra – 95 Km from Project site.
By rail	New Jalpaiguri –85 Km from Project site, Siliguri – 80 Km
Hydrology	
Catchment Area	4500 Sq. Km
Maximum Design Flood	7103 Cumecs

Diversion Design Discharge	700 Cumecs
Reservoir	
Full Reservoir Level (FRL)	EL. 360 m
Minimum Draw Down Level (MDDL)	EL. 354 m
Gross Storage at FRL	3.18 Mm^3
Live Storage	1.83 Mm^3
Area of submergence at FRL	36 ha
Barrage & Appurtenant Works	
Top Elevation	361.5 m
Length at Top	105 m
Crest Elevation	338 m
Downstream Floor Elevation	330.5 m
Maximum Height from Bed	23.5 m
Type of Gates	Radial
No. of Spans	6 Nos.
Size of Gate	12.5 m (W)X 14 m (H)
Thickness of Pier	6 m
Water Conductor System	
Intake	
Type	Bell Mouth, Rectangular
Size	6.5 m (H)X 8.85 m (W)
Number of Units	4 (Four)
Intake Tunnel	4 Nos of 6.5 m Diameter
Desilting Chamber	
Type	Underground
Number	4 (Four)
Shape	Hopper shaped with arched roof
Size	550 m (L) X 18.5 m (H) X8.5 m (W)
Average Velocity	0.324 m/ second
Head Race Tunnel	
Design Discharge	531 cumec
Number	2 (Two)
Shape	Circular
Size	11.8 km (L) X 9.5 m (D)
Surge Shaft	
Type	Underground; Restricted Orifice
Number	2 (Two)
Size	28 m (D) X 115 m (L)
Pressure Shaft	
Type	Vertical
Numbers	4 (Four)
Size	5.40 m (D) X 150 m to 226 m (H)
Shape	Circular
Steel Lining Thickness	24 mm with Stiffeners
Tail Race Tunnel	
Number	2 (Two)
Type	Circular
Size	9.5 m (D) X 1.7 Km (L)
Maximum Tail Water Level	242 m
Minimum Tail Water Level	240 m
Power House Complex	

Type	Underground
Type of Turbine	Francis (Vertical Shaft)
Type of Generator	13.8 KV, 50 Hz Vertical Shaft Synchronous Generator.
Size of Cavern	140 m (L) X 22 m (W) X 50 m (H)
Gross head (Average)	116 m
Net Head (Average)	103.2 m
Transformer Cavern	
Type	Underground
Size of Transformer Cavern	110 m X 15 m X 25 m
Generator Transformer	13.8/400 KV, 3 x 51 MVA, Oil Directed Water Forced Type.
GIS	Accommodated in this Cavern
Down Stream Surge Chamber	
Type	Underground
Size of Cavern	160 m X 18 m X 45.5 m
Pothead Yard	
Type	Surface
Size	30 m X 100 m
Evacuation System	400 KV, D/C Transmission Line from Power House Pothead Yard to Pooling Station

3.3 TEESTA INTERMEDIATE HEP

The project is located on river Teesta, near Melli village of Darjeeling district in West Bengal. Access to the project site lies from left bank from Siliguri-Gangtok route NH 31. All the project components are located on the left bank of the river with its power house at the barrage toe. The barrage site is located about 4 km upstream on Teesta river from Teesta Rangit confluence. The nearest airport is at Bagdora and nearest rail head at New Jalpaiguri. The project is also connected by road with a distance of about 65 km from Siliguri.

In general, the project consists of a diversion barrage, an intake, a surface power house with surface transformer hall and a tail race channel. The project layour map is enclosed as Figure-3.1. The project components are briefly described in following paragraphs.

Diversion Barrage

The diversion barrage is envisaged to be a RCC raft of about 19.5 m in height with its top level at EL 241m, FRL at El 240m and MDDL at El 235 m. The barrage is provided with 7 bays each of 15m X 11.5m to surpass design discharge SPF of 15762m^3/s.

The regulation cum diversion structure is a 136m long barrage across the river at about 5km upstream of the Teesta–Rangit confluence. Besides regulating the discharge, the barrage shall also raise the water level and provide a higher head for power generation. The FRL for the project has been kept at El. 240m. The MDDL has been kept at El. 235m to provide storage for peaking during lean flow period. The water in excess of the requirement of power generation shall be passed through spillway bays, regulated by radial gates. The crest of the barrage has been kept at El. 221.5m. i.e. almost at the river bed so that retrogressive silt flushing near the intakes is effective. Therefore, no separate silt exclusion arrangement has been provided.

Intake Arrangement

The intake structure shall consist four bell mouth opening with trash rack.

Power House Complex

A surface power house of 90m long x 28.50 m wide x 38 high has been provided to house 4 units of 21 MW Bulb turbines. The total installed capacity is 84 MW. A surface Transformer deck has been provided to accommodate (4+ 1 spare) nos. three phase 132 kV transformers, each of 26 MVA capacity.

Tail Race Conduit (TRC)

222 m long Tail Race channel has been proposed to discharge the tailrace water directly into the river at an elevation of 218 m.

PROJECT BENEFITS

The annual energy from the project has been assessed as 419.37 GWh on 90% dependable basis. The project would also provide peaking benefits of 84 MW round the year.

PROJECT COST

The Project is estimated to cost Rs. 7409.34 **million** as

i) Cost of Generation at March 2012 Price Level

a)	Civil Works	3846.73 million
b)	Electro-Mechanical Works	3562.61million

The salient features of Teesta Intermediate HEP are given in Table-3.2. The project layout map is enclosed as Figure-3.1.

Table-3.2: Salient features of Teesta Intermediate HEP

LOCATION		
a)	Project Area	West Bengal
b)	River	Teesta in West Bengal
c)	Barrage Site	Near Melli Village
d)	Power House	Near Melli Village
e)	District	Darjeeling
f)	Latitude	27^0 06’ 17’’ N
g)	Longitude	88^0 28’ 1.7’’E
HYDROLOGY		
a)	Catchment Area	5573 km^2
b)	Design Flood PMF SPF	 20670m^3/sec 15762m^3/sec
RESERVOIR		
a)	Maximum Water Level	E.L.240 m
b)	Full Reservoir Level	E.L.240m

c)	Minimum Draw- Down Level	E.L.235 m
d)	Total Volume	3.603 Million m^3
e)	Peaking Volume	1.943 Million m^3
f)	Storage at MDDL	1.66 Million m^3
g)	Surface Area at FRL	0.495 km^2
h)	Reservoir extent along the river	3.174 km (upto a point 1.4 km d/s of Teesta VI HEP Tail Race Outfall)
BARRAGE		
a)	Type	RCC Raft
b)	Top elevation of barrage	E.L.241 m
c)	Average river bed elevation Rock level	E.L.221.5 m E.L.198.8 m
d)	Height above crest level	19.5 m
e)	Length	136 m, (Straight)
f)	Barrage Axis Orientation	N 86° W to S 86° E
g)	Spillways :	
h)	Barrage Bays No. Size(Radial Gates) Crest EL	 7 15m (W) x 11.5m (H) 221.5 m
i)	Energy Dissipater	Stilling Basin
j)	Stilling Basin Invert	211
INTAKE		
a)	Location	Left Bank
b)	Number	4
c)	Type	Straight intake with bell mouth.
d)	Maximum discharge per unit	148.80 m^3/sec (with10% overload)
e)	Intake C/L level	E.L. 214.0 m
DIVERSION ARRANGEMENT		
a)	Diversion Flood(25 year Non-monsoon)	1706 m3/sec
POWER HOUSE		
a)	Power House	Surface Power House (4 Units)
b)	Alignment	N 86° E to S 86° W
c)	Size **(LxWxH)** of Main Installed capacity	L-90.00m, W-28.5m, H-38.0m
d)	Centre Line of Turbine	E.L.-214.00m
TAIL RACE CHANNEL		
a)	Size	50m X 7m Rectangular
b)	Length of Tail Race Channel	222m
c)	Type of flow	Free Flow
GENERATING PLANT		
TURBINE		
a)	Type	Bulb Type Horizontal Axis
b)	Number	Four (4)
c)	Capacity	21 MW
d)	Design Net Head	17.00 m
e)	Rated Discharge/Machine	135.28 m^3/sec
f)	Speed	125 rpm
GENERATOR		
a)	Type	Horizontal Shaft Synchronous M/C
b)	Number	Four (4)

c)	Capacity	21 MW
d)	Voltage	11 KV
TRANSFORMER		
a)	Type	Three Phase
b)	Number	4+1 (spare)
c)	Capacity	26 MVA
d)	Rated Voltage	11/132kV
ENERGY GENERATION		
a)	Annual Energy Generation(90 % Dependable Year)	419.37 GWhr
b)	Load factor (lean period)	21.08%
c)	Load factor (90%)	56.99 %
TRANSMISSION		
a)	132 KV Lines	1 No. Double Circuit
PROJECT COST		
a)	Civil works	Rs. 3846.73 million
b)	Electro mechanical works	Rs. 3562.61 million
c)	Total Cost	Rs. 7409.34 million
TARIFF		
a)	Levellized Tariff (Rs./Kwh)	3.85
b)	First Year Tariff (Rs./Kwh)	4.52

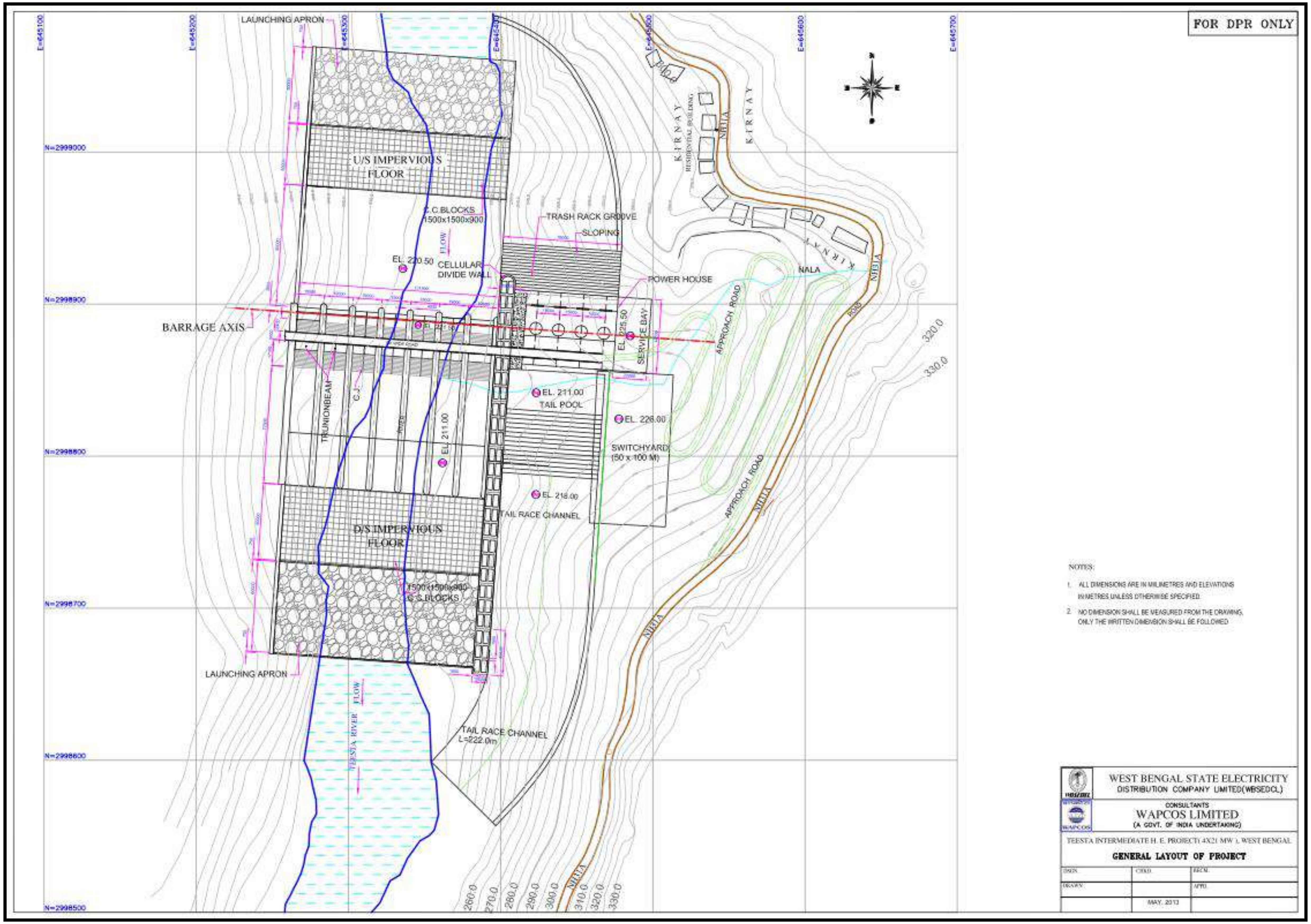


Figure-3.1: Project Layout Map of Teesta Intermediate H.E. Project

3.4 TEESTA LOW DAM I &II COMBINED HYDRO ELECTRIC PROJECT

The Teesta Low I&II Combined hydroelectric project is located on Badi Rangit or Great Rangit River, a principal tributary of Teesta, near Melli village of Darjeeling district in West Bengal. The access to the project site is from right bank from Tessta bazar bridge on river Teesta on Siliguri- Gangtok route NH 31. All the project components are located on the right bank of the river with its power house at the dam toe. The dam site is located at about 2 km upstream on Rangit River from Teesta Rangit confluence. The nearest airport is at Bagdora and nearest rail head at New Jalpaiguri. The project is also connected by road with a distance of about 60 km from Siliguri.

Teesta Low Dam I&II Combined Hydro Electric Project is a run-off-the river scheme with pondage for diurnal peaking to harness the potential of Rangit river, Sikkim. The FRL of the Teesta LDP I&II Combined reservoir has been kept at EL. 254 m which is 4m below the tail water level of which is 258m of Jorethang Loop H.E. project on its upstream, under construction by Dans Energy group.

The tailrace outfall point of the project has been selected where the tail water level is EL. 208.5 m. The river gradient downstream of this point is quite gentle upto the confluence of Rangit river with Teesta river.

The key components of the project are:

- Concrete Gravity dam
- Diversion tunnel
- Intake works
- Surface Penstocks
- Surface Power House
- Tail-race Channel

The project layout map is enclosed as Figure-3.2.

Concrete Dam

Teesta Low Dam I&II Combined H.E. Project which intercepts a total catchment area of 2132 sq. km. envisages construction of a concrete gravity type dam, 74.1 m high above the deepest foundation level and 248 m long at the top. The overall length of the waterway is 161.00m comprising of eight numbers sluice spillway bays, each of 11.5m width, with crest elevation at El. 226.00 m and one number auxiliary spillway bay of 5m width, with crest elevation at El. 251.00 m. The overall length of the non-overflow section of the dam is 42m which consists of one NOF block between intake & overall spillway and one each on either sides. The sluices have been designed to pass the PMF discharge of 21462 cumec. The dam would provide a gross pondage of 22.19 Mm^3 and live pondage of 2.98 Mm^3 between MDDL 251 m and FRL 254 m to enable the power generation envisaged under the project, to cater to diurnal variations in power requirements. The dam top has been kept at El.258.0 m

Diversion Dam

The diversion dam is envisaged to be a concrete gravity dam of about 74.1 m in height with its top level at EL 258m, FRL at El 254m and MDDL at El 251 m. The dam is provided with 8 sluice radial gates each of 11.50 mX15.25 m with one overflow spillway gate to surpass design discharge PMF of 21462 m^3/s.

Intake Arrangement

The intake structure shall consist three bell mouth opening of 5m dia. with trash rack.

Penstock/Pressure Shaft

Three horizontal/vertical steel lined underground pressure shafts, each of 5m to feed the three Francis turbine of 27 MW each.

Power House Complex

A surface power house of 86m long x 20 m wide x 44 high has been provided to house 3 units of 27 MW Francis turbines (Total capacity-81 MW).

A surface Transformer deck at Elevation 217.60 m of size has been provided to accommodate (3+ 1 spare) nos. three phase 132 kV transformers(2 in nos.), each of 33 MVA capacity.

Tail Race Conduit (TRC)

Two concrete lined conduit of 107.5 m and 113.5 m length have been proposed to discharge the tailrace water directly into the river at an elevation of 207 m.

Project Benefits

The annual energy from the project has been assessed as 344.80 GWh on 90% dependable basis and design energy as 323.77GWh. The project would also provide peaking benefits of 81 MW round the year.

Project Cost

The Project is estimated to cost Rs. 8591.00 million or as under:

ii) **Cost of Generation at March 2012 Price Level**

c) Civil Works	Rs.6067.6 million
d) Electro-Mechanical Works	Rs. 2523.4 million

The salient features of Teesta Low Dam I & II HEP is given in Table-3.3.

Table-3.3: Salient features: Teesta Low Dam I & II (combined) H. E. Project

LOCATION		
a)	River	Badi Rangit or Great Rangit in West Bengal
b)	Dam Site	Near Melli Village
c)	Power House	Near Melli Village
d)	District	Darjeeling
e)	Dam Axis	$27^0$05'09'' N to $27^0$05'16'' N, $88^0$24'53'' E to $88^0$24'58'' E
HYDROLOGY		
a)	Catchment Area	2132 km^2
b)	Design Flood	PMF –21462 m^3/sec SPF –15961 m^3/sec
RESERVOIR		
a)	Emergency Level	E.L.257 m
b)	Full Reservoir Level	E.L.254m
c)	Minimum Draw Down Level	E.L.251 m
d)	Total Volume	22.19 Million m^3
e)	Peaking Volume	2.98 Million m^3
f)	Storage at MDDL	19.21 Million m^3
g)	Surface Area at FRL	1.63 km^2
h)	Reservoir extent along the river	8.575 Km (upto a point 1.214 Km d/s of Jorethang loop HEP Tail Race Outfall)
DAM		
a)	Type	Concrete gravity dam
b)	Top elevation of dam	E.L.258 m
c)	Average river bed elevation	E.L.210.5 m
d)	Length	248 m (Straight)
e)	Dam Axis Orientation	N 30° E to S 30° W
f)	Spillways :	
	i) Sluice Spillway -No. -Size -Crest EL -Gate	 8 11.50m (W) x 15.25m (H) 226.0 m Radial Type gates
	ii) Overflow Spillway -No. -Size -Crest EL -Gate	 1 5m (W) x 5m (H) 251m Vertical Lift fixed wheel gates
g)	Energy Dissipator	Trajectory Bucket type
INTAKE		
a)	Location	Right Bank
b)	Number	3
c)	Type	Straight intake with bell mouth.
d)	Maximum discharge	75.933 m^3/sec (With 10% Overload)
e)	Intake C/L level	E.L. 245.50 m
f)	Penstock	3 nos., 5.0 m Dia Circular Steel Lined
g)	Gates	3 nos. 5.0 m x5.0 m Vertical lift fixed wheel gate (service gate)

PENSTOCK		
a)	Type	Steel lined
b)	Number of units	3 nos.
c)	Diameter	5 m
d)	Length(PS-I,PS-II& PS-III)	Length-229.81m
e)	C/C distance between Penstock	15 m
f)	Velocity flow at designed Q	3.52 m^3/sec
DIVERSION TUNNEL		
a)	Location	Right Bank
b)	Length	624.50 m
c)	Dia	12 m, Circular Shaped
d)	Diversion discharge(25 year Monsoon)	1764 m^3/sec
POWER HOUSE		
a)	Power House	Surface Power House (3 Units)
b)	Size (LxWxH) of Main Installed capacity	L-86.00m W-20m H-44m
c)	Centre Line of Turbine	E.L. 205.60m
TAIL RACE CONDUIT		
a)	Size	6m D-shaped
b)	Type of flow	Free Flow
	GENERATING PLANT	
TURBINE		
a)	Type	Vertical Francis
b)	Number	Three (3)
c)	Capacity	27 MW
d)	Design Net Head	42.83 m
e)	Rated Discharge/Machine	69.03 m^3/sec
f)	Speed	187.50 rpm
GENERATOR		
a)	Type	Vertical Shaft Synchronous Machine
b)	Number	Three(3)
c)	Capacity	27 MVA
TRANSFORMER		
a)	Type	Three Phase
b)	Number	3+1(Spare)
c)	Capacity	33 MVA
ENERGY GENERATION		
a)	Average power	13.66 MW
b)	Annual Energy Generation	344.80 GWh
c)	Load factor (lean period)	16.87%
d)	Load factor (average annual)	48.59%
TRANSMISSION		
a)	132 KV Lines	Two Double Circuits
PROJECT COST		
a)	Civil works	Rs. 6067.6 million
b)	Electro mechanical works	Rs. 2523.4 million
c)	Total Cost	Rs. 8591.0 million
TARIFF		
a)	Levellized Tariff (Rs./Kwh)	5.42
b)	First Year Tariff (Rs./Kwh)	6.37
c)	Internal Rate of Return(IRR)	14.02%

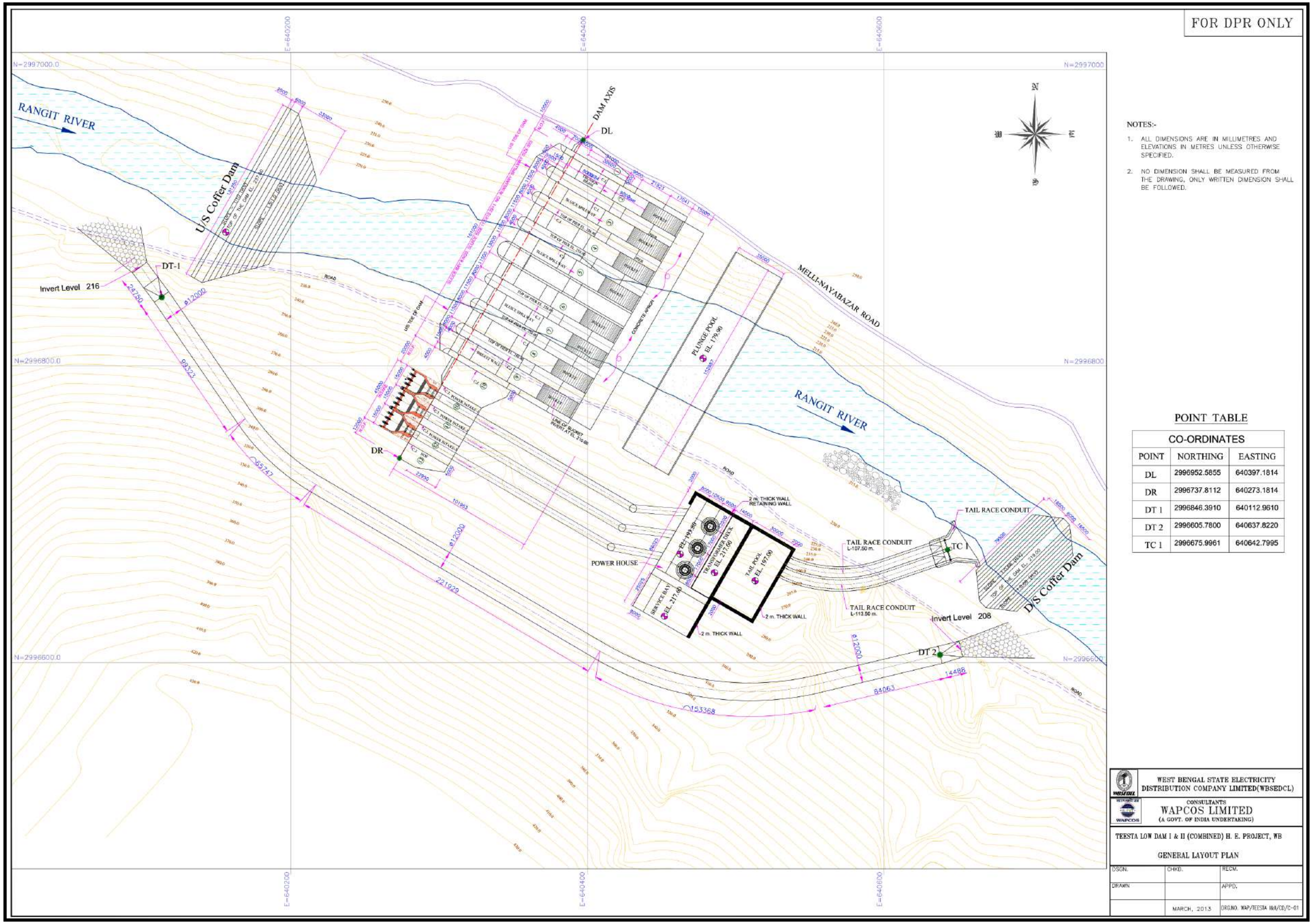


Figure-3.2: Project Layout Map of Teesta Low Dam I & II (Combined) H.E. Project

3.5 TEESTA LOW DAM PROJECT STAGE-III HEP

Teesta Low Dam Project Stage-III is the last but one, in the series of four projects envisaged as a run of the river scheme in a cascade development on the lower stretch of Teesta river. The project is located about 7.2 km downstream of Teesta bridge near Teesta Bazaar village. The project is planned to generate 132 MW of power with a design discharge of 693.6 cumecs, to be utilized over a rated head of 21.34 m. The key components of the project are:

- R.C.C. raft type barrage 32.5 m high, and 140 m long at top
- Cellular type divide wall between barrage and power house.
- Water conductor system comprising of gated intake structures with a 7 m diameter steel penstock for each unit.
- Surface powerhouse of size 125x22x56m housing 4 Kaplan units of 33 MW each
- Tail Race Channel 100 m long

In addition to the above, diversion arrangement comprising of diversion channel alongwith dykes etc. is also envisaged in different phases of construction.

Barrage and spillway

The regulation cum diversion structure is a 140 m long barrage across the river at about 300 m upstream of its confluence with Relli Khola. Besides regulating the discharge, the barrage shall also raise the water level and provide a higher head for power generation. The FRL for the project has been kept at El. 208 m to keep the submergence and related problems to a minimum. The MDDL has been kept at El. 203 m to provide storage for peaking during lean flow period. The water in excess of the requirement of power generation shall be passed through spillway bays, regulated by radial gates. The crest of the barrage has been kept at El 183 m, i.e. almost at the riverbed so that retrogressive silt flushing near the intakes is effective. Therefore, no separate silt exclusion arrangement has been provided. It is also proposed to operate the reservoir at El. 205.5 m during monsoon so as to reduce the quantum of sedimentation in the live storage of reservoir.

Spillway

The spillway has 7 bays with openings of 14 m wide x 18 m high to pass 11130 cumec flood. The spillway bays are separated by 3 m thick piers. The general riverbed at the barrage site is at about El. 182, therefore large radial gates are required to raise the water level to FRL i.e. EL 208 m. A breast wall has been provided between the piers to reduce the gate height. The bottom elevation of the breast wall has been kept at El. 201 m. The bottom of the trunion beam has been kept at El. 195.0, which is above the nappe.

Cellular wall and fish ladder

A cellular wall separates the barrage from the powerhouse complex. The cellular wall shall abut with the last pier of the barrage. A contraction joint has been provided between the two for separation of the wall from the barrage. The top level of the cellular wall varies from El. 209.5 to El. 197m. The wall shall be founded on rock and shall be 20 m wide. The foundation shall be levelled with PCC before laying the bottom raft. The raft shall be anchored to the rock. The cells of the walls shall be formed by R.C.C. panels, which shall then be filled with random fill. A fish ladder has been provided in the body of the cellular wall to allow for fish migration.

Intake and Water Conductor System

The intake structure and the powerhouse are provided in a block configuration in line with the barrage. Separate intakes are proposed for each of the generating units, which shall be connected at the top by a bridge for facilitating the movement of the gantry crane.

A trash rack has been provided upstream of the intakes on the reservoir face for checking the entry of trash into the turbines. The spacing of the trash rack bars shall be lesser than the opening between the runner blades. Separate gantry cranes have been provided for the trash rack cleaning machine and for the intake bulk head gates. A concrete bridge has been provided at the top of the barrage at El 211 m which provides approach to intake structure as well.

Powerhouse and GIS Complex

A surface powerhouse has been provided for housing the electro-mechanical equipment. It is situated on the right bank of the river in juxtaposition to the barrage and is separated from it by a 20 m wide cellular concrete wall. Both the powerhouse and the cellular walls are founded on the rock. The size of the power house shall be about 125x22x56 m. The powerhouse is to be equipped with four Kaplan turbines, each having a capacity of 33 MW. Water shall be released into the tail channel through 22 m long draft tubes.

Tailrace Channel

The water from power house is discharged into the river through a 100 m long tailrace channel. The bed of the channel shall be lined with plain cement concrete. At the end of the channel a 96 m long concrete weir has been provided with its top at El. 178.5 m.

The salient features of Teesta Low Dam Stage-III HEP are given in Table-3.4. The project layout map is enclosed as Figure-3.3.

Table-3.4: Salient features of Teesta Low Dam-III HEP

LOCATION	
• State	West Bengal
• District	Darjeeling

• River	Teesta
• Barrage Site	72 km downstream of Teesta Bridge Latitude 27°00'00" N Longitude 88°27'30"E
• Nearest BG Rail Head	New Jalpaiguri
• Nearest Airport	Bagdogra
HYDROLOGY	
• Catchment Area	7755 sq km.
• Location of Catchment	Latitude 27°00' N to 28°07' N Longitude 88°0'E to 88°53' E
• Annual Average Rainfall	2218 mm
• Average Max. Temperature	37° C
• Average Min. Temperature	8° C
• Maximum Observed discharge at Teesta Bazar	3650 cumec
• Minimum bridge discharge at Teesta Bazar	86 cumec
RESERVOIR	
• Full Reservoir Level (FRL)	EL 208 m
• Min. Draw Down Level (MDDL)	EL 203 m
• Gross Storage	18.36 MCM
• Area under submergence at FRL	156.49 ha
• Capacity at MDDL	11.57 M cum
BARRAGE	
• Type	RCC Raft with Piers
• Top Elevation	EL 211 m
• Crest Elevation	EL 183 m
• Downstream Floor Level	EL 178.5 m
• Length of Floor	175 m
• Length at the top	140 m
• Thickness of D/S Raft	5.5 m
• Upstream floor Level	EL 182 m
• Upstream Floor thickness	2 m
• Thickness of Pier	3.0 m
• Height of Barrage	32.5 m
SPILLWAY	
• Design Flood for Spillway	11130 cumec
• Type	Gated weir with breast wall
• Crest Elevation	EL 183 m
• Number & Size of spillway opening	7 Nos., 14 m (W) x 18 m(H)
• Design Discharge for Energy Dissipator	5565 cumec
• Energy Dissipation	Stilling Basin with End Sill
DIVERSION ARRANGEMENT	
• Type	Diversion Channel and Dykes
• Diversion Capacity	3710 cumec
• Height of concrete coffer wall	18 m
• Height of Dykes	12 m
INTAKE	
• Overt Level	EL 197.75 m
• Invert Level	EL 188.65
• Number & Size of Gate Opening	4 Nos, 7.0 m x 7 m

• Trash Rack	Inclined at 10° Opening size 87.5 m x 24 m with intermediate piers and Beams
• Angle of Trash Rack Cleaning Machine track with stop log gantry	10°
• Stoplogs Openings	4 sets 7 m x 7 m
PENSTOCK	
• Number	Four
• Shape	Circular, Steel Lined
• Length	50 m each
• Diameter	7 m
POWER HOUSE	
• Type	Surface
• Design discharge	693.6 cumec
• Installed Capacity	4 x 33 MW
• Power House Size	125 m x 22 m x 56 m
• Draft Tube Opening (each)	8 openings – 5.95 x 7.4 m
• Gross Head	22.09 m
• Rated net Head	21.34 m
• Type of Turbine	Kaplan
• Service / Bay	EL 197.00 m
• Machine Hall Floor	EL 190.50 m
• Centre Line of M/C	EL 179.00 m
• Bottom of Draft Tube	EL 165.00 m
• Min. Tail Water Level (for one machine)	EL 182.73 m
• Max. tail Water Level (for four machines)	EL 184.24 m
• Max. Flood Level for 11130 cumec	EL 195.10 m
TAIL RACE CHANNEL	
• Shape	Trapezoidal
• Base Width	96 m
• Length	100 m
• Weir Level	El. 178.5 m
POT HEAD YARD	
• Size and Location	60 x 30 m at EL 260m on right bank
POWER GENERATION	
• Annual Energy Generation in 90% dependable year	594.42 MU
PROJECT COST (Stage III)	
• Total Cost	Rs. 856.19 crore
• Civil works	Rs. 534.35 crore
• E&M Works	Rs. 248.68 crore
• IDC	Rs. 73.17 crore
COST OF GENERATION	
• Cost of Energy at bus bar (including 12% free power to state and Return on equity)	Rs. 3.28 per kWH
LEVELISED TARRIF	Rs. 2.87 per kWH

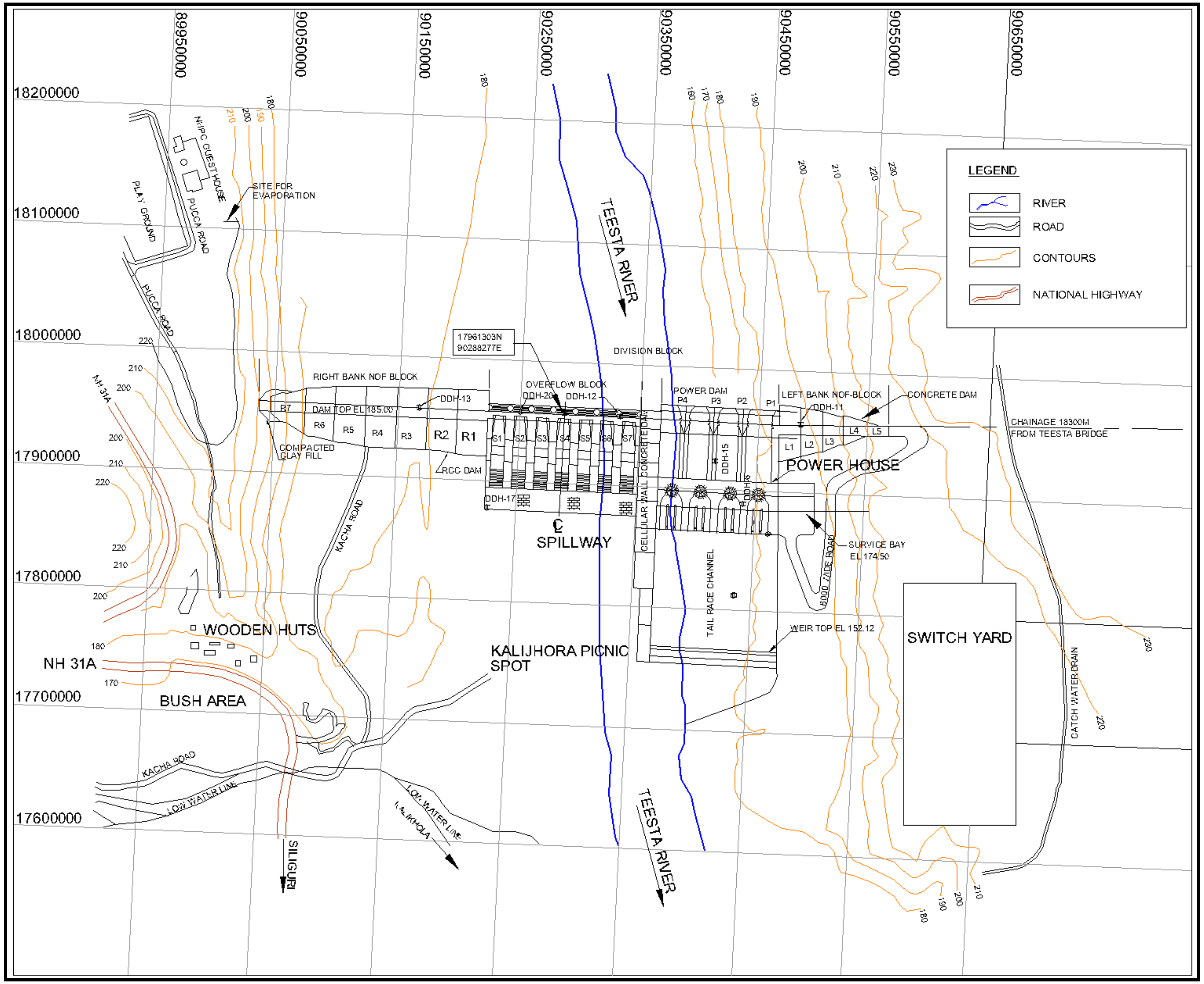


Figure-3.3: Project Layout Map of Teesta Low Dam-III H.E. Project

3.6 TEESTA LOW DAM-IV HEP

The Teesta Low Dam-IV hydroelectric project envisages a concrete gravity dam, about 45 m high from the deepest foundation level and 30 m high from the river bed. The FRL for the dam has been kept at El. 182.25 m and MDDL at El.179 m. The dam top is at El. 185 m. The design discharge is 716 cumec and for 10% overload this works out to 786.5 cumec. A drainage gallery has been provided for the drainage holes and curtain grouting.

- Spillway section
- Power dam
- Left bank N.O.F. section
- Right bank RCC section

The FRL is fixed at El 182.25 m. The minimum drawdown level has been fixed at El. 179 m, based on the optimization studies for power generation and diurnal pondage requirement. The reservoir so formed has a gross storage capacity of 36.63 Mm^3 at FRL. The storage upto El.179 m is 28.72 Mm^3. The live storage is 7.91 Mm^3. The reservoir is spread over an area of 257 ha and major portion is the river and forestland. It extends to about 11 km upstream and the tail of the reservoir almost coincides with the tail water level of the upstream project i.e. TLDP, Stage-III. The pondage required for the peaking power in stage-IV shall be augmented from the regulated release of water from the Stage-III reservoir.

Spillway

The spillway is 128 m long comprising of 7-spillway bay and is equipped with radial gates to pass a design discharge of 15400 cumecs (PMF). The spillway is a low-level orifice type and is provided with radial gates with crest at El. 157 m.

Intakes

Each of the intakes shall be provided with quick acting gates for regulation. A set of stop logs has been provided for maintenance purpose. As length of water conductor system is very small, no MIV is provided in the powerhouse and the quick acting intake gates shall suffice. The invert level of the intake has been kept at El 164.5 m, in order to restrict the entry of silt into the penstocks. The design discharge is 786.5 cumec, which is corresponding to 10% overload conditions.

Powerhouse Complex

A surface powerhouse has been provided for housing the electro-mechanical equipment. It is situated on the left bank of the river in block configuration with the dam and is separated from it by the cellular concrete wall. Both the powerhouse and the cellular walls are founded on the rock. The size of the power house shall be about 130x24x63 m. The powerhouse is to be equipped with four number Kaplan turbines, each having a capacity of 40 MW. The service bay has been kept at El.174.50 m, which is higher than the maximum expected flood level. The machine hall floor is kept at El.159.15 m. Water shall be released into the tail channel through 29 m long draft tubes.

Tailrace Channel

The water from Power House will be discharged into the river through a 98 m long tailrace channel. The bed of the channel shall be lined with reinforced cement concrete. The left side of the channel is formed by hill slope cut in rock and overburden.

Fish Ladder Gate

Two nos. slide type gates of structural steel construction for opening size 1.0 m x 1.4 m with two sets of embedded parts have been provided for migration of fish from upstream to downstream and vice-versa. The gate shall have upstream skin plate and sealing. The gate shall be designed to close under flowing water condition corresponding to FRL i.e. EL 182.25 m. The sill of the gates are located at EL 181.0 m and 178.0 m respectively. The lifting of the gates shall be under unbalanced condition and the operation of gates will be done by means of suitable capacity manually operated screw hoists mounted on hoist supporting structure.

The salient features of Teesta Low Dam – IV HEP are given in Table-3.5. The project layout map is enclosed as Figure-3.4.

Table-3.5: Salient features of Teesta Low Dam-IV HEP

LOCATION	
• State	West Bengal
• District	Darjeeling
• River	Teesta
• Dam Site	18.3 km downstream of Teesta Bridge on NH 31A
• Power House	50 m downstream of Dam axis on the left bank
• Nearest BG Rail Head	New Jalpaiguri
• Nearest Airport	Bagdogra
HYDROLOGY	
• Catchment Area	8021 sq. Km.
• Location of Catchment	Latitude 26°55'32" N to 28°07' N Longitude 88°0'E to 88°53' E
• Annual Average Rainfall	2218 mm
• Average Max. Temperature	37°C
• Average Min. Temperature	8°C
• Maximum Observed discharge at coronation bridge	5090 cumec
• Minimum bridge discharge at coronation bridge	100 cumec
RESERVOIR	
• Full Reservoir Level (FRL)	EL 182.25 m
• Min. Draw Down Level (MDDL)	EL 179.0 m

• Gross Storage	36.63 MCM
• Live Storage	7.91 MCM
• Area under submergence at FRL	257.26 ha
DAM	
• Type	Concrete Gravity / RCC
• Top Elevation	EL 185.00 m
• Length at the top	511 m
• Height of Dam above river bed level	30 m
• Height of Dam above deepest FDN Level	45 m
SPILLWAY	
• Design Flood	15400 cumec (PMF)
• Type	Sluice type with breast wall
• Crest Elevation	EL 157 m
• Number & Size of spillway opening	7 Nos., 11 m (W) x 17 m(H)
• Energy Dissipation	Solid Roller Bucket
• Bucket Invert	EL 145.00 m
DIVERSION ARRANGEMENT	
• Type	Stage Diversion (Channel with u/s and d/s coffer dams and Dykes)
Diversion Channel	
• No. of Channels	1
• Shape and Size	Trapezoidal; Base width – 40 m & Top width – 75 m
• Length	660 m
• Diversion Capacity	4000 cumec
Coffer Dams	
• Type	Rockfill with central clay core
• Length U/S Coffer Dam D/S Coffer Dam	 200 m 200 m
• Height U/S Coffer Dam D/S Coffer Dam	 11 m 10 m
INTAKE	
• Invert Level	EL 164.50 m
• Number of intakes	4 Nos
• Gate Opening	7 m (W) x 7 m (H)
• Design Discharge (with 10% overload)	787.60 cumec
• Trash Rack	Front face inclined opening area 16 m (W) x 13 m (H)
• Stoplogs	1 set of Stoplog (7 m wide)
PENSTOCK	
• Number	Four
• Shape	Circular, Steel Lined
• Length	45 m each
• Diameter	7 m

POWER HOUSE	
• Type and Location	Surface, Left Bank
• Design discharge	716.00 cumec
• Type of Turbine	Kaplan
• Installed Capacity	4 x 40 MW
• Power House Size	130 m x 24 m x 63 m
• Gross Head	25.76 m
• Rated net Head	25.05 m
• Draft Tube Gate	4.87 M(W) x 6.50 m (H) 3 Nos. for each unit
• Top of power house	EL 196.50 m
• EOT Gantry Level	EL 187.50 m
• Service Bay	EL 174.50 m
• Machine Hall Floor	EL 162.00 M
• Centre Line of M/C	EL 150.60 m
• Bottom of Draft Tube	EL 133.60 m
• Tail Water Level (for 1 machine)	EL 153.00 m
• Tail Water Level (for 4 machines)	EL 155.40 m
• High Flood level (for 15400 cumecs)	EL 173.85 m
TAIL RACE CHANNEL	
• Shape	Trapezoidal
• Number	1
• Bottom Width	100 m
• Length	98 m
• Weir Level	El. 152.12 m
SWITCHYARD	
• Size and Location	200 m x 95 m; Left Bank; EL± 210/215.00 m
• Type	Surface
PROJECT COST	
• Total Cost	Rs. 1114.26 crore
• Civil works	Rs. 698.77 crore
• E&M Works	Rs. 314.32 crore
• IDC	Rs. 101.17 crore
COST OF GENERATION	
• Cost of Energy at bus bar (including 12% free power to state and Return on equity)	Rs. 3.46 per kWH
LEVELISED TARRIF	Rs. 2.73 per kWH

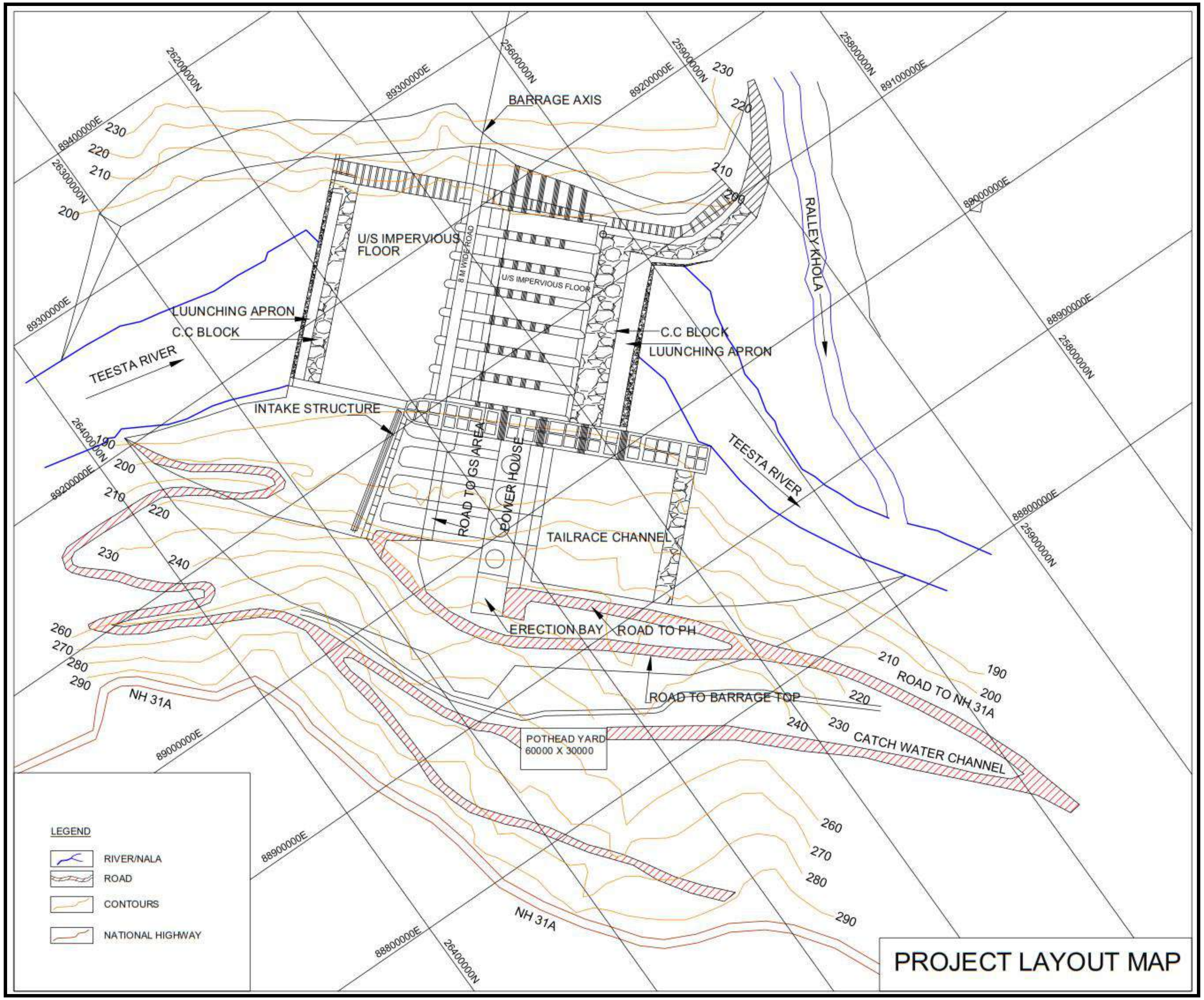


Figure-3.4: Project Layout Map of Teesta Lower Dam-IV H.E. Project

3.7 TEESTA LOW DAM-V HEP

The barrage axis site of Teesta Low Dam-V HEP is located about 931.33 m upstream of Sevoke Rail Bridge and 1482.28m downstream of the Coronation Bridge. The project is planned to generate 80 MW of power with a design discharge of 700 cumec, to be utilized over a rated head of 13 m. The principal components of the project are:

- R.C.C. raft type barrage 19m high, and 144m long at top.
- 20m wide Cellular type divide wall between barrage and power house.
- Water conductor system comprising of gated intake structures with a 7.6m diameter steel penstock for each unit.
- Surface powerhouse of size 80(W) X 48.5(L) X 31(H) m housing 4 Bulb units of 20 MW each.
- Tail Race Channel of 100 m length.
- In addition to the above, the diversion arrangement comprising of diversion channel alongwith dykes etc. Is also envisages in different phases of construction.

Barrage and Spillway

The regulation cum diversion structure is a 141m long barrage across the river at about 800m upstream of Sevoke Rail Bridge. Besides regulating the discharge, the barrage shall also raise the water level and provide a higher head for power generation. The FRL for the project has been kept at El. 154m. The MDDL has been kept at El. 151 m to provide storage for peaking during lean flow period. The water in excess of the requirement of power generation shall be passed through spillway bays, regulated by radial gates. The crest of the barrage has been kept at El. 138m. i.e. almost at the river bed so that retrogressive silt flushing near the intakes is effective. Therefore, no separate silt exclusion arrangement has been provided.

Spillway and Energy Dissipation

The spillway has 8 bays with openings of 15m wide x 12m high to pass 12226 cumecs flood. The spillway bays are separated by 3m thick piers the general river bed at the barrage site is at about El. 138 therefore, large radial gates are required to raise the water level to FRL i.e. El. 154m. A breast wall has been provided between the piers to reduce the gate height. The bottom elevation if the breast wall has been kept at El. 150m. The bottom of the trunion beam has been kept above the nappe. A conventional stilling basin type energy dissipation arrangement of 71m length has been provided with its floor at El. 135 m. This will dissipate the energy of flow by the formation of hydraulic jump.

Cellular Wall and Fish Ladder

A cellular wall separates the barrage from the Powerhouse complex. The cellular wall shall abut with the last pier of the barrage. The top level of the cellular wall varies from El. 155.5 to El. 148m. The wall shall be founded on rock and shall be 20m wide. The foundation shall be levelled with PCC before laying the bottom raft. The raft shall be anchored to the rock. The cells of the walls shall be formed by R.C.C. panels, which shall then be filled with random fill. A fish ladder has been provided in the body of the fish ladder.

Intake and Water Conductor System

The intake structure and the powerhouse are provided in a block configuration in line with the barrage. Separate intakes are perceived for each of the generating units, which shall be connected at the top by a bridge for facilitating the movement of the gantry crane.

The intake structures forms an angle of 10° with the barrage axis and one intake for each of the individual units. Therefore intakes on the right are comparatively towards upstream in the reservoir in comparison with the intake on the left. This avoids the obstruction to the entry of water into the intakes. Each of the units shall be provided with quick acting gates in the intake for regulation. As length of water conductor system is very small, no MIV is provided in the powerhouse and the quick acting intake gates shall suffice. The invert level of the intake has been kept at El. 140 m, in order to restrict the entry of silt into the penstocks.

A trash rack has been provided upstream of the intakes on the reservoir face for checking the entry of trash into the turbine. The spacing of the trash rack bar shall be lesser than the opening between the runner blades. The axis of the trash rack makes an angle of 10° with barrage axis. Separate gantry cranes have been provided for the trash rack cleaning machine and for the intake bulk head gates.

A concrete bridge has been provided at the top of the barrage at El. 157m which provides approach to intake structure as well.

Powerhouse Complex

A surface powerhouse has been provided for housing the electro-mechanical equipment. It is situated on the right bank of the river in juxtaposition to the barrage and is separated from it by a 20m wide cellular concrete wall. Both the powerhouse and the cellular walls are founded on the rock. The size of the Power House shall be about 80(W) x 48.5(L) x 31(H) m. The powerhouse is to be equipped with four number Bulb turbines, each having a capacity of 20 MW. The service bay has been kept at El. 142m,

Tailrace Channel

The water from Power House is discharged into the river through a 100m long tailrace channel. The bed of the channel shall be lined with plain cement concrete. The right side of the channel is formed by hill slope cut in rock. The same shall be protected by shotcrete, rock bolts etc.

The salient features of Teesta Low Dam-V HEP are given in Table-3.6. The project layout map is enclosed as Figure-3.5.

Table-3.6: Salient features of Teesta Low Dam-V HEP

Location	
▪ State	: West Bengal
▪ District	: Darjeeling
▪ River	: Teesta
▪ Nearest BG Rail Head	: New Jalpaiguri
▪ Nearest Airport	: Bagdogra
▪ Latitude & Longitude	: $26^0$53'16"N 88^0 28' 26" E
Hydrology	
▪ Catchment Area	: 8210 sq.km
▪ Average maximum temperature	: 28.7^0C
▪ Average minimum temperature	: 6^0C
Reservoir	
▪ Full Reservoir level (FRL)	: 154m
▪ Minimum draw down level (MDDL)	: 151m
▪ Gross storage	: 6.75 Mcum
▪ Area under sub-mergence at FRL	: 82.50 Hact
▪ Capacity at MDDL	: .4.58 Mcum
▪ Live Storage	: 2.17 Mcum
Diversion Structure	
▪ Type	: Barrage
▪ Top elevation	: 157 m
▪ Crest elevation	: 138.0m
▪ Downstream floor level	: 135.0m
▪ Length of floor	: 111.0m
▪ Thickness of raft	: 5.50m
▪ Thickness of Pier	: 3.0m
▪ Height of Barrage	: 19.0m
▪ River bed level u/s & d/s	: 138.0m & : 137.0 m
▪ Design flood (SPF)	: 12226 cumec
Bays	
▪ Crest elevation	: 138.0m
▪ Number & size of opening	: 8 bays of 15m each
▪ No. & size of Gates	: 8 No.& 12m
▪ Size of service gates	: 15x12m
Intake	
▪ Overt level	: 157 m
▪ Invert level	: 140 m
▪ Number & size of gate opening	: 4 Nos.
▪ Emergency openings	: 4 Nos.

Penstock ▪ Number ▪ Shape ▪ Length ▪ Diameter	: 4 : Circular : 30m : 7.6m
Power House ▪ Type ▪ Installed capacity ▪ Number of units ▪ Unit size ▪ Power house size ▪ Type of turbine ▪ Rated head to turbine ▪ Transformer ▪ Rated Discharge **Important Elevation** ▪ Service bay ▪ Centre line of Turbine ▪ Bottom of draft tube ▪ Minimum tail water level (one machine) ▪ Maximum running Tail water level (all four machines) ▪ HFL SPF	: Surface : 80 MW : 4 Nos. : 20 MW : 80(W) X 48.5(L)X 31(H) : Bulb : 13m : 25MVA 11/132 KV 3-phase : 699.84 cumec : 142.0m : 133.19m : 128.40 m : 138.5 m : 140.5m : 147.5m
Tail Channel ▪ Shape ▪ Base width ▪ Length	: Rectangular : 40.0m : 100.0m
Switch Yard ▪ Voltage level	: 132 kV
Energy generation ▪ Annual energy generation in 90% dependable year	: 382.25 GWh
Plant Load Factor	
Average Annual load factor%	54.55
Lean Period Load factor%	20.80
Project cost ▪ Hard cost ▪ Civil works ▪ E & M works ▪ IDC	520.43 crore : 335.781 crore : 184.65 crore : 93.24 crores
Levelised Tariff (Rs./kwh) First Year Tariff (Rs./kwh)	: 2.80 : 3.31

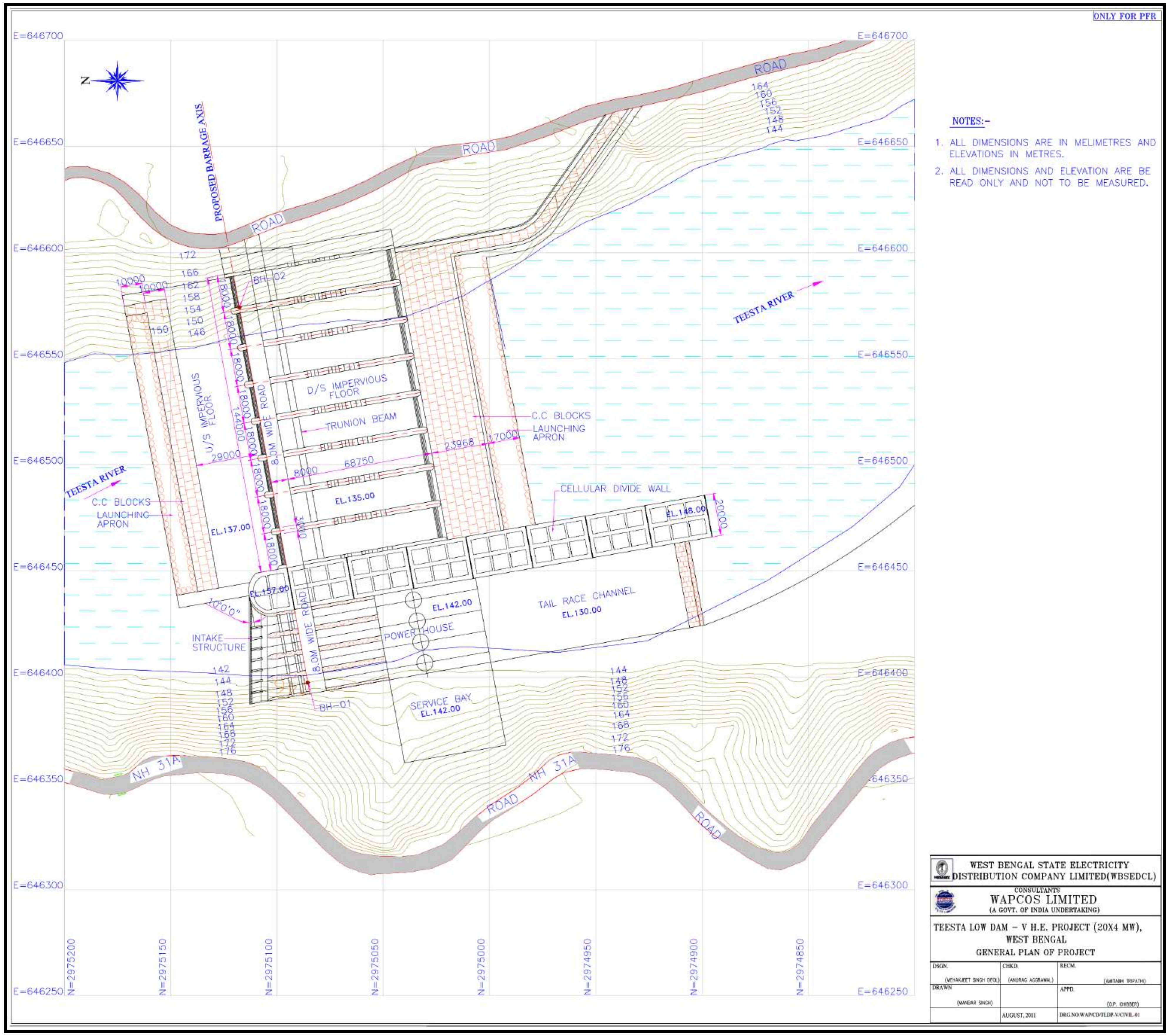


Figure-3.5: Project Layout Map of Teesta Lower Dam-V H.E. Project

3.8 JORETHANG LOOP HEP

The Dans Energy Private Limited (DEPL), an independent power producer signed an MOU with the Sikkim The Jorethang Loop Hydroelectric Power Project, a run-of-river hydro-electric project is the terminal project in the cascade development of five projects (the upstream four projects conceived by CWC are the Rangit Stages I to IV) planned on the Rangit River in Sikkim, which is a tributary of the Teesta River (the main river of the State of Sikkim). It is located in South / West district of Sikkim about 5 km upstream of Jorethang town.

The project envisages a barrage with silt excluder arrangement on the main Rangit river near the village Pipley, a Power Intake on the left bank to divert the flows into a 6.8 km long Head Race Tunnel along the chord of the Jorethang Loop, a Surge Shaft of 25 m diameter, Pressure Shaft, a surface Powerhouse at the confluence of the Rangit river with Bhari Khola with installation of 96 MW (two units of 48 MW capacity each), a Tailrace pool, an outdoor 220 KV Switchyard just above the Powerhouse, and 220 KV Double Circuit Transmission line of 13 km length to evacuate the power to the grid station at Melli. The plant will have an installed capacity of 96 MW and a total average annual energy generation (50 % dependable Year) of around 535 GWh.

Jorethang Loop HEP is a run-of-river scheme with minimal storage of 0.63 MCM and no people rendered homeless or landless. The submergence area that will be created due to the construction of the diversion structure is only 14.48 ha (at FRL), none of which comes under private land or renders anyone homeless or landless.

The project has been accorded final environmental clearance in July 2006. The Forest Clearance for the project was received in May 2008.

The salient features of Jorethang HEP is given in Table-3.7.

Table-3.7: Salient features of Jorethang HEP

Location	
State	Sikkim
District	South and West District
Latitude	27° 09’ 37” N
Longitude	88° 17’ 47” E
Barrage	
Type	Gravity Floor on Permeable Foundation
Height of Barrage (from River Bed level)	15 m
Silt excluder tunnels	Three (2.67mx3m each) located below the under sluice on intake side
Number of Gates	Seven Vertical Lift Gates – Five spillway Gates and Two under sluice gates
HRT	
Shape in cross-section	Modified horseshoe
Length	6867 m

Diameter	7.10 m (Finished)
Lining	Fully concrete lined
Design discharge	140.00 m^3/sec.
Surge Shaft	
Type	Restricted orifice type vertical
Diameter of Surge Shaft	25.0 m
Height	62 m
Penstock	
Type and diameter	Steel lined of 6.0m dia bifurcating into two of 4.25m at power house end
Design discharge	140.0 m^3/sec
Total length	315m
Power House	
Type	Surface
Number of Units	Two (2)
Installed capacity	96 MW
Machine Type	Vertical Axis Francis Turbine
TRC	
Type	Tail Race Pool
Design Discharge	140 m3/sec.
Switchyard & Transmission	
Switchyard Type	Outdoor
Voltage/ Bus bars	220 kV/ 11 kV
Transmission Line Type	Switchyard to Grid station at Melli, double circuit, 220 kV on same towers
Length	10 km

3.9 RAMMAM STAGE-I HYDROELECTRIC PROJECT

The Rammam Hydel Project, Stage-I envisages to harness the hydro power potential of Rammam river in its upper reaches between El.2074m to El 1542m.

The project lies within longitudes 88°04'00" E & 88°06'00" E and latitudes 27°07'00" N & 27°10'00" N. The project envisages a surface power house, situated on the right bank of Rammam river. The salient features of Rammam Stage-I HEP are given in Table-3.8 and the project layout is enclosed as Figure-3.6.

Table-3.8: Salient features of Rammam Stage-I HEP

A	**General**	
1.	State	West Bengal
2.	District	Darjeeling
3.	River	Rammam
4.	Coordinates	88°04'00"E to 88°06'00" E and 27°07'00" N to 27°10'00"N
5.	Access: ➢ Road (from Siliguri	➢ Ghoom on NH 55 – 78 km ➢ Ghoom to Rimbick by all weather road – 75 km ➢ Rimbick to site on foot track – 10 km
	➢ Rail	Nearest Broad gauge railway station – Siliguri Junction

	➢ Air	Nearest airport – Bagdogra – 12 km from Siliguri
B.	**Scope**	
	Installation	4 (four) units of 12 (twelve) MW each (48 MW)
C.	**Hydrology**	
1.	Catchment area a. Rammam b. Shirikhola	 68.53 km^2 43.27 km^2 (=16.61 + 26.66)
2.	Mean Annual rainfall	2480 mm
3.	Annual Dependable flow (from data series) (cumec)	

Data series basis	90 %			50 %		
	Maximum	Minimum	Year	Maximum	Minimum	Year
10-daily (1965-76)	46.00	1.79	1969-70	50.01	1.83	1966-67

D.	**Project Features**			
1.	**Intake**			
		Rammam	Partham Khola	Shiri Khola
	a. Type	Drop Type	Drop Type	Drop Type
	b. Length (m)	15.00	10.00	10.00
	c. Top Width (m)	2.50	2.50	2.50
	d. Slope	1:10	1:10	1:10
	e. Invert level (m)	2069.0	2076.0	2069.0
	f. Design Discharge (cumec)	10.00	3.00	5.00
2.	**Water Conductor System**			

		Rammam	Partham Khola	Shiri Khola	Combined upto Forebay
a.	Type of Tunnel (Horse-shoe)	Gravity	C.C. Duct (gravity)	Gravity	Gravity
b.	Internal finished diameter (m)	3.00	3.5 x 2.5	3.00	3.00
c.	Length (km)	2.56	0.60	2.66	1.24
d.	Design Discharge at intake (cumec)	10.00	3.00	5.00	13.40
e.	Slope	1:450	1:300	1:480	1:450

3.	**Forebay**	
a.	Type	Open pond formed by R.C.C. retaining wall
b.	Capacity (m^3)	22,000
c.	Full Supply Level (FSL) (m)	EL. 2061.50
d.	Minimum drawdown level (m)	EL. 2057.50
e.	C.L. of Intake (m)	EL. 2054.39
4.	**Penstock**	
a.	Number/Diameter	02 (two) nos. 1.40 m ∅ 04 (four) nos. 1.00 m ∅
b.	Length	1.40 m ∅ - 2x1024.00 m 1.00 m ∅, 4x24.00 m
5.	**Power House**	
a.	Type	Surface

b.	Dimensions (m)	65 m (L) x 25 m (B)
c.	Service bay elevation (m)	EL. 1611.00
d.	Installed capacity (MW)	(4x12 MW) 48 MW
e.	Type of machine	Horizontal shaft pelton wheel
f.	C.L. of turbine (m)	EL. 1610.00
g.	Maximum net operating head (m)	441.50
h.	Minimum net operating head (m)	437.50
i,	Unit Discharge (cumec)	3.00
6.	**Tail Race Channel**	
a.	Size (m)	2.50 x 2.50
b.	Length (m)	80.00
c.	Slope	1:300
d.	Maximum flood level in river near power station (m)	EL. 1603.00
7.	**Switchyard**	
a.	Location	Near Power house
b.	Dimensions (m)	72.00 (m) x 40.00 (m)
c.	Level (m)	EL. 1625.00
8.	**Power Generation**	
	Annual Energy Generation	
a.	90% dependable year (GWh)	209.358
b.	50% dependable year (GWh)	212.288
c.	Design Energy (90% dependable year) (GWh)	201.491
E.	**Construction Cost**	
a.	Hard Cost	Rs. 376.94 crore Approx.
b.	I.D.C.	Rs. 57.17 Crore Approx.
c.	Total Cost	Rs. 434.11 Crore Approx.
F.	**Cost of Generation**	
a.	Cost per MW of Installed Capacity	Rs. 9.04 Crore (including IDC)
b.	Cost of Generation (Level. Tariff)	Rs. 4.26 per kWh

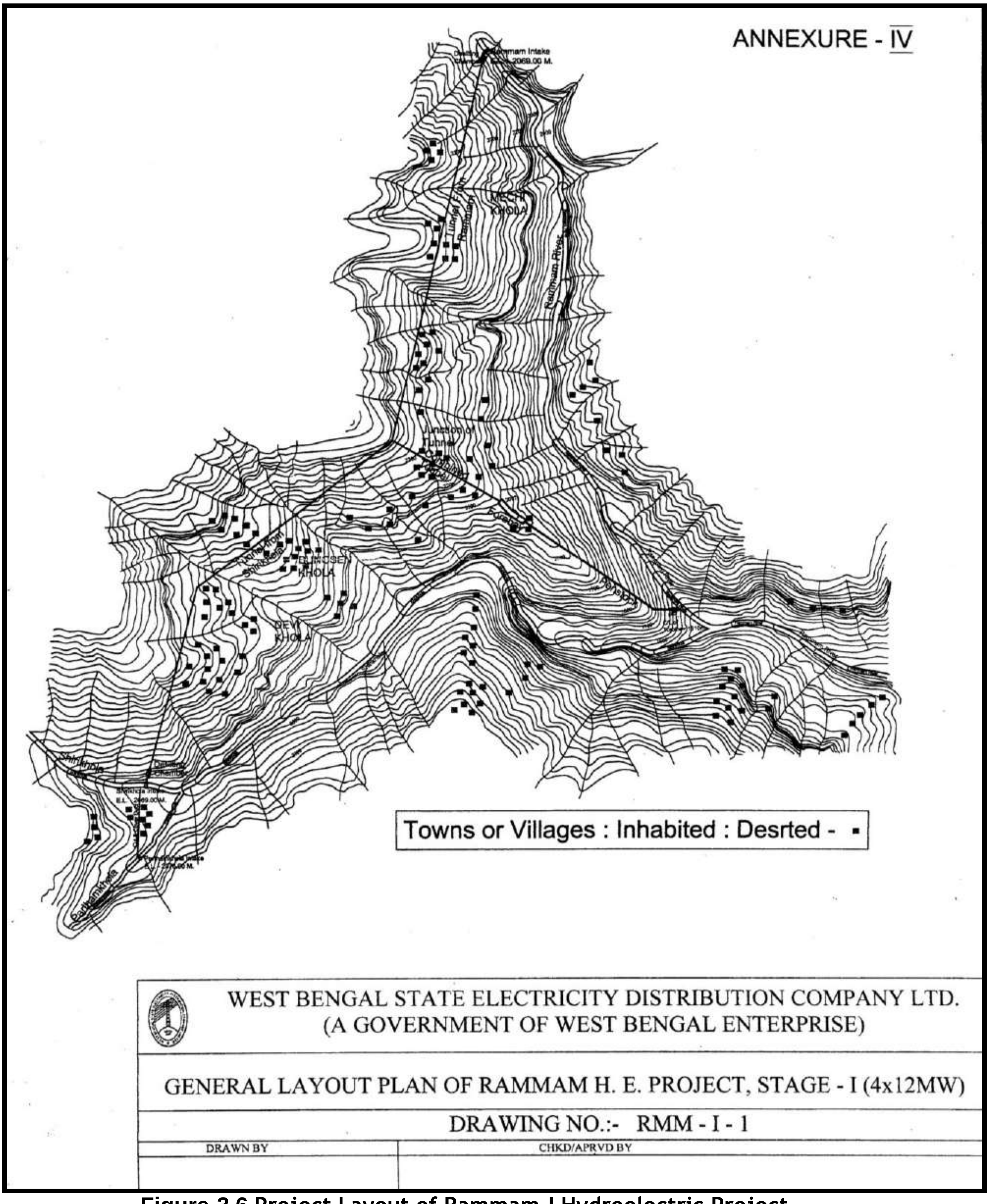


Figure-3.6 Project Layout of Rammam-I Hydroelectric Project

3.10 RAMMAM INTERMEDIATE HYDRO ELECTRIC PROJECT

The Rammam Intermediate Stage Hydro Electric Project (RISHEP) is envisaged as a run-of-the river scheme, for utilisation of residual head in between Rammam Stage-I tail race to Rammam Stage-II intake, for development of power potential in the head reaches of River Rammam which is a tributary of Rangit. The diversion site is located near Rajaphir village. The coordinates of the site are 27º07'56.02"N and 88º05'50.97"E. The powerhouse is located near village Rammam, with coordinates are 27º07'52.31" N and 88º06'07.77"E. The installed capacity of the project is (2 x 6) 12 MW and is expected to generate 49.51 GWh in a 75% dependable year which would help in adding to the Hydro Power which is the need of the North Bengal system of Eastern Regional Grid.

The head works can be approached by access roads Siliguri-Rammam of via nearest railway station at Ghoom & New Jalpaiguri. The salient features of the project are given in Table-3.9. The project layout is enclosed as Figure-3.7.

Table-3.9: Salient features of Rammam Intermediate HEP

Location	
State	West Bengal
District	Darjeeling
River/Tributary	Rammam
Diversion Barrage	27º07'56.02"N, 88º05'50.97" E
Power House Site	27º07'52.31"N, 88º06'07.77" E
Hydrology	
Catchment Area at intake site	153.96 km^2
Design Discharge	16.87 m^3/s
Design Flood	1040 m^3/s
Diversion Flood	75 m^3/s
Diversion Structure	
Type	Barrage
No. of Bays	3 bays
Length of Barrage	21 m
Maximum height from RBL	13 m
Top EL of Barrage	EL 1532.0 m
Average River Bed Level	EL. 1519.0 m
FRL	EL. 1530.0 m
MDDL	EL.1526.0 m
Pondage	0.0083 Mm^3
U/S HFL	EL 1530.00
D/S HFL	El. 1518.30
Crest Level for Spillway bays	EL 1519.0 m
Intake	
Type	RCC structure with breast wall and vertical gate and trash rack provisions
Size	Elliptical mouth opening of 3.25 m (W) x 2.5m (H)
Length	10.5 m
Invert level of mouth	EL. 1521.0 m

<table>
<tr><td>Intake Tunnel</td><td></td></tr>
<tr><td>No.</td><td>1</td></tr>
<tr><td>Size and shape</td><td>3.25 m diameter D shaped</td></tr>
<tr><td>Length</td><td>62.5 m</td></tr>
<tr><td>Velocity at intake</td><td>1 m/s</td></tr>
<tr><td>Slope</td><td>1 in 250 till desilting chamber</td></tr>
<tr><td>Desilting Chamber</td><td></td></tr>
<tr><td>Type</td><td>Underground</td></tr>
<tr><td>Shape</td><td>Closed dome shaped with hopper</td></tr>
<tr><td>No. of Basin</td><td>1</td></tr>
<tr><td>Size of Basin</td><td>130 m (L) x 7 m (W) x 11.25 m (H)
Including dome and hopper</td></tr>
<tr><td>Minimum size of particles to be removed</td><td>0.2 mm</td></tr>
<tr><td>Settling velocity</td><td>2.64 cm/s</td></tr>
<tr><td>Silt Flushing Arrangement</td><td></td></tr>
<tr><td>No. and size</td><td>2 nos. RCC conduits (0.5 m wide and increasing depth from 0.2 m to 1 m). These conduits exit the desilting chamber into 3.5 m diameter D shaped tunnel which will flush to the nearest river.</td></tr>
<tr><td>Discharge capacity</td><td>3.31 m^3/s</td></tr>
<tr><td>Flushing velocity</td><td>>3 m/s</td></tr>
<tr><td>Size & Shape of silt flushing tunnel</td><td>3.5 m diameter, D shaped</td></tr>
<tr><td>Length</td><td>128 m</td></tr>
<tr><td>Head Race Tunnel</td><td></td></tr>
<tr><td>Type and size</td><td>3 m diameter, D shaped</td></tr>
<tr><td>Length</td><td>173.6 m</td></tr>
<tr><td>Velocity of nominal discharge</td><td>2 m/s</td></tr>
<tr><td>Slope</td><td>1 in 346 till pressure shaft</td></tr>
<tr><td>Thickness of concrete lining</td><td>250 mm in class I-IV and 400 mm in Class V</td></tr>
<tr><td>Penstock</td><td></td></tr>
<tr><td>Type</td><td>Steel lined circular</td></tr>
<tr><td>Grade</td><td>ASTM 537 Class I</td></tr>
<tr><td>Size of main pipe</td><td>2.4 m diameter</td></tr>
<tr><td>Length</td><td>79 m till bifurcation
Bifurcation
<table>
<tr><td>Dia (m)</td><td>Length (m)</td></tr>
<tr><td>1.7</td><td>51.16</td></tr>
<tr><td>1.7</td><td>57.23</td></tr>
<tr><td>Thickness of steel liner</td><td>10 mm throughout</td></tr>
</table></td></tr>
<tr><td>Power House</td><td></td></tr>
<tr><td>Location</td><td>Near Rammam</td></tr>
<tr><td>Type</td><td>Surface</td></tr>
<tr><td>Installed Capacity</td><td>(2x6) 12 MW</td></tr>
<tr><td>Type of Turbine</td><td>Horizontal Francis</td></tr>
<tr><td>C/L turbine</td><td>EL 1446 m</td></tr>
<tr><td>Design Head</td><td>81.93 m</td></tr>
<tr><td>Dimensions of Power House</td><td>37 m (L)x13m(W) x 22.2 m (H)</td></tr>
<tr><td>Minimum Tail Water Level</td><td>EL 1445.0 m</td></tr>
<tr><td>Maximum Tail Water Level</td><td>EL 1446.0 m</td></tr>
</table>

Tail Pool	
Length of pool	Roughly 9 m, average of both banks
Width of pool	15.8 m at the start, the end walls tapering at 45” to meet Rammam river
Transmission Line	
No. of lines	One no. of Double circuit
Length of Each line	10 km
Voltage	33 kV
Power Generation	
Installed capacity	12MW
Design Energy Generation	
75% dependable year	49.00 GWh
Plant Load factor	48%
Cost Estimate	
Civil & HM works	Rs. 73.16 crore
Electromechanical works (including switchyard)	Rs. 19.67 crore
Transmission works	Rs. 1.28 crore
Total cost of project including Transmission cost	Rs. 94.11 crore
IDC & Financing charges	Rs. 5.08 crore
Total project cost (including IDC)	Rs. 99.19 crore

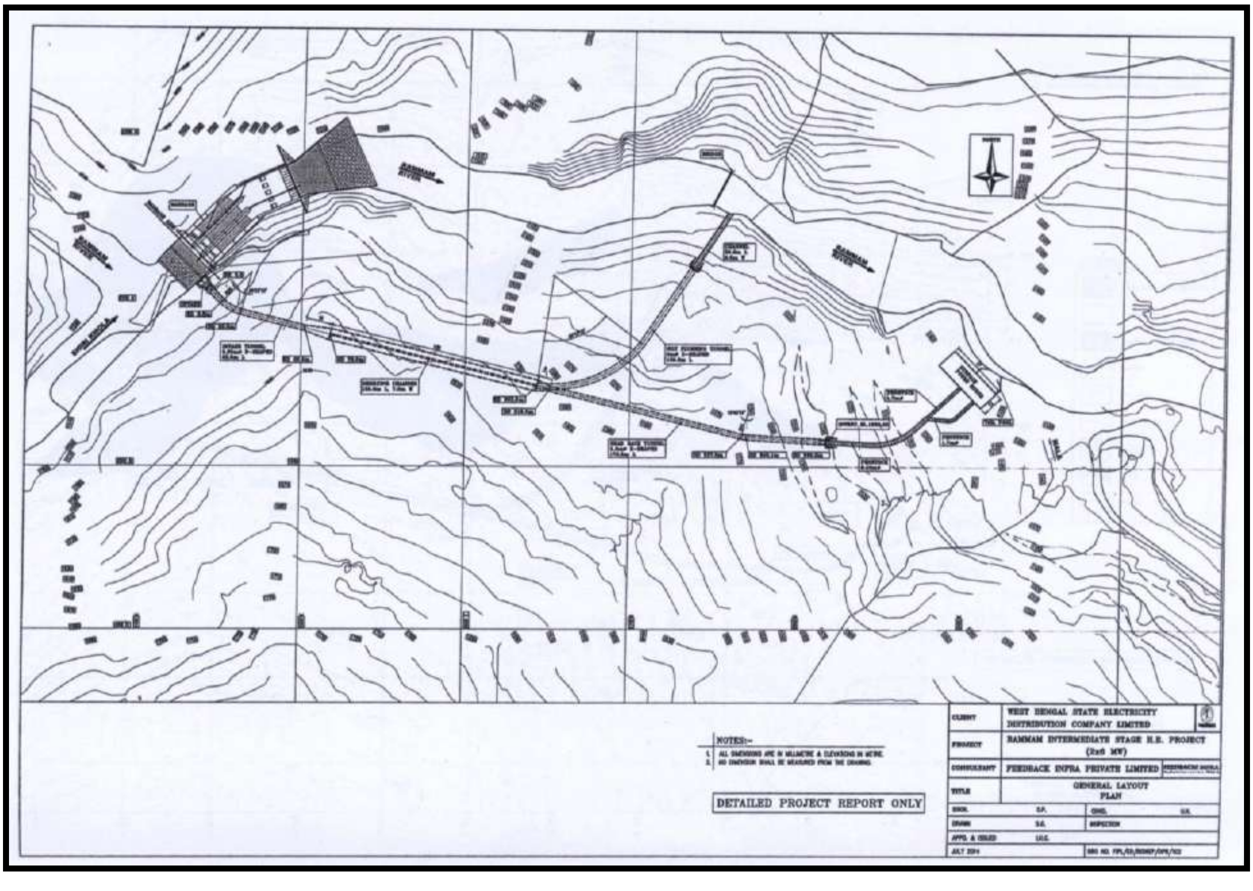


Figure-3.7 Project Layout of Rammam Intermediate Hydroelectric Project

3.11 RAMMAM STAGE-II HYDROELECTRIC PROJECT

Rammam Hydel Project Stage-II constitutes the scheme of development to harness hydro-electric potential of rivers Rammam and Lodhama situated in the District of Darjeeling. The proposed scheme is located within latitudes 88°6’0” to 88°8’0” sec. and longitudes 27°5’0” sec. to 27°8’0”. The installed capacity of the project is 51 MW. The salient features of Rammam Stage-II HEP are given in Table-3.10. The project layout is enclosed as Figure-3.8.

Table-3.10: Salient features of Rammam Stage-II HEP

1.	**General**	
	Project Area	In Darjeeling district, West Bengal
	Location	Across Rammam River and Lodhama Khola
	Scope of the Scheme	Power Generation
	Installed capacity	4 x 12.75 MW = 51 MW
	Generation starts in year of self sufficiency	Eighth Year
	Area to be served	In grid with other generating station
2.	**Hydrology**	
	Catchment area a. West Bengal side b. Sikkim side Total	 50.12 km^2 81.01 km^2 **131.13 km^2**
	Average annual rainfall	2475.20 mm
	Minimum discharge in Rammam river	2.3 cumec
	Minimum discharge in Lodhama Khola	0.8 cumec
	Maximum discharge in Rammam river	1218 cumec
	Maximum discharge in Lodhama Khola	549 cumec
3.	**Intake**	
	Rammam	
	Type	Drop type weir
	Elevation at C/L. of trash rack	1439.85 m
	Size	70’-0” x 15’-0”
	Lodhama side	
	Type	Drop type weir
	Elevation of C/L. of trash rack	
	Size	70’-0” x 10’-0”
4.	**Water Conductor System**	
	Rammam side	
i)	Duct	
	Length	
	Size	10’-0” x 5’-0”
	Shape	R.C.C. Rectangular
ii)	Tunnel	
	Length	3254.0 m
	Size	7’-0” dia

	Shape	`D' Section
	Cross-sectional	
	Area	44.13 m
	Invert level at intake portal	1432.52 m
	Bed slope	1:500
iii)	Cut and cover duct	
	Length	182.88 m
	Size	7'\-0" dia, `D' Section
	Lodhama side	
i)	Duct	
	Length	59.86 m
	Size	6'-0" x 6'-0"
	Shape	R.C.C. Rectangular
ii)	Flume	
	Length	6644 m
	Size	6'-0" x 3' – 6"
	Shape	R.C.C. Rectangular
	Bed slope	1:582.27 upto desilting basin 1:511.87 desilting basing to Forebay
	Desilting Basin	
	Rammam side :	
	Size	640'-o" x 100'-0" x 22' – 6"
	Lodhama side:	
	Size	240'-o" x 40'-0" x 12' – 6"
7.	**Common Forebay**	
	Full Reservoir level	1432.10 m
	Size	329.18 m x 6.0 m to 18.28 m
	Capacity	0.49 cft
	Invert level	1426 m
8.	**Spillway at Forebay**	
	Crest level of weir	1432.25 m
	Invert level of stilling basin	1432.25 m
	Invert level at the junction with river	926.59 m
	Length of chute with stilling basin	17.37 m
	Length of related development by artificial cascade	223.72 m
	Spilling capacity	420 cumecs
	Length of weir crest	15.29 m
9.	**Penstock**	
	Number	Two
	Length	932.68 m each
	Internal diameter a. 4.30 ft upto bifurcation b. 2.40 ft. bifurcation to turbine	
	Plate thickness	10 mm to 50 mm
	Nos. of Anchor	13 nos.
	Spacing of saddle supports	7.6 m – C/C/
	No. of expansion joint	10 nos.

10.	**Power House**	
	Size of power house	170' – 0" x 62'-0"
	Generator floor level	912.87 m
	Centre line of turbine	912.87 m (sise (Nozzle)
	Centre line distance of each unit	33'-0"
	Number of bays	4 unit bays 1 service bay
11.	**Tailrace Channel**	
	Length	72.54 m
	Width	3.6 m to 5.48 m
	Invert level at the channel in side power house	911.04 m
	Invert level at the Channel in outside power house	910.13 m (TR Channel no. 1)
	Invert level at the channel in Normal to power house	909.83 m (TR chall no. 2)
	Invert level at end	899.16 m
	Bed Slope:	
i)	1:1000 upto 100 ft. (Open channel)	
ii)	1:250 from 100 ft. to 175 ft. (chute portion)	
iii)	Nominal for the rest (sloped rip rap)	
12.	**Turbine**	
	Type of turbine	Impulse type (pelton wheel horizontal shaft)
	Number	4 units
	Discharge/Unit	110 cusecs
	Gross head available	519.23 m
	Rating	18,000 B.H.P.
13.	**Generator**	
	Number	4 nos.
	Type	Synchronous A.C. Generator induction type
	Rating	15,000 kVA
	Power factor	0.85
	Phase & frequency	3 phase, 50 c/s.
	Generation voltage	11 kVA
14.	**Main Step up Transformer**	
	Type	Single phase `ON' type
	Number	7 (seven) Nos.
	Voltage Ratio	11/ 132/√3 K.V.
	Phase & frequency	Single phase, 50 c/S.
	Rating	10 MVA
15.	**Capital Cost/Unit Cost**	
	Capital outlay	Rs. 2413.66 lacs
	Cost per K.W. installed	11.11 per
	Cost of generation per unit sold	20 paise
	O&M + depreciation charges	Rs. 69.19 lacs
16.	**Financial results**	
	Net revenue in the operational year	1^{st} year - Rs. 144.94 lacs 2^{nd} year - Rs. 316.47 lacs
	Percentage net return in operational year	1^{st} year - 5.44% 2^{nd} year – 12.79%

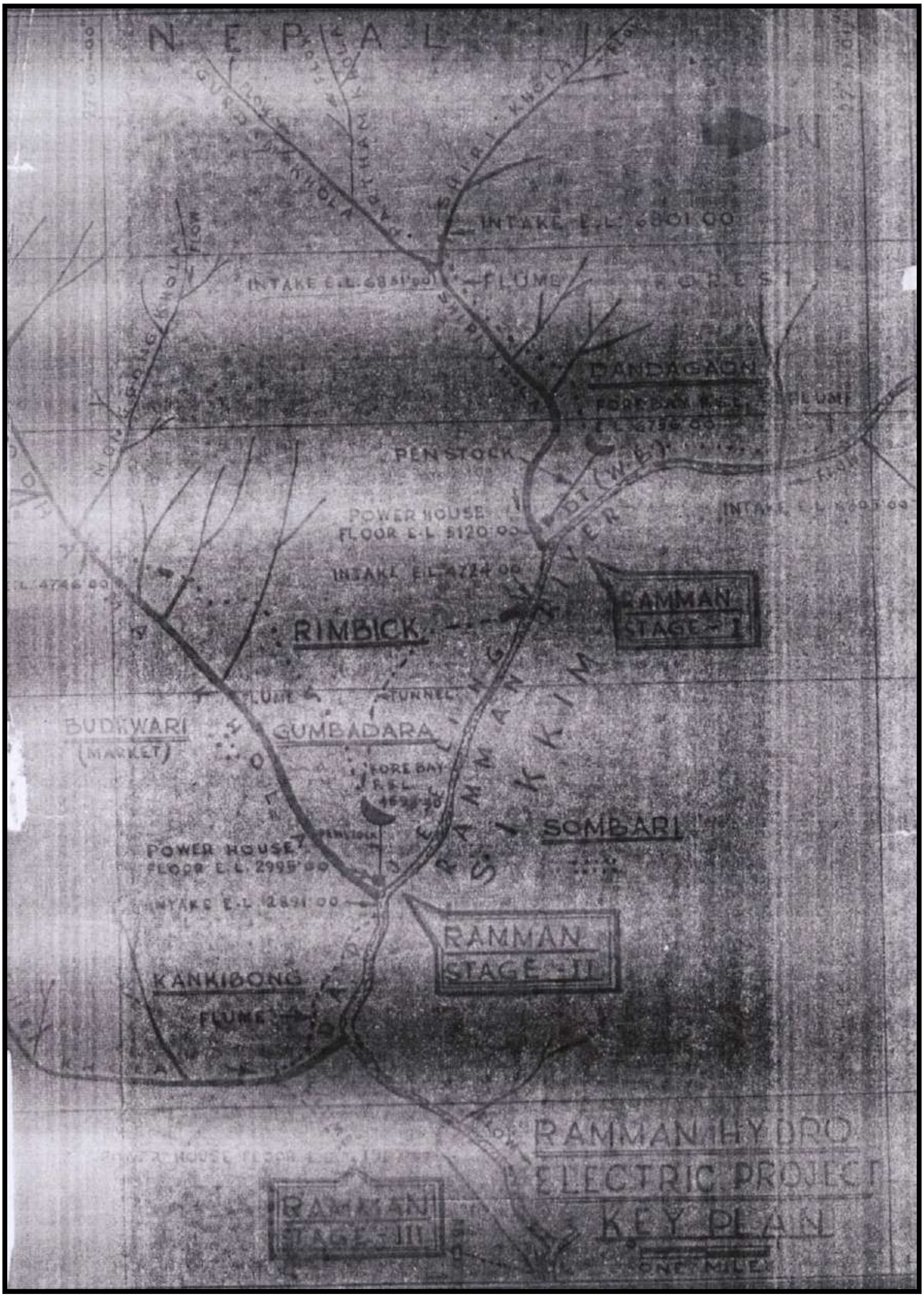


Figure-3.8 Project Layout of Rammam-II Hydroelectric Project

3.12 RAMMAM STAGE-III HYDROELECTRIC PROJECT

The Rammam Stage- III Hydro Electric Project in district Darjeeling proposes to harness the hydro power potential of Rammam river in the stretch of confluence of Lodhama Khola with Rammam to Rammam with Great Rangit. The Rammam river, in the project area, forms the boundary between West Bengal and Sikkim. Project components like intake, water conductor system, power house etc. are located in West Bengal and Left abutment of Barrage and approach road to power house lie in Sikkim. The installed capacity of this project is (3 x 40) 120 MW.

The project area is characterized by rugged topography with the development of steep escarpment slope and asymmetrical valleys. Slope stability is characterized by slides, rock cum debris slide due to erosion. Downstream, however, asymmetric terraces are observed which may be due to increase and decrease of hydraulic gradient.

A brief description of various project components is given in the following parameters.

Barrage

It is proposed to construct a Barrage with its axis about 240 m downstream of confluence of Rammam with Lodhama Khola. Barrage comprises of 5 nos. of overflow bays with crest level at EL. 884.0m/882.0m, having size of 11.0m (L) x 7.0m (H) and overall width of 77.5m, including pier thickness. It also comprises of 2 non-overflow blocks on each bank. The total length of Barrage at top is 122.50 m.

Water Conductor System

Intake and Intake Tunnel

For withdrawal of 33.00 cumec of water, an Intake structure, located 25 m upstream of Barrage axis, having 20.2 m width comprising 4 bays of 3.1 m width and one bay of 2.8 m and two nos. D shaped intake tunnels of size 2.85 m are proposed to be constructed. 85 m have been proposed.

Desilting Chamber

Two numbers underground desilting chambers each of size 140.0 m x 7.5 m x 12.50 m have been proposed to be constructed. Sloping hoppers with central duct have been provided for collecting the settled silt particle.

Silt Flushing Tunnel

A 230 m long silt flushing tunnel of size 2.5 m x 3.0 m has been provided for disposing the settled silt back in the Rammam river from each desilting chamber. The part length of silt flushing tunnel is proposed to be constructed as cut and cover section wherever rock cover is inadequate.

Head Race Tunnel

For conveying 28.31 cumec of water from desilting chamber to surge shaft, 8.2 km long and 3.5 m dia Horse Shoe shape head race tunnel is proposed to be constructed.

For construction of HRT, one adit of 800 m length has been proposed from left bank of Jhepi Nala. Apart from this, an adit near surge shaft has also been proposed.

Surge Shaft

Restricted orifice type, top open, surge shaft of 14.5 m diameter and 52.5m high is proposed to be constructed.

Valve house

A valve house having dimensions of 1 0.2mx12.0mx13.0m is proposed to be constructed.

Pressure Shaft / Penstock

For conveying water from surge shaft to power house penstock/pressure shaft of 2.7 m and 1520 m length are proposed to be constructed.

Tail Race Channel

A 740 m long, Tail Race Channel of dimensions 4.0 m X 3.0 m & slope 1: 740 is proposed to be constructed.

Power House

A Surface power house of 120 MW (3x40 MW) of size 73.5 m x 22.40 m x 41.60 m is proposed to be constructed at 50.0 m upstream of the confluence of the Ramshu Khola with Rammam river on right bank. Transformer bay is located adjacent to power house and switch yard is located near to power house.

Hydro-Mechanical Works

The project has been planned with the following Hydro-Mechanical Works for meeting different functional requirements.

- Trash racks - 7 nos. interchangeable panels per bay of panel size 3.3 x 3.34 m For 3.10 m width bay (4 bays) & 3.0 x 3.34m for 2.8m width bay (1 bay) and bolted with supporting structure in concrete.
- Trash Rack Cleaning Machine - 1 no.
- Spillway- 5 Radial gates of size11.00m x 7.00m operated with twin cylinder Hydraulic hoist.
- One set of stop logs operated with gantry crane and lifting beam.
- Two Nos. of Intake gates operated with rope drum hoist supported on trestles.
- One no. of Intake Bulk head gate operated with gantry crane.
- Two nos. of desilting chamber gates operated with rope drum hoist.
- Four nos. of silt flushing gates operated with hydraulic hoist.

- One no. surge shaft gate operated with rope drum hoist.
- One no. Tail race channel gate operated with mono rail hoist.
- One no. tail race outfall gate operated with rope drum hoist supported on trestle.
- One no. hinged type Adit-2 Gate of size 1500mm x 1500mm and manually operated.

The salient features of the project are given in Table-3.11 and layout is enclosed as Figure-3.9.

Table-3.11: Salient features of Rammam Stage-III HEP

1.	**LOCATION**	
	Name of the river	Ramman
	State	West Bengal
	District	Darjeeling
	Longitude	88°8'00"E to 88°14'00"E
	Latitude	27°6'00" N to 27°9'00"N
2.	**POWER**	
	Installed Capacity	3 x 40 MW
3.	**HYDROLOGY**	
	Type of Scheme	Run-of River
	Catchment area upto the project site	247 sq.km
	Average yield	686.56 MCM
	Maximum/Minimum yield	1040.37/485.65 MCM
	Average Annual rainfall	280 cm
	Design Flood	1825 m^3/s
	Available discharge at 90%	15.43 m^3/s
4.	**RESERVOIR**	
	Full Reservoir Level (FRL)	903.00 m
	Maximum Drawdown Level (MDDL)	892.00 m
5.	**BARRAGE**	
	Length of barrage	122.5 m
	Top of Barrage	905.0 m
	Height of Barrage	27 m (above u/s apron level)
	Number of gated Bays	5
	Type of Gate	Radial (above by hydraulic hoists)
	Size of Gates	11 m (L) x 7 m (H)
	Crest elevation	884.00 m
6.	**POWER INTAKE**	
	Number	2 Nos.
	Design discharge of intake	33.00 m^3/s
	Centre line of intake	886.175 m
	Intake tunnel	D shaped, 2 Nos. each of dia 2.85 m
	Number & sizes of gates	2 nos. of 2.60 m x 2.85 m
	Type of gates	Fixed wheel type
	Intake Bulk Head Gate	1 No. of 2.60 x 2.85 m, fixed wheel type
7	**DESILTING CHAMBER**	
	Type	Underground
	Size of chamber	2 Nos. (140 m x 7.50 x 12.55 m each)
	Design discharge	16.50 m^3/s
	Silt flushing discharge	4.69 m3/s (for both SFT)

	Efficiency of removal	90%
	Particle size to be removed	0.2 mm& above
8.	**HEAD RACE TUNNEL**	
	Alignment	Right Bank
	Length	8200 m
	Shape & Size	Horseshoe 3.5 m diameter
	Design discharge	28.31 m^3/s
	No. of Adit Gates	2 (Near Jhepi Khole & surge shaft)
9.	**SURGE SHAFT**	
	Type	Restricted Orifice
	Diameter	14.5 m (finished)
	Height	52.5 m
10.	**PRESSURE SHAFT/PENSTOCK**	
	Number	1
	Discharge through pressure shaft	28.31 m^3/s
	Diameter of Pressure shaft	2.7 m, circular
	Length	1526 m
	Velocity	4.88 m/sec
11.	**POWER HOUSE COMPLEX**	
	Location	Near Barbatia village in West Bengal
	Type	Deep seated surface power house
	Size of power house	73.50 m x 22.40 m x 41.60 m
	No. of Turbines	Three nos. Vertical Pelton
	Rated unit capacity	40 MW
	EL of the Centre line of the Turbine	400.0 m
	Gross Design Head	499.33 m
	Net Design Head	473.00 m
16.	**TAIL RACE CHANNEL**	
	Length (m) of tunnel	740 m
	Shape & Size	4 m x 3 m cut & cover box section
	Tail Water Level	EL 391.00 m (min.), 393.00 mm (max)

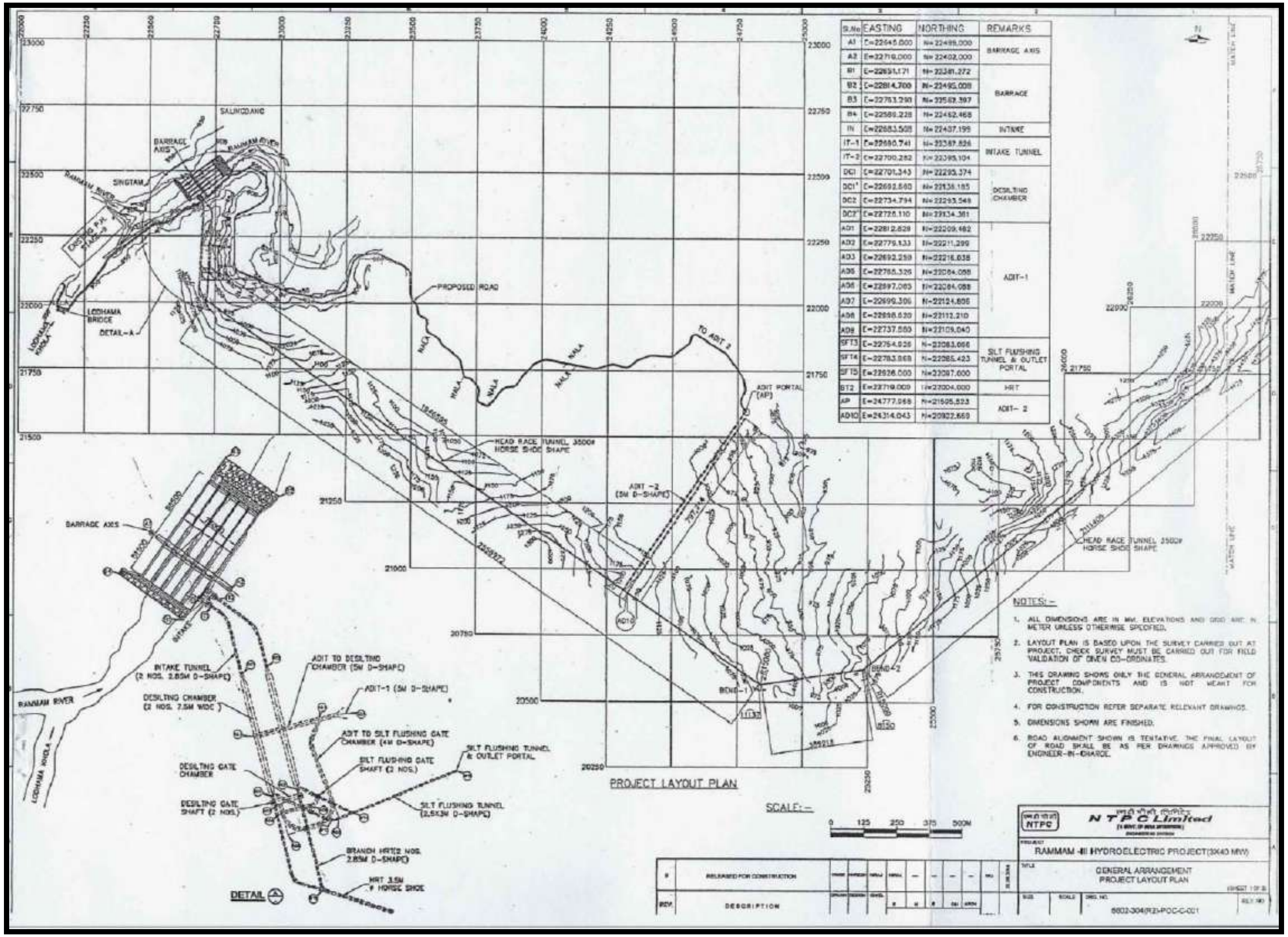
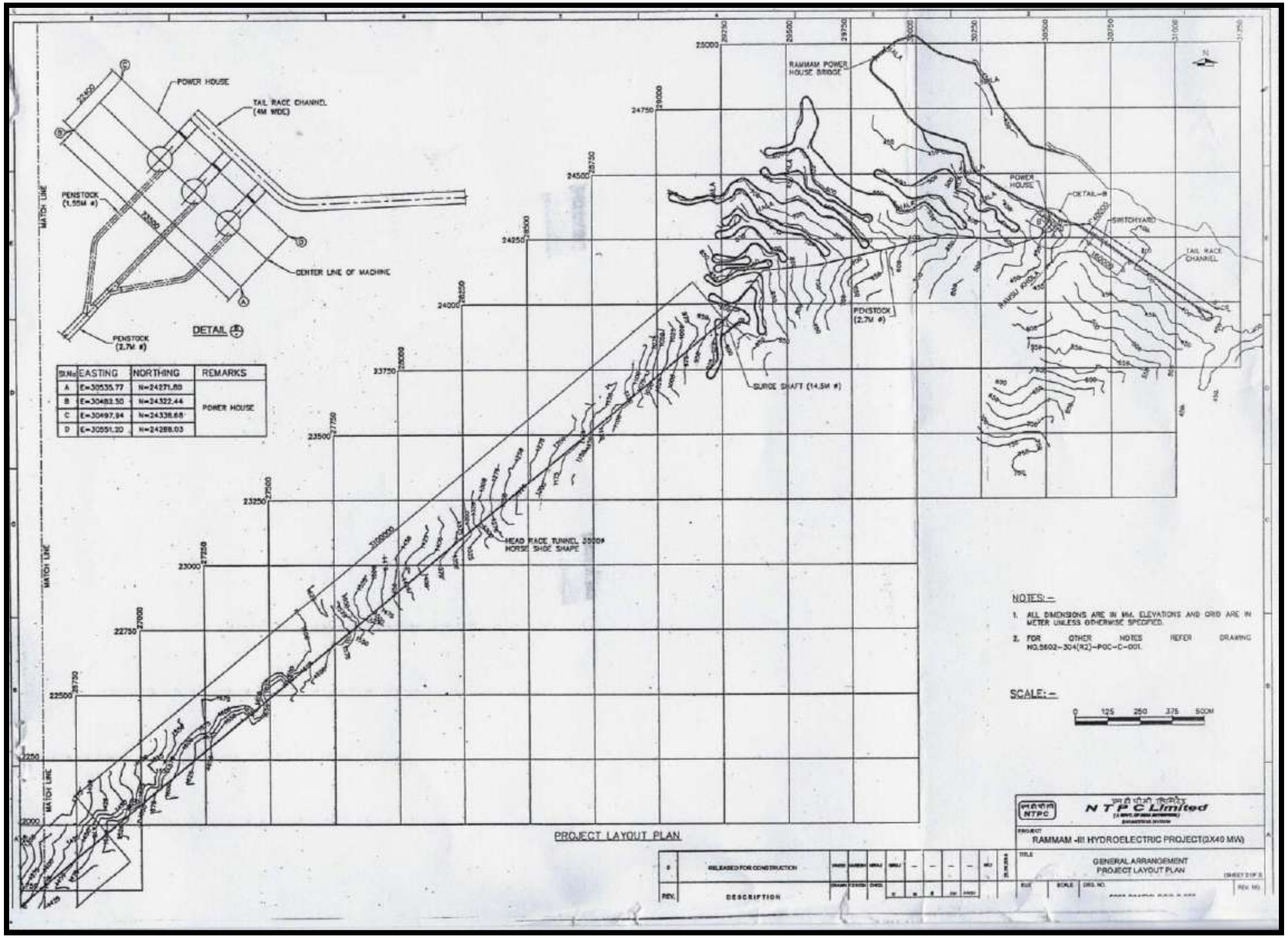


Figure-3.9(A) Project Layout of Rammam-III HEP



Sl.No	EASTING	NORTHING	REMARKS
A	E=30535.77	N=24271.80	POWER HOUSE
B	E=30482.50	N=24322.44	
C	E=30497.94	N=24338.68	
D	E=30551.20	N=24288.03	

Figure-3.9(B) Project Layout of Rammam-III HEP

CHAPTER 4
HYDROLOGY

CHAPTER-4
HYDROLOGY

4.1 TEESTA RIVER BASIN

The river Teesta is a major tributary of Brahamputra River, which originates in the Himalayas. The river rising from the Himalayan hills is snow fed from the glaciers of Zemu, Changane, Khanpu and gets enlarged by the contributions from a large number of tributaries. The river gets its name Teesta after the confluence of two streams namely Lachan Chu and Lachung Chu at Chungthang in North Sikkim. The river is joined by other tributaries namely Rangopo, Rangit, Raman, Rangli etc. before meeting Brahamputra in Bangladesh. The river forms a common boundary between the states of Sikkim and West Bengal during its journey to Bangladesh.

Rangit River originates as Rangitchu from a ridge which divides watershed of Rangit and Talungchu. Kayamchu is a major tributary of Rangitchu. Rangitchu meanders for a distance of 8.4 km upto confluence of Barmechu. The river then flows further for a distance of 3.8 km when, it is joined by Relchu on its right. After confluence of Relchu with Rangitchu, it is known as Rangit River. It receives water from various streams like ChilKhola, SangrungKhola, BaniaKhola, Rathangchu, KalejKhola etc. Rangit River after its confluence with KhalejKhola travels for 4.2 km when it is joined by Rayong Khola from left side at an elevation of 421 m. The river receives water from several streams including Rammam (Rangbang) Khola which joins on its right bank. Rammam Khola drains from forested areas. The Rangit River after its confluence with Rammam changes its course towards east, and the river is then known as Great Rangit River. It acts as an inter-state boundary between West Bengal and Sikkim. Manpur Khola is only significant tributary on its left bank in this stretch. The river finally joins Teesta River at Melli Bazar.

4.2 BASIN CHARACTERISTICS

The basin is a rectangular shaped basin in which majority of its tributaries flow in canoe shaped basin. The drainage pattern in Rangit basin is mostly dendrite. However, towards the mouth of the major tributaries, rectangular drainage pattern is observed.

4.2.1 Topography and Physiography

Most of the terrain of Teesta River and Rangit River is mountainous and full of ridges, valleys and low hill ranges with elevation ranging from 200 to 8500 m. High Mountains are perpetually covered with snow. The forest cover is more than 40% of the area and is central to people’s livelihood and is a major source of food, fuel and medical herbs.

4.2.2 Climate

The climate of basin varies from severe cold in higher reaches and tropical heat in the plains. The sharp variation in altitude results in abrupt changes in climatic conditions.

The high mountains act as a barrier for the movement of monsoon winds. The rainfall also gets influenced by the direction of the wind and aspects of hill slopes. The valleys along Teesta and its tributaries receive good rainfall while the valley of Rangit receives less rainfall.

The areas receives rainfall from June to October, when it receives heavy rains. November to May is considered as non-monsoon period. Thunderstorms do occur in earlier months. The period from November to February is dry. The winter month season lasts from mid-November to mid-April. During this period, temperature is close to freezing point. The summer season lasts from April to May. The humidity is quite high during morning and in afternoon for the major part of the year. It, however, decreases considerably in north and at higher elevation. The mean daily minimum temperature varies from 26.9^{0}C in September to 20.7^{0}C in January.

The relative humidity varies from 63.8 % to 88.7 % over the basin. The mean daily relative humidity is 68.3 % in January, 66.2 % in April, 88.7% in July and 68.0 % in October.

The mean monthly wind speed varies from as low as 43.2 km/hour in July to September and high as 98.4 km/ hour in the month of April.

GAUGE AND DISCHARGE NETWORK

At present, there are 10 gauge and discharge stations being maintained by CWC on Teesta and Rangit rivers. The location of the G&D stations is given in Table-4.1.

Table-4.1: Details of G& D sites in Teesta Basin

S.No	State	Site Name	District	River	Type	Date of Start
1.	Sikkim	Rangpo	South District Nomechi	RangpochuTeesta	GD	7.12.69
2.	Sikkim	Chungthang	Sikkim	Teesta	GD	4.1.75
3.	Sikkim	Rongni Chu	Sikkim	Rongi Chu	GD	11.8.94
4.	Sikkim	Sankalang	Sikkim	Talang Chu	GD	11.3.90
5.	Sikkim	Sirwani	Sikkim	Teesta	GD	19.3.84
6.	Sikkim	Tarkhola	Sikkim	Teesta	GD	13.2.95
7.	Sikkim	Majhitar	Namchi	Rangit	GD	1.6.82
8.	Sikkim	Reshi	Sikkim	Rangit	GD	16.2.00
9.	West Bengal	Singla Bazar	Darjeeling	Rangit	GD	1.5.75
10.	Sikkim	Rangit Stage-III	Sikkim	Rangit	GD	1.6.75

GD = Gauge – Discharge site

4.3 WATER AVAILIBLITY STUDIES FOR PROJECTS ON TEESTA AND GREAT RANGIT RIVERS

The hydrological data was available for the following projects:

- Teesta Intermediate HEP
- Teesta Low Dam I&II HEP
- Teesta Low Dam III HEP
- Teesta Low Dam-IV HEP

- Teesta Low Dam-V HEP
- Jorethang Loop HEP

As per the present level of investigation hydrological data is not available for Teesta Stage-VI HEP. The 90% dependable year data for the above listed six projects is given in Tables-4.2 to 4.7.

Table-4.2 : 90% Dependable year flow for Teesta Intermediate HEP (1995-96)

Month		**Inflow (cumec)**
June	I	656.09
	II	925.97
	III	823.73
July	III	1187.40
	II	785.20
	III	663.99
August	I	669.65
	II	651.29
	III	804.86
September	I	547.50
	II	493.27
	III	644.40
October	I	371.00
	II	396.64
	III	350.08
November	I	294.64
	II	278.71
	III	239.18
December	I	204.83
	II	187.43
	III	206.73
January	I	177.22
	II	105.50
	III	107.97
February	I	94.53
	II	93.18
	III	89.09
March	I	106.94
	II	175.82
	III	231.53
April	I	215.38
	II	275.14
	III	314.46
May	I	491.19
	II	724.76
	III	745.81

Source: DPR

Table-4.3 : 90% Dependable year flow for Teesta Low Dam-I and II HEP (2005-06)

Month		Inflows (cumec)
June	I	79.26
	II	130.44
	III	274.99
July	III	594.87
	II	480.05
	III	382.00
August	I	258.83
	II	520.54
	III	332.21
September	I	240.51
	II	197.06
	III	207.63
October	I	196.58
	II	154.89
	III	120.96
November	I	88.84
	II	64.98
	III	49.25
December	I	43.79
	II	39.04
	III	36.92
January	I	35.57
	II	28.33
	III	26.98
February	I	30.95
	II	34.21
	III	9.35
March	I	4.79
	II	7.97
	III	15.85
April	I	24.00
	II	15.15
	III	33.65
May	I	30.87
	II	78.18
	III	156.18

Source: DPR

Table-4.4 : 90% Dependable year flow for Teesta III HEP (1988-89)

Month		Inflows (cumec)
June	I	416.09
	II	699.31
	III	657.65
July	III	745.70
	II	808.17
	III	981.79
August	I	772.33
	II	867.84
	III	854.72
September	I	648.70

Month		Inflows (cumec)
	II	471.16
	III	583.07
October	I	515.41
	II	518.05
	III	488.15
November	I	284.85
	II	159.07
	III	135.53
December	I	192.12
	II	176.95
	III	126.22
January	I	177.76
	II	164.43
	III	157.45
February	I	132.62
	II	131.44
	III	128.49
March	I	160.94
	II	168.79
	III	179.37
April	I	151.19
	II	190.90
	III	316.33
May	I	226.82
	II	231.66
	III	400.69

Source: DPR

Table-4.5 : 90% Dependable year flow for Teesta IV HEP (1986-87)

Month		Inflows (cumec)
June	I	341.20
	II	410.08
	III	735.26
July	III	833.39
	II	808.08
	III	967.24
August	I	798.59
	II	684.34
	III	723.44
September	I	649.03
	II	879.92
	III	673.76
October	I	608.68
	II	510.59
	III	430.61
November	I	242.42
	II	221.51
	III	196.92
December	I	178.92
	II	171.99
	III	154.91

Month		Inflows (cumec)
January	I	141.25
	II	134.40
	III	127.96
February	I	156.72
	II	151.28
	III	151.11
March	I	126.81
	II	137.64
	III	160.48
April	I	223.07
	II	215.28
	III	244.11
May	I	423.01
	II	281.28
	III	312.90

Source: DPR

Table-4.6 : 90% Dependable year flow for Teesta V HEP (1998-99)

Month		Inflows (cumec)
June	I	440.5
	II	740.3
	III	696.2
July	III	789.5
	II	855.6
	III	1039.4
August	I	817.6
	II	918.8
	III	904.9
September	I	686.8
	II	498.8
	III	617.3
October	I	545.7
	II	548.4
	III	516.8
November	I	301.6
	II	168.4
	III	143.5
December	I	203.4
	II	187.3
	III	133.6
January	I	188.2
	II	174.1
	III	166.7
February	I	140.4
	II	139.2
	III	136.0
March	I	170.4

Month		Inflows (cumec)
	II	178.7
	III	189.9
April	I	160.1
	II	202.1
	III	334.9
May	I	240.1
	II	245.3
	III	424.2

Source: DPR

Table-4.7 : 90% Dependable year flow for Jorethang Loop HEP (1995-96)

Month		Inflow (cumec)
June	I	111.4
	II	189.3
	III	163.9
July	III	221.7
	II	197.1
	III	150.1
August	I	170.8
	II	246.6
	III	214.5
September	I	170.8
	II	122.4
	III	214.5
October	I	103.4
	II	84.9
	III	65.6
November	I	50.8
	II	47.8
	III	39.9
December	I	31.1
	II	27.3
	III	24.3
January	I	24.3
	II	24.9
	III	24.6
February	I	24.3
	II	24.0
	III	23.7
March	I	22.7
	II	27.5
	III	24.7
April	I	43.6
	II	44.7
	III	41.1

Month		Inflow (cumec)
May	I	70.2
	II	45.6
	III	51.8

Source: DPR

4.4 RAMMAM RIVER BASIN

The river Rammam is a major tributary of the Ranjit river which confluences with the Teesta river. It rises from the Mane Bhanjan - Tongbu - Phalut ridge of the lower Himalayas which are continuation of Kanchan Jungha mountain ranges, at an elevation of about 3631 m. The river Rammam forms the natural boundary between the states of West Bengal and Sikkim. The main tributaries of Rammam river are Kali Khola, Shiri Khola, Lodhama khola, Jhepi Khola and Riyang Khola. In the initial stretch the river, Rammam flows along W-E direction for about 6 km upto the confluence with its tributary Kali Khola EL. 2448 m. Further, its course changes towards N-S direction upto confluence with Shiri Khola at EL. 1542 after traversing 18 km from origin, where Stage-I of Rammam H.E scheme is located. The slope of the river is moderate in this stretch (1 in 11.25). Further downstream, river confluences with its tributary Lodhama Khola at EL. 900m where the power house of Stage-II of the Rammam H.E scheme is located. The tributaries Jhepi Khola and Riyang Khola join the river at about 2.5 km and 6.5 km downstream of confluence point of Lodhama Khola respectively. At an elevation of 700 m, the river takes an '5' bend at 1.5km downstream of diversion structure of stage-III. The meandering course between the diversion weir and the proposed power house of Stage-III project is about 26 km and the average gradient is about 1 in 26. The river flows in westerly direction up to confluence with Rangit river at an elevation of 305 m. There is considerable snowfed region in the catchment area of Rammam river in its upper reaches. A significant portion of the catchment area is covered with dense forest. The Rammam river has a length of about 42 km from its source in Phalut to its confluence point with Rangit river at Naya Bazar.

4.5 WATER AVAILIBLITY STUDIES FOR PROJECTS ON RIVER RAMMAM

The hydrological data was available for the following projects:

- Rammam Stage-I HEP
- Rammam Intermediate HEP
- Rammam Stage-II HEP
- Rammam Stage-III HEP

4.5.1 Rammam Stage-I HEP

The Hydrological data on 10-daily basis is available for 1965-66 to 1975-76 i.e. 10 years keeping aside the discharge measurement of 1967-68. Water flows series for all 10 years have been utilized for computing power benefits.

The release of waters from the intake downstream into the river continuously during various months/periods of the year has been considered during operation of the project to maintain flows in the river as per environmental considerations. The 10 daily flows for 90% dependable years for Rammam Stage-I HEP are given in Table-4.8.

Table-4.8: 90% Dependable year flow for Rammam Stage-I HEP

Month		Inflows (cumec)
April	I	1.83
	II	1.86
	III	1.81
May	I	2.17
	II	2.20
	III	2.51
June	I	24.58
	II	10.10
	III	18.78
July	I	19.76
	II	46.52
	III	15.76
August	I	19.16
	II	18.77
	III	17.83
September	I	20.26
	II	17.21
	III	35.56
October	I	15.88
	II	14.99
	III	9.15
November	I	7.12
	II	5.97
	III	4.19
December	I	2.72
	II	2.43
	III	2.18
January	I	2.50
	II	2.43
	III	2.09
February	I	2.56
	II	2.27
	III	2.53
March	I	2.43
	II	2.92
	III	2.90

4.5.2 Rammam Intermediate HEP

The Environmental Flow will be 20% of lean period and 25% of flows during the non-lean/non-monsoon period corresponding to 75% dependable year. The Environmental Flows including spillage during monsoon period shall be about 30% of cumulative inflows during the monsoon period corresponding to 75% dependable year. The 90%, 75% and 50% dependable year flow series for Rammam Intermediate HEPs are given in Table-4.9.

Table-4.9: 90%, 75% and 50% dependable year flow series for Rammam Intermediate HEPs

Month	Period	90% Dependable Year	75% Dependable year	50% Dependable Year
		1967-68	1975-76	1966-67
June	I	5.53	10.82	4.89
	II	12.97	14.22	7.77
	III	10.42	21.48	12.24
July	I	12.09	19.24	42.86
	II	15.02	33.93	51.74
	III	14.75	64.04	68.23
August	I	10.49	34.21	52.56
	II	13.43	25.74	35.27
	III	12.07	24.66	42.74
September	I	12.45	37.93	63.55
	II	11.90	44.36	54.71
	III	12.68	37.52	37.60
October	I	9.71	24.88	27.66
	II	9.36	18.60	13.58
	III	7.93	10.48	13.44
November	I	7.32	7.48	14.11
	II	6.76	7.26	10.15
	III	5.95	6.44	9.16
December	I	5.60	5.80	8.00
	II	5.34	5.70	7.38
	III	4.98	5.51	7.46
January	I	4.92	5.26	7.90
	II	4.59	4.96	7.36
	III	4.24	4.82	7.17
February	I	3.92	5.34	5.34
	II	3.43	4.13	4.19
	III	2.95	3.58	3.42
March	I	2.69	2.79	2.49
	II	3.29	2.58	3.04
	III	2.55	2.53	3.86
April	I	2.40	2.49	3.61
	II	3.00	2.49	4.25
	III	3.03	2.60	3.98
May	I	4.82	3.02	4.09
	II	3.53	3.04	6.53
	III	5.48	3.02	4.83

4.5.3 Rammam Stage-II HEP

The total catchment area for stage-II development is 208.8 km^2. The details are given in Table-4.10.

Table-4.10: River Wise Break Up of the Catchment

River	Catchment area in West Bengal (km^2)	Catchment area in Sikkim (km^2)	Total Catchment Area (sq.km)
Shrikhola	15.41	Nil	15.41
Lodhama Khola	21.20	Nil	21.20
Rammam River	12.75	30.79	43.54
Total	**49.36**	**30.79**	**80.15**

The Rainguages are maintained by Forest department for rainfall record at Dandagaon (long 88°N Lat. 27°7') at an elevation of 2,400 ft. and the average annual rainfall is 2475.20 mm.

The 10 daily flow observed at Rammam intake stage-II and at Lodhama Khola are given in Tables-4.11 and 4.12 respectively.

Table-4.11: 10 daily flow series observed at Rammam intake stage-II

Month	10 D block	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
January	I	5.15	13.32	7.97	4.97	4.24	3.40	3.57	2.82	9.71	7.44	3.17	5.31
	II	4.92	5.36	7.43	4.63	3.84	3.31	2.78	2.76	8.95	6.31	3.98	5.58
	III	4.65	5.00	7.23	4.28	3.76	2.85	2.63	2.66	9.01	5.63	2.98	4.86
February	I	4.62	5.21	5.39	3.96	3.68	3.49	2.44	2.61	9.24	4.17	3.07	5.39
	II	4.55	5.09	4.23	3.46	3.30	3.09	2.41	2.51	8.60	2.69	3.02	4.17
	III	4.44	4.52	3.45	2.97	3.14	3.45	2.33	2.38	8.60	2.59	3.04	3.62
March	I	4.31	4.02	2.52	2.71	3.09	3.31	2.31	2.40	12.1	2.67	2.92	2.82
	II	4.12	3.71	3.07	3.32	3.04	3.97	2.28	2.38	8.60	2.41	2.76	2.60
	III	4.16	3.34	3.90	2.57	2.70	3.96	3.09	2.35	7.04	3.08	2.59	2.55
April	I	4.08	2.89	3.64	2.42	2.49	2.83	3.02	2.52	4.52	3.08	2.50	2.51
	II	3.68	2.67	4.29	3.03	2.54	2.80	3.17	3.02	5.54	3.08	2.54	2.51
	III	3.18	3.11	4.01	3.06	2.47	2.81	2.91	3.30	12.17	3.46	3.37	2.63
May	I	4.52	2.71	4.13	4.87	2.95	3.09	3.60	3.52	12.02	3.96	4.02	3.05
	II	4.31	2.77	6.59	3.56	2.99	6.33	3.92	4.07	17.82	4.05	6.67	3.07
	III	5.30	4.01	4.87	5.53	3.42	6.86	3.27	4.52	12.95	3.01	7.89	3.05
June	I	4.67	4.93	5.58	15.83	33.47	21.10	12.39	5.21	10.10	-	10.92	5.10
	II	6.98	7.84	13.09	23.23	13.75	72.02	52.78	7.33	45.72	10.50	14.35	5.80
	III	14.04	12.35	10.51	30.04	25.56	62.43	43.61	16.69	35.01	23.82	21.68	6.99
July	I	31.63	85.25	12.20	42.56	26.90	65.33	44.99	22.34	24.32	39.66	19.42	
	II	49.84	52.22	15.15	39.57	63.34	109.61	43.54	33.72	31.39	86.08	34.24	
	III	62.79	68.86	14.89	38.94	21.46	229.11	43.76	50.98	84.46	116.01	64.64	
August	I	65.88	53.04	10.58	45.78	26.07	177.97	54.32	55.73	101.82	115.16	34.53	
	II	77.31	35.59	13.56	30.36	25.55	53.19	56.10	46.07	100.20	55.23	25.98	
	III	69.02	43.13	12.18	30.57	24.28	27.84	45.77	47.11	74.51	58.33	24.88	
September	I	43.04	64.14	12.57	30.91	27.59	27.80	40.22	47.98	47.23	45.91	38.28	
	II	42.26	55.22	12.02	30.74	23.43	25.18	29.10	33.70	53.19	45.23	44.77	
	III	32.96	37.95	12.80	29.54	48.41	21.06	19.43	28.08	91.63	33.06	37.86	
October	I	27.86	27.90	9.80	87.09	21.62	20.37	20.19	16.06	-	21.14	25.11	
	II	19.82	13.71	9.45	63.25	20.40	16.89	15.62	-	93.85	14.81	18.78	
	III	17.07	13.57	8.00	36.27	12.46	13.11	5.07	9.81	38.16	13.72	10.58	

Month	**10 D block**	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**
November	I	15.20	14.25	7.39	33.21	9.69	9.53	3.82	7.06	25.19	10.03	7.55	
	II	12.59	10.24	6.83	11.03	8.13	7.78	3.26	5.97	21.98	7.22	7.33	
	III	11.20	9.24	6.00	7.61	5.70	6.16	3.17	4.85	20.49	5.96	6.50	
December	I	7.23	8.07	5.65	6.11	3.71	5.35	2.98	4.28	18.55	4.97	5.85	
	II	6.06	7.45	5.39	5.30	3.32	4.20	2.94	3.29	15.65	4.17	5.75	
	III	5.53	7.53	5.02	4.72	2.97	3.34	2.85	2.92	10.27	3.40	5.56	

Table-4.12: 10 Daily flow series observed discharge at Lodhama Khola

Month	10 D block	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
January	I	1.87	8.07	1.37	1.74	1.91	1.28	1.48	1.68	1.81	1.95	1.53	1.96
	II	1.86	4.15	1.27	1.56	1.62	1.28	1.40	1.47	1.74	1.94	1.39	1.92
	III	1.68	2.14	1.12	1.40	1.52	1.51	1.30	1.41	1.79	1.95	1.27	1.87
February	I	1.50	1.34	1.03	1.37	1.42	1.40	1.28	1.34	1.70	1.57	1.21	1.64
	II	1.38	1.18	0.95	1.30	1.25	1.36	1.26	1.27	1.42	1.23	1.12	1.36
	III	1.24	1.25	-	1.28	1.16	1.33	1.25	1.19	1.52	1.03	1.12	1.04
March	I	1.13	1.07	0.94	1.18	1.10	1.15	1.37	1.74	1.97	0.96	1.02	1.04
	II	1.17	1.01	1.09	1.14	1.03	1.12	1.00	1.67	1.59	0.98	0.95	1.04
	III	1.14	0.94	1.18	1.00	1.01	1.06	1.03	1.79	1.38	1.17	0.96	1.15
April	I	0.99	1.03	1.17	0.94	0.93	1.02	1.31	1.13	1.35	1.93	0.96	1.09
	II	1.12	1.00	1.08	1.00	0.95	1.37	1.56	1.25	1.20	1.85	0.96	1.07
	III	1.43	1.01	1.34	1.04	0.92	1.27	1.91	1.25	1.43	2.12	1.58	1.20
May	I	2.12	0.96	1.77	1.37	1.07	1.56	1.79	2.13	1.70	2.72	2.63	1.41
	II	2.93	1.01	2.79	1.27	1.18	2.14	1.84	1.98	1.64	2.78	4.11	1.41
	III	3.25	1.46	2.62	1.69	1.44	2.35	1.72	2.37	1.75	2.71	4.18	1.39
June	I	2.52	1.91	2.37	2.40	10.94	5.65	4.13	2.50	3.87	4.72	4.13	2.05
	II	4.09	2.97	3.57	7.20	4.76	23.93	13.55	2.37	7.24	7.26	5.48	2.40
	III	5.01	5.44	3.92	9.29	7.99	19.21	21.94	5.41	5.54	8.80	-	2.72
July	I	6.79	20.44	5.28	15.03	8.74	20.73	29.33	5.35	4.97	15.28	6.86	-
	II	7.76	13.13	7.72	14.14	24.67	34.34	23.75	10.29	5.90	22.49	12.99	-
	III	9.07	17.85	9.13	12.31	7.91	62.85	22.04	26.62	6.99	25.85	24.30	-
August	I	11.33	18.07	5.78	13.47	7.78	51.91	28.01	23.79	25.98	28.06	13.12	-
	II	13.40	14.47	6.27	14.48	13.58	20.04	26.25	9.38	30.25	14.44	9.79	-
	III	13.09	16.91	6.27	14.46	9.57	12.88	25.78	7.26	18.75	13.65	9.39	-
September	I	10.79	19.85	4.55	13.75	9.54	13.58	20.19	17.38	9.30	11.74	14.43	-
	II	7.87	20.01	4.14	9.32	8.55	10.43	12.97	5.38	7.62	11.33	17.91	-
	III	7.94	11.88	4.39	8.81	16.92	8.05	10.54	7.16	13.68	8.00	14.24	-
October	I	6.32	5.63	3.82	178.70	10.64	8.46	10.41	4.54	8.93	5.00	5.00	9.57
	II	5.17	2.89	3.53	25.50	6.43	6.52	7.28	3.32	15.25	3.79	3.79	7.10
	III	3.00	2.08	2.91	16.39	3.22	13.31	4.02	3.73	9.64	3.54	3.54	4.05

Month	**10 D block**	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**
November	I	2.29	1.87	2.75	15.21	2.41	3.65	3.56	3.56	6.89	3.00	3.00	2.90
	II	1.93	1.88	2.56	6.23	1.88	03	2.81	2.67	5.99	2.38	2.38	2.71
	III	1.91	1.82	2.49	3.53	1.79	22.80	2.66	2.23	4.44	1.87	1.87	2.50
December	I	1.69	1.50	4.86	2.69	1.73	1.96	2.51	1.94	3.40	1.35	1.35	2.30
	II	1.51	1.46	1.99	2.58	1.70	1.72	2.32	1.64	2.75	1.66	1.66	2.25
	III	1.32	1.42	1.87	2.06	1.63	1.60	2.03	1.87	2.16	1.56	1.56	2.12

4.5.4 Rammam Stage-III HEP

The average ten daily flows at Rammam Stage-III hydroelectric project (inclusive of Lodhama flows) based on observed generation data of Rammam Stage-II hydroelectric project is given in Table-4.13.

Table-4.13: Average ten daily flows at Rammam Stage-III hydroelectric project

Month		Flow (cumecs)
June	I	8.62
	II	11.24
	III	21.02
July	I	30.99
	II	30.92
	III	44.26
August	I	43.96
	II	38.10
	III	38.38
September	I	43.12
	II	33.38
	III	28.49
October	I	22.87
	II	17.21
	III	13.38
November	I	12.61
	II	10.93
	III	9.04
December	I	8.33
	II	7.62
	III	6.29
January	I	5.42
	II	5.77
	III	5.31
February	I	5.24
	II	4.81
	III	4.67
March	I	4.49
	II	4.72
	III	4.99
April	I	5.01
	II	5.15
	III	6.63
May	I	7.17
	II	7.40
	III	11.12
Annual Average		**15.89**

CHAPTER 5
WATER QUALITY

CHAPTER-5
WATER QUALITY

5.1 INTRODUCTION

The quality of water is always attributed to the physical, chemical and biological characteristics. In natural condition, characteristics of water including its fauna and flora respond to the seasons, geographic and topographic features of the drainage area and under geographical conditions it varies in time and space. Land use/land cover of the catchment have also a considerable impacts on the water quality, thus changes in the land use are anticipated to have immense impacts on the physical and chemical characteristics of water (Azrina et al., 2003) and inevitably responded by biotic communities like algae, macro-invertebrates and fish. The catchment area of Teesta river in hilly region bestowed with snowy region, alpine meadows and dense forests with sparse population and do not receive much sewage outfall and agricultural runoff as compared to other rivers like Ganga and Yamuna.

Teesta river has been planned for cascade development in Sikkim and West Bengal. The cascade development leads to the physical alteration of a large river channel in the form of impoundment and deprivation. The physical alteration changes the hydrological pathway and may change the physical, chemical and biological characteristics not only by changing hydrological pathway but adding various pollutants to landscape (Peters and Meybek, 2000). In addition, alteration of hydrological pathway may have various social, cultural and economic impacts.

5.2 WATER QUALITY

Detailed monthly data on physical and chemical characteristics for various projects in study area. Water quality of study area including Teesta and Rangit rivers was assessed using various physical and chemical characteristics at spatial and temporal scales. The water quality sampling location is shown in Figure-5.1 and the details are given Table-5.1. The drinking water quality standards are given in Table-5.2. The elevation limits of study area extend from 134 to 281 m.

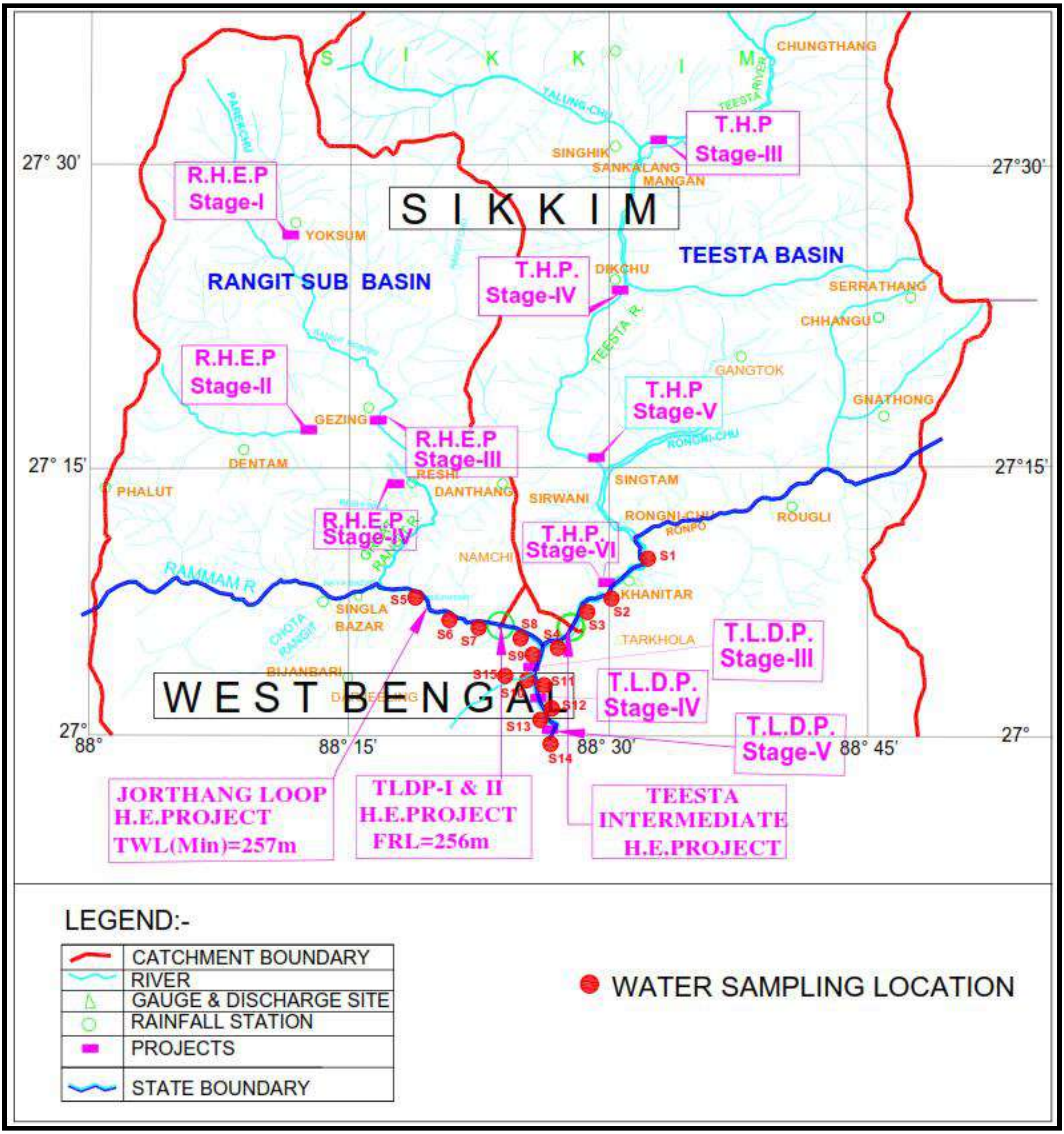


Figure-5.1: Water quality sampling location Map

Table-5.1: Details of Water Sampling Location

Site	Coordinates Lat/Long	River	Elevation (m)	Description of sites
S1	$27^0$09'59"N $88^0$31'43"E	Teesta	281	Upstream of Powerhouse of Teesta Stage VI
S2	$27^0$07'55"N $88^0$30'05"E	Teesta	245	Proposed Powerhouse of Teesta Stage VI
S3	$27^0$07'12"N $88^0$28'31"E	Teesta	223	Upstream of Teesta Intermediate dam
S4	$27^0$05'42"N $88^0$27'42"E	Teesta	219	Downstream of Teesta Intermediate dam
S5	$27^0$07'13"N $88^0$19'10"E	Rangit	270	Upstream of Proposed Powerhouse of Jorethang Loop HEP
S6	$27^0$05'44"N $88^0$23'06"E	Rangit	227	Downstream powerhouse of Jorethang Loop HEP
S7	$27^0$05'23"N $88^0$24'10"E	Rangit	220	Upstream of Teesta Low Dam I & II
S8	$27^0$04'52"N $88^0$25'50"E	Rangit	209	Downstream of Teesta Low Dam I & II
S9	$27^0$02'59"N $88^0$25'36"E	Teesta	208	Upstream of Teesta Low Dam III
S10	$26^0$59'53"N $88^0$26'10"E	Teesta	188	Downstream of Teesta Low Dam III
S11	$26^0$56'10"N $88^0$27'05"E	Teesta	158	Upstream of Teesta Low Dam IV
S12	$26^0$55'16"N $88^0$27'41"E	Teesta	150	Downstream of Teesta Low Dam IV
S13	$26^0$53'19"N $88^0$28'28"E	Teesta	144	Teesta Low dam V
S14	$26^0$52'50"N $88^0$28'36"E	Teesta	134	Downstream of Teesta Low dam stage V (near Sevok)
S15	$26^0$59'36"N $88^0$25'42"E	Riyang	187	Riyang is a tributary of Teesta, joins on right bank downstream Teesta Low dam III

Table-5.2: Drinking Water Quality Standards

Characteristics	*Acceptable	**Cause for Rejection
Turbidity (units on JTU scale)	2.5	10
Colour (Units on platinum cobalt scale)	5.0	25
Taste and Odour	Unobjectionable	Unobjectionable
pH	7.0 to 8.5	<6.5 or >9.2
Total Dissolved Solids (mg/l)	500	1500
Total hardness (mg/l) (as $CaCO_3$)	200	600
Chlorides as CD (mg/l)	200	1000
Sulphates (as SO_4)	200	400
Fluorides (as F) (mg/l)	1.0	1.5
Nitrates (as NO_3) (mg/l)	45	45
Calcium (as Ca) (mg/l)	75	200
Magnesium (as Mg) (mg/l) If there are 250 mg/l of sulphates, Mg content can be increased to a maximum of 125 mg/l with the reduction of sulphates at the rate of 1 unit per every 2.5 units of	30	150

Characteristics	*Acceptable	**Cause for Rejection
sulphates		
Iron (as Fe) (mg/l)	0.1	1.0
Manganese (as Mn) (mg/l)	0.05	0.5
Copper (as Cu) (mg/l)	0.05	1.5
Zinc (as Zn) (mg/l)	5.0	15.0
Phenolic compounds (as phenol) (mg/l)	0.001	0.002
Anionic detergents (as MBAS) (mg/l)	0.2	1.0
Mineral Oil (mg/l)	0.01	0.3
Toxic materials		
Arsenic (as As) (mg/l)	0.05	0.05
Cadmium (as Cd) (mg/l)	0.01	0.01
Chromium (as hexaalent Cr) (mg/l)	0.05	0.05
Cyanides (as CN) (mg/l)	0.05	0.05
Lead (as Pb) (mg/l)	0.1	0.1
Selenium (as Se) (mg/l)	0.01	0.01
Mercury (total as Hg) (mg/l)	0.001	0.001
Polynuclear aromatic hydrocarbons (PAH)	0.2 μg/l	0.2 μg/l

Notes :-

1. *The figures indicated under the column `Acceptable' are the limits upto which water is generally acceptable to the consumers
2. **Figures in excess of those mentioned under `Acceptable render the water not acceptable, but still may be tolerated in the absence of alternative and better source but upto the limits indicated under column "Cause for Rejection" above which are supply will have to be rejected

Water quality monitoring was conducted on a monthly basis for a period of 12 months from April 2014 to March 2015. The results of month wise water quality sampling are depicted in Tables-5.3 to 5.14.

The monthly variation in the physical and chemical characteristics at various sampling sites is given in Figure-5.2.

Table-5.3: Physical and chemical characteristics of Teesta and Rangit rivers in the Study Area for the month of April 2014.

Parameters	Sampling locations													
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14
Water Temperature (˚C)	20	19	18	15	18	18	20	19	17	19	18	19	20	19
Colour	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less
Odour	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less
Turbidity (ntu)	4.95	9.38	10.5	13.47	9.87	13.85	6.45	6.78	12.98	25	23.9	51.5	38.6	22
pH	8.08	8.01	8.04	8.22	8.55	8.97	8.99	8.52	7.93	8.3	8.34	8.1	7.88	8.05
Dissolved Oxygen (mg/l)	6.6	7	7	8.4	7.6	7.7	6.4	6.4	7.76	6.87	7.9	8.26	7.9	6.9
BOD, mg/l	1.5	1.6	1.5	1.5	1.6	1.7	1.5	1.6	1.5	1.6	1.6	1.7	1.7	1.6
COD, mg/l	3	2.9	2.8	2.9	3.1	3.2	3	3.1	2.9	3.1	3.4	3.1	3.6	3.1
Electric Conductivity (µs)	91.8	84.5	86.9	83.2	76.03	84.3	81.56	73.36	77.06	83.2	85.2	77	81.16	79.9
Total Dissolved Solid (mg/l)	69.17	63.37	65.3	62.9	57.7	63.6	61.3	55.2	58.3	62.9	64.4	58.86	62.1	61
Alkalinity (mg/l)	54	52	50	48	56	60	56	54	54	54	50	48	56	58
Total Hardness (mg/l)	72	68	68	70	66	70	72	62	64	70	74	72	76	70
Calcium Hardness (mg/l)	71.4	56.7	60.9	60.9	46.2	54.6	54.6	54.6	58.8	58.8	63	56.7	63	60.9
Calcium ions (mg/l)	28.6	22.71	24.39	24.39	18.5	21.87	21.87	21.87	23.55	23.55	25.23	22.71	25.23	24.39
Magnesium Hardness (mg/l)	0.6	11.3	7.1	9.1	19.8	15.4	17.4	7.4	5.2	11.2	11	15.3	13	9.1
Magnesium Ions (mg/l)	0.15	2.75	1.73	2.21	4.81	3.74	4.23	1.8	1.26	2.72	2.67	3.72	3.16	2.21
Chloride (mg/l)	24	24	24	26	24	23	27	28	33	29	29	26	26	26
Sodium (mg/l)	4.01	3.66	3.26	3.29	3.95	4.25	4.63	4.84	3.51	3.49	3.47	3.52	3.54	5.69
Potassium (mg/l)	1.77	1.69	1.61	1.59	1.22	1.32	1.35	1.48	1.39	1.54	1.62	1.73	1.75	1.98
Nitrates (mg/l)	0.49	0.45	0.83	0.45	0.53	0.1	0.67	0.75	0.11	0.06	0.44	1.18	0.44	0.15
Phosphates (mg/l)	0.12	0.02	0.23	0.45	0.12	0.43	0.23	0.11	0.23	0.32	0.21	0.1	0.02	0.05
Silicates (mg/l)	7	0.92	0.95	2.96	1.86	4.91	8.67	9.08	0.6	10.66	0.75	0.89	1.52	0.89
Iron (Fe; mg/l)	0.11	0.11	0.11	0.14	0.12	0.12	0.11	0.13	0.14	0.09	0.11	0.12	0.11	0.13
Copper (mg/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Chromium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Lead, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mercury, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc, mg/l	0.2	0.2	0.3	0.2	0.3	0.1	0.2	0.4	0.2	0.4	0.3	0.2	0.1	0.3

Table-5.4: Physical and chemical characteristics of Teesta and Rangit rivers in the Study Area for the month of May 2014.

Parameters	Sampling locations													
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14
Water Temperature (˚C)	16	17	19	19	21	24	24	25	21	22	19	19	20	20
Colour	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less
Odour	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less
Turbidity (ntu)	329	259	235	214	19.91	12.84	8.44	9.51	760	8.88	43.5	260	251	245
pH	8.08	7.97	7.91	7.87	8.28	8.82	8.72	8.67	7.78	7.77	8.05	8.04	7.82	7.86
Dissolved Oxygen (mg/l)	6.9	7.5	7.1	6.4	6.7	5.6	5.4	5.1	5.6	5.4	6.5	6.8	7.3	7.1
BOD, mg/l	1.6	1.5	1.5	1.6	1.6	1.7	1.6	1.7	1.5	1.6	1.5	1.7	1.7	1.6
COD, mg/l	3.2	3.1	3.2	2.9	2.8	3.2	3.1	3.1	3.2	2.9	2.9	3.1	3.2	3.1
Electric Conductivity (µs)	50	50.1	50.7	51.4	63.3	65.2	69.4	72.4	51.1	73.1	58.9	57.3	62.4	60.3
Total Dissolved Solid (mg/l)	38.3	38.1	38.8	39.2	48.5	50	52.6	54.8	38.1	54.8	45.1	43.2	46.7	45.4
Alkalinity (mg/l)	36	42	42	42	56	56	56	60	52	56	56	48	50	50
Total Hardness (mg/l)	60	56	58	58	60	56	70	72	62	86	84	78	68	64
Calcium Hardness (mg/l)	42	35.7	46.2	48.3	44.1	42	42	42	37.8	52.5	44.1	42	46.2	50.4
Calcium ions (mg/l)	16.82	14.3	18.5	19.34	17.66	16.82	16.82	16.82	15.14	21.03	17.66	16.82	18.5	20.19
Magnesium Hardness (mg/l)	18	20.3	11.8	9.7	15.9	14	28	30	24.2	33.5	39.9	36	21.8	13.6
Magnesium Ions (mg/l)	4.37	4.93	2.87	2.36	3.86	3.4	6.8	7.29	5.88	8.14	9.7	8.75	5.3	3.3
Chloride (mg/l)	28	28	28	29	28	29	29	29	36	29	27	31	30	30
Sodium (mg/l)	1.26	1.03	1.72	1.92	3.54	3.59	3.62	3.67	2.89	2.67	2.72	2.69	2.76	2.79
Potassium (mg/l)	1.76	1.7	1.68	1.67	1.12	1.13	1.15	1.18	1.32	1.44	1.46	1.46	1.49	1.49
Nitrates (mg/l)	0.1	0.17	0.15	0.11	0.22	0.19	0.19	0.46	0.24	0.21	1.06	0.86	0.52	0.45
Phosphates (mg/l)	0.21	0.05	0.12	1.38	0.24	0.87	0.33	0.04	0.26	0.43	0.42	0.42	0.35	0
Silicates (mg/l)	0.3	0.45	0.54	0.67	0.98	3.62	3.01	3.23	3.34	8.39	4.7	0.96	0.89	0.97
Iron (Fe; mg/l)	0.11	0.11	0.16	ND	0.11	0.11	0.16	ND	0.11	0.12	0.08	0.12	0.07	0.03
Copper (mg/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Chromium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Lead, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mercury, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc, mg/l	0.2	0.3	0.3	0.2	0.2	0.2	0.3	0.3	0.2	0.4	0.3	0.4	0.4	0.2

Table-5.5: Physical and chemical characteristics of Teesta and Rangit rivers in the Study Area for the month of June 2014.

Parameters	Sampling locations													
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14
Water Temperature (˚C)	19	19	19	19	21	22	22	22	19	19	20	20	21	21
Colour	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less
Odour	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less
Turbidity (ntu)	247	317	368	384	653	356	534	539	431	535	513	463	412	410
pH	7.99	8.18	8.16	8.18	8.2	8.18	7.8	7.85	8.04	7.95	8.17	8.22	8	8.03
Dissolved Oxygen (mg/l)	6.5	6.6	7	7.4	6.7	5.9	5.9	6.4	7.8	7.4	7.6	8.3	7.1	6.8
BOD, mg/l	1.3	1.1	1.2	1.2	1.3	1.3	1.1	1.1	1.2	1.1	1.3	1.2	1.3	1.2
COD, mg/l	2.6	2.8	2.5	2.5	2.9	2.7	2.3	2.1	2.6	2.6	2.4	2.2	2.6	2.1
Electric Conductivity (µs)	48.63	49.5	50.5	50.97	40.4	74.7	46.1	47.5	52.8	53.8	53.9	49.3	55.4	56.6
Total Dissolved Solid (mg/l)	37.2	38.8	38.9	39	31.9	56.9	35.1	38.4	40.3	41.3	41.7	37.3	42.8	43.3
Alkalinity (mg/l)	86	92	88	86	84	90	84	84	72	74	82	60	68	66
Total Hardness (mg/l)	84	60	60	60	78	84	84	88	90	72	84	74	80	82
Calcium Hardness (mg/l)	50.4	56.7	48.3	46.2	50.4	37.8	42	42	46.2	46.2	42	42	46.2	42
Calcium ions (mg/l)	20.19	22.71	19.34	18.5	20.19	15.14	16.82	16.82	18.5	18.5	16.82	16.82	18.5	16.82
Magnesium Hardness (mg/l)	33.6	3.3	11.7	13.8	27.6	46.2	42	46	43.8	25.8	42	32	33.8	40
Magnesium Ions (mg/l)	8.16	0.8	2.84	3.35	6.71	11.23	10.21	11.18	10.64	6.27	10.21	7.78	8.21	9.72
Chloride (mg/l)	2.09	1.98	1.97	2.11	2.82	2.89	3.34	3.29	3.12	2.54	2.28	2.21	2.42	2.41
Sodium (mg/l)	1.81	1.69	1.63	1.54	1.51	1.53	1.59	1.66	2.13	2.02	2.13	2.01	1.99	1.97
Potassium (mg/l)	34	38	42	40	44	40	56	52	50	44	46	47	44	40
Nitrates (mg/l)	0.75	0.18	0.38	0.41	0.39	0.6	0.66	0.52	0.6	0.1	0.79	0.73	0.75	0.81
Phosphates (mg/l)	0.01	0.04	0.15	0.14	0.22	0.16	0.16	0.14	0.09	0.09	0.11	0.12	0.07	0.05
Silicates (mg/l)	1.08	0.95	13.54	13.1	0.88	2.05	0.64	0.87	7.36	0.75	6.86	2.4	0.98	0.87
Iron (Fe; mg/l)	0.17	0.12	0.09	0.08	0.13	0.14	0.11	0.07	0.13	0.11	0.09	0.09	0.08	0.09
Copper (mg/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Chromium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Lead, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mercury, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc, mg/l	0.2	0.2	0.3	0.3	0.2	0.3	0.2	0.2	0.3	0.2	0.3	0.3	0.3	0.2

Table-5.6: Physical and chemical characteristics of Teesta and Rangit rivers in the Study Area for the month of July 2014.

Parameters	Sampling locations													
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14
Water Temperature (˚C)	19	19	19	21	25	25	25	25	20	20	20	20	20	20
Colour	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less
Odour	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less
Turbidity (ntu)	297	398	348	324	70.5	27.9	65.76	97.3	303	411	378	419	408	399
pH	8.1	8.04	8	8.03	8.17	8.11	8.09	8.08	8.02	8.15	7.9	8.04	8.09	7.89
Dissolved Oxygen (mg/l)	6.4	6.8	7.1	6.9	6.6	6.1	6.2	6.8	7.6	6.4	7.4	8	7.9	7.6
BOD, mg/l	1.3	1.2	1.2	1.1	1.2	1.2	1.3	1.2	1.2	1.3	1.3	1.2	1.1	1.3
COD, mg/l	2.6	2.7	2.7	2.6	2.6	2.1	2.3	2.6	2.1	2.3	2.3	2.3	2.3	2.5
Electric Conductivity (μs)	43	43.1	44.1	44.1	42.67	66.4	64.26	46.03	46.27	44.1	43.4	44.43	43.21	47.17
Total Dissolved Solid (mg/l)	41.5	49.94	46.09	17.57	23.05	27.4	27.25	26.35	43.18	51.48	48.44	52.25	52.09	51.46
Alkalinity (mg/l)	40	40	36	40	36	44	40	40	36	40	36	48	40	40
Total Hardness (mg/l)	80	80	68	68	72	84	88	92	92	76	120	152	128	132
Calcium Hardness (mg/l)	37.8	42	50.4	46.2	42	50.4	46.2	50.4	42	54.6	54.6	84	46.2	50.4
Calcium ions (mg/l)	15.14	16.82	20.19	18.5	16.82	20.19	18.5	20.19	16.82	21.87	21.87	33.64	18.5	20.19
Magnesium Hardness (mg/l)	42.2	38	17.6	21.8	30	33.6	41.8	41.6	50	21.4	65.4	68	81.8	81.6
Magnesium Ions (mg/l)	10.25	9.23	4.28	5.3	7.29	8.16	10.16	10.11	12.15	5.2	15.89	16.52	19.88	19.83
Chloride (mg/l)	34	36	42	40	40	40	34	34	40	44	40	46	42	42
Sodium (mg/l)	2.11	2.09	2	2.23	2.7	2.82	3.11	3.2	2.97	2.78	2.58	2.52	2.5	2.46
Potassium (mg/l)	1.68	1.62	1.59	1.48	1.46	1.49	1.53	1.57	1.99	1.89	1.89	1.91	1.88	1.87
Nitrates (mg/l)	0.52	1.15	0.87	0.96	0.05	0.78	0.65	0.37	ND	6.63	ND	5.97	4.87	3.6
Phosphates (mg/l)	0.02	0.16	1.09	0.25	0.21	0.38	0.28	0.24	0.1	0.31	0.48	0.04	0.03	0.11
Silicates (mg/l)	0.42	2.06	3.33	4.21	5.81	5.86	6.42	7.44	4.94	5.53	2.71	2.11	2.35	2.41
Iron (Fe; mg/l)	0.17	0.15	0.1	0.14	0.16	0.13	0.13	0.11	0.12	0.09	0.1	1.15	0.12	0.14
Copper (mg/l)	0.005	0.004	0.011	0.012	0.01	0.011	0.006	0.005	0.004	0.002	0.002	0.003	0.003	0.01
Total Chromium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Lead, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mercury, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc, mg/l	0.2	0.2	0.4	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.2	0.2	0.2	0.2

Table-5.7: Physical and chemical characteristics of Teesta and Rangit rivers in the Study Area for the month of August 2014.

Parameters	Sampling locations													
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14
Water Temperature (˚C)	20	19	18	15	18	18	20	19	17	19	18	19	20	19
Colour	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less
Odour	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less
Turbidity (ntu)	4.95	9.38	10.5	13.47	9.87	13.85	6.45	6.78	12.98	25	23.9	51.5	38.6	22
pH	8.05	7.85	7.82	7.9	7.65	7.81	7.9	7.93	7.9	7.8	8.04	7.66	7.88	7.59
Dissolved Oxygen (mg/l)	5.5	6.3	5.9	6.1	6.53	5.9	6.42	5.1	6.4	6.3	6.43	7.55	7.37	6.13
BOD, mg/l	1.2	1.2	1.3	1.1	1.1	1.1	1.2	1.2	1.3	1.2	1.2	1.3	1.1	1.3
COD, mg/l	2.5	2.7	2.6	2.3	2.1	2.3	2.3	2.4	2.6	2.3	2.3	2.6	2.4	2.4
Electric Conductivity (μs)	44.15	43.2	45	47.3	51.62	62.9	62.23	48.35	49.45	49.8	48.17	53.2	51.95	53.35
Total Dissolved Solid (mg/l)	33.4	33.75	35.2	34.95	35.25	46.95	37.7	36.8	37.25	36.45	36.45	38.25	36.5	40.4
Alkalinity (mg/l)	22	38	32	34	34	44	42	26	38	32	32	28	32	36
Total Hardness (mg/l)	54	58	46	46	46	56	48.2	44	52	46	50	48	48	48
Calcium Hardness (mg/l)	46.2	31.5	44.1	42.2	25.2	37.8	38.2	37.8	35.7	37.8	33.6	44.1	44.8	42
Calcium ions (mg/l)	18.5	12.62	17.66	16.9	10.09	15.14	15.3	15.14	14.3	15.14	13.46	17.66	16.86	16.82
Magnesium Hardness (mg/l)	7.8	26.5	1.9	3.8	20.8	18.2	12.6	6.2	16.3	8.2	16.4	3.9	3.2	6
Magnesium Ions (mg/l)	1.9	6.44	0.46	0.92	5.05	4.42	3.06	1.51	3.96	1.99	3.99	0.95	0.77	1.46
Chloride (mg/l)	13	15	20	19.99	17	20	17.99	15	15	19	14	16	16.99	14
Sodium (mg/l)	2.48	2.44	2.41	2.17	2.38	2.54	2.72	3.09	3.16	3.09	2.85	2.77	2.74	2.72
Potassium (mg/l)	1.36	1.49	1.56	1.33	1.05	1.11	1.18	1.32	1.81	1.66	1.52	1.51	1.51	1.49
Nitrates (mg/l)	0.34	0.73	0.23	nd	0.75	0.51	0.41	0.72	0.91	0.55	0.71	0.78	0.9	6.27
Phosphates (mg/l)	0.08	0.23	0.12	0.06	0.14	0.27	0.31	0.15	0.16	0.43	0.43	0.41	0.32	0.36
Silicates (mg/l)	0.2	4.81	5.23	1.19	7.39	9.24	7.43	6.88	5.81	9	6.24	8.21	7.65	7.34
Iron (Fe; mg/l)	0.27	0.19	0.11	0.15	0.21	0.19	0.17	0.16	0.15	0.19	0.21	0.2	0.22	0.21
Copper (mg/l)	0.001	0.0176	0.0062	0.0052	0.0052	0.0018	0.0021	0.0125	0.0031	0.0081	0.0093	0.002	0.008	0.001
Total Chromium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Lead, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mercury, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc, mg/l	0.2	0.2	0.3	0.3	0.2	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.3	0.2

Table-5.8: Physical and chemical characteristics of Teesta and Rangit rivers in the Study Area for the month of September 2014.

Parameters	Sampling locations													
	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Water Temperature (°C)	18.5	18	19	20	22.5	20	20	21.5	21	19	20.5	19.5	20	20.5
Colour	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less
Odour	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less
Turbidity (ntu)	3.53	3.72	3.86	2.89	1.18	1.33	0.94	0.72	2.24	10.49	9.72	12.81	10.54	11.69
pH	8.07	8	7.87	7.98	8.15	7.95	8.01	8.04	8.07	7.82	7.99	7.91	7.76	7.59
Dissolved Oxygen (mg/l)	7.47	7.57	6.4	6.65	6.03	5.83	6.12	6.5	7.1	5.33	5.9	7.67	7.21	7.17
BOD, mg/l	1.2	1.3	1.2	1.3	1.3	1.3	1.2	1.2	1.3	1.2	1.3	1.1	1.2	1.3
COD, mg/l	2.6	2.6	2.5	2.4	2.5	2.6	2.4	2.3	2.6	2.3	2.3	2.4	2.5	2.6
Electric Conductivity (µs)	50.07	50.17	50.73	50.34	52	54.53	56.76	54.8	60.67	50.03	51.7	51.63	59.76	61.43
Total Dissolved Solid (mg/l)	38.8	38.3	38.77	37.65	39.9	41.43	42.43	41.43	45.8	37.87	39.53	39.13	42.31	46.4
Alkalinity (mg/l)	54	36	42	42	44	48	54	60	62	40	56	62	56	54
Total Hardness (mg/l)	76	50	58	60	62	66	68	98	68	69	66	68	61	62
Calcium Hardness (mg/l)	48.3	37.8	37.8	42	46.2	29.4	46.2	69.3	39.9	42	39.9	35.7	48.25	48.3
Calcium ions (mg/l)	19.34	15.14	15.14	16.8	18.5	11.77	18.5	27.75	15.98	16.82	15.98	14.3	19.3	19.34
Magnesium Hardness (mg/l)	27.7	12.2	20.2	18	15.8	36.6	21.8	28.7	28.1	27	26.1	32.3	12.75	13.7
Magnesium Ions (mg/l)	6.73	2.96	4.91	4.37	3.84	8.89	5.29	6.97	6.83	6.56	6.34	7.85	3.09	3.33
Chloride (mg/l)	12	14	18	15	13	10	15	12	13	12	13	13	13	13
Sodium (mg/l)	3.42	3.49	3.75	3.25	3.56	3.85	4.12	4.36	4.56	4.23	3.27	3.72	3.66	3.42
Potassium (mg/l)	1.79	1.98	1.91	1.81	1.53	1.61	1.71	1.82	2.09	2.02	1.93	1.97	1.81	1.77
Nitrates (mg/l)	0.68	0.42	0.34	0.45	0.12	0.23	0.34	1.21	1.64	0.12	0.98	0.54	0.43	0.32
Phosphates (mg/l)	0.11	0.1	0.09	0.06	0.12	0.04	0.05	0.09	0.11	0.08	0.07	0.18	0.08	0.49
Silicates (mg/l)	5.13	4.19	4.19	4.02	3.83	5.02	4.89	4.7	5.62	4.4	4.2	4.36	4.28	4.22
Iron (Fe; mg/l)	0.17	0.15	0.13	0.17	0.19	0.2	0.18	0.19	0.18	0.17	0.2	0.2	0.21	0.18
Copper (mg/l)	ND	ND	ND	ND	ND	ND	0.01	0.03	ND	ND	ND	0.02	0.001	ND
Total Chromium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Lead, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mercury, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc, mg/l	0.2	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.3	0.2

Table-5.9: Physical and chemical characteristics of Teesta and Rangit rivers in the Study Area for the month of October 2014.

Parameters	Sampling locations													
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14
Water Temperature (˚C)	18	18	18.5	19	22	20	19.52	21	21	19.5	20	19	19	20.5
Colour	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less
Odour	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less
Turbidity (ntu)	2.6	2.24	2.17	2.69	1.21	2.34	1.24	1.12	2.38	4.56	12.58	7.58	7.68	16.38
pH	7.48	7.89	7.66	7.89	8.01	8.09	8.08	8.01	7.89	7.95	8.11	8.04	7.17	7.44
Dissolved Oxygen (mg/l)	7.77	7.89	7.91	7.24	7.16	7.24	7.12	7.45	8.12	7.23	6.49	7.88	7.78	7.98
BOD, mg/l	1.6	1.8	1.7	1.8	1.9	1.8	1.8	1.7	1.8	1.8	1.7	1.9	1.8	1.9
COD, mg/l	3.2	3.4	3.5	3.5	3.9	3.5	3.5	3.2	3.6	3.2	3.6	3.5	3.4	3.8
Electric Conductivity (μs)	62.1	63.78	62.78	60.5	66.45	64.58	71.25	70.25	71.25	62.97	65.38	64.52	59.47	69.52
Total Dissolved Solid (mg/l)	40.25	41.26	42.56	40.25	43.56	46.35	47	44.49	49.8	38.53	41.35	41.13	43.69	48.69
Alkalinity (mg/l)	52	44	44	40	46	47	48	52	54	44	52	54	52	51
Total Hardness (mg/l)	72	56	60	61	63	65	69	59	66	71	67	66	65	64
Calcium Hardness (mg/l)	46.23	36.25	43.56	44.58	45.36	46.57	46.2	42.15	45.68	52.38	49.58	46.12	45.38	46.23
Calcium ions (mg/l)	18.57	14.56	17.49	17.9	18.22	18.7	18.55	16.93	18.35	21.04	19.91	18.52	18.22	18.57
Magnesium Hardness (mg/l)	25.77	19.75	16.44	16.42	17.64	18.43	22.8	16.85	20.32	18.62	17.42	19.88	19.62	17.77
Magnesium Ions (mg/l)	6.27	4.81	4	4	4.29	4.48	5.55	4.1	4.94	4.53	4.24	4.84	4.77	4.32
Chloride (mg/l)	14	13	16	16	15	12	16	13	15	15	16	14	12	15
Sodium (mg/l)	8.06	7.25	6.58	6.11	3.12	2.89	2.79	2.89	3.64	3.16	3.52	3.71	3.22	3.02
Potassium (mg/l)	2.9	2.77	2.96	2.51	1.12	0.89	0.89	0.73	1.39	1.3	1.21	1.44	1.55	1.65
Nitrates (mg/l)	0.06	0.08	0.11	0.08	0.11	0.12	0.07	0.05	0.04	0.06	0.08	0.07	0.04	0.06
Phosphates (mg/l)	0.09	0.03	0.08	0.03	0.03	0.04	0.08	0.07	0.12	0.03	0.06	0.1	0.05	0.13
Silicates (mg/l)	7.13	6.25	6.11	5.12	5.21	7.12	5.23	5.71	7.22	6.48	7.32	5.39	6.23	6.21
Iron (Fe; mg/l)	0.12	0.13	0.11	0.18	0.21	0.16	0.15	0.13	0.22	0.19	0.17	0.14	0.13	0.11
Copper (mg/l)	0.01	ND	ND	ND	ND	ND	0.002	0.003	ND	ND	ND	0.002	0.002	0.001
Total Chromium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Lead, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mercury, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc, mg/l	0.3	0.2	0.4	0.2	0.4	0.4	0.5	0.2	0.3	0.5	0.2	0.2	0.4	0.2

Table-5.10: Physical and chemical characteristics of Teesta and Rangit rivers in the Study Area for the month of November 2014.

Parameters	Sampling locations													
	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Water Temperature(°C)	16.5	16.5	18.5	17.5	19.5	19	18.5	18.5	19.5	18.5	19.5	17.5	18.5	17.5
Colour	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less
Odour	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less
Turbidity (ntu)	2.12	2.26	2.86	3.12	2.28	2.47	1.9	2.18	2.14	3.28	2.27	3.11	2.54	3.65
pH	7.71	8.08	7.89	8.02	7.98	8.01	8.18	8.11	8.01	7.91	8.01	8.14	7.33	7.61
Dissolved Oxygen (mg/l)	7.79	7.81	7.68	7.44	7.42	7.37	7.56	7.88	8.02	7.76	7.45	8.12	8.23	8.21
BOD, mg/l	1.7	1.8	1.8	1.8	1.9	1.7	1.8	1.7	1.7	1.8	2	1.9	2	2
COD, mg/l	3.4	3.5	3.6	3.5	3.9	3.6	3.6	3.5	3.5	3.6	3.9	3.8	3.9	3.8
Electric Conductivity (μs)	65.38	66.49	66.53	64.58	63.5	68.53	71.76	72.2	73.62	71.68	70.33	73.64	73.69	73.68
Total Dissolved Solid (mg/l)	45.63	48.69	47.69	49.38	48.67	50.87	51.35	52.39	54.69	46.39	48.69	44.33	49.69	52.09
Alkalinity (mg/l)	56	38	44	49	46	47	53	57	62	44	54	59	52	49
Total Hardness (mg/l)	73	60	63	66	61	63	61	60	67	67	72	67	67	68
Calcium Hardness (mg/l)	56.27	45.58	46.01	49.23	45.68	46.23	45.23	46.11	50.87	50.43	55.89	51.02	50.98	50.12
Calcium ions (mg/l)	22.6	18.31	18.48	19.77	18.35	18.57	18.16	18.52	20.43	20.25	22.45	20.49	20.47	20.13
Magnesium Hardness (mg/l)	16.73	14.42	16.99	16.77	15.32	16.77	15.77	13.89	16.13	16.57	16.11	15.98	16.02	17.88
Magnesium Ions (mg/l)	4.07	3.51	4.13	4.08	3.73	4.08	3.84	3.38	3.92	4.03	3.92	3.89	3.9	4.35
Chloride (mg/l)	13	14	17	14	12	14	14	17	16	17	16	14	15	18
Sodium (mg/l)	3.41	3.66	3.85	3.95	3.58	3.22	3.6	4.53	5.05	4.63	4.16	3.98	3.81	3.66
Potassium (mg/l)	1.62	1.65	1.83	1.33	0.99	1.24	1.29	1.21	1.55		2.01	1.89	1.51	1.53
Nitrates (mg/l)	0.02	0.03	0.09	0.03	0.08	0.07	0.03	0.02	ND	0.08	0.11	0.03	ND	0.02
Phosphates (mg/l)	0.02	0.01	0.03	0.02	0.03	ND	0.03	0.02	ND	0.03	0.04	ND	ND	ND
Silicates (mg/l)	9.23	8.46	11.23	12.35	13.65	15.36	13.68	17.56	12.87	14.14	7.36	18.69	16.38	16.54
Iron (Fe; mg/l)	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.03	0.04	0.04
Copper (mg/l)	0.02	ND	0.001	0	0.03	ND	ND	0.001	0.001	ND	0.005	ND	0.002	ND
Total Chromium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Lead, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mercury, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc, mg/l	0.2	0.4	0.2	0.4	0.3	0.5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Table-5.11: Physical and chemical characteristics of Teesta and Rangit rivers in the Study Area for the month of December 2014.

Parameters	Sampling locations													
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14
Water Temperature (˚C)	15	15	16	16	17	16	16	17	16	17	17	16	17	16
Turbidity (ntu)	1.16	1.49	1.9	1.1	0.56	0.55	0.65	0.69	1.15	1.8	1.71	4.01	3.75	3.47
Colour	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less
Odour	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less
pH	8	8.02	8.06	8.12	8.29	8.3	8.25	8.09	8.21	7.51	8.23	8.38	8.21	8.29
Dissolved Oxygen (mg/l)	7.43	7.87	7.3	7.43	7.6	8.37	8.1	8.23	7.83	6.6	7.5	8.57	7.94	7.83
BOD, mg/l	1.6	1.5	1.6	1.5	1.5	1.6	1.7	1.8	1.6	1.8	1.6	1.6	1.5	1.8
COD, mg/l	3.2	3	3.1	3	3	3.5	3.5	3.6	3.2	3.5	3.5	3.5	3.3	3.4
Electric Conductivity (µs/cm)	78.37	77.3	76.63	75.35	62.47	71.33	72.15	73.9	73.63	76.73	98.97	77.5	76.2	75.57
Total Dissolved Solid (mg/l)	59.37	58.83	57.17	54.32	47.17	54.33	56.9	55.93	56.4	59.03	75.1	58.4	58.12	57.03
Alkalinity (mg/l)	44	40	48	44	44	50	44	46	52	50	56	44	44	54
Total Hardness (mg/l)	74	76	72	68	62	60	60	60	66	66	94	68	68	70
Calcium Hardness (mg/l)	56.7	60.9	54.6	50.4	42	46.2	44.2	39.9	50.4	60.9	71.4	52.5	54.2	54.6
Calcium ions (mg/l)	22.71	24.39	21.87	20.19	16.82	18.5	17.68	15.98	20.19	24.39	28.6	21.03	21.68	21.87
Magnesium Hardness (mg/l)	17.3	15.1	17.4	17.6	20	13.8	15.8	20.1	15.6	5.1	22.6	15.5	13.8	15.4
Magnesium Ions (mg/l)	4.2	3.67	4.23	4.28	4.86	3.35	3.84	4.88	3.79	1.24	5.49	3.77	3.35	3.74
Chloride (mg/l)	15	16	15	15	15	19	15	21	25	19	19	18	17	22
Sodium (mg/l)	3.22	3.12	3.28	3.12	3.32	3.22	3.1	3.24	4.21	4.12	4.22	3.18	3.36	3.16
Potassium (mg/l)	1.69	1.45	1.77	1.43	1.1	1.04	1.18	1.11	1.32	1.22	1.98	1.59	1.32	1.33
Nitrate (mg/l)	ND	ND	0.14	ND	1.71	ND	ND	ND	ND	0.94	1.26	ND	ND	ND
Phosphate (mg/l)	0.13	ND	ND	ND	ND	ND	ND	ND	ND	0.16	0.17	ND	ND	ND
Silicate (mg/l)	24.7	19.1	23.88	30.04	32.21	35.87	36.42	39.12	23.71	18.49	15.22	29.19	25.43	23.07
Iron (Fe; mg/l)	0.03	0.02	0.01	0.03	0.02	0.02	0.02	0.02	ND	ND	ND	0.03	0.02	0.02
Copper (mg/l)	0.02	ND	ND	0	0.02	ND	ND	ND	ND	ND	ND	ND	0.003	ND
Total Chromium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Lead, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mercury, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc, mg/l	0.3	0.4	0.4	0.3	0.2	0.5	0.2	0.2	0.2	0.5	0.2	0.5	0.2	0.3

Table-5.12: Physical and chemical characteristics of Teesta and Rangit rivers in the Study Area for the month of January 2015.

Parameters	Sampling locations													
	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Water Temperature (˚C)	10	10	11	11	13	13	12	13	12	17	17	13	14	14
Turbidity (ntu)	1.68	2.39	1.21	1.2	1.22	1.16	1.21	1.73	1.6	1.69	7.52	2.75	2.76	3.42
Colour	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less
Odour	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less
pH	7.97	8.06	7.87	8.21	8.2	8.12	8.23	7.89	8.23	7.63	8.26	8.21	8.12	8.17
Dissolved Oxygen (mg/l)	8.93	9.73	9.03	8.95	8.83	7.13	7.43	7.9	8.27	7.87	7.5	7.33	8.23	8.23
BOD, mg/l	1.6	1.5	1.5	1.6	1.6	1.5	1.5	1.6	1.7	1.6	1.5	1.7	1.6	1.5
COD, mg/l	3.1	3.2	3.1	3.1	3.1	3.2	3.1	3.1	3.3	3.2	3.2	3.2	3.2	3.1
Electric Conductivity (µs/cm)	84.03	80.1	80.3	76.65	68.63	79.2	76.54	73.97	75.5	81.37	84.27	80.3	81.29	82.33
Total Dissolved Solid (mg/l)	65.07	61.13	61.83	57.35	52.73	60.37	54.48	56.1	57.1	60.37	63.87	59.53	62.53	63.4
Alkalinity (mg/l)	46	52	44	44	50	52	48	54	50	48	54	52	54	52
Total Hardness (mg/l)	110	90	90	90	86	100	86	82	102	90	82	102	96	94
Calcium Hardness (mg/l)	65.1	60.9	63	58	52.5	42	54	50.4	48.3	63	69.3	60.9	64.2	86.1
Calcium ions (mg/l)	26.07	24.39	25.23	23.2	21.03	16.82	21.6	20.19	19.34	25.23	27.75	24.39	25.68	34.48
Magnesium Hardness (mg/l)	44.9	29.1	27	32	33.5	58	32	31.6	53.7	27	12.7	41.1	31.8	7.9
Magnesium Ions (mg/l)	10.91	7.07	6.56	7.78	8.14	14.09	7.78	7.68	13.05	6.56	3.09	9.99	7.73	1.92
Chloride (mg/l)	20	16	15	15	14	17	17	15	17	14	16	18	19	22
Sodium (mg/l)	3.61	5.31	3.74	3.87	3.94	3.6	3.71	3.99	3.85	3.78	0	4.32	4.26	4.2
Potassium (mg/l)	1.37	1.75	1.37	1.15	0.98	0.94	1.11	1.06	1.16	1.38	1.68	1.4	1.43	1.47
Nitrate (mg/l)	ND	0.83	0.26	ND	ND	ND	ND	ND	ND	0.12	0.27	0.2	ND	0.08
Phosphate (mg/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silicate (mg/l)	17.11	25.74	25.74	19.24	17.08	19.47	21.23	24.58	33.4	26.35	18.41	25.68	21.32	23.78
Iron (mg/l)	0.11	0.1	0.1	0.1	0.1	ND	0.13	0.12	0.13	0.15	0.13	0.11	0.11	0.11
Copper (mg/l)	0.01	ND	0.01	ND	0.01	ND	ND	ND	0.02	ND	ND	ND	ND	ND
Total Chromium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Lead, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mercury, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc, mg/l	0.2	0.4	0.4	0.2	0.2	0.5	0.3	0.2	0.2	0.2	0.5	0.3	0.4	0.2

Table-5.13: Physical and chemical characteristics of Teesta and Rangit rivers in the Study Area for the month of February 2015.

Parameters	Sampling locations													
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14
Water Temperature (˚C)	14.1	15.3	15.47	15	16.25	17.13	16.9	16.87	14.23	18.1	14.91	17.1	18	20
Colour	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less
Odour	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less
Turbidity (ntu)	0.4	1.43	0.61	0.94	0.8	0.33	0.54	0.83	0.76	0.56	1.43	0.94	1.02	1.48
pH	7.89	8.21	8.18	8.26	8.21	8.61	8.21	8.74	8.32	7.11	8.34	8.29	8.23	8.7
Dissolved Oxygen (mg/l)	5.47	8.47	8.47	8	7.68	7.47	7.62	8.2	6	6.67	5.5	5.65	6.25	5.5
BOD, mg/l	1.2	1.4	1.2	1.5	1.2	1.6	1.2	1.2	1.5	1.4	1.5	1.6	1.5	1.4
COD, mg/l	2.6	3	2.6	3.4	2.6	3.4	2.6	2.7	3.4	3	3.4	3.5	3.2	3
Electric Conductivity (µs)	100.67	92.73	91.93	94.73	92.25	89.2	81.65	83.3	86.87	82.73	87.6	97.5	95.65	95.9
Total Dissolved Solid (mg/l)	72.33	66.9	67.63	68.53	67.25	62.5	60.52	59.07	62.6	60.27	62.63	71.67	70.25	72
Alkalinity (mg/l)	108	100	128	124	120	121.2	100	102	104	84	108	100	100	100
Total Hardness (mg/l)	150.4	116	112	101.2	105.2	121.2	94	100	100	120	88	134.8	136.32	146.8
Calcium Hardness (mg/l)	75.6	53.13	55.23	48.3	54.26	60.06	43.05	56.25	47.25	39.9	45.15	76.54	73.57	63
Calcium ions (mg/l)	30.28	21.28	22.12	19.34	21.7	24.05	17.24	22.5	18.92	15.98	18.08	23.55	29.43	25.23
Magnesium Hardness (mg/l)	74.8	62.87	56.77	52.9	50.94	61.14	50.95	43.75	52.75	80.1	42.85	58.26	62.75	83.8
Magnesium Ions (mg/l)	18.18	15.28	13.8	12.85	12.38	14.86	12.38	10.63	12.82	19.46	10.41	14.15	15.25	20.36
Chloride (mg/l)	14	10.3	11	10.6	10.6	10.49	14.7	12.35	11.3	11.3	14	13	14	19.7
Sodium (mg/l)	4.05	5.89	4.14	4.56	4.76	4.52	4.86	5.02	4.55	4.36	4.29	5.09	5.23	4.88
Potassium (mg/l)	1.97	2.02	1.89	1.75	1.39	1.87	1.9	1.96	1.81	2.03	2.11	1.96	2.09	2.21
Nitrate (mg/l)	ND	0.43	0.12	ND	ND	ND	ND	ND	ND	0.05	ND	ND	ND	0.04
Phosphate (mg/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silicate (mg/l)	12.27	8.9	16.12	8.82	8.9	8.93	11.98	12.65	15.3	11.55	14.27	10.44	10.54	11.09
Iron (mg/l)	0.15	0.13	0.14	0.12	0.13	0.11	0.12	0.15	0.16	0.18	0.19	0.18	0.19	0.18
Copper (mg/l)	0.01	0.01	0.01	0.001	0.01	0.003	0.001	0.001	0.006	0.003	0.006	0.003	0.009	0.008
Total Chromium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Lead, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mercury, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc, mg/l	0.2	0.2	0.2	0.4	0.2	0.2	0.2	0.3	0.4	0.2	0.3	0.2	0.2	0.3

Table-5.14: Physical and chemical characteristics of Teesta and Rangit rivers in the Study Area for the month of March 2015.

Parameters	Sampling locations													
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14
Water Temperature (˚C)	21	24	23	23	24	22	23	25	24	19	20	19	20	21
Colour	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less	Colour -less
Odour	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less
Turbidity (ntu)	2.86	5.57	2.14	4.24	0.34	0.51	1.87	0.39	10.83	2.07	0.72	1.14	1.75	1.32
pH	8.19	6.6	8.4	8.23	8.38	8.36	8.22	8.22	8.07	8.03	8.36	8.32	8.15	8.2
Dissolved Oxygen (mg/l)	7.53	6.53	7.07	7.1	8.07	8.77	8.15	7.63	7.07	7.5	5	6.17	7.95	7.52
BOD, mg/l	1.5	1.4	1.2	1.5	1.6	1.2	1.4	1.5	1.3	1.5	1.5	1.5	1.5	1.5
COD, mg/l	3.2	3	2.7	3.3	3.6	2.7	2.9	3	2.7	3.1	3.2	3.3	3.2	3.3
Electrical Conductivity (µs)	73.07	89.73	90.7	87.32	81.27	76.93	79.85	81.7	75.07	104.27	90.3	93.47	87.54	90.65
Total Dissolved Solid (mg/l)	44.37	49.33	55.03	52.1	53.13	46.67	54.28	49.1	46.27	63.17	54.9	56.07	45.35	51.95
Total alkalinity (mg/l)	45	47	46	45	56	58	56	57	53	55	53	48	53	54
Total hardness (mg/l)	66	62	63	64	63	63	71	67	63	78	79	75	72	67
Calcium hardness (mg/l)	56.7	46.2	53.55	54.6	45.15	48.3	48.3	48.3	48.3	55.65	53.55	49.35	54.6	55.65
Calcium Ions (mg/l)	22.68	18.48	21.42	21.84	18.06	19.32	19.32	19.32	19.32	22.26	21.42	19.74	21.84	22.26
Magnesium hardness (mg/l)	9.3	15.8	9.45	9.4	17.85	14.7	22.7	18.7	14.7	22.35	25.45	25.65	17.4	11.35
Magnesium Ions (mg/l)	2.26	3.84	2.3	2.28	4.34	3.57	5.52	4.54	3.57	5.43	6.18	6.23	4.23	2.76
Chloride (mg/l)	26	26	26	27.5	26	26	28	28.5	34.5	29	28	28.5	28	28
Sodium (mg/l)	4.47	6.13	4.44	4.97	5.19	4.99	5.25	5.62	5.12	5.11	4.89	5.54	5.88	5.23
Potassium (mg/l)	2.2	2.32	2.2	2	1.63	2.09	2.13	2.27	2	2.23	2.42	2.28	2.37	2.39
Nitrate (ppm)	0.2	0.94	0.31	0.25	0.97	0.09	0.54	0.47	0.53	0.05	0.13	0.09	0.1	0.14
Phosphate (ppm)	0.03	0.25	0.5	0.42	0.29	0.18	0.11	0.01	0.05	0.19	0.18	0.03	0.12	0.21
Silicate (ppm)	6.58	7.35	8.32	9.25	12.47	12.92	12.75	14.57	15.46	11.55	11.64	9.51	10.54	9.42
Iron (mg/l)	0.19	0.16	0.18	0.17	0.16	0.16	0.16	0.16	0.19	0.21	0.22	0.23	0.23	0.22
Copper (mg/l)	0.006	0.009	0.006	0.009	0.009	0.009	0.008	0.007	0.009	0.008	0.007	0.006	0.009	0.006
Total Chromium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Lead, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mercury, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc, mg/l	0.2	0.4	0.2	0.3	0.5	0.6	0.5	0.5	0.4	0.4	0.4	0.3	0.3	0.4

In general, water quality parameters show gradual changes along the spatial and temporal scales. However, in this study no considerable changes in the water quality parameters were observed at spatial scale except in water temperature and turbidity. In Teesta river average values of different parameters did not show significant variations between different sites. However, slight variations were observed in a few parameters like water temperature, dissolved oxygen etc. at Sites S10 and S11. Both sites pertained to the downstream of Teesta Low Dam III. This stretch of the river received water directly from dam body. In Teesta river spatial variation was less prominent as compared to the temporal variation. In general all parameters showed a temporal trend in their magnitude except current velocity, nitrate, phosphate and copper.

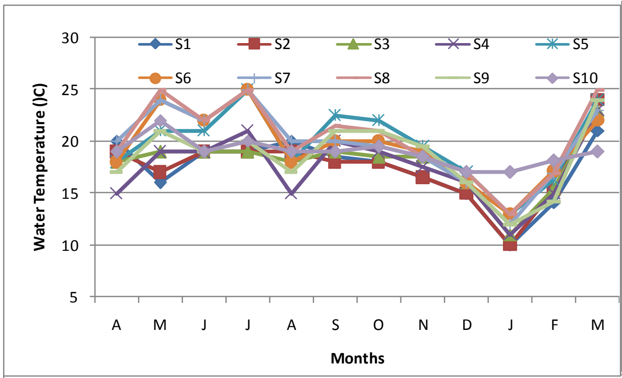
The TDS level ranged from 17.57 to 75.1 mg/l which is well below the permissible limit of 500 mg/l specified for drinking water. The TDS level was found to be lower in monsoon season as compared to summer season. This trend was observed for various cations and anions monitored as a part of the study. This could be attributed to higher discharges in monsoon months.

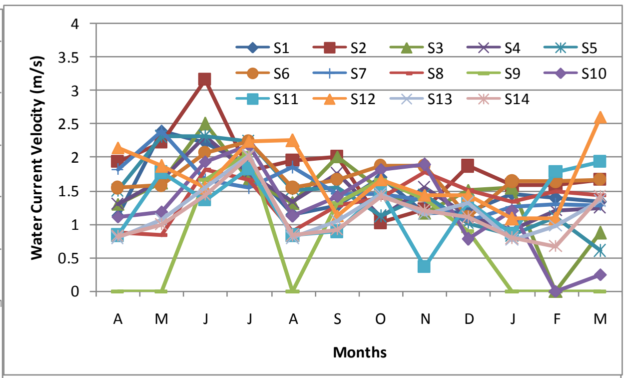
Hardness is caused by divalent metallic cations. The principal hardness causing cations are calcium, magnesium, strontium and ferrous and iron. The hardness level ranged from 47 to 54 mg/l indicating soft nature. The hardness level was well below the permissible limit of 200 mg/l specified for drinking water. The low levels of calcium and magnesium are mainly responsible for the soft nature of water.

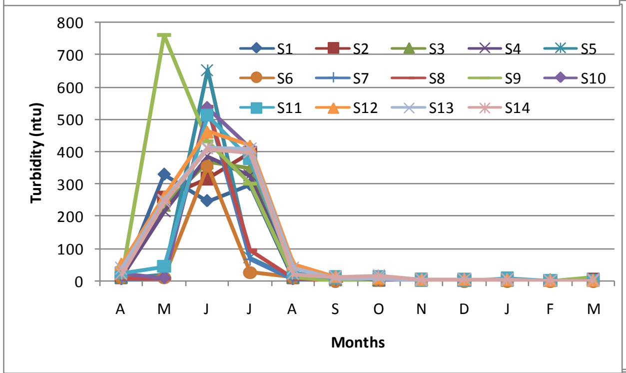
The chlorides level ranged from 1.97 to 46 mg/l, which are well below the permissible limit of 200 mg/l, specified for meeting drinking water requirements. The concentration of nitrates and phosphates at various sampling locations was observed to be ranging from 0.02 to 6.63 mg/l and 0 to 1.38 mg/l respectively.

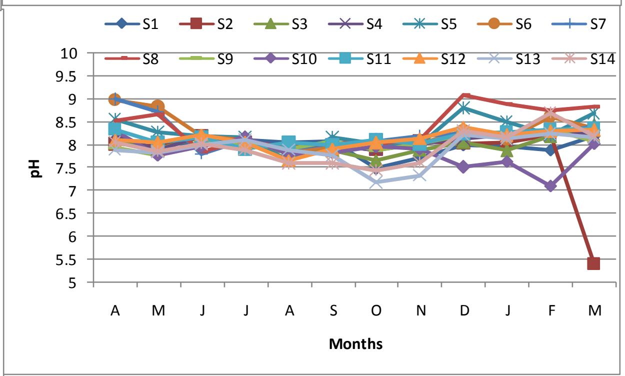
The concentration of various cations, e.g. sodium, potassium, calcium and magnesium was observed to be quite low which is also reflected by the low TDS level. Iron was found to be ranged from 0.01 to 1.15 mg/l.

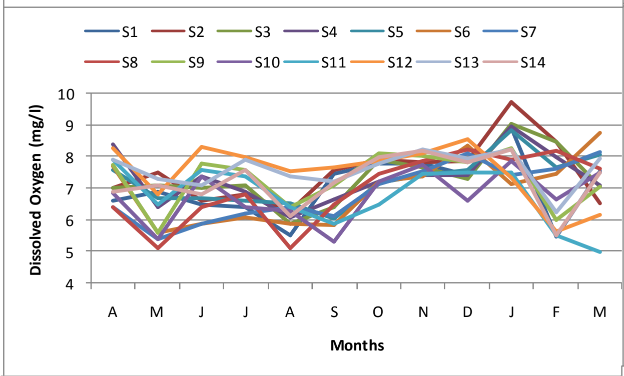
The concentration of various heavy metals was found to be well below the permissible limits. The BOD values ranged from 1.1 to 2.0 mg/l and are well within the permissible limits, which indicates the absence of organic pollution loading. This is mainly due to the low population density and absence of water polluting industries in the area. The low COD values (2.0 to 3.9 mg/l) also indicate the absence of chemical pollution loading in the area. The DO level ranged from 5.0 to 9.73 mg/l at various sampling locations monitored on a monthly basis during the study period.

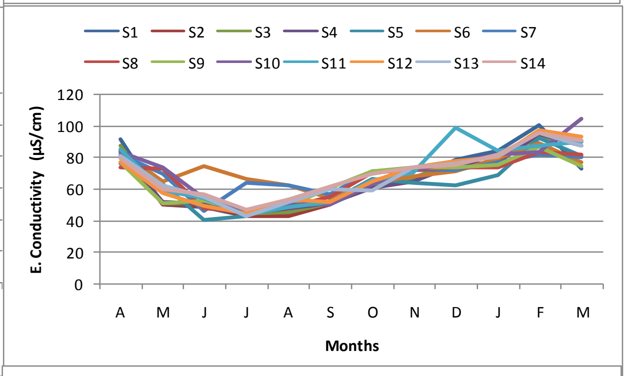

S1 S2 S3 S4 S5 S6 S7 S8 S9 S10
Water Temperature (]C)
A M J J A S O N D J F M
Months

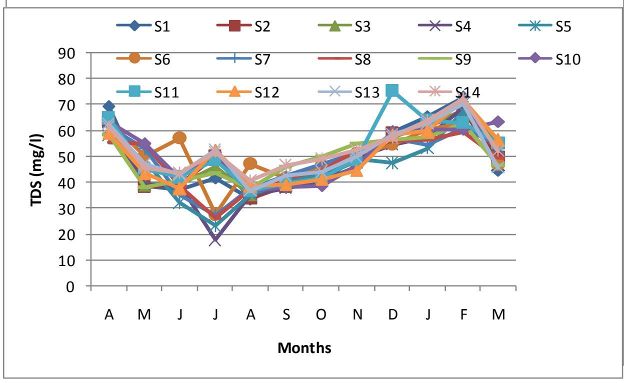

S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14
Water Current Velocity (m/s)
A M J J A S O N D J F M
Months

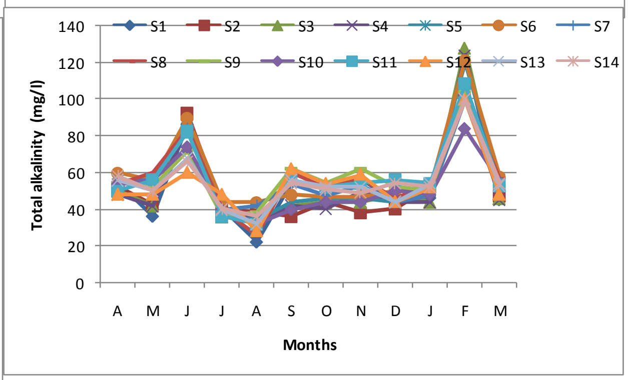

S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14
Turbidity (ntu)
A M J J A S O N D J F M
Months

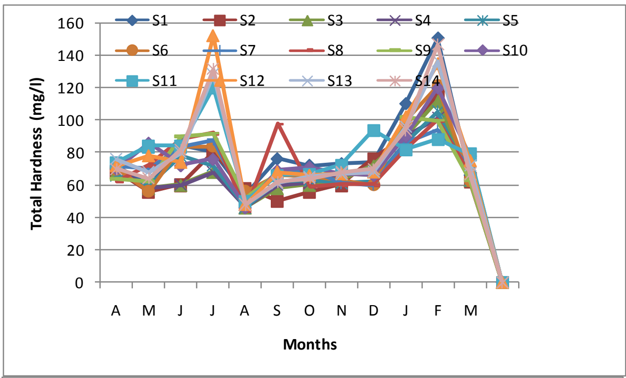

S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14
pH
A M J J A S O N D J F M
Months

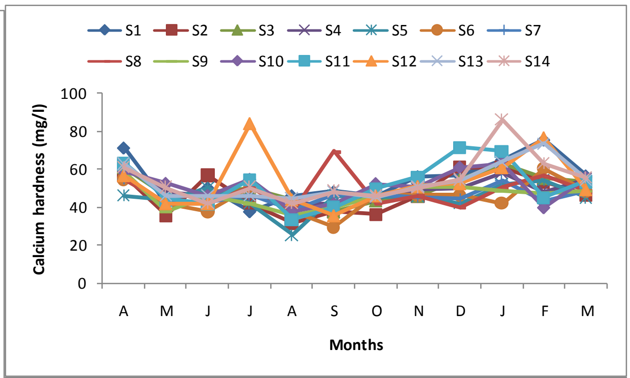

S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14
Dissolved Oxygen (mg/l)
A M J J A S O N D J F M
Months

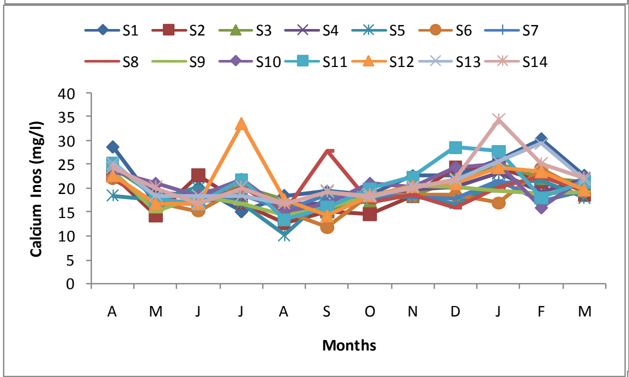

S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14
E. Conductivity (µS/cm)
A M J J A S O N D J F M
Months

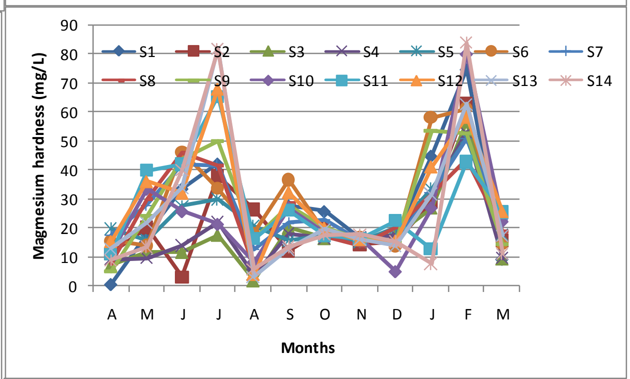

S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14
TDS (mg/l)
A M J J A S O N D J F M
Months

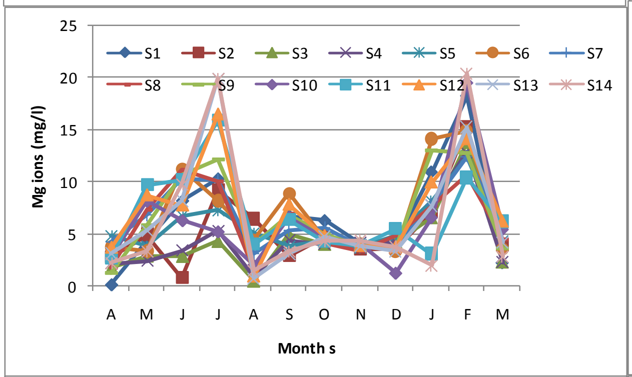

S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14
Total alkalinity (mg/l)
A M J J A S O N D J F M
Months

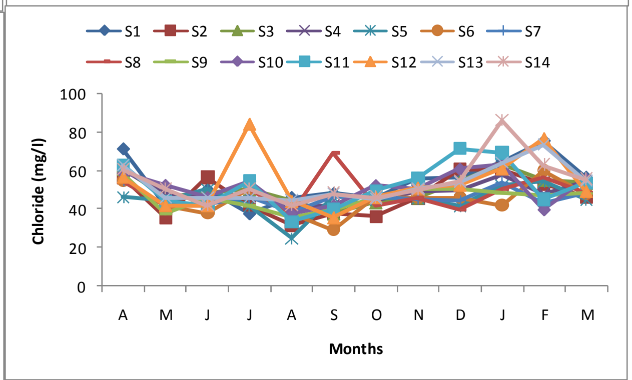

S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14
Total Hardness (mg/l)
0 20 40 60 80 100 120 140 160
A M J J A S O N D J F M
Months

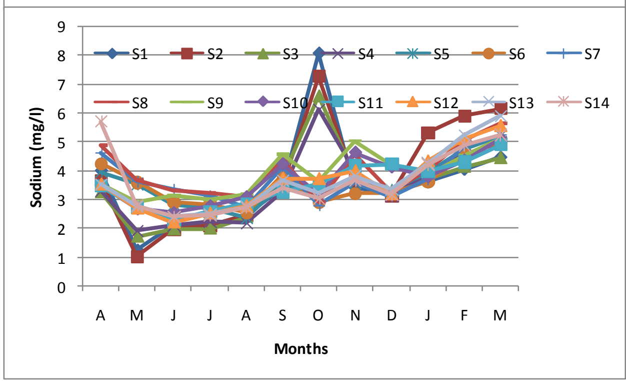

S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14
Calcium hardness (mg/l)
0 20 40 60 80 100
A M J J A S O N D J F M
Months


S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14
Calcium Inos (mg/l)
0 5 10 15 20 25 30 35 40
A M J J A S O N D J F M
Months


S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14
Magmesium hardness (mg/L)
0 10 20 30 40 50 60 70 80 90
A M J J A S O N D J F M
Months


S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14
Mg ions (mg/l)
0 5 10 15 20 25
A M J J A S O N D J F M
Month s


S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14
Chloride (mg/l)
0 20 40 60 80 100
A M J J A S O N D J F M
Months


S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14
Sodium (mg/l)
0 1 2 3 4 5 6 7 8 9
A M J J A S O N D J F M
Months

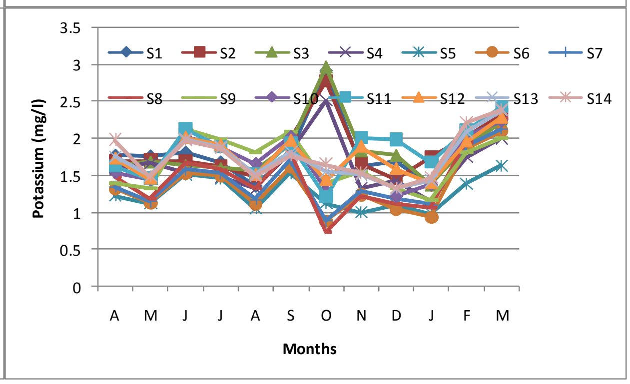

S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14
Potassium (mg/l)
0 0.5 1 1.5 2 2.5 3 3.5
A M J J A S O N D J F M
Months

Figure-5.2 Monthly variation in the physical and chemical characteristics at various sampling sites

5.3 WATER QUALITY OF RIVER RAMMAM

Apart from domestic sources, there are no other sources of pollution in Rammam river basin. The area has no major water polluting industries. Even under minimum flow condition, there is sufficient water available in river Rammam, for dilution of untreated sewage generated from domestic sources. Thus, water quality in such settings is expected to be excellent in the project area.

As a part of the field studies for EIA report preparation for Rammam Stage-III HEP, water samples from river Rammam and tributaries were collected from various locations listed in Table-5.15.

Table-5.15: Location of various water sampling locations

Sample No.	Sampling location
W1	River Rammam, upstream of barrage/dam site
W2	River Rammam, downstream of barrage/dam site
W3	River Rammam, upstream of power house site
W4	River Rammam, downstream of power house site
W5	Rani Khola a tributary confluencing with river Rammam, upstream of power house site
W6	Lodhama, a tributary of river Rammam

The water quality has been monitored during January 2006, April 2006 and October 2006, representing winter, summer and post-monsoon seasons respectively. The results of water quality analysis are given in Table-5.16.

Table-5.16: Water Quality monitoring results in the study area for Rammam Stage-III HEP

Parameters	Stations					
	W1	W2	W3	W4	W5	W6
Winter Season (January 2006)						
pH	7.06	7.43	7.10	6.88	7.0	7.1
Electrical Conductivity (μs/cm)	41	48	41	38	42	38
Turbidity, NTU	<1.0	1.2	<1.0	<1.0	<1.0	<1.0
Total Dissolved Solids, mg/l	29	34	30	28	31	26
Total Alkalinity (as $CaCO_3$) mg/l	16.8	18.2	15.8	13.8	14.4	14.2
Total hardness (as $CaCO_3$), mg/l	11.0	11.5	11.2	11.4	10.8	11.4
Carbonates (as $CaCO_3$), mg/l	Nil	Nil	Nil	Nil	Nil	Nil
BOD (3 days at 27^oC), mg/l	0.10	0.20	0.10	0.1	0.2	0.2
COD, mg/l	0.40	0.8	0.40	0.40	0.7	0.8
Nitrates, mg/l	1.41	0.45	0.50	2.22	0.60	1.1
Phosphates, mg/l	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Fluorides, mg/l	0.08	0.02	0.02	0.03	0.02	0.02
Chlorides, mg/l	3.6	3.8	4.4	3.2	3.1	3.8
Sulphates, mg/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sodium, mg/l	4.0	6.0	4.0	2.5	2.5	2.5
Potassium, mg/l	1.3	1.4	1.2	1.2	0.8	1.0
Calcium, mg/l	2.4	2.8	3.2	3.4	3.2	3.2

Parameters	Stations					
	W1	W2	W3	W4	W5	W6
Magnesium, mg/l	0.80	0.80	0.90	0.90	0.90	0.90
Oil & grease, mg/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Iron, mg/l	0.02	0.17	0.02	0.08	0.07	0.10
Manganese, mg/l	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Copper, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc, mg/l	0.04	0.10	0.05	0.08	0.05	0.10
Phenolic compound, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cadmium, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cyanides, mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Lead, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Mercury, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total coliform	10	18	10	12	18	12
Summer Season(April 2006)						
pH	7.1	7.36	7.08	6.91	7.1	7.1
Electrical Conductivity (µs/cm)	38	42	40	38	40	37
Turbidity, NTU	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Dissolved Solids, mg/l	27	32	29	26	29	27
Total Alkalinity (as $CaCO_3$) mg/l	15.1	15.7	15.2	12.9	13.8	13.8
Total hardness (as $CaCO_3$), mg/l	8.1	8.4	9.0	9.0	8.4	9.2
Carbonates (as $CaCO_3$), mg/l	Nil	Nil	Nil	Nil	Nil	Nil
BOD (3 days at 27°C), mg/l	0.10	0.10	0.10	0.10	0.10	0.10
COD, mg/l	0.28	0.31	0.38	0.30	0.26	0.32
Nitrates, mg/l	1.2	0.4	0.5	1.2	0.5	1.0
Phosphates, mg/l	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Fluorides, mg/l	0.08	0.02	0.02	0.03	0.02	0.02
Chlorides, mg/l	3.2	3.4	3.8	3.0	3.0	3.5
Sulphates, mg/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sodium, mg/l	3.1	4.2	3.0	2.1	2.2	2.0
Potassium, mg/l	1.3	1.2	1.2	1.2	0.8	1.0
Calcium, mg/l	2.0	2.2	2.5	2.5	2.4	2.5
Magnesium, mg/l	0.60	0.60	0.60	0.60	0.60	0.60
Oil & grease, mg/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Iron, mg/l	0.02	0.10	0.02	0.05	0.05	0.06
Manganese, mg/l	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Copper, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc, mg/l	0.04	0.04	0.01	0.05	0.04	0.05
Phenolic compound, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cadmium, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cyanides, mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Lead, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Mercury, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Coliform, mg/l	10	10	10	15	18	18
Post-monsoon season (October 2006)						

Parameters	Stations					
	W1	**W2**	**W3**	**W4**	**W5**	**W6**
pH	7.2	7.2	7.2	7.05	7.05	7.2
Electrical Conductivity (μs/cm)	44	45	45	44	43	45
Turbidity, NTU	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Dissolved Solids, mg/l	33	34	34	33	32	34
Total Alkalinity (as $CaCO_3$) mg/l	17.2	16.8	17.5	14.7	15.4	15.2
Total hardness (as $CaCO_3$), mg/l	9.4	8.8	10.1	8.7	11.8	11.3
Carbonates (as $CaCO_3$), mg/l	Nil	Nil	Nil	Nil	Nil	Nil
BOD (3 days at 27°C), mg/l	0.10	0.10	0.10	0.10	0.10	0.10
COD, mg/l	0.48	0.34	0.43	0.35	0.34	0.39
Nitrates, mg/l	1.1	1.0	1.2	1.1	0.9	1.2
Phosphates, mg/l	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Fluorides, mg/l	0.08	0.07	0.07	0.05	0.05	0.03
Chlorides, mg/l	4.0	4.2	4.5	3.8	3.5	4.2
Sulphates, mg/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sodium, mg/l	3.6	4.7	3.7	3.0	3.2	2.5
Potassium, mg/l	1.8	1.8	1.8	1.8	1.4	1.5
Calcium, mg/l	2.1	2.4	2.3	2.7	2.7	2.9
Magnesium, mg/l	0.60	0.60	0.60	0.60	0.60	0.60
Oil & grease, mg/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Iron, mg/l	0.05	0.14	0.09	0.09	0.09	0.07
Manganese, mg/l	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Copper, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc, mg/l	0.05	0.05	0.05	0.05	0.05	0.04
Phenolic compound, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cadmium, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cyanides, mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Lead, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Mercury, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Coliform, mg/l	12	14	14	18	18	12

The total hardness in various water samples ranged from 8-11.8 mg/l in various seasons covered as part of field studies. The low calcium and magnesium levels are responsible for soft nature of water. The total hardness level in the water is well below the permissible limit of 200 mg/l.

The low EC and TDS values indicate the lower concentration of cations and anions. The concentration of TDS level ranged from 28 to 34 mg/l, 27 to 32 mg/l and 32 to 34 mg/l in winter, summer and post-monsoon seasons respectively, which is much lower than the permissible limit of 500 mg/l specified for domestic use. This is also reflected by the fact that the concentration of most of the cations and anions are well within the permissible limit. The fluorides level was lower than the permissible limit (1 mg/l) for drinking requirements. Use of water with such fluorides level could lead to dental caries. The iron content ranged from 0.02 to 0.08 mg/l in various seasons is well below the permissible limits.

The BOD values were well within the permissible limits, which indicate the absence of organic pollution loading. This is mainly due to the low population density and absence of industries in the area. The low COD values also indicates the absence of chemical pollution loading in the area. The marginal quantity of pollution load which enters river Rammam, gets diluted. In fact, even for the minimum flow, there is more than adequate water available for dilution. The concentration of various heavy metals was below the detectable limits, indicating the suitability of water for meeting domestic requirement. The concentration of cyanides and phenolic compounds was also observed to be below the detectable limits.

The Total Coliform level was well within the permissible limits. The oil & grease level were below 1.0 mg/l in all the samples, which is expected in the project area, as there are no sources of pollution which can increase oil & grease

CHAPTER 6
FLORISTICS

CHAPTER-6

FLORISTICS

6.1 INTRODUCTION

The state of West Bengal is located in the eastern part of India and covering a geographic area of about 88,752 sq km. It is bounded on the north by Sikkim and Bhutan, on the east by Assam and Bangladesh, on the south by the Bay of Bengal, on the west by Bihar and Orissa and on the north-west by Nepal. There are five broad geographical regions in the state i.e. The Darjeeling Himalaya, Tarai-Duars region, Western undulating highland and plateau, North and South Bengal Plains and Gangetic delta. The Darjeeling Himalaya region lies on the extreme northern boundary of West Bengal and covers Darjeeling, Kurseong and Kalimpong sub-divisions of Darjeeling district and northern fringe of Jalpaiguri district. The Sinchula range forms the common boundary between Bhutan and Jalpaiguri district and has an average height of 1600 m. The temperature varies generally between 15 to 20^{o}C during summer but the winter is very cold with temperature falling below 5^{o}C. The average annual rainfall is 300 cm. The southern part of Darjeeling district and entire Jalpaiguri district except a few pockets on the north fringe constitute the Tarai Duars region. Reddish loamy soils mixed with sand, pebbles, gravels and stones are found here. The average temperature is 29^{o}C in summer and 17^{o}C in winter. A heavy rainfall occurs in monsoon.

The river Ganges divides plains of Bengal into North and south Bengal plains. The main rivers in the northern part of the state are Teesta, Torsa and Jaldhaka, which drain into Brhamputra. The Ganges and the Hooghly drain into the Bay of Bengal and forming famous delta of Indian Sunderbans. Climate varies from moist tropical in the southeast to dry tropical in the southwest and from sub-tropical to temperate in the hills of north.

Botanical diversity of West Bengal has attracted the attention of many explorers and botanists since the beginning. Anderson (1862) collected plants from Kolkata for providing guidelines for preservation and examination of plant specimens. Gamble (1875) provided a detailed account of vegetation of Darjeeling forest, and subsequently in 1878 published a list of trees, shrubs and large climbers of Darjeeling district. A detailed study on vegetation of West Bengal and adjoining areas was made by Prain (1903 &1905), Cowan and Cowan (1929), Benerjee (1934), Sengupta (1937), Biswas (1966), Datta and Majumdar (1966), Guha (1968), Bennet (1979), Pal *et al.* (1991), Chakrawverty and Jain (1984), Das and Ghosh (1982) and Sanyal (1994). Apart from these, Hooker (1872-1879), Hara (1966, 1971), Ohashi (1975), Sharma *et al.* (1993), Hajra *et al.* (1995), etc. have explored some parts West Bengal.

6.2 FOREST TYPES

West Bengal is reported to have 13.99 % of the geographic area under forest which includes very dense, moderately dense, open forest and scrub (FSI, 2005). The major forest types found in the state are Northern tropical wet evergreen forests, Northern tropical semi evergreen forests, North India moist deciduous forests, Littoral and swamp forests (mangroves), Northern tropical dry deciduous forests, Northern sub-tropical broad leaved wet hill forests, Northern montane wet temperate forests, East Himalayan moist temperate forests and Sub-alpine forests (Champion & Seth, 1968). The catchment area of the Lower Teesta Basin covers almost all types of these forests. However, the seven projects in the Study Area are located over a length of about 30 to 20 km along the Teesta and Rangit rivers. They cover Northern tropical semi-evergreen and North India moist deciduous forests. Two Wild Life Sanctuaries fall in the Lower Teesta valley i.e Mahananda Wild Life Sanctuary in southern Jalpaiguri Divisision and Senchal Wild Life Sanctuary in northern Kalimpong Division of N. Bengal.

The vegetation in these forests particularly in lower Terai region of Darjeeling district comprises Northern tropical moist deciduous and tropical semi-evergreen forests. Sub-tropical wet hills and temperate forest occurs in the surrounding upper catchment area of Teesta and Rangit Basin. In the entire valley of the catchment, from Tarai to an elevation of 650 m, the area is either covered by dense tropical semi-evergreen and tropical moist deciduous forests along the low hills or degraded moist deciduous forests interspersed with agricultural fields. The forests present in the catchment area have been grouped into different forest types following the classification of Cowan and Cown (1929), Champion & Seth (1968), Negi (1989, 1996), and Mudgal & Hajra (1999). The major forest types found in this catchment are discussed below.

Sub-group 2B Northern Tropical Semi-evergreen Forests

The forests of this sub-group occur in the moderately heavy to heavy rainfall tracts of north-east India, Bengal and Orissa. The mean annual rainfall ranges from 1500 mm to 3000 mm. The forest types found in this sub-group are described in the following paragraphs:

2B/C1a ***Assam alluvial Plains semi-evergreen forests***

This type of forest extends from the foot hills of tarai region to an elevation of 1000 m in the heavy rainfall tracts of North Bengal. The top canopy is closed and mainly made up of evergreen species with a varying proportion of tall deciduous tree species. *Ailanthus integrifolia, Albizia chinensis, Bischofia javanica, Canarium strictum, Castanopsis indica, Dysoxylum gobara, Engelhardtia spicata, Magnolia hodgsoni, Mangifera indica, Michelia* *champaca, Pterospermum acerifolium, Sterculia villosa, Terminalia myriocarpa*, etc. form the top storey. Second storey is also dense with varied undergrowth. The important species of second storey include *Actinodaphne obovata, Casearia vareca, Chukrasia tabularis, Gynocardia odorata, Garcinia xanthoclymus, Turpinia pomifera,* etc. Understorey is thick and represented by some tall shrubs like *Boehmeia pendulifera, Chromolaena odoratum, Coffea bengalensis, Costus speciosus, Leea compactiflora, Oxyspora paniculata,* and *Strobilanthes echinata*. This type of forest was observed in lower Kalimpong and Darjeeling hills. Among the climbers and twiners are *Bauhinia vahlii, Dioscorea bulbifera, Entada phaseoloides, Lygodium japonicum, Mikania macrantha, Puraria tuberosa, Stephania glandulifera,* etc. Epiphytes are represented by species of mosses, ferns and orchids. Among epiphytic orchids are species of *Bulbophyllum, Cymbidium, Dendrobium*, etc. The ground vegetation is represented by some pteridophytes, herbs and grasses. The predominant herbs are species of *Achyranthes, Adiantum, Ageratum, Athyrium, Bidens, Conyza, Nephrolepis, Persicaria, Saccharum,* etc.

2B/C1b *Eastern submontane semi-evergreen forest*

This type of forest is present in the sub-himalayan tract from the foothill to about 760m. A dense or irregular high forest in which evergreen species predominate but a number of deciduous or nearly deciduous species also present in the top canopy. Second storey is generally evergreen with or without bamboos in the lower storey. The top canopy is represented by species e.g., *Ailanthus integrifolia, Artocarpus lacucha, Bauhinia purpurea, Bombax ceiba, Castanopsis indica, Duabanga grandiflora, Dysoxylum* spp., *Gmelina arborea, Phoebe hainesiana, Tetrameles nudiflora, Toona myriocarpa*, etc. Second storey consists of moderately sized tree species such as *Actinodaphne angustifolia, Albizia procera, Celtis tetrandra, Ficus semicordata, Gynocardia odorata, Mallotus philippinensis* and *Turpinia pomifera*. The understorey is represented by shrubs and few species of bamboos like *Chromolaena odoratum, Dendrocalamus hamiltonii, Desmodium pulchelum, Psychotria calocarpa, Rubus hamiltonii, R. paniculatus,* etc. Climbers and twiners are represented by species of *Cayratia japonica, Derris microptera, Dioscorea bulbifera, Smilax aspericaulis, Stephania glandulifera* and *Tinospora cordifolia*. Epiphytes are represented by species of ferns like *Drynaria, Lepisorus* and Vitiria and orchids such as *Bulbophyllum, Celogyne* and *Dendrobium*. This type of forest is observed in lower hills of Kalimpong and Lower Teesta valley. The ground floor is represented by few species of ferns, herbs and grasses. Among predominant herbs and grasses are *Achyranthes aspera, Aconogonum molle, Ageratum conyzoides, Bidens bipinnata, Oplismenus compositus, Persicaria barbata, P. chinensis, Saccharum longisetosum, S. narenga, Strobilanthes auriculata, Thysanolaena latifolia,* etc.

Sub-group3C North Tropical Moist Deciduous Forests

This type of forests occurs from tarai to an elevation of 650m or more throughout northern India viz., in parts of UttarPradesh, Bihar, Orissa and West Bengal. The forest types observed in this sub-group are described in the following paragraphs.

3C/ C1a (i) *E. Himalayan Sal*

These forests are found in the foot hills of Teesta valley, Rangit valley and Kurseong Division of West Bengal with well drained soils. The important species of the first storey are *Bauhinia purpurea, Bridelia retusa, Garuga pinnata, Lagerstroemia parviflora, Persea wallichii, Pinus roxburghii, Schima wallichii, Shorea robusta, Terminalia bellerica,* and *Tetrameles nudiflora*. Second storey consists of *Callicarpa arborea, Litsea monopetala, Mallotus philippinensis, Phoenix sylvestris,* and *Tectona grandis*. Third storey consists of *Bauhinia vahlii, Colebrookea oppositifolia, Dendrocalamus hamiltonii, Lantana camara, Leea compactiflora, Woodfordia fruticosa*, etc.

3C/C1b (i) *East Hiamlayan upper Bhabar sal*

These forests occur in the Bhabar tract (300m) at the base of lower hills of eastern Himalaya. These forests have scattered population of Sal and are found in the heavy rainfall areas of Kurseong Division of West Bengal. The main species in the first storey are *Aphanamixis polystachys, Bombax ceiba, Canarium strictum, Chukrasia tabularis, Duabanga grandiflora, Eleocarpus aristatus, Gmelina arborea, Lagerstroemia parviflora, Neonauclea griffithii, Shorea robusta* and *Sterculia villosa*. Second storey consists of *Alangium chinense, Aporosa roxburghii, Artocarpus lacucha, Bauhinia purpurea, Callicarpa arborea, Dillinia pentagyna, Ficus glomerata, Macarangha denticulata, Oroxylum indicum, Mallotus philippinensis, Spondias pinnata* and *Vitex*. Lower storey is represented by few lianas shrubs and small trees e.g., *Boehmeria macrophylla, Clerodendrum japonicum, Coffea bengalensis, Dendrocalamus hamiltonii, Leea compactiflora,* etc.

3C/C1b (ii) *East Hiamlayan lower bhabar sal*

The forests are high quality Sal and are found on alluvial and well drained soil in Jalpaiguri division of West Bengal. The main associates of the first storey are *Dillenia pentagyna, Shorea robusta, Terminalia bellirica,* and *T. tomentosa*. Second storey is represented by *Amoora wallichii, Aporosa dioica, Careya arborea, Holarrhena antidysentrica, Lagerstroemia parviflora, Macaranga denticulata, Mallotus philippinensis, Premna bengalensis*, etc. Understorey is represented by few shrubs, climbers, herbs and ferns. Among shrubs are *Acacia nilotica, Cassia tora, Coffea bengalensis, Clerodendrum viscosum, Leea crispa* and *Melastoma malabathricum*.

3C/C3b *East Himalayan moist mixed deciduous forest*

This type of forests occur on the well drained soils on the upper Bhabar tracts of the outer Himalayan ranges up to 650 m in North Bengal. The main associates of the first storey are *Bombax ceiba, Lagerstroemia parviflora, Neonauclea griffithii, Schima wallichii, Sterculia villosa* and *Terminalia bellerica*. Second storey consists of few trees like *Aphanamixis chittagonga, Bauhinia purpurea, Careya arborea* and *Dalbergia sissoo, Meliosma simplicifolia,* and *Oroxylum indicum*. The forest floor is damp and is covered with shrubs like *Ardisia solanacea, Coffea bengalensis, Mussaenda glabra, Maesa macrophylla,* etc. Among climbers *Bauhinia vahlii, Carayita japonica, Clematis sp., Cissus repanda, Dioscorea bulbifera, Icnocarpus frutescens, Mucuna macrocarpa, Puraria tuberosa*, etc. are observed.

Sub-group 8B Northern Sub-tropical Broad-leaved Hill Forests

The forest belonging to this sub-group occurs in east and north-east India. The forest types observed in this sub-group are described in the following paragraphs.

8B/CI *East Himalayan Sub-tropical wet hill forests*

The sub-tropical hill forests occur on hilly terrain between 1000-2000 m and are mostly dominated by evergreen species with some deciduous trees in the top storey. Prevalence of *Alnus, Prunus, Engelhardtia,* and *Quercus* is characteristic of the type throughout its range, though it also extends downwards into the tropical forest. This type of forest is observed in the upper ridges of Kalimpong and Darjeeling hills. The dominant species in the first storey are *Acer thomsoni, Albizia procera, Alnus nepalensis, Beilschmiedia roxburghiana, Betula cylindrostachys, Castanopsis indica, C. tribuloides, Engelhardtia spicata, Saurauia napaulensis, Schima wallichii, Toona ciliata,* etc. The second storey consists of middle sized trees like *Alangium chinense, Boehmeria rugulosa, Brassiopsis glomerulata, Ficus semicordata, Lyonia ovalifolia, Macropanax undulatus, Ostodes paniculata, Oroxylum indicum, Trevesia palmata,* etc. The third storey consists of some small trees and shrubs. Among shrubs *Boehmeria macrophylla, Dendrocalamus sikkimensis, Eurya acuminata, Maesa chisia, Oxyspora paniculata, Strobilanthes* spp., etc. are observed. Climbers are few represented *Cayratia, Clematis, Dioscorea, Mikania, Rhaphidophora* and *Stephania*. Epiphytes are represented by mosses, ferns and orchids. Among epiphytic ferns are *Colysis, Lepisorus, Pyrrosia, Vittaria* and orchids belonging to species of *Bulbophyllum, Cymbidium, Dendrobium,* etc. The common ground herbs are species of *Anaphalis, Anemone, Aster, Cardamine, Impatiens, Persicaria, Saccharum, Themeda, Viola,* etc.

Sub-group 11B Northern Montane Wet temperate Forests

The forest of this group occurs in the East Himalaya from East Nepal eastwards on the higher hills of Bengal, Assam and Arunachal Pradesh. The forest types present in this sub-group are briefly described in the following paragraphs.

11B/C1 *East Himalayan wet temperate forests*

These forests are found between 1,750 and 2,750m elevations and divided into three sub-types according to altitudinal zones. Towards higher altitudes they merge with sub-alpine forests. The forests of this group are comprised of following types:

11B/C1a Lauraceous forest

This forest ranges between 1800 to 2100 m elevations and charactrised by the preponderence of mixed oaks and laurels. This sub-type of forests is found in Kalimpong division of North Bengal. The common species of the first storey are *Acer campbellii, Betula alnoides, Castanopsis hystrix, Cinnamomum bejolghota, Engelhardtia spicata, Litsea elongata, Lithocarpus pachyphylla, Michelia cathcartii, Prunus nepalensis Persea odoratissima, P. duthei, Symplocos theifolia,* etc. Along streams and water courses *Alnus nepalensis* grows in these forests. Second storey is composed of small trees and shrubs. Among shrubs are *Brassiopsis glomerulata, Daphne payracea, Eurya acuminata, Macropanax dispermus, Mahonia napaulensis, Rhamnus nepalensis, Rubus ellipticus, Stobilanthes oligocephalus, S. divaricatus*, etc.

11B/C1b *Buk oak forests*

This forest category ranges from 2150 m to 2440 m elevation and is dominated by buk oak (*Quercus lamellosa*). This sub-type of forests is observed in upper reaches of Kalimpong and Darjeeling Divisions of West Bengal. The main associates of the first storey are *Acer campbellii, Betula alnoides, Castanopsis tribuloides, Lithocarpus elegans, Litsea doshia, Michelia doltsopa,* and *Sloanea dasycarpa*. Second storey consists of few trees like *Carpinus viminea, Litsea kingii, Lyonia ovalifolia, Persea odoratissima*, etc. Dense thickets of small bamboos (*Thamnocalamus aristatus*) occur with other shrubs in the undertorey. The common shrubs in the forest are *Cotoneaster bacilaris*, *Rubus niveus, R. paniculatus, R. pentagona, Strobilanthes echinata*, *S. oligocephala* and *Viburnum erubescens*. Twiners and climber species are few belonging to the genera like *Clematis, Parthenocissus, Rubus, Smilax*, etc. The epiphytes are loaded on the trunks of trees and shrubs.

11B/C1c *High level Oak forests*

These forests are characteristic of high altitude areas and ranges between 2400 m - 2750 m. These forests are observed in the upper ridges of Darjeeling area and Upper Teesta valley of Sikkim. The important constituents of the first storey are *Acer campbellii,* *Castanopsis tribuloides, Lithocarpus pachyphylla, Magnolia campbellii* and *Quercus lamellosa*. Second storey is represented by species of *Eurya, Ilex, Merrilopanax, Schefflera* and *Symplocos*. Among shrubs are *Cotoneaster, Dichroa, Rubus, Salix, Thamnocalamus* and *Viburnum*. This type of forest is obsereved in Senchal area of Darjeeling Division. Climbers are very few like species of *Clematis, Herpetospermum,* and *Smilax*. Forest floor is occupied by rich growth of ferns and herbs. In addition to these, some lichens found growing on the bark of trees and on stones.

12 Himalayan Moist Temperate Forests

This type forest extends along the whole length of the Himalaya between sub-tropical pine forests and sub-alpine forests and comprised of coniferous and broad-leaved species. This forest type is observed at elevations ranging from 500 – 3300 m. These forests may be of the following types:

12/C3 ***East Himalayan mixed coniferous forests***

This is a mixed coniferous forest with oaks and Rhododendrons. Hemlock occurs in varying extent on dry ridges and gives way to fir (*Abies densa*) at higher elevations. These forests are observed in Raman Darjeeling Division of West Bengal. Apart from conifers, some other oak mixed deciduous species are *Acer campbellii, Betula Betula utilis, Magnolia campbellii* and *Rhododendron arboreum*. The undergrowth is represented by many evergreen shrub species such as *Cotoneaster microphyllus, Daphne papyracea, Mahonia napaulensis, Strobilanthes oligocephala, Thamnocalamus aristatus* and *Viburnum erubecens*. Most of the shrubs are laden with many epiphytic species of mosses and lichens.

6.3 VEGETATION PROFILE IN THE INFLUENCE ZONE

The description of vegetation of the project areas proposed along the Teesta and the Rangit rivers has been presented in terms of zones which correspond to topographic/elevational class within the 10 km radius influence zone of the project. The important sites for the primary surveys were:

i) Area between Siliguri and Sevok
ii) Sevok, Riyang, Kalizora and Teesta Bazar
iii) Teesta Bazar-Melle, Jorethang, Sombaria-Kiatam wildlife sanctuary and Rangit river catchment
iv) Teesta Bazar-Lapchu, Lamta-Jorbanglow, Darjeeling and Senchal Wildlife Sanctuary
v) Area betweenTeesta Bazar and 3rd Mile, and Kalimpong area
vi) Melle-Rangpo, Singtam, up to Sherwani

i) Area between Siliguri and Sevok

This area covers the large proportion of reserve forest range of Mahananda Wild Life Sanctuary. East Hamalyan lower Bhabar sal forest occurs in plain tracts of Siliguri area of Jalpaiguri Forest Division, whereas a dense storied tropical semi-evergreen forest occur in the sub-Himalayan Sevok Terai region. Second storey is also dense with varied undergrowth including bamboo, palms, canes, etc. The main associates of the first storey are *Ailanthus integrifolia, Albizia lucida, Artocarpus lacucha, Bombax ceiba, Canarium strictum, Duabanga grandiflora, Garuga pinnata, Neonauclea griffithii, Shorea robusta, Terminalia myriocarpa,* etc. The river terraces and stream sides are occupied by *Casearia vareca, Glochiodon hirsutum, Lannea coromandelica, Macaranga denticulata, Rhus chinensis, Oroxylum indicum*, etc. In the understorey wherever water is available and exposure is less tree ferns (*Alsophila spinulosa*), canes and Kewra trees (*Pandanus nepalensis*) are seen growing. The trunks of tall trees are seen often laden with lichens, ferns and orchid species. Ground floor is disturbed show gaps and occupied by herbs, weeds and grasses.

The vegetation around Sevok is characterized by fairly dense submontane semi-evergreen forest. Wherever water is available and exposure is less, tree ferns, palms and canes occur in the understorey. But on dry slopes *Shorea robusta* remains dominant. The dominant trees in the forest are *Aphanamixis polystachya, Bauhinia purpurea, Bombax ceiba, Castanopsis indica, Duabanga grandiflora, Garcinia cowa, Lagerstroemia hirsuta, Terminalia myriocarpa, Wrightea arborea,* etc. Other tree species include *Aglaia hiernii, Albizia odoratissima, Bischofia javanica, Chukrasia tabularis, Garuga pinnata, Mallotus philippinensis, Mangifera indica,* and *Phoebe hainesiana*. Epiphytic ferns, orchids, and twiners, etc are loaded on trees and on ground surface abundantly. Undergrowth is luxuriant and consists of many spreading shrubs. Some cultivated trees of *Artocarpus integrifolia, A. chama*, and Figs like *Ficus bengalensis, F. elastica*, etc are often seen along road of Teesta valley. The ground vegetation is rich with terrestrial ferns, herbs and grasses.

ii) Sevok, Riyang, Kalizora and Teesta bazar/Village

This area covers patchy riverine semi-evergreen forest on lower reaches, whereas East Himalayan moist mixed deciduous forest on the middle reaches. Scattered or patchy Eastern submontane semi-evergreen forest occurs between Sevok to Kalizora. The prominent tree species of the forest are *Ailanthus integrifolia, Artocarpus lacucha, Bauhinia purpurea, Castanopsis indica, Duabanga grandiflora, Gmelina arborea, Phoebe hainesiana, Schima wallichii, Toona ciliata,* etc. These trees offer natural habitat for many epiphytic ferns, orchids and parasitic plants. The lower storey is mainly evergreen with shrubby undergrowth. Among predominant shrubs are *Bambusa tulda, Bauhinia vahlii, Chromolaena odoratum, Ficus hedracea, Lantana camara, Maesa chisia*, etc.

A tall or dense mixed forest of *Shorea robusta, Tectona grandis, Duabanga grandiflora*, etc. is observed in upstream of Kalizora area. Wherever exposure is less and moist conditions are available shrubby growth is abundant. *Abroma angusta, Antistrophe oxyantha, Boehmeria macrophylla, Chromolaeana odoratum, Lantana camara, Leea compactiflora, Rauwolfia serpentina, Vernonia volkemerifolia,* etc are important shrubs in the forest. Epiphytes and twiners are not common. Ground vegetation varied from place to place. The predominant herbs are species of *Achyranthes, Athyrium, Bidens, Digitaria, Oplismenus, Persicaria, Pteris, Saccharum, Thysanolaena,* etc.

Along Riyang Khola, especially near Teesta Low dam site, scattered or patchy riverine semi-evergreen forest is noticed. *Albizia procera, A. lucida, Callicarpa arborea, Dalbergia sissoo, Duabanga grandiflora, Ficus semicordata, Lagerstroemia hirsute, Mallotus philippinensis,* etc. are present in the tree layer. Downstream of dam site, a patchy growth of few tall trees like *Albizia chinensis, Dalbergia sissoo, Shorea robusta*, etc were observed on gentle slopes along the Riyang Khola.

Around Teesta Bridge, vegetation is patchy and riverine type. Few large tree species like *Albizia chinensis, Bischofia javanica, Canarium strictum, Duabanga grandiflora, Neonauclea griffithii*, etc are noticed all along the Teesta bank. Second storey is also scattered and consists of *Bauhinia variegata, Callicarpa arborea, Mallotus philippinensis, Wrightea arborea,* etc. Among shrubs species, namely *Clerodendrum, Costus, Jatropha, Lantana, Woodfordia*, *Zizyphus*, etc. are observed. Epiphytes and twiners are not common. Ground floor is disturbed mainly covered by few terrestrial ferns, herbs and weeds.

iii) Teesta Bazar-Melle, Jorethang, Sombaria-Kitam Wild Life sanctuary and Rangit river catchment

From the confluence of the Rangit with Teesta river, upstream of Teesta Bazar (209m), hilly tracts of South Sikkim are inhabited by East Himalayan moist mixed deciduous forest and Assam valley semi-evergreen forest. Sal (*Shorea robusta*) is gregarious and is the dominant tree species and form a pure or patchy population at many places. Other tree associates include *Albizia lebbeck, Aphanamixis polystachya, Bauhinia purpurea, Bischofia javanica, Duabanga grandiflora, Dysoxylum binectariferum, Garuga pinnata, Gynocardia odorata, Harpulia cupanioides, Lagerostromia hirsuta, Terminalia myriocarpa, Tetrameles nudiflora, Toona ciliata*, *Walsura tubulata*, etc. Besides these tree species, Teak (*Tectona grandis*) is often seen planted along the roadside and in the forest fringes. The undergrowth varied place to place. *Bambusa tulda, Boehmeria macrophylla, B. pendulifera, Chromolaena odoratum, Debregeasia longifolia, Lantana camara, Rhamnus nepalensis, Rubus ellipticus, R. niveus,* and *Saurauia roxburghii*. Climbers and epiphytes are abundant. *Bauhinia vahlii, Mimosa himalayana, Entada physaloides, Pothos cathcartii, Raphidophora glabra, Stephania glabra,* etc. are important climbers. Many epiphytic orchid species of *Bulbophyllum, Cymbidium, Dendrobium*, etc. can be seen on trunks of large trees. Many terrestrial ferns, herbs and grasses can be seen growing especially in open forest areas.

The vegetation around Jorethang is characterized by moist mixed deciduous type on lower reaches, whereas middle ridges show pure and patchy sal forest. At many places, degraded and disturbed forest can be seen due to road extension activities and human settlements especially along the roadside. At right bank of river Rangit, a gentle slope interspersed with terrace rice cultivation can be seen in lower reaches. Towards Naya Bazar a patchy distribution of Sal trees was noticed along the roadside with other planted trees like *Albizia lebbeck, Altsonia scholaris, Eucalyptus* sp.*, Ficus bengalensis, F. religiosa, Tectona grandis*, etc.

On way to Sombaria, a fairly dense forest of Sal (*Shorea robusta*) is observed in lower reaches. But the upper ridges show mixed deciduous vegetation with many tall and useful timber trees. The main tree associates in the canopy are *Alangium chinense, Bauhinia variegata, Callicarpa arborea, Duabanga grandiflora, Endospermum chinense, Eucalyptus globules, Lannea coromandelica, Phyllanthus emblica, Phoebe lanceolata*, *Tectona grandis,* etc. Undergowth is scant and open patchy represented by few shrubby species. Ground floor is disturbed and occupied by some ferns, herbs and grasses. *Ageratum conyzoides, Bidens pilosa, Chrysopogon serrulatus, Pogonatherum paniceum, Saccarum rufipelum* and *Thysanolaena latifolia.*

iv) Teesta Bazar-Lapchu, Lamta-Jorbanglow, Darjeeling and Senchal Wild Life Sanc.

There are two motor routes to visit Senchal Reserve Forest from Teesta bridge i.e. one road is through Teesta Bazar-Jobanglow via Lapchu-Lamta and another is Rambi-Mungpo. A dense moist mixed decuidous forest occurs on way to Teesta-Jorbanglow road. Sal (*Shorea robusta*) is a gregarious and dominant species on lower reaches. Other prominent trees are *Albizia procera, A. chinensis, Beilschmiedia roxburghiana, Chukrasia tabularis, Engelhardtia spicata, Prunus cerasoides, Schima wallichii, Tectona grandis*, etc. Few trees of *Pandanus nepalensis* and *Phyllanthus emlica* are also seen in the dry rocky area. The narrow valley gradually opens and gradient is gentle where tea plantation can be seen.

The vegetation near Lapchu is characterized by East Himalayan Sub-tropical wet hill forest. The important trees are *Alnus nepalensis, Callicarpa arborea, Castanopsis indica, Cpressus coreneyana, Engelhardtia spicata, Macaranga denticulata, Michelia glabra,* *Schima wallichii*, etc. Undergrowth is shrubby represented by *Bambusa tulda, Boehmeria macrophylla, Clerodendrum japonicum, Dichroa fabrifuga, Randia dumatorum, Rhamnus nepalensis*, etc. Epiphytes and climbers are not common. Herbs are represented by species of *Achyranthes, Ageratina, Aster, Bidens, Duchesnea, Isachne, Oplismenus, Strobilanthes,* etc. Towards Lamata, A large stands of *Cryptomeria japonica* is often seen in shaded areas. Among broad-leaved trees are *Acer laevigatum, Alangium chinense, Castanopsis hystrix, Eurya japonica, Exbucklandia populnea, Litsea monopetala, Lyonia ovalifolia, Quercus serrata*, etc.

Understorey is shrubby and represented by species of *Boehmeria macrophylla, Dichroa fabrifuga, Hydrangea robusta, Mahonia acanthifolia, Macroopanax dispermus, Rubus calycinoides, Strobilanthes sabineana*, etc. In upstream of Lamata, a rich diversity of some tall terrestrial ferns like *Athyrium drepanopterum, Dicranopteris linearis, Plagiogyria scandens, Pteris* spp., can be seen on gentle slopes. Other herbaceos elelements are represented by *Arisaema, Carex, Circium, Duchesnea, Equisetum, Ohiopogon, Persicaria, Selaginella*, etc.

Around Jorebanglow, mixed temeperate coniferous forest can seen. The main constituents are *Acer laevigatum, Alnus nepalensis, Cryptomeria japonica, Cupressus corneyana, Lindera assamica, Pinus wallichiana, Prunus cerasoides, Quercus serrata, Sauarauia napaulensis,* etc. The gentle slopes are covered by mainly shrubby and herbaceous vegetation. In the shrub layer species of *Berberis, Cotoneaster, Hydrangea, Rubus, Strobilanthes, Thamnocalamus, Zanthoxylum*, etc are important. Herbaceous elements are species of *Achyranthes, Circium wallichii, Duchesnia indica, Hydrocotyle nepalensis, Impatiens pulchra, Isodes lophanthoides, Potentilla nepalensis, Ranunculus cantoniensis, Viola betonicifolia*, etc.

The vegetation around Senchal Reserve forest is characterized by dense montane wet temperate forest. The main associates of the top canopy are *Acer laevigatum, Castanopsis hystrix, Cryptomeria japonica, Dodecadenia grandiflora, Elaeocarpus lanceifolius, Lindera assamica, Litsea kingii, Quercus serrata*, etc. Lower storey consists of small trees and shrubs. Among shrubs are species of *Berberis, Cotoneaster, Hydrangea, Leea, Leucosceptrum, Pteridium, Rubus, Viburnum*, etc. Epiphytes are represented by some, mosses, lichens and fen species. Climbers are not common.

v) Area between Teesta Bazar and 3rd Mile, on way to Kalimpong area

This area covers the reserve forest of Kalimpong Division. The lower reaches in this zone are characterized by East Himalayan moist mixed deciduous forest, whereas upper reaches especially towards Kalimpong show patchy East Himalayan Sub-tropical wet hill forest.

The vegetation around 3rd mile is characterised by moist mixed deciduous type in which sal (*Shorea robusta*) remains gregarious and dominant species. Other tree species of the forest are *Aphanamixis polystachya, Duabanga grandiflora, Canarium strictum, Gynocardia odorata, Lannea coromandelica, Mangifera sylvatica, Neonauclea griffithii, Sterculia kingii, Terminalia myriocarpa, Tectona grandis, Walsura tubulata,* etc. Second storey consists of moderate sized trees like *Ficus semicordata, Flacourtia jangomas, Oroxylum indicum, Pandanus nepalensis,* etc. Dense thickets of tall bamboos (*Bambusa tulda* and *Denrocalamus hamiltonii*) and some spreading shrub species form understorey. Among shrubs are *Boehmeria macrophylla, Bytneria aspera, Chromolaena odoratum, Derris scandens, Leea asitica, Mussaenda roxburghii, Rhamnus nepalensis, Rubus paniculatus,* etc. Epiphytes and climbers are abundant. *Cissampelos pareira, Dioscorea bulbifera, Entada phaseoloides, Mikania macrantha, Rhaphidophora decursiva, Smilax aspericaulis, Thunbergia coccinea*, etc are loaded on large and small trees and some covers the ground strata. Herbs include species of ferns, weeds and some grasses like *Ageratum conyzoides, Ageratina adenophora, Bidens bipinnata, Blumea procera, Persicaria capitat, Pepromia pellucida, Pilea scripta, Saccharum longisetosum, Sporobolus diander, Thysanolaena latifolia,* etc.

Beyond 3rd mile the vegetation is degraded and semi-evergreen type. Few trees such as *Alangium chinense, Anthocephalus cadamba, Bombax ceiba, Erythrina stricta, Ficus semicordata, F. elastica, Lagerstroemia hirsuta, Schima wallichii*, etc seen scatteredly along the roadside. At some places bamboo thickets seen in the barren and near settlement areas. Other shrubs are *Boehmeria macrophylla, Leucosceptrum canum, Oxyspora paniculata, Rubus ellipticus, R. paniculatus*, etc. Ground floor is disturbed show gaps and covered by few herbs and grasses.

vi) Melle-Rangpo, Singtam, up to Sherwani

This area covers the reserve forest of South-East Sikkim. The vegetation in the lower hilly tracts of South Sikkim area is characterized by tropical moist mixed deciduous type. Sal (Shorea robusta) is a dominant tree species along the lower part of Teesta and Rangit rivers and form a pure or patchy population at many places. Other tree associates include *Albizia chinensis, Aglaia hiernii, Bauhinia purpurea, Bischofia javanica, Bombax ceiba, Celtis tetrandra, Chukrasia tabularis, Duabanga grandiflora, Dysoxylum excelsum, Garuga pinnata, Gynocardia odorata, Schima wallichii, Tectona grandis, Terminalia myriocarpa, T. bellerica, Toona ciliata*, etc. The undergrowth is also rich in composition consisting of shrubs under close canopy forest but grasses found wherever the canopy is broken. *Bambusa tulda, Chromolaena odoratum, Dendrocalamus hamiltonii, Lantana camara, Leea compactiflora, Rhamnus nepalensis, Rubus ellipticus,* etc. are important shrub species observed in the area. Tre ferns are seen where exposure is less and shade is available along the road side. Climbers and epiphytes are not common. Climbers are represented by *Bauhinia vahlii, Mimosa himalayana, Entada physaloides, Pothos cathcartii, Rhaphidophora glabra* and *Stephania glabra* are important woody climbers. Some epiphytic as well as parasitic orchids seen growing on large tree trunks.

The vegetation in and around Singtam is characterised by tropical moist mixed deciduous and riverine type. The dominant tree species are *Albizia chinensis, Duabanga grandiflora, Ficus semicordata, Oroxylum indicum, Pandanus nepalensis, Shorea robusta, Terminalia myriocarpa, Toona ciliata*, etc.

Towards Sherwani dam site, Sal (*Shorea robusta*) is seen as the dominant tree species. Other trees occur in the layer are *Altsonia scholaris, Aphanamixis polystachya, Canarium strictum, Duabanga grandiflora, Gruga pinnata, Dysoxylum excelsum, Gynocardia odorata, Terminalia myriocarpa, Tectona grandis* etc. At some places dense thickets of bamboos are seen. Among shrubs are *Chomolaena odoratum, Denrocalamus hamiltonii, Ficus hedracea, Lantana camara, Mussaenda roxburghii, Rhamnus nepalensis, Woodfordia frticosa*, etc. The commonly observed herb species are *Ageratum conyzoides, Ageratina adenophora, Begonia megaptera, B. nepalensis, B. rubravina, Houttuynia cordata, Pepromia pellucida, Pilea scripta,* etc.

6.4 FLORISTICS OF PROJECT AREA

6.4.1 Floral Composition in the Vicinity of Teesta Stage-VI Powerhouse Site

Fairly dense and patchy tropical mixed deciduous forest was observed in the upstream of powerhouse site. The important associates of the first storey are *Bischofia javanica, Bombax ceiba, Dysoxylum binectarifolium, Gmelina arborea, Lagerstroemia lanceifolia, Schima wallichii, Sterculia urens, Tectona grandis* and *Terminalia bellerica*. Second storey consists of few trees like *Alangium chinense, Bauhinia purpurea, Dalbergia sissoo, Lannea coromandelica, Mallotus philippinensis,* and *Oroxylum indicum*. The forest floor is disturbed and covered with few shrubs like *Boehmeria platyphylla, Cassia floribunda*, *Chromolaena odoratum, Cletrodendrum japonicum, Colebrookea oppositifolia, Lantana camara, Woodfordia fruticosa,* etc. Among climbers and twiners are *Bauhinia vahlii, Carayita japonica, Clematis sp., Dioscorea bulbifera, Mikania macrantha, Puraria tuberosa, Stephania glandulifera,* etc.

In the vicinity of proposed power house site, a patchy dry deciduous forest is seen on the lower reaches of hills. On the middle and upper reaches East Himalayan sal forest occurs. At left bank the top storey is represented by *Bombax ceiba, Callicarpa arborea, Dysoxylum binectarifolium, Gmelina arborea, Schima wallichii, Tectona grandis* and *Toona* microcarpa. Second storey represented by moderate sized trees like *Alangium chinense, Bridelia retusa, Callicarpa arborea, Lannea coromandelica, Mallotus philippinensis, Phyllanthus emblica, Wrightea arborea,* etc. Understorey is represented by some tall shrubs, small trees and twiners. Shrub layer comprises of *Bambusa tulda, Caesalpinia cuculata, Chromolaena odoratum, Clerodendrum japonicum, Colebrookea oppositifolia, Lantana camara, Woodfordia frruticosa, etc.* The common twiners are *Cynachum, Dioscorea bulbifera, Entada pahseoloides, Stephania glandulifera,* etc. The epiphytic flora comprises of ferns like *Drynaria, Lepisorus, Pyrrosia,* etc. The common tall grasses are *Arundinella decompedalis, Arunodo donax, Capillipedium assimile, Imperata cylindrica, Setaria palmifolia,* etc.

6.4.2 Floral Composition in the Vicinity of Teesta Intermediate HEP

This area covers fairly dense mixed Eastern sub-montane semi-evergreen and moist mixed deciduous forest on the lower reaches. At left bank, The first storey is represented by *Ailanthus integrifolia, Albizia procera, A. chinensis, Anthocephalus cadamba, Bombax ceiba, Canatrium strictum, Engelhardtia spicata, Magnolia hodgsonii, Neonauclea griffithii, Schima wallichii,* and *Shorea robusta.* Second storey include *Gynocardia odorata, Lannea coromandelica, Mallotus philippinensis, Phyllanthus emblica, Wrightea arborea,* etc. Undergrowth is disturbed and covered with few shrubs like *Allophylus zeylanicus, Bambusa tulda, Boehmeria pendulifera, Chromolaena odoratum, Clerodendrum japonicum, Colebrookea oppositifolia, Lantana camara, Woodfordia fruticosa,* etc. Epiphytes and twiners are not very common. Among twiners, commonly observed species are *Bauhinia vahlii, Carayita japonica, Clematis buchnaniana, Dioscorea bulbifera, Mikania macrantha, Puraria tuberosa, Stephania glandulifera,* etc. Herbs are represented by few ferns, weeds and grasses. The common herbs are species of *Ageratum, Artemisia, Bidens, Crassocephalum, Desmodium, Hydrocotyle, Persicaria,* etc.

6.4.3 Floral composition in the vicinity of Teesta Low Dam I & II HEP (TLD I & II)

A dense tropical semi-evergreen forest was observed in the upstream of proposed dam site. At right bank of Rangit river, the main associates of the first storey are *Ailanthus integrifolia, Anthocephalus cadamba, Bischofia javanica, Bombax ceiba, Duabanga grandiflora, Harpulia capanioides, Spondias pinnata, Terminalia myriocarpa,* and *Walsura tubulata.* Second storey is also dense mixed consists of trees like *Alangium chinense, Albizia procera, Altsonia scholaris, Bauhinia purpurea, Callicarpa arborea, Ficus semicordata, Lepisanthes rubiginosa, Mallotus philippinensis, Samanea saman, Sapium baccatum,* etc. Understorey is dense evergreen and composed of many tall and spreading shrubs, climbers and small trees. The dominant shrubs include *Boehmeria macrophylla, B.*

pendulifera, Cudrania javanensis, Medinella rubicunda, Melocalamus compactiflorus, Trevesia palmata, etc. Rich growth of ferns and herbs were observed on the forest floor.

In the downstream area mixed deciduous and riverine forest is noticed on lower reaches. Tree layer is represented by few trees like *Albizia procera, Duabanga grandiflora, Glochidion velutinum, Lannea coromandelica, Lagersstroemia lanceolata, Persea robusta*, and *Tectona grandis*. Some small trees viz., *Alangium chinense, Boehmeria rugulosa, Ficus semicordata, Mallotus philippenensis, Pandanus nepalensis,* etc. noticed in the lower storey. Shrubs and climbers are few. The common shrubs include *Cassia mimosoides*, *Chromolaeana odoratum, Colebrookea oppositifolia, Leea asiatica, and woodfordia fruticosa.*

6.4.4 Floral Composition in the Vicinity of Teesta Low Dam (TLD) III HEP

A patchy riverine and moist deciduous forest is noticed in the vicinity of project. Top storey is represented by few trees like *Albizia, Dalbergia, Canarium, Duabanga, Elaeocarpus, Engelhardtia, Erythrina, Garcinia, Gmelina,* and *Pterospermum*. Second storey consists of trees like *Bauhinia, Caraya, Ficus, Glochidion, Mallotus* and *Oroxylum*. Shrubs are represented by species of *Chromolaena, Cassia, Lantana, Rubus*, etc. Few tall reed grasses viz., *Arundo donax, Saccharum longisetosum, Thysanolaena latifolia*, etc. were observed with dense patches along the river bank. In the downstream area very thin growth of few trees were observed on lower reaches. Upper reaches consists of fairly dense mixed teak and deciduous forest. The common trees are species of *Albizia, Altsonia, Dalbergia, Erythrina, Macaranga* and *Persia*. Undergrowth is disturbed and covered with few tall shrubs and undershrubs.

6.4.5 Floral composition in the vicinity of Teesta Low Dam IV HEP

A patchy tropical riverine semi-evergreen forest is observed on lower reaches of project area. The main associates of top storey include species like *Albizia lucida, Altsonia scholaris, Callophyllum polyanthum, Neoneuclea griffithii, Pterospermum acerifolium, Syzygium formosum*, and *Toona ciliata*. Second storey consists of *Brassiopsis, Callicarpa, Flacourtia, Macropanax, Pandanus, Trema*, etc. Shrubs and twiners are not common. *Boehmeria macrophylla, Bambusa tulda, Cassia ternifolia, Clerodendrum japonicum, Leea asiatica, Maesa chisia*, etc. are some tall shrubs. Among twiners species of *Dioscorea, Mikania, Piper, Puraria,* and *Thunbergia* are observed.

In the downstream area, a fairly dense mixed semi-evergreen forest is noticed on the lower reaches. The dominant trees include *Albizia procera, Engelhardtia spicata, Macaranga denticulata, Terminalia myriocarpa,* etc.

6.4.6 Floral composition in the vicinity of Teesta Low Dam V HEP

A fairly dense mixed semi-evergreen riverine forest is observed on the middle and upper reaches, while lower reaches has a patchy semi-evergreen forest in the vicinity of project. At right bank, the top storey is represented by tall tree species like *Albizia chinensis, A. lucida, Canarium bengalense, Chukrasia tabularis, Duabanga grandiflora, Dysoxylum binectarifolium, Neoneuclea griffithii, Phoebe hainesiana, Sterculia villosa,* etc. Middle storey is also dense with varied undergrowth.*Alangium chinense, Bauhinia variegata, Claoxylon longipetiolatum, Casearia graveolens, Glochidion velutinum, Litsea chartacea, Olea dioica, Pandanus nepalensis, Pterospermum acerifoliym*, etc form the middle storey. Bamboos are absent but some thickets occur along dry rocky areas. Other shrubs are species of *Boehmeria, Cassia, Chromolaena, Clerodendrum, Leea, Strobilanthes,* etc. Twiners and climbers are commonly represented by species of *Cissampelos, Combretum, Derris, Rhaphidophora, Piper, Pothos, Smilax,* etc.

The middle reaches of left bank has also dense storied high forest in which evergreen species predominate. The dominant tree species in the canopy are *Albizia lucida, Choreospondias axillaris, Duabanga grandiflora, Engelhardtia spicata, Garcinia cowa, Gmelina arborea, Neonauclea griffithii, Pterospermum acerifolium, Sterculia villosa, Wrightia arborea,* etc. Second storey is represented by evergreen genera like *Bauhinia, Callicarpa, Casearia, Glochidion, Lannea, Mallotus,* and *Michelia*. Undergrowth is also dense mixed with rich growth of climbers and shrubs. Among shrubs, *Bauhinia vahlii, Buddleja asiatica, Cassia mimosoides, Coffea bengalensis, Combretum decandrum, Derris scandens, Dichroa fabrifuga, Eranthemum griffithii, Leea compactiflora, Rubus niveus,* etc. In open areas some tall grasses are seen.

6.4.7 Floral composition in the vicinity of Jorthang Loop HEP

A thin patchy E. Himalayan Sal and riverine semi-evergreen forest is observed on the lower reaches of upstream project area. The main associates of tree layer include *Albizia chinensis, Bridelia retusa, Bombax ceiba, Callicarpa arborea, Garuga pinnata, Lagerstroemia lanceolata, Lannea coromandelica, Macaranga denticulata,* and *Shorea robusta*. Shrubs and climbers are not common. Species of *Bambusa, Chromolaena, Cassia, Lantana, Woodfordia,* etc. are some common spreading shrubs. Epiphytes and climbers are very few. The common twiners are species of *Cissampelos, Mikania, Puraria, Stephania*, etc.

On the downstream area a fairly dense mixed moist deciduous forest is observed. The main associates of the forests are *Albizia chinensis, Boswelia serrata, Endospermum cinense, Garuga pinnata, Glochidion velutinum, Holarrhena pubescens* and *Shorea robusta*. Second storey is also dense mixed with dense shrubby undergrowth.

6.5 COMMUNITY STRUCTURE

A community is a social unit of any rank occupying particular a territory or habitat and having characteristic composition and structure. In order to understand the community structure, vegetation samplings were carried out at different locations of proposed projects and adjoining catchment area along the Teesta and Rangit river Basin. For woody layer composition, nineteen sites were selected for vegetation structure study on the basis of the presence of forest patches in the projects as well as catchment during pre-monsoon season (i.e. during May, 2014). For herbaceous vegetation, the sampling was carried out for three seasons (i.e. pre-monsoon, monsoon and post-monsoon).

6.5.1 Trees, Shrubs & Saplings

i) Density and Abundance

The maximum number of tree species was recorded from the upstream site of TLD I & II Project area (V5, right bank of Rangit river) and Kitam Bird Sanc (V5, Sombaria, right bank of Rangit) in catchment area. Other Dam sites as well downstream sites did not show as many tree species due to extensive felling for timber and land use changes (Table-6.1). The herb species was poorly represented in all sites except upstream site of Teesta VI power house and TLD I & II dam site during pre-monsoon season (Table-6.2).

On the upstream of Teesta VI power house site, the tree stratum was dominated by *Callicarpa arborea* and *Albizia chinensis* having maximum density (100 trees/ha). The associated species in the tree canopy were *Tectona grandis, Bridelia pubescens, Rhus chinensis, Bischofia javanica, Gmelina arborea, Terminalia bellirica, Lannea cormandelica* and *Mallotus philippinensis*. In the sapling stratum, *Albizia chinensis* was found to be the most dominant species having maximum density. In the shrub strata, *Chromolaena odoratum* was found to be the most dominant species having high density. Other competing species in the understorey were *Lantana camara, Strobilanthes anisophylla, Cassia floribunda* and *Boehmeria platyphylla* (Table-6.1).

At the sampling station near power house site of Teesta VI, *Dalbergia sissoo* was found to be the most dominant tree species having maximum frequency (70%) and density (90 trees/ha). The associated species in the tree canopy were *Lannea coromandelica, Callicarpa arborea, Altsonia scholaris, Boswellia serrata, Mallotus philippinensis* and *Gmelina arborea*. In the sapling stratum, *Casearia graveolens* was found to be the most dominant species having maximum density. In the shrub layer *Lantana camara* was found to be the most dominant species having high density. Other competing species of the layer were *Chromolaena odoratum, Urena lobata, Mimosa himalayana, Clerodendrum japonicum, Woodfordia fruticosa* and *Colebrookia oppositifolia*.

Near Teesta intermediate dam site (Above Bhap Khola, left bank of Teesta), the tree stratum was dominated by *Shorea robusta* having maximum density (70 trees/ha). The associated species in the canopy were *Wrightea arborea, Albizia procera, Neonauclea griffithii, Phyllathus emblica, Callicarpa arborea, Bridelia retusa, Pandanus nepalensis, Bauhinia variegata* and *Magnolia hodgsonii*. In the sapling stratum, *Wrightea arborea* was found to be the most dominant species having maximum density. In the shrub layer *Bambusa tulda* was found to be the most dominant species having high density. Other competing species in the layer were *Strobilanthes hamiltoniana, Boehmeria penulifera,* and *Bauhinia vahlii*.

On downstream of Teesta intermediate site, tree stratum was dominated by *Shorea robusta* having maximum frequency (30%) and density (50 trees/ha). The associated species in the tree layer were *Duabanga grandiflora, Wrightea arborea, Neonauclea griffithii, Albizia chinensis, Schima wallichii* and *Gynocardia odorata*. *Mallotus philippinensis* was recorded as the most dominant species with high density in the sapling layer. In the shrub layer *Chromolaena odoratum* was found to be the most dominant species with high density. Other competing species in the understorey were *Lantana camara, Clerodendrum japonicum, Urena lobata, Bauhinia vahlii, Strobilanthes auriculata* and *Boehmeria platyphylla*.

At near TLD I & II Dam site (right bank of Rangit), tree stratum was dominated by *Ailanthus integrifolia* having maximum frequency (50%) and density (60 trees/ha). The associated species in the canopy were *Alangium chinense, Bauhinia purpurea, Boswellia serrata, Walsura tubulata, Duabanga grandiflora, Spondias pinnata, Albizia procera, Terminalia myriocarpa, Mallotus philippinensis, Samanea saman, Lepisanthes rubiginosa* and *Bombax ceiba*. In the sapling stratum, *Alangium chinense* was found to be the most dominant species having maximum density. In the shrub layer, *Boehmeria pendulifera* was found to be the most dominant species having high density. Other competing species in the layer were *Boehmeria macrophylla, Cudrania javanensis, Trivesia palmata, Melocalamus compactiflrus* and *Solanum surettense*.

On downstream of Teesta Low Dam (near Rangit Confuence with Teesta), tree stratum was dominated by *Tectona grandis* having maximum frequency (40%) and density (90 trees/ha) (Refer Table 6.1). The associated species in the canopy were *Boehmeria rugulosa, Callicarpa arborea, Lannea coromandelica, Ficus semicordata, Lagerstroemia hirsuta, Glochidion velutinum, Mallotus philippinensis* and *Albizia chinensis*. In the sapling layer, *Ficus semicordata* and *Wrightia arborea* were found to be the most dominant species having high density. In the shrub layer *Chromolaena odoratum* was found to be the most dominant species having high density. Other competing species in the layer were

Clerodendrum japonicum, Lantana camara, Caesalpinia decapetala, Mimosa himalayana, Colebrookia oppositifolia, Leea asitica and *Woodfordia fruticosa.*

At near Teesta Low Dam III (right bank of Teesta), the tree stratum was dominated by *Albizia procera* having maximum frequency (60%) and density (90 trees/ha). The associated species in the canopy were *Glochidion oblatum, Dalbergia sissoo, Duabanga grandiflora, Callicarpa arborea, Terminalia bellerica, Mallotus philippinensis, Phoebe hainesiana, Gmelina arborea* and *Pterospermum heterophyllum.* In the sapling layer, *Callicapa arborea* was found to be the most dominant species having high density. In the shrub layer *Chromolaena odoratum* was found as the most dominant species with high density. Other competing species in the layer were *Bambusa tulda, Cassia mimosoides, Boehmeria platyphylla, Lanatana camara, Cudrania javanensi*s and *Clerodendrum japonicum.*

At downstream of Teesta low dam III (right bank of Teesta), the tree and sapling strata were dominated by *Callicarpa arborea* having maximum frequency and density. The associated species in the tree canopy were *Ficus semicordata, Dalbergia sissoo, Albizia chinensis, Macaranga denticulata, Albizia lucida,* and *Engelhardtia spicata.* In the shrub layer *Chromolaena odoratum* was found to be the most dominant species followed by *Lantana camara* in terms of density (Refer Table 6.1).

At near Teesta Low Dam IV (right bank of Teesta), tree and sapling strata were dominated by *Heteropanax fragrans* having maximum frequency and density. The associated species in the tree canopy were *Pandanus nepalensis, Altsonia scholaris, Flacoutia jangomas, Gmelina arborea, Garcinia cowa, Bombax ceiba, Pterospermum acerifolium* and *Callicarpa arborea.* In the shrub layer, *Boehmeria macrophylla* was found to be the most dominant species followed by *Bambusa tulda, Chromolaena odoratum* and *Boehmeria glomerulifera* in terms of density.

At downstream of Teesta Low Dam IV (right bank of Teesta), tree strata was dominated by *Erythrina stricta* having maximum frequency (40%) and density (90 trees/ha). The associated species in the tree layer were *Engelhardtia spicata, Macaranga denticulata, Beilschmiedia roxburghiana, Alangium chinense, Griwia eriocarpa, Neonauclea griffithii, Oroxylum indicum, Sterculia villosa, Albizia procera* and *Salix tetrasperma.* The sapling layer was dominated by *Casearia vareca* and followed by *Bridelia retusa* and *Engelhardtia spicata* in terms of density. In the shrub layer *Chromolaena odoratum, Ficus hederacea* and *Boehmeria platyphylla* were found dominant species in terms of density.

At near Teesta Low Dam Vth (left bank of Teesta), tree and sapling strata were dominated by *Albizia lucida* having maximum frequency and density. The associated species in the tree layer were *Neonauclea griffithii, Gmelina arborea, Pterospermum acerifolium, Wrightea arborea, Macaranga denticulata, Dubanga grandiflora, Albizia odoratissima, Bauhinia* *purpurea, Dysoxylum binectariferum, Garcinia cowa, Sterculia villosa* and *Callicarpa arborea.* In the shrub layer *Leea asiatica* was found to be the most dominant species having maximum density. Other competing species in the layer were *Chromolaena odoratum, Bambusa tulda, Coffea bengalensis, Leea compactiflora, Clerodendrum japonicum, Leptodermis suaveolens, Combretum decandrum, Cassia mimosoides, Bauhinia vahlii, Buddleja asiatica, Rubus niveus* and *Dichroa fabrifuga* (Refer Table 6.1).

At downstream of Teesta Low Dam Vth (right bank of Teesta river), the tree stratum was dominated by *Albizia lucida* having maximum frequency (30%) and density (40 trees/ha). The associated species in the tree layer were *Duabanga grandiflora, Macaranga grandiflora, Neonauclea griffithii, Pandanus nepalensis, Altsonia scholaris, Olea dioica, Chukrasia tabularis, Phoebe hainesiana, Lannea coromandelica, Albizia chinensis, Canarium bengalense, Sterculia villosa* and *Litsea chartacea.* In the saplings layer *Glochidion velutinum* was found to be most dominant species in terms of density. In the shrub layer, *Bambusa tulda* was found to be the most dominant species having maximum density. Other competing species in the layer were *Clerodendrum japonicum, Boehmeria macrophylla, Combretum decandrum, Buddleja asiatica, Rubus paniculatus* and *Costus speciosus* (Refer Table 6.1).

At upstream of Jorethang powerhouse site (left bank of Rangit river), the tree stratum was dominated by *Lannea coromandelica* having maximum frequency (60%) and density (60 trees/ha). The associated species in the canopy were *Ficus semicordata, Callicarpa arborea, Ficus auriculata, Bridelia retusa, Tectona grandis, Garuga pinnata, Lagerstroemia hirsuta, Mallotus philippinensis, Bombax ceiba, Macaranga denticulata* and *Shorea robusta.* In the sapling layer *Ficus auriculata* and *Mallotus philippinensis* were found as dominant species. In the shrub layer *Chromolaena odoratum* was found to be the most dominant species having maximum density. Other competing species of the layer were *Bambusa tulda, Clerodendrum japonicum, Lantana camara* and *Woodfordia fruticosa.*

On downstream of Jorethang powerhouse site (left bank of Rangit), the tree stratum was dominated by *Mallotus philippinensis* having maximum frequency (40%) and density (120 trees/ha). The associated species in the canopy were *Garuga pinnata, Shorea robusta, Lannea coromandelica, Endospermum chinense, Glochidion hirsutum, Callicarpa arborea, Dysoxylum binectariferum, Ficus semicordata,* etc. In the sapling layer, *Garuga pinnata* was found to be the most dominant species followed by *Mallotus philippinensis* in terms of density. In the shrub layer, *Chromolaena odoratum* was found to be most dominant species in terms of density. Other copeting species of the layer were *Boehmeria platyphylla, Woodfordia fruticosa, Cassia mimosoides* and *Phoenix sylvestris.*

At 3 miles (catchment area, on way to Kalimpong), the tree stratum was dominated by *Firmania colorata* having maximum density (50 trees/ha). The associated species in the canopy were *Gynocardia odorata, Tectona grandis, Canarium strictum, Aphanamixis polystachya, Terminalia myriocarpa, Mallotus philippinensis, Mangifera sylvatica, Flacourtia jangomas, Lannea coromandelica, Walsura tubulata, Sterculia kingii, Shorea robusta* and *Neonauclea griffithii*. In the sapling layer *Brassiopsis glomerata* was found to be the most dominant species followed by Mallotus philippinensis in terms of density. In the shrub layer *Chomolaena odoratum* was found to be the most dominant species having maximum density. Other competing species of the layer were *Bambusa tulda, Strobilanthes auriculata, Clerodendrum japonicum, Colebrookia oppositifolia, Leea asiatica, Rhamnus nepalensis, Boehmeria macrophylla* and *Rubus paniculatus*.

At Lapchu (catchment area, on way to Darjeeling), the tree and saplings strata were dominated by *Castanopsis indica* having maximum frequency (60%) and density (110 trees/ha). The associated species in the canopy were *Schima wallichii, Alnus nepalensis, Cupressus corneyana, Persea robusta, Engelhardtia spicata, Albizia chinensis, Michelia glabr*a and *Lepisanthes senegalensis*. In the shrub layer, *Boehmeria macrophylla* was found to be the most dominant species having maximum density. It was followed by *Dichroa fabrifuga, Randia dumetorum, Clerodendrum bracteatum, Rubus paniculatus, R. ellipticus* and *Oxyspora paniculata*.

At 6th Mile (catchment area, Lamta Phatak on way tto Darjeeling), the tree stratum was dominated by *Castanopsis indica* having maximum frequency (70%) and density (90 trees/ha). The associated species in the tree layer were *Michelia cathcartii, Erythrina arborescens, Alnus nepalensis, Ilex dipyrena, Lyonia ovalifolia, Quercus serrata* and *Cryptomeria japonica*. In the sapling layer *Eurya cerasifolia* was found to be most dominant species followed by *Michelia cathcartii, Castanopsis hystrix, Erythrina arborescens*, etc in terms of density. In the shrub layer *Rubus niveus* was found to be the most dominant species having maximum density. Other competing species in the layer were *Dichroa fabrifuga, Rubus ellipticus, Boehmeria macrophylla, Girardinia diversifolia, Rubus calycinoides, Macropanax dispermus* and *Viburnum erubescens*.

At Senchal (Catchment area, Wild Life Sanctuary), the tree and sapling strata were dominated by *Eurya cerasifolia* having maximum frequency and density. The associated species in the tree layer were *Quercus serrata, Alangium chinense, Acer laevigatum, Lindera assamica, Eurya japonica, Litsea kingii, Castanopsis hystrix, Cryptomeria japonica, Quercus thomsonii, Elaeocarpus lanceifolius* and *Persea fructifera*. In the shrub layer *Thamnocalamus aristatus* was found to be the most dominant species having maximum density. Other competing species in the layer were *Mahonia acanthifolia, Hydrangea robusta, Viburnum erubescens, Rubus niveus, Strobilanthes divaricata* and *Rubus ellipticus*.

At Kitam Bird Sanctuary (Catchment area near Sombaria), the tree stratum was dominated by *Shorea robusta* having maximum frequency (50%) and density (110 trees/ha). The associated species in the tree layer were *Eucalyptus tereticornis, Lannea coromandelica, Callicarpa arborea, Tectona grandis, Phoebe lanceolata, Duabanga grandiflora, Alangium chinense, Garuga pinnata, Wrightia arborea, Sterculia kingii, Terminalia myriocarpa, Holarrhena pubescens, Endospermum chinense, Phyllanthus emblica* and *Pinus roxburghii*. In the sapling stratum *Mallotus philippinensis* was found to be the most dominant species having maximum density. In the shrub layer *Chromolaena odoratum* was found to be the most dominant species having maximum density. Other competing species in the layer were *Boehmeria platyphyllum, Clerodendrum japonicum, Bauhinia vahlii, Colebrookia oppositifolia, Leea asiatica* and *Woodfordia fruticosa*.

Across all the sites/stands the total tree density ranged from 250 trees/ha at downstream of TLD III (right bank of Teesta) to 490 trees/ha at downstream of Jorethang Powerhouse site (left bank of Rangit river). The complete absence of seedlings of all major species in all the forest sites indicates heavy anthropogenic pressure in the area. The total density for saplings and shrubs ranged from 700 to 4800 individuals ha^{-1} and 3000 to 15800 individuals ha^{-1}, respectively. Shrub density was comparatively higher at TLD IV (right bank of Teesta) (15800 individual ha^{-1}) as compared to other sites. The maximum individual shrub density was recorded for *Chromolaena odoratum* (10200 individual ha^{-1}) at upstream of Jorethang power house site (Refer Table 6.1). This species is fast spreading and invading which may destroy the local native flora.

The total basal area ranged from 53.70 m^2/ha at TLD III (right bank of Teesta) to 300.47 m^2/ha at 3rd Mile (Catchment area, on way to Darjeeling) (Refer Table 6.1). The lowest mean basal area (0.073 m^2/tree) was recorded for *Grewia laevigata* at Teesta VI power house site, while the highest values were recorded for *Anthocephalus cadamba* (3.799 m^2/tree) at TLD I & II site. *Tectona grandis* was the most dominant species with an IVI of 88.68 at TLD I & II Project site, whereas *Castanopsis indica* was the most dominant species (96.00) at 6th Mile (Catchment area, Lamta Phatak).

Table-6.1 Vegetational attributes of woody vegetation in Teesta Basin

	Species	Frequency (F%)	Density (ha^{-1})	TBC(m^2ha^{-1})	IVI	H
V1 U/s of Teesta VI Power house site (left bank of Teesta) 281m						
Trees						
1	*Bischofia javanica*	20	20	4.44	14.93	
2	*Lannea coromandelica*	10	10	0.80	6.47	
3	*Callicarpa arborea*	80	100	47.21	85.66	
4	*Bridelia pubescens*	20	30	2.62	16.21	
5	*Bombax ceiba*	20	20	1.56	12.90	
6	*Terminalia bellirica*	10	10	1.26	6.78	
7	*Glochidion multiloculare*	10	10	0.99	6.60	
8	*Albizia chinensis*	50	100	42.99	72.68	
9	*Rhus chinensis*	20	30	2.46	16.09	
10	*Mallotus philippinensis*	10	10	2.37	7.58	
11	*Tectona grandis*	30	30	14.09	27.64	
12	*Gmelina arborea*	20	20	20.76	26.46	
	Total	**300**	**390**	**141.55**		**2.12**
Saplings						
1	*Callicarpa arborea*	10	100	3.80	17.20	
2	*Rhus chinensis*	30	600	13.29	66.87	
3	*Syzygium cumini*	10	100	1.13	12.61	
4	*Oroxylum indicum*	10	100	1.23	12.78	
5	*Albizia chinensis*	30	1000	31.40	114.03	
6	*Mallotus philippinensis*	30	300	3.06	37.27	
7	*Dysoxylum binectariferum*	20	200	3.08	26.63	
8	*Lannea coromandelica*	10	100	1.13	12.61	
	Total	**150**	**2500**	**58.12**		**1.68**
Shrubs						
1	*Caesalpinia cuculata*	10	200	5.09	11.49	
2	*Lantana camara*	80	2700	34.73	97.80	
3	*Chromolaena odoratum*	80	3600	31.16	103.97	
4	*Clerodendrum japonicum*	20	700	6.89	22.86	
5	*Strobilanthes anisophylla*	40	1500	13.73	46.77	
6	*Cassia floribunda*	10	300	3.39	10.82	
7	*Boehmeria platyphylla*	10	100	1.13	6.27	
	Total	**250**	**9100**	**96.12**		**1.47**
V2 Near Teesta VI Powerhouse site (left bank of Teesta) 245m						
Trees						
1	*Dalbergia sissoo*	70	90	44.56	73.76	
2	*Callicarpa arborea*	50	50	12.31	34.51	
3	*Lannea coromandelica*	50	80	20.12	47.43	
4	*Boswellia serrata*	20	20	7.26	15.58	
5	*Tectona grandis*	10	10	7.54	10.76	
6	*Altsonia scholaris*	20	30	3.40	14.97	
7	*Phyllanthus emblica*	10	10	2.29	6.77	
8	*Terminalia bellirica*	10	10	2.12	6.64	
9	*Schima wallichii*	10	10	1.26	5.98	
10	*Mallotus philippinensis*	20	20	3.04	12.37	
11	*Toona microcarpa*	10	10	1.96	6.52	
12	*Grewia laevigata*	10	10	0.73	5.58	
13	*Oroxylum indicum*	10	10	1.26	5.98	

	Species	Frequency (F%)	Density (ha^{-1})	TBC(m^2ha^{-1})	IVI	H
14	*Euonymus hamiltonii*	10	10	1.32	6.03	
15	*Lagerstroemia hirsuta*	10	10	1.38	6.08	
16	*Gmelina arborea*	20	20	4.84	13.74	
17	*Bombax ceiba*	10	10	1.96	6.52	
18	*Dysoxylum binectarifolium*	10	10	12.27	14.36	
19	*Alangium chinense*	10	10	1.81	6.40	
	Total	**370**	**430**	**131.42**		**2.55**
Saplings						
1	*Lagerstroemia hirsuta*	10	100	7.07	21.90	
2	*Celtis tetradra*	20	200	1.83	25.19	
3	*Casearia graveolens*	40	600	12.82	73.34	
4	*Toona microcarpa*	10	200	3.30	20.75	
5	*Callicarpa arborea*	10	100	7.07	21.90	
6	*Samanea saman*	10	100	4.52	18.05	
7	*Oroxylum indicum*	10	300	4.29	26.80	
8	*Meyna spinosa*	10	100	3.14	15.96	
9	*Dysoxylum binectarifolium*	10	200	2.26	19.18	
10	*Mallotus philippinensis*	20	300	19.81	56.93	
	Total	**150**	**2200**	**66.11**		**2.11**
Shrubs						
1	*Urena lobata*	20	500	4.33	19.89	
2	*Lantana camara*	80	3800	42.96	130.60	
3	*Chromolaena odoratum*	50	2200	19.04	70.99	
4	*Mimosa rubicaulis*	30	400	10.63	29.64	
5	*Clerodendrum japonicum*	20	300	3.11	15.96	
6	*Woodfordia fruticosa*	20	200	10.61	22.65	
7	*Colebrookia oppositifolia*	10	200	3.08	10.26	
	Total	**230**	**7600**	**93.76**		**1.36**
V3 Near Teesta intermediate dam site (above BhapKhola, left bank of Teesta) 223m						
Trees						
1	*Callicarpa arborea*	20	20	5.65	15.94	
2	*Bombax ceiba*	10	20	2.09	9.87	
3	*Albizia procera*	40	40	10.47	31.27	
4	*Anthocephalus cadamba*	10	10	20.10	20.69	
5	*Albizia chinensis*	10	10	1.32	6.86	
6	*Neonauclea griffithii*	10	30	33.91	35.75	
7	*Canarium strictum*	10	10	0.75	6.44	
8	*Pandanus nepalensis*	10	20	3.04	10.57	
9	*Altsonia sholaris*	10	10	0.80	6.48	
10	*Schima wallichii*	10	10	1.38	6.91	
11	*Aglaia heirni*	10	20	5.84	12.63	
12	*Bridelia retusa*	20	20	2.51	13.63	
13	*Wrightea arborea*	40	50	4.54	29.33	
14	*Shorea robusta*	30	70	12.24	36.44	
15	*Bauhinia purpurea*	10	10	3.63	8.56	
16	*Terminalia bellirica*	10	10	7.54	11.44	
17	*Phyllanthus emblica*	10	30	5.29	14.66	
18	*Magnolia hodgsonii*	10	10	7.66	11.53	
19	*Lannea coromandelica*	10	10	6.94	11.00	
	Total	**290**	**410**	**135.72**		**2.72**

	Species	Frequency (F%)	Density (ha^{-1})	TBC(m^2ha^{-1})	IVI	H
Saplings						
1	*Casearia graveolens*	10	100	6.15	24.09	
2	*Dysoxylum binectariferum*	10	100	1.13	14.79	
3	*Toona ciliata*	20	300	4.88	39.43	
4	*Albizia procera*	20	300	13.56	55.50	
5	*Altsonia scholaris*	10	100	7.07	25.77	
6	*Wrightea arborea*	20	500	10.69	60.17	
7	*Syzygium cumini*	10	200	3.53	24.23	
8	*Mallotus philippinensis*	10	200	2.45	22.23	
9	*Shorea robusta*	20	200	4.54	33.79	
	Total	**130**	**2000**	**54.01**		**2.06**
Shrubs						
1	*Boehmeria pendulifera*	30	800	12.31	29.64	
2	*Chromolaena odoratum*	100	5000	43.27	123.54	
3	*Strobilanthes hamiltoniana*	40	1500	16.40	43.75	
4	*Debregeasia longifolia*	10	100	7.07	10.71	
5	*Bauhinia vahlii*	20	200	5.97	14.63	
6	*Allophylus zeylanicus*	10	100	1.13	5.77	
7	*Woodfordia fruticosa*	10	200	7.26	11.85	
8	*Bambusa tulda*	10	1800	19.67	37.89	
9	*Randia dumetorum*	10	200	3.77	8.95	
10	*Leptodermis suaveolens*	10	200	2.26	7.69	
11	*Clerodendron japonicum*	10	100	0.92	5.59	
	Total	**260**	**10200**	**120.02**		**1.58**
V4 Downstream of Teesta intermediate(opp. Rangpo Wine Fac, left Bank of Teesta)219m						
Trees						
1	*Shorea robusta*	30	50	19.51	50.19	
2	*Gynocardia odorata*	10	10	3.63	11.34	
3	*Schima wallichii*	20	20	4.92	20.10	
4	*Duabanga grandiflora*	30	40	12.07	38.65	
5	*Trema politora*	10	10	1.26	8.72	
6	*Callicarpa arborea*	20	20	5.28	20.49	
7	*Albizia chinensis*	20	20	10.05	25.75	
8	*Wrightea arborea*	20	30	4.81	23.31	
9	*Neonauclea griffithii*	20	20	9.55	25.21	
10	*Engelhardtia spicata*	10	10	1.59	9.09	
11	*Alangium chinense*	10	10	0.75	8.17	
12	*Dalbergia sissoo*	10	20	5.01	16.20	
13	*Magnolia hodgonii*	10	10	3.79	11.52	
14	*Bischofia javanica*	10	10	4.07	11.82	
15	*Phyllanthus emblica*	10	10	0.80	8.22	
16	*Ailanthus integrifolia*	10	10	3.52	11.22	
	Total	**250**	**300**	**90.63**		**2.61**
Saplings						
1	*Wrightea arborea*	20	200	5.09	40.02	
2	*Mallotus philippinensis*	30	400	6.15	64.17	
3	*Shorea robusta*	20	200	6.60	43.09	
4	*Albizia chinensis*	30	300	9.42	63.67	
5	*Bridelia retusa*	10	100	2.01	18.92	
6	*Dalbergia sissoo*	10	100	7.07	29.21	

	Species	Frequency (F%)	Density (ha^{-1})	TBC(m^2ha^{-1})	IVI	H
7	*Phyllanthus emblica*	10	100	12.81	40.90	
	Total	**130**	**1400**	**49.15**		**1.81**
Shrubs						
1	*Clerodendrum japonicum*	30	500	4.41	36.06	
2	*Lantana camara*	40	1000	12.27	68.34	
3	*Bauhinia vahlii*	20	200	6.28	27.48	
4	*Chromolaena odoratum*	40	1500	13.23	81.85	
5	*Woodfordia fruticosa*	20	300	7.63	32.45	
6	*Strobilanthes auriculata*	10	200	2.04	13.91	
7	*Urena lobata*	20	400	3.46	26.61	
8	*Boehmeria platyphylla*	10	200	1.73	13.30	
	Total	**190**	**4300**	**51.05**		**1.79**
V5 Near TLD I & II dam site (right bank of Rangit river)220m						
Trees						
1	*Spondias pinnata*	10	10	11.30	10.72	
2	*Walsura tubulata*	10	30	2.98	13.02	
3	*Albizia procera*	10	10	12.27	11.12	
4	*Ailanthus integrifolia*	50	60	43.77	51.24	
5	*Alangium chinense*	40	40	5.70	26.67	
6	*Boswellia serrata*	30	30	22.16	27.34	
7	*Oroxylum indicum*	10	10	1.52	6.71	
8	*Harpulia capanioides*	10	10	1.96	6.89	
9	*Anthocephalus cadamba*	10	10	37.99	21.68	
10	*Bauhinia variegata*	20	30	7.39	18.05	
11	*Terminalia myriocarpa*	10	10	16.50	12.86	
12	*Bombax ceiba*	10	10	28.34	17.72	
13	*Mallotus philippinensis*	10	10	0.91	6.46	
14	*Samanea saman*	10	10	9.50	9.98	
15	*Lannea coromandelica*	10	10	1.26	6.60	
16	*Duabanga grandiflora*	20	20	23.75	21.92	
17	*Altsonia scholaris*	10	10	1.38	6.65	
18	*Lepisanthes rubiginosa*	10	10	1.26	6.60	
19	*Sapium baccatum*	10	10	11.30	10.72	
20	*Callicarpa arborea*	10	10	2.37	7.06	
	Total	**310**	**350**	**243.62**		**2.77**
Saplings						
1	*Phoebe hainesiana*	10	100	6.15	21.60	
2	*Mallotus philippinensis*	20	200	6.28	32.15	
3	*Sapium baccatum*	10	100	6.38	22.01	
4	*Wrightea arborea*	10	300	9.61	37.46	
5	*Bischofia javanica*	10	100	1.13	12.39	
6	*Putrangiva roxburghii*	10	100	0.87	11.90	
7	*Alangium chinense*	40	500	8.83	62.22	
8	*Ailanthus integrifolia*	30	300	3.62	37.59	
9	*Harpulia capanioides*	10	100	1.54	13.14	
10	*Bauhinia variegata*	10	100	7.07	23.27	
11	*Pterospermum acerifolium*	20	200	3.08	26.28	
	Total	**180**	**2100**	**54.55**		**2.22**
Shrubs						
1	*Boehmeria pendulifera*	80	7000	130.32	188.73	

	Species	Frequency (F%)	Density (ha^{-1})	TBC(m^2ha^{-1})	IVI	H
2	*Solanum surattense*	10	200	1.83	8.92	
3	*Medinella rubicunda*	10	200	2.65	9.36	
4	*Cudrania javanensis*	20	200	2.04	14.91	
5	*Trivesia palmata*	10	200	9.81	13.18	
6	*Eranthemum griffithii*	10	200	1.73	8.87	
7	*Melocalamus compactiflorus*	10	200	0.10	8.00	
8	*Boehmeria macrophylla*	20	1500	39.00	48.03	
	Total	**170**	**9700**	**187.49**		**1.00**
V6 Downstream of TLD I ans II Combined Dam (near Rangit & Teesta Confluence) 209m						
Trees						
1	*Tectona grandis*	40	90	50.57	88.68	
2	*Lagerstroemia hirsuta*	20	20	3.18	17.05	
3	*Callicarpa arborea*	30	30	11.21	31.26	
4	*Persea odoratissima*	10	10	2.83	9.62	
5	*Shorea robusta*	10	10	9.50	15.50	
6	*Boehmeria rugulosa*	40	50	11.87	42.09	
7	*Ficus semicordata*	20	30	4.56	21.39	
8	*Lannea coromandelica*	30	30	2.72	23.77	
9	*Albizia chinensis*	10	10	4.84	11.39	
10	*Samanea saman*	10	10	1.26	8.23	
11	*Glochidion velutinum*	10	10	0.78	7.81	
12	*Mallotus philippinensis*	10	10	1.52	8.46	
13	*Duabanga grandiflora*	10	10	8.65	14.75	
	Total	**250**	**320**	**113.48**		**2.24**
Saplings						
1	*Wrightia arborea*	20	300	12.90	76.75	
2	*Altsonia scholaris*	20	200	4.02	47.37	
3	*Persea robusta*	10	100	3.14	26.27	
4	*Ficus semicordata*	30	300	16.41	94.79	
5	*Lannea coromandelica*	10	100	1.13	21.67	
6	*Pandanus nepalensis*	10	100	6.15	33.16	
	Total	**100**	**1100**	**43.75**		**1.67**
Shrubs						
1	*Clerodendrum japonicum*	20	2200	21.66	58.37	
2	*Chromolaena odorata*	50	5000	43.27	129.46	
3	*Mimosa rubicaulis*	10	100	7.07	13.98	
4	*Lantana camara*	30	600	6.78	31.22	
5	*Boehmeria platyphylla*	10	100	0.88	7.90	
6	*Caesalpinia decapetala*	10	300	10.89	20.04	
7	*Ventilago denticulata*	10	100	3.14	10.12	
8	*Colebrookea oppositifolia*	10	100	2.54	9.53	
9	*Leea asiatica*	10	100	0.88	7.90	
10	*Woodfordia fruticosa*	10	100	4.52	11.48	
	Total	**170**	**8700**	**101.64**		**1.27**
V7 Near Teesta Low Dam III (right bank of Teesta) 220m						
Trees						
1	*Phoebe hainesiana*	10	10	1.52	9.62	
2	*Glochidion oblatum*	30	50	5.30	36.12	
3	*Terminalia bellirica*	20	20	8.14	28.73	

	Species	Frequency (F%)	Density (ha^{-1})	TBC(m^2ha^{-1})	IVI	H
4	*Albizia procera*	60	90	11.76	71.45	
5	*Mallotus philippinensis*	20	20	2.77	18.73	
6	*Duabanga grandiflora*	40	40	6.94	40.07	
7	*Callicarpa arborea*	20	30	2.64	21.44	
8	*Ficus semicordata*	10	10	5.02	16.14	
9	*Dalbergia sissoo*	30	50	7.60	40.39	
10	*Gmelina arborea*	10	10	0.75	8.19	
11	*Pterospermum heterophyllum*	10	10	1.26	9.13	
	Total	**260**	**340**	**53.70**		**2.13**
Saplings						
1	*Clausena heptaphylla*	10	100	3.14	22.50	
2	*Callicarpa arborea*	40	700	7.27	96.69	
3	*Mallotus philippinensis*	10	200	9.04	42.21	
4	*Bauhinia variegata*	10	100	1.13	17.92	
5	*Albizia procera*	10	100	7.07	31.45	
6	*Terminalia myriocarpa*	10	100	1.54	18.85	
7	*Dalbergia sissoo*	10	200	7.60	38.92	
8	*Albizia chinensis*	10	100	7.07	31.45	
	Total	**110**	**1600**	**43.85**		**1.75**
Shrubs						
1	*Lantana camara*	10	200	2.86	10.78	
2	*Chromolaena odoratum*	80	7800	67.51	191.37	
3	*Boehmeria platyphylla*	10	500	4.33	15.13	
4	*Woodfordia fruticosa*	20	300	2.75	17.47	
5	*Cassia mimosoides*	20	500	4.92	21.65	
6	*Cudrania javanensis*	10	100	0.90	7.77	
7	*Clerodedrum japonicum*	10	100	0.88	7.75	
8	*Bambusa tulda*	10	1200	10.39	28.08	
	Total	**170**	**10700**	**94.53**		**1.02**
V8 Downstream of TLD III dam site (right bank of Teesta) 188m						
Trees						
1	*Dalbergia sissoo*	10	40	12.66	41.62	
2	*Ficus semicordata*	30	50	16.58	63.50	
3	*Lagerstroemia hirsuta*	10	10	0.85	11.21	
4	*Persea robusta*	10	10	3.85	15.88	
5	*Albizia lucida*	10	10	3.02	14.59	
6	*Callicarpa arborea*	40	50	9.19	57.86	
7	*Altsonia scholaris*	10	10	1.13	11.65	
8	*Erythrina stricta*	10	10	1.96	12.94	
9	*E ngelhardtia spicata*	10	10	3.85	15.88	
10	*Albizia chinensis*	10	20	5.52	22.49	
11	*Albizia procera*	10	10	4.07	16.23	
12	*Macaranga denticulata*	10	20	1.46	16.16	
	Total	**170**	**250**	**64.15**		**2.24**
Saplings						
1	*Duabanga grandiflora*	10	200	5.67	29.24	
2	*Callicarpa arborea*	50	600	30.63	126.36	
3	*Alangium chinense*	10	100	1.13	16.04	
4	*Ficus racemosa*	10	200	3.08	25.06	
5	*Dysoxylum binectariferm*	10	100	1.13	16.04	

	Species	Frequency (F%)	Density (ha^{-1})	TBC(m^2ha^{-1})	IVI	H
6	*Bridelia retusa*	10	200	9.81	35.92	
7	*Ficus semicordata*	10	100	1.13	16.04	
8	*Albizia chinensis*	10	200	9.42	35.30	
	Total	**120**	**1700**	**62.00**		**1.87**
Shrubs						
1	*Lantana camara*	40	1100	12.43	60.68	
2	*Chromolaena odoratum*	60	3600	31.16	143.99	
3	*Alsophila spinulosa*	10	100	2.54	11.30	
4	*Glochidion hirsutum*	10	200	7.95	21.61	
5	*Entada phaseoloides*	10	100	0.92	8.71	
6	*Solanum barbisetum*	10	200	2.26	12.55	
7	*Coffea bengalensis*	20	300	2.80	20.65	
8	*Boehmeria platyphylla*	10	200	1.83	11.86	
9	*Solanum surattense*	10	100	0.88	8.66	
	Total	**180**	**5900**	**62.77**		**1.32**
V9 Near Teesta Low Dam IV site (right bank of Teesta) 158m						
Trees						
1	*Syzygium formosum*	10	10	2.83	13.87	
2	*Albizia lucida*	10	10	0.80	10.17	
3	*Toona ciliata*	10	10	0.96	10.46	
4	*Clusena heptaphylla*	10	10	1.02	10.56	
5	*Pandanus nepalensis*	20	30	2.88	26.38	
6	*Sterculia villosa*	10	10	1.81	12.01	
7	*Trema politora*	10	10	0.93	10.41	
8	*Heteropanax fragrans*	20	50	9.81	46.45	
9	*Flacourtia jangomas*	20	20	2.77	22.47	
10	*Altsonia scholaris*	10	30	2.95	21.51	
11	*Macropanax undulatus*	10	10	1.26	11.00	
12	*Garcinia cowa*	10	10	15.39	36.83	
13	*Callicarpa arborea*	10	10	1.96	12.29	
14	*Alangium chinense*	10	10	0.80	10.17	
15	*Bombax ceiba*	10	10	1.59	11.61	
16	*Pterospermum acerifolium*	10	10	2.83	13.87	
17	*Gmelina arborea*	10	20	4.12	19.93	
	Total	**200**	**270**	**54.71**		**2.65**
Saplings						
1	*Pandanus nepalensis*	10	200	9.04	17.24	
2	*Heteropanax fragrans*	80	2300	41.71	123.61	
3	*Casearea vareca*	30	800	26.39	55.19	
4	*Macaranga denticulata*	10	200	4.54	12.99	
5	*Clausena heptaphylla*	40	700	11.55	43.66	
6	*Bridelia retusa*	10	100	2.54	9.03	
7	*Litsea monopetala*	10	100	0.92	7.49	
8	*Alangium chinense*	10	200	4.02	12.50	
9	*Sterculia villosa*	10	100	1.54	8.08	
10	*Mallotus philipinensis*	10	100	3.80	10.21	
	Total	**220**	**4800**	**106.06**		**1.65**
Shrubs						
1	*Cassia mimosoides*	10	300	5.30	9.11	
2	*Chromolaena odoratum*	50	3000	26.46	55.04	

	Species	Frequency (F%)	Density (ha^{-1})	TBC(m^2ha^{-1})	IVI	H
3	*Boehmeria macrophylla*	70	6000	54.94	100.75	
4	*Rubus paniculatus*	20	200	1.73	9.60	
5	*Rhamnus nepalensis*	20	400	3.94	12.38	
6	*Solanum surattense*	10	100	0.90	4.82	
7	*Leea compactiflora*	10	100	0.92	4.83	
8	*Murraya koengii*	10	100	1.54	5.26	
9	*Cudrania javanensis*	10	100	0.87	4.80	
10	*Desmodium triflorum*	10	100	1.13	4.98	
11	*Bambusa tulda*	20	3200	27.17	46.08	
12	*Boehmeria glomerilifera*	10	500	4.58	9.88	
13	*Claoxylon indicum*	10	200	2.74	6.72	
14	*Clerodendrum japonicum*	20	1500	13.23	25.73	
	Total	**280**	**15800**	**145.43**		**1.78**
V10	**Downstream of Teesta Low Dam IV (right bank of Teesta) 150m**					
Trees						
1	*Erythrina stricta*	40	90	46.93	65.16	
2	*Macaranga denticulata*	40	60	9.37	37.13	
3	*Engelhardtia spicata*	20	80	27.69	43.84	
4	*Salix tetrasperma*	10	10	1.96	7.79	
5	*Albizia procera*	10	10	9.50	11.87	
6	*Careya arborea*	10	10	0.75	7.14	
7	*Celtis tetrandra*	10	10	0.74	7.13	
8	*Grewia eriocarpa*	10	20	1.46	10.09	
9	*Beilschmiedia roxburghiana*	20	20	7.47	17.51	
10	*Albizia chinensis*	10	10	25.43	20.50	
11	*Heteropanax fragrans*	10	10	0.85	7.19	
12	*Terminalia myriocarpa*	10	10	7.54	10.81	
13	*Alangium chinense*	10	20	1.51	10.11	
14	*Neonauclea griffithii*	10	10	25.43	20.50	
15	*Oroxylum indicum*	10	10	0.80	7.17	
16	*Sterculia villosa*	10	10	17.19	16.04	
	Total	**240**	**390**	**184.65**		**2.35**
Saplings						
1	*Bridelia retua*	20	300	9.90	34.70	
2	*Macropanax undulata*	10	100	3.14	13.11	
3	*Aralia foliosa*	10	200	1.83	15.09	
4	*Celtis tetrandra*	10	100	0.87	10.11	
5	*Macaranga denticulata*	30	300	11.40	41.94	
6	*Clausena heptaphylla*	20	200	2.08	20.67	
7	*Garcinia cowa*	10	100	1.13	10.46	
8	*Casearia vareca*	20	500	10.05	42.31	
9	*Engelhardtia spicata*	20	300	11.92	37.37	
10	*Dysoxylum binectariferum*	10	200	11.03	27.22	
11	*Beilschmedia roxburghiana*	10	100	3.63	13.76	
12	*Sterculia villosa*	10	200	5.67	20.15	
13	*Ficus semicordata*	10	100	3.14	13.11	
	Total	**190**	**2700**	**75.77**		**2.43**
Shrubs						
1	*Elatostema sessile*	10	300	2.60	14.26	

	Species	Frequency (F%)	Density (ha^{-1})	TBC(m^2ha^{-1})	IVI	H
2	*Desmodium triflorum*	20	300	3.39	21.46	
3	*Leea asiatica*	20	400	15.90	38.00	
4	*Chromolaena odoratum*	30	1000	8.65	45.46	
5	*Ficus hederacea*	10	1000	20.10	46.60	
6	*Boehmeria platyphylla*	10	1000	9.16	33.56	
7	*Lantana camara*	10	100	1.13	9.24	
8	*Eranthemum griffithii*	10	100	0.85	8.90	
9	*Clerodendrum japonicum*	10	800	6.92	27.62	
10	*Rubus paniculatus*	10	200	1.87	11.75	
11	*Boehmeria glomerilifolia*	10	100	6.15	15.22	
12	*B. macrophylla*	10	800	7.19	27.93	
	Total	**160**	**6100**	**83.90**		**2.21**
V11	**Near Teesta Low Dam V (left bank of Teesta)134m**					
Trees						
1	*Gmelina arborea*	20	20	6.84	15.76	
2	*Altsonia scholaris*	10	10	11.30	10.60	
3	*Mallotus philippinensis*	10	10	0.80	6.97	
4	*Flacourtia jangomas*	10	10	0.85	6.99	
5	*Duabanga grandiflora*	10	20	4.75	11.46	
6	*Albizia odoratissima*	10	10	1.96	7.37	
7	*Macaranga denticulata*	10	20	3.18	10.92	
8	*Neonauclea griffithii*	40	40	101.17	61.75	
9	*Bauhinia purpurea*	10	10	0.80	6.97	
10	*Dysoxylum binectariferum*	10	10	11.30	10.60	
11	*Wrightea arborea*	20	20	18.65	19.84	
12	*Choreospondias axillaris*	10	10	17.66	12.80	
13	*Bauhinia variegata*	10	10	1.66	7.27	
14	*Albizia lucida*	40	60	25.79	41.95	
15	*Engelhardtia spicata*	10	10	2.83	7.67	
16	*Pterospermum acerifolium*	20	20	50.87	30.97	
17	*Garcinia cowa*	10	10	20.10	13.64	
18	*Sterculia villosa*	10	10	6.36	8.89	
19	*Callicarpa arborea*	10	10	2.46	7.55	
	Total	**280**	**320**	**289.35**		**2.74**
Saplings						
1	*Albizia procera*	10	100	0.87	10.99	
2	*Ficus semicordata*	20	200	7.60	30.32	
3	*Callicarpa arborea*	20	200	5.67	27.58	
4	*Glochidion velutinum*	30	300	9.90	43.35	
5	*Duabanga grandiflora*	10	100	4.52	16.19	
6	*Albizia chinensis*	10	100	7.07	19.80	
7	*Albizia lucida*	40	500	12.02	60.89	
8	*Bauhinia purpurea*	20	200	9.81	33.46	
9	*Michelia glabra*	10	100	1.13	11.37	
10	*Mallotus philippinensis*	10	100	4.52	16.19	
11	*Casearea vareca*	10	100	1.13	11.37	
12	*Lannea coromandelica*	10	100	6.15	18.51	
	Total	**200**	**2100**	**70.39**		**2.31**
Shrubs						
1	*Bauhinia vahlii*	10	200	5.67	10.65	

	Species	Frequency (F%)	Density (ha^{-1})	TBC(m^2ha^{-1})	IVI	H
2	*Leea asiatica*	30	1700	40.87	64.31	
3	*Buddleja asiatica*	10	200	1.73	7.52	
4	*Chromolaena odoratum*	20	1000	8.82	26.61	
5	*Cassia mimosoides*	10	200	6.60	11.39	
6	*Rubus niveus*	10	200	3.53	8.95	
7	*Combretum decandrum*	20	300	3.51	13.85	
8	*Leea compactiflora*	30	600	7.36	24.28	
9	*Eranthemum griffithii*	10	100	1.13	5.82	
10	*Leucosceptrum canum*	10	400	4.52	12.17	
11	*Derris scandens*	10	200	1.83	7.60	
12	*Bambusa tulda*	10	1000	8.65	22.78	
13	*Coffea bengalensis*	20	900	7.94	24.69	
14	*Cudrania javanensis*	20	200	9.04	17.03	
15	*Clerodendrum japoncum*	30	400	3.59	18.85	
16	*Dichroa fabrifuga*	10	200	7.60	12.18	
17	*Leptodermis suaveolens*	10	400	3.46	11.33	
	Total	**270**	**8200**	**125.86**		**2.52**
V12	**Downstream of Teesta Low dam V site (right bank of Teesta) 144m**					
Trees						
1	*Olea dioica*	10	10	1.96	10.40	
2	*Albizia lucida*	30	40	5.15	34.21	
3	*Chukrasia tabularis*	10	10	3.02	11.58	
4	*Neonauclea griffithii*	20	20	10.25	27.89	
5	*Pandanus nepalensis*	20	20	2.33	19.00	
6	*Duabanga grandiflora*	20	30	20.54	43.29	
7	*Phoebe hainesiana*	10	10	30.78	42.73	
8	*Dysoxylum binectarifolium*	10	10	0.74	9.03	
9	*Litsea chartacea*	10	10	1.29	9.64	
10	*Lannea coromandelica*	10	10	1.26	9.60	
11	*Ficus semicordata*	10	10	1.38	9.75	
12	*Macaranga denticulata*	20	30	2.88	23.47	
13	*Altsonia scholaris*	20	20	1.75	18.35	
14	*Albizia chinensis*	10	10	1.52	9.90	
15	*Canarium bengalense*	10	10	3.42	12.03	
16	*Sterculia villosa*	10	10	0.83	9.12	
	Total	**230**	**260**	**89.10**		**2.63**
Saplings						
1	*Casearea graveolens*	10	100	1.13	21.34	
2	*Clausena heptaphylla*	10	100	0.92	20.74	
3	*Chukrasia tabularis*	10	100	6.15	35.39	
4	*Glochidion velutinum*	20	200	6.60	54.81	
5	*Syzygium formosum*	10	100	6.15	35.39	
6	*Albizia lucida*	10	100	1.13	21.34	
7	*Claoxylon longipetiolatum*	10	100	2.54	25.29	
8	*Alangium chinense*	10	100	0.93	20.79	
9	*Macaranga denticulata*	10	100	3.14	26.96	
10	*Lannea coromandelica*	10	100	7.07	37.94	
	Total	**110**	**1100**	**35.76**		**2.27**
Shrubs						
1	*Combretum decandrum*	10	200	2.26	17.55	

	Species	Frequency (F%)	Density (ha^{-1})	TBC(m^2ha^{-1})	IVI	H
2	*Costus speciosus*	10	100	0.92	12.12	
3	*Clerodendrum japonicum*	40	900	7.79	69.52	
4	*Boehmeria macrophylla*	20	700	7.52	48.96	
5	*Bambusa tulda*	20	2000	17.31	101.50	
6	*Budleja asiatica*	10	200	1.87	16.62	
7	*Rubus paniculatus*	10	200	1.76	16.38	
8	*Cassia mimosoides*	10	100	3.14	17.34	
	Total	**130**	**4400**	**42.57**		**1.57**
V13	**U/s of Jorethang Loop Powerhouse site (Majhitar, left bank of Rangit) 270m**					
Trees						
1	*Tectona grandis*	10	20	15.70	28.59	
2	*Bridelia retusa*	20	20	4.00	18.97	
3	*Ficus auriculata*	30	30	6.20	28.68	
4	*Lannea coromandelica*	60	60	9.24	53.72	
5	*Callicarpa arborea*	30	40	13.27	40.15	
6	*Garuga pinnata*	10	10	1.81	9.26	
7	*Lagerstroemia hirsuta*	10	10	9.50	18.12	
8	*Mallotus philippinensis*	10	10	1.52	8.93	
9	*Ficus semicordata*	40	60	15.84	53.63	
10	*Albizia chinensis*	10	10	6.08	14.18	
11	*Bombax ceiba*	10	10	0.80	8.11	
12	*Macaranga denticulata*	10	10	0.91	8.22	
13	*Shorea robusta*	10	10	1.96	9.44	
	Total	**260**	**300**	**86.84**		**2.30**
Saplings						
1	*Tectona grandis*	10	100	6.15	53.69	
2	*Mallotus philippinensis*	10	200	7.26	72.05	
3	*Ficus auriculata*	20	200	2.08	69.57	
4	*Oroxylum indicum*	10	100	4.52	47.66	
5	*Bridelia retusa*	10	100	7.07	57.05	
	Total	**60**	**700**	**27.07**		**1.55**
Shrubs						
1	*Chromolaena odoratum*	80	10200	88.28	164.51	
2	*Woodfordia fruticosa*	10	200	12.31	14.51	
3	*Clerodendrum japonicum*	30	1400	12.82	33.58	
4	*Cassia mimosoides*	30	400	15.20	28.70	
5	*Lantana camara*	20	500	5.65	17.82	
6	*Bambusa tulda*	10	3000	25.96	40.87	
	Total	**180**	**15700**	**160.22**		**1.07**
V14	**Downstream of Jorethang Loop Powerhouse site (left bank of Rangit) 227m**					
Trees						
1	*Ficus semicordata*	20	20	4.66	13.21	
2	*Lannea cormandelica*	30	40	15.61	26.81	
3	*Callicarpa arborea*	20	20	6.63	14.35	
4	*Glochidion hirsutum*	20	30	3.40	14.53	
5	*Boehmeria rugulosa*	10	10	1.52	6.14	
6	*Wrightea arborea*	20	40	3.47	16.61	
7	*Shorea robusta*	30	40	10.93	24.13	
8	*Garuga pinnata*	40	80	80.47	75.50	
9	*Mallotus philippinensis*	40	120	29.33	54.26	

	Species	Frequency (F%)	Density (ha^{-1})	TBC(m^2ha^{-1})	IVI	H
10	*Endospermum chinense*	30	30	5.43	18.92	
11	*Samanea saman*	10	10	5.02	8.16	
12	*Terminalia bellerica*	10	10	0.80	5.73	
13	*Dysoxylum binectariferum*	20	20	1.46	11.37	
14	*Boswelia serrata*	10	20	5.19	10.29	
	Total	**310**	**490**	**173.93**		**2.36**
Saplings						
1	*Lannea coromandelica*	20	200	9.04	39.39	
2	*Oroxylum indicum*	10	200	7.06	28.50	
3	*Neonauclea griffithii*	10	100	3.80	18.77	
4	*Ficus semicordata*	10	100	4.52	19.69	
5	*Mallotus philippinensis*	20	400	7.45	48.45	
6	*Garuga pinnata*	20	500	30.77	83.95	
7	*Endospermum chinense*	10	100	7.07	22.96	
8	*Wrightea arborea*	10	100	7.07	22.96	
9	*Alangium chinense*	10	100	1.13	15.34	
	Total	**120**	**1800**	**77.90**		**1.98**
Shrubs						
1	*Woodfordia fruticosa*	20	300	9.90	49.95	
2	*Chromolaena odoratum*	30	1900	16.44	126.78	
3	*Cassia mimosoides*	20	200	6.92	40.08	
4	*Antidesma acidum*	10	100	1.54	15.81	
5	*Boehmeria platyphylla*	20	400	3.59	39.42	
6	*Phoenix sylvestris*	10	100	7.07	27.97	
	Total	**110**	**3000**	**45.46**		**1.20**
V15 3 miles (Catchment area, on way to Kalimpong) 700m						
Trees						
1	*Terminlia myriocarpa*	20	20	35.33	27.12	
2	*Gynocardia odorata*	30	30	13.96	27.69	
3	*Flacourtia jangomas*	10	20	3.18	12.07	
4	*Lannea coromandelica*	10	10	8.01	10.35	
5	*Aphanamixis polystachya*	20	30	28.76	28.27	
6	*Firmania colorata*	10	50	4.54	22.52	
7	*Canarium strictum*	20	30	47.49	34.50	
8	*Tectona grandis*	30	30	91.02	53.34	
9	*Walsura tubulata*	10	10	20.10	14.37	
10	*Mallotus philippinensis*	20	20	1.46	15.85	
11	*Mangifera sylvatica*	20	20	19.17	21.74	
12	*Sterculia kingii*	10	10	15.39	12.80	
13	*Shorea robusta*	10	10	0.78	7.94	
14	*Neonauclea griffithii*	10	10	11.30	11.44	
	Total	**230**	**300**	**300.47**		**2.51**
Saplings						
1	*Alangium chinense*	10	100	1.65	13.23	
2	*Pentapanax parasiticus*	10	100	4.15	16.30	
3	*Gynocardia odorata*	10	100	1.13	12.60	
4	*Photinia griffithii*	10	100	6.15	18.75	
5	*Wrightea arborea*	20	200	7.60	31.73	
6	*Mallotus philippinensis*	40	500	23.56	78.25	

	Species	Frequency (F%)	Density (ha^{-1})	TBC(m^2ha^{-1})	IVI	H
7	*Albizia chinensis*	10	100	4.91	17.22	
8	*Careya arborea*	10	200	14.13	33.06	
9	*Brassiopsis glomerulata*	10	600	6.78	42.25	
10	*Dysoxylum binectariferum*	10	100	4.52	16.75	
11	*Schima wallichii*	10	100	7.07	19.86	
	Total	**150**	**2200**	**81.65**		**2.11**
Shrubs						
1	*Rhamnus nepalensis*	10	100	1.13	10.55	
2	*Rubus paniculatus*	10	100	3.14	14.82	
3	*Boehmeria macrophylla*	10	100	1.13	10.55	
4	*Clerodendrum japonicum*	20	300	3.62	26.27	
5	*Chromolaena odoratum*	20	1400	12.12	69.29	
6	*Colebrookia oppositifolia*	20	200	3.08	22.84	
7	*Cassia mimosoides*	10	100	2.01	12.42	
8	*Solanum surattense*	10	100	1.13	10.55	
9	*Bambusa tulda*	10	800	6.92	38.75	
10	*Bytneria aspera*	10	100	1.04	10.36	
11	*Leea asiatica*	20	200	3.63	24.01	
12	*Derris scandens*	10	100	1.13	10.55	
13	*Strobilanthes auriculata*	10	800	7.06	39.04	
	Total	**170**	**4400**	**47.13**		**2.05**
V16 Lapchu (Catchment area, on way to Darjeeling) 1350m						
Trees						
1	*Alnus nepalensis*	40	60	45.93	55.47	
2	*Litsea panamanja*	10	10	1.26	6.39	
3	*Macranga denticulata*	10	10	2.12	6.92	
4	*Persea robusta*	30	30	17.42	27.63	
5	*Castanopsis indica*	60	110	35.37	66.95	
6	*Schima wallichii*	50	70	16.97	43.11	
7	*Albizia procera*	10	10	1.96	6.82	
8	*Ostodes paniculata*	10	10	2.29	7.03	
9	*Prunus cerasoides*	10	10	1.38	6.47	
10	*Engelhardtia spicata*	20	20	4.25	13.85	
11	*Albizia chinensis*	10	20	12.16	15.42	
12	*Michelia glabra*	10	20	11.34	14.92	
13	*Cupressus corneyana*	20	50	7.43	22.64	
14	*Lepisanthes senegalensis*	10	10	1.26	6.39	
	Total	**300**	**440**	**161.14**		**2.28**
Saplings						
1	*Alangium chinense*	10	100	1.65	18.90	
2	*Ostodes paniculata*	20	200	3.53	38.58	
3	*Schima wallichii*	40	600	12.82	106.60	
4	*Cinnamomum glaucescens*	10	100	0.88	16.31	
5	*Castanopsis indica*	20	700	7.27	76.18	
6	*Michelia glabra*	10	200	2.26	25.96	
7	*Mallotus philippinensis*	10	100	1.23	17.47	
	Total	**120**	**2000**	**29.64**		**1.64**
Shrubs						
1	*Dichroa fabrifuga*	40	1000	12.27	42.38	
2	*Boehmeria macrophylla*	40	1100	10.07	41.18	

	Species	Frequency (F%)	Density (ha^{-1})	TBC(m^2ha^{-1})	IVI	H
3	*Rubus niveus*	10	400	3.59	13.27	
4	*R. paniculatus*	30	600	5.29	25.15	
5	*R. ellipticus*	20	500	12.72	28.92	
6	*Datura stramonium*	20	200	2.57	12.90	
7	*Camelia serrata*	10	100	1.13	6.27	
8	*Cudrania javanensis*	10	400	5.14	15.09	
9	*Rhamnus nepalensis*	40	400	4.67	25.25	
10	*Oxyspora paniculata*	20	500	6.53	21.66	
11	*Clerodendrum bracteatum*	10	800	7.60	23.45	
12	*Colebrookia oppositifolia*	10	100	0.93	6.04	
13	*Eranthemum griffithii*	10	200	1.73	8.34	
14	*Randia dumetorum*	10	1000	10.93	30.10	
	Total	**280**	**7300**	**85.19**		**2.44**
V17	**6th Mile (Catchment area, Lamta Phatak on way to Darjeeling) 2000m**					
Trees						
1	*Ilex dipyrena*	20	30	16.42	26.44	
2	*Michelia cathcartii*	50	50	17.62	43.80	
3	*Castanopsis hystrix*	70	90	69.83	96.00	
4	*Litsea monopetala*	10	10	1.52	7.48	
5	*Lyonia ovalifolia*	20	20	2.90	14.88	
6	*Acer cappadocicum*	10	10	2.83	8.31	
7	*Erythrina arborescens*	40	50	4.74	32.01	
8	*Cupressus corneyana*	10	10	9.50	12.57	
9	*Alnus nepalensis*	20	40	22.69	33.38	
10	*Quercus serrata*	20	20	5.94	16.81	
11	*Cryptomeria japonica*	10	10	2.83	8.31	
	Total	**280**	**340**	**156.81**		**2.13**
Saplings						
1	*Ilex dipyrena*	20	300	11.40	31.36	
2	*Eurya cerasifolia*	40	1100	18.16	72.88	
3	*Michelia cathcartii*	40	800	19.23	64.94	
4	*Castanopsis hystrix*	30	400	15.90	44.23	
5	*Cinnamomum bejolghota*	10	100	0.92	9.02	
6	*Tetradium fraxinifolium*	20	200	8.45	25.16	
7	*Erythrina arborescens*	40	400	18.85	52.41	
	Total	**200**	**3300**	**92.90**		**1.72**
Shrubs						
1	*Mahonia acanthifolia*	10	100	2.54	9.09	
2	*Dichroa fabrifuga*	70	1300	12.80	65.67	
3	*Rubus calycinoides*	10	200	1.83	9.60	
4	*R. ellipticus*	20	500	12.72	33.43	
5	*Melastoma malabathricum*	20	400	3.59	19.11	
6	*R. niveus*	70	3000	25.96	109.90	
7	*Macropanax dispermus*	10	200	2.26	10.20	
8	*Viburnum erubescens*	10	100	1.23	7.24	
9	*Boehmeria macrophylla*	10	500	4.58	18.00	
10	*Leucosceptrum canum*	10	100	1.54	7.67	
11	*Girardinia diversifolia*	10	200	2.19	10.10	
	Total	**250**	**6600**	**71.24**		**1.75**
V18	**Senchal (Catchment area, Wildlife Sanctuary) 2100m**					

	Species	Frequency (F%)	Density (ha^{-1})	TBC(m^2ha^{-1})	IVI	H
Trees						
1	*Elaeocarpus lanceifolius*	10	10	15.39	20.01	
2	*Quercus serrata*	40	40	10.17	34.61	
3	*Acer laevigatum*	20	20	3.32	15.75	
4	*Lindera assamica*	20	20	11.34	22.84	
5	*Litsea kingii*	10	20	2.90	11.68	
6	*Alangium chinense*	20	30	2.56	17.78	
7	*Litsea sericea*	10	20	1.87	10.76	
8	*Eurya cerasifolia*	60	100	9.89	57.99	
9	*Eurya japonica*	20	20	4.75	17.01	
10	*Dodecadenia grandiflora*	10	10	1.38	7.63	
11	*Castanopsis hystrix*	10	20	12.72	20.35	
12	*Cryptomeria japonica*	10	20	17.31	24.41	
13	*Cinnadenia paniculata*	10	10	2.37	8.51	
14	*Quercus thomsonii*	10	20	16.33	23.55	
15	*Persea fructifera*	10	10	0.80	7.12	
	Total	**270**	**370**	**113.12**		**2.45**
Saplings						
1	*Alangium chinense*	10	100	3.80	25.00	
2	*Litsea kingii*	10	100	7.07	33.18	
3	*Acer laevigatum*	10	100	4.52	26.81	
4	*Lindera assamica*	20	300	6.81	55.15	
5	*Eurya cerasifolia*	40	500	9.43	92.68	
6	*Daphne bholua*	10	100	2.01	20.51	
7	*Eurya japonica*	10	100	3.14	23.34	
8	*Ilex excelsa*	10	100	3.14	23.34	
	Total	**120**	**1400**	**39.91**		**1.83**
Shrubs						
1	*Hydrangea robusta*	70	1000	25.43	61.12	
2	*Rubus ellipticus*	10	200	6.28	11.99	
3	*R. niveus*	30	600	5.29	23.46	
4	*Mahonia acanthifolia*	40	1100	45.68	71.25	
5	*Macropanax undulatus*	10	200	2.26	8.28	
6	*Melastoma malabathricum*	20	400	4.52	16.56	
7	*Viburnum erubecesens*	50	700	11.55	37.34	
8	*Strobilanthes divaricata*	30	400	3.46	18.91	
9	*Astilebe rivularis*	10	100	0.87	5.56	
10	*Thamnocalamus aristatus*	30	2300	2.89	45.53	
	Total	**300**	**7000**	**108.24**		**1.97**
V19 Kitam Bird sanctuary (Catchment area, on way to Sombaria, right bank of Rangit) 700m						
Trees						
1	*Phoebe lanceolata*	10	10	2.83	7.15	
2	*Duabanga grandiflora*	10	10	28.34	15.72	
3	*Eucalyptus tereticornis*	40	90	44.65	52.31	
4	*Callicarpa arborea*	20	20	2.58	13.27	
5	*Lannea coromandelica*	20	30	3.40	16.05	
6	*Shorea robusta*	50	110	127.26	88.75	
7	*Garuga pinnata*	10	10	0.75	6.46	
8	*Alangium chinense*	10	10	0.91	6.51	
9	*Wrightia arborea*	10	10	7.54	8.73	

	Species	Frequency (F%)	Density (ha^{-1})	TBC(m^2ha^{-1})	IVI	H
10	*Sterculia kingie*	10	10	6.36	8.34	
11	*Tectona grandis*	10	20	26.53	17.61	
12	*Holarrhena pubescens*	10	10	6.94	8.53	
13	*Terminalia myriocarpa*	10	10	17.19	11.98	
14	*Bauhinia variegata*	10	10	6.08	8.24	
15	*Terminalia bellirica*	10	10	4.07	7.57	
16	*Endospermum chinense*	10	10	3.63	7.42	
17	*Pinus roxburghii*	10	10	7.54	8.73	
18	*Phyllanthus emblica*	10	10	1.26	6.63	
	Total	**270**	**400**	**297.85**		**2.38**
Saplings						
1	*Alangium chinense*	20	200	11.45	37.87	
2	*Gmelina arborea*	10	100	6.15	19.47	
3	*Lannea coromandelica*	10	100	7.07	20.61	
4	*Mallotus philippinensis*	40	500	26.53	85.84	
5	*Ficus racemosa*	20	200	4.54	29.26	
6	*Phoebe lanceolata*	10	100	1.23	13.33	
7	*Tectona grandis*	10	100	7.07	20.61	
8	*Altsonia scholaris*	10	100	4.52	17.44	
9	*Ficus auriculata*	10	100	1.54	13.72	
10	*Shorea robusta*	10	200	9.04	28.63	
11	*Mangifera indica*	10	100	1.13	13.21	
	Total	**160**	**1800**	**80.26**		**2.21**
Shrubs						
1	*Leea asiatica*	10	200	2.26	8.50	
2	*Chromolaena odoratum*	80	5000	43.27	126.28	
3	*Bauhinia vahlii*	30	800	12.31	32.66	
4	*Clerodendrum japonicum*	30	1300	11.90	37.44	
5	*Colebrookia oppositifolia*	20	600	15.26	28.97	
6	*Boehmeria platyphylla*	30	1400	13.30	39.75	
7	*Cassia mimosoides*	10	100	0.87	6.18	
8	*Woodfordia fruticosa*	10	200	2.08	8.33	
9	*Phoenix sylvestris*	10	100	7.07	11.90	
	Total	**230**	**9700**	**108.31**		**1.52**

6.5.2 Herbs

6.5.2.1 Pre-monsoon season

Among the herbaceous species, *Cyrtococcum accrescens* was the most dominant species having maximum density (32000 plants/ha) during pre-monsoon at the upstream of Teesta VI power house site. It was followed by *Oplismenus compositus* (24000 plant/ha), *Mikania macrantha* (24000 plant/ha) and *Saccharum narenga* (16000 plant/ha) (Refer Table 6.2). As per IVI values, *Saccharum narenga* was the most dominant species (85.50). It was followed by *Cyrtococcum accrescens* (31.99), *Mikania macrantha* (28.43) and *Oplismenus compositus* (24.34). The lowest IVI of 3.35 was recorded in *Achyranthes aspera* during pre-monsoon.

At near Teesta VI power house site, *Saccharum narenga* was found to be the most dominant species having maximum density (55000 plants/ha) during pre-monsoon. It was followed by *Oplismenus composites* and *Capillipedium assimile* in terms of density (Refer Table 6.2). Maximum value of IVI was observed in *Saccharum narenga* followed by *Oplismenus compositus* (56.96) and *Carex myosurus* (37.34). The minimum IVI of 3.98 was noted for *Lygodium japonicum* during pre-monsoon (Refer Table 6.2).

At near Teesta intermediate dam site, *Arundinella decempedalia* was the most dominant species having maximum density (90000 plants/ha) during pre-monsoon. It was followed by *Oplismenus compositus* and *Mikania macrantha* in terms of density. Maximum IVI was observed in *Arundinella decempedalia* (133.79) during pre-monsoon. The minimum IVI of 8.21 was recorded in *Ageratum conyzoides* during pre-monsoon.

At downstream of Teesta intermediate dam, *Imperata cylindrica* was the most dominant species having maximum density (24000 plants/ha) during pre-monsoon. It was followed by *Oplismenus composites* and *Mikania macrantha* in terms of density. Maximum IVI was observed in *Ageratum conyzoides* (40.90) followed by Imperata cylindrical (40.03) during pre-monsoon. The lowest IVI of 6.37 was recorded in *Adiantum lunulatum* during pre-monsoon.

At near TLD I & II dam site, *Oplismenus composites* was the most dominant species having maximum density (38000 plants/ha) during pre-monsoon. It was followedby *Cyrtococcum accrescens* and *Kyllinga brevifolia*. Maximum value of IVI was observed in *Amomum subulatum* (53.79) followed by *Urtica parviflora* (47.61). The minimum IVI of 3.58 was noted for *Gnaphalium affine*.

On downstream of TLD I & II dam, *Pogonatherum paniceum* was the dominant species having maximum density (48000 plants/ha) during pre-monsoon. It was followed by *Cymbopogon khasianus*, *Ageratum conyzoides* and *Saccharum spontaneum* in terms of density. Maximum value of IVI was observed in *Pogonatherum paniceum* (44.67) followed by *Saccharum spontaneum* (26.81) and *Cymbopogon khasianus* (25.33) during pre-monsoon. The lowest IVI of 5.85 was recorded in *Capillipedium assimile* during pre-monsoon.

At near Teesta Low Dam IIIrd site, *Thysanolaena latifolia* was the most dominant species having maximum density (38000 plants/ha) during pre-monsoon. It was followed by *Saccharum longisetosum* (34000 plants/ha). Maximum IVI was observed in *Saccharum narenga* (69.00) during pre-monsoon. It was followed by *Thysanolaena latifolia* (57.60) and *Saccharum longisetosum* (46.34). The minimum IVI of 5.14 was noted for *Cissampelos pariera* and *Lindernia viscosa*.

On downstream of Teesta Low Dam IIIrd, *Saccharum longisetosum* was the most dominant species having maximum density (33000 plants/ha) during pre-monsoon. It was followed by *Arundinella decempedalis* (30000 plants/ha) and Oplismenus composites (29000 plants/ha). Maximum IVI was observed in *Saccharum longisetosum* (62.37) followed by *Thysanolaena latifolia* (55.21) and *Saccharum narenga* (50.47). The lowest IVI of 5.38 was recorded in *Adiantum venustum*.

At near Teesta Low Dam IVth, *Oplismenus compositus* was the most dominant species having maximum density (47000 plants/ha) during pre-monsoon. It was followed by *Mikania macrantha* (27000 plants/ha) and *Achyranthes aspera* (21000 plants/ha). Maximum IVI was observed in *Oplismenus compositus* (48.35) followed by *Mikania macrantha* (45.65). The lowest IVI of 4.94 was recorded in *Commelina benghalensis*.

On downstream of Teesta Low Dam IVth, *Capillipedium assimile* and *Gompherina globosa* were the dominant species having maximum density (20000 plants/ha) during pre-monsoon. Maximum IVI was observed in *Persicaria chinensis* (42.68) followed by *Mikania macrantha* (40.33). The lowest IVI of 5.99 was recorded in *Conyza stricta*.

At near Teesta Low Dam Vth (left bank of Teesta), *Oplismenus compositus* was the most dominant species having maximum density (38000 plants/ha) during pre-monsoon. Maximum IVI was observed in *Oplismenus compositus* (73.17). It was followed by *Arisaema nepenthoides* (41.91), *Carex myosurus* (29.53) and *Passiflora geminiflora* (27.78). The lowest IVI of 5.20 was recorded in *Commelina bengalensis*.

On downstream of Teesta Low Dam Vth (right bank of Teesta), *Saccharum narenga* was the most dominant species having maximum density (18000 plants/ha) during pre-monsoon. It was followed by *Ageratum conyzoides* (11000 plants/ha) and *Thysanolaena latifolia* (10000 plants/ha). Maximum IVI was observed in *Saccharum narenga* (87.42). It was followed by *Thysanolaena latifolia* (43.64) and *Ageratum conyzoides* (32.99). The lowest IVI of 7.45 was recorded in *Bidens bipinnata*.

At upstream of Jorethang Power house site, *Phragmtes australis* was the most dominant species having maximum density (52000 plants/ha) during pre-monsoon. It was followed by *Thysanolaena latifolia* (24000 plants/ha). Maximum IVI was observed in *Phragmites australis* (117.23). It was followed by *Thysanolaena latifolia* (31.94). The lowest IVI of 5.57 was recorded in *Justicia gendarussa*.

On downstream of Jorethang power house site, *Saccharum spontaneum* was the most dominant species having maximum density (38000 plants/ha) during pre-monsoon. It was followed by *Pogonatherum paniceum* (28000 plants/ha). Maximum IVI was observed in *Saccharum spontaneum* (76.23) followed by *Thysanolaena latifolia* (55.01) and *Pogonatherum paniceum* (34.67). The lowest IVI of 13.43 was recorded in *Cyanotis vaga*.

At 3rd Mile (Catchment area, on way to Kalimpong), *Cyrtococcum accrescens* was the most dominant species having maximum density (40000 plants/ha) during pre-monsoon. It was followed by *Barlaria cristata* and *Cyperus rotundus* in terms of density. Maximum IVI was observed in *Cyrtococcum accrescens* (64.26). It was followed by *Barlaria cristata* (47.18). The lowest IVI of 7.45 was recorded in *Youngia japonica* (Refer Table 6.2).

At Lapchu (Catchment area, on way to Darjeeling), *Oplismenus composites* was the most dominant species having maximum density (62000 plants/ha) during pre-monsoon. It was followed by Maximum IVI was observed in *Hedychium spicatum*. It was followed by *Oplismenus composites* (54.00), *Persicaria chinensis* (28.30) and *Athyrium attenuatum* (25.78). The lowest IVI of 3.89 was recorded in *Asplenium unilaterale* (Refer Table 6.2).

On 6th Mile (Catchment area, on way to Darjeeling) *Isodon lophanthoides* was the most dominant species having maximum density (54000 plants/ha). It was followed by *Isachne himalaica, Persicaria brbata,* and *ramosissimum* in terms of density. Maximum IVI was recorded in *Isodon lophanthoides* (47.81) followed by *Isachne himalaica* (36.67), *Molineria capitulata* (31.25) and *Persicaria barbata* (24.54). The lowest IVI of 3.09 was recorded in *Viola betonicifolia*.

At Senchal Wild life Sanctuary (Catchment area), *Pilea umbrosa* was found to be the most dominant species having maximum density (49000 plants/ha). It was followed by *Isachne albens, Ophiopogon intermedius* and *Plectranthus barbatus* in terms of density. Maximum IVI was recorded in *Pilea umbrosa* (53.59) followed by *Pteridium aquilinum* (34.00), *Plectranthus barbatus* (26.80) and *Pollia subumbellata* (23.33). The lowest IVI of 4.07 was noted for *Arisaema tortuosum*.

At Kitam Bird Sanctuary (Catchment area, on way to Sombaria), *Cyrtococcum accrescens* was found to be the most dominant species having maximum density (32000 plants/ha). It was followed by *Mikania macrantha* in terms of density. Maximum IVI was recorded in *Mikania macrantha* (71.57) followed by *Saccharum longisetosum* (51.50), *Cyrtococum accrescens* (44.90) and *Thysanolaena latifolia* (43.03). The lowest IVI of 8.21 was noted for *Pogonatherum paniceum*.

Table-6.2 Vegetational attributes of herbaceous vegetation in Teesta Basin

	Species	Frequency (F%)	Density (ha-1)	TBC(m2ha-1)	IVI	H
V1	**U/s of Teesta VI Power house site (left bank of Teesta) 281m**					
1	*Arundinella decempedalia*	30	13000	0.26	19.97	
2	*Strobilanthes himalayana*	10	2000	0.04	4.19	
3	*Chorcorus aestuans*	30	6000	0.04	11.00	
4	*Digitaria adscendens*	30	11000	0.05	14.04	
5	*Mikania macrantha*	70	17000	0.15	28.43	
6	*Dioscorea bulbifera*	20	3000	0.05	7.20	
7	*Amaranthus viridis*	10	2000	0.04	4.27	
8	*Carex myosurus*	10	2000	0.02	3.79	

	Species	Frequency (F%)	Density (ha-1)	TBC(m2ha-1)	IVI	H
9	*Cyrtococcum accresens*	40	32000	0.23	31.99	
10	*Urena lobata*	10	3000	0.03	4.70	
11	*Oplismenus compositus*	40	24000	0.09	24.34	
12	*Kyllinga brevicaulis*	20	6000	0.02	8.21	
13	*Oxalis corniculata*	10	2000	0.01	3.48	
14	*Chrysopogon aciculatus*	10	5000	0.03	5.62	
15	*Justicea simplex*	20	11000	0.08	12.39	
16	*Adiantum capillaris-veneris*	10	5000	0.02	5.36	
17	*Saccharum narenga*	40	16000	2.83	85.50	
18	*Commelina bengalensis*	10	8000	0.06	8.00	
19	*Euphorbia hirta*	10	2000	0.01	3.51	
20	*Bidens bipinnata*	10	10000	0.13	10.76	
21	*Achyranthes aspera*	10	1000	0.02	3.25	
	Total	**450**	**181000**	**4.17**		**2.68**
V2	**Near Teesta VI Powerhouse site (left bank of Teesta) 245m**					
1	*Mikania macarantha*	20	10000	0.13	17.60	
2	*Carex myosurus*	40	19000	0.30	37.34	
3	*Bidens bipinnata*	10	4000	0.05	7.67	
4	*Cyanotis vaga*	30	20000	0.12	25.48	
5	*Saccharum narenga*	40	55000	0.87	84.40	
6	*Urena lobata*	20	6000	0.06	12.15	
7	*Oplismenus compositus*	70	54000	0.17	56.96	
8	*Adiantum venustum*	10	4000	0.01	5.72	
9	*Capillipedium assimie*	10	22000	0.08	18.17	
10	*Dioscorea bulbifera*	30	5000	0.06	15.05	
11	*Lygodium japonicum*	10	1000	0.01	3.98	
12	*Achyranthes aspera*	30	5000	0.08	15.73	
	Total	**320**	**205000**	**1.94**		**2.00**
V3	**Near Teesta intermediate dam site (above BhapKhola, left bank of Teesta) 223m**					
1	*Mikania macrantha*	40	22000	0.19	37.79	
2	*Oplismenus compositus*	40	24000	0.08	33.61	
3	*Achyranthes aspera*	30	9000	0.11	22.83	
4	*Ageratum conyzoides*	10	4000	0.04	8.21	
5	*Urena lobata*	30	8000	0.13	22.94	
6	*Cyrtococcum accrescens*	10	10000	0.04	11.54	
7	*Arundinella decempedalia*	60	90000	1.25	133.79	
8	*Adiantum venustum*	10	8000	0.03	9.82	
9	*Arundo donax*	10	4000	0.28	19.71	
	Total	**240**	**179000**	**2.13**		**1.63**
V4	**Downstream of Teesta intermediate site (opp. Rangpo Wine Fac., left bank of Teesta) 219m**					
1	*Cyrtococcum accrescens*	30	9000	0.03	23.66	
2	*Ageratum conyzoides*	30	11000	0.15	40.90	
3	*Stephania glandulifera*	10	1000	0.02	7.28	
4	*Imperata cylindica*	20	24000	0.09	40.03	
5	*Bidens bipinnata*	20	6000	0.12	28.27	
6	*Dioscorea bullifera*	10	2000	0.06	12.98	
7	*Adiantum lunulatum*	10	2000	0.01	6.37	
8	*Oplismenus compositus*	30	18000	0.06	34.99	
9	*Gnaphalium affine*	10	4000	0.02	9.24	

	Species	Frequency (F%)	Density (ha-1)	TBC(m2ha-1)	IVI	H
10	*Oxalis corniculata*	10	4000	0.01	8.89	
11	*Cynodon dactylon*	20	12000	0.04	22.82	
12	*Commelina bengalensis*	20	6000	0.04	18.35	
13	*Euphorbia hirta*	10	5000	0.02	10.15	
14	*Mikania macrantha*	30	14000	0.10	36.42	
	Total	**260**	**118000**	**0.76**		**2.36**
V5	**Near TLD I & II dam site (right bank of Rangit river) 220m**					
1	*Strobilanthes anisophylla*	10	1000	0.02	3.72	
2	*Oplismenus compositus*	50	38000	0.14	35.70	
3	*Hedychium spicatum*	10	1000	0.08	4.53	
4	*Oxalis corniculata*	20	11000	0.03	11.85	
5	*Gnaphalium affine*	10	1000	0.01	3.58	
6	*Mikania macrantha*	20	14000	0.10	14.28	
7	*Amomum subulatum*	20	8000	3.04	53.79	
8	*Colocasia esculenta*	10	2000	0.14	5.98	
9	*Pteris dctylina*	10	8000	0.06	7.74	
10	*Persicaria nepalensis*	10	8000	0.03	7.32	
11	*Urtica parviflora*	20	10000	2.54	47.61	
12	*Cyrtococcum accrescens*	30	32000	0.10	26.20	
13	*Carex cruciata*	20	6000	0.04	9.48	
14	*Athyrium attenuatum*	10	5000	0.14	7.47	
15	*Urena lobata*	10	1000	0.07	4.44	
16	*Achyranthes aspera*	10	4000	0.05	5.66	
17	*Cyanotis vaga*	30	10000	0.07	14.82	
18	*Ageratum conyzoides*	20	12000	0.15	14.03	
19	*Scutellaria scandens*	10	1000	0.02	3.72	
20	*Kyllinga brevifolia*	10	28000	0.09	18.14	
	Total	**340**	**201000**	**6.92**		**2.53**
V6	**Downstream of TLD I & II Dam (d/s of Rangit & Teesta Confluence) 209m**					
1	*Boehravia diffusa*	30	9000	0.06	23.15	
2	*Cyperus rotundus*	30	12000	0.04	22.04	
3	*Ageratum conyzoides*	10	20000	0.06	19.34	
4	*Bidens bipinnata*	10	4000	0.04	9.81	
5	*Sida acuta*	10	2000	0.03	8.28	
6	*Mikania macrantha*	20	5000	0.04	14.31	
7	*Achyranthes aspera*	10	1000	0.02	6.67	
8	*Capillepedium assimile*	10	2000	0.01	5.85	
9	*Digitaria adscendens*	10	18000	0.06	17.84	
10	*Setaria palmifolia*	10	10000	0.11	19.65	
11	*Pogonatherum paniceum*	20	48000	0.15	44.67	
12	*Imperata cylindrica*	10	10000	0.04	12.47	
13	*Saccharum spontaneum*	10	20000	0.14	26.81	
14	*Nephrolepis auriculata*	10	8000	0.03	10.85	
15	*Adiantum venusutum*	10	10000	0.03	11.84	
11	*Cymbopogon khasianus*	10	28000	0.09	25.33	
12	*Arundinella nepalensis*	10	15000	0.11	21.20	
	Total	**230**	**222000**	**1.05**		**2.51**
V7	**Near Teesta Low Dam III site (right bank of Teesta) 220m**					
1	*Saccharum longisetosum*	20	34000	2.16	46.34	
2	*Mikania macrantha*	20	6000	0.04	12.80	

	Species	Frequency (F%)	Density (ha-1)	TBC(m2ha-1)	IVI	H
3	*Echinochloa colona*	10	4000	0.01	6.89	
4	*Arundinella nepalensis*	30	26000	0.10	29.00	
5	*Adiantum venustum*	10	10000	0.03	10.40	
6	*Oplismenus compositus*	10	5000	0.02	7.48	
7	*Thysanolaena latifolia*	30	38000	2.69	57.60	
8	*Cissampelos pareira*	10	1000	0.00	5.14	
9	*Saccharum narenga*	30	27000	4.77	69.00	
10	*Arundo donax*	10	10000	1.77	25.05	
11	*Saccharum spontaneum*	10	10000	0.20	11.79	
12	*Euphorbia hirta*	10	2000	0.01	5.72	
13	*Lindernia viscose*	10	1000	0.00	5.14	
14	*Carex cruciata*	10	5000	0.04	7.64	
	Total	**220**	**179000**	**11.84**		**2.20**
V8	**Downstream of TLD III Dam (right bank of Teesta) 188m**					
1	*Arundinella decempedalis*	20	30000	0.34	29.93	
2	*Mikania macrantha*	60	25000	0.18	41.54	
3	*Adiantum venustum*	10	2000	0.01	5.38	
4	*Saccharum narenga*	30	18000	2.03	50.47	
5	*Thysanolaena latifolia*	30	29000	1.93	55.21	
6	*Pteris vittata*	20	5000	0.10	12.50	
7	*Oplismenus compositus*	30	29000	0.09	30.13	
8	*Saccharum longisetosum*	20	33000	2.59	62.37	
9	*Ageratum conyzoides*	10	4000	0.05	7.11	
10	*Digitaria adscendens*	10	2000	0.01	5.40	
	Total	**240**	**177000**	**7.32**		**2.00**
V9	**Near Teesta Low Dam IV (right bank of Teesta) 158m**					
1	*Achyranthes aspera*	30	21000	0.20	28.22	
2	*Mikania macrantha*	70	27000	0.22	45.65	
3	*Bidens bipinnata*	10	4000	0.06	7.46	
4	*Piper attenuatum*	10	2000	0.04	5.59	
5	*Athyrium attenuatum*	30	11000	0.15	20.76	
6	*Oplismenus compositus*	40	47000	0.23	48.35	
7	*Aconogonum molle*	10	3000	0.12	8.19	
8	*Costus speciosa*	10	3000	0.46	17.21	
9	*Lecanthus peduncularis*	20	13000	0.09	17.08	
10	*Commelina bengalensis*	10	2000	0.01	4.94	
11	*Ageratum conyzoides*	10	4000	0.03	6.54	
12	*Thysanolaena latifolia*	10	8000	0.51	21.52	
13	*Carex cruciata*	10	4000	0.03	6.54	
14	*Colocasia esculenta*	10	5000	0.36	15.84	
15	*Urtitca dioica*	10	5000	0.57	21.14	
16	*Hedychium spicatum*	10	3000	0.76	25.06	
	Total	**300**	**162000**	**3.84**		**2.28**
V10	**Downstream of Teesta Low Dam IV (right bank of Teesta) 150m**					
1	*Arundinella nepalensis*	10	10000	0.03	12.97	
2	*Cyperus cyperoides*	10	5000	0.06	10.88	
3	*Equisetumr ramosissimum*	10	8000	0.06	13.10	
4	*Capillipedium assimle*	10	20000	0.06	21.60	
5	*Mikania macrantha*	50	17000	0.14	40.33	
6	*Conyza stricta*	10	1000	0.02	5.99	

	Species	Frequency (F%)	Density (ha-1)	TBC(m2ha-1)	IVI	H
7	*Colocasia esculenta*	10	3000	0.23	17.38	
8	*Pogonatherum paniceum*	10	12000	0.04	14.70	
9	*Athyrium attenuatum*	10	8000	0.35	26.72	
10	*Saccharum longisetosum*	10	12000	0.57	39.95	
11	*Aconogonum chinense*	40	10000	0.38	42.68	
12	*Commelina bengalensis*	40	14000	0.10	32.06	
13	*Gompherina globosa*	10	20000	0.06	21.60	
	Total	**230**	**140000**	**2.12**		**2.40**
V11	**Near Teesta Low dam V site (left bank of Teesta) 134m**					
1	*Cyperus cyperoides*	10	5000	0.06	15.18	
2	*Mikania macrantha*	10	3000	0.02	8.69	
3	*Passiflora geminiflora*	40	8000	0.06	27.78	
4	*Digitaria adscendens*	10	3000	0.01	7.41	
5	*Barlaria cristata*	10	4000	0.02	9.02	
6	*Oplismenus compositus*	50	38000	0.17	73.17	
7	*Athyrium attenuatum*	20	8000	0.09	24.60	
8	*Carex baccans*	10	2000	0.01	6.75	
9	*Elephantopus sp.*	10	2000	0.02	7.50	
10	*Carex myosurus*	40	9000	0.06	29.53	
11	*Saccharum narenga*	10	2000	0.03	8.14	
12	*Capillipedium assimile*	10	4000	0.01	8.74	
13	*Hedychium spicatum*	10	1000	0.08	12.62	
14	*Arisaema nepenthoides*	30	4000	0.25	41.91	
15	*Adiantum venustum*	10	8000	0.03	14.02	
16	*Commelina bengalensis*	10	1000	0.01	5.20	
	Total	**290**	**102000**	**0.92**		**2.24**
V12	**Downstream of Teesta Low dam site V (right bank of Teesta) 144m**					
1	*Carex baccans*	10	8000	0.03	15.02	
2	*Adiantum venustum*	10	4000	0.01	9.90	
3	*Oplismenus compositus*	30	9000	0.04	26.41	
4	*Arundinella nepalensis*	10	6000	0.04	13.37	
5	*Arisaema tortuosum*	10	2000	0.04	8.75	
6	*Piper attenuatum*	10	3000	0.05	10.34	
7	*Molineria capitulate*	10	1000	0.07	9.18	
8	*Saccharum narenga*	10	18000	1.14	74.54	
9	*Ageratum conyzoides*	30	11000	0.14	32.99	
10	*Gompherina globosa*	10	4000	0.01	9.90	
11	*Cyperus cyperoides*	20	5000	0.05	17.42	
12	*Nephrolepis auriculata*	20	9000	0.03	21.28	
13	*Bidens bipinnata*	10	2000	0.01	7.45	
14	*Thysanolaena latifolia*	10	10000	0.64	43.64	
	Total	**200**	**92000**	**2.29**		**2.42**
V13	**U/s of Jorethang Powerhouse site (left bank of rangit) 270m**					
1	*Cynoglosum glochidiatum*	10	2000	0.31	8.19	
2	*Pogonatherum paniceum*	10	18000	0.06	13.74	
3	*Adiantum venusutum*	10	14000	0.04	11.65	
4	*Mimosa pudica*	20	12000	0.04	14.96	
5	*Mikania macrantha*	10	8000	0.06	8.81	
6	*Adiantum capillaris-veneris*	10	4000	0.01	6.43	
7	*Saccharum spontaneum*	10	10000	0.13	10.44	

	Species	Frequency (F%)	Density (ha-1)	TBC(m2ha-1)	IVI	H
8	*Justicia gendarussa*	10	2000	0.03	5.57	
9	*Phragmites australis*	40	52000	8.00	117.23	
0	*Digitaria adscendes*	10	18000	0.06	13.74	
10	*Urena lobata*	30	5000	0.08	16.24	
11	*Bidens bipinnata*	10	4000	0.03	6.58	
12	*Cyrtococcum accrescens*	10	4000	0.01	6.43	
13	*Thysanolaena latifolia*	10	24000	1.70	31.94	
14	*Arundinella nepalensis*	10	10000	0.07	9.93	
15	*Athyrium attenuatum*	10	8000	0.11	9.32	
16	*Capillipedium assimile*	10	8000	0.06	8.81	
	Total	**230**	**203000**	**10.78**		**2.48**
V14	**Downstream of Jorethang powerhouse site (left bank of Rangit) 227m**					
1	*Saccharum spontaneum*	20	38000	0.60	76.23	
2	*Arundinella decempedalis*	10	6000	0.17	21.01	
3	*Pogonatherum paniceum*	10	28000	0.09	34.67	
4	*Capillipedium assimile*	20	10000	0.07	26.98	
5	*Cyperus rotundus*	10	10000	0.04	17.66	
6	*Digitaria adscendens*	20	7000	0.05	23.50	
7	*Thysanolaena latifolia*	10	10000	0.79	55.01	
8	*Adiantum venusutum*	10	8000	0.03	15.40	
9	*Piper attenuatum*	10	3000	0.12	15.88	
10	*Cyanotis vaga*	10	4000	0.05	13.43	
	Total	**130**	**124000**	**2.00**		**1.99**
V15	**3 miles (Catchment area, on way to Kalimpong) 700m**					
1	*Cyrtococcum accrescens*	40	40000	0.15	64.26	
2	*Barlaria cristata*	30	22000	0.16	47.18	
3	*Mikania macrantha*	30	7000	0.06	25.11	
4	*Adiantum capillus-veneris*	10	4000	0.01	8.73	
5	*Hedyotis vestita*	10	5000	0.02	10.85	
6	*Kyllinga brevifolia*	10	4000	0.01	8.73	
7	*Athyrium drepanopterum*	10	4000	0.11	20.41	
8	*Capillipedium assimile*	10	10000	0.04	16.07	
9	*Blumea procera*	10	2000	0.03	8.73	
10	*Cyperus rotundus*	20	20000	0.06	30.60	
11	*Digitaria ciliaris*	20	6000	0.02	15.49	
12	*Cyperus cyperoides*	10	6000	0.12	22.42	
13	*Youngia japonica*	10	2000	0.01	7.45	
14	*Ageratum conyzoides*	10	5000	0.05	13.59	
	Total	**230**	**137000**	**0.86**		**2.23**
V16	**Lapchu (Catchment area, on way to Darjeeling) 1350m**					
1	*Elatostema platyphyllum*	20	6000	0.04	11.01	
2	*Persicaria chinensis*	30	19000	0.30	28.30	
3	*Athyrium attenuatum*	40	12000	0.24	25.78	
4	*Gnaphalium polycaulon*	10	2000	0.01	4.75	
5	*Artemisia nilagirica*	10	1000	0.08	5.76	
6	*Pilea glaberrima*	30	10000	0.20	20.41	
7	*Ageratina adenophora*	20	9000	0.45	22.96	
8	*Dichrocephala chrysanthemoides*	10	2000	0.08	6.31	

	Species	Frequency (F%)	Density (ha-1)	TBC(m2ha-1)	IVI	H
9	*Nephrolepis auriculata*	10	4000	0.01	5.88	
10	*Commelina benghalensis*	10	5000	0.06	7.71	
11	*Commelina paludosa*	10	2000	0.04	5.37	
12	*Asplenium unilaterale*	10	1000	0.00	3.89	
13	*Hedychium spicatum*	20	18000	2.03	67.59	
14	*Lepidagathis incurva*	10	2000	0.13	7.56	
15	*Oplismenus compositus*	40	62000	0.19	54.00	
16	*Setaria palmifolia*	20	8000	0.13	14.29	
17	*Selaginella indica*	10	8000	0.03	8.53	
	Total	**310**	**171000**	**4.02**		**2.22**
V17	**6th Mile (Catchment area (Lamta Phatak), on way to Darjeeling) 2000 m**					
1	*Equisetum ramosissimum*	20	25000	0.18	16.97	
2	*Isodon lophanthoides*	50	54000	0.86	47.81	
3	*Isachne himalaica*	50	51000	0.36	36.67	
4	*Rubia cordifolia*	60	13000	0.16	21.29	
5	*Selaginella indica*	20	9000	0.03	8.24	
6	*Pilea glaberrima*	20	6000	0.04	7.45	
7	*Hydrocotyle nepalensis*	10	8000	0.03	5.60	
8	*Viola betonicifolia*	10	2000	0.01	3.09	
9	*Aster molliusculus*	10	2000	0.01	3.09	
10	*Molineria capitulata*	20	4000	1.26	31.25	
11	*Ageratina adenophora*	10	4000	0.25	8.79	
12	*Achyranthes aspera*	20	10000	0.10	9.97	
13	*Carex filicina*	10	2000	0.03	3.45	
14	*Persicaria barbata*	30	28000	0.39	24.54	
15	*Pilea umbrosa*	20	14000	0.07	10.85	
16	*Rubus nepalensis*	20	14000	0.22	13.96	
17	*Anaphalis busua*	20	13000	0.15	12.08	
18	*Arisaema tortuosum*	10	2000	0.15	5.99	
19	*Ambrosia artemisiifolia*	10	4000	0.45	12.79	
20	*Commelina paludosa*	20	10000	0.07	9.46	
21	*Carex myosurus*	10	4000	0.15	6.76	
	Total	**450**	**279000**	**4.95**		**2.58**
V18	**Senchal (Catchment area, Wild Life Sanc.) 2100m**					
1	*Anaphalis margaritacea*	10	5000	0.08	9.55	
2	*Pteridium aquilinum*	30	13000	0.37	34.00	
3	*Isachne albens*	30	19000	0.06	21.96	
4	*Plectranthus barbatus*	30	12000	0.24	26.80	
5	*Ophiopogon intermedius*	30	19000	0.09	23.65	
6	*Persicaria chinensis*	30	10000	0.07	17.37	
7	*Aconogonum molle*	10	4000	0.09	9.76	
8	*Pilea umbrosa*	50	49000	0.24	53.59	
9	*Swerrtia ciliata*	10	1000	0.18	12.15	
10	*Polllia subumbellata*	20	9000	0.25	23.33	
11	*Carex filicina*	20	6000	0.04	10.96	
12	*Impatiens puberula*	30	7000	0.09	16.53	
13	*Selaginella indica*	10	3000	0.01	4.89	
14	*Arisaema tortuosum*	10	1000	0.02	4.07	
15	*Viola betonicifolia*	10	3000	0.02	5.63	
16	*Hydrocotyle himalaica*	10	4000	0.01	5.62	

	Species	Frequency (F%)	Density (ha-1)	TBC(m2ha-1)	IVI	H
17	*Isodon lophanthoides*	20	6000	0.11	14.29	
18	*Achyranthes aspera*	10	4000	0.02	5.97	
	Total	**370**	**175000**	**1.99**		**2.45**
V19	**Kitam Bird Sanc.(On way to Sombaria) 700m**					
1	*Cyrtococcum accrescens*	30	32000	0.14	44.90	
2	*Mikania macrantha*	70	30000	0.38	71.57	
3	*Agaeratum conyzoides*	10	5000	0.06	11.17	
4	*Oplismenus compositus*	30	17000	0.06	29.71	
5	*Paspalum scrobiculatum*	10	4000	0.03	8.89	
6	*Blumea procera*	10	4000	0.06	10.42	
7	*Oxalis corniculata*	10	8000	0.03	11.88	
8	*Carex cruciata*	10	2000	0.06	8.55	
9	*Saccharum longisetosum*	20	12000	0.76	51.50	
10	*Pogonatherum paniceum*	10	4000	0.01	8.21	
11	*Thysanolaena latifolia*	10	10000	0.71	43.03	
	Total	**220**	**128000**	**2.31**		**2.07**

Species Diversity

The diversity index value (H) in the tree layer ranged from 2.12 at upstream of Teesta VIth powerhouse site to 2.77 at TLD I & II dam site. The species diversity for sapling and shrub strata ranged from 1 .55 to 2.43 and 1.00 to 2.55, respectively (Table 6.1). The occurrence of shrubs in large numbers at Teesta Low Dam Vth (left bank of Teesta) site can be attributed to the anthropogenic disturbances. The value of species diversity (H) in the herbaceous layer ranged from 1.63 (near Teesta intermediate dam site) to 2.68 (u/s of Teesta VI power house site), respectively (Refer Table 6.2).

Plant Biodiversity

A total of 316 species of plants were recorded under the ecological investigation from different cascade projects as well as their catchment during pre-monsoon sampling. Out of which 127 were trees, 61 shrubs, 19 climbers and 109 herbs (i.e.79 herbs from different cascade projects & 30 herbs from catchment along the Lower Teesta Basin). The ground vegetation comprised of ephemeral, annual, and perennial species of grasses, sedges, legumes and non-legume forbs.

6.5.2.2 Monsoon Season

i) Density and Abundance

The herb species was poorly represented in all sites except upstream site of Teesta VI power house (left bank of Teesta) and TLD I & II dam site (right bank of Rangit river) during monsoon season (Refer Table 6.3).

On the upstream of Teesta VI power house site, *Eragrostis tenella* was the dominant species having maximum density (36000 plants/ha) during monsoon season. It was followed by *Mikania macrantha* (25000 plant/ha), *Kyllinga brevifolia and Arthraxon lancifolius*

(20000 plant/ha) (Refer Table 6.3). Maximum value of IVI was observed in *Prunella frutescens* (32.75) followed by *Mikania macrantha* (30.16), *Eragrostis tenella* (20.97) and *Saccharum narenga* (20.55). The lowest IVI of 3.67 was recorded for *Euphorbia hirta*.

At near Teesta VI power house site, *Oplismenus compositus* was found to be the most dominant species having maximum density (70000 plants/ha) during monsoon season. It was followed by *Sida acuta* and *Capillipedium assimile* (22000 plants/ha) in terms of density (Refer Table 6.3). As per IVI values, *Sida acuta* was the most dominant species (90.16). It was followed by *Oplismenus compositus* (62.72) and *Mikania macrantha* (28.18). The minimum IVI of 4.70 was noted for *Lygodium japonicum* (Refer Table 6.3).

At near Teesta intermediate dam site, *Oplismenus composites* was the dominant species having maximum density (67000 plants/ha) followed by *Mikania macrantha* (40000 plants/ha) and *Cyrtococcum accrascens* (22000 plants/ha). Maximum value of IVI was observed in *Oplismenus compositus* (71.32) followed by *Mikania macrantha* (56.57) during monsoon season. The lowest IVI of 4.75 was recorded in *Oxalis corniculata*.

At downstream of Teesta intermediate dam, *Carex myosurus* was the dominant species having maximum density (24000 plants/ha) during monsoon. It was followed by *Oplismenus composites* (20000 plants/ha) in terms of density. Maximum value of IVI was observed in *Achyranthes aspera* (52.38) followed by *Oplismenus compositus* (35.32), *Carex myosurus* (31.89), *Mikania macrantha* (29.85) and *Ageratum conyzoides* (29.49) during monsoon. The lowest IVI of 5.99 was recorded in *Adiantum lunulatum*.

At near TLD I & II dam site, *Oplismenus compositus* was the dominant species having maximum density (51000 plants/ha) during monsoon. It was followed by *Isachne albens* (42000 plants/ha) and *Mikania macrantha* (31000 plants/ha). Maximum value of IVI was observed in *Oplismenus compositus* (35.19) followed by *Mikania macrantha* (33.20) and *Musa balbisiana* (32.36). The minimum IVI of 3.07 was noted for *Scutellaria scandens*.

At downstream of TLD I & II dam site, *Pogonatherum paniceum* was the dominant species having maximum density (38000 plants/ha) during monsoon season. It was followed by *Ageratum conyzoides* (28000 plants/ha), *Cymbopogon khasianus* (25000 plants/ha), *Kyllinga brevifolia* and *Saccharum spontaneum* (20000 plants/ha) in terms of density. Maximum value of IVI was observed in *Pogonatherum paniceum* (36.28) followed by Ageratum conyzoides (28.76), *Saccharum spontaneum* (26.44) and *Cymbopogon khasianus* (25.98) during monsoon season. The lowest IVI of 5.35 was recorded in *Capillipedium assimile*.

At near Teesta Low Dam IIIrd site, *Saccharum narenga* was the dominant species having maximum density (35000 plants/ha) during monsoon. It was followed by *Isachne albens* (24000 plants/ha), *Setaria palmifolia* and *Bothriochloa pertusa* (2000plants/ha). Maximum value of IVI was observed in *Saccharum narenga* (60.25) followed by *Isachne albens* (27.38) and *Setaria palmifolia* (25.40). The minimum IVI of 4.25 was noted for *Commelina bengalensis*.

On downstream of Teesta Low Dam IIIrd, *Saccharum longisetosum* was the dominant species having maximum density (100000 plants/ha) during monsoon. It was followed by *Saccharum narenga* (50000 plants/ha), *Mikania macrantha* (34000 plants/ha) and *Thysanolaena latifolia* (25000 plants/ha). Maximum value of IVI was observed in *Saccharum longisetosum* (117.62) followed by *Saccharum narenga* (55.52), *Mikania macrantha* (37.78) and *Thysanolaena latifolia* (32.65). The lowest IVI of 4.36 was recorded in *Oplismenus compositus*.

At near Teesta Low Dam IVth, *Oplismenus compositus* was the dominant species having maximum density (69000 plants/ha) during monsoon. It was followed by *Cyrtococcum accrescens* (28000 plants/ha) and *Thysanolaena latifolia* (27000 plants/ha). Maximum value of IVI was observed in *Thysanolaena latifolia* (70.42) followed by *Oplismenus compositus* (64.81) and *Cyrtococcum accrescens* (25.60). The minimum IVI of 3.65 was not for *Stephania japonica*.

On downstream of Teesta Low Dam IVth, *Mikania macrantha* was the dominant species having maximum density (40000 plants/ha). It was followed by *Pogonatherum paniceum* (24000 plants/ha) during monsoon. Maximum value of IVI was observed in *Mikania macrantha* (61.52) followed by *Commelina bengalensis* (27.57) and *Pogonatherum paniceum* (21.26). The lowest IVI of 8.26 was recorded in *Cheilanthes tenuifolia*.

At near Teesta Low Dam Vth (left bank of Teesta), *Achyranthes aspera* was the dominant species having maximum density (30000 plants/ha). Maximum value of IVI was observed in *Achyranthes aspera* (65.01) followed by *Cassia tora* (29.08), *Thysanolaena latifolia* (28.81) and *Blepharis cristata* (28.17). The lowest IVI of 5.79 was recorded in *Thunbergia coccinea*.

On downstream of Teesta Low Dam Vth (right bank of Teesta), *Thysanolaena latifolia* was the dominant species having maximum density (26000 plants/ha) during monsoon. It was followed by *Saccharum narenga* (18000 plants/ha) and *Nephrolepis auriculata* (17000 plants/ha). Maximum value of IVI was observed in *Thysanolaena latifolia* (76.14) followed by *Saccharum narenga* (55.17), *Nephrolepis auriculata* (27.35) and *Ageratum conyzoides* (22.96). The lowest IVI of 6.50 was recorded in *Piper attenuatum*.

At upstream of Jorethang Power house site, *Saccharum narenga* was the dominant species having maximum density (78000 plants/ha) during monsoon. It was followed by *Arundinella decempedalia* (44000 plants/ha) and Mikania macrantha (32000 plants/ha). Maximum value of IVI was observed in *Saccharum narenga* (108.36) followed by

Arundinella decempedalia (43.26), *Mikania macrantha* (33.17). The lowest IVI of 4.50 was recorded in *Carex cruciata*.

On downstream of Jorethang power house site, *Pogonatherum paniceum* was the dominant species (46000 plants/ha). It was followed by *Thysanolaena latifolia* (35000 plants/ha) and *Equisetum ramosissimum* (33000 plants/ha). Maximum value of IVI was observed in *Thysanolaena latifolia* (80.18) followed by *Pogonatherum paniceum* (33.78), *Saccharum spontaneum* (33.46) and *Equisetum ramosissimum* (26.47). The lowest IVI of 4.16 was recorded in *Crepis japonica*.

Species Diversity

The value of species diversity (H) in the herbaceous layer ranged from 1.78 (Downstream of TLD III) to 2.91 (Upstream of Teesta VI power house), respectively (Refer Table 6.3).

Table-6.3 Vegetational attributes of herbaceous vegetation (Monsoon season) in Teesta Basin

	Species	Frequency (F%)	Density (ha-1)	TBC(m2ha-1)	IVI	H
V1	**U/s of Teesta VI (left bank of Teesta) 281m**					
1	*Prunella frutescens*	10	8000	0.63	32.75	
2	*Mikania macrantha*	50	25000	0.18	30.16	
3	*Oplismenus compositus*	20	13000	0.04	11.95	
4	*Sida acuta*	20	6000	0.12	12.54	
5	*Kyllinga brevifolia*	10	20000	0.06	13.05	
6	*Barlaria prionites*	10	3000	0.04	5.36	
7	*Cynodon arcuatus*	20	19000	0.07	15.36	
8	*Cleome viscosa*	10	2000	0.03	4.43	
9	*Eragrostis tenella*	10	36000	0.10	20.97	
10	*Conyza bonariensis*	10	8000	0.10	10.01	
11	*Arundinella decempedalia*	20	12000	0.06	12.34	
12	*Pogonatherum paniceum*	10	12000	0.04	8.86	
13	*Arthraxon lancifolius*	10	20000	0.06	13.05	
14	*Achyranthes aspera*	20	12000	0.15	16.29	
15	*Chloris dolistachya*	10	2000	0.04	5.03	
16	*Dioscorea bulbifera*	20	4000	0.05	8.85	
17	*Amaranthus viridis*	10	2000	0.03	4.71	
18	*Carex myosurus*	10	2000	0.02	4.17	
19	*Cyrtococcum accresens*	30	17000	0.05	16.61	
20	*Urena lobata*	10	3000	0.03	5.20	
21	*Saccharum narenga*	30	8000	0.23	20.55	
22	*Commelina bengalensis*	10	6000	0.04	6.73	
23	*Euphorbia hirta*	10	2000	0.01	3.67	
24	*Capillipedium assimile*	10	5000	0.02	5.57	
25	*Bidens bipinnata*	10	10000	0.13	11.87	
	Total	**390**	**257000**	**2.32**		**2.91**
V2	**Teesta VI Powerhouse (left bank of Teesta) 245m**					
1	*Oplismenus compositus*	40	70000	0.22	62.72	
2	*Mikania macrantha*	40	15000	0.11	28.18	
3	*Urena lobata*	10	1000	0.04	6.11	

	Species	Frequency (F%)	Density (ha-1)	TBC(m2ha-1)	IVI	H
4	*Cyperus cyperoides*	10	2000	0.03	6.05	
5	*Pogonatherum paniceum*	10	5000	0.02	7.23	
6	*Sida acuta*	40	22000	1.40	90.16	
7	*Digitaria ciliaris*	20	15000	0.06	18.28	
8	*Discorea glabra*	20	2000	0.01	9.10	
9	*Capillipedium assimile*	10	10000	0.07	12.38	
10	*Achyranthes aspera*	10	4000	0.05	8.25	
11	*Carex thomsonii*	10	4000	0.03	7.26	
12	*Arundinella nepalensis*	10	10000	0.10	13.53	
13	*Adiantum lunulatum*	10	4000	0.01	6.55	
14	*Capillipedium assimie*	10	22000	0.08	19.38	
15	*Lygodium japonicum*	10	1000	0.01	4.70	
	Total	**260**	**187000**	**2.22**		**2.09**
V3	**Teesta Intermediate (above BhapKhola, left bank of Teesta) 223m**					
1	*Mikania macrantha*	70	40000	0.30	56.57	
2	*Oplismenus compositus*	70	67000	0.33	71.32	
3	*Commelina bengalensis*	30	10000	0.08	18.18	
4	*Cyrtococcum accresens*	20	22000	0.07	20.51	
5	*Urena lobata*	10	2000	0.13	10.58	
6	*Persicaria chinensis*	20	9000	0.11	16.34	
7	*Oxalis corniculata*	10	2000	0.01	4.75	
8	*Ageratum conyzoides*	10	8000	0.06	9.90	
9	*Strobilanthes himalayana*	20	6000	0.43	30.94	
10	*Bidens bipinnata*	10	4000	0.05	7.60	
11	*Adiantum proliferum*	10	8000	0.03	8.42	
12	*Conyza bonariensis*	10	2000	0.13	10.58	
13	*Ischaemum indicum*	20	16000	0.13	20.61	
14	*Boerahvia diffusa*	10	2000	0.03	5.32	
15	*Setaria sphacelata*	10	4000	0.06	8.14	
	Total	**330**	**202000**	**1.94**		**2.11**
V4	**Teesta intermediate (opp. Rangpo Wine Fac., left bank of Teesta) 219m**					
1	*Achyranthes aspera*	30	12000	0.34	52.38	
2	*Mikania macrantha*	20	16000	0.11	29.85	
3	*Oplismenus compositus*	20	20000	0.14	35.32	
4	*Carex myosurus*	20	24000	0.08	31.89	
5	*Arundinella decempedalia*	20	8000	0.10	23.07	
6	*Adiantum lunulatum*	10	2000	0.01	5.99	
7	*Capillipedium assimile*	10	10000	0.05	15.62	
8	*Cyrtococcum accrescens*	30	10000	0.03	21.96	
9	*Ageratum conyzoides*	30	12000	0.10	29.49	
10	*Gnaphalium affine*	10	4000	0.02	8.23	
11	*Oxalis corniculata*	10	4000	0.01	7.98	
12	*Cynodon dactylon*	20	12000	0.04	19.95	
13	*Commelina bengalensis*	10	4000	0.03	9.46	
14	*Euphorbia hirta*	10	5000	0.02	8.98	
	Total	**250**	**143000**	**1.06**		**2.45**
V5	**TLD I & II(right bank of Rangit river) 220m**					

	Species	Frequency (F%)	Density (ha-1)	TBC(m2ha-1)	IVI	H
1	*Athyrium drepanopterum*	10	6000	0.23	8.63	
2	*Oplismenus compositus*	50	51000	0.36	35.19	
3	*Mikania macrantha*	80	31000	0.22	33.20	
4	*Pollia hasskarlii*	10	8000	0.40	12.48	
5	*Ageratum conyzoides*	20	20000	0.25	15.94	
6	*Achyranthes aspera*	10	4000	0.01	3.91	
7	*Digitaria ciliaris*	10	3000	0.02	3.70	
8	*Isachne albens*	40	42000	0.21	27.00	
9	*Saccharum narenga*	10	4000	0.20	7.43	
10	*Commelina bengalensis*	20	12000	0.12	10.81	
11	*Cyperus cyperoides*	10	5000	0.08	5.49	
12	*Thysanolaena latifolia*	10	16000	1.02	26.56	
13	*Setaria sphacelata*	10	20000	0.18	12.26	
14	*Strobilanthes himalayana*	10	4000	0.08	5.14	
15	*Paspalum scrobiculatum*	10	4000	0.03	4.21	
16	*Echinochloa colona*	10	8000	0.04	5.71	
17	*Musa balbisiana*	10	1000	1.59	32.36	
18	*Urena lobata*	10	1000	0.02	3.13	
19	*Cyanotis vaga*	10	8000	0.06	6.03	
20	*Cyrtococcum accrescens*	20	24000	0.08	13.96	
21	*Scutellaria scandens*	10	1000	0.02	3.07	
22	*Kyllinga brevifolia*	10	24000	0.08	11.58	
23	*Carex cruciata*	10	5000	0.04	4.66	
24	*Pteris dactylina*	10	4000	0.03	4.21	
25	*Gnaphalium affine*	10	2000	0.02	3.39	
	Total	**420**	**308000**	**5.36**		**2.74**
V6	**D/s of TLD Ist(d/s of Rangit & Teesta Confluence) 209m**					
1	*Cyperus rotundus*	20	8000	0.03	13.71	
2	*Ageratum conyzoides*	20	28000	0.09	28.76	
3	*Bidens bipinnata*	10	8000	0.06	12.88	
4	*Sida acuta*	20	4000	0.05	14.32	
5	*Boehravia diffusa*	20	5000	0.04	13.34	
6	*Mikania macrantha*	20	5000	0.04	13.34	
7	*Achyranthes aspera*	10	1000	0.02	6.18	
8	*Capillepedium assimile*	10	2000	0.01	5.35	
9	*Digitaria adscendens*	10	10000	0.03	11.37	
10	*Setaria palmifolia*	10	8000	0.06	12.88	
11	*Kyllinga brevifolia*	20	20000	0.06	22.74	
12	*Gnaphalium affine*	10	2000	0.01	6.11	
13	*Pogonatherum paniceum*	20	38000	0.12	36.28	
14	*Imperata cylindrica*	10	10000	0.04	12.00	
15	*Saccharum spontaneum*	10	20000	0.14	26.44	
16	*Nephrolepis auriculata*	10	8000	0.03	10.37	
17	*Adiantum lunulatum*	10	5000	0.02	7.61	
18	*Cymbopogon khasianus*	10	25000	0.11	25.98	
19	*Arundinella nepalensis*	10	15000	0.11	20.79	
	Total	**260**	**222000**	**1.04**		**2.62**

	Species	Frequency (F%)	Density (ha-1)	TBC(m2ha-1)	IVI	H
V7	**Teesta Low dam III (right bank of Teesta) 220m**					
1	*Saccharum narenga*	30	35000	0.63	60.25	
2	*Blepharis cristata*	10	4000	0.01	6.05	
3	*Setaria verticillata*	10	8000	0.06	10.42	
4	*Isachne albens*	30	24000	0.09	27.38	
5	*Neanotis hirsuta*	20	12000	0.05	15.51	
6	*Setaria palmifolia*	20	20000	0.16	25.40	
7	*Rungia pectinata*	10	2000	0.01	4.93	
8	*Paspalum scrobiculatum*	10	2000	0.02	5.17	
9	*Sida cordata*	10	4000	0.20	15.37	
10	*Oplismenus compositus*	30	10000	0.03	16.73	
11	*Bothriochloa pertusa*	10	20000	0.06	17.32	
12	*Mikania macrantha*	30	14000	0.10	22.27	
13	*Urena lobata*	20	2000	0.14	14.56	
14	*Strobilanthes himalayana*	10	4000	0.31	20.97	
15	*Adiantum lunulatum*	10	2000	0.01	4.64	
16	*Didymocarpus aurantiacus*	10	2000	0.03	5.57	
17	*Bidens bipinnata*	10	4000	0.05	7.91	
18	*Capillipedium assimile*	10	8000	0.03	8.99	
19	*Commelina bengalensis*	10	1000	0.01	4.25	
20	*Cyrtococcum accrescens*	10	4000	0.02	6.32	
	Total	**310**	**182000**	**2.02**		**2.58**
V8	**Downstream of TLD III (right bank of Teesta) 188m**					
1	*Saccharum narenga*	50	50000	1.41	55.52	
2	*Crepis japonica*	10	1000	0.01	3.95	
3	*Thysanolaena latifolia*	30	25000	0.96	32.65	
4	*Mikania macrantha*	60	34000	0.24	37.78	
5	*Capillipedium assimile*	10	5000	0.04	5.96	
6	*Saccharum longisetosum*	40	100000	5.02	####	
7	*Athyrium drepanopterum*	10	2000	0.04	4.77	
8	*Inula cappa*	10	2000	0.04	4.77	
9	*Pteris vittata*	10	3000	0.08	5.74	
10	*Ageratum conyzoides*	10	4000	0.01	5.26	
11	*Paspalum commersonii*	10	5000	0.10	6.74	
12	*Sida acuta*	10	2000	0.06	4.98	
13	*Oplismenus compositus*	10	2000	0.01	4.36	
14	*Cheilanthes belangeri*	10	4000	0.01	5.26	
15	*Achyranthes aspera*	10	2000	0.03	4.59	
	Total	**290**	**241000**	**8.06**		**1.78**
V9	**Teesta Low dam IV (right bank of Teesta) 158m**					
1	*Thysanolaena latifolia*	30	27000	1.53	70.42	
2	*Pteris vittata*	10	4000	0.08	7.01	
3	*Mikania macrantha*	30	8000	0.06	13.38	
4	*Oplismenus compositus*	90	69000	0.34	64.81	
5	*Piper attenuatum*	10	3000	0.05	5.56	
6	*Cyrtococcum accrescens*	40	28000	0.09	25.60	
7	*Commelina bengalensis*	10	8000	0.10	9.43	
8	*Cheillathes belangeri*	10	4000	0.02	5.00	

	Species	Frequency (F%)	Density (ha-1)	TBC(m2ha-1)	IVI	H
9	*Achyranthes aspera*	10	8000	0.06	8.23	
10	*Rungia pectinata*	10	5000	0.06	6.91	
11	*Passiflora maliformis*	10	1000	0.01	3.54	
12	*Blepharis cristata*	20	16000	0.11	15.94	
13	*Athyrium drepanopterum*	20	12000	0.15	15.50	
14	*Selaginella chrysocaulos*	10	12000	0.04	9.04	
15	*Cyperus rotundus*	10	4000	0.02	4.90	
16	*Bidens pilosa*	10	8000	0.06	7.97	
17	*Ageratum conyzoides*	10	8000	0.10	9.43	
18	*Bidens bipinnate*	10	8000	0.10	9.43	
19	*Gynura nepalensis*	10	2000	0.02	4.30	
20	*Stephania japonica*	10	1000	0.02	3.65	
	Total	**370**	**236000**	**3.01**		**2.47**
V10	**D/s of Teesta low dam IV(right bank of Teesta) 150m**					
1	*Equisetum ramosissimum*	10	15000	0.11	17.47	
2	*Mikania macrantha*	70	40000	0.28	61.52	
3	*Artemisia nilagirica*	10	2000	0.08	8.40	
4	*Oplismenus compositus*	10	8000	0.04	10.08	
5	*Pogonatherum paniceum*	10	24000	0.08	21.26	
6	*Commelina bengalensis*	40	13000	0.13	27.57	
7	*Cheilanthes tenuifolia*	10	4000	0.05	8.26	
8	*Saccharum longisetosum*	10	4000	0.25	18.27	
9	*Thysanolaena latifolia*	10	4000	0.28	19.69	
10	*Cyrtococcum accrescens*	10	8000	0.03	9.39	
11	*Persicaria chinensis*	30	9000	0.10	20.64	
12	*Ageratum conyzoides*	10	14000	0.18	20.30	
13	*Piper attenuatum*	20	10000	0.16	20.57	
14	*Strobilanthes himalayana*	30	11000	0.09	21.15	
15	*Sonchus wightianus subsp.wightianus*	10	4000	0.20	15.65	
	Total	**290**	**170000**	**2.04**		**2.43**
V11	**Teesta Low dam site V (left bank of Teesta) 134m**					
1	*Urena lobata*	10	4000	0.11	14.36	
2	*Achyranthes aspera*	40	30000	0.38	65.01	
3	*Thysanolaena latifolia*	10	8000	0.31	28.81	
4	*Blepahris cristata*	20	14000	0.13	28.17	
5	*Sida acuta*	20	11000	0.15	27.07	
6	*Cassia tora*	10	10000	0.28	29.08	
7	*Sporobolus diander*	10	4000	0.01	8.72	
8	*Athyrium attenuatum*	10	2000	0.06	9.45	
9	*Mikania macrantha*	10	4000	0.03	9.54	
10	*Thunbergia coccinea*	10	1000	0.01	5.79	
11	*Oplismenus compositus*	10	3000	0.01	7.62	
12	*Aristolochia saccata*	10	1000	0.01	6.11	
13	*Arundinella nepalensis*	10	8000	0.06	14.54	
14	*Conyza japonica*	10	3000	0.12	13.64	
15	*Adiantum lanulatum*	10	8000	0.03	12.75	
16	*Commelina bengalensis*	10	2000	0.01	7.04	

	Species	Frequency (F%)	Density (ha-1)	TBC(m2ha-1)	IVI	H
17	*Cyperus cyperoides*	10	5000	0.06	12.35	
	Total	**220**	**118000**	**1.76**		**2.46**
V12	**Downstream of Teesta Low dam site V (right bank of Teesta) 144m**					
1	*Thysanolaena latifolia*	20	26000	1.65	76.14	
2	*Urena lobata*	10	2000	0.10	8.47	
3	*Pogonatherum paniceum*	10	5000	0.02	8.42	
4	*Mikania macrantha*	10	2000	0.02	6.05	
5	*Strobilanthes himalayana*	10	4000	0.15	11.60	
6	*Achyranthes aspera*	10	10000	0.07	13.97	
7	*Chloris montana*	10	8000	0.03	11.07	
8	*Cynodon dactylon*	10	5000	0.02	8.42	
9	*Arisaema tortuosum*	10	2000	0.04	6.63	
10	*Piper attenuatum*	10	2000	0.03	6.50	
11	*Saccharum narenga*	20	18000	1.14	55.17	
12	*Ageratum conyzoides*	30	11000	0.08	22.96	
13	*Gompherina globosa*	10	4000	0.01	7.54	
14	*Cyperus cyperoides*	20	5000	0.05	13.27	
15	*Nephrolepis auriculata*	30	17000	0.06	27.35	
16	*Bidens bipinnata*	30	5000	0.02	16.42	
	Total	**250**	**126000**	**3.48**		**2.46**
V13	**U/s of Jorethang Powerhouse site (left bank of rangit) 270m**					
1	*Pogonatherum paniceum*	10	10000	0.03	8.67	
2	*Saccharum narenga*	50	78000	3.00	####	
3	*Mikania macrantha*	40	32000	0.23	33.17	
4	*Pteris vittata*	10	2000	0.07	5.93	
5	*Carex cruciata*	10	1000	0.01	4.50	
6	*Thysanolaena latifolia*	10	12000	0.68	21.65	
7	*Arundinella decempedalia*	30	44000	0.70	43.26	
8	*Saccharum spontaneum*	10	18000	0.23	15.70	
9	*Bidens bipinata*	10	4000	0.05	6.48	
10	*Urena lobata*	10	1000	0.02	4.64	
11	*Capillipedium parviflorum*	10	10000	0.05	8.93	
12	*Cynoglosum glochidiatum*	10	2000	0.14	7.34	
13	*Athyrium attenuatum*	10	4000	0.06	6.58	
14	*Justicia gendarussa*	10	2000	0.03	5.16	
15	*Digitaria adscendes*	10	8000	0.03	7.71	
16	*Mimosa pudica*	10	4000	0.03	6.07	
17	*Adiantum lunulatum*	10	4000	0.01	5.78	
	Total	**260**	**236000**	**5.35**		**2.12**
V14	**Downstream of Jorethang powerhouse site(left bank of Rangit) 227m**					
1	*Mikania macrantha*	30	18000	0.13	21.02	
2	*Galium asperifolium*	10	4000	0.02	5.60	
3	*Saccharum longisetosum*	20	12000	0.60	25.06	
4	*Thysanolaena latifolia*	50	35000	2.23	80.18	
5	*Achyranthes aspera*	10	8000	0.23	11.81	
6	*Crepis japonica*	10	1000	0.01	4.16	
7	*Ageratum conyzoides*	20	12000	0.04	13.01	

	Species	Frequency (F%)	Density (ha-1)	TBC(m2ha-1)	IVI	H
8	*Euphorbia hirta*	10	2000	0.01	4.47	
9	*Pogonatherum paniceum*	30	46000	0.14	33.78	
10	*Saccharum spontaneum*	20	28000	0.66	33.46	
11	*Commelina bengalensis*	10	2000	0.01	4.63	
12	*Equisetum ramosissimum*	20	33000	0.23	26.47	
13	*Arundinella decempedalia*	20	14000	0.27	18.95	
14	*Brachiaria reptans*	10	8000	0.03	7.52	
15	*Sida acuta*	10	1000	0.06	5.25	
16	*Mimosa pudica*	10	2000	0.01	4.63	
	Total	**290**	**226000**	**4.69**		**2.32**

Plant Biodiversity

A total of 96 species of herbs were recorded under the ecological investigation from different project sites along the Teesta and Rangit river Basin during monsoon sampling. Out of which 09 were climbers and 87 herbs. The ground vegetation comprised of ephemeral, annual, and perennial species of grasses, sedges, legumes and non-legume forbs.

6.5.2.3 Post-monsoon Season

Density and Abundance

The number of herb species was highest on all the fourteen project sites during postmonsoon sampling as compared to monsoon and pre-monsoon samplng. And again the maximum number of herb species was recorded in upstream site of Teesta VI power house (left bank of Teesta) and TLD I & II dam site (right bank of Rangit river) during post-monsoon sampling (Refer Table 6.4).

On the upstream of Teesta VI power house site, *Eragrostis tenella* was again dominant species having maximum density (28000 plants/ha) probably due to its exotic nature and capability to grow in moist and shady places. It was followed by *Mikania macrantha, Kyllinga brevifolia and Arundinella decempedalia* (20000 plants/ha) (Refer Table 6.4). Maximum value of IVI was observed in Saccharum narenga (30.72) followed by *Mikania macrantha* (28.86) and *Prunella frutescens* (28.80). The minimum IVI of 3.60 was noted for Urena lobata during post-monsoon.

At near Teesta VI power house site, *Oplismenus compositus* was found the dominant species having maximum density (35000 plants/ha) during post-monsoon. It was followed by *Saccharum narenga* (28000 plants/ha) in terms of density (Refer Table 6.4). As per IVI values, *Saccharum narenga* was the dominant species (46.62) followed by *Oplismenus compositus* (43.79) and *Sida acuta* (35.03). The lowest IVI of 6.65 was recorded in *Carex thomsonii* and *Lygodium japonicum* (Refer Table 6.4).

On near Teesta intermediate dam site, *Oplismenus compositus* was the dominant species having maximum density (42000 plants/ha) during post-monsoon. As per IVI values, *Oplismenus compositus* was the dominant species (50.20) followed by *Arundinella decempedalis* (35.04), *Arundo donax* (25.39) and *Mikania macrantha* (24.49) during post-monsoon. The lowest IVI of 5.70 was recorded in *Persicaria chinensis*.

At downstream of Teesta intermediate dam, *Cynodon dactylon* was the dominant species having maximum density (22000 plants/ha) during post-monsoon. It was followed by *Oplismenus compositus* and *Imperata cylindrica* (20000 plants/ha) in terms of density. Maximum value of IVI was observed in *Achyranthes aspera* (45.59) followed by *Mikania macrantha* (31.09), *Cynodon dactylon* (28.53), *Oplismenus compositus* (26.79) and *Carex myosurus* (26.36) during post-monsoon. The lowest IVI of 4.87 was recorded in *Adiantum lunulatum*.

At near TLD I & II dam site, *Oplismenus compositus* was the dominant species having maximum density (31000 plants/ha) during post-monsoon. It was followed by *Cyrtococcuum accrescens* (22000 plants/ha), *Ageratum conyzoides* (18000 plants/ha) and *Mikania macrantha* (17000 plants/ha). Maximum value of IVI was observed in *Musa balbisiana* (56.90) followed by *Oplismenus compositus* (26.91), *Mikania macrantha* (20.60) and *Thysanolaena latifolia* (19.29). The minimum IVI of 3.03 was noted for *Strobilanthes himalayana*.

On downstream of TLD I & II dam site, *Saccharum spontaneum* was the dominant species having maximum density (25000 plants/ha) during post-monsoon. It was followed by *Ageratum conyzoides* (22000 plants/ha), *Cymbopogon khasianus* (20000 plants/ha) and *Eragrostis tenella* (15000 plants/ha) in terms of density. Maximum value of IVI was observed in *Saccharum spontaneum* (53.74) followed by *Ageratum conyzoides* (31.72) and *Bidens bipinnata* (25.99) during post-monsoon. The lowest IVI of 4.54 was recorded in *Adiantum lunulatum* and *Oxalis corniculata*.

At near Teesta Low Dam IIIrd site, *Saccharum narenga* was the dominant species having maximum density (27000 plants/ha) during post-monsoon. It was followed by *Isachne albens* (16000 plants/ha), *Oplismenus compositus* and *Mikania macrantha* (11000 plants/ha). Maximum value of IVI was observed in *Saccharum narenga* (68.60) followed by *Arundinella nepalensis* (25.13), *Isachne albens* (20.55) and *Oplismenus compositus* (25.55). The minimum IVI of 4.71 was noted for *Paspalum scrobiculatum*.

On downstream of Teesta Low Dam IIIrd, *Saccharum longisetosum* was the dominant species having maximum density (22000 plants/ha) during post-monsoon. It was followed by *Arundinella decempedalis* (18000 plants/ha), *Mikania macrantha* and *Ageratum conyzoides* (15000 plants/ha). Maximum value of IVI was observed in *Saccharum* *longisetosum* (61.31) followed by *Thysanolaena latifolia* (45.24). The lowest IVI of 4.20 was recorded in *Crepis japonica*.

At near Teesta Low Dam IVth, *Oplismenus compositus* was the dominant species having maximum density (30000 plants/ha) during post-monsoon. It was followed by *Mikania macrantha, Thysanolaena latifolia* (18000 plants/ha) and *Cyrtococcum accrescens* (16000 plants/ha). Maximum value of IVI was observed in *Thysanolaena latifolia* (44.49) followed by *Oplismenus compositus* (32.35) and *Mikania macrantha* (28.53). The minimum IVI of 3.66 was not for *Gynura nepalensis*.

On downstream of Teesta Low Dam IVth, *Equisetum ramosissimum* was the dominant species having maximum density (17000 plants/ha). It was followed by *Mikania macrantha* (15000 plants/ha) and *Ageratum conyzoides* (14000 plants/ha) during post-monsoon. Maximum value of IVI was observed in *Saccharum longisetosum* (43.51) followed by *Mikania macrantha* (30.52) and *Thysanolaena latifolia* (30.24). The lowest IVI of 6.51 was recorded in *Piper attenuatum*.

At near Teesta Low Dam Vth (left bank of Teesta), *Oplismenus compositus* was the dominant species having maximum density (14000 plants/ha). It was followed by *Achyranthes aspera* and *Saccharum narenga* (12000 plants/ha) during post-monsoon. Maximum value of IVI was observed in *Achyranthes aspera* (31.88) followed by *Oplismenus compositus* (26.45) and *Cyperus cyperoides* (25.05). The lowest IVI of 6.41 was recorded in *Adiantum lunulatum*.

On downstream of Teesta Low Dam Vth (right bank of Teesta), *Nephrolepis auriculata* was the dominant species having maximum density (20000 plants/ha) during post-monsoon. It was followed by *Thysanolaena latifolia* (18000 plants/ha), *Ageratum conyzoides* and *Blumea hieracifolia* (17000 plants/ha). Maximum value of IVI was observed in *Thysanolaena latifolia* (72.98) followed by *Ageratum conyzoides* (31.72) and *Blumea hieraccifolia* (24.69). The lowest IVI of 5.00 was recorded in *Adiantum lunulatum*.

At upstream of Jorethang Power house site, *Saccharum narenga* was the dominant species having maximum density (42000 plants/ha) during post-monsoon. Maximum value of IVI was observed in *Saccharum narenga* (83.79) followed by *Thysanolaena latifolia* (44.35) and *Mikania macrantha* (29.87). The lowest IVI of 4.84 was recorded in *Mimosa pudica*.

On downstream of Jorethang power house site, *Thysanolaena latifolia* was the dominant species (22000 plants/ha). It was followed by *Arundinella decempedalia* (18000 plants/ha) and *Mikania macrantha* (16000 plants/ha). Maximum value of IVI was observed in *Thysanolaena latifolia* (67.25) followed by *Saccharum spontaneum* (32.82) and *Arundinella decempedalia* (28.67). The lowest IVI of 4.24 was recorded in *Crepis japonica*.

Species Diversity

The value of species diversity (H) in the herbaceous layer ranged from 2.45 (near Teesta VI Power house site) to 3.03 (Upstream of Teesta VI power house), respectively (Refer Table 6.4).

Table-6.4 Vegetational attributes of herbaceous vegetation (Post-monsoon Season) in Teesta Basin

	Species	Frequency (F%)	Density (ha-1)	TBC(m2ha-1)	IVI	H
V1	**U/s of Teesta VI (left bank of Teesta) 281m**					
	Species					
1	*Corchorus aestuans*	20	4000	0.03	6.56	
2	*Mikania macrantha*	80	20000	0.14	28.86	
3	*Oplismenus compositus*	40	18000	0.06	17.03	
4	*Sida acuta*	10	2000	0.04	4.23	
5	*Kyllinga brevifolia*	20	16000	0.05	12.09	
6	*Prunella frutescens*	10	8000	0.63	28.80	
7	*Carex myosurus*	10	3000	0.03	4.23	
8	*Cyrtococcum accresens*	30	18000	0.07	15.52	
9	*Urena lobata*	10	2000	0.02	3.60	
10	*Barlaria prionites*	10	3000	0.04	4.56	
11	*Cynodon arcuatus*	20	14000	0.05	11.42	
12	*Cleome viscosa*	20	5000	0.06	8.25	
13	*Eragrostis tenella*	20	28000	0.08	17.90	
14	*Conyza bonariensis*	10	4000	0.05	5.43	
15	*Arundinella decempedalia*	20	20000	0.14	17.10	
16	*Justicea simplex*	10	5000	0.04	5.25	
17	*Adiantum capillaris-veneris*	10	5000	0.02	4.51	
18	*Saccharum narenga*	40	10000	0.50	30.72	
19	*Commelina bengalensis*	20	6000	0.04	7.87	
20	*Euphorbia hirta*	10	4000	0.02	4.10	
21	*Pogonatherum paniceum*	10	16000	0.05	10.13	
22	*Arthraxon lancifolius*	10	4000	0.01	4.00	
23	*Capillipedium assimile*	10	5000	0.02	4.85	
24	*Achyranthes aspera*	20	16000	0.20	17.78	
25	*Dioscorea bulbifera*	10	3000	0.04	4.56	
26	*Amaranthus viridis*	10	4000	0.08	6.49	
27	*Bidens bipinnata*	20	12000	0.15	14.31	
	Total	**510**	**255000**	**2.65**		**3.03**
V2	**Teesta VI Powerhouse (left bank of Teesta) 245m**					
1	*Bidens bipinnata*	20	5000	0.06	13.99	
2	*Oplismenus compositus*	40	35000	0.13	43.79	
3	*Mikania macrantha*	30	17000	0.12	28.47	
4	*Cyanotis vaga*	20	8000	0.04	14.12	
5	*Pogonatherum paniceum*	10	8000	0.03	9.97	
6	*Sida acuta*	20	6000	0.38	35.03	
7	*Saccharum narenga*	20	28000	0.35	46.62	
8	*Urena lobata*	10	2000	0.10	11.12	
9	*Capillipedium assimile*	10	12000	0.05	13.73	
10	*Dioscorea bulbifera*	20	3000	0.04	11.15	
11	*Lygodium japonicum*	10	3000	0.02	6.65	

	Species	Frequency (F%)	Density (ha-1)	TBC(m2ha-1)	IVI	H
12	*Achyranthes aspera*	20	5000	0.06	13.99	
13	*Carex thomsonii*	10	3000	0.02	6.65	
14	*Arundinella nepalensis*	10	10000	0.10	15.75	
15	*Adiantum lunulatum*	20	6000	0.02	11.79	
16	*Digitaria ciliaris*	20	12000	0.05	17.18	
	Total	**290**	**163000**	**1.56**		**2.45**
V3	**Teesta Intermediate (above BhapKhola, left bank of Teesta) 223m**					
1	*Ageratum conyzoides*	20	8000	0.08	15.48	
2	*Mikania macrantha*	30	15000	0.11	24.49	
3	*Oplismenus compositus*	50	42000	0.16	50.20	
4	*Cyrtococcum accrescens*	10	10000	0.04	11.39	
5	*Arundinella decempedalia*	20	20000	0.28	35.04	
6	*Adiantum lunulatum*	20	9000	0.03	13.13	
7	*Arundo donax*	10	5000	0.32	25.39	
8	*Adiantum proliferum*	10	4000	0.01	6.16	
9	*Conyza bonariensis*	20	4000	0.15	17.72	
10	*Ischaemum indicum*	20	8000	0.06	14.71	
11	*Boerahvia diffusa*	10	4000	0.03	7.12	
12	*Setaria sphacelata*	30	10000	0.13	22.62	
13	*Achyranthes aspera*	20	6000	0.08	14.16	
14	*Oxalis corniculata*	20	5000	0.02	9.91	
15	*Urena lobata*	20	6000	0.10	15.38	
16	*Persicaria chinensis*	10	2000	0.03	5.70	
17	*Commelina bengalensis*	20	5000	0.04	11.10	
	Total	**340**	**163000**	**1.64**		**2.52**
V4	**Teesta intermediate (opp. Rangpo Wine Fac., left bank of Teesta) 219m**					
1	*Bidens bipinnata*	20	6000	0.12	19.93	
2	*Imperata cylindrica*	20	20000	0.08	24.79	
3	*Mikania macrantha*	30	18000	0.13	31.09	
4	*Stephania glandulifera*	10	1000	0.01	4.80	
5	*Cyrtococcum accrescens*	30	16000	0.06	24.21	
6	*Adiantum lunulatum*	10	2000	0.01	4.87	
7	*Capillipedium assimile*	10	8000	0.04	11.30	
8	*Oplismenus compositus*	30	20000	0.06	26.79	
9	*Gnaphalium affine*	20	5000	0.02	10.89	
10	*Oxalis corniculata*	10	5000	0.02	7.48	
11	*Cynodon dactylon*	30	22000	0.07	28.53	
12	*Commelina bengalensis*	20	4000	0.03	11.08	
13	*Euphorbia hirta*	10	5000	0.02	7.48	
14	*Arundinella decempedalia*	20	12000	0.15	26.36	
15	*Carex myosurus*	20	10000	0.03	14.96	
16	*Achyranthes aspera*	30	12000	0.34	45.59	
	Total	**320**	**166000**	**1.17**		**2.55**
V5	**TLD I & II(right bank of Rangit river) 220m**					
1	*Hedychium spicatum*	10	2000	0.35	7.00	
2	*Mikania macrantha*	50	17000	0.12	20.60	
3	*Strobilanthes himalayana*	10	1000	0.02	3.03	
4	*Oplismenus compositus*	50	31000	0.12	26.91	
5	*Cyrtococcum accrescens*	30	22000	0.07	17.67	
6	*Carex cruciata*	10	4000	0.03	4.44	

	Species	Frequency (F%)	Density (ha-1)	TBC(m2ha-1)	IVI	H
7	*Athyrium attenuatum*	20	9000	0.25	11.44	
8	*Urena lobata*	10	2000	0.13	4.59	
9	*Pollia hasskarlii*	10	4000	0.20	6.28	
10	*Ageratum conyzoides*	20	18000	0.23	15.21	
11	*Achyranthes aspera*	10	4000	0.01	4.27	
12	*Digitaria ciliaris*	20	7000	0.04	8.28	
13	*Isachne albens*	30	14000	0.07	14.04	
14	*Saccharum narenga*	10	14000	0.54	14.41	
15	*Commelina bengalensis*	10	5000	0.04	5.02	
16	*Cyperus cyperoides*	10	2000	0.02	3.39	
17	*Thysanolaena latifolia*	10	15000	0.95	19.29	
18	*Setaria sphacelata*	10	10000	0.09	7.82	
19	*Paspalum scrobiculatum*	10	8000	0.06	6.55	
20	*Echinochloa colona*	10	2000	0.01	3.30	
21	*Musa bulbisiana*	20	3000	4.77	56.90	
22	*Carex cruciata*	10	4000	0.03	4.44	
23	*Colocasia esculenta*	10	2000	0.51	8.66	
24	*Gnaphalium affine*	10	3000	0.03	3.99	
25	*Urtica parviflora*	10	4000	0.62	10.70	
26	*Scutellaria scandens*	10	2000	0.04	3.65	
27	*Kyllinga brevifolia*	10	12000	0.04	8.16	
	Total	**430**	**221000**	**9.37**		**2.94**
V6 D/s of TLD I & II Combined (d/s of Rangit & Teesta Confluence) 209m						
1	*Sida acuta*	20	4000	0.05	11.71	
2	*Cyperus rotundus*	20	8000	0.03	12.10	
3	*Ageratum conyzoides*	30	22000	0.16	31.72	
4	*Bidens bipinnata*	30	14000	0.13	25.99	
5	*Boehravia diffusa*	10	2000	0.01	5.09	
6	*Mikania macrantha*	20	3000	0.02	9.15	
7	*Achyranthes aspera*	30	7000	0.09	18.98	
8	*Digitaria adscendens*	10	8000	0.03	9.07	
9	*Setaria palmifolia*	20	6000	0.04	12.23	
10	*Kyllinga brevifolia*	20	8000	0.03	12.10	
11	*Gnaphalium affine*	10	2000	0.01	5.09	
12	*Pogonatherum paniceum*	10	10000	0.03	10.57	
13	*Saccharum spontaneum*	20	25000	0.49	53.74	
14	*Nephrolepis auriculata*	20	12000	0.05	15.67	
15	*Adiantum lunulatum*	10	2000	0.01	4.54	
16	*Cymbopogon khasianus*	10	20000	0.09	20.05	
17	*Arundinella nepalensis*	10	12000	0.08	15.38	
18	*Oxalis corniculata*	10	2000	0.01	4.54	
19	*Eragrostis tenella*	10	15000	0.05	14.35	
20	*Paspalum scrobiculatum*	10	5000	0.04	8.17	
	Total	**330**	**187000**	**1.43**		**2.74**
V7 Teesta Low dam III (right bank of Teesta) 220m						
1	*Setaria verticillata*	10	10000	0.07	11.80	
2	*Mikania macrantha*	30	11000	0.08	18.25	
3	*Echinochloa colona*	10	4000	0.01	5.72	
4	*Arundinella nepalensis*	30	22000	0.08	25.13	
5	*Adiantum lunulatum*	10	4000	0.01	5.72	

	Species	Frequency (F%)	Density (ha-1)	TBC(m2ha-1)	IVI	H
6	*Oplismenus compositus*	30	11000	0.04	16.57	
7	*Saccharum narenga*	30	27000	1.04	68.60	
8	*Blepharis cristata*	10	4000	0.03	6.38	
9	*Isachne albens*	30	16000	0.06	20.55	
10	*Neanotis hirsuta*	20	8000	0.03	11.78	
11	*Setaria palmifolia*	10	5000	0.04	7.49	
12	*Paspalum scrobiculatum*	10	2000	0.02	4.71	
13	*Sida cordata*	10	3000	0.15	10.97	
14	*Urena lobata*	20	2000	0.14	12.76	
15	*Strobilanthes himalayana*	10	4000	0.31	18.49	
16	*Cyrtococcum accrescens*	20	10000	0.05	13.50	
17	*Didymocarpus aurantiacus*	10	2000	0.03	5.05	
18	*Bidens bipinnata*	20	8000	0.10	14.63	
19	*Capillipedium assimile*	10	7000	0.02	8.02	
20	*Commelina bengalensis*	20	4000	0.03	9.16	
21	*Rungia pectinata*	10	2000	0.01	4.50	
	Total	**360**	**166000**	**2.36**		**2.75**
V8	**Downstream of TLD III (right bank of Teesta) 188m**					
1	*Thysanolaena latifolia*	20	14000	0.89	45.24	
2	*Arundinella decempedalis*	20	18000	0.20	26.46	
3	*Adiantum lunulatum*	10	2000	0.01	4.93	
4	*Mikania macrantha*	40	15000	0.11	27.55	
5	*Crepis japonica*	10	1000	0.01	4.20	
6	*Achyranthes aspera*	30	8000	0.10	18.88	
7	*Saccharum longisetosum*	30	22000	1.11	61.31	
8	*Athyrium drepanopterum*	10	2000	0.04	5.98	
9	*Inula cappa*	10	2000	0.04	5.98	
10	*Pteris vittata*	10	3000	0.08	8.17	
11	*Ageratum conyzoides*	30	15000	0.14	25.53	
12	*Paspalum commersonii*	10	5000	0.10	10.10	
13	*Sida acuta*	10	2000	0.06	6.52	
14	*Oplismenus compositus*	20	6000	0.02	11.56	
15	*Cheilanthes belangeri*	10	2000	0.01	4.93	
16	*Bidens bipinnata*	20	10000	0.13	17.96	
17	*Digitaria adscendens*	10	4000	0.02	6.72	
18	*Conyza bonariensis*	10	2000	0.10	7.92	
	Total	310	133000	3.15		2.53
V9	**Teesta Low dam IV (right bank of Teesta) 158m**					
1	*Mikania macrantha*	50	18000	0.14	28.53	
2	*Bidens bipinnata*	20	12000	0.19	18.01	
3	*Piper attenuatum*	10	2000	0.04	5.01	
4	*Thysanolaena latifolia*	20	18000	1.02	44.49	
5	*Pteris vittata*	10	3000	0.06	6.16	
6	*Oplismenus compositus*	40	30000	0.11	32.35	
7	*Athyrium attenuatum*	20	7000	0.10	12.36	
8	*Aconogonum molle*	10	4000	0.15	9.38	
9	*Cyrtococcum accrescens*	30	16000	0.05	19.30	
10	*Commelina bengalensis*	10	3000	0.04	5.58	
11	*Achyranthes aspera*	10	5000	0.04	6.87	
12	*Rungia pectinata*	10	2000	0.03	4.62	

	Species	Frequency (F%)	Density (ha-1)	TBC(m2ha-1)	IVI	H
13	*Passiflora maliformis*	20	4000	0.05	9.24	
14	*Ageratum conyzoides*	20	12000	0.15	16.91	
15	*Selaginella chrysocaulos*	20	5000	0.02	8.90	
16	*Cyperus rotundus*	10	4000	0.02	5.57	
17	*Bidens pilosa*	10	4000	0.03	5.93	
18	*Stephania japonica*	10	1000	0.02	3.75	
19	*Colocasia esculenta*	10	5000	0.36	15.71	
20	*Gynura nepalensis*	10	1000	0.01	3.66	
21	*Urtitca dioica*	10	5000	0.57	21.30	
22	*Hedychium spicatum*	10	2000	0.45	16.39	
	Total	**370**	**163000**	**3.64**		**2.71**
V10	**D/s of Teesta low dam IV(right bank of Teesta) 150m**					
1	*Artemisia nilagirica*	10	4000	0.20	14.83	
2	*Equisetum ramosissimum*	20	17000	0.12	25.21	
3	*Mikania macrantha*	40	15000	0.11	30.52	
4	*Cyperus cyperoides*	10	4000	0.05	8.77	
5	*Conyza bonariensis*	10	2000	0.04	6.81	
6	*Pogonatherum paniceum*	10	12000	0.04	14.38	
7	*Commelina bengalensis*	20	8000	0.08	16.60	
8	*Cheilanthes tenuifolia*	10	3000	0.04	7.51	
9	*Saccharum longisetosum*	10	12000	0.76	43.51	
10	*Thysanolaena latifolia*	10	7000	0.53	30.24	
11	*Cyrtococcum accrescens*	20	9000	0.03	15.41	
12	*Persicaria chinensis*	20	4000	0.05	12.48	
13	*Ageratum conyzoides*	20	14000	0.18	25.16	
14	*Piper attenuatum*	10	2000	0.03	6.51	
15	*Strobilanthes himalayana*	20	7000	0.06	15.01	
16	*Aconogonum molle*	10	4000	0.15	12.94	
17	*Commelina bengalensis*	10	3000	0.02	6.84	
18	*Gompherina globosa*	10	4000	0.01	7.26	
	Total	**270**	**131000**	**2.49**		**2.69**
V11	**Teesta Low dam site V (left bank of Teesta) 134m**					
1	*Achyranthes aspera*	30	12000	0.15	31.88	
2	*Passiflora geminiflora*	20	4000	0.03	11.86	
3	*Digitaria adscendens*	20	8000	0.03	15.08	
4	*Barlaria cristata*	10	5000	0.02	8.94	
5	*Cyperus cyperoides*	20	10000	0.13	25.05	
6	*Mikania macrantha*	20	7000	0.05	16.20	
7	*Oplismenus compositus*	30	14000	0.06	26.45	
8	*Athyrium attenuatum*	20	6000	0.07	16.85	
9	*Elephantopus sp.*	20	5000	0.05	14.35	
10	*Carex myosurus*	30	7000	0.05	19.23	
11	*Sida acuta*	20	8000	0.11	22.10	
12	*Saccharum narenga*	10	12000	0.15	25.82	
13	*Capillipedium assimile*	10	4000	0.01	7.54	
14	*Hedychium spicatum*	10	1000	0.08	10.08	
15	*Arisaema nepenthoides*	20	2000	0.13	18.22	
16	*Adiantum lanulatum*	10	3000	0.01	6.41	
17	*Commelina bengalensis*	10	2000	0.01	5.93	
18	*Conyz bonariensis*	10	3000	0.04	8.73	

	Species	Frequency (F%)	Density (ha-1)	TBC(m2ha-1)	IVI	H
19	*Urena lobata*	10	2000	0.06	9.40	
	Total	**330**	**115000**	**1.22**		**2.76**
V12	**Teesta Low dam site V (right bank of Teesta) 144m**					
1	*Oplismenus compositus*	30	11000	0.05	19.69	
2	*Arundinella nepalensis*	10	5000	0.04	8.42	
3	*Urena lobata*	10	2000	0.10	9.44	
4	*Thysanolaena latifolia*	20	18000	1.14	72.98	
5	*Arisaema tortuosum*	10	2000	0.04	6.41	
6	*Nephrolepis auriculata*	20	20000	0.08	23.95	
7	*Bidens bipinnata*	20	8000	0.03	13.33	
8	*Pogonatherum paniceum*	10	8000	0.03	10.00	
9	*Ageratum conyzoides*	30	17000	0.21	31.72	
10	*Gompherina globosa*	10	4000	0.01	6.67	
11	*Cyperus cyperoides*	20	5000	0.05	12.23	
12	*Blumea hieracifolia*	30	17000	0.06	24.69	
13	*Bidens bipinnata*	10	4000	0.01	6.67	
14	*Piper attenuatum*	10	2000	0.03	6.20	
15	*Molineria capitulata*	10	2000	0.14	11.39	
16	*Strobilanthes himalayana*	10	3000	0.04	7.17	
17	*Achyranthes aspera*	10	4000	0.03	7.41	
18	*Carex myosurus*	10	4000	0.02	6.79	
19	*Adiantum lunulatum*	10	2000	0.01	5.00	
20	*Cynodon dactylon*	10	8000	0.03	10.00	
	Total	**300**	**146000**	**2.12**		**2.70**
V13	**U/s of Jorethang Loop Powerhouse site (left bank of rangit) 270m**					
1	*Adiantum lunulatum*	10	4000	0.01	6.23	
2	*Saccharum narenga*	40	42000	1.62	83.79	
3	*Mimosa pudica*	10	2000	0.01	4.84	
4	*Bidens bipinata*	20	8000	0.03	12.46	
5	*Mikania macrantha*	40	20000	0.14	29.87	
6	*Pteris vittata*	10	2000	0.06	6.22	
7	*Carex cruciata*	10	2000	0.03	5.36	
8	*Cyrtococcum accrescens*	20	10000	0.03	13.86	
9	*Thysanolaena latifolia*	10	16000	1.13	44.35	
10	*Cynoglosum glochidiatum*	10	1000	0.06	5.80	
11	*Athyrium attenuatum*	10	4000	0.06	7.41	
12	*Justicia gendarussa*	10	2000	0.03	5.36	
13	*Digitaria adscendes*	20	14000	0.04	16.64	
14	*Saccharum spontaneum*	10	10000	0.28	17.31	
15	*Ageratum conyzoides*	20	11000	0.03	14.55	
16	*Pogonatherum paniceum*	10	8000	0.06	9.88	
17	*Conyza bonariensis*	20	3000	0.01	9.13	
18	*Capillipedium parviflorum*	10	5000	0.02	7.07	
	Total	**290**	**164000**	**3.64**		**2.47**
V14	**Downstream of Jorethang Loop Powerhouse site(left bank of Rangit) 227m**					
1	*Saccharum longisetosum*	20	12000	0.60	32.82	
2	*Capillipedium assimile*	10	8000	0.04	9.40	
3	*Cyperus rotundus*	20	10000	0.04	13.82	
4	*Mikania macrantha*	30	16000	0.11	23.11	
5	*Galium asperifolium*	10	4000	0.02	6.17	

	Species	Frequency (F%)	Density (ha-1)	TBC(m2ha-1)	IVI	H
6	*Digitaria adscendens*	20	12000	0.08	16.53	
7	*Commelina bengalensis*	10	2000	0.01	4.90	
8	*Equisetum ramosissimum*	20	9000	0.06	14.01	
9	*Arundinella decempedalia*	20	18000	0.35	28.67	
10	*Brachiaria reptans*	10	4000	0.01	6.09	
11	*Sida acuta*	10	1000	0.06	5.84	
12	*Mimosa pudica*	10	2000	0.01	4.90	
13	*Conyza bonariensis*	10	3000	0.02	5.74	
14	*Thysanolaena latifolia*	30	22000	1.40	67.25	
15	*Achyranthes aspera*	10	8000	0.23	15.27	
16	*Crepis japonica*	10	1000	0.01	4.24	
17	*Ageratum conyzoides*	20	14000	0.04	16.48	
18	*Euphorbia hirta*	20	4000	0.01	9.32	
19	*Pogonatherum paniceum*	10	10000	0.03	10.39	
20	*Commelina bengalensis*	10	2000	0.01	4.90	
	Total	**310**	**162000**	**3.18**		**2.72**

Plant Biodiversity

A total of 105 species of herbs were recorded under the ecological investigation from different project sites along the Teesta and Rangit river Basin during post-monsoon sampling. Out of which 09 were climbers and 96 herbs. The ground vegetation comprised of ephemeral, annual, and perennial species of grasses, sedges, legumes and non-legume forbs.

6.6 TAXONOMIC DIVERSITY

Lower Teesta Basin, located on the extreme northern boundary of West Bengal, is one of the richest treasure house of floristic diversity. It includes Darjeeling, Kurseong and Kalimpong sub-divisions of Darjeeling district and a northern fringe of Jalpaiguri district. All the representative forest types of Eastern Himalaya are found in this Basin (Champion & Seth, 1968). The three distinct botanical zones viz., tropical, subtropical and temperate are rich in the tree, shrub and other twining woody components. In the present study, 669 species of woody angiosperms and gymnosperms could be recorded from the Lower Teesta Basin (Annexure-IIIA). The dicotyledons are represented by 634 species belonging to 325 genera and 95 families, while the monocotyledons are represented by 16 woody genera, 25 species and 3 families. Gymnosperms are represented by 4 families, 7 genera and 10 species. This region is also rich in other group of lower plants like algae, fungi, lichens, bryophytes, pteridophytes, etc.

6.7 PHYTOGEOGRAPHY

The floral elements in the catchment area of the Lower Teesta Basin were analysed for their floristic similarities with other regions of the world and to find out the nature and composition of the flora. Floral elements from South East Asian region, which included

Myanmar, Thailand, Indo-China, Indonesia and Malaysia were found in the tropical and subtropical forest of the project area. These include many trees, shrubs and climbers such as *Bauhinia vahlii, Bischofia javanica, Bombax ceiba, Brassaiopsis glomerulata, Duabanga grandiflora, Engelhardtia spicata, Lithocarpus elegans, Oroxylum indicum, Exbucklandia populnea,* etc. Sino-Japanese elements such as *Lyonia ovalifolia, Quercus glauca, Rhus chinensis* and *Schima wallichii* are quite common in this region. The European and Mediterranean elements are represented by the species of *Allium, Anemone, Artemisia, Gentiana, Ranunculus,* etc. Some species like *Geranium nepalense, Houttuynia cordata, Lyonia ovalifolia* and *Quercus glauca* are distributed from Western Himalaya to Japan. Some Tibetan elements like *Arenaria bryophylla, Juncus thomsonii* and *Hippophae salicifolia* are found in high altitude areas of the catchment. The New world elements are represented by weeds of agricultural lands, open forest areas and waste places viz., *Ageratina adenophora, Ageratum conyzoides, Chromolaena odoratum* and *Lanatana camara*.

6.8 ENDEMIC SPECIES

Teesta valley in Kurseong division, Upper Bhabar tract in Kalimpong Division and Rangit valley forests in West Bengal are well known for the East Himalayan sal, East Himalayan upper bhabar sal and Assam alluvial plains semi-evergreen forests. The moist deciduous and riverine semi-evergreen forests support a wide variety of plants. Some of the important Eastern Himalayan endemic plants found in the catchment are *Acer campbeli, A. hookeri, Calamus inermis, Capparis sikkimensis, Casearia glomerata, Hypericum monanthenum, Hydrocotyle himalaica, Pandanus nepalensis, Plectocomia himalayana,* and *Sterculia kingii*.

6.9 THREATENED FLORA

The flora of N. Bengal is under great pressure due to biotic factors like various developmental projects viz., many hydro power projects, road construction, heavy deforestation and encroachment for agricultural fields, tourist bunglows, etc. As result many plant species have become rare and threatened. Nayar and Sastry (1987, 1988 & 1990) have discussed the rare and endangered plant species of lower and higher groups (flowering plants) in Red Data Book of Indian Plants from Sikkim Himalaya (includes Adjacent Darjeeling Himalaya and Bhutan) and Eastern Himalaya. Some of the rare and threatened taxa of the Lower Teesta valley and Rangit valley of Kalimpong division are *Begonia rubella, Calamus inermis, Cissus spectabilis, Livistona jenkinsiana* and *Ophiorrhiza lurida* (Refer Table 6.5).

Table 6.5 Rare and endangered plants of the Lower Teesta Basin (as per Nayar & Sastry)

Name of species	Status	Distribution
Thelypteridaceae		
Christella clarkia	VU	Darjeeling
Ranunculaceae		
Aconitum ferox	VU	Darjeeling
Aceraceae		
Acer hookeri var. *Major*	EN	Darjeeling
A. osmastonii	EN	Darjeeling
Begoniaceae		
Begonia rubella	Rare	Darjeeling
Begonia satrapis	Rare	Darjeeling
Vitaceae		
Cissus spectabilis	Rare	Siliguri
Apiaceae		
Pimpinella tongloensis	EN	Darjeeling
Rubiaceae		
Hedyotis scabra	Rare	Darjeeling
Ophiorrhiza lurida	Rare	Darjeeling
Campnulaceae		
Codonopsis affinis	Rare	Darjeeling
Ericaceae		
Rhododendron edgeworthii	Rare	Darjeeling
Orchidaceae		
Bulleyia yunnanensis	Rare	Darjeeling
Cymbidium eburnum		
Diplomeris hirsute	VU	Darjeeling
Cocalvulaceae		
Tricarpelema giganteum	*Rare*	
Arecaceae		
Calamus inermis	EN	Kurseong
Phoenix rupícola	Rare	Teesta valley

EN =Endangered ; VU= Vulnerable

6.10 ECONOMICALLY IMPORTANT PLANTS

Lower Teesta valley in West Bengal has a spectacular plant diversity endowed with a flora ranging from dry deciduous scrub vegetation of terai stretch to the temperate vegetation of Darjeeling district. Local residents exploits the wealth of these plant resources for medicinal, fiber, fuel, fodder, timber and various other miscellaneous purposes. Comprehensive account of these plant resources are given below:

6.10.1 Medicinal plants

Teesta valley is rich in medicinal plants though some areas are distributed in various climatic zones. Some of the medicinally important plants like *Berberis aristata, Bergenia ciliata, Lycopodium clavatum, Mahonia nepaulensis, Rhododendron arboreum, Rubia manjith, Valeriana hardwickii, Viola betonicifolia,* and *Zanthoxylum alatum* are quite common in the temperate and sub-temperate zones. Tropical zone is also rich in medicinal flora wherein plants such as *Abroma angusta, Cymbidium aloifolium, Cissampelos pariera, Costus speciosus, Cuscuta reflexa, Dendrobium formosum, Hollarhena pubescens, Jatropa curcas, Oroxylum indicum, Rauvolfia serpentina, Terminalia chebula, Vitex negundo,* etc. grow abundantly. The hills of Teesta valley is inhabited by different ethnic groups with their different system of practice. The practice of using herbs here are broadly two types i. e. the Nepalese and Tibetan system. The list of some over exploited plant species found in the catchment are given in Table 6.6.

Table-6.6 Some of the over exploited medicinal plant species found in the catchment area

S.No.	Botanical Name	Vernacular/Local name
1.	*Asparagus racemosus*	Nyayshing
2.	*Bergenia ciliata*	Pakhanbhed
3.	*Berberis aristata*	-
4.	*Cissampelos paiera*	Pahari Jad
5.	*Costus speciosus*	-
6.	*Cymbidium aloifolium*	-
7.	*Dendrobium formosum*	-
8.	*Equisetum ramosissimum*	-
9.	*Houttuynia cordata*	-
10.	*Lycopodium clavatum*	-
11.	*Mahonia nepaulensis*	-
12.	*Oroxylum indicum*	Hathi Phali
13.	*Phyllanthus emblica*	Aonla
14.	*Rauvolfia serpentina*	Sarpgandha
15.	*Rhododendron arboretum*	Gurans
16.	*Terminalia chebula*	Harad
17.	*T. Bellerica*	Bahera
18.	*Valeriana hardwickii*	Tagar
19.	*Viola betonicifolia*	Vanfsa
20.	*Vitex nigundu*	Nirgundi
21.	*Zanthoxylum alatum*	Timur

6.10.2 Wild edible plants

There are number of wild flowering plants and pteridophytes found in diverse localities of the state and which may serve as life saving food products. These include : rhizomes of *Diosorea* spp. (Tarul); tubers of *Colocasia esculenta* (Arbi); twigs of *Gerardiana diversifolia* (Dholan) and *Urtica dioica* (Chhota sisnu); fruits of *Spondias pinnata* (Amra), *Phyllanthus emblica* (Aonla), *Terminalia chebula* (Harad); leaves of *Fagopyrum esculentum* (Kaunlya), *Houttuynia cordata* and flowers and flower buds of *Rhododendron arboretum* and *Bauhinia* spp. are used in the area.

6.10.3 Fibre yielding plants

Apart from the traditional fibre plants like Jute, cotton, Sunhemp, Coconut there are other plants whose parts can be utilized for extacting fibre from this region. *Abutilon indicum, Agave sislana, Cannabis sativa, Gerardiana diversifolia, Grewia optiva, Kydia* *calycina, Sida acuta, Urtica dioca, Urena lobata,* etc. are some soft and hard fibre yielding plants.

6.10.4 Fodder plants

Fodder comprises of tree leaves, fodder grasses, agricultural crop residues, fodder crops followed by occasional grazing. Although a large number of species are used for feeding the livestock, the preferred ones include *Celtis tetrandra, Ficus auriculata, F. hirta, Grewia optiva, Morus alba, Quercus glauca, Saurauria nepaulensis*, etc. Some grasses also grown for fodder purposes such as *Echinochloa frumentacea*, *Panicum miliacum*, *Paspalum dilatatum*, *Pennisetum americanum*, *Pseudosorghum fasiculare, Rottboelia cochinchinensis, Saccharum officinarum, Setaria palmifolia, Thysolaena latifolia,* etc.

6.10.5 Timber trees and fuelwood

In lower altitudes, the local people uses *Alnus nepalensis, Castanopsis indica, Canarium bengalense*, *Dalbergia sissoo, Engelhardtia spicata, Michelia champaca, Schima wallichii, Shorea robusta, Terminalia myriocarpa,* and *Tectona grandis* for the purpose of timber, fuelwood and making agricultural implements (Rai & Rai 1994; Singh & Das 2002). At higher altitudes various Oak and coniferous species such as *Cryptomeria japonica, Pinus wallichiana,* and *Tsuga dumosa* are used. In addition to these trees, many tall and woody bamboos (*Bambusa arundinacea, B. tulda, Dendrocalamus hamitonii and D. sikkimensis*) also used for these purposes.

Upstream area of Teesta VI Power house site

Near Teesta Intermediate Dam site along Teesta river

Panoramic view of Teesta Low Dam III submergence near Teesta Bridge

Dam site of Teesta Low Dam (TLD) IV project

Upstream area of TLD Vth near Sevok Coronation bridge

Downstream area of Teesta Low dam V HEP

Near dam site view of TLD 1 & 2 along Rangit river

Downstream view of TLD I & II project (near Confluence of Teesta with Rangit)

6.11 FLORAL DETAILS IN RAMMAM BASIN

6.11.1 Forest Types

The forest type in Rammam basin categorized mainly into three classes:

- Semi tropical Low-level forest
- Temperate forests
- Sub alpine forest

The above mentioned forest classes are briefly described in the following paragraphs

Semi-tropical low level forests

These forests are found in the valleys and the lower slopes of the hills upto an elevation of 1000 to 1300 m above mean level. Sal (*Shorea rubusta*) is the dominant tree species in these forests found in association with Champa (*Michelia champaea*), Lampata *(Duabanga sonneratioides)*, Pakasaj (*Terminalia tomentosa)*, Panisaj (*Terminelia myriocarpa*), and rubber (*Ficus elastica*). The soils in the these forests is generally freshly laid allvium deposited by the rivers and streams.

Temperate forests

These forests are observed at elevation between 1200 to 3000 m above mean sea level. The forests area characterized by excessive atmospheric moisture, and their most striking feature is the wealth of orchids, fern and mosses and other epiphytes and creepers which load the branches of old trees. Large number of tree ferns, interspersed with small bamboo and wild plants are observed at lower elevations of this zone. The most valuable tree species observed in the area is *Michelia excelsa*, whose timber is used for panelling and flooring in houses, and is consequently in great demand. The other important tree species observed in these forests is Toon (*Cedrela toona*) which provides one of the best light planking wood in India. Earlier, the timber from this tree was most popular in the country for making tea boxes. The other tree species found in these forests are Bak (*Quercus lamellose*), Phalat (*Quercus lineate*), Singari Katus (*Quercus pachyphylla),* Katus (*Castonopsis hystrix*), Pipli (*Bucklandia populnea*), etc.

Sub-alpine Forests

These forests are observed at elevation above 2500 to 3600 m. At higher elevations Silver fir is dominant, while spruce is the dominant species at lower elevations. The other dominant tree in these forests is Birch (*Betula utilis*). At higher elevation, the undergrowth consists of hill bamboos (*Arundinaria recemosa*) which are used for making mats. Several species of aconite are also found which have some economic value.

The commonly observed tree species reported in the study area are given in Table-6.7.

Table-6.7: List of plant species reported in the study area

Common Name	Scientific Name
Trees	
Gokul	*Ailanthus grandis*
Siris	*Albizzia procera*
Utis	*Alnus nepalensis*
Lali	*Amoora wallichii*
Kadam	*Anthocephalus kadamba*
Sour	*Betula alnoides*
Kaijal	*Bischofia javanica*
Simul	*Bombax ceiba*
Pipali	*Bucklandia populnea*
Dhupi	*Cryptomeria japonica*
Lampate	*Duabanga sonneratioides*
Gamar	*Gmelina arborea*
Sidha	*Lagerstroemia parviflora*
Malatia	*Machilus edulis*
Chiple Kawla	*Machilus gammieana*
Mahua	*Mahoganis sp.*
Champ	*Michelia champaka*
Banana	*Musa sapiendis*
Chilauni	*Schima wallichii (M)*
Sal	*Shorea robusta (M)*
Odal	*Sterculia villosa*
Bahara	*Terminalia belerica*
Panisaj	*Terminalia myriocarpa*
Pakasaj	*Terminalia tomentosa*
Sautara	*Citrus lemon*
Herbs and Shrubs	
Satmuli	*Asparagus racemosus (M)*
Datura	*Datura fastposa (M)*
Bhang	*Cannabis sativa (M)*

Common Name	Scientific Name
Pipermint	*Mentha piperita (M)*
Tomru	*Zanthoxylum alatum*
Chirata	*Swertia chirata (M)*
Dhai phul	*Woodfordia floribunda*
Bamboo and Grasses	
Hill Bamboo	*Arundinasia racemosa*
Tama	*Dendrocalamus hamiltonii*
Dabdabe	*Garuga pinnata*
Bepari	*Ostodes paniculata*

Note:M - Plants having medicinal value

6.11.2 Singalila National Park

Singalila National Park, which was declared as National Park in 1993 is located in the Darjeeling subdivision of Darjeeling district. It is bordered on the north by the state of Sikkim and on the west by the country of Nepal.

Singalila National Park is located on the north-west side of project area at a distance of about 5 km from the barrage site of Rammam Stage-III HEP. A part of the catchment area of Rammam Stage-III HEP lies in the National Park. Singalila National Park extends within an altitudinal range of 2400-3636 m covering an area of 78 sq.km.

The park supports a variety of vegetation types. It consists of different colour of blooming plant species throughout the year. The flora reported in the Singalila National Park is given in Table-6.8.

Table-6.8: Vegetation reported in Singalila National Park

Altitude (2400-2700 m)	Altitude(2700- 3000m)	Altitude (>3000 m)
Quercus pachyphylla	*Quercus* spp.	*Abies densa*
Quercus lamellosa	*Betula utilis*	*Tsuga brunoniana*
Quercus lineata	*Sorbus cuspidata*	*Rhododendron*
Machilus odoratissima	*Castanopsis* spp.	*campanulatum*
Acer campbellii	*Lkitsea elougata*	*Rhgododendrou barbatam*
Mellisoma wallichii	*Tsuga brannoniana*	*Rhododendrou cinnabarium*
Castanopsis tribuloides	*Arundinaria maling*	*Rhododendrou hodgsonii*
Magnolia campbellii	*Arundinaria aristata*	*Rhododendrou grande*
Rhododendron arboreuem	*Daphne* spp.	*Rhododendrou galeoneri*
Viburnum erubesans	*Berberis aristata*	*Rhododendrou lepidotum*
Dapne cannabina	*Piptanthus* spp.	*Arundiwaria* spp.
Symplocas spp.	*Rhododendrou grandi*	*Cotoneaster microphylla*
	Schefflera impressa	*Betula utilis*

The park also hordes a variety of rare and important medicinal plants like *Aconitum* spp., *Vaccinium* spp., *Swertia chirata*, *Iris* spp., *Acorus* spp. *Aralia pseudoginsang, Meconopsis* spp. A variety of orchids are also observed in the park, which include *Satyrium* spp., *Pleione kumilis*, *Rhychostylis* spp., *Coelogyne* spp. etc. During the post-monsoon season a variety of wild flowers are in bloom. These include *Primulas, Geraniums, Saxifraga, Bistora, Senecio, Cotoneaster*, etc.

6.11.3 Findings of Field studies for Rammam-III HEP as a part of EIA Study

The terrestrial ecological survey for winter, summer and post-monsoon seasons were conducted in the months of January 2006, April 2006 and October 2006, respectively. The sampling was conducted at the following sites:

Floristic composition

A total of 62, 59 and 63 plant species were recorded during floristic survey conducted at the sampling sites in the winter, summer and post-monsoon seasons respectively. The number of plant species belonging to different groups is summarised in Table-6.9. No rare and endangered species was reported from the project area and its surroundings.

Table-6.9: Summary table of plants belonging to different groups listed during the vegetation survey

Plant Group	Winter Season (January 2006)	Summer Season (April 2006)	Post-monsson season (October 2006)
Tree	30	30	30
Shrub	16	16	15
Herb and Grasses	16	13	18
Total	**62**	**59**	**63**

Dominance of various floral species

Submergence area

The tree density in submergence area was 290 trees/ha. The dominant tree species was *Engelherdtia* sp. (Mahua) found in association with *Schima wallichii* (Chilauni). *Cotebrookia oppositifolia and Enkianthus* sp. was observed as dominant shrubs. The dominant herb species at this site were Ferns and *Cyndon dactylon*.

Penstock alignment – The most dominant tree species found were *Shorea robusta* and *Schima wallichii*. *Enkiathus* sp. *and Colebrookia oppositifolia* were observed as dominant shrubs while dominant herbs were *Cynodon dactylon* and *Aster thomsonii*.

Power house site and Colony area

The major tree species observed were *Shorea robusta* (Sal) and *Schima wallichi*. Amongst the shrubs, most dominant species were *Cotebrookia oppositifute* and *Erkianthus* sp. The dominant herb species was *Artemisia nilgirica*.

Adit at Desilting Chamber

The dominant tree species observed at this sampling site were *Taluma hodgsoni* and *Alnus nepalensis* (Utis). Amongst the shrubs, dominant species were *Datura fastuosa* and

Bauhinia purpurea. The dominant herb species were *Cyanodon dactylon* and *Porthanium* sp.

Adit at Jhepikhola

The major tree species observed at this site was *Schima wallichii (*Chilauni) found in association with *Alnus nepalensis. Zanthoxylumabtum and Ekianthus sp.* and *Bauhinia purporea* were the dominant shrub species. Amongst the herbs, the most dominant species were *Cynadon dactylon* and *Artimisia nilgirica*.

6.12 BRYOPHYTES, LICHENS AND PTERIDOPHYTES

The list of Bryophytes, Lichens and Pteridophytes of Teesta Basin (West Bengal Portion) is given in Table-6.10.

Table-6.10: List of Bryophytes, Lichens and Pteridophytes of Teesta Basin (west Bengal Portion)

Species	Habit
Bryophytes:	
Mosses	
Sphagnaceae	
Sphagnum cuspidatum	terrestrial moss
S. khasianum	terrestrial moss
Polytrichaceae	
Atrichum longifolium	epiphytic moss
A. undulatum	epiphytic moss
Pogonatum aloides	epiphytic moss
Funariaceae	
Physcomitrium coorgense	epiphytic moss
Recomitrium crispulum	epiphytic moss
Fissidentaceae	
Fissidens allanii	terr./epiphytic
F. nobilis	epiphytic moss
F. sylvatus	terrestrial moss
Ditrichum apophysatum	terrestrial moss
D. heteromallum	terrestrial moss
Bruchiaceae	
Trematodon hookeri	terrestrial moss
T. kurzii	terrestrial moss
Dicranaceae	
Dicranella pseudosubulatum	terr./epiphytic moss
D. himalayanum	terr./epiphytic moss
Leucobraaceae	
Compylopodiella tenella	epiphytic moss
Leucobryum sanctum	epiphytic moss
Bryaceae	
Bryum paradoxum	terrestrial moss
Mniaceae	

Species	Habit
Mnium pseudopunctatum	terrestrial moss
Orthotrichaceae	
Macromitrium nepalense	epiphytic moss
Orthotrichum sikkimense	epiphytic moss
Hookeriaceae	
Daltonia apiculata	terrestrial moss
Thuidiaceae	
Thuidium assimile	epiphytic moss
T. cymbifolium	epiphytic moss
Entodontaceae	
Entodon chloropus	terrestrial moss
E. myurus	terrestrial moss
Liverworts :	
Marchantiaceae	
Marchantia linearis	terrestrial
M. polymorpha	terrestrial
Aytoniaceae	
Plagiochasma appendiculata	terrestrial
Ricciaceae	
Riccia himalayensis	terrestrial
Hornworts	
Anthocerataceae	
Anthoceros bharadwajii	terrestrial
A. formosae	terrestrial
Lichens :	
Crustose lichens :	
Graphidaceae	
Graphina sp.	epiphytic
Pyrenulaceae	
Anthracothecium assamiense	epiphytic
Foliose lichens :	
Parmeliaceae	
Bulbothrix sp.	epiphytic
Parmotrema latissima	epiphytic
Caliciaceae	
Dirineria picta	epiphytic
Physciaceae	
Heterodermia sp.	epiphytic
Fruticose lichens :	
Cladoniaceae	
Cladonia pyxidata	epiphytic
Ramalinaceae	
Ramalina farinacea	epiphytic
Usneaceae	
Usnea sp.	Epiphytic
Ptridophytes :	
Equisetaceae	

Species	Habit
Equisetum diffusum	terrestrial herb
Equisetum ramosissimum	terrestrial herb
Lycopodiaceae	
Lycopodium pseudoclavatum	terrestrial herb
Selaginellaceae	
Selaginella indica	terrestrial herb
S. involvens	terrestrial herb
S. repanda	terrestrial herb
S. chrysocaulos	terrestrial herb
Ophioglossaceae	
Ophioglossum vulgatum	terrestrial herb
Angiopteridaceae	
Angiopteris wallichiana	terrestrial herb
Marsileaceae	
Marsilea minuta	aquatic herb
Cyatheaceae	
*Alsophila spinulosa**	tree fern
Gleicheniaceae	
Diplopterygium giganteum	terrestrial herb
Dicranopteris linearis	terrestrial herb
Lygodiaceae	
Lygodium flexuosum	twining herb
Hymenophyllaceae	
Mecodium polyanthos	terrestrial herb
Adiantaceae	
Adiantum lunulatum	terrestrial herb
A. capillus veneris	terrestrial herb
Vittariaceae	
Vittaria sikkimensis	epiphytic herb
V. amboinensis	epiphytic herb
Pteridaceae	
Pteris vittata	terrestrial herb
P. subindivisa	terrestrial herb
P. himalayensis	terrestrail herb
Ptridiaceae	
Pteridium aquilinum	terrestrial herb
Hemionitidaceae	
Coniogramme falcata	terrestrial herb
C. caudata	terrestrial herb
Polypodiaceae	
Pyrrosia adnascens	epiphytic fern
P. nuda	epiphytic fern
P. beddomeana	epiphytic fern
Colysis hemionitidea	terrestrial fern
Lepisorus nudus	epiphytic fern
Microsorium membranaceum	epiphytic fern
Aspleniaceae	

Species	Habit
Asplenium tenuifolium	terrestrial herb
Athyriaceae	
Athyrium attenuatum	terrestrial herb
A. drepanopterum	terrestrial
Nephrolepidaceae	
Nephrolepis biauriculata	terrestrial herb

Source : Primary survey

None of the species is endemic and threatened categories, except *Alsophila spinulosa** (in Checklist of CITES)

6.13 FLOWERING PLANTS

The list of flowering plants in Teesta Basin (West Bengal Portion) is given in Table-6.11.

Table-6.11: List of flowering plants of Teesta basin (West Bengal Portion)

Species	Habit
Gymnosperms	
Pinaceae	
Pinus roxburghii	tree
P. wallichiana	tree
P. kesia	tree
Taxodiaceae	
Cryptomeria japonica	tree
Taxodium distichum	tree
Cupressaceae	
Cupressus corneyana	tree
Juniperus indica	tree
J. recurva	tree
Thuja orientalis	
Gnetaceae	
**Gnetum montana*	shrub
Angiosperms	
Dicots :	
Dilleniaceae	
Dillenia indica	tree
D. pentagyna	tree
Magnoliaceae	
Magnolia campbelli	tree
M. gustavi	tree
M. hodgsonii	tree
M. insignis	tree
M. pterocarpa	tree
M.rabaniana	tree
Michelia cathcartii	tree
M. champaca	tree
M. doltsopa	tree

Species	Habit
M. glabra	tree
M. kisopa	tree
M. punduana	tree
M. velutina	tree
Annonaceae	
Miliusa globosa	tree
M. longiflora	tree
M. macrocarpa	tree
Artabotrys caudatus	Shrub
Alphonsea lutea	tree
Berberidaceae	
Mahonia acanthifolia	small tree/shrub
M. calamicaulis	shrub
Berberis asiatica	shrub
Lardizabalaceae	
Decaisnea insignis	shrub
Capparidaceae	
Capparis cantoniensis	shrub
C.multiflora	*shrub*
C. olacifolia	*shrub*
Crateva religiosa	tree
C. unilocularis	tree
Violaceae	
Rinorea bengalensis	tree
Bixaceae	
Bixa orellana	small tree/shrub
Flacourtiaceae	
Casearia glomerata	tree
C. graveolens	tree
C. kurzii	tree
C. tomentosa	tree
Flacourtia jangomas	small tree
Gynocardia odorata	tree
Homalium zeylanicum	tree
Polygallaceae	
Polygala arillata	shrub
Clusiaceae	
Calophyllum polyanthum	tree
Garcinia anomala	tree
G. cowa	tree
G.stipulata	tree
G.xanthochymus	tree
Mesua ferrea	tree
M. floribunda	tree
Theaceae	
Camellia kissi	small tree
Eurya acuminata	small tree

Species	Habit
E. cavinervis	small tree
E. cerasifolia	small tree
E. japonica	small tree
Gordonia exelsa	small tree
Schima wallichii	tree
Ternostroemia gymnanthera	small tree
Actinidiaceae	
Saurauia fasciculata	small tree
S. griffithii	small tree
S. macrotricha	small tree
S. napaulensis	tree
S. punduana	tree
S. roxburghii	small tree
Stachyuraceae	
Stachyurus himalaicus	small tree
Dipterocarpaceae	
Shorea robusta	tree
Malvaceae	
Kydia calycna	tree
Nayariophyton ziziphifolium	small tree
Bombacaceae	
Bombax ceiba	tree
Ceiba pentandra	tree
Sterculiaceae	
Abroma angusta	shrub
Eriolaena hookeriana	small tree
E. wallichii	
Firmiana colorata	tree
F. fulgens	tree
Pterospermum acerifolium	tree
Pterygota alata	tree
Reevesia pubescens	tree
R. wallichii	tree
Sterculia hamiltonii	tree
S. kingii	tree
S. roxburghii	small tree
S. villosa	tree
Tiliaceae	
Grewia serrulata	Tree
G. abutilifolia	small tree
G. asiatica	tree
G. eriocarpa	small tree
G. optiva	tree
G. rothii	small tree
G. vestita	small tree
Microcos paniculata	small tree
Elaeocarpaceae	

Species	**Habit**
Elaeocarpus aristatus	tree
E. floribundus	tree
E. lanceifolius	tree
E. serratus	tree
E. sphaericus	tree
E. tectorius	tree
E. varunus	tree
Sloanea dasycarpa	tree
S. sterculcea var. *assamica*	tree
S. sterculcea var. sterculiacea	tree
S. tomentosa	tree
Rutaceae	
Acronychia pedunculata	tree
Aegle marmelos	tree
Citrus reticulata	tree
C. limon	small tree
Micromelum integerrimum	shrub
Murraya koenigii	shrub
M. paniculata	shrub
Tetradium fraxinifolium	tree
T. ruticarpum	tree
Clausena excavata	tree
C. heptaphylla	small tree
Glycosmis cymosa	shrub
G. pentaphylla	shrub
Paramignya griffithii	shrub
Zanthoxylum acanthopodium	shrub
Z. armatum	shrub
Z. ovalifolium	shrub
Z. rhesta	shrub
Simaroubaceae	
Ailanthus integrifolia	tree
Brucea mollis	small tree
Picrasma javanica	tree
Burseraceae	
Canarium bengalense	tree
C. strictum	tree
Garuga pinnata	tree
G. floribunda	tree
Meliaceae	
Aglaia perviridis	tree
A. heirnii	tree
Aphanomixis chittagonga	tree
A. polystachya	tree
Chukrasia tabualris	tree
Cipadensa baccifera	tree
Azadirachta indica	tree

Species	Habit
Dysoxylum binecterium	tree
D. mollissimum	tree
D. reticulatum	tree
Heynea trijuga	small tree
Melia azedarach	tree
Sphaerosacme decandra	tree
Toona ciliata	tree
T. microphylla	tree
T. sureni	tree
Walsura tubulata	tree
Olaceae	
Olax acuminata	tree
Icacinaceae	
Platea latifolia	tree
Nothopodytys foetida	small tree
Opiliaceae	
Lepionurus sylvestris	
Aquifoliaceae	
Ilex dipyrena	tree
I. fragilis	tree
I. godajam	tree
I. hookeri	tree
I. kingiana	tree
Celastraceae	
Cassine glauca	tree
Euonymus hamiltonianus	tree
Maytenus hookeri	shrub
M. kurzii	shrub
M. rufa	shrub
M. sikkimensis	shrub
Lophopetalum wightianum	small tree
Rhamnaceae	
Hovenia acerva	shrub
Rhamnus nepalensis	shrub
R. virgatus	shrub
Sageretia lanceolatus	shrub
Zizyphus incurva	shrub
Z. jujuba	shrub
Z. mauritiana	shrub
Leeaceae	
Leea asiatica	shrub
L. compactiflora	shrub
Sapindaceae	
Lepisanthes rubiginosa	tree
Sapindus detergens	tree
Hippocastanceae	
Aesculus indica	tree

Species	Habit
Aceraceae	
Acer oblongum	tree
A. oblongum var. *sikkimensis*	tree
A. osmastonii¥	tree
A. hookeri¥	tree
Staphyleaceae	
Turpinia nepalensis	tree
T. pomifera	tree
Sabiaceae	
Meliosma dillenifolia	tree
M. pinnata	tree
Sabia parviflora	shrub
Anacardiaceae	
Choerospondias axillaris	tree
Drimycarpus racemosus	tree
Lannea coromandelica	tree
Mangifera sylvatica	tree
Rhus chinensis	tree
R. griffithii	tree
Semecarpus anacardium	tree
Spondias pinnata	tree
Moringaceae	
Moringa oleifera	tree
Mimosaceae	
Acacia auriculiformis	tree
A. catechu	tree
A. decurrens	tree
A. farnesiana	tree
A. lenticularis	tree
A. melanoxylum	tree
Albizia chinensis	tree
A. lebbeck	tree
A. lucida	tree
A. odoratissima	tree
A. procera	tree
Leucaena leucocephala	tree
Mimosa himalayana	shrub
M. pudica	undershrub
Caesalpiniaceae	
Acrocarpus fraxinifolius	tree
Adenathera pavonia	tree
Bauhinia malabarica	tree
B. purpurea	tree
B. variegata	tree
Tamarindus indicus	tree
Caesalpinia cucullata	shrub
C. crista	shrub

Species	Habit
C. bonduc	climber
Cassia mimosoides	shrub
Cassia sophera	shrub
C. occidentalis	shrub
C. ora	shrub
C. fistula	tree
Papilionaceae	
Delonix regia	tree
Butea monosperma	*tree*
Dalbergia assamica	
D. latifolia	tree
D. rimosa	tree
D. sericea	tree
D. sissoo	tree
Erythrina stricta	tree
E. arborescens	tree
Milletia pachycarap	climber
M. glaucescens	climber
M. pulchra	tree
Pongamia pinnata	tree
Samanea saman	tree
Indigofera dosua	shrub
Desmodium pulchelum	shrub
D. triangulare	shrub
D. gyroides	shrub
D. gangeticum	shrub
D. confertum	shrub
D. triflorum	shrub
D. laxiflorum	shrub
Crotolaria cystisoides	shrub
C. juncea	shrub
Rosaceae	
Cotoneaster bacillaris	shrub
C. fragidus	shrub
C. microphyllus	shrub
Docynia indica	shrub
Eriobotrya hookeriana	tree
E. dubia	tree
E. petiolata	tree
Malus pumila	tree
Photinia integrifolia	tree
P. cuspidata	tree
Prunus armeniaca	tree
P. cerasoides	tree
P. cornuta	tree
P. domestica	tree
P. napaulensis	tree

Species	Habit
P. persica	tree
P. rufa	tree
P. pashia	tree
P. communis	tree
Sorbus rhamnoides	tree
S. thomsonii	tree
Rubus niveus	shrub
R. ellipticus	shrub
R. brunoni	shrub
Rosa sericea	shrub
Hydrangeaceae	
Hydrangea heteromala	shrub
H. robusta	shrub
Dichroa fabrifuga	shrub
Philadelphaceae	
Deutzia crenata	shrub
Hamamelidaceae	
Altingia excelsa	tree
Exbuclandia populnea	tree
Combretaceae	
Terminalia alata	tree
T. bellirica	tree
T. chebula	tree
T. catappa	tree
T. crinata	tree
T. myriocarpa	tree
Myrtaceae	
Eucalyptus tereticornis	tree
Psidium guajava	tree
Eugenia bracteata	tree
Syzygium cuminii	tree
S. formosum	tree
S. jambos	tree
S. venosum	tree
S. ramosissimum	tree
Lecythidaceae	
Careya arborea	tree
Melastomataceae	
Melastoma malabathricum	shrub
M. normale	shrub
Osbeckia chinensis	shrub
O. nepalensis	shrub
O. stellata	shrub
Ostodes paniculata	tree
Oxyspora paniculata	shrub
Lythraceae	
Lagerstroemia minuticarpa	tree

Species	Habit
L. parviflora	tree
L. hirsurta	tree
Woodfordia fruticosa	shrub
Lawsoniainermis	shrub
Sonneratiaceae	
Duabanga grandiflora	tree
Datisacceae	
Tetrameles nudiflora	tree
Araliaceae	
Aralia foliosa	small tree
A. armata	shrub
Brassiopsis glomerulata	small tree
B. hainla	small tree
B. hispida	small tree
B. mitis	small tree
Gambelia ciliata	small tree
Hetropanax fragrans	small tree
Macropanax dispermus	small tree
M. undulatus	tree
Pentapanax fragrans	small tree
P. racemosus	shrub
Schefflera elata	small tree
S. impressa	tree
S. benghalensis	tree
Trevesia palmata	shrub
Cornaceae	
Mastixia arborea	tree
M. penticulata	tree
Benthamidia capiatata	shrub
Swida controversa	tree
Helwingia himlaica	shrub
Alangiaceae	
Alangium alpinum	tree
A. chinense	tree
Nyssaceae	
Nyssa javanica	shrub
Caprifoliaceae	
Viburnum erubescens	shrub
V. coriaceum	shrub
V. mullaha	shrub
Rubiaceae	
Haldina cordifolia	tree
Neolamarckia cadamba	tree
Canthium glabrum	tree
Cephalanthus tetrandra	small tree
Psilanthus bengalensis	shrub
P. campanulata	small tree

Species	**Habit**
Hymenodictyon excelsum	shrub
H. flaccidum	shrub
Hyptianthera stricta	shrub
Meyna spinosa	tree
Ixora athroantha	shrub
I. coccinea	shrub
Lasianthus biermanii	shrub
L. sikkimensis	shrub
Luculia gratissima	shrub
Mitragyna parviflora	tree
Morinda angustifolia	small tree
Mussaenda frondosa	shrub
M. glabra	shrub
M. roxburghii	shrub
Neonaulea griffithii	tree
Uncaria sessiliffructus	climber
Neohymenopogon parasiticus	shrub
Hymenodictyon flaccdum	shrub
Ophiorrhiza fasciculata	shrub
Pavetta tomentosa	shrub
Psychotria erratica	shrub
P. calocarpa	shrub
P. denticulata	shrub
Paederia cuddasiana	shrub
Randia sikkimensis	shrub
Psydrax kingii	shrub
Wendlandia coriacea	tree
W. grandis	tree
W. tinctoria	tree
W. wallichii	tree
Tamilnadia ulginosa	small tree
Asteraceae	
Vernonia taulimifolia	small tree
V. volkameriifolia	small tree
V. subsessilis	shrub
Ericaceae	
Enkianthus deflexus	small tree
Lyonia ovalifolia	tree
L. villosa	tree
Pieris formosa	shrub
Gaultheria fragrantissima	shrub
G. semi-infera	shrub
G. hookeri	shrub
G. nummularoides	shrub
Agaptes auriculata	epiphytic shrub
A. sikkimensis	epiphytic shrub
A. saligna	epiphytic shrub

Species	**Habit**
A. surpens	epiphytic shrub
A. hookeri	epiphytic shrub
Vaccinum dunalianum	epiphytic shrub
V. glauco-album	shrub
V. retusum	ep. shrub
V. nummularia	ep. shrub
V. vacciniaceum	shrub
Rhododendron anthopogon	shrub
R. arboreum var.*roseum*	tree
R. cinnabarinum subsp.*cinnabarinum*	shrub
R. dalhousiae	shrub
R. edgeworthii	small tree
R. falconeri	small tree
R. grande	tree
R. griffithianum	small tree
R. lepidotum	shrub
R. triflorum	shrub
R. vaccinioides	shrub
R. wallichii	shrub
Myrsinaceae	
Maesa chisia	shrub
M. macrophylla	shrub
M. rugosa	shrub
M. indica	small tree
M. montana	shrub
Rapanea capitellata	small tree
Myrsine semiserrata	shrub
Embelia ribes	shrub
E. floribunda	shrub
E. tsjeriam-cottam	small tree
Ardisia macrocarpa	shrub
A. colorata	shrub
A. thyrsiflora	shrub
A. solanacea	shrub
Sapotaceae	
Diploknema butyracea	tree
Xantolis hookeri	tree
Sarcospermaceae	
Sarcosperma arboreum	tree
Ebenaceae	
Diospyros lanceaefolia	tree
D. malabarica	tree
Styraceae	
Styrax serrulatus	small tree
S. grandiflorus	small tree
Symplocaceae	
Symplocos cochinensis	tree

Species	**Habit**
S. sumunita	small tree
S. racemosa	tree
S. ramosissima	tree
S. lucida	tree
Oleaceae	
Fraxinus paxiana var. *sikkimensis*	tree
Osmanthus suavia	tree
O. fragrans	small tree
Chionanthus ramiflorus	small tree
Olea dioica	tree
O. gamblei	tree
Ligustrum confusum	small tree
Nyctanthes arbor-tristis	tree
Loganniaceae	
Buddleja asiatica	shrub
Strychnaceae	
Gardneria angustifolia	climber
Apocynaceae	
Carissa paucinerva	shrub
C. spinarum	shrub
Cerbera manghas	small tree
Rauvolfia serpentina	shrub
Alyxia gracilis	climber
Allamcanda cathartica	shrub
Plumeria rubra	small tree
Altsonia scholaris	tree
Holarrhena pubescens	tree
Tabernaemontana divaricata	shrub
Wrightia coccinea	tree
W. arborea	tree
Beaumontia grandiflora	climber
Vallaris solanacea	climber
Strophanthus wallichii	climber
Aganosma marginata	robust climber
Chonemorpha fragrans	large climber
Trachelospermum axillare	large climber
T. lucidum	large climber
Ichnocarpus polyanthus	climber
I. volubilis	climber
Asclepiadaceae	
Cryptolepis buchanani	climber
C. sinensis	climber
Hemidesmus indicus	Shrub
Periploca calophylla	climber
Toxocarpus himalensis	climber
Genianthus laurifolius	climber
Cynanchum corymbosum	Climber

Species	Habit
Calotropis acia	Shrub
C. gigantea	Shrub
C. procera	Shrub
Asclepias curassavica	Shrub
Gymnema tingens	climber
G. macranthum	climber
Gongronema nepalense	climber
G. thomsonii	climber
Telosma pallida	climber
Marsdenia tinctoria	climber
M. roylei	climber
Hoya linearis	climber
H. longifolia	climber
H. lanceolata	Shrub
H. arnottiana	Shrub
Tylophora hirsuta	Shrub
Ceropegia pubescens	climber
Convolvulaceae	
Rivea ornata	climber
Argyreia sikkimensis	climber
A. roxburghii	climber
Ipomoea carnea	Shrub
Porana grandiflora	climber
Boraginaceae	
Cordia obliqua	tree
Ehretia wallichiana	tree
Cynoglossum pedicellata	Herb
Cuscutaceae	
Cuscuta reflexa	Herb
Solanaceae	
Solanum verbascifolium	Shrub
Scrophulariaceae	
Wightia speciosissima	tree
Gesneriaceae	
Rhynchotechum ellipticum	herb
Bignoniaceae	
Jacaranda mimosifolia	tree
Oroxylum indicum	tree
Sterospermum chelonoides	tree
S. personatum	tree
Acanthaceae	
Phlogacanthus thyrsiflorus	Shrub
Verbenaceae	
Callicarpa arborea	tree
Clerodendrum colebrookeanum	shrub
C. bracteatum	Shrub
Gmelina arborea	tree

Species	Habit
Premna barbata	tree
P. bracteata	tree
P. latifolia	tree
Tectona grandis	tree
Vitex negundo	tree
V. heterophylla	tree
Lamiaceae	
Leucoceptrum canum	shrub
Myrsticaceae	
Horsfieldia kingii	tree
Kneema linifolia	tree
Lauraceae	
Actinodaphne angustifolia	tree
A. obovata	tree
A. sikkimensis	tree
Alseoddaphne owdenii	tree
Beilschmiedia roxburghiana	tree
B. assmica	tree
B. dalzellii	tree
Cinnamomum bejolghota	tree
C. paniculata	tree
C. glanduliferum	tree
C. glauscescens	tree
C. tamala	tree
Cryptocarya amygdalina	tree
Dodacadenia grandiflora	tree
Lindera assamica	tree
L. heterophylla	tree
L. neesiana	tree
L. pulcherrima	tree
Litsea albescens	tree
L. chartacea	tree
L. cubeba	tree
L. elongata	tree
L. hookeri	tree
L. kingii	tree
L. monopetala	tree
L. panamanja	tree
L. polyantha	tree
Persea edulis	tree
P. americana	tree
P. clarkeana	tree
P. duthei	tree
P. gamblei	tree
P. odoratissima	tree
P. robusta	tree
Phoebe attenuata	tree

Species	**Habit**
P.hainesiana	tree
P. lanceolata	tree
Proteaceae	
Helicia nilagirica	tree
Santalaceae	
Pyrularia edulia	Shrub
Bischofiaceae	
Bischofia javanica	tree
Euphorbiaceae	
Alchornea mollis	tree
A. tiliifolia	tree
Antidesma acidum	tree
A. acuminatum	tree
A. bunius	tree
Aporosa octandra	tree
Baccaurea ramiflora	tree
Bridelia tomentosa	tree
B. pubescens	tree
B. retusa	tree
Cleidion spiciflorum	tree
Croton caudatus	tree
C. roxburghii	tree
Drypetes assamica	tree
Endospermum chinense	tree
Flueggea virosa	Shrub
F. acuminatum	Shrub
Glochidion hirsutum	tree
G. lanceolarium	tree
G. nubigenum	tree
G. thomsonii	tree
G. velutinum	tree
Macaranga denticulata	tree
M. pustulata	tree
Mallotus philippinensis	tree
M. oreophilus	tree
M. repandus	tree
M. tetracoccus	tree
Ostodes paniculata	tree
Phyllanythus emblica	tree
Sapium baccatum	tree
S. insigne	tree
Trewia nudiflora	tree
Daphniphyllaceae	
Daphniphyllum himalense	tree
Urticaceae	
Boehmaria macrophylla	Shrub
B. rugulosa	tree

Species	Habit
B. pendulifera	Shrub
Sarcochlamys pulcherrima	Shrub
Villebrunea rubescens	Shrub
Debregeasia longifolia	Shrub
Ulmaceae	
Celtis tetrandra	tree
Ulmus lanceifolia	tree
Trema timorensis	tree
T. orientalis	tree
Moraceae	
Artocarpus chama	tree
A. integrifolia	tree
A. lacucha	tree
Brassonetia papyrifera	Shrub
Ficus altisima	tree
F. auriculata	tree
F. benghalensis	tree
F. benjamina	tree
F. concinna	tree
F. cryptophylla	tree
F. squamosa	tree
F. semicordata	tree
F. oligodon	tree
F. hispida	tree
F. racemosa	tree
F. religiosa	tree
F. eleastica	tree
F. neriifolia	tree
F. virens	tree
F. hookeriana	tree
F. tinctoria	tree
F. subincisa	tree
F. glaberrima	tree
F. hederacea	Shrub
Betulaceae	
Alnus nepalensis	tree
Carpinus viminea	tree
Betula alnoides	tree
Juglandaceae	
Engelhardtia spicata	tree
Juglans regia	tree
Fagaceae	
Castanea sativa	tree
Castanopsis indica	tree
C. hystrix	tree
C. lanceifolia	tree
C. tribuloides	tree

Species	Habit
Lithocarpus elegans	tree
L. pachyphylla	tree
Quercus glauca	tree
Q. griffithii	tree
Q. lamellosa	tree
Q. thomsoniana	tree
Salicaceae	
Populus cliata	tree
P. gamblei	tree
Salix babylonica	tree
S. ongifolia	tree
S. tetrasperma	tree
S. wallichiana	shrub
Monocots :	
Arecaceae	
Areca catechu	tree
Caryota urens	tree
Cocos nucifera	tree
Livistona chinensis	tree
L. jenkinsiana	tree
Trachycarpus fortunei	tree
Calamus erectus	shrub
C. flagellum	shrub
C. leptospadix	shrub
C. acanthospathus	climber
C. guruba	climber
Plectocomia himalayana	shrub
Wallichia densiflora	shrub
Pinanga gracilis	shrub
Pandanaceae	
Pandanus nepalensis	tree
Poaceae	
Bambusa arundinacea	shrub
B. pallida	shrub
B. tulda	shrub
Chimnobambusa hookeriana	shrub
Dendrocalamus hamiltonii	shrub
D. sikkimensis	shrub
D. hookeri	shrub
Phyllostachys assamica	shrub
Yushania pantlingii	shrub
Thamnocalamus aristatus	shrub

Source : Primary Survey

* = threatened species from secondary sources

(*Checklist of CITES; Red Data Book of India¥ (Nayar & Sastry (1987, 1988, 1990)

6.14 RARE, ENDEMIC AND THREATENED PLANTS

The list of Rare, Endemic and Threatened Plants of Teesta Basin, West Bengal (Portion) is given in Table-6.12.

Table-6.12: List of Rare, Endemic and Threatened Plants of Teesta Basin, West Bengal Portion

Species	**Habit**	**RDB Status**
Pteridophytes		
Thelypteridaceae		
Christella clarkia	terrestrial fern	VU
Ranunculaceae		
Aconitum ferox	terrestrial herb	VU
Aceraceae		
Acer hookeri var. *major*	tree	EN
A. osmastonii	tree	EN
Begoniaceae		
Begonia rubella	herb	Rare
Begonia satrapis	herb	Rare
Vitaceae		
Cissus spectabilis	Shrub	Rare
Apiaceae		
Pimpinella tongloensis	herb	EN
Rubiaceae		
Hedyotis scabra	herb	Rare
Ophiorrhiza lurida	herb	Rare
Campnulaceae		
Codonopsis affinis	twining herb	Rare
Ericaceae		
Rhododendron edgeworthii	small tree	Rare
Orchidaceae		
Bulleyia yunnanensis	herb	Rare
Cymbidium eburnum	herb	
Diplomeris hirsute	herb	VU
Cocalvulaceae		
Tricarpelema giganteum	Rare	
Arecaceae		
Calamus inermis	shrub	EN
Phoenix rupicola	tree	Rare

Source :**Secondary (Red Data Book of India,** Nayar & Sastry (1987, 1988 and 1990)
EN = Endangered' ; VU = Vulnerable*

CHAPTER 7
FAUNAL ELEMENTS

CHAPTER-7

FAUNAL ELEMENTS

7.1 INTRODUCTION

Teesta river is one of the largest and important tributaries of Brahamputra river, draining two states of India - Sikkim and West Bengal and a part of Bangladesh. Total Length of river is about 414 km and drains an area of about 12,159 sq. km. of which 3225 sq. km lies in West Bengal. Teesta river basin in West Bengal can be divided into Bengal plains (up to 150 m), Siwalik belt (up to 800 m) and Darjeeling Himalaya. The river channels are cut in bedrock or filled with coarse boulders. Their unstable gradient is marked by waterfalls and hanging tributary valleys. In general, the flood plains of Teesta basin in West Bengal is dominated with agricultural land and built up area while its hilly terrains in west Bengal is covered mainly with dense and open forests. The low land areas of Teesta river basin in West Bengal are slightly distressed by small settlements, national highway and high traffic density but uphill areas in the catchment are endowed with rich forests and patchily distributed settlements especially on right bank in general. The rich biodiversity in the catchment is signified by the presence of rich protected are network, viz. Mahanada Wildlife Sanctuary, Senchal Wildlife Sanctuary and Kitam Bird Sanctuary.

The Study Area is mainly covered with Semi Evergreen, Tropical Moist deciduous, Sub Tropical Wet Hill Forests and Temperate forests. The climate of the region is tropical monsoonal with wet (May to October) and dry (November to April) periods. The area is highly humid throughout the year (Humidity range: 70 – 100%).

Apart from the settlements, agricultural and horticultural practices including tea plantation, road construction, vehicular movement, etc no other anthropogenic pressures were prevalent in immediate vicinity of Teesta river draining Darjeeling hills. In recent years developmental activities have increased rapidly in the area, the environmental issues, therefore, become more debatable due to excessive development pressure. The cascade development in Teesta valley is assumed to bring the land use changes and its cumulative impacts on the habitat of wildlife can be considered as challenging problem (e.g. Theobald et al., 1997). The developmental activities may affect wildlife habitats directly and wildlife indirectly. The direct impacts which are associated with habitats are habitat loss, habitat fragmentation, changing landscape, hampering animal corridors, high noise, increasing population etc., which in turn affect wildlife depending upon the distance from the activities area. Such distance depends on the types and nature of activities, individual animal, seasons and habitat type.

Notably, the impacts are also foreseen beyond the actual area of development. In this study, therefore, the baseline data have been addressed in view of the impacts of individual projects as well as cumulative impacts of all existing and likely impacts of proposed projects. The pragmatic issue is that what geographical area should be addressed where impacts of developmental activities are anticipated to lead immense effects.

7.2 FAUNAL AFFINITIES

Geographical position of the present study area confirms the rich faunal diversity as it is a transitional zone between Bhutan and north-eastern region of India on east, West Bengal on south, Sikkim on north and Nepal on west. Thus, high altitude faunal elements have an affinity with Palaearctic forms and medium and low altitude species are allied with Indo-Malayan and oriental forms. The important species which are of Palaearctic origin are *Cuon alpinus, Vulpes vulpes, Martes foina, Mustella sibirica, Lutra lutra, Selenarctos thibetanus, Chrysoplegma flavinucha, Dendrocopos darjellensis* etc. (e.g. Chattopadhayay et.al. 2006). The fauna which are mostly Indo-Chinese or Indo-Malayan in origin are *Soriculus nigrescens, Rousettus leschenaulti, Macaca assamensis, Semnipithecus entellus, Prionodon pardicolor, Viverra zibetha, Arctictis binturong*, Heron, Cormorant, Hornbill species etc

7.3 MAMMALS

7.3.1 Species Composition and Distribution Pattern

Mammalian fauna in the study area comprises of about 80 species belonging to 24 families. Shrews (Soricomorpha) comprises of about 4 species. *Soriculus nigrescens* is distributed in the forests of middle hills while *Tupaia belangeri lepcha* is commonly found in lower reaches of the study area. *Suncus murinus soccatus* and *Euroscaptor micrura* are widely distributed in the catchment.

Bats (Chiroptera) are represented nearly by 16 species. Most of the species are distributed commonly in the Study Area. However, species like *Barbastella leucomelas darjelingensis* is restricted above 1000 m in Darjeeling and Kalimpong hills while a few species, like *Tylonycteris pachypus fulvida* are found in lower reaches inhabiting bamboo thickets.

Non human primates are represented by 3 species. *Macaca assamensis* and *Macaca mulatta* are widely distributed in the study area up to 1500 m. While *Semnopithecus hector* is restricted in lower reaches like nearby area of Mahananda Wildlife Sanctuary and left bank of Teesta river near Sevok and Kalijora area. Macaques are generally found in groups while Langur are scattered. The flocks of Rhesus and Assamese macaques are found all along national highways and near human habitation. These two are most adaptable and are habitual to live amidst human habitations. These species are foreseen to be affected least by developmental activities.

Canidae (Carnivora) is represented by three species, of which Golden Jackal (*Canis aureus indicus*) is widely distributed in the study area from foothills to 1500 m while Indian Wild Dog (*Cuon alpinus primaevus*) and Red Fox (*Vulpes vulpes montana*) are restricted in their occupancy. They are distributed along the Darjeeling hills, probably within Senchal Wildlife Sanctuary. Cats include 8 species in the Study Area. *Prionailurus bengalensis horsfieldi*, *Prionailurus viverrinus viverrinus* and *Panthera pardus* are common in distribution while *Panthera tigris* is restricted in the foothills mostly in the Mahananda Wildlife Sanctuary. Clouded Leopard (*Neofelis nebulosa macrosceloides*) inhabits inner part of forests like Kalimpong and Darjeeling hills. Asian Golden Cat (*Catopuma temminckii temminckii*) is distributed up to an elevation of 1500 m. Mongoose comprised of three species. They are mostly found on the scrubby area and are commonly observed from river valleys to uphill area.

Family Mustelidae is represented by 6 species. Common Indian Hill Otter (*Lutra lutra monticola*) is found in Teesta and Rangit rivers within Study Area. Local residents also revealed its presence in these rivers. Himalayan Yellow-throated Marten(*Martesflavigula flavigula*) is distributed 1200–2700 m and commonly found in the study area. Hog Badger (*Arctonyx collaris collaris*) and Yellow-bellied Weasel (*Mustela kathiah kathiah*) inhabits dense forests of the catchment. Red Panda (*Ailurus fulgens*) is basically inhabitant of temperate and sub-alpine zone. In the study area it is reportedly reintroduced in Senchal Wildlife Sanctuary. Bear family includes Sloth Bear (*Melursus ursinus*) and Asiatic or Himalayan Black Bear (*Ursus thibetanus*). Both species are found in the north West Bengal including Darjeeling hills. Civets comprises of 4 species and are widely distributed in the study area.

Order Proboscidea is represented by Indian Elephant (*Elephas maximus indicus*) within study area, it is restricted to Mahananda Wildlife Sanctuary and sighted many times by visitors and local people. However, its movement near the project sites and Sevok is not frequent.

Artiodactyla comprises of 7 species of three families. Wild Boar (*Sus scrofa*) is widely distributed in the study area. Its distribution range extends from 50 m to 1500 m in the study area. It is one of the most commonly sighted animals in this area. Spotted Deer (*Axis axis*) is restricted to lower reaches (Mahananda Wildlife Sanctuary and its surroundings) while Barking Deer (*Muntiacus muntjak*) is one of the most common species in this area. It is widely distributed and its calls are generally noted by the people. Sambar (*Rusa unicolor*) inhabits dense forests up to middle hills of the study area. Brown Goral (*Naemorhedus goral*) and Mountain Goat *Capricornis sumatraensis*) are distributed up to 1100 m in the study area while Indian Bison (*Bos gaurus*) is restricted lower fringe of the study area, which cover a part of Mahananda Wildlife Sanctuary. It is not a commonly sighted animal.

About 8 species of the squirrels inhabit the Study Area. Among the squirrels Hoary-bellied Himalayan Squirrel (*Callosciurus pygerythrus*) and Orange-bellied Himalayan Squirrel (*Dremomys lokriah lokriah*) are most commonly observed. In elevation laying from foothill stretch to 2000 m. Black Giant Squirrel (*Ratufa bicolor gigantean*) is not common and inhabits woody forest stands. It is generally reported from surroundings of Rangpo area. Flying squirrels inhabit inner dense forests Particolored Flying Squirrel (*Hylopetes alboniger*) is found above an elevation of 1500 m. Spotted Giant Grey-headed Flying Squirrel (*Petaurista elegans*) and Common Red Giant Flying Squirrel (*Petaurista petaurista*) are distributed from 500–2000 m in the study area. Family Muridae is represented nearly by 7 species. Generally they are common in distribution. Two species of porcupines, viz. Himalayan Porcupine (*Hystrix brachyuran*) and Indian Crested Porcupine (*Hystrix indica indica*) are reported from the area. Former is restricted to the hilly areas while Crested Porcupine *Hystrix indica indica* is found all over the Kanchenjunga Conservation Area including Mahananda Wildlife Sanctuary. Indian Black-naped Hare (*Lepus nigricollis*) is widely distributed in the study area from Foothills to Kalimpong hills.

Family Manidae (order- Pholidota) comprises of 2 species namely *Manis crassicaudata* and *Manis pentadactyla aurita*. Former is restricted to foothills while *Manis pentadactyla aurita* is distributed along the middle Darjeeling and Kalimpong hills. The list of mammal species found in the Study Area alongwith their conservation status is given in Table-7.1.

Table-7.1. Species composition and their conservation status in the study area

S. No	Family/Common Name	Scientific Name	Conservation status	
			IUCN (2015)	IWPA
	Soricidae			
1.	Mouse-tailed Forest Shrew	*Soriculus nigrescens*	LC	-
2.	Grey Musk Shrew or House Shrew	*Suncus murinus soccatus*	LC	-
	Talpidae			
3.	Eastern Short-tailed	*Euroscaptor micrura*	LC	-
	Tupaiidae			
4.	Assam Tree-shrew	*Tupaia belangeri lepcha*	LC	-
	Pteropodidae			
5	Short-nosed Indian Fruit Bat	*Cynopterus sphinx sphinx*	LC	V
6.	Indian Fulvous Fruit Bat	*Rousettus leschenaulti*	LC	V
	Rhinolophidae			
7.	Great Eastern Woolly Horseshoe Bat	*Rhinolophus luctus perniger*	LC	-
8.	Least Horseshoe Bat	*Rhinolophus pusillus*	LC	-
9.	Gray Fulvous Leaf-nosed Bat	*Hipposideros fulvus*	LC	-

S. No	Family/Common Name	Scientific Name	Conservation status	
			IUCN (2015)	IWPA
10.	Andersen's Leaf-nosed Bat	*Hipposideros pomona*	LC	-
	Vespertilionidae			
11	Eastern Barbastelle Bat	*Barbastella leucomelas*	LC	-
12.	Common Serotine Bat	*Eptesicus serotinus*	LC	-
13	Common Indian Noctule	*Nyctalus noctula*	LC	-
14	Himalayan Pipistrelle	*Pipistrellus babu*	LC	-
15.	Coromondel Pipistrelle	*Pipistrellus coromandra*	LC	-
16.	Javan's Pipistrelle	*Pipistrellus javanicus*	LC	-
17	Indian Pygmy Pipistrelle	*Pipistrellus mimus*	LC	-
18.	Club-footed or Bamboo Bat	*Tylonycteris pachypus*	LC	-
19	Hutton's Tube-nosed Bat	*Murina huttoni*	LC	-
20.	Scully's Tube-nosed Bat	*Murina tubinaris*	LC	-
	Cercopithecidae			
21.	Assamese Macaque	*Macaca assamensis*	NT	II
22.	The Rhesus Macaque	*Macaca mulatta*	LC	II
23	Grey Langur	*Semnopithecus hector*	NT	II
	Canidae			
24.	Golden Jackal	*Canis aureus indicus*	LC	II
25.	Indian Wild Dog	*Cuon alpinus*	EN	II
26.	Red Fox	*Vulpes vulpes montana*	LC	II
	Felidae			
27	Asian Golden Cat	*Catopuma temminckii*	NT	I
28.	Jungle Cat	*Felis chaus affinis*	LC	II
29.	Leopard Cat	*Prionailurus bengalensis*	LC	I
30.	Fishing Cat	*Prionailurus viverrinus*	EN	I
31.	Clouded Leopard	*Neofelis nebulosa*	VU	I
32.	Leopard or Panther	*Panthera pardus*	NT	I
33.	Tiger	*Panthera tigris*	EN	I
34.	Marbled Cat	*Pardofelis marmorata*	VU	I
	Herpestidae			
35.	Indian Grey Mongoose	*Herpestes edwardsii*	LC	IV
36.	Small Indian Mongoose	*Herpestes auropunctatus*	-	IV
37.	Crab-eating Mongoose	*Herpestes urva*	LC	IV
	Mustelidae			
38.	Common Indian Hill Otter	*Lutra lutra monticola*	NT	II
39.	Small Clawed Otter	*Amblonyx cinereus*	VU	I
40.	Hog Badger	*Arctonyx collaris collaris*	NT	I
41.	Himalayan Yellow-throated Marten	*Martes flavigula*	LC	II
42.	Beech Marten or Stone Marten	*Martes foina*	LC	II
43.	Yellow-bellied Weasel	*Mustela kathiah*	LC	II
	Ailuropodidae			
44.	Red Panda	*Ailurus fulgens*	VU	I
	Ursidae			
45.	Sloth Bear	*Melursus ursinus*	VU	I
46.	Asiatic or Himalayan Black Bear	*Ursus thibetanus*	VU	I
	Viverridae			

S. No	Family/Common Name	Scientific Name	Conservation status	
			IUCN (2015)	IWPA
47.	Himalayan or Masked Palm Civet	*Paguma larvata*	LC	II
48.	Common Palm Civet	*Paradoxurus hermaphrodit us*	LC	II
49.	Large Indian Civet	*Viverra zibetha zibetha*	NT	II
50.	Small Indian Civet	*Viverricula indica baptistae*	LC	II
	Elephantidae			
51.	Indian Elephant	*Elephas maximus indicus*	EN	I
	Suidae			
52.	Indian Wild Boar	*Sus scrofa cristatus*	LC	IV
	Cervidae			
53.	Spotted Deer or Cheetal	*Axis axis axis*	LC	
54.	Sambar	*Rusa unicolor*	VU	IV
55.	The Barking Deer	*Muntiacus muntjak*	LC	III
	Bovidae			
56.	Brown Goral	*Naemorhedus goral*	NT	III
57.	Mountain Goat	*Capricornis sumatraensis*	VU	I
58.	Indian Bison	*Bos gaurus*	VU	I
	Sciuridae			
59.	Hoary-bellied Himalayan Squirrel	*Callosciurus pygerythrus*	LC	-
60.	Orange-bellied Himalayan Squirrel	*Dremomys lokriah lokriah*	LC	-
61.	Black Giant Squirrel	*Ratufa bicolor gigantea*	NT	II
62.	Himalayan Striped Squirrel	*Tamiops macclellandi*	LC	-
	Pteromyidae			
63.	Particolored Flying Squirrel	*Hylopetes alboniger*	LC	II
64.	Spotted Giant Grey-headed Flying Squirrel	*Petaurista elegans*	LC	II
65.	Common Red Giant Flying Squirrel	*Petaurista petaurista*	LC	II
66.	Hodgson's Common Giant Flying Squirrel	*Petaurista magnificus hodgsoni* LC	II	
	Muridae			
67.	House Mouse	*Mus musculus*	LC	V
68.	Bush Rat	*Mus pahari pahari*	LC	V
69.	Smoke-bellied Rat	*Niviventer eha*	LC	V
70.	Himalayan Chestnut White-bellied Rat	*Niviventer fulvescens*	LC	V
71.	Hodgson's Grey-bellied or Himalayan Rat	*Rattus nitidus*	LC	V
72.	House Rat	*Rattus rattus*	LC	V
73.	Sikkim rat	*Rattus sikkimensis*	LC	V
74.	Indian Long-tailed or Hodgson's Tree-mouse *Vandeleuria oleracea*	LC	V	
	Hystricidae			
75.	Himalayan Porcupine	*Hystrix hogsonii*	LC	II
76.	Indian Crested Porcupine	*Hystrix indica*	LC	IV

S. No	Family/Common Name	Scientific Name	Conservation status	
			IUCN (2015)	IWPA
	Ochotonidae			
77.	Indian Black-naped Hare	*Lepus nigricollis*	LC	IV
	Manidae			
79	Indian Pangolin	*Manis crassicaudata*	EN	I
80	Chinese Pangolin	*Manis pentadactyla aurita*	EN	I

7.3.2 Site Specific Study

During the primary surveys a total of 14 mammalian species were recorded from the study area through direct and indirect evidences (Refer Table-7.2). Assamese Macaque (*Macaca assamensis*) and Rhesus Macaque (*Macaca mulatta*) were most common species, found in all three seasons. Other species listed in Table 7.2 were spotted at different sites in different seasons. Except Barking deer, all species were directly spotted from different areas; while Barking deer was spotted with the help of its call in the vicinity of Teesta Low Dam ProjectStage I & II along the Rangit river. In addition to the species recorded during pre-monsoon, monsoon and post monsoon seasons, Black Bear was spotted from the Kitam forests in the month of February. The information was also collected to find the trophies as indirect evidence of the presence of mammalian species. During 3 season surveys none of the trophies could be located in the surveyed households. Local people were interviewed during the survey to confirm the presence mammalian species in the study area. Local people confirmed the presence of most of the species listed in Table 7.1 in the study area.

Table 7.2 Mammalian species recorded during the primary surveys in the study area during pre-monsoon, monsoon and post-monsoon seasons

Species	**proposed projects**																	
	TVI						**TVI**						**TVI**					
	PrM		**PrM**		**PrM**		**PrM**		**PrM**		**PrM**		**PrM**		**PrM**		**PrM**	
Assamese Macaque (*Macaca assamensis*)	-	-	+	-	+	+	-	-	+	+	-	-	+	+	-	+	+	-
The Rhesus Macaque (*Macaca mulatta*)	-	-	-	-	-	-	+	-	+	+	-	-	-	-	-	-	-	-
Grey Langur (*Semnopithecus hector*)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+
Jungle Cat (*Felis chaus*)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
Golden Jackal (*Canis aureus*)	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
Indian Grey Mongoose (*Herpestes edwardsii*)	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	+	-	-
Stone Marten (*Martes foina*)	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Himalayan Palm Civet (*Paguma larvata*)	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
The Barking Deer (*Muntiacus muntjak*)*	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Himalayan Squirrel (*Dremomys lokriah*)	-	-	-	-	-	-	-	-	-	+	-	-	+	+	+	+	-	-
Grey-headed Flying Squirrel (*Petaurista elegans*)	-	-	-	-	-	-	+	-	-	-	-	-	-	+	-	-	-	-
Himalayan Striped Squirrel (*Tamiops macclellandi*)	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Short-nosed Bat (*Cynopterus sphinx sphinx*)	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
Andersen's Leaf-nosed Bat (*Hipposideros Pomona*)	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TVI = Teesta Stage VI; TINT = Teesta Intermediate; TLI&II = Teesta Low Dam ProjectSatge I and II; TLIII = Teesta Low Dam Project Stage III; TLIV = Teesta Low Dam ProjectStage IV; TLV = Teesta Low Dam ProjectStage V; PrM = pre-monsoon, M = Monsoon, PoM = Post-monsoon

Macaca assamese ***Semnopithecus hector*** ***Dremomys lokriah***

7.4 AVI-FAUNA

7.4.1 Species Composition

The inventory of avifauna is based mainly on the primary surveys, however, a few species reported from the study area by different sources (http://ibcn.in/) were included in the list outlined in Table-7.3. An inventory of 151 species of birds including 9 species from other sources was prepared from the study area during 3 season studies. The species were grouped under 44 families. Pre-monsoon, monsoon and post-monsoon surveys recorded 81, 79 and 65 species respectively. A few species like *Arborophila mandellii, Aceros nipalensis, Buceros bicornis, Gyps bengalensis, Gyps tenuirostris, Houbaropsis bengalensis, Brachypteryx hyperythra, Sphenocichla humei, Turdoides longirostris* and *Prinia cinereocapilla* were confirmed to inhabit the study area, however, they could not be located during the primary surveys. Majority of the species are common in the study area, however, the species confined to valleys nears water bodies included Common Merganser, Ibis, Egrets, Heron, Lapwings, Water Hen, Plover and Cormorants. Of these Oriental White Ibis (*Threskiornis melanocephalus*), which is restricted to foothill stretch especially in Mahananda Wildlife Sanctuary of the study area while River Lapwing (*Vanellus duvaucelii*) and Long-billed Plover (*Charadrius placidus*). are restricted to the lower reaches and found abundantly along the river banks of Teesta river.

Galliformes comprises of 4 species. These species are not common in the Study Area and show fragmented distribution. All species are found in the surroundings of Rangit river like Kitam and in lower reaches like Mahanada Wildlife Sanctuary. Relatively, Kaleej Pheasant (*Lophura leucomelana*) and Jungle Fowl (*Gallus Gallus*) are widely distributed in the study area.

Piciformes is represented by 9 species belonging to Picidae and Megalaimidae families. All species except Fulvous-breasted Woodpecker (*Dendrocopos macei*) and Darjeeling Woodpecker (*Dendrocopos darjellensis*) are commonly distributed in the study area, however, they are restricted in area occupancy and inhabit only woody forest stands. *Dendrocopos macei* and *Dendrocopos darjellensis* are found in the middle and upper hills of the catchment.

A total of 7 species belonging to 4 families represent Coraciformes. Indian Roller (*Coracias benghalensis*) and Bee Eaters are found all over the Study Area while all kingfishers are restricted to the valleys area of Teesta and Rangit river. Two species of Hornbills namely Rufous-necked Hornbill (*Aceros nipalensis*) and Great Hornbill (*Buceros bicornis*) are reported from this region. They are distributed in the dense forests of Darjeeling hills, Kitam hills, Kalimpong hills and Mahananda Wildlife Sanctuary.

Upupiformes includes only *Upupa epops*, which is very common in the distribution. Cuculiformes is represented by 7 species. Majority of species are common in distribution and inhabit open forests. Asian Koel (*Eudynamys scolopacea*) is rarely observed species and inhabits lower and middle reaches. Green-bellied Malkoha (*Phaenicophaeus tristis*) was spotted from ridge of Kitam bird Sanctuary

Falconiformes comprises of 8 species belonging to 2 families. White-rumped Vulture (*Gyps bengalensis*), Slender-billed Vulture (*Gyps tenuirostris*) and Common Kestrel *Falco tinnunculus*) are widely distributed from foothills (Mahananda Wildlife Sanctuary) to uphills (Kitam Bird Sanctuary) while Red-headed Vulture (*Sarcogyps calvus*) and Pallid Harrier (*Circus macrourus*) are mainly found in lower reaches like Mahananda Wildlife Sanctuary). Otidiformes is represented by a single species - Bengal Florican (*Houbaropsis benghalensis*), which is highly restricted in the flood plains and Mahananda Wildlife Sanctuary.

Trogoniformes is represented by a single species namely Ward's Trogon (*Harpactes wardi*). This species have wide distribution in general and distributed from tropical to temperate forests. In the study area it is found mainly in Kitam bird sanctuary and its adjacent area.

Strigidae comprised of three species, which are commonly distributed in the zone of influence. Two species (*Glaucidium* spp.) were spotted from Kitam forests while Bubo bubo was spotted from Kalijora valley.

Columbiformes comprises of about 6 species belonging to family Columbidae. Rock Pigeon *Columba livia* (Oriental Turtle Dove), *Streptopelia orientalis*) and Spotted Dove (*Streptopelia chinensis*) are very common and abundant in the study area. Yellow-footed Green Pigeon (*Treron phoenicoptera*) and Ashy Wood Pigeon (*Columba pulchricollis*) are also found in this region in wide range, however, they are not common and abundant as compared to other species of columbidae.

Passeriformes comprises of 89 species grouped under a total of 21 families. Muscicapidae is largest family comprising of 22 species. In general passerins are widely distributed in the study area however, a few species viz. Large Niltava (*Niltava grandis*), White-naped Yuhina (*Yuhina bakeri*), Green-backed Tit (*Parus monticolus*), Yellow Wagtail (*Motacilla flava*) are confined to upper and middle reaches of the study area. On the other hand, the species like Pied myna (*Sturnus contra*) and Richard’s Pipit (*Anthus richardi*) are restricted to lower reaches of the Teesta basin.

7.4.2 Distribution Habit

Present study area includes floodplains and foothill areas as well as middle hills of Teesta basin. Considering the entire study area about 47.5% bird species are widespread resident, however, slight variation in the composition can be observed between foothills and upper – middle hills of the basin. Widespread resident species are followed by sparse resident accounting for about 23% of the total species. Passage migrant species comprise of *Cuculus canorus*, *Falco amurensis*, *Dicrurus hottentottus*, *Turdus unicolor* and *Anthus richardi*, which descend in the winter season, however, they can be observed in the floodplains of study area. Summer visitor and winter visitor comprise of 5 and 4 species, respectively, however, winter visitors are common in lower reaches. There is only a vagrant species - *Mergus merganser*, recorded from Rimbi nallah.

Table-7.3 Avifaunal species composition, their distribution habit and conservation status in study area of Teesta basin

Family/Common Name	Scientific Name	Distribution Habit	IUCN (2015)	IWPA (1972)	Seasonal Distribution		
					PrM	M	PoM
Anatidae							
Common Merganser	*Mergus merganser*	v	LC	IV	-	-	+
Threskiornithidae							
Oriental White Ibis	*Threskiornis melanocephalus*	R	NT	IV	+	+	-
Rallidae							
Common Moorhen	*Gallinula chloropus*	R	LC	IV	+	+	+
White-breasted Water Hen	*Amaurornis phoenicurus*	R	LC	IV	-	+	-
Ardeidae							
Pond Heron	*Ardeola grayii*	R	LC	IV	-	-	+
Intermediate Egret	*Mesophoyx intermedia*	R	-	IV	+	+	+
Cattle Egret	*Bubulcus ibis*	R	LC	IV	+	+	+
Charadriidae							
River Lapwing	*Vanellus duvaucelii*	R	NT	IV	+	-	+
Long-billed Plover	*Charadrius placidus*	r	LC	IV	+	-	-
Phalacrococorax							
Great Cormorant	*Phalacrocorax carbo*	RW	LC	IV	+	+	-
Small Cormorant	*Microcarbo niger*	R	LC	IV	-	+	+
Phasianidae							
Red Jungle fowl	*Gallus gallus*	R	LC	IV	-	-	+
Indian Peafowl	*Pavo cristatus*	R	LC	I	-	+	+
Chestnut-breasted Partridge	Arborophila mandellii	r	VU	IV	-	-	-
Kaleej Pheasant	*Lophora leucomelanos*	R	LC	IV	-	-	+
Picidae							
Grey-capped Pygmy Woodpecker	Picoides *canicapillus*	R	LC	IV	+	-	-
Grey-headed Woodpecker	*Picus canus*	r		IV	-	+	-
Fulvous-breasted Woodpecker	*Dendrocopos macei*	R	LC	IV	+	-	-
Darjeeling Woodpecker	*Dendrocopos darjellensis*	R	LC	IV	+	+	-

Family/Common Name	Scientific Name	Distribution Habit	IUCN (2015)	IWPA (1972)	Seasonal Distribution		
					PrM	M	PoM
Greater Yellownap	Chrysoplegma *flavinucha*	R	LC	IV	-	+	-
Megalaimidae							
Blue-throated Barbet	*Megalaima asiatica*	R	-	IV	+	-	-
Great Barbet	*Megalaima virens*	R	LC	IV	+	+	+
Blue-eared Barbet	*Megalaima australis*	R	-	IV	+	+	+
Golden-throated Barbet	*Megalaima franklinii*	R	-	IV	-	+	-
Bucerotidae							
Rufous- necked Hornbill*	*Aceros nipalensis*	r	VU	I	-	-	-
Great Hornbill*	*Buceros bicornis*	R	NT	I	-	-	-
Upupidae							
Hoopoe	*Upupa epops*	RW	LC	IV	+	+	-
Coracidae							
Indian Roller	*Coracias benghalensis*	R	LC	IV	+	+	-
Alcedinidae							
Common Kingfisher	*Alcedo atthis*	R	LC	IV	+	-	+
White-throated Kingfisher	*Halcyon smyrnensis*	R	LC	IV	+	+	-
Cerylidae							
Crested Kingfisher	*Megaceryle lugubris*	R	LC	IV	-	-	+
Pied Kingfisher	*Ceryle rudis*	r		IV	-	+	-
Meropidae							
Green Bee-eater	*Merops orientalis*	R	LC	IV	+	-	+
Chestnut-headed Bee-eater	*Merops leschenaulti*	R	LC	IV	+	+	-
Cuculidae							
Asian Koel	*Eudynamys scolopacea*	R	LC	IV	+	-	-
Lesser Coucal	*Centropus bengalensis*	r	LC	IV	+	+	-
Crow pheasant	*Centropus sinensis*	R	LC	IV	+	-	-
Grey-bellied Cuckoo	*Cacomantis passerinus*	r	LC	IV	-	+	-
Plaintive cuckoo	*Cacomantis merulinus*	r	LC	IV	-	+	-
Common Cuckoo	*Cuculus canorus*	p	LC	IV	-	-	+
Green-billed Malkoha	*Phaenicophaeus tristis*	R	LC	IV	-	-	+
Psitticidae							

Family/Common Name	**Scientific Name**	**Distribution Habit**	**IUCN (2015)**	**IWPA (1972)**	**Seasonal Distribution**		
					PrM	**M**	**PoM**
Alexandrine Parakeet	*Psittacula eupatria*	R	LC	IV	+	-	-
Slaty-headed Parakeet	*Psittacula himalayana*	R	LC	IV	-	+	-
Accipitridae							
Northern Sparrowhawk	*Accipiter gentilis*	rw	LC	IV	+	+	-
Long-legged buzzard	*Buteo rufinus*	rW	LC	IV	-	-	+
White-rumped Vulture*	Gyps bengalensis	r	CR	IV	-	-	-
Slender-billed Vulture*	Gyps tenuirostris	r	CR	IV	-	-	-
Red-headed Vulture	*Sarcogyps calvus*	r	CR	IV	-	+	+
Pallid Harrier	*Circus macrourus*	w	NT	IV	-	+	-
Falconidae							
Common Kestrel	*Falco tinnunculus*	RW	LC	IV	-	+	+
Amur Falcon	*Falco amurensis*	p	LC	IV	+	+	-
Otididae							
Bengal Florican*	*Houbaropsis bengalensis*	w	CR	IV	-	-	-
Trogonidae							
Ward's Trogon	Harpactes wardi	r	NT	IV	+	-	-
Strigidae							
Asian Barred Owlet	*Glaucidium cuculoides*	r	LC	IV	+	+	-
Collared Owlet	*Glaucidium brodiei*	r	LC	IV	+	+	-
Eurasian Eagle Owl	*Bubo bubo*	r	LC	IV	-	+	-
Columbidae							
Rock Pigeon	*Columba livia*	R	LC	IV	+	+	+
Emerald Dove	*Chalcophaps indica*	r	LC	IV	+	-	-
Oriental Turtle Dove	*Streptopelia orientalis*	RW	LC	IV	+	+	+
Spotted Dove	*Streptopelia chinensis*	R	-	IV	+	+	+
Yellow-footed Green Pigeon	*Treron phoenicoptera*	R	LC	IV	+	-	-
Ashy Wood Pigeon	*Columba pulchricollis*	R	LC	IV	+	-	-
Hirundinidae							
Barn Swallow	*Hirundo rustica*	RW	LC	IV	+	+	+

Family/Common Name	Scientific Name	Distribution Habit	IUCN (2015)	IWPA (1972)	Seasonal Distribution		
					PrM	M	PoM
Nepal House Martin	*Delichon nipalensis*	r	LC	IV	+	-	-
Pittidae							
Hooded Pitta	*Pitta sordida*	R	LC	IV	-	+	-
Irenidae							
Orange-bellied Leaf Bird	*Chloropsis hardwickii*	r	LC	IV	-	+	+
Golden Fronted Leaf Bird	*Chloropsis aurifrons*	r	LC	IV	-	-	+
Lanidae							
Long-tailed Shrike	*Lanius schach*	R	LC	IV	-	-	+
Grey-backed Shrike	*Lanius tephronotus*	s	LC	IV	-	+	+
Brown Shrike	*Lanius cristatus*	s	LC	IV	-	+	-
Corvidae							
House Crow	*Corvus splendens*	R	LC	IV	+	+	+
Jungle Crow	*Corvus macrorhynchos*	R	LC	IV	+	+	+
Yellow-billed Blue Magpie	*Urocissa flavirostris*	R	LC	IV	+	-	-
Himalayan Treepie	*Dendrocitta formosae*	R	LC	IV	+	+	+
Green Magpie	*Cissa chinensis*	R	LC	IV	-	+	-
Dicruridae							
Ashy Drongo	*Dicrurus leucophaeus*	R	LC	IV	+	+	-
Bronzed Drongo	*Dicrurus aeneus*	r	LC	IV	+	-	-
Black Drongo	*Dicrurus adsimilis*	R	LC	IV	+	+	+
Spangled Drongo	*Dicrurus hottentottus*	p	LC	IV	-	-	+
Campephagidae							
Longtailed Minivet	*Pericrocotus ethologos*	R	LC	IV	+	-	+
Scarlet Minivet	*Pericrocotus flammeus*	R	LC	IV	+	+	+
Grey-chined Minivet	*Pericrocotus solaris*	r	LC	IV	+	+	-
Cinclidae							
Brown Dipper	*Cinclus pallasii*	R	LC	R	+	+	-
Muscicapidae							
Blue Whistling Thrush	*Myophonus caeruleus*	R	LC	IV	+	+	+
Blue Rock Thrush	*Monticola solitarius*	s	LC	IV	-	-	+
Blue-capped Rock Thrush	*Monticola cinclorhynchus*	s	LC	IV	-	-	+

Family/Common Name	Scientific Name	Distribution Habit	IUCN (2015)	IWPA (1972)	Seasonal Distribution		
					PrM	M	PoM
Scaly Thrush	*Zoothera dauma*	s	LC	IV	-	+	+
White-browed Bush Robin	*Tarsiger indicus*	r	LC	IV	+	+	-
Golden Bush Robin	*Tarsiger chrysaeus*	r	LC	IV	-	+	-
Oriental Magpie Robin	*Copsychus saularis*	R	LC	IV	+	-	-
White-rumped Shama	*Copsychus malabaricus*	R	LC	IV	+	-	-
White-tailed Stone Chat	*Saxicola leucurus*	r	LC	IV	-	-	+
Plumbeous Water Redstart	*Phoenicurus fuliginosus*	r	LC	IV	+	+	+
Blue-fronted Redstart	*Phoenicurus frontalis*	r	LC	IV	-	-	+
White-capped Water Redstart	*Chaimarrornis leucocephalus*	r	LC	IV	+	+	+
Small Niltava	*Niltava macgrigoriae*	r	LC	IV	+	+	+
Large Niltava	*Niltava grandis*	r	LC	IV	+	-	-
Pygmy Blue Flycatcher	*Muscicapella hodgsonii*	r	LC	IV	+	-	-
Verditer Flycatcher	*Eumyias thalassina*	R	LC	IV	-	+	-
Little Forktail	*Enicurus scouleri*	r	LC	IV	-	-	+
Spotted Forktail	*Enicurus maculatus*	R	LC	IV	+	+	-
Grey-winged Thrush	*Turdus boulboul*	r	LC	IV	+	-	-
Tickel's Thrush	*Turdus unicolor*	p	LC	IV	-	+	-
Dark -throated Thrush	*Turdus ruficollis*	r	LC	IV	-	+	-
Rusty-bellied Shortwing	Brachypteryx hyperythra	r	NT	IV	-	-	-
Sturnidae							
Common Myna	*Acridotheres tristis*	R	LC	IV	+	+	+
Hill Mynah	*Gracula religiosa*	r	LC	IV	-	-	+
Pied myna	*Sturnus contra*	R	LC	IV	+	+	+
Pycnonotidae							
Himalayan Bulbul	*Pycnonotus leucogenys*	R	LC	IV	+	+	+
Red-vented Bulbul	*Pycnonotus cafer*	R	LC	IV	+	+	+
Black-creasted Bulbul	*Pycnonotus flaviventris*	R	LC	IV	+	+	+
Timalidae							
Rufous-capped Babbler	*Stachyris ruficeps*	r	LC	IV	-	+	-

Family/Common Name	Scientific Name	Distribution Habit	IUCN (2015)	IWPA (1972)	Seasonal Distribution		
					PrM	M	PoM
Blackish-breasted Babbler	*Sphenocichla humei*	r	NT	IV	-	-	-
Rufous-throated Wren-babbler	Spelaeornis caudatus	r	NT	IV	-	+	-
Whiskered Yuhina	*Yuhina flavicollis*	R	LC	IV	+	+	+
White-naped Yuhina	Yuhina bakeri	r	LC	IV	-	+	+
Black-breasted Parrotbill	Paradoxornis flavirostris	r	VU	IV	+	-	+
Sylviidae							
Lemon-rumped Warbler	*Phylloscopus chloronotus*	rW	LC	IV	+	+	-
Greenish Warbler	*Phylloscopus trochiloides*	rW	LC	IV	+	-	+
Tickell's Leaf Warbler	*Phylloscopus affinis*	sW	LC	IV	+	+	+
Yellow-vented Warbler	Phylloscopus cantator	r	LC	IV	+	-	-
Flycatcher Warbler	*Abroscopus superciliaris*	r	LC	IV	-	-	+
Grey hooded Warbler	*Seicercus xanthoschistos*	R	LC	IV	+	+	+
Spectacled Warbler	*Seicercus burkii*	R	LC	IV	-	+	-
Leiothricidae							
Jungle Babbler	*Turdoides striatus*	r	LC	IV	+	+	+
Slender-billed Babbler	Turdoides longirostris	r	VU	IV	-	-	-
Black-yeared Shrike Babbler	*Pteruthius melanotis*	r	LC	IV	-	+	-
Striated Laughingthrush	*Garrulax striatus*	r	LC	IV	+	+	-
White-crested Laughingthrush	*Garrulax leucolophus*	R	LC	IV	+	-	-
Streaked Laughingthrush	*Garrulax lineatus*	R	LC	IV	+	+	-
Chestnut-crowned Laughingthrush	*Garrulax erythrocephalus*	r	LC	IV	+	+	+
Rufous Sibia	*Heterophasia capistrata*	R	LC	IV	-	-	+
Grey Sibia	*Heterophasia gracilis*	r	LC	IV	+	-	-
Cisticolidae							

Family/Common Name	**Scientific Name**	**Distribution Habit**	**IUCN (2015)**	**IWPA (1972)**	**Seasonal Distribution**		
					PrM	**M**	**PoM**
Grey-crowned Prinia	Prinia cinereocapilla	R	VU	IV	-	+	-
Dark-necked Tailor Bird	*Orthotomus atrogularis*	R	LC	IV	-	-	+
Sittidae							
Chestnut nuthatch	*Sitta castanea*	R	LC	IV	+	-	+
Beautiful Nuthatch	*Sittaformosa*	r	VU	IV	+	+	+
Wall Creeper	*Tichodroma muraria*	R	LC	IV	-	-	+
Paridae							
Great Tit	*Parus major*	R	LC	IV	+	+	-
Green-backed Tit	*Parus monticolus*	R	LC	IV	+	+	+
Yellow cheeked Tit	*Parus spilonotus*	r	LC	IV	-	-	+
Passeridae							
Tree Sparrow	*Passer montanus*	R	LC	IV	+	+	+
House sparrows	*Passer domesticus*	R	LC	IV	+	+	+
	Richard's Pipit	*Anthus richardi*	p	LC	IV	+	-
Olive-Black Pipit	*Anthus hogsonii*	r	LC	IV	-	+	-
Motacillidae							
Grey Wagtail	*Motacilla cinerea*	rW	LC	IV	+	+	-
Yellow Wagtail	*Motacilla flava*	W	LC	IV	+	-	+
White Browed Wagtail	*Motacilla maderaspatensis*		LC	IV	+	+	+
Nectariniidae							
Mrs Gould's Sun bird	*Aethopyga gouldiae*	r	LC	IV	+	-	-
Streaked Spider Hunter	*Arachnothera magna*	r	LC	IV	-	-	+
Certhidae							
Tree Creper	*Certhia familiaris*	R	LC	IV	+	+	+
Rusty-flanked Tree Creeper	*Certhia nipalensis*	r	LC	IV	+	-	-

R = widespread resident, r = sparse resident, W = widespread winter visitor, w = sparse winter visitor; s= summer visitor; p = passage migrant; v = vagrant; LC = least concerned, NT = near threatened; VU = vulnerable, EN = endangered; CR = critically endangered

Great Egret (*Ardea alba*)

Indian Pond Heron (*Ardeola grayii*)

Common Merganser (*Mergus merganser*)

Little Cormorant (*Phalacrocorax niger*)

Hoopoe (*Upupa epops*)

White-throated Kingfisher (*Halcyon smyrnensis*)

Common Kingfisher (*Alcedo atthis*)

Crested Kingfisher (*Megaceryle lugubris*)

Blue-throated Barbet (*Megalaima asiatica*) **Chestnut-headed Bee-eater (*Merops leschenaulti*)**

Crow-pheasant (*Centropus sinensis*) **Common Cuckoo (*Cuculus canorus*)**

Spotted Dove (*Streptopelia chinensis*) **Rock Pigeon (*Columba livia*)**

Yellow-footed Green Pigeon (*Treron phoenicoptera*) **Barn Swallow (*Hirundo rustica*)**

Rufous-bellied flycatcher (*Muscicapa vivida*) **Magpie Robin (*Copsychus saularis*)**

White-rumped Shama (*Copsychus malabaricus*) **Rufous Sibia (*Heterophasia capistrata*)**

Blue- capped RockThrush (*Monticola cinclorhynchus*) **Blue Rock Thrush (*Monticola solitaries*)**

Himalayan Bulbul (*Pycnonotus leucogenys*) **Red-vented Bulbul (*Pycnonotus cafer*)**

Black-creasted Bulbul (*Pycnonotus flaviventris*) **Red-whiskered Bulbul (*Pycnonotus jacosus*)**

Black Drongo (*Dicrurus macrocercus*) **Spangled Drongo (*Dicrurus hottentottus*)**

Scarlet Minivet (Pericrocotus speciosus)Mrs Gould's Sun bird (*Aethopyga gouldiae*)

India Myna (*Acridotherus tristis*) **Pied Mynah (*Sturnus contra*)**

Tree Sparrow (*Passer montanus*)

Grey Wagtail (*Motacilla cinerea*)

Richard's Pipit (*Anthus richardi*)

Streaked Spider Hunter (*Arachnothera magna*)

7.5 REPTILES

7.5.1 Species composition

The Study Area is rich in the reptilian fauna, comprising of about 91 species. These species are grouped under 13 families with maximum in Colubridae. The list of reptile species observed in the Study Area alongwith their conservation status is given in Table-7.4. Turtles and tortoises are not common in study area, even local people during the field visit could not confirm their presence in the study area. The species belonging to families Gekkonidae and Agamidae are relatively common and abundant from foothills to 1800 m. Scincidae is represented by 4 species, in which Indian Forest Skink is relatively common in occurrence. Varanidae comprises of 2 species namely Common Indian Monitor (*Varanus bengalensis*) and Common Water Monitor (*Varanus salvator*). *Varanus bengalensis* is widely distributed and well known to inhabit Mahananda Wildlife Sanctuary and its surrounding and Kitam forests. *Varanus salvator* is relatively less common and restricted to the valleys. Typhlopidae includes 3 species distributed in wet places. They are non poisonous snakes.

Family Pathonidae is represented by Burmese Python (*Python molurus*) having patchy distribution. Python is not common in study area, however, reported from surroundings of Rangir river near Kitam forests and in lower reaches in Mahananda Wildlife Sanctuary. Rough-tailed Sand Boa (*Gongylophis conicus*) of family Boidae is confined to valleys in foothills of study area.

Colubridae is largest family of reptile accounting for more than 50% of the total reptilian species. In general their diversity is higher in lower reaches and decreases along the elevational gradients. The species like Copper-Head Trinket Snake (*Coelognathus radiates*), Black-Banded Trinket Snake (*Oreophis porphyraceus*), Trinket Snake (*Coelognathus helena*), etc. inhabit dense and inner forests while Oriental Rat Snake *(Ptyas mucosa*), Chinese Rat Snake (*Ptyas korros*), Green Rat Snake *Ptyas nigromarginata*) etc. are common in settlement areas and open places. Most of the Kukri snakes like Common Kukri Snake *Oligodon melaneus*), Bronzed-Backed Kukri Snake (*Dendrelaphis tristis*) etc inhabit evergreen forests, tea gardens and distributed up to higher elevations. A few species viz., Checkered Keelback (*Xenochrophis piscator*), Common Kelback (*Xenochrophis sanctijohannis*), Yunnan keelback (*Amphiesma parallelum*), Himalayan Keel Back (*Amphiesma platyceps*), and Red-necked Keel Back (*Rhabdophis subminiatus*) are distributed in the tropical limits of the Study Area and also found in water bodies like Teesta andRangitrivers. Majority of the Colubrids are fairly common in the study area, however, there are a few species Stripped-neck Snake (*Liopeltis stoliczkae*) and Walnut Kukri Snake (*Oligodon juglandifer*), which are extremely rare in this area.

Family Elapidae comprises of 7 species, all are fairly common in the study area. King Cobra (*Ophiophagus hannah*) is relatively rare in this area distributed up to 1250 m. It is one of the largest snakes in this region. Monocled Cobra (*Naja kaouthia*) is fairly common in forests, tea gardens, settlement area, rivers etc. Banded Krait (*Bungarus fasciatus*) and MacClelland's Coral snake (*Sinomicrurus macclellandi*) are distributed along the middles hills of the study area and are rare in their occurrence. Family Viperidae is represented by 9 species. Except Himalayan pit viper (*Gloydius himalayanus*) andCommon Bamboo Viper (*Trimeresurus gramineus*) all species are fairly common in the study area. *Gloydius himalayanus* is distributed between 2000-3000 m and *Trimeresurus gramineus* is found above 500 m.

Table 7.4. Reptile species composition in the Study area of Teesta basin in West Bengal

Family/Common Name	**Scientific name**	**Conservation status**	
		IUCN (2015)	**IWPA (1971)**
Bataguridae			
Three-keeled Land Turtle	*Melanochelys tricarinata*	VU	I
Indian Black Turtle	*Melanochelys trijuga*	NT	IV
Testudinidae			
Yellow-headed Tortoise	*Indotestudo elongata*	EN	IV
Trionychidae			
Indian Flap-shelled Turtle	*Lissemys punctata*	LC	I
Gekkonidae			
Common House Gecko	*Hemidactylus frenatus*	LC	-
Common Gecko	*Hemidactylus bowringii*	-	-
Flat-tailed House Gecko	*Cosymbotus platyurus*	-	-
Khasi Hills bent-toed Gecko	*Cyrtodactylus khasiensis*	-	-
Sikkimese Bent-toed Gecko	*Cyrtodactylus gubernatoris*	NT	-
Agamidae			

Family/Common Name	Scientific name	Conservation status	
		IUCN (2015)	IWPA (1971)
Oriental Garden Lizard	*Calotes versicolor*	-	-
Jerdon's Forest Lizard	*Calotes jerdoni*		-
Three Keeled Mountain Lizard	*Japalura tricarinata*	LC	
Variegated Mountain Forest Agama	*Japalura variegata*	LC	
Scincidae			
Indian Forest Skink	*Sphenomorphus indicus*	-	-
Spotted Forest Skink	*Sphenomorphus maculates*	-	-
Keeled Indian Mabuya	*Mabuya carinata*	-	-
Sikkim Ground Skink	*Asymblepharus sikimmensis*	-	-
Anguidae			
Asian Glass Lizard	*Ophisaurus gracilis*	-	-
Varanidae			
Common Indian Monitor	*Varanus bengalensis*	LC	II
Common Water Monitor	*Varanus salvator*	LC	II
Typhlopidae			
Few-scaled Worm Snake	*Typhlops oligolepis*	DD	IV
Jerdon's Worm Snake	*Typhlops jerdoni*	-	IV
Brahminy Blind Snake	*Ramphotyphlops braminus*	-	IV
Pythonidae			
Burmese Python	*Python molurus*	VU	I
Boidae			
Rough-tailed Sand Boa	*Gongylophis conicus*	-	IV
Colubridae			
Green Rat Snake	*Elaphe prasina*	-	IV
Copper-Head Trinket Snake	*Coelognathus radiatus*	LC	IV
Hodgsons Snake	*Orthriophis hodgsonii*	-	IV
Cantor's Rat Snakeq	*Orthriophis cantoris*	-	IV
The Beauty Rat Snake	*Orthriophis taeniurus*	-	IV
Black-Banded Trinket Snake	*Oreophis porphyraceus*	-	IV
Trinket Snake	*Coelognathus Helena*	-	IV
The Common Slug Snake	*Pareas monticola*	-	IV
Spotted Slug Snake	*Pareas macularius*	-	IV
Indian Egg EatingSnake	*Elachistodon westermanni*	LC	I
Oriental Rat Snake	*Ptyas mucosa*	-	II
Chinese Rat Snake	*Ptyas korros*	-	IV
Green Rat Snake	*Ptyas nigromarginata*	-	IV
The Banded Racer	*Argyrogena fasciolata*	-	IV
Stripped-neck Snake	*Liopeltis stoliczkae*	-	IV
Himalayan Stripe-Necked Snake	*Liopeltis rappi*	DD	IV
Light Barred Kukri Snake	*Oligodon albocinctus*	-	IV
Nagarkot Kukri Snake	*Oligodon erythrogaster*	-	IV
Common Kukri Snake	*Oligodon melaneus*	-	IV
Walnut Kukri Snake	*Oligodon juglandifer*	VU	IV
Bronzed-Backed Kukri Snake	*Dendrelaphis tristis*	-	IV
Painted Bronzed Back Snake	*Dendrelaphis pictus*	-	IV
Wall's Bronze Back	*Dendrelaphis cyanochloris*	LC	IV
E.Himalayan Bronze-brown Snake	*Dendrelaphis gorei*	LC	IV

Family/Common Name	**Scientific name**	**Conservation status**	
		IUCN (2015)	**IWPA (1971)**
Golden Tree Snake	*Chrysopelea ornata*	-	IV
Yellow-speckled Wolfsnake	*Lycodon jara*	-	IV
Gammie's Wolf Snake	*Dinodon gammiei*	-	IV
White-banded Wolf Snake	*Dinodon septentrionalis*	-	IV
Checkered Keelback	*Xenochrophis piscator*	-	II
Common Kelback	*Xenochrophis sanctijohannis*	-	IV
Collared Black-headed Snake	*Sibynophis collaris*	LC	IV
Yunnan keelback	*Amphiesma parallelum*	-	IV
The Buff Striped Keelback	*Amphiesma stolatum*	-	IV
Himalayan Keel Back	*Amphiesma platyceps*	-	IV
Red-necked Keelback	*Rhabdophis subminiatus*	LC	IV
The orange-collared keelback	*Rhabdophis himalayanus*	-	IV
Large-eyed False Cobra	*Pseudoxenodon macrops*	-	IV
Darjeeling Slender Snake	*Trachischium fuscum*	-	IV
Gunther's Oriental Worm Snake	*Trachischium guentheri*	-	IV
The Yellowbelly Worm-Eating Snake	*Trachischium tenuiceps*	-	IV
The Tawny Cat Snake	*Boiga ochraceus*	-	IV
The Arrowback Tree Snake	*Boiga gokool*	-	IV
Green Cat Snake	*Boiga cyanea*	-	IV
Many-Banded Tree Snake	*Boiga multifasciata*	DD	IV
Eyed Cat Snake	*Boiga ocellata*	-	IV
Reddish Peninsular Cat Snake	*Boiga forsteni*	LC	IV
Common Cat Snake	*Boiga trigonata*	LC	IV
The Common Mock Viper	*Psammodynastes pulverulentus*	-	IV
Gunther's Whip Snake	*Ahaetulla prasina*	LC	IV
River Vine Snake	*Ahaetulla fronticincta*	LC	IV
Elapidae			
King Cobra	*Ophiophagus hannah*	VU	II
Monocled Cobra	*Naja kaouthia*	LC	II
Banded Krait	*Bungarus fasciatus*	LC	IV
The northeastern hill krait	*Bungarus bungaroides*	-	IV
Lesser Black Krait	*Bungarus lividus*	-	IV
The greater Black Krait	*Bungarus niger*	-	IV
MacClelland's Coral snake	*Sinomicrurus macclellandi*	-	IV
Viperidae			
Eastern Russell's Viper	*Daboia russelii*	-	IV
Himalayan pit viper	*Gloydius himalayanus*	-	IV
Taiwan Mountain Pit Viper	*Ovophis monticola*	LC	IV
Yellow Speckled Lance head	*Protobothrops jerdonii*	LC	IV
Common Bamboo Viper	*Trimeresurus gramineus*	LC	IV
Pope's Pit Viper	*Popeia popeiorum*	LC	IV
Red-tail Pit Viper	*Cryptelytrops erythrurus*	LC	IV
White-lipped Tree Viper	*Cryptelytrops albolabris*	LC	IV
Gumprecht's Pit Viper	*Viridovipera gumprechti*	LC	IV

LC = least concerned, NT = near threatened; VU = vulnerable.

7.5.2 Site Specific Study

During the primary surveys a total of 14 reptilian species were recorded at different sites of study area with maximum of 11 species in post-monsoon season and minimum of 7 species in monsoon season. Common House Gecko (*Hemidactylus frenatus*), Common Gecko (*Hemidactylus bowringii*) and Jerdon's Forest Lizard (*Calotes jerdoni*) were relatively common species, found in all over study area. The list of reptilian species spotted during field studies in various seasons is given in Table-7.5. Local people revealed the presence of many other reptilian species in the area. Though, locals were not able to identify most of them at species level, however, a few species were confirmed with the help of their vernacular name. The important species whose presence were confirmed with the help of Nepali vernacular names were *Varanus bengalensis* (Goh), *Python molurus* (Ajgar Saamp), *Ptyas mucosa* (Ghariya Saamp), *Ophiophagus hannah* (Shesh Naag) etc.

Japalura tricarinata

Calotes versicolor

Dendrelaphis pictus

7.6 AMPHIBIANS

7.6.1 Species Composition

Amphibia comprises of 21 species of 4 families in study area (Table 4.6). Bufonidae is represented by 3 species, of which *Bufo abatus* is extremely rare in the study area. It inhabits damp places in the middle Darjeeling and Kalimpong hills. Common Toad (*Duttaphrynus melanostictus*) and The Himalayan Toad (*Duttaphrynushimalayanus*) are fairly common from foothills to 1500 m. Family Megophryidae includes 2 species, of which Little Spadefoot Toad (*Megophrys parva*) is distributed above 1500 m while Large Spadefoot Toad (*Megophrys robusta*) is rarely observed species. Ranidae is largest families comprising of 7 species. Torrent Frog (*Amolops formosus*) and *Amolops afghanus* are confined to the higher hills in the catchment area while Sikkim Frog (*Chaparana sikkimensis*) inhabits dense forests and common in distribution. Other species of Ranidae are commonly distributed in the study area.

Table 7.5 Reptilian species spotted during different seasons in Teesta Basin in West Bengal

Species	Influence area of proposed projects																	
	TVI			TINT			TLI &II			TLIII			TLIV			TLV		
	Pr M	M	Po M	Pr M	M	Po M	Pr M	M	Po M	Pr M	M	Po M	Pr M	M	Po M	PrM	M	Po M
Common House Gecko (*Hemidactylus frenatus*)	+	+	+	+	+	-	+	-	-	+	-	-	+	+	-	+	+	-
Common Gecko (*Hemidactylus bowringii*)	+	-	+	-	+	+	+	+	-	-	-	-	-	+	-	+	+	-
Oriental Garden Lizard (*Calotes versicolor*)	-	-	-	-	-	+	-	-	-	-	-	-	-	+	+	-	-	-
Jerdon's Forest Lizard (*Calotes jerdoni*)	-	+	-	+	+	-	-	-	+	+	-	-	-	-	+	-	-	-
Khasi Hills Gecko (*Cyrtodactylus khasiensis*)	+	-	-	-	-	+	-	-	-	-	-	-	+	-	-	-	-	+
Mountain Forest Agama (*Japalura variegata*)	-	-	-	-	-	+	-	-	-	-	-	-	+	-	+	-	-	+
Three Keeled Mountain Lizard (*Japalura tricarinata*)	-	-	-	-	-	-	-	-	+	-	+	-	-	+	-	-	-	-
Sikkim Ground Skink (*Asymblepharus sikimmensis*)	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Spotted Forest Skink (*Sphenomorphus maculates*)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
Water Snake(*Amphiesma* sp.)	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Darjeeling Slender Snake (*Trachischium fuscum*)	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Common Cat Snake (*Boiga trigonata*)	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trinket Snake (*Coelognathus Helena*)	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
Bronzed Back Snake (*Dendrelaphis pictus*)	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-

TVI = Teesta Stage VI; TINT = Teesta Intermediate; TLI&II = Teesta Low Dam ProjectSatge I and II; TLIII = Teesta Low Dam ProjectStage III; TLIV = Teesta Low Dam ProjectStage IV; TLV = Teesta Low Dam ProjectStage V.

Rhacophoridae is represented by 7 species in the study area. East Himalayan Bush Frog (*Raorchestes annandalii*), Darjeeling Bubble-nest Frog(*Philautus dubius*) and Jerdon's Bush Frog (*Philautus jerdonii*) are the species of wet temperate forests inhabiting the middle hills of Darjeeling and Kalimpong. *Polypedates leucomystax* is widely distributed from the foothills to middle hills in the catchment. All species of *Rhacophorus* are arboreal in habit and dwells evergreen dense forests. Himalayan Newt (*Tylototriton verrucosus*) (Salamandridae) is distributed in the northeast Himalaya but highly restricted in the area occupancy. It inhabits an elevational range from 1200 to 2000 m. It population is decreasing at the alarming rate. Ichthyophidae is comprised of a single species namely Sikkim Blindworm (*Ichthyophis sikkimensis*). It is distributed from 1000 to 1500 m.

The species composition of amphibians in the Study Area along with their conservation study is given in Table-7.6.

Table-7.6 Species composition in the Amphibians in Lower Teesta basin in West Bengal

Family/Common Name	Scientific name	Conservation status	
		IUCN (2015)	IWPA 1971)
Bufonidae			
Common Toad	*Duttaphrynus melanostictus*	LC	-
The Himalayan Toad	*Duttaphrynushimalayanus*	LC	-
-	*Bufo abatus*	-	-
Megophryidae			
Little Spadefoot Toad	*Megophrys parva* a	-	-
Large Spadefoot Toad	*Megophrys robusta*	-	-
Ranidae			
Torrent Frog	*Amolops formosus*	LC	IV
Torrent Frog	*Amolops afghanus*	-	IV
Sikkim Frog	*Chaparana sikkimensis*	-	IV
Common Frog	Odorr*ana livida*	DD	IV
-	*Amolops gerbillus*	LC	IV
Skipping Frog	*Euphlyctis cyanophlyct*is	LC	IV
-	*Rana annandalii*		
Rhacophoridae			
East Himalayan Bush Frog	*Raorchestes annandalii*	LC	-
Darjeeling Bubble-nest Frog	*Philautus dubius*	DD	-
Jerdon's Bush Frog	*Philautus jerdonii*	DD	-
East Asian Tree Frog	*Polypedates leucomystax*	LC	-
Jerdon’s Flying Frog	*Rhacophorus jerdonii*	DD	-
Reinwardti's Frog	*Rhacophorus reinwardtii*	NT	-
-	*Rhacophorus maximus*	LC	-
Salamendridae			
Himalayan Newt	*Tylototriton verrucosus*	LC	II
Ichthyophidae			
Sikkim Blindworm	*Ichthyophis sikkimensis*	DD	-

7.7 BUTTERFLIES

The baseline data on butterfly is commenced with the primary survey as no secondary data is available for the study area under discussion. A total of 111 species were recorded during the pre-monsoon, monsoon seasons and monsoon seasons. No significant variations were observed in the species richness between different seasons as it ranged from 67 to 69 species. Considering the surroundings of individual sites, the richness ranged from 21 species at site TLIV during post-monsoon season to 40 species at site TVI in monsoon season. Most common species of the basin, which were recorded at all sites in all seasons were Common Bluebottle (*Graphium sarpedon*), Red Helen (*Papilio helenus Linn*aeus), Common Grass Yellow (*Eurema hecabe*), Large Cabbage White (*Pieris brassicae*), Indian Cabbage White (*Pieris canidia*), Chocolate Soldier (*Precis iphita*), Indian Fritillary (*Argyreus hyperbius*), Queen of Spain Fritillary (*Issoria lathonia*), Common Sailer (*Neptis hylas*), Cruiser (*Vindula erota*) etc .

Family Papilionidae comprised of about 9 species; all were commonly distributed in the study area. Family Pieridae is represented by 20 species, of which Common Grass Yellow (*Eurema hecabe*), Large Cabbage White (*Pieris brassicae*), Indian Cabbage White (*Pieris canidia*), and Chocolate Albatross (*Appias lyncida vasava*) were most common and abundant species. Family Lycaenidae comprises of a total of 22 species. Most of the species except a few viz. Fluffy Tit (*Zeltus amasa*), Orchid Tit (*Chliaria othona*), Blue Tit (*Hypolycaena erylus*) etc. were rarely observed species. Fluffy Tit (*Zeltus amasa*) and Orchid Tit (*Chliaria othona*), were confined in the lower reaches of Rangit valley.

Nymphalidae was largest family comprised of a total of 50 species. Indian Fritillary (*Argyreus hyperbius*), Green Commodore (*Sumalia daraxa*), Common Sailer (*Neptis hylas*), Yellow Sailer (*Neptis ananta*), Indian Tortoise Shell (*Aglais cashmiriensis*), Indian Red Admiral (*Vanessa indica*) and Cruiser (*Vindula erota*) were most common and widely distributed in the study area. However, none of them except *Vindula erota*was predominant. A few species which were recorded rarely were Danaid Eggfly (*Hypolimnas misippus*), Commander (*Moduza procris* procris) and Bicolour Commodore (*Parasarpa zayla*) In the Nymphalidae Golden Emperor (*Dilipa morgiana*), Knight (*Lebadea martha*), Sordid emperor (*Apatura sordida)* and Common Maplet (*Chersonesia risa* were rarely observed species restricted to one or two sites. Family Hesperiidae was represented by a total of 10 species. They are not common in the distribution as compared to the other taxa. The list of butterflies species recorded from the Study Area in various seasons is given in Table-7.7.

7.8 CONSERVATION STATUS & VULNERABILITY

Study area is inhabited by many threatened (IUCN redlist 2015) and Scheduled species (IWPA, 1972), in which maximum comes from mammalian fauna. In order to consider the vulnerability of study area a total of 18 species of mammals, which are either Threatened (Critically endangered, Endangered, Vulnerable), Schedule I or both have been taken into account (Table 6.8). All 'Endangered' mammalian species except *Cuon alpinus* are Schedule I species, in which *Panthera tigris*, *Elephas maximus indicus* and *Manis crassicaudata* are restricted to foothills (especially in Mahananda Wildlife Sanctuary), surroundings of Teesta Low Dam Project Stage V while others are widely distributed in the study area. There are a total of 9 'Vulnerable' species, of which 8 are also categorised as Schedule I species. Most of the 'vulnerable' species are widely distributed in the study area, however a few have restricted distribution. *Ailurus fulgens* (Red Panda) is confined to middle Darjeeling hills (especially in Senchal Wildlife Sanctuary) while *Rusa unicolor* and *Bos gaurus* are distributed in foothills mostly in Mahananda Wildlife Sanctuary. Other Schedule I species are *Catopuma temminckii*, *Pr*ionailurus bengalensis and *Arctonyx collaris collaris*; they are widely distributed from foothills to middle hills. In the avifauna a total of 11 species are either threatened, Schedule I or both. 'Critically endangered' species included *Gyps bengalensis, Gyps tenuirostris*, *Sarcogyps calvus* and *Houbaropsis bengalensis*. Former three species are widely distributed in the study area while *Houbaropsis bengalensis* is confined to foothills and floodplain areas in the surroundings of Teesta Low Dam Project Stage IV and V. All vulnerable species like *Paradoxornis flavirostris, Turdoides longirostris, Prinia cinereocapilla, Sitta formosa* and *Aceros nipalensis* (Schedule I) are distributed from foothills to about 1500 m. Other 2 Schedule I species includes *Buceros bicornis* and *Pavo cristatus*. Former is widely distributed while *Pavo cristatus* is mainly found in Kitam Bird Sanctuary and Mahananda Wildlife Sanctuary.

Common Mormon (*Papilio Polytes*)

Common Blue Bottle (*Graphium sarpedon*)

Great Orangetip (*Hebomoia glaucippe*)

Chocolate Albatross (*Appias elenora*)

Grenvein White (*Pieris melaina*)

White (*Pieris* sp.)

Indian Cabbage White (*Pieris canidia*) **Small Grass Yellow (*Eurema brigitta*)**

Fluffy Tit (*Zeltus amasa*) **Common Pierrot (*Castalius rosimon*)**

Common Pierrot (*Castalius rosimon*) **Metallic Cerulean (*Jamides alecto*)**


Purple Sapphire (*Heliophorus epicles*) **Common Three Ring (*Ypthima***
***asterope*)**


Leopard Lacewing (Cethosia cyane) **Lemon Pansy (*Junonia lemonias*)**


The Color Sergent (*Athyma nefte*) **Yellow Sailor (*Neptis ananta*)**

Common Sailor (*Neptis hylas*)

Common Map (*Cyrestis thyodamas*)

Orange Oakleaf (*Kallima inachus*)

Commander (*Moduza procris procris*)

Knight (*Lebadea martha*)

The Dart (*Potanthus* sp.)

Table 7.7. Butterfly species recorded from different sites in the Teesta basin

S. No.	Name of species	TVI			TINT			TLI &II			TLIII			TLIV			TLV		
		PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM
Papilionidae																			
1	Common Bluebottle (*Graphium sarpedon*)			+			+	+	+		+	+		+	+		+	+	+
2	Glassy Blue Bottle (*Graphium cloanthus*)								+									+	
3	Red Helen (*Papilio helenus Linnaeus*)	+		+	+	+	+		+			+	+		+			+	+
4	Common Birdwing (*Troides helena*)														+			+	
5	Common Peacock (*Papilio polyctor*)	+			+			+				+	+						+
6	Blue Peacock (*Papilio acturus*)	+			+			+											
7	Common Raven (*Papilio castor*)		+			+									+				
8	Common Mormon (*Papilio Polytes*)									+					+				
9	Tailed Red-breasted (*Princeps janaka*)				+		+	+			+								
Pieridae																			
10	Small Grass Yellow (*Eurema brigitta*)	+	+					+	+		+	+	+				+		+
11	Common Grass Yellow (*Eurema hecabe*)	+		+	+		+	+			+			+	+		+		
12	One spot Grass Yellow (*Eurema andersoni*)			+			+			+				+					
13	Tree Yellow (*Gandaca harina*)					+						+			+				
14	Plain Sulphur (*Dercas lycorias*)	+										+	+						+
15	Common Emigrant (*Catopsilia pomona*)									+						+			
16	Pale Clouded Yellow (*Colias erate*)	+																	
17	Psyche (*Leptosia nina nina*)		+	+			+		+							+		+	+
18	Large Cabbage White (*Pieris*		+	+	+		+	+	+		+	+		+	+	+	+	+	+

S. No.	Name of species	TVI			TINT			TLI &II			TLIII			TLIV			TLV		
		PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM
	brassicae)																		
19	Indian Cabbage White (*Pieris canidia*)	+	+		+		+	+	+		+			+	+		+	+	
20	Grenvein White (*Pieris melaina*)													+			+		
21	Chumbi White (*Pieris dubernardi*)		+			+													
22	Chocolate Albatross (*Appias lyncida vasava*)		+			+	+	+	+				+	+		+			
23	Pale Wanderer (*Pareronia avatar*)									+			+			+			
24	Common Gull (*Cepora nerissa nerissa*)									+			+						
25	Red-base Jezebel (*Delias pasithoe*)		+			+						+	+		+		+		+
26	Red-spot Jezebel (*Delias descombesi*)				+	+					+				+				
27	Hill Jezebell (*Delias belladonna*)									+									
28	Yellow Orangetip (*Ixas pyrene*)				+						+	+	+		+				+
29	Great Orangetip (*Hebomoia glaucippe*)							+						+					
Lycaenidae																			
30	Purple Sapphire (*Heliophorus epicles*)	+								+	+				+	+			
31	Golden Sapphire (*Heliophorus brahma*)									+	+					+			+
32	Silver Grey Silverline (*Spindasis nipalicus*)	+																	
33	Angled Sunbeam (*Curetis dentata*)		+			+			+				+			+			
34.	Common Cerulean (*Jamides celano*)		+	+		+		+				+	+	+			+		
35	Dark Cerulean (*Jamides bochus*)	+	+		+			+			+	+		+			+		
36	Metallic Cerulean (*Jamides alecto*)			+		+			+	+								+	
37	Glistening Cerulean (*Jamides elpis*)		+			+	+						+	+				+	

S. No.	Name of species	TVI			TINT			TLI &II			TLIII			TLIV			TLV		
		PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM
38	Yamfly (*Loxura atymnus*)			+															
39	Silver Hairstreak (*Chrysozephyrus syla*)		+															+	
40	Dark Grass Blue (*Zizeeria karsandra*)	+										+	+		+				+
41	Centaur Oakblue (*Nilasera fulla*)		+			+		+				+		+			+		
42	Spotless Oakblue (*Narathura fulla*)										+								
43	Common Pierrot (*Castalius rosimon*)		+	+		+	+				+		+	+				+	
44	Angled Pierrot (*Caleta caleta*)	+			+													+	
45	Striped Pierrot (*Tarucus nara*)			+						+									
46	Elbowed Pierrot (*Caleta elna*)				+						+					+			+
47	Opaque 6-line Blue (*Nacaduba kurava*)		+			+					+	+		+					
48	Fluffy Tit (*Zeltus amasa*)										+		+						+
49	Orchid Tit (*Chliaria othona*)								+										
50	Blue Tit (*Hypolycaena erylus*)									+									+
51	Longbanded Silverline (*Spindasis lohita*)		+	+			+			+		+							+
Nymphalidae																			
52	Jungle Glory (*Thaumantis diores*)		+						+										
53	Common Tree Brown (*Lethe rohria*)	+			+			+							+			+	
54	Banded Tree Brown (*Lethe confuse*)			+			+			+		+							
55	Brown Forester (*Lethe serbonis*)	+											+			+			
56	Yellow Woodbrown (*Lethe nicetas*)	+														+			+
57	Straight banded Tree Brown (*Lethe verma*)	+	+										+			+			+
58	Danaid Eggfly (*Hypolimnas misippus*)				+			+											
59	Trebel Silverstripe (*Zophoessa*					+			+						+				

S. No.	Name of species	TVI			TINT			TLI &II			TLIII			TLIV			TLV		
		PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM
	baladeva)																		
60	Lemon Pansy (*Precis lemonias*)				+			+			+						+		
61	Chocolate Soldier (*Precis iphita*)		+		+	+		+		+	+	+			+			+	+
62	Himalayan Sergent (*Athyma opalina*)		+		+			+				+		+	+			+	
63	Orange Staff Sergeant (*Athyma cama*)		+						+	+		+			+			+	
64	The Color Sergent (*Athyma nefte*)							+			+		+	+		+			
65	Small Silverfork (*Zophoessa jalaurida*)	+					+												+
66	Pallid Argus (*Callerebia scandal*)	+					+						+						
67	Common Three Ring (*Ypthima asterope*)		+			+			+	+	+			+			+		+
68	Large Threering (*Ypthima nareda*)	+		+			+			+									
69	Himalayan Fivering (*Ypthima sacra*)	+	+	+	+				+		+				+			+	+
70	Indian Fritillary (*Argyreus hyperbius*)	+	+	+	+	+	+	+		+	+		+	+			+	+	
71	Queen of Spain Fritillary (*Issoria lathonia*)	+	+	+	+	+		+		+	+	+		+	+	+	+	+	+
72	Green Commodore (*Sumalia daraxa*)	+			+		+	+											
73	Commander (*Moduza procris procris*)							+									+		
74	Bicolour Commodore (*Parasarpa zayla*)	+			+			+			+			+			+		
75	Common wanderer (*Pareronia valeria*)							+											
76	Glassy Tiger (*Parantica aglea*)		+			+					+	+			+			+	
77	Chestnut Tiger (*Parantica cita*)						+			+			+		+			+	
78	Blue Tiger (*Tirumala limniace*)			+			+			+									+
79	Common Sailer (*Neptis hylas*)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

S. No.	Name of species	TVI			TINT			TLI &II			TLIII			TLIV			TLV		
		PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM
80	Yellow Sailer (*Neptis ananta*)	+	+			+	+	+	+	+	+								
81	Plane Sailor (*Neptis cartica*)									+	+					+			+
82	Small Yellow Sailer (*Neptis miah miah*)		+	+			+		+										
83	Yellow Jack Sailer (*Lassipa viraja*)						+		+	+			+		+				+
84	Indian Red Admiral (*Vanessa indica*)	+	+			+								+		+	+		
85	Indian Tortoise Shell (*Aglais cashmiriensis*)	+	+		+	+		+	+		+			+	+		+		
86	Striped blue Crow (*Euploea mulciber*)				+			+			+			+			+		
87	Common Crow (*Euploea core*)							+			+	+	+	+		+	+	+	+
88	Striped edge Blue Baron (*Euthalia phemius*)		+												+				
89	Common Baron (*Euthalia aconthea*)						+			+									
90	Grey Count (*Tanaecia lepidea*)							+			+			+					
91	Circe (*Hestina nama*)													+					
92	Yellow Kaiser (*Penthema lisarda*)		+			+			+					+			+		
93	Common Jester (*Symbrenthia liaea*)			+					+					+					
94	Orange Oakleaf (*Kallima inachus*)													+			+		
95	Tabby (*Psuedergolis wedah*)																		
96	Common Map (*Cyrestis thyodamas*)		+				+		+									+	
97	Common Maplet (*Chersonesia risa*)									+									
98	Leopard Lacewing (*Cethosia cyane*)								+		+			+	+			+	
99	Cruiser (*Vindula erota*)	+		+	+		+	+			+	+				+	+		+
100	Blue Prince (*Rohana Parisatis*)		+			+		+				+	+	+		+			+
101	Sordid emperor (*Apatura sordida)*						+												
102	Golden Emperor (*Dilipa morgiana*)								+			+							

S. No.	Name of species	TVI			TINT			TLI &II			TLIII			TLIV			TLV		
		PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM
103	Knight (*Lebadea martha*)									+									
Hesperiidae																			
104	Indian Skipper (*Spialia galba*)		+							+						+		+	
105	Tiger Hopper (*Ochus subvittatus*)		+			+			+										
106	Grass Bob (*Suada swerga*)		+						+						+			+	
107	Spotted Demon (*Notocrypta fiesthamelii*)			+			+			+									
108	Forest Bob (*Scobura isota*)						+			+									
109	Himalayan Pied Flat (*Pseudocoladenia dan fabia*)	+			+			+						+					
110	Yellow Flat (*Mooreana trichoneura*)																	+	
111	The Dart (*Potanthus* sp.)		+			+					+	+					+	+	+
	Total No. of species	31	40	23	27	28	30	34	28	31	35	27	25	33	29	21	25	29	30

TVI = Teesta Stage VI; TINT = Teesta Intermediate; TLI&II = Teesta Low Dam ProjectSatge I and II; TLIII = Teesta Low Dam Project Stage III; TLIV = Teesta Low Dam ProjectStage IV; TLV = Teesta Low Dam ProjectStage V; PrM = pre-monsoon, M = Monsoon, PoM = Post-monsoon

In the reptiles a total of 4 species namely *Melanochelys tricarinata*, *Python molurus, Oligodon juglandifer*, *Ophiophagus h*annah are 'Vulnerable', in which former has also been categorised as Schedule I species. Distribution of *Melanochelys tricarinata* is not defined but it is rarely spotted in the study area. *Python molurus* is reportedly distributed in the inner forests of KItam Bird Sanctuary, right bank of Rangit river and Mahananda Wildlife sanctuary; constitute surrounding areas of TLIV, TLIV and TLI & II Projects. *Indotestudo elongata* is an 'endangered species and is widely distributed in the foothills. Indian Egg EatingSnake (*Elachistodon westermanni*) and Walnut Kukri Snake (*Oligodon juglandifer*) are other Schedule I species. They are widely distributed in the study area. In Amphibia, there is no threatened and Schedule I species in the study area. The list of faunal species in the study area and assessment of vulnerability of influence area of hydro-electric projects is summarized in Table-7.8.

Table-7.8 Conservation status of faunal species in the study area and assessment of vulnerability of influence area of hydro-electric projects

	Species	Conservation Status		Distribution
		IUCN	IWPA	
	Mammals			
1.	Asian Golden Cat (*Catopuma temminckii*)	NT	I	All projects
2.	Leopard Cat (*Prionailurus bengalensis*)	LC	I	All projects
3.	Fishing Cat (*Prionailurus viverrinus*)	EN	I	All projects
4.	Clouded Leopard (*Neofelis nebulosa*)	VU	I	All projects
5.	Leopard or Panther (*Panthera pardus*)	NT	I	All projects
6.	Tiger (*Panthera tigris*)	EN	I	TLV, TLIV
7.	Marbled Cat (*Pardofelis marmorata*)	VU	I	All projects
8.	Hog Badger (*Arctonyx collaris collaris*)	NT	I	TLIII, TL I& II
9.	Red Panda (*Ailurus fulgens*)	VU	I	TLIII, TL I& II
10.	Sloth Bear (*Melursus ursinus*)	VU	I	TLV, TLIII
11.	Asiatic Black Bear (*Ursus thibetanus*)	VU	I	TLV, TLIII
12.	Indian Elephant (*Elephas maximus indicus*)	EN	I	TLV
13.	Mountain Goat (*Capricornis sumatraensis*)	VU	I	TLV
14.	Indian Bison (*Bos gaurus*)	VU	I	TLV
15.	Sambar (*Rusa unicolor*)	VU	IV	TLV, TLIV
16.	Indian Wild Dog (*Cuon alpines*)	EN	II	-
17.	Indian Pangolin	EN	I	TLV, TLIV
18.	Chinese Pangolin (*Manis pentadactyla aurita*)	EN	I	TLIII, I, II
	Birds			
19.	Indian Peafowl (*Pavo cristatus*)	LC	I	TLV, TLI& II
20.	Chestnut-breasted Partridge (*Arborophila mandellii*)	VU	IV	TLV, TLI, & II, III,
21.	Rufous- necked Hornbill (*Aceros nipalensis*)	VU	I	All projects
22.	Great Hornbill (*Buceros bicornis*)	NT	I	All Projects
23.	White-rumped Vulture (*Gyps bengalensis*)	CR	IV	All projects
24.	Slender-billed Vulture (*Gyps tenuirostris*)	CR	IV	TL IV, V
25.	Red-headed Vulture (*Sarcogyps calvus*)	CR	IV	All projects
26.	Bengal Florican (*Houbaropsis bengalensis*)	CR	IV	TLV, IV
27.	Slender-billed Babbler (*Turdoides longirostris*)	VU	IV	TLIV, V

	Species	Conservation Status		Distribution
		IUCN	IWPA	
28.	Black-breasted Parrotbill (*Paradoxornis flavirostris*)	VU	IV	All projects
29.	Grey-crowned Prinia (*Prinia cinereocapilla*)	VU	IV	All Projects
30.	Beautiful Nuthatch (*Sitta formosa*)	VU	IV	All Projects
	Herpetofauna			
31.	Three-keeled Land Turtle (*Melanochelys tricarinata*)	VU	I	-
32.	Yellow-headed Tortoise (*Indotestudo elongata*)	EN	IV	TLI & II,
33.	Indian Flap-shelled Turtle (*Lissemys punctata*)	LC	I	
34.	Burmese Python (*Python molurus*)	VU	I	TL I & II, V
35.	Indian Egg EatingSnake (*Elachistodon westermanni*)	LC	I	All projects
36.	Walnut Kukri Snake (*Oligodon juglandifer*)	VU	IV	All projects
37.	King Cobra (*Ophiophagus Hannah*)	VU	II	All projects
	Butterfly			
38.	Orchid Tit (*Chliaria othona)*	-	I	TL I & II
39.	Golden Emperor (*Dilipa morgiana*)	-	I	All projects
40.	Common Pierrot (*Castalius rosimon*)	LC	I	All projects

TVI = Teesta Stage VI; TINT = Teesta Intermediate; TLI&II = Teesta Low Dam ProjectSatge I and II; TLIII = Teesta Low Dam ProjectStage III; TLIV = Teesta Low Dam ProjectStage IV; TLV = Teesta Low Dam ProjectStage V

7.9 CONCLUSIONS

All hydro-electric projects of Teesta basin in West Bengal are located roughly between 100 m and 300 m. Thus, influence zones of all projects are almost similar in area, climatic conditions, land use/land cover, relief, topography and other physiographic features. Generally, these characteristics of the basin influence the faunal diversity. The study area is inhabited nearly by 80 species of mammals, 151 species of avifauna, 90 species reptiles, 21 species amphibian and 111 species butterflies. A total of 35 species inhabiting the area either threatened, schedule I or both. Due to similar conditions no significant variations in the biodiversity were observed between the influence zones of the hydro-electric projects. Except a few species (*Panthera tigris*, *Elephas maximus indicus*, *Manis crassicaudata*, *Houbaropsis bengalensis*, *Rusa unicolor*, *Bos gaurus*, etc. confined in the foothills and *Ailurus fulgens* is distributed in the middle hills), majority of the species are common in distribution. In general entire study area is rich in faunal biodiversity as indicated by the presence of many protected areas in the catchment. It is difficult to isolate an influence area of an individual project from the low or high biodiversity point of view.


Macaca assamese


Semnopithecus hector


Dremomys lokriah

Common Mammalian species in Teesta Lower Basin in West Bengal


Great Egret (*Ardea alba*)


Indian Pond Heron (*Ardeola grayii*)


Common Merganser (*Mergus merganser*)


Little Cormorant (*Phalacrocorax niger*)


Hoopoe (*Upupa epops*)


White-throated Kingfisher (*Halcyon smyrnensis*)

Common Bird Species of Lower Teesta Basin in West Bangal

Common Kingfisher (*Alcedo atthis*)

Crested Kingfisher (*Megaceryle lugubris*)

Blue-throated Barbet (*Megalaima asiatica*)

Chestnut-headed Bee-eater (*Merops leschenaulti*)

Crow-pheasant (*Centropus sinensis*)

Common Cuckoo (*Cuculus canorus*)

Spotted Dove (*Streptopelia chinensis*)

Rock Pigeon (*Columba livia*)

Common Bird Species of Lower Teesta Basin in West Bangal

Yellow-footed Green Pigeon (*Treron phoenicoptera*)

Barn Swallow (*Hirundo rustica*)

Rufous-bellied flycatcher (*Muscicapa vivida*)

Magpie Robin (*Copsychus saularis*)

White-rumped Shama (*Copsychus malabaricus*)

Rufous Sibia (*Heterophasia capistrata*)

Blue- capped Rock Thrush (*Monticola cinclorhynchus*)

Blue Rock Thrush (*Monticola solitaries*)

Common Bird Species of Lower Teesta Basin in West Bangal

Himalayan Bulbul (*Pycnonotus leucogenys*)

Red-vented Bulbul (*Pycnonotus cafer*)

Black-creasted Bulbul (*Pycnonotus flaviventris*)

Red-whiskered Bulbul (*Pycnonotus jacosus*)

Black Drongo (*Dicrurus macrocercus*)

Spangled Drongo (*Dicrurus hottentottus*)

Scarlet Minivet (Pericrocotus speciosus)

Mrs Gould's Sun bird (*Aethopyga gouldiae*)

Common Bird Species of Lower Teesta Basin in West Bangal

India Myna (*Acridotherus tristis*)

Pied Mynah (*Sturnus contra*)

Tree Sparrow (*Passer montanus*)

Grey Wagtail (*Motacilla cinerea*)

Richard's Pipit (*Anthus richardi*)

Streaked Spider Hunter (*Arachnothera magna*)

Common Bird Species of Lower Teesta Basin in West Bangal


Japalura tricarinata


Calotes versicolor


Dendrelaphis pictus

Common reptilian species in Teesta basin, West Bengal


Common Mormon (*Papilio Polytes*)


Common Blue Bottle (*Graphium sarpedon*)


Great Orangetip (*Hebomoia glaucippe*)


Chocolate Albatross (*Appias elenora*)

Common Butterflies in Lower Teesta Basin

Grenvein White (*Pieris melaina*)

White (*Pieris* sp.)

Indian Cabbage White (*Pieris canidia*)

Small Grass Yellow (*Eurema brigitta*)

Fluffy Tit (*Zeltus amasa*)

Common Pierrot (*Castalius rosimon*)

Common Butterflies in Lower Teesta Basin

Common Pierrot (*Castalius rosimon*)

Metallic Cerulean (*Jamides alecto*)

Purple Sapphire (*Heliophorus epicles*)

Common Three Ring (*Ypthima asterope*)

Leopard Lacewing (Cethosia cyane)

Lemon Pansy (*Junonia lemonias*)

Common Butterflies in Lower Teesta Basin

The Color Sergent (*Athyma nefte*)

Yellow Sailor (*Neptis ananta*)

Common Sailor (*Neptis hylas*)

Common Map (*Cyrestis thyodamas*)

Orange Oakleaf (*Kallima inachus*)

Commander (*Moduza procris procris*)

Common Butterflies in Lower Teesta Basin

Knight (*Lebadea martha*)

The Dart (*Potanthus* sp.)

Common Butterflies in Lower Teesta Basin

7.10 FAUNA IN RAMMAM SUB-BASIN

As mentioned earlier, the project area, did not have good vegetation. Since the project area does not support good habitats there is hardly any movement of wildlife. The locals stated that wild animals are not common in this area. However, one may have stray sightings of fox, Wild boar (*Sus scrofa*) and Jackal *(Canis aureus*). The list of major animal species reported in the study area is given in Table-7.9.

Table-7.9: List of major animal species reported in the study area

S. No.	Zoological Name	English Name	Schedule as per Wildlife Conservation Act
MAMMALS			
1.	*Canis aureus*	Jackal	II
2.	*Felis bengalensis*	Leopard cat	I
3.	*Felis chaus*	Jungle cat	II
4.	*Hystrix indica*	Indian Porcupine	IV
5.	*Lepus nigricollis*	Indian hare	IV
6.	*Macaca mulatto*	Rhesus Monkey	II
7.	*Muntiacus muntjak*	Barking deer	III
8.	*Panthera pardus*	Leopard	I
9.	*Sus scrofacristatus*	Wild Boar	III
10.	*Vul bengalensis*	Indian Fox	II
BIRDS			
1.	*Acridotheres tristis*	Indian Myana	IV
2.	*Alectoris Chukar*	Chukor Patridge	IV
3.	*Arborophila torqueola*	Hill Patridge	IV
4.	*Bubo bubo bengalensis*	Eagle Owl	IV
5.	*Columbia livia*	Rock Pigeon	IV
6.	*Corvus macrorhynchos*	Jungle Crow	
7.	*Corvus splendens*	House crow	
8.	*Dendrocopos himalayensis*	Himalayan Woodpecker	IV
REPTILES			

S. No.	Zoological Name	English Name	Schedule as per Wildlife Conservation Act
1.	*Agama tuberculata*	Common lizard	
2.	*Argyrogena ventromaculatus*	Gray's rat snake	II
3.	*Naja naja*	Indian cobra	II
4.	*Varanus bengalensis*	Indian monitor lizard	II

Singalila National Park

The Singalila National Park is located at a distance of 5 km on the north-west side of the barrage site of Singalila National Park. The park has major mammalian fauna like the Red Panda (*Ailurus fulgens*), Himalayan Black Bear (*Selenarctos thibetanus*) Leopard cat (*Felis bengalensis*), Clouded Leopard (*Neofeis nebulosa*), Barking Deer (*Muntiacus muntjak*) Serow (*Capricornis sumatraensis*), Yellow Throated Marten (*Matres flavigula*), Wild Boar (*Sus scrofa*), Himalayan Mouse Hare (*Ochotona royle*), Wild dog (*Cuon alpinus*), Porcupine (*Hystrix indica*) and fox (*Vulpes vulpes*). Of the above mentioned species, five species belong to Endangered category. These are Red Panda (*Ailurus* sp.), Leopard Cat (*Felis benghalensis*), Barking deer (*Muntiacus muntjak*), Wild boar (*Sus scrofa*), Fox (*Vulpes vulpes*).

The park is quite rich in avi-fauna and has many interesting galliform species like the Satyrtragopan (*Tragopan satyra*), Kaleej Pheasant (*Lophura Leu – comelana*), Blood Pheasant (*Ithaginis cruentus*) and the red breasted Hill Patridge (*Abrophilla mandelii*). Besides this, birds of all shapes, sizes, colours and hues have their homes in this park.

CHAPTER 8
AQUATIC ECOLOGY

CHAPTER-8
AQUATIC ECOLOGY

8.1 INTRODUCTION

The quality of water is always attributed to the physical, chemical and biological characteristics. In natural condition, characteristics of water including its fauna and flora respond to the seasons, geographic and topographic features of the drainage area and under geographical conditions it varies in time and space. Land use/land cover of the catchment have also a considerable impacts on the water quality, thus changes in the land use are anticipated to have immense impacts on the physical and chemical characteristics of water (Azrina et al., 2003) and inevitably responded by biotic communities like algae, macro-invertebrates and fish. Catchment area of Teesta river in hilly region bestowed with snowy region, alpine meadows and dense forests with sparse population and do not receive much sewage outfall and agricultural runoff as compared to other rivers like Ganga and Yamuna.

Teestariver has been planned for cascade development (it has been regulated in Sikkim and West Bengal). The cascade development leads to the physical alteration of a large river channel in the form of impoundment and deprivation. The physical alteration changes the hydrological pathway and may change the physical, chemical and biological characteristics not only by changing hydrological pathway but adding various pollutants to landscape (Peters and Meybek, 2000). In addition, alteration of hydrological pathway may have various social, cultural and economic impacts.

Change in the flow pattern due to cascade development in a river is a major factor, which ultimately triggers the ecological changes, viz. sediment inflow, water quality, biotic communities and fisheries. It has various socio-cultural and economic impacts. The social-economic impacts like impacts on drinking water, irrigation, aesthetic and religious importance, if any are also addressed imperatively while studying the overall carrying capacity of a basin. This study focuses on the water quality and aquatic ecology of Teestariver in West Bengal, where many hydro-electric projects are proposed. In view of the altered ecological conditions baseline data on water quality and ecological parameters have been retrieved from Teestariver and its tributaries in West Bengal to assess the likely impacts of upcoming hydro-electric projects.

8.2 BIOLOGICAL CHARACTERISTICS

Biological parameters included algae in planktonic and benthic forms, zooplankton, macro-invertebrates and fish fauna. Fish fauna has separately been given in this report. Monthly variation in the densities of various biotic communities is given in Table-8.1. Densities of various biotic communities in Teesta and Rangitrivers indicated a highly disturbed profile of these rivers, therefore, there is lack of temporal and spatial patterns as usually running waters show. However, the seasonal effects were prevalent in the densities. In all communities, higher densities were recorded in the winter months (December, January, and February) while lower densities were recorded in the monsoon months (June, July, August). Densities in phytoplankton and phytobenthos reached exceptionally high in the month of February while in zooplankton high densities were recorded in the month of April **(Table-8.1,Figure-8.1**). High water discharge and turbidity wash out the major parts of biotic communities in monsoon months. Comparing two rivers Rangitriver recorded high densities in phytoplankton, phytobenthos, zooplankton and macro-invertebrates.

8.3 SPECIES COMPOSITION

8.3.1 Zooplankton

Zooplankton community in Teestariver comprised of Protozoa, Rotifera, Cladocera and Copepoda, of which rotifer and copepod were predominant in terms of diversity and density, respectively. Predominant taxa of rotifera were *Lecane* sp., *Testudinella*sp.,*Polyarthra* sp., *Brachionus* sp., *Polyarthra* sp., *Filinia*sp. and*Keratella*. *Filiniaterminalis* and *Keratellahiemalis* were common species among the rotifers, which were recorded from rivers and from maximum sites. Copepoda represented by at least 8 species, of which *Cyclops* spp., *Diaptomus*sp. and*Nauplius*sp. were most common and abundant. Many copepods could not be identified. In the Cladocera*Daphnia* spp. *Bosmina*sp.And*Moina*spp were most common and inhabit all sites of Teesta and Rangit rivers. During the field investigation, no overgrowth of zooplankton was recorded in the study area.

8.3.2 Phytoplankton

Phytoplankton of Teesta basin comprised of more than 20 species of cyanophyceae, 25 species of chlorophyceae, 3 species of dinophyceae and nearly 140 species of bacillariophyceae. The most common species in cyanophyceae were *Lyngbya* sp., *Lyngbya purpurea*, *Phormidium uncinatum*, *Stigonema mamillosum* and *Ocillatoria nigra*. *Microcystis robusta* was recorded from the stagnant water while *Nostoc* spp., *Chroococcus* sp. and *Merismopedia elegans* were restricted to the floodplain of Teesta river. The species which were recorded rarely were *Aphanocapsa pulchra*, *Chlorogloea simplex*, *Gloeotrichia* sp. and *Stigonema* sp. A few species which dominated a particular site were *Lyngbya* sp. (11.23%), *Lyngbya purpurea* (14.5%), *Anabaena* spp. (10.3%) and *Phormidium uncinatum* (13.2%). In the overall plankton none of the species of cyanophyceae was dominant.

Chlorophyceae was represented by more than 25 species. *Ulothrix zonata, Cladophora glomerata, Spirogyra nitida, Spirogyra rhizobrachialis, Oedogonium* spp., *Pediastrum* spp., *Dictyospherim* sp., *Rivularia* sp., *Netrium digitus, Closterium acerosum* and *Cosmarium pseudogranatum* were most common species. *Staurastrum pachyrhynchum*, *Gonatozygon monotaenium* and *Spirotaenia* sp. were common in the Rangit river while *Microspora* sp. was recorded from reservoir of Teesta Low dam III. The rarely observed species were *Scenedesmus* sp., *Chlorogonium* sp. and Z*ygnema* sp. *Cladophora glomerata*, *Spirogyra nitida* and *Oedogonium* sp. (10.4 – 14.1%) dominated many sites in Teesta river while *Gonatozygon monotaenium* and *Spirotaenia* sp (11.6 – 12.4&) were found to dominate green algae at Rangit river. *Closterium acerosum* and *Cosmarium pseudogranatum* wereone among thedominant species in Riyang Khola in winter months. In the overall planktonic algae none of the chlorophyceae species was dominant. Dinophyceae included three species, viz. *Ceratium* sp., *Glenodinium*spp. None of the Dinophyceae species was predominant in Teesta, Rangit and Riyang khola.

More than 140 species of planktonic diatoms were recorded at various sites in Rangit and Teesta rivers during the field investigation. The number of species at each site varied from 0 in the month of June at all sites to 55 during February at site S7 (Rangit river). Species richness generally increased from the month of July and got peak in February (**Table-8.2,Figure 8.2**). Prominent irregularities in the physical and chemical characteristics in Rangit and Teesta rivers due to river regulation in upstream were found to affect the biological characteristics of these rivers. The planktonic algae were absent in the month of June and at many sites in July due to high turbidity. Species richness was high in Rangit river as compared to Teesta river. *Achninthidium*, *Cymbella*, *Gomphonema* and *Navicula* were most diverse taxa in the planktonic communities. The species which were dominant at many sites (>10%) included *Achnanthidium linearis, A. lanceolata, A. minutissima, A. minutissima* var. *minutissima*, *A. biasolettiana*, *Cymbella turgida*, *Synedra ulna, Nitzschia thermalis*, *Gomphonema insigniforme*. Monotypic taxa comprised of *Geissleria* sp., *Gyrosigma* sp., *Reimeria sinuata*, *Planothidium lanceolata* and *Psammothidium levanderi*. All monotypic species were not common and abundant.

Riyang Khola (a small tributary of Teesta river) recorded a total of 94 species of diatom with minimum nil in the month of June and maximum 35 taxa in January. The trend of species richness was similar to other sites, gradually increased from July and peaked in January (Annexure-VID). *Achnanthes affinis, A. biasolettiana, A. exilis, Cymbella affinis*, etc were relative common taxa of Riyang Khola. *Achnanthes* and *Gomphonema* were most abundant taxa in Riyang Khola in term of species richness. No substantial variation was recorded in species composition between Riyang Khol and main rivers.

8.3.3 Phytobenthos

Likewise phytoplankton, Phytobenthos comprised of Chlorophyceae, Cynophyceae and bacillariophyceae, however, higher diversity of filamentous algae was recorded in planktonic forms. In the phytobenthos, cyanophyceae was represented by 9 species and chlorophyceae included a total of 14 species. In the cyanophyceae the dominant taxa were *Lyngbya purpurea*, *Phormidium uncinatum*, *Ocillatoria nigra*, *Ocillatoria* sp. and *Anabaena* spp. Some rarely observed species were represented by *Chlorogloea simplex* and *Stigonema* sp. None of the species belonging to cyanophyceae had a regular and common distribution. Their presence and abundance varied spatially and temporally. A few species like *Stigonema mamillosum*, *Microcystis robusta*, *Nostoc* spp., *Chroococcus* sp. and *Merismopedia elegans* were not found in the benthic form.

Among the 14 species of chlorophyceae *Closterium acerosum, Cosmarium pseudogranatum*, *Ulothrix zonata, Cladophora glomerata, Spirogyra nitida, Oedogonium* spp., *Pediastrum* spp., and *Cosmarium pseudogranatum* were relatively common species. *Spirotaenia* sp. and *Zygnema* sp. were rarely observed species. A few species, viz. *Dictyospherim Rivularia* sp., *Netrium digitus,* and *Gonatozygon monotaenium* were absent in the benthic forms.

Bacillariophyceae in the phytobenthos was represented by more than 170 species with maximum in the month of February. Benthic diatom species richness at different site ranged from 0 in the month of June at all sites to 57 at site S1 in February;(**Table-8.3, Figure.8.2**). Likewise plankton, species richness increased from August and peaked in February in general. Diatom richness was substantially low in the months of June, July and August. The species like *Achnanthidium biasolettiana*, *Cymbella ventricosa*, *Gomphonema lanceolatum*, *G. sphaerophorum*, *Navicula rhynchocephala*, *Surirella* sp. etc. can be considered as more tolerant species as they were recorded in high discharge and turbid waters. *Achnanthidium* and *Gomphonema* were most diverse taxa in Teesta and Rangit river. Generally Rangit river recorded high benthic diatom richness as compared to Teesta river. Most common taxa of Teesta basin were *Achnanthidium biasolettiana, A. minutissima*, *Geissleria accetata*, *Cymbella turgid*, *Cymbella ventricosa*, *Cymbella superparva*, *Cymbella tumida*, *Encyonema subminisculus*, etc. Monotypic taxa included *Planothidium lanceolata*, *Melosira varians*, *Gyrosigma* sp., *Geissleria accetata*, *Anomoneis* sp. *Melosira varians* was absent in the plantonic communities.

Benthic diatoms in Riyang Khola were represented by a total of 106 species. They were absent in the months of June, July and August. The highest species richness of 45 taxa was recorded in the month January. Benthic diatom richness followed the pattern as described in plankton. Species richness gradually from September and got peak in January. *Achnanthes affinis* was most common species, followed by *A. biasolettiana*, *Achnanthidium minutissima*, *Planothidium lanceolata* etc. No significant variation was observed in species composition between Riyang Khola and other sites of Teesta river.

8.3.4 Macro-invertebrates

Macro-invertebrates are considered as good indicators of water quality and habitat characteristics. Richness mostly depends on the water discharge, water current velocity and nature of substratum. More than 40 taxa were recorded at various sites of Teesta river river basin (Table-8.4). Various sites of Teesta, Rangit and Riyang Khola recorded more than 21, 31, and 23 taxa, respectively. Rangit river seems more rich in macro-invertebrates, though it has more sampling sites as compared to Riyang Khola(Table-8.5). The richness of macro-invertebrates in all rivers generally increased from the month of September and got peak in December and started to decrease gradually. During the months of high floods due to monsoonal rains (May to September) low densities can be attributed to the high turbidity and water discharge, which washed out most of the taxa. In the month of October the macro-invertebrate communities were found to restore itself. Also Teesta as well as Rangit rivers are regulated in upstream. Therefore, regulated stretches of these rivers are anticipated to affect these communities adversely. Due to regular fluctuation in the water levels in rivers, a regular pattern could not be observed. The distribution pattern in macro-invertebrates is highly uneven in the basin, most of the genera come from Rangit river. The irregular pattern of distribution at different sites and rivers can be related to the regular fluctuation in the flow due to upstream river regulation. Most common and abundant taxa in all rivers were *Ablabesmyia* sp., *Baetis* sp. *Cinygmula* sp. *Hydropsyche* sp. They were recorded from more than 10 sites from the basin.

Ephemerella subvaria, *Leucotrichia*, *Perlesta*, and *Stenocolus* were recorded exclusively from Teesta river. The taxa which were specific to Rangit river were *Antocha pupa*, *Heterlimnius* and*Sphenus*. Riyang Khola is a small tributary of Teesta river. It is non regulated stream. Considering the sample size, it was found relatively rich as compared to Teesta and Rangit rivers. Out of more than 23 taxa in Riyang Khola, *Enallagma*, *Horaia*, *Neoperla* and *Simulium pictipes* were specific to Riyang Khola.

8.5 CONCLUSION

Physical, chemical and biological characteristics of water bodies are attributed to the health of rivers/lakes. Generally water characteristics are affected by natural phenomena like climate, rocks, geology and land use/land cover and anthropogenic factors like sewerage outfall, agricultural runoff, river regulation, sand mining etc. Overall quality of waters of Teesta basin is good and does not seem to be affected largely by organic pollution, agricultural runoff and sand mining, though these activities are there but not prevalent. Water quality seems to be affected by river regulation. Both Teesta and Rangit rivers are regulated for the purpose of power generation. Regular fluctuations in the water level were observed not only visually but it reflected in the physical, chemical and biological characteristics. Generally, these features show more or less stable pattern in their magnitude at temporal as well as spatial gradients, but such patterns were not observed in Teesta and Rangit rivers. The same characteristics of water of Riyang Khola show relatively a stable pattern. Riyang Khola is an unregulated river. However all physical and chemical parameters of basin waters are within desirable limit of water quality standards of India (**as per IS:10500, 2012).** Also, water is rich in species composition. Relatively unregulated stream Riyang Khola was rich in biodiversity as compared to Teesta and Rangit rivers.

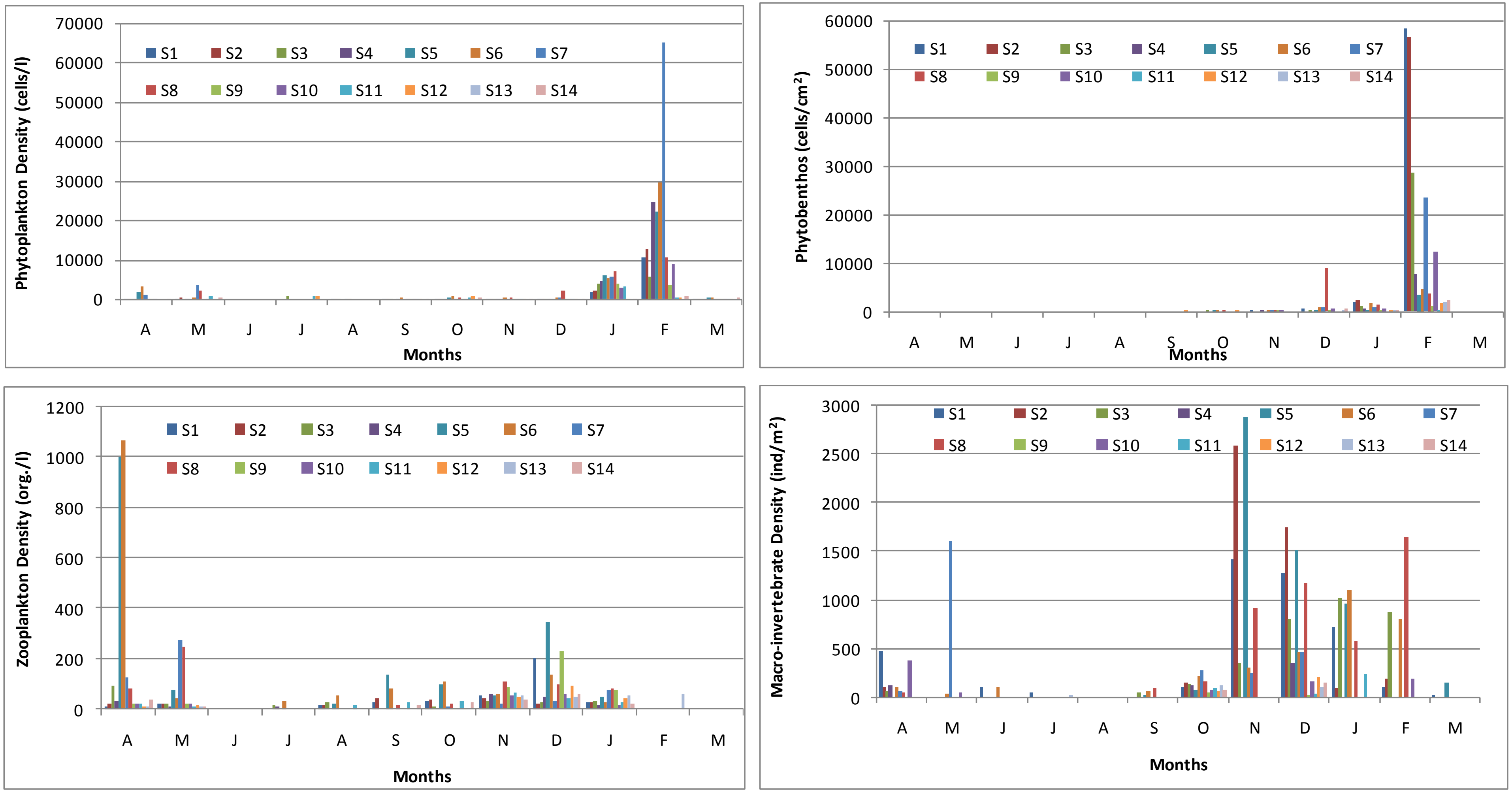


Figure-8.1: Monthly variation in the density of different biotic communities at different sites of Teesta and Rangit rivers

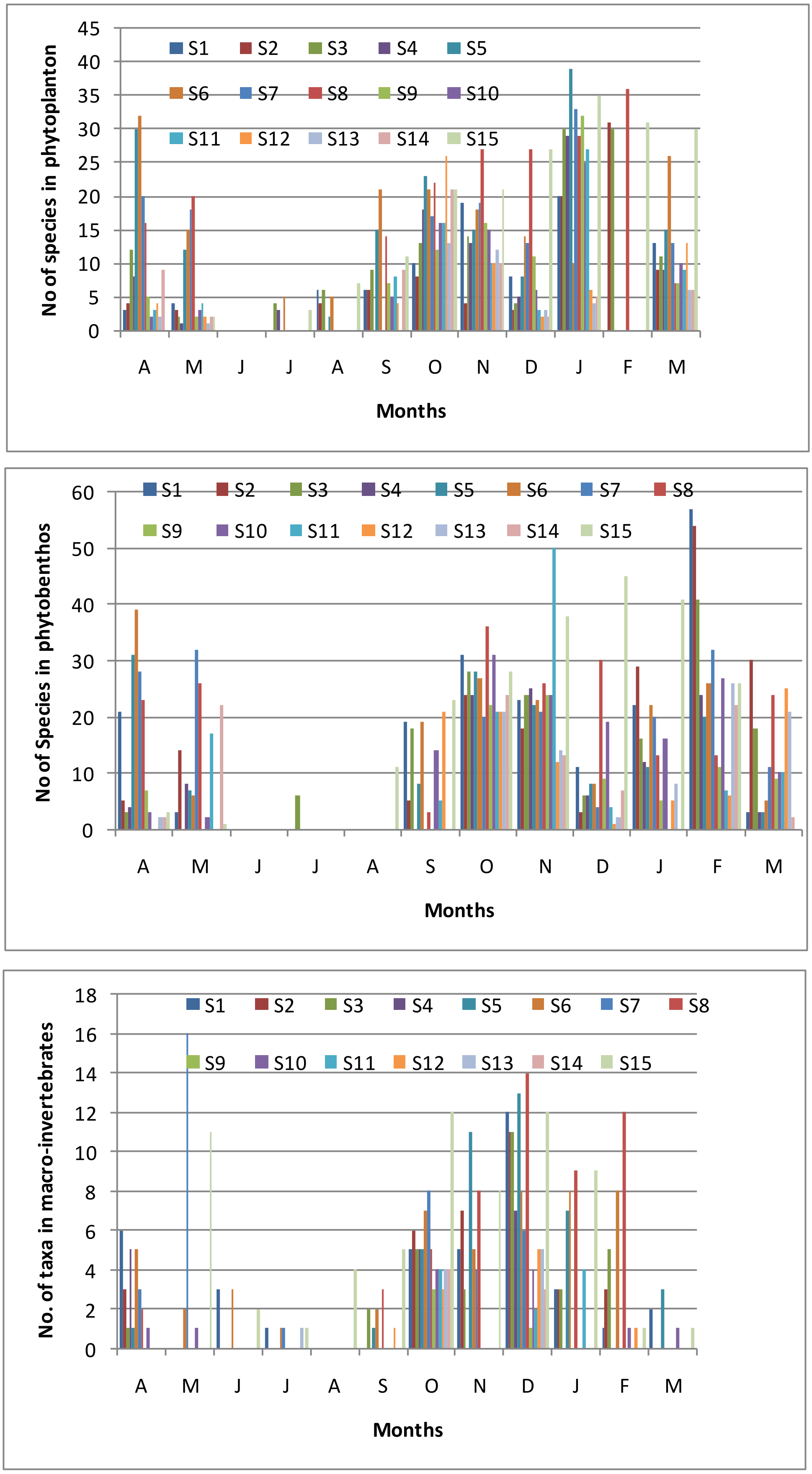


Figure-8.2: Species/taxa richness in the different biotic communities of Teesta, Rangit and Riyang khola

Table-8.1 Monthly variations in the densities of different biotic communities in Teesta and Rangit rivers

Phytoplankton (cells/l)												
Sites	**Apr**	**May**	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**
S1	112	21	0	0	28	35	30	102	112	1800	10440	41
S2	15	374	0	0	30	18	35	66	35	2045	12540	32
S3	15	0	0	600	39	53	56	78	22	3840	5490	76
S4	15	110	0	0	0	0	85	132	38	4595	24800	134
S5	1692	110	0	0	11	120	230	138	58	6020	22054	187
S6	3260	216	0	0	29	367	687	232	521	5264	29400	213
S7	1110	3572	0	0	0	0	100	146	435	5645	64980	114
S8	39	2210	0	0	0	75	220	252	2146	6900	10652	41
S9	34	0	0	0	0	33	187	102	165	3920	3600	71
S10	32	8	0	0	0	16	168	76	88	2876	8820	65
S11	0	711	0	813	0	35	250	166	77	3295	372	76
S12	0	0	0	720	0	17	650	136	23	164	306	98
S13	12	0	0	0	0	0	120	72	18	76	765	34
S14	8	456	0	0	0	35	287	66	22	90	1440	241
Phytobenthos (cells/cm^2)												
	Apr	**May**	**Jun**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	Mar
S1	12	12	0	0	**0**	102	235	302	579	2096	58397	31
S2	25	11	31	0	0	**20**	250	122	42	2453	56640	142
S3	12	0	0	0	24	124	354	214	338	1240	28800	134
S4	37	0	11	0	0	0	120	278	218	795	7760	65
S5	23	10	0	0	**0**	22	280	208	552	541	3425	68
S6	33	11	0	12	0	135	428	326	893	1758	4693	61
S7	12	24	10	0	**0**	0	120	432	987	1125	23680	102
S8	26	0	0	0	**0**	15	350	465	9087	1576	3895	120
S9	24	0	10	0	0	0	200	456	336	545	1220	76
S10	12	21	21	0	0	96	235	312	700	715	12540	110
S11	49	216	21	0	**0**	24	250	0	73	0	407	120
S12	25	0	11	0	**0**	304	450	68	15	393	1760	227

S13	11	0	0	0	0	0	120	138	321	325	2185	132
S14	11	66	0	19	0	0	230	28	760	529	2520	21
Zooplankton (organisms/l)												
Sites	**Apr**	**May**	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**
S1	12	23	0	0	15	30	32	54	201	26	235	6
S2	23	24	0	0	16	42	40	44	24	26	321	3
S3	94	20	0	19	27	0	10	32	25	34	331	12
S4	35	12	0	12	0	0	2	65	52	18	421	13
S5	1003	78	0	0	21	140	100	56	347	50	321	11
S6	1067	42	0	33	53	81	110	62	137	26	654	8
S7	127	276	0	0	0	0	10	23	34	76	643	10
S8	83	248	0	0	0	19	23	112	97	80	218	15
S9	21	24	0	0	0	0	5	88	232	75	113	6
S10	24	20	0	0	0	0	6	56	58	18	208	12
S11	24	12	0	0	15	27	32	67	46	28	76	11
S12	11	15	0	0	0	0	7	52	93	43	53	10
S13	12	10	0	0	0	0	8	54	49	54	63	21
S14	36	11	0	0	0	18	25	36	59	24	131	17
Macroinvertebrates (organisms/m^2)												
	Apr	**May**	**Jun**	**July**	**Aug.**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**
S1	477	0	100	45	0	0	110	1422	1278	711	111	22
S2	111	0	0	0	0	0	144	2588	1744	89	188	0
S3	56	0	0	0	0	44	132	344	800	1021	877	0
S4	121	0	0	0	0	0	121	0	344	0	0	0
S5	11	0	0	0	0	22	77	2888	1522	967	0	144
S6	99	33	99	11	0	55	221	311	467	1099	800	0
S7	66	1599	0	11	0	0	275	245	456	0	0	0
S8	44	0	0	0	0	89	156	911	1178	577	1644	0

S9	0	0	0	0	0	0	44	0	22	0	1	0
S10	378	44	0	0	0	0	77	0	155	0	189	11
S11	0	0	0	0	0	0	88	0	33	233	0	0
S12	0	0	0	0	0	11	66	0	199	0	11	0
S13	0	0	0	22	0	0	121	0	110	0	0	0
S14	0	0	0	0	0	0	77	0	143	0	0	0

Table-8.2 Relative abundance of phytoplankton (Diatom) in Teesta Basin in West Bengal

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
April														
Achnanthidium affinis	0.0	0.0	0.0	0.0	0.0	9.7	0.0	10.3	0.0	57.1	0.0	0.0	0.0	16.7
A. biasolettiana	0.0	0.0	0.0	0.0	11.2	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. conspicua	0.0	0.0	0.0	0.0	0.0	2.9	0.0	7.7	0.0	0.0	0.0	0.0	0.0	0.0
A. exilis	0.0	0.0	0.0	0.0	0.0	1.0	2.4	0.0	16.7	0.0	0.0	0.0	0.0	0.0
A. gibberula var. genuina	0.0	0.0	0.0	0.0	3.7	2.9	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. Grimmei	0.0	0.0	0.0	0.0	2.8	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. kryophila	0.0	0.0	10.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. linearis	75.0	12.5	10.0	0.0	19.6	24.3	14.3	35.9	16.7	0.0	50.0	0.0	50.0	12.5
A. lanceolata	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0
A. lanceolata var. elliptica	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. minutissima	0.0	25.0	0.0	0.0	0.0	4.9	14.3	0.0	0.0	42.9	25.0	0.0	0.0	0.0
A. plonensis	0.0	0.0	13.3	0.0	4.7	1.0	4.8	0.0	16.7	0.0	0.0	0.0	0.0	0.0
A. subsalsa	0.0	0.0	0.0	18.2	0.0	1.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cocconeis placentula	0.0	0.0	0.0	0.0	0.0	2.9	6.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0
C. placentula var. *euglypta*	0.0	0.0	0.0	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.3
Cymbella affinis	0.0	0.0	6.7	0.0	5.6	1.9	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. amphicephala	0.0	0.0	0.0	0.0	4.7	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0
C. hebridica	0.0	0.0	0.0	0.0	0.0	1.9	2.4	0.0	0.0	0.0	0.0	33.3	0.0	0.0
C. kerkevarensis	0.0	0.0	0.0	0.0	0.0	4.9	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
C. laevis	0.0	0.0	0.0	0.0	2.8	0.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. perpusila	0.0	0.0	0.0	0.0	0.0	1.0	2.4	0.0	0.0	0.0	25.0	0.0	0.0	0.0
C. Reinhardtii	0.0	0.0	10.0	0.0	0.9	0.0	2.4	5.1	0.0	0.0	0.0	0.0	0.0	0.0
C. sinuata	0.0	0.0	0.0	0.0	0.0	2.9	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. turgida	0.0	0.0	0.0	0.0	2.8	0.0	6.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0
C. ventricosa	0.0	0.0	0.0	0.0	3.7	1.9	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diatoma hiemale	0.0	0.0	0.0	0.0	0.0	4.9	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fragilaria sp.	0.0	37.5	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0
F. construens	0.0	0.0	0.0	9.1	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0	0.0	8.3
F. capucina	0.0	0.0	6.7	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. intermedia	0.0	0.0	0.0	9.1	0.9	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0
F. pinnata	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. rumpens	0.0	0.0	10.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema gracile	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
G. intricatum var. *vibrio*	0.0	0.0	0.0	9.1	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. intricatum var. *pumila*	0.0	0.0	6.7	0.0	0.0	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0
G. longiceps	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. longiceps var. *subclavata*	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceum	0.0	0.0	6.7	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceum var. *minutissima*	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. parvulum	25.0	0.0	0.0	0.0	0.0	1.9	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0
G. tergestinum	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema sp.	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula cincta	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. cryptocephala	0.0	0.0	10.0	0.0	0.0	1.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0
N. cryptocephala	0.0	0.0	0.0	0.0	1.9	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. cryptocephala var. *veneta*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	8.3
N. gracilis	0.0	0.0	0.0	9.1	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
N. microcephala	0.0	0.0	6.7	0.0	0.0	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0
N. radiosa	0.0	0.0	0.0	0.0	0.9	1.9	0.0	2.6	0.0	0.0	0.0	0.0	0.0	8.3
N. radiosa var. *tenella*	0.0	0.0	0.0	0.0	1.9	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula sp.	0.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitzschia heufloriana	0.0	0.0	0.0	18.2	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pinnularia appendiculata	0.0	0.0	0.0	0.0	1.9	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pinnularia sp.	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Planothidium lanceolata	0.0	0.0	0.0	18.2	0.0	0.0	0.0	0.0	33.3	0.0	0.0	0.0	0.0	0.0
Synedra acus	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S. ulna	0.0	0.0	3.3	0.0	1.9	1.0	7.1	0.0	0.0	0.0	0.0	0.0	50.0	20.8
S. ulna var. *aequalis*	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S. ulna var. *amphirhynchus*	0.0	0.0	0.0	0.0	1.9	1.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	16.7
Total No. of Taxa	**3.0**	**4.0**	**12.0**	**8.0**	**30.0**	**32.0**	**20.0**	**16.0**	**5.0**	**2.0**	**3.0**	**4.0**	**2.0**	**9.0**
May														
Achnanthidium exilis	0.0	42.9	0.0	0.0	0.0	2.9	4.2	4.1	0.0	25.0	0.0	0.0	0.0	0.0
A. linearis	28.6	0.0	0.0	0.0	0.0	11.4	0.0	10.2	66.7	0.0	50.0	0.0	0.0	50.0
A. lanceolata	0.0	0.0	0.0	0.0	8.3	2.9	6.3	6.1	0.0	0.0	0.0	66.7	0.0	0.0
A. lanceolata var. *elliptica*	0.0	0.0	0.0	0.0	0.0	2.9	0.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0
A. minutissima	0.0	0.0	0.0	0.0	11.1	17.1	8.3	4.1	33.3	50.0	0.0	0.0	0.0	0.0
Cymbella affinis	0.0	0.0	0.0	0.0	5.6	2.9	2.1	0.0	0.0	0.0	25.0	0.0	0.0	0.0
C. laevis	0.0	14.3	0.0	0.0	0.0	5.7	8.3	4.1	0.0	0.0	0.0	0.0	0.0	0.0
C. ventricosa	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fragilaria sp.	0.0	0.0	50.0	0.0	0.0	5.7	8.3	2.0	0.0	0.0	12.5	0.0	100.0	0.0
F. capucina	0.0	0.0	0.0	100.0	0.0	0.0	4.2	2.0	0.0	0.0	0.0	0.0	0.0	0.0
F. intermedia	0.0	0.0	0.0	0.0	0.0	5.7	4.2	4.1	0.0	0.0	0.0	33.3	0.0	0.0
Gomphonema parvulum	28.6	0.0	0.0	0.0	8.3	5.7	0.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0
G. tergestinum	0.0	0.0	0.0	0.0	11.1	0.0	8.3	2.0	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceum	0.0	0.0	0.0	0.0	5.6	0.0	0.0	8.2	0.0	25.0	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Gomphonema sp.	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula cryptocephala	0.0	0.0	0.0	0.0	0.0	5.7	8.3	2.0	0.0	0.0	0.0	0.0	0.0	0.0
N. gracilis	0.0	42.9	0.0	0.0	0.0	0.0	0.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0
N. microcephala	0.0	0.0	0.0	0.0	0.0	5.7	10.4	8.2	0.0	0.0	0.0	0.0	0.0	0.0
N. radiosa	0.0	0.0	0.0	0.0	11.1	0.0	4.2	6.1	0.0	0.0	0.0	0.0	0.0	0.0
N. radiosa var. *tenella*	0.0	0.0	0.0	0.0	5.6	0.0	4.2	4.1	0.0	0.0	0.0	0.0	0.0	0.0
Navicula sp.	14.3	0.0	0.0	0.0	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Planothidium lanceolata	0.0	0.0	0.0	0.0	13.9	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	50.0
Synedra ulna	0.0	0.0	50.0	0.0	0.0	8.6	4.2	10.2	0.0	0.0	12.5	0.0	0.0	0.0
S. ulna var. *aequalis*	0.0	0.0	0.0	0.0	11.1	5.7	4.2	2.0	0.0	0.0	0.0	0.0	0.0	0.0
S.ulna var.*amphirhynchus*	28.6	0.0	0.0	0.0	0.0	11.4	2.1	8.2	0.0	0.0	0.0	0.0	0.0	0.0
Total No of Taxa	**4.0**	**3.0**	**2.0**	**1.0**	**12.0**	**15.0**	**18.0**	**20.0**	**2.0**	**3.0**	**4.0**	**2.0**	**1.0**	**2.0**
July														
Achnanthidium linearis	0.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cymbella affinis	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. ventricosa	0.0	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fragilaria sp.	0.0	0.0	25.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. capucina	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema parvulum	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. tergestinum	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. microcephala	0.0	0.0	0.0	0.0	0.0	28.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. radiosa	0.0	0.0	0.0	0.0	0.0	28.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S. ulna var. *aequalis*	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S.ulna var. *amphirhynchus*	0.0	0.0	0.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total No of Taxa	**0.0**	**0.0**	**4.0**	**3.0**	**0.0**	**5.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
August														
Achnanthidium affinis	0.0	7.1	0.0	0.0	0.0	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. lanceolata	15.4	0.0	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
A. linearis	0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. minutissima	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diatoma hiemale	23.1	0.0	11.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema angustatum0	28.6	0.0	0.0	0.0	0.0	15.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. parvulum	0.0	0.0	17.7	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. sphaerophorum	0.0	21.4	0.0	0.0	0.0	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema sp.	23.1	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
Hannaea arcus	0.0	0.0	17.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula radiosa	15.4	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
Navicula rhynchocephala	0.0	0.0	0.0	0.0	0.0	83.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula sp.	0.0	28.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitzschia thermalis	0.0	0.0	23.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Surirella sp.	23.1	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
Synedra ulna	0.0	0.0	0.0	0.0	0.0	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Synedra sp.	0.0	0.0	23.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total No of Taxa	**6.0**	**4.0**	**6.0**	0.0	**2.0**	**5.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
September														
Achnanthidium affinis	10.5	0.0	0.0	0.0	8.3	3.5	0.0	9.5	0.0	7.7	0.0	0.0	0.0	0.0
A. lanceolata	0.0	0.0	0.0	0.0	6.7	0.0	0.0	7.1	19.2	0.0	14.3	13.3	0.0	0.0
A. linearis	0.0	0.0	15.6	0.0	8.3	8.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.3
A. minutissima	0.0	27.3	0.0	0.0	8.3	7.0	0.0	0.0	15.4	0.0	0.0	0.0	0.0	0.0
Amphora sp.	0.0	0.0	12.5	0.0	0.0	7.0	0.0	7.1	0.0	0.0	5.7	0.0	0.0	8.3
Cocconeis placentula	5.3	0.0	0.0	0.0	3.3	3.5	0.0	11.9	0.0	0.0	0.0	0.0	0.0	0.0
Cymbella affinis	0.0	9.1	6.3	0.0	0.0	3.5	0.0	0.0	19.2	0.0	0.0	0.0	0.0	16.7
Diatoma hiemale	0.0	0.0	0.0	0.0	3.3	3.5	0.0	4.8	0.0	0.0	8.6	0.0	0.0	0.0
Fragilaria sp.	0.0	18.2	0.0	0.0	6.7	3.5	0.0	0.0	15.4	0.0	0.0	0.0	0.0	8.3
Gomphonema angustatum	15.8	0.0	0.0	0.0	6.7	3.5	0.0	4.8	0.0	0.0	11.4	0.0	0.0	0.0
G. intricatum	0.0	0.0	12.5	0.0	0.0	8.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
G. parvulum	0.0	0.0	0.0	0.0	8.3	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.5
G. sphaerophorum	0.0	18.2	0.0	0.0	0.0	0.0	0.0	9.5	7.7	0.0	11.4	0.0	0.0	0.0
Gomphonema sp.	0.0	0.0	6.3	0.0	0.0	8.8	0.0	0.0	0.0	0.0	0.0	26.7	0.0	0.0
Gyrosigma sp.	0.0	0.0	0.0	0.0	6.7	1.8	0.0	4.8	0.0	23.1	0.0	0.0	0.0	12.5
Hannaea arcus	0.0	0.0	6.3	0.0	0.0	1.8	0.0	0.0	7.7	0.0	14.3	0.0	0.0	0.0
Navicula linearis	0.0	0.0	9.4	0.0	0.0	7.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0	8.3
Navicula radiosa	15.8	0.0	0.0	0.0	0.0	3.5	0.0	0.0	0.0	15.4	5.7	0.0	0.0	0.0
Navicula rhynchocephala	0.0	0.0	0.0	0.0	6.7	1.8	0.0	9.5	0.0	0.0	0.0	20.0	0.0	0.0
Navicula sp.	0.0	0.0	0.0	0.0	8.3	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitzschia subtilis	0.0	0.0	6.3	0.0	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	8.3
Nitzschia thermalis	0.0	9.1	0.0	0.0	0.0	5.3	0.0	0.0	0.0	15.4	0.0	13.3	0.0	0.0
Reimeria sinuata	21.1	0.0	0.0	0.0	6.7	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0	0.0
Surirella sp.	0.0	0.0	6.3	0.0	0.0	3.5	0.0	4.8	15.4	0.0	11.4	0.0	0.0	0.0
Synedra ulna	0.0	18.2	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	26.7	0.0	0.0
Synedra sp.	31.6	0.0	18.8	0.0	8.3	5.3	0.0	9.5	0.0	38.5	17.1	0.0	0.0	16.7
Total No. Of Taxa	**6.0**	**6.0**	**9.0**	**0.0**	**15.0**	**21.0**		**14.0**	**7.0**	**5.0**	**8.0**	**4.0**		**9.0**
October														
Achnanthes affinis	10.0	0.0	0.0	29.4	10.0	5.1	2.0	2.3	8.0	1.2	8.4	4.8	0.0	11.5
A. Hauckiana	10.0	0.0	10.7	0.0	0.9	1.6	0.0	8.6	1.1	10.1	0.0	1.5	22.5	0.0
A. minutissima	0.0	31.4	0.0	0.0	8.3	0.9	6.0	1.4	10.7	8.3	8.4	16.2	0.0	0.7
A. minutissima var. *cryptocephala*	26.7	0.0	0.0	7.1	0.0	7.6	0.0	1.4	0.5	1.8	20.0	0.3	0.0	21.6
Cocconeis placentula	0.0	0.0	3.6	0.0	0.9	1.6	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0
Cymbella affinis	6.7	17.1	0.0	3.5	0.0	1.0	0.0	0.0	1.6	6.6	0.0	18.6	0.0	8.7
C. laevis	0.0	0.0	1.8	1.2	0.9	1.2	0.0	7.3	0.0	1.2	0.0	6.0	0.0	0.7
C. exigua	0.0	0.0	0.0	0.0	0.0	2.8	1.0	0.0	12.3	0.0	0.0	0.0	0.0	0.0
C. hungarica	0.0	0.0	3.6	2.4	0.4	0.0	0.0	1.8	0.0	1.2	0.0	0.2	1.7	3.8
C. Hustedii	0.0	5.7	0.0	0.0	0.0	1.8	0.0	8.2	1.1	0.0	0.0	9.4	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
C. ventricosa	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	1.1
Cymbella sp.	0.0	0.0	7.1	8.2	0.0	5.1	2.0	0.0	3.7	0.0	8.0	0.9	4.2	4.5
C. turgidula	0.0	2.9	14.3	0.0	3.5	0.3	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0
F. brevistriata	0.0	0.0	0.0	5.9	0.0	7.6	8.0	1.8	1.1	0.0	2.4	0.0	0.0	0.4
F. vaucheriae	10.0	0.0	5.4	0.0	2.2	1.2	3.0	0.0	0.0	0.0	3.6	1.7	0.0	0.0
Gomphonema bohemicum	0.0	0.0	0.0	2.4	0.4	0.0	0.0	2.3	2.1	1.2	0.0	0.0	0.8	2.4
G. gracile	0.0	0.0	3.6	2.4	0.9	1.8	3.0	0.0	0.0	0.0	2.8	2.3	0.0	4.9
G. insigniforme	0.0	20.0	5.4	0.0	11.3	0.0	2.0	0.9	17.1	0.0	3.6	0.0	51.7	2.4
G. intricatum	3.3	0.0	0.0	0.0	0.0	5.1	8.0	2.3	0.0	0.0	0.0	0.5	0.0	2.8
G. lanceolata	3.3	0.0	0.0	1.2	4.8	0.0	0.0	5.0	1.6	0.0	0.0	2.0	0.0	5.2
G. micropus	0.0	0.0	3.6	0.0	3.9	1.9	7.0	6.4	1.1	0.0	3.2	1.7	0.0	1.4
G. olivaceoides	6.7	0.0	5.4	1.2	2.2	1.8	0.0	5.9	0.0	0.0	0.0	1.9	0.0	1.7
G. parvulum	0.0	5.7	7.1	3.5	9.1	10.5	8.0	10.5	2.1	18.5	6.8	2.6	2.5	4.9
Hannaea arcus	6.7	0.0	0.0	8.2	10.9	5.2	4.0	6.8	3.2	14.3	9.6	3.4	3.3	4.9
N. cryptocephala	0.0	8.6	0.0	0.0	0.0	7.0	0.0	0.5	1.1	6.6	0.0	2.9	0.0	0.7
N. cryptotenella	0.0	0.0	3.6	5.9	3.9	4.8	5.0	6.8	10.7	0.0	4.4	3.5	3.3	1.7
N. radiosa	0.0	0.0	8.9	1.2	3.0	4.8	0.0	5.0	0.0	5.4	7.2	2.6	1.7	1.1
N. rhyncocephala	0.0	0.0	0.0	1.2	7.8	0.0	12.0	0.9	3.7	0.0	0.0	6.5	0.0	0.0
Navicula sp.	0.0	0.0	16.1	2.4	0.9	3.8	0.0	5.9	0.0	4.2	2.4	2.9	2.5	4.2
Pinnularia sp.	0.0	0.0	0.0	0.0	0.4	9.3	0.0	0.0	1.1	0.0	0.0	1.4	0.0	0.0
Planothidium lanceolata	16.7	0.0	0.0	0.0	11.3	0.0	11.0	0.0	15.5	13.1	6.4	3.2	1.7	0.0
Reimeria sinuata	0.0	8.6	0.0	8.2	0.4	5.7	9.0	7.3	0.0	3.0	0.0	0.0	1.7	8.7
Surirella sp.	0.0	0.0	0.0	4.7	1.3	0.9	9.0	0.9	0.5	3.0	2.8	0.8	0.0	0.0
Total No of Taxa	**10.0**	**8.0**	**13.0**	**18.0**	**23.0**	**21.0**	**17.0**	**22.0**	**12.0**	**16.0**	**16.0**	**26.0**	**13.0**	**21.0**
November														
Achnanthes affinis	12.8	6.1	1.3	8.3	8.7	0.0	0.0	0.0	14.7	0.0	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
A. biasolettiana	15.7	0.0	0.0	0.0	12.3	7.8	0.0	6.0	1.0	5.3	30.7	0.0	8.3	0.0
A. grischuma	0.0	0.0	0.0	0.0	9.4	0.0	5.5	3.6	5.9	0.0	0.0	0.0	0.0	15.2
A. linearis	1.0	0.0	15.4	0.8	0.0	5.6	0.0	4.0	0.0	0.0	0.0	0.0	5.6	0.0
A. minutissima	0.0	39.4	0.0	0.0	0.0	9.1	1.4	0.0	8.8	27.6	0.0	22.8	0.0	6.1
A. minutissima var. cryptocephala	3.9	0.0	0.0	9.1	0.0	6.5	0.0	2.0	0.0	0.0	27.7	0.0	2.8	31.8
Cocconeis placentula	0.0	0.0	0.0	0.0	2.9	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cymbella affinis	2.0	0.0	2.6	6.1	0.0	0.0	0.0	4.8	0.0	6.6	0.0	0.0	0.0	0.0
C. amphicephala	10.8	0.0	0.0	0.0	2.2	3.0	4.1	0.8	0.0	0.0	0.0	0.0	16.7	0.0
C. excisa	0.0	0.0	0.0	1.5	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	12.5	7.6
C. exigua	2.9	0.0	0.0	0.0	0.0	5.6	4.8	0.0	5.9	1.3	0.6	3.7	0.0	0.0
C. hungarica	0.0	0.0	6.4	0.0	5.1	5.2	0.0	1.2	0.0	0.0	0.6	0.0	0.0	0.0
C. Hustedii	4.9	0.0	0.0	0.0	0.0	0.0	5.5	2.0	2.0	1.3	0.0	0.0	0.0	0.0
C. ventricosa	0.0	12.1	0.0	0.0	1.5	0.0	0.0	2.0	0.0	0.0	0.0	5.2	5.6	0.0
Cymbella sp.	2.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0	2.0	0.0	0.0	0.0	0.0	7.6
Fragilaria sp.	0.0	0.0	3.9	0.0	2.9	0.0	5.5	0.0	0.0	1.3	2.4	0.0	0.0	0.0
F. vaucheriae	0.0	0.0	0.0	3.8	0.0	5.6	6.2	0.8	0.0	2.6	0.0	3.7	2.8	0.0
Gomphonema bohemicum	12.8	6.1	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. gracile	0.0	0.0	1.3	11.4	0.0	0.0	5.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. insigniforme	7.8	0.0	0.0	0.0	9.4	0.9	0.0	0.0	14.7	0.0	2.4	0.0	4.2	3.0
G. intricatum	0.0	7.6	0.0	0.0	0.0	0.0	6.9	2.8	7.8	4.0	0.0	0.0	0.0	0.0
G. micropus	0.0	0.0	0.0	2.3	0.0	2.6	0.7	2.0	0.0	0.0	0.0	15.4	0.0	0.0
G. olivaceum	0.0	0.0	26.9	11.4	2.2	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0	4.6
G. parvulum	2.0	0.0	0.0	0.0	0.0	14.2	3.4	0.8	0.0	14.5	0.0	2.9	1.4	0.0
Gomphonema sp.	0.0	16.7	2.6	9.1	2.2	0.0	0.0	0.4	8.8	0.0	0.0	0.0	0.0	1.5
G. sphaerophorum	0.0	0.0	0.0	0.0	0.0	0.9	1.4	3.6	0.0	1.3	1.2	0.0	0.0	0.0
Hannaea arcus	2.0	0.0	0.0	18.2	1.5	0.4	0.0	3.6	0.0	11.8	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Navicula cincta	0.0	0.0	6.4	0.0	0.0	0.0	0.7	1.6	2.0	0.0	0.0	16.9	0.0	4.6
N. cryptocephala	2.9	3.0	0.0	0.0	0.0	6.9	0.0	1.2	0.0	2.6	3.6	0.0	9.7	0.0
N. cryptotenella	2.9	0.0	5.1	5.3	0.0	0.0	0.0	0.0	8.8	0.0	0.0	0.0	0.0	0.0
N. cryptotenelloides	0.0	0.0	2.6	0.0	4.4	0.0	10.3	1.2	7.8	0.0	1.2	0.0	0.0	12.1
N. radiosa	2.9	0.0	0.0	0.0	0.0	7.3	0.0	0.0	0.0	2.6	0.0	10.3	0.0	0.0
N. rhyncocephala	0.0	0.0	0.0	3.8	8.7	0.0	0.0	2.0	1.0	0.0	0.0	0.0	0.0	3.0
Navicula sp.	1.0	0.0	21.8	0.0	0.0	0.0	2.7	5.2	0.0	0.0	0.0	5.9	0.0	0.0
Pinnularia sp.	0.0	0.0	0.0	0.8	0.0	6.0	2.7	0.8	0.0	0.0	7.2	0.0	25.0	0.0
Planothidium lanceolata	4.9	0.0	2.6	1.5	13.0	2.2	14.4	0.4	7.8	15.8	0.0	11.8	0.0	1.5
Reimeria sinuata	3.9	9.1	0.0	0.0	0.0	5.6	9.6	2.8	0.0	0.0	0.0	0.0	0.0	0.0
Surirella sp.	0.0	0.0	0.0	0.0	12.3	0.4	5.5	0.8	1.0	1.3	0.0	1.5	5.6	1.5
Synedra sp.	1.0	0.0	1.3	6.8	0.0	0.4	0.0	0.0	0.0	0.0	22.3	0.0	0.0	0.0
Total No of Taxa	**19.0**	**4.0**	**14.0**	**13.0**	**15.0**	**18.0**	**19.0**	**27.0**	**16.0**	**15.0**	**10.0**	**10.0**	**12.0**	**10.0**
December														
Achnanthes affinis	9.1	0.0	0.0	25.0	12.5	0.0	0.0	2.3	15.6	0.0	0.0	0.0	0.0	0.0
A. biasolettiana	22.7	0.0	0.0	0.0	18.8	9.4	0.0	10.3	0.0	11.1	41.7	0.0	14.3	0.0
A. grischuma	0.0	0.0	0.0	0.0	12.5	0.0	7.1	12.6	6.3	0.0	0.0	0.0	0.0	50.0
A. lemmarmanii	0.0	0.0	0.0	0.0	0.0	12.5	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0
A. linearis	0.0	0.0	33.3	0.0	0.0	0.0	0.0	13.8	0.0	0.0	0.0	0.0	0.0	0.0
A. minutissima	0.0	50.0	0.0	0.0	0.0	6.3	0.0	3.5	9.4	33.3	0.0	50.0	0.0	0.0
A. minutissima														
var. minutissima	13.6	0.0	0.0	25.0	0.0	15.6	0.0	2.3	0.0	0.0	33.3	0.0	0.0	50.0
Cocconeis placentula	4.6	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
Cymbella affinis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.6	0.0	5.6	0.0	0.0	0.0	0.0
C. amphicephala	0.0	0.0	0.0	0.0	0.0	3.1	3.6	1.2	0.0	0.0	0.0	0.0	42.9	0.0
C. excisa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
C. exigua	0.0	0.0	0.0	0.0	0.0	6.3	3.6	0.0	6.3	0.0	0.0	0.0	0.0	0.0
C. hungarica	0.0	0.0	0.0	0.0	6.3	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0
C. Hustedii	0.0	0.0	0.0	0.0	0.0	0.0	7.1	2.3	0.0	0.0	0.0	0.0	0.0	0.0
C. ventricosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0
Cymbella sp.	0.0	0.0	0.0	0.0	0.0	3.1	0.0	0.0	3.1	0.0	0.0	0.0	0.0	0.0
Fragilaria sp.	0.0	0.0	16.7	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. brevistriata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0
F. vaucheriae	0.0	0.0	0.0	0.0	0.0	6.3	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema bohemicum	4.6	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
G. gracile	0.0	0.0	0.0	12.5	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. insigniforme	0.0	0.0	0.0	0.0	12.5	0.0	0.0	0.0	21.9	0.0	0.0	0.0	42.9	0.0
G. intricatum	0.0	0.0	0.0	0.0	0.0	0.0	10.7	3.5	0.0	0.0	0.0	0.0	0.0	0.0
G. lanceolata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0
G. micropus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceoides	9.1	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
G. olivaceum	0.0	0.0	16.7	0.0	0.0	0.0	0.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0
G. parvulum	4.6	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	22.2	0.0	0.0	0.0	0.0
Gomphonema sp.	0.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	9.4	0.0	0.0	0.0	0.0	0.0
G. sphaerophorum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0
Hannaea arcus	0.0	0.0	0.0	25.0	0.0	0.0	0.0	1.2	0.0	16.7	0.0	0.0	0.0	0.0
Navicula cincta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0
N. cryptocephala	0.0	0.0	0.0	0.0	0.0	3.1	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0
N. cryptotenella	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.4	0.0	0.0	0.0	0.0	0.0
N. cryptotenelloides	0.0	0.0	0.0	0.0	0.0	0.0	7.1	1.2	6.3	0.0	0.0	0.0	0.0	0.0
N. radiosa	9.1	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. rhyncocephala	0.0	0.0	0.0	0.0	12.5	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Navicula sp.	0.0	0.0	33.3	0.0	0.0	0.0	3.6	1.2	0.0	0.0	0.0	0.0	0.0	0.0
Nitzschia sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0	0.0
Pinnularia sp.	0.0	0.0	0.0	0.0	0.0	6.3	3.6	2.3	0.0	0.0	0.0	0.0	0.0	0.0
Planothidium lanceolata	13.6	0.0	0.0	0.0	18.8	0.0	17.9	0.0	9.4	11.1	0.0	50.0	0.0	0.0
Reimeria sinuata	9.1	25.0	0.0	0.0	0.0	12.5	14.3	6.9	0.0	0.0	0.0	0.0	0.0	0.0
Surirella sp.	0.0	0.0	0.0	0.0	6.3	0.0	3.6	1.2	0.0	0.0	25.0	0.0	0.0	0.0
Synedra sp.	0.0	0.0	0.0	12.5	0.0	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total No of Taxa	**8.0**	**3.0**	**4.0**	**5.0**	**8.0**	**14.0**	**13.0**	**27.0**	**11.0**	**6.0**	**3.0**	**2.0**	**3.0**	**2.0**
January														
Achnanthes affinis	1.6	0.0	0.0	2.4	3.6	8.0	4.4	3.3	2.5	0.0	1.2	0.0	0.0	0.0
A. biasolettiana	0.0	22.5	4.7	3.6	2.9	24.0	7.3	7.6	9.9	12.6	13.4	24.2	0.0	0.0
A. grischuma	0.0	2.8	0.0	0.0	1.4	0.0	6.5	0.0	4.1	2.1	0.0	0.0	0.0	25.0
A. Hauckiana	0.0	5.6	0.0	3.6	2.9	14.0	0.0	1.1	0.0	0.0	1.2	0.0	0.0	0.0
A. holsatica	0.0	0.0	0.0	4.8	0.0	0.0	4.4	0.0	4.1	3.2	0.0	0.0	0.0	0.0
A. lanceolata	4.8	0.0	0.0	0.0	3.6	12.0	0.0	6.0	0.0	0.0	2.4	12.1	0.0	0.0
A. lanceolata														
var. lanceolata	0.0	4.2	0.0	6.0	2.9	0.0	2.2	0.0	5.0	4.2	0.0	0.0	0.0	0.0
A. lemmarmanii	0.0	7.0	2.3	0.0	4.3	0.0	2.9	3.3	0.0	0.0	2.4	15.2	0.0	8.3
A. linearis	3.2	0.0	0.0	7.2	5.0	6.0	0.0	6.5	5.0	0.0	0.0	0.0	18.2	0.0
A. minutissima	23.8	12.7	10.5	6.0	2.9	0.0	3.6	8.2	2.5	2.1	0.0	0.0	0.0	0.0
Anomoneis sp.	0.0	0.0	0.0	1.2	0.7	8.0	0.0	0.5	0.0	0.0	3.7	0.0	0.0	0.0
Cocconeis placentula	7.9	0.0	4.7	3.6	0.0	0.0	2.9	1.1	3.3	1.1	0.0	0.0	0.0	16.7
Cymbella affinis	3.2	0.0	0.0	2.4	0.7	4.0	0.0	1.6	4.1	0.0	2.4	0.0	0.0	0.0
C. amphicephala	0.0	4.2	0.0	2.4	1.4	6.0	4.4	2.7	1.7	3.2	0.0	0.0	0.0	0.0
C. excisa	0.0	0.0	2.3	1.2	0.0	0.0	3.6	0.0	4.1	0.0	1.2	0.0	0.0	0.0
C. exigua	0.0	1.4	0.0	0.0	1.4	8.0	5.8	1.6	0.0	2.1	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
C. gracile	0.0	0.0	2.3	0.0	2.1	0.0	2.9	1.1	1.7	0.0	2.4	0.0	0.0	0.0
C. hungarica	4.8	0.0	0.0	4.8	0.0	10.0	0.0	1.1	0.0	4.2	0.0	0.0	0.0	0.0
C. Hustedii	0.0	1.4	3.5	0.0	1.4	0.0	2.2	1.6	4.1	0.0	0.0	0.0	0.0	0.0
C. kolbei	0.0	0.0	2.3	3.6	0.0	0.0	2.9	0.0	2.5	2.1	0.0	0.0	0.0	0.0
C. kolbei														
var. angusta	3.2	0.0	1.2	3.6	0.0	0.0	0.0	1.1	0.8	0.0	0.0	0.0	0.0	0.0
C. ventricosa	0.0	0.0	5.8	0.0	2.9	0.0	3.6	0.0	2.5	0.0	0.0	0.0	0.0	0.0
Cymbella sp.	0.0	2.8	0.0	2.4	2.1	0.0	0.0	1.1	0.0	3.2	0.0	0.0	0.0	0.0
Fragilaria sp.	3.2	0.0	2.3	0.0	1.4	0.0	2.2	0.0	3.3	0.0	0.0	0.0	0.0	0.0
Fragilaria vaucheriae	0.0	0.0	7.0	0.0	2.1	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0
Geissleria sp.	1.6	0.0	1.2	0.0	1.4	0.0	2.9	0.0	1.7	3.2	0.0	0.0	0.0	0.0
Gomphonema bohemicum	0.0	4.2	2.3	0.0	2.9	0.0	0.0	1.6	0.0	0.0	2.4	12.1	0.0	0.0
G. gracile	3.2	0.0	0.0	3.6	0.0	0.0	3.6	1.1	0.0	5.3	0.0	0.0	0.0	0.0
G. insigniforme	0.0	0.0	3.5	0.0	2.1	0.0	0.7	2.2	0.0	0.0	3.7	0.0	0.0	0.0
G. intricatum	0.0	4.2	0.0	2.4	0.0	0.0	0.0	1.1	4.1	4.2	0.0	0.0	36.4	0.0
G. lanceolata	4.8	0.0	4.7	0.0	2.9	0.0	1.5	1.6	0.0	0.0	6.1	15.2	0.0	0.0
G. micropus	0.0	0.0	2.3	0.0	3.6	0.0	0.0	2.2	2.5	4.2	0.0	0.0	18.2	0.0
G. olivaceoides	3.2	2.8	0.0	1.2	0.0	0.0	2.2	1.6	0.0	0.0	4.9	12.1	0.0	0.0
G. olivaceum	0.0	0.0	3.5	0.0	2.1	0.0	0.0	2.2	1.7	3.2	0.0	0.0	27.3	0.0
G. parvulum	4.8	0.0	0.0	0.0	8.6	0.0	2.9	4.4	0.0	0.0	4.9	3.0	0.0	33.3
*Gomphonema*sp.	0.0	2.8	2.3	0.0	2.1	0.0	0.0	3.3	2.5	5.3	0.0	6.1	0.0	0.0
G. sphaerophorum	3.2	0.0	1.2	3.6	0.0	0.0	1.5	3.8	0.0	0.0	2.4	0.0	0.0	0.0
Hannaea arcus	0.0	0.0	1.2	0.0	1.4	0.0	0.0	1.6	1.7	2.1	0.0	0.0	0.0	0.0
Hannaea arcus var. *amphioxys*	3.2	1.4	0.0	2.4	0.0	0.0	2.9	2.2	0.0	0.0	3.7	0.0	0.0	0.0
Navicula cincta	0.0	0.0	2.3	0.0	2.1	0.0	1.5	0.0	4.1	4.2	0.0	0.0	0.0	0.0
N. cryptocephala	6.4	0.0	3.5	1.2	0.0	0.0	0.0	2.7	0.0	2.1	2.4	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
N. cryptotenella	0.0	4.2	0.0	2.4	0.0	0.0	3.6	1.1	1.7	1.1	2.4	0.0	0.0	0.0
N. cryptotenelloides	0.0	0.0	2.3	0.0	1.4	0.0	2.2	0.0	3.3	3.2	0.0	0.0	0.0	0.0
N. grimmei	0.0	1.4	2.3	0.0	1.4	0.0	0.0	2.2	0.0	1.1	6.1	0.0	0.0	0.0
N. radiosa	4.8	0.0	4.7	0.0	5.0	0.0	2.9	1.1	0.0	0.0	4.9	0.0	0.0	0.0
N. rhyncocephala	0.0	2.8	3.5	4.8	2.1	0.0	0.0	1.6	2.5	4.2	3.7	0.0	0.0	0.0
N. salinicola	0.0	0.0	2.3	0.0	2.9	0.0	1.5	1.1	0.0	0.0	6.1	0.0	0.0	0.0
Navicula sp.	0.0	2.8	0.0	2.4	0.0	0.0	0.0	2.2	3.3	2.1	4.9	0.0	0.0	16.7
Nitzschia sp.	0.0	0.0	2.3	1.2	1.4	0.0	0.7	0.0	4.1	0.0	1.2	0.0	0.0	0.0
Pinnularia sp.	6.4	0.0	0.0	2.4	0.0	0.0	0.0	2.7	0.0	2.1	1.2	0.0	0.0	0.0
Planothidium lanceolata	3.2	0.0	3.5	7.2	5.0	0.0	5.8	0.0	2.5	8.4	2.4	0.0	0.0	0.0
Reimeria sinuata	0.0	5.6	0.0	3.6	3.6	0.0	0.0	1.1	0.0	3.2	6.1	0.0	0.0	0.0
Surirella sp.	0.0	0.0	2.3	1.2	0.7	0.0	1.5	4.4	0.8	1.1	0.0	0.0	0.0	0.0
Synedra sp.	0.0	2.8	0.0	1.2	1.4	0.0	0.7	0.5	2.5	0.0	0.0	0.0	0.0	0.0
Total No of Taxa	**20.0**	**20.0**	**30.0**	**29.0**	**39.0**	**10.0**	**33.0**	**29.0**	**32.0**	**25.0**	**27.0**	**6.0**	**4.0**	**5.0**
February, 2015														
Achnanthes affinis	5.8	0.0	6.6	2.6	2.7	0.0	3.6	4.2	0.0	7.4	0.0	0.0	0.0	0.0
Achnanthes biasolettiana	5.3	4.5	0.0	4.6	1.1	0.9	2.1	0.0	0.0	0.0	0.0	12.5	0.0	0.0
Achnanthes grischuma	0.0	1.8	0.0	0.0	2.1	0.0	2.1	5.1	0.0	2.7	0.0	0.0	0.0	0.0
Achnanthes lanceolata var. *lanceolata*	0.0	2.7	0.0	3.9	0.0	1.8	0.6	0.0	9.1	0.0	0.0	0.0	0.0	17.1
Achnanthes lemmarmanii	4.5	5.4	0.0	0.0	4.0	0.0	1.5	0.0	0.0	3.4	0.0	16.7	0.0	0.0
Achnanthes linearis	0.0	5.4	0.0	5.4	2.1	0.0	1.5	9.3	0.0	0.0	4.4	0.0	8.5	0.0
Achnanthidium arcus	0.0	0.0	1.8	0.0	3.2	0.0	1.2	0.0	0.0	6.7	0.0	0.0	0.0	0.0
Achnanthidium minutissimum	7.8	0.0	4.4	6.3	0.0	2.7	0.9	0.0	3.8	0.0	0.0	0.0	0.0	12.9
Achnanthidium affine	0.0	4.5	0.0	1.7	4.3	0.0	1.8	5.9	0.0	3.4	0.0	0.0	0.0	0.0
Anomoneis sp.	0.0	0.0	2.2	0.0	0.0	1.4	0.6	0.0	9.1	0.0	8.7	0.0	0.0	0.0
Cocconeis placentula	1.8	0.0	6.2	0.0	3.5	0.0	0.0	5.5	0.0	4.0	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Cocconeis placentula var *lineata*	0.0	4.1	0.0	0.2	0.0	1.8	1.8	0.0	8.3	0.0	0.0	0.0	0.0	0.0
Cocconeis placentula var. *euglypta*	0.0	3.2	0.0	0.7	1.1	0.0	0.0	5.9	0.0	4.7	0.0	25.0	0.0	0.0
Cymbella affinis	1.0	0.0	1.3	0.0	4.0	0.0	1.5	0.0	0.0	2.0	0.0	0.0	7.8	0.0
Cymbella gracile	2.0	0.0	3.1	2.6	0.0	0.0	0.0	0.0	0.0	2.7	0.0	0.0	0.0	8.6
Cymbella kolbei var. angusta	0.0	2.3	0.0	0.0	1.9	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cymbella ventricosa	1.8	0.0	2.7	2.2	0.0	0.0	1.2	0.0	3.0	0.0	0.0	0.0	0.0	0.0
Cymbella hungarica	2.3	2.3	0.0	0.0	2.7	0.9	0.0	0.0	0.0	4.0	0.0	8.3	0.0	0.0
Cymbella laevis Nägeli	0.0	0.0	4.4	3.0	0.8	0.0	3.0	0.0	0.0	2.0	0.0	0.0	0.0	5.7
Cymbella lancettula	0.0	3.2	0.0	0.0	3.8	2.3	0.0	4.7	0.0	1.3	0.0	0.0	0.0	0.0
Cymbella nagpurensis	3.0	0.0	3.1	0.0	0.8	0.0	0.0	5.9	0.0	0.0	21.7	0.0	0.0	0.0
Cymbella parva	0.0	2.3	0.0	0.7	1.1	3.2	3.6	0.0	0.0	0.0	4.4	0.0	0.0	0.0
Cymbells affinis	0.0	1.4	0.0	0.0	1.6	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0
Encyonema sp.	2.5	0.0	2.2	1.1	0.3	0.9	4.5	0.9	0.0	5.4	0.0	0.0	4.3	0.0
Encyonema subminisculus	0.0	4.5	0.0	0.0	4.0	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0
Encyonema elginense	0.0	5.9	0.0	0.0	3.8	0.0	4.2	0.0	0.0	6.0	17.4	0.0	0.0	0.0
Encyonema gracile	0.0	6.3	0.0	1.3	3.2	5.9	0.0	0.9	0.0	0.0	0.0	0.0	0.0	10.0
Encyonema hebridicum	2.0	0.0	5.3	0.0	0.0	0.0	3.9	0.0	3.8	0.0	0.0	0.0	0.0	0.0
Encyonema jemtlandicum var. *venezolana*	0.0	2.7	0.0	3.0	0.5	5.4	0.0	1.3	0.0	2.0	0.0	0.0	0.0	0.0
Fragilaria sp.	2.5	0.0	0.0	0.0	1.1	0.0	2.7	0.0	2.3	0.0	0.0	0.0	0.0	5.7
Fragilaria vaucheriae	0.0	1.8	0.0	0.0	0.0	4.1	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema acuminatum	0.0	2.3	0.0	0.0	0.0	0.0	2.4	0.0	4.6	0.0	13.0	0.0	0.0	0.0
Gomphonema aff bohemicum ssp. *angustatum*	4.5	0.0	0.0	2.4	0.0	0.0	0.0	5.9	0.0	4.7	0.0	0.0	0.0	8.6
Gomphonema bohemicum	0.0	2.7	0.0	0.0	1.3	5.9	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema gracile	0.8	0.0	0.0	3.0	0.0	0.0	0.9	5.1	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema insigniforme	0.0	4.5	1.3	0.0	1.9	0.0	3.9	0.0	0.0	1.3	0.0	0.0	0.0	0.0
Gomphonema intricatum	0.0	5.4	0.0	3.7	0.0	1.8	0.6	3.4	0.0	0.0	0.0	20.8	0.0	7.1

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Gomphonema intricatum var. *subclavata*	0.0	0.0	2.2	0.0	1.1	0.0	3.3	0.9	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema lacus var. vulcari	0.0	3.6	0.0	2.6	0.0	1.8	0.9	0.0	0.0	0.7	0.0	0.0	0.0	0.0
Gomphonema lanceolata	3.8	0.0	0.0	0.0	3.2	0.0	3.0	2.1	0.0	0.0	0.0	0.0	0.0	5.7
Gomphonema loglinear	0.0	5.4	0.0	2.8	0.0	0.5	0.0	0.4	0.0	8.1	0.0	0.0	0.0	0.0
Gomphonema micropus	4.5	0.0	4.4	0.0	0.0	6.3	2.7	0.0	0.0	0.0	13.0	0.0	0.0	0.0
Gomphonema olivaceoides	0.0	2.3	0.0	2.0	3.0	0.0	0.6	0.9	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema olivaceum	3.8	0.0	0.0	2.2	0.0	5.9	2.4	0.0	0.0	6.7	0.0	0.0	0.0	0.0
Gomphonema olivaceum var. *olivaceoides*	2.5	0.0	5.3	2.6	0.0	0.0	2.1	1.3	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema parvulum	0.0	1.8	0.0	0.0	3.5	0.0	0.9	0.0	3.0	0.0	0.0	0.0	0.0	4.3
Gomphonema parvulum var. *pumilum*	2.3	0.0	0.0	0.9	0.0	5.4	0.3	0.0	0.0	0.0	0.0	0.0	8.5	0.0
Gomphonema perpusila	0.0	1.4	0.0	1.7	0.0	0.0	1.5	0.0	4.6	0.0	0.0	0.0	0.0	0.0
Gomphonema sp.	1.3	0.0	4.0	0.0	3.8	0.0	0.0	0.9	0.0	0.0	0.0	0.0	10.6	0.0
Gomphonema sphaerophorum	0.0	0.0	0.0	2.8	0.0	5.0	0.9	3.4	0.0	5.4	0.0	0.0	0.0	2.9
Gomphonema auritum	0.0	0.0	3.5	0.0	4.3	0.0	3.6	0.0	0.0	0.0	0.0	0.0	9.9	0.0
Gomphonema bohemicum	0.0	0.0	0.0	0.0	0.0	5.9	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema clavatum	0.8	0.0	0.0	2.2	0.0	0.0	2.7	0.0	0.0	3.4	0.0	0.0	8.5	0.0
Gomphonema cymbelliclinum	0.0	0.0	2.7	0.0	3.5	1.4	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema grovei var. *lingulatum*	1.8	0.0	0.0	2.6	0.0	1.4	0.6	0.0	3.0	0.0	0.0	0.0	0.0	0.0
Gomphonema helveticum	0.0	0.0	3.1	0.0	2.7	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema innocens	0.0	2.3	0.0	0.7	0.0	3.6	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0
Gomphonema intricatum	3.8	0.0	2.2	0.0	0.8	0.0	1.5	0.0	0.0	1.3	0.0	0.0	0.0	0.0
Gomphonema intricatum var. *pumilum*	0.0	0.0	0.0	1.3	0.0	0.0	0.9	0.0	1.5	0.0	0.0	0.0	0.0	0.0
Gomphonema intricatum var. *vibrio*	4.5	0.0	4.4	0.0	0.0	3.2	0.0	1.3	0.0	0.0	17.4	8.3	0.0	0.0
Gomphonema longiceps	0.0	2.3	0.0	0.0	3.2	0.0	2.1	0.0	0.0	2.0	0.0	0.0	0.0	0.0
Gomphonema micropus	3.5	0.0	0.0	2.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	8.5	0.0
Gomphonema micropus var. *aequale*	0.0	0.0	2.7	0.0	0.0	0.0	1.8	1.7	0.0	0.7	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Gomphonema olivaceum var. *minutissimum*	2.5	0.0	0.0	2.2	0.0	0.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	4.3
Hannaea arcus	0.0	0.0	3.1	0.0	0.0	2.3	1.8	0.0	0.0	0.7	0.0	0.0	1.4	0.0
Hannaea arcus var. *amphioxys*	0.0	0.0	0.0	2.6	0.0	1.4	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0
Navicula cincta	4.0	1.8	0.0	0.0	0.0	0.0	0.9	0.0	0.0	1.3	0.0	0.0	0.0	1.4
Navicula cryptocephala	0.0	0.0	0.0	2.0	0.0	1.8	0.0	0.0	15.9	0.0	0.0	0.0	0.0	0.0
Navicula grimmei	0.0	0.0	3.1	0.0	3.2	0.0	1.2	2.5	0.0	0.0	0.0	0.0	3.6	0.0
Navicula radiosa	2.3	0.0	0.0	3.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0
Navicula rhyncocephala	0.0	0.0	4.0	0.0	0.0	2.7	0.6	0.0	0.0	2.7	0.0	0.0	5.0	0.0
Navicula salinicola	2.0	0.0	0.0	0.0	4.0	0.0	1.2	0.0	3.0	0.0	0.0	0.0	0.0	0.0
Navicula sp.	0.0	0.5	0.0	2.8	0.0	2.3	0.0	0.9	0.0	0.7	0.0	8.3	0.0	0.0
Nitzschia sp.	0.0	0.0	0.0	2.6	0.0	0.0	1.8	0.0	3.0	0.0	0.0	0.0	0.0	0.0
Pinnularia sp.	1.3	0.0	5.3	1.7	0.0	3.2	0.0	1.3	0.0	0.0	0.0	0.0	1.4	0.0
Planothidium lanceolata	0.0	0.0	0.0	0.0	5.6	0.0	0.9	0.0	4.6	0.0	0.0	0.0	0.0	4.3
Planothidium lanceolata														
for. *ventricosa*	5.3	0.0	0.0	2.6	0.0	0.5	0.6	0.0	0.0	2.0	0.0	0.0	8.5	0.0
Psammothidium levanderi	0.0	0.0	4.4	0.0	0.0	0.0	2.1	0.0	5.3	0.0	0.0	0.0	11.4	0.0
Reimeria sinuata	0.0	0.0	0.0	2.2	0.0	0.9	0.0	1.7	0.0	0.0	0.0	0.0	2.1	1.4
Surirella sp.	0.8	0.0	0.9	0.0	0.3	0.0	1.5	0.0	2.3	0.0	0.0	0.0	0.0	0.0
Synedra amphirhynchus	0.0	0.0	0.0	1.7	0.0	1.4	0.0	0.9	0.0	0.7	0.0	0.0	0.0	0.0
Synedra oxyrhynchus	2.5	0.0	0.0	2.0	1.1	0.0	0.6	0.0	3.8	0.0	0.0	0.0	0.0	0.0
Synedra sp.	1.5	0.0	5.3	3.3	0.0	0.5	0.9	0.4	1.5	0.0	0.0	0.0	0.0	0.0
Total no. of taxa	**35.0**	**31.0**	**30.0**	**43.0**	**40.0**	**38.0**	**55.0**	**36.0**	**22.0**	**31.0**	**8.0**	**6.0**	**14.0**	**15.0**
March, 2015														
Achnanthes affinis	12.2	26.9	35.9	0.0	2.5	8.6	2.2	0.0	20.8	0.0	12.5	20.0	7.7	15.4
A. biasolettiana	0.0	7.7	0.0	7.1	30.0	2.5	0.0	12.5	0.0	15.4	0.0	3.3	0.0	0.0
A. conspicua	4.8	0.0	7.7	0.0	0.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
A. exilis	1.4	0.0	0.0	10.7	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	30.8	0.0
A. linearis	40.8	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
Achnanthidium lanceolata	0.0	0.0	12.8	0.0	5.0	4.9	0.0	0.0	0.0	3.9	0.0	6.7	0.0	15.4
A. lanceolata var. elliptica	4.8	0.0	0.0	0.0	5.0	0.0	0.0	0.0	8.3	0.0	12.5	0.0	0.0	0.0
A. minutissima	9.5	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	7.7	0.0
A. plonensis	8.2	0.0	0.0	3.6	0.0	3.7	0.0	0.0	0.0	11.5	0.0	3.3	0.0	0.0
A. subsalsa	0.0	0.0	0.0	0.0	2.5	0.0	13.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0
Cocconeis placentula	5.4	0.0	0.0	0.0	0.0	4.9	2.2	0.0	16.7	0.0	0.0	0.0	0.0	23.1
Achnanthes sp.	0.0	0.0	0.0	0.0	7.5	0.0	0.0	0.0	0.0	7.7	0.0	0.0	0.0	0.0
C. placentula var. *euglypta*	0.0	0.0	0.0	0.0	0.0	2.5	6.5	0.0	0.0	0.0	0.0	13.3	0.0	0.0
Cymbella affinis	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0
C. amphicephala	0.0	0.0	0.0	0.0	0.0	0.0	8.7	0.0	0.0	15.4	0.0	0.0	15.4	0.0
C. hebridica	0.0	0.0	0.0	0.0	0.0	6.2	0.0	0.0	0.0	0.0	4.2	0.0	0.0	0.0
C. kerkevarensis	1.4	0.0	0.0	0.0	0.0	0.0	10.9	0.0	0.0	7.7	0.0	3.3	0.0	0.0
C. laevis	0.0	0.0	0.0	0.0	5.0	2.5	6.5	0.0	12.5	0.0	0.0	0.0	0.0	23.1
C. perpusila	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. Reinhardtii	2.0	0.0	0.0	0.0	2.5	2.5	6.5	0.0	0.0	0.0	16.7	0.0	0.0	0.0
C. sinuata	0.0	0.0	0.0	10.7	7.5	4.9	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0
C. turgida	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
C. ventricosa	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	15.4
Diatoma hiemale	4.1	0.0	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fragilaria sp.	0.0	0.0	0.0	0.0	5.0	4.9	10.9	0.0	0.0	15.4	0.0	0.0	15.4	0.0
F. construens	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.5	0.0	0.0	0.0
F. capucina	0.0	7.7	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. intermedia	0.0	0.0	10.3	0.0	0.0	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. pinnata	0.0	3.9	0.0	7.1	0.0	0.0	4.4	0.0	12.5	0.0	0.0	3.3	0.0	0.0
F. rumpens	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0
Gomphonema gracile	0.0	0.0	0.0	10.7	5.0	3.7	0.0	0.0	0.0	3.9	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
G. longiceps var. *subclavata*	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	3.3	0.0	0.0
G. olivaceum	0.0	23.1	0.0	0.0	0.0	2.5	0.0	18.8	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceum var. *minutissima*	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	11.5	0.0	13.3	0.0	7.7
G. parvulum	0.0	0.0	0.0	3.6	0.0	1.2	0.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0
G. tergestinum	0.0	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula cincta	0.0	3.9	5.1	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	6.7	0.0	0.0
N. cryptocephala var. *veneta*	2.0	0.0	0.0	10.7	0.0	4.9	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0
N. gracilis	0.0	0.0	0.0	3.6	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. microcephala	0.0	7.7	2.6	0.0	0.0	3.7	2.2	0.0	0.0	0.0	0.0	0.0	15.4	0.0
N. radiosa	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0
N. radiosa var. tenella	0.0	0.0	2.6	0.0	0.0	2.5	0.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula sp.	0.0	11.5	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pinnularia appendiculata	0.0	0.0	0.0	0.0	0.0	1.2	4.4	0.0	8.3	0.0	0.0	10.0	0.0	0.0
Pinnularia sp.	0.0	0.0	5.1	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reimeria sinuata	0.0	0.0	0.0	7.1	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Planothidium lanceolata	0.0	0.0	0.0	0.0	0.0	7.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Synedra acus	0.7	0.0	2.6	0.0	0.0	1.2	2.2	0.0	0.0	0.0	8.3	0.0	0.0	0.0
Synedra ulna	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0	7.7	0.0	0.0	0.0	0.0
Synedra ulna var. aequalis	0.0	0.0	2.6	0.0	0.0	2.5	0.0	6.3	0.0	0.0	0.0	0.0	7.7	0.0
Synedra ulna var. amphirhynchus	0.0	0.0	0.0	3.6	0.0	0.0	8.7	0.0	8.3	0.0	4.2	0.0	0.0	0.0
Total no. of taxa	**13.0**	**9.0**	**11.0**	**9.0**	**15.0**	**26.0**	**13.0**	**7.0**	**7.0**	**10.0**	**9.0**	**13.0**	**6.0**	**6.0**

Table-8.3 Relative abundance of Phytobenthos (diatoms) in Teesta basin of West Bengal

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
April														
Achnanthidium affinis	3.5	0.0	33.3	0.0	4.5	6.8	0.0	14.3	0.0	25.0	0.0	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
A. biasolettiana	0.0	0.0	0.0	14.3	4.5	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. conspicua	6.7	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. exigua	0.0	0.0	0.0	0.0	5.6	4.5	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. exilis	0.0	0.0	0.0	0.0	1.1	0.0	1.9	0.0	10.0	0.0	0.0	0.0	0.0	0.0
A. gibberula var. *genuina*	0.0	0.0	0.0	0.0	1.1	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. Grimmei	8.8	0.0	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. kryophila	0.0	0.0	33.3	0.0	0.0	2.3	1.9	0.0	0.0	50.0	0.0	0.0	0.0	0.0
A. linearis	0.0	20.0	0.0	0.0	14.0	11.3	11.7	7.1	0.0	0.0	0.0	0.0	0.0	50.0
A. lanceolata	5.1	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. lanceolata var. *elliptica*	0.0	0.0	0.0	0.0	5.6	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. minutissima	6.1	0.0	0.0	0.0	0.0	4.5	11.7	0.0	20.0	0.0	0.0	0.0	0.0	50.0
A. plonensis	0.0	0.0	0.0	14.3	4.5	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. subsalsa	0.0	0.0	0.0	0.0	1.1	1.1	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cocconeis placentula	6.1	0.0	0.0	0.0	0.0	2.3	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cocconeis placentula var. euglypta	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cymbella affinis	0.0	0.0	0.0	0.0	5.6	3.4	7.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. amphicephala	5.1	0.0	0.0	0.0	0.0	1.1	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0
C. oxyrhynchus	0.0	0.0	0.0	0.0	4.5	2.3	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. gracile	8.8	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. laevis	0.0	0.0	0.0	0.0	2.2	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cymbella sp.	0.0	0.0	0.0	0.0	0.0	1.1	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. nagpurensis	8.8	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. lata	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. turgida	3.5	0.0	0.0	0.0	0.0	2.3	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. ventricosa	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diatoma hiemale	0.0	0.0	0.0	0.0	0.0	2.8	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D. hiemale var. *mesodon*	0.0	30.0	33.3	0.0	5.6	1.1	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0
Fragilaria construens	0.0	0.0	0.0	0.0	0.0	2.3	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
F. intermedia	6.1	0.0	0.0	0.0	1.1	1.1	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. rumpens	0.0	0.0	0.0	0.0	2.2	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fragilaria sp.	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. vaucherae	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema gracile	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. intricatum	0.0	0.0	0.0	0.0	0.0	1.1	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. longiceps	3.5	0.0	0.0	0.0	2.2	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0
G. longiceps var. subclavata	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceum	5.2	0.0	0.0	0.0	5.6	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceoides	0.0	0.0	0.0	0.0	0.0	1.1	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. parvulum	6.1	0.0	0.0	57.1	0.0	1.1	1.9	14.3	10.0	0.0	0.0	0.0	50.0	0.0
G. sphaerophorum	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema sp.	0.0	30.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. tergestinum	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula cincta	3.5	0.0	0.0	0.0	2.2	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. cryptocephala	0.0	10.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. exigua	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. halophila	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. gracilis	3.5	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. radiosa	6.1	0.0	0.0	0.0	1.1	1.1	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. radiosa var. *tenella*	0.0	10.0	0.0	0.0	0.0	2.8	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0
N. rhyncocephala	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula sp.	0.0	0.0	0.0	0.0	2.2	0.0	1.9	7.1	0.0	0.0	0.0	0.0	0.0	0.0
Nitzschia sp.	*3.5*	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pinnularia sp.	9.5	0.0	0.0	14.3	0.0	1.1	0.0	0.0	0.0	25.0	0.0	0.0	0.0	0.0
Planothidium lanceolata	0.0	0.0	0.0	0.0	1.1	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Synedra acus	3.5	0.0	0.0	0.0	2.2	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S. ulna	0.0	0.0	0.0	0.0	0.0	1.1	5.8	0.0	20.0	0.0	0.0	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
S. ulna var. *aequalis*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	50.0	0.0
S. ulna var. *amphirhynchus*	6.1	0.0	0.0	0.0	2.2	2.3	3.9	0.0	10.0	0.0	0.0	0.0	0.0	0.0
Total No of taxa	**21.0**	**5.0**	**3.0**	**4.0**	**31.0**	**39.0**	**28.0**	**23.0**	**7.0**	**3.0**	0.0	0.0	**2.0**	**2.0**
May														
Achnanthidium affinis	0.0	7.1	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	4.3	0.0	0.0	0.0
A. austriaca	0.0	3.6	0.0	0.0	0.0	0.0	0.0	2.7	0.0	0.0	4.3	0.0	0.0	0.0
A. conspicua	25.0	0.0	0.0	0.0	0.0	18.8	0.0	2.7	0.0	0.0	0.0	0.0	0.0	3.5
A. exilis	0.0	0.0	0.0	11.8	0.0	0.0	1.7	4.1	0.0	0.0	0.0	0.0	0.0	3.5
A. gibberula var. genuina	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0	0.0	0.0	3.5
A. lanceolata	0.0	0.0	0.0	17.7	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. lanceolata var. elliptica	0.0	0.0	0.0	0.0	0.0	12.5	0.0	2.7	0.0	0.0	0.0	0.0	0.0	3.5
A. linearis	0.0	17.9	0.0	11.8	0.0	0.0	12.8	0.0	0.0	0.0	8.5	0.0	0.0	8.6
A. minutissima	0.0	7.1	0.0	0.0	0.0	0.0	5.1	6.8	0.0	0.0	12.8	0.0	0.0	0.0
A. subsalsa	0.0	0.0	0.0	11.8	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Amphora delicatula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0
Amphora sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	5.2
Cocconeis placentula	0.0	3.6	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	4.3	0.0	0.0	0.0
Cymbella affinis	50.0	0.0	0.0	0.0	0.0	0.0	3.4	2.7	0.0	0.0	0.0	0.0	0.0	6.9
C. amphicephala	0.0	3.6	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	6.4	0.0	0.0	0.0
C. hebridica	0.0	0.0	0.0	0.0	0.0	12.5	0.0	2.7	0.0	0.0	0.0	0.0	0.0	3.5
C. laevis	0.0	3.6	0.0	0.0	0.0	0.0	3.4	4.1	0.0	0.0	8.5	0.0	0.0	0.0
C. nagpurensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	6.9
C. perpusila	0.0	0.0	0.0	0.0	8.3	0.0	2.6	0.0	0.0	0.0	6.4	0.0	0.0	0.0
C. ventricosa	0.0	7.1	0.0	0.0	0.0	0.0	0.0	5.4	0.0	0.0	0.0	0.0	0.0	1.7
Diatoma hiemale	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diatoma hiemale var. *mesodon*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	3.5
Fragilaria capucina	0.0	0.0	0.0	0.0	8.3	0.0	1.7	5.4	0.0	0.0	0.0	0.0	0.0	10.3
F. construens	25.0	0.0	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	4.3	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
F. intermedia	0.0	0.0	0.0	11.8	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	1.7
Fragilaria sp.	0.0	0.0	0.0	0.0	16.7	0.0	3.4	4.1	0.0	50.0	0.0	0.0	0.0	0.0
F. vaucherae	0.0	0.0	0.0	11.8	0.0	0.0	1.7	4.1	0.0	0.0	4.3	0.0	0.0	0.0
Gomphonema angustatum	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	3.5
G. gracile	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	2.1	0.0	0.0	0.0
G. intricatum var. *pumila*	0.0	3.6	0.0	0.0	0.0	0.0	0.0	5.4	0.0	0.0	0.0	0.0	0.0	0.0
G. intricatum var. *vibrio*	0.0	0.0	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	2.1	0.0	0.0	0.0
G. longiceps	0.0	0.0	0.0	0.0	8.3	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	5.2
G. olivaceoids	0.0	0.0	0.0	0.0	0.0	0.0	2.6	5.4	0.0	0.0	0.0	0.0	0.0	3.5
G. olivaceum	0.0	7.1	0.0	0.0	0.0	0.0	3.4	0.0	0.0	50.0	0.0	0.0	0.0	0.0
G. parvulum	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
Gomphonema sp.	0.0	0.0	0.0	17.7	0.0	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	3.5
G. sphaerophorum	0.0	0.0	0.0	5.9	0.0	0.0	0.0	6.8	0.0	0.0	8.5	0.0	0.0	0.0
Navicula construens	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	5.2
N. gracilis	0.0	0.0	0.0	0.0	0.0	12.5	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0
N. grimmei	0.0	0.0	0.0	0.0	0.0	25.0	0.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0
N. halophila	0.0	0.0	0.0	0.0	0.0	18.8	0.0	5.4	0.0	0.0	0.0	0.0	0.0	0.0
N. microcephala	0.0	0.0	0.0	0.0	16.7	0.0	1.7	5.4	0.0	0.0	0.0	0.0	0.0	3.5
N. radiosa	0.0	7.1	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	8.5	0.0	0.0	0.0
N. rhyncocephala	0.0	7.1	0.0	0.0	0.0	0.0	3.4	4.1	0.0	0.0	0.0	0.0	0.0	1.7
N. similis	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	6.9
Navicula sp.	0.0	0.0	0.0	0.0	8.3	0.0	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Planothidium lanceolata	0.0	7.1	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Synedra acus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	0.0	0.0	6.4	0.0	0.0	0.0
S. ulna	0.0	0.0	0.0	0.0	33.3	0.0	1.7	4.1	0.0	0.0	0.0	0.0	0.0	5.2
S. ulna var. *aequalis*	0.0	14.3	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	4.3	0.0	0.0	0.0
Total No of species	**3.0**	**14.0**	0.0	**8.0**	**7.0**	**6.0**	**32.0**	**26.0**	0.0	**2.0**	**17.0**	0.0	0.0	**22.0**
July														

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Achnanthidium affinis	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	7.7	0.0	0.0
A. austriaca	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0
A. exilis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.5	0.0	0.0
A. gibberula var. *genuina*	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. lanceolata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	0.0	0.0	0.0
A. lanceolata var. *elliptica*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	3.9	0.0	0.0
A. linearis	0.0	0.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	7.7	0.0	0.0
A. minutissima	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.9	0.0	0.0	0.0
Amphora delicatula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0
Cocconeis placentula	0.0	0.0	7.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7	0.0	0.0
Cymbella affinis	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0
C. amphicephala	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7	0.0	0.0
C. hebridica	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. laevis	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. nagpurensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0
C. perpusila	0.0	0.0	7.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0
C. ventricosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0
Diatoma hiemale	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0
Fragilaria capucina	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	0.0	0.0	0.0
F. construens	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. intermedia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7	0.0	0.0
Fragilaria sp.	0.0	0.0	7.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7	0.0	0.0
F. vaucherae	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema angustatum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0
G. gracile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0
G. intricatum var. *pumila*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0
G. intricatum var. *vibrio*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0
G. olivaceoids	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
G. olivaceum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0
G. parvulum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0
Gomphonema sp.	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0
G. sphaerophorum	0.0	0.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5	0.0	0.0	0.0
Navicula halophila	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0
N. microcephala	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	0.0	0.0	0.0
N. radiosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0
N. rhyncocephala	0.0	0.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. similis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0
Navicula sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0
Planothidium lanceolata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0
Synedra acus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5	0.0	0.0	0.0
S. ulna	0.0	0.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S. ulna var. *aequalis*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	3.9	0.0	0.0
Total No of taxa	**0.0**	**0.0**	**17.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**22.0**	**17.0**	**0.0**	**0.0**
August														
Achnanthidium biasolettiana	0.0	0.0	17.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cymbella ventricosa	0.0	0.0	17.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema lanceolatum	0.0	0.0	8.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula cryptocephala	0.0	0.0	8.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula rhynchocephala	0.0	0.0	21.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Surirella sp.	0.0	0.0	26.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total No of taxa	**0.0**	**0.0**	**6.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
September														
Achnanthidium affinis	6.3	0.0	9.6	0.0	0.0	8.9	0.0	0.0	0.0	5.3	0.0	3.2	0.0	0.0
A. *biasolettiana*	0.0	13.3	7.7	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. *exigua*	3.1	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	15.4	6.4	0.0	0.0
A. *fragilaroides*	3.1	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
A. *lanceolata*	6.3	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	0.0	6.4	0.0	0.0
A. *linearis*	0.0	0.0	7.7	0.0	0.0	11.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. *microcephala*	0.0	33.3	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0
A. *minutissima*	6.3	0.0	0.0	0.0	0.0	0.0	0.0	57.1	0.0	0.0	0.0	0.0	0.0	0.0
Amphora sp.	3.1	0.0	0.0	0.0	0.0	8.9	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0
Cocconeis placentula	0.0	6.7	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0
C. *placentula* var. *euglypta*	6.3	0.0	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0
Cymbella affinis	0.0	0.0	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	0.0	0.0
C. amphicephala	3.1	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
C. nagpurensis	0.0	0.0	3.9	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0
C. ventricosa	3.1	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
Diatoma hiemale	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D. hiemale var. *mesodon*	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
Eunotia sp.	0.0	0.0	1.9	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0
Fragilaria construens	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. vaucheriae	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0
Gomphonema angustatum	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
G. bohemicum	0.0	0.0	0.0	0.0	0.0	8.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. gracile	0.0	0.0	7.7	0.0	0.0	0.0	0.0	28.6	0.0	0.0	0.0	6.4	0.0	0.0
G. intricatum	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0
G. lanceolata	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	9.5	0.0	0.0
G. lanceolatum	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
G. nagpurensis	0.0	0.0	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0
G. olivaceoides	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	7.9	0.0	0.0
G. olivaceum	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
G. parvulum	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.8	0.0	0.0	0.0
G. sphaerophorum	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
Gomphonema sp.	0.0	0.0	0.0	0.0	0.0	8.9	0.0	0.0	0.0	0.0	0.0	6.4	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Gyrosigma sp.	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0	0.0	0.0
Hannaea arcus	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.2	0.0	0.0	0.0	0.0
Hanztschia amphioxys	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.0	7.7	3.2	0.0	0.0
Hanztschia sp.	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
Melosira varians	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0
Navicula cryptocephala	0.0	0.0	0.0	0.0	28.6	0.0	0.0	0.0	0.0	10.5	0.0	0.0	0.0	0.0
Navicula halophila	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0
Navicula linearis	3.1	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0
Navicula radiosa	0.0	0.0	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.4	0.0	0.0	0.0
Navicula rhynchocephala	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.2	0.0	0.0	0.0	0.0
Navicula sp.	0.0	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	0.0	6.4	0.0	0.0
Nitzschia thermalis	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	15.4	0.0	0.0	0.0
Reimeria sinuata	0.0	0.0	7.7	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	7.9	0.0	0.0
Surirella sp.	3.1	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0
Synedra ulna	0.0	26.7	7.7	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	6.4	0.0	0.0
Synedra sp.	6.3	20.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	15.4	0.0	0.0	0.0
Total No of taxa	**19.0**	**5.0**	**18.0**	**0.0**	**8.0**	**19.0**	**0.0**	**3.0**	**0.0**	**14.0**	**5.0**	**21.0**	**0.0**	**0.0**
October														
Achnanthidium affinis	2.6	0.8	6.8	1.7	4.3	2.6	7.5	2.0	0.5	4.7	2.8	14.0	4.2	9.6
A. *biasolettiana*	2.6	0.0	0.0	5.0	0.0	0.0	0.0	10.3	0.0	5.1	0.0	9.3	0.0	19.6
A. *exigua*	0.9	0.0	0.9	0.0	7.9	0.0	8.3	1.1	18.0	6.8	0.0	0.0	0.8	0.0
A. *fragilaroides*	5.1	2.0	11.3	0.0	0.0	4.7	0.0	4.0	0.0	8.9	4.4	5.1	0.0	7.0
A. *lanceolata*	0.0	0.0	0.0	7.5	0.0	0.0	3.3	4.3	0.5	0.4	7.2	0.0	0.8	19.6
A. *linearis*	0.9	2.8	9.6	0.0	0.4	0.5	9.2	8.0	0.0	0.0	11.2	10.2	0.0	0.0
A. *minutissima*	0.0	9.6	11.0	0.8	9.3	0.0	0.0	2.9	0.0	6.4	0.0	31.6	4.2	1.7
A. minutissima var. *inconspicua*	9.8	0.0	17.0	0.0	0.0	14.7	10.0	0.0	0.0	0.0	18.4	0.2	0.0	0.0
A. saccula	0.9	2.0	0.6	7.5	2.5	0.0	3.3	2.6	0.0	0.0	7.6	0.0	0.8	2.2

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
A. undata	0.0	0.0	6.5	0.0	0.0	1.9	0.0	4.0	0.0	2.6	0.0	0.0	5.8	0.0
Amphora sp.	0.9	0.0	0.9	0.8	12.5	0.0	0.0	0.0	6.5	0.0	0.0	0.0	0.0	0.0
Cocconeis placentula	0.9	10.4	0.6	0.0	0.0	1.9	4.2	2.3	0.0	7.7	4.4	0.9	5.0	0.0
C. *placentula* var. *euglypta*	7.2	0.0	7.6	4.2	0.0	0.0	0.0	2.0	0.5	0.0	0.0	0.0	0.0	3.5
Cymbella affinis	4.7	2.4	0.3	1.7	9.6	1.6	1.7	0.9	0.0	3.8	2.0	0.0	0.8	0.0
C. amphicephala	0.0	0.0	4.5	0.0	0.0	0.0	0.0	3.1	0.0	1.3	0.0	13.6	0.0	6.5
C. excisiformis	3.0	0.8	0.6	2.5	0.7	12.6	0.0	0.6	0.5	0.4	0.0	0.0	0.8	0.0
C. exigua	0.0	0.0	0.6	0.0	0.0	0.0	7.5	0.0	0.0	0.0	3.2	1.1	0.0	0.0
C. gracile	0.0	0.0	0.0	4.2	2.1	1.9	0.0	4.3	0.5	0.4	0.0	0.0	4.2	0.4
C. hanztschiana	0.4	1.6	0.6	0.0	0.0	0.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. hungarica	0.0	0.0	0.0	0.0	0.0	3.5	0.0	1.4	0.0	2.1	0.0	0.4	4.2	0.0
C. Hustedii	2.1	2.0	0.0	0.8	1.8	7.7	5.8	0.0	2.0	0.0	2.0	0.0	0.0	5.7
C. nagpurensis	0.0	0.0	1.1	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0
C. ventricosa	2.1	3.2	0.0	0.0	0.0	4.7	0.0	0.0	0.0	3.4	0.0	0.0	9.2	0.0
Diatoma hiemale	0.0	0.0	3.7	4.2	0.0	0.0	0.8	1.1	0.0	0.0	0.0	0.0	0.0	0.4
D. hiemale var. *mesodon*	2.1	0.0	0.0	0.0	1.4	0.5	0.0	3.7	0.0	3.0	2.8	0.4	0.0	0.4
Eunotia sp.	0.9	3.2	0.3	0.0	0.7	0.0	0.0	2.3	0.0	0.4	0.0	0.0	1.7	0.0
Fragilaria construens	0.0	0.0	0.0	3.3	5.0	0.0	0.0	0.0	0.0	4.7	2.4	0.0	0.0	1.7
F. vaucheriae	0.4	2.0	0.6	0.0	0.0	0.0	0.0	1.1	6.0	0.0	0.0	0.0	0.0	0.0
Gomphonema angustatum	0.0	0.0	0.0	0.0	0.4	6.5	0.0	3.7	0.0	5.1	0.0	0.0	5.0	0.0
G. bohemicum	3.4	0.4	0.0	3.3	0.0	0.0	0.0	0.3	0.5	0.0	17.6	0.9	0.0	2.2
G. gracile	0.0	0.0	0.0	0.0	9.3	0.0	0.0	0.0	6.5	0.9	2.0	0.0	0.0	0.0
G. intricatum	0.0	2.0	0.0	0.0	0.0	0.0	6.7	4.0	0.0	0.0	0.0	0.0	5.8	0.0
G. lanceolata	2.1	0.0	0.0	0.0	0.4	9.6	0.0	0.0	1.0	6.4	0.0	0.9	0.0	1.7
G. lanceolatum	0.0	1.6	1.1	0.0	0.0	0.0	4.2	2.6	0.0	0.0	0.0	0.0	0.0	1.7
G. nagpurensis	0.0	0.0	0.0	1.7	0.4	1.2	0.0	4.9	0.0	6.4	2.8	0.0	1.7	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
G. olivaceoides	1.7	4.0	0.0	0.0	5.4	0.2	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0
G. olivaceum	0.0	0.0	0.6	13.3	0.0	1.4	0.0	0.0	3.5	0.4	1.6	0.0	0.0	2.2
G. parvulum	11.9	19.2	0.3	0.0	3.9	1.6	1.7	2.6	0.0	0.0	0.0	0.0	22.5	0.0
G. sphaerophorum	0.0	0.0	0.0	3.3	0.0	1.2	0.0	0.9	0.0	0.9	0.0	0.0	0.0	0.0
Gomphonema sp.	14.5	1.6	0.6	0.0	2.1	0.0	0.0	0.0	6.5	0.0	0.0	0.2	0.0	0.9
Gyrosigma sp.	2.1	0.0	0.0	0.0	0.0	8.2	1.7	0.0	7.5	2.6	0.0	0.0	3.3	0.0
Hannaea arcus	0.0	1.6	0.6	3.3	1.8	0.0	0.0	3.4	0.0	3.0	0.4	0.0	0.0	4.8
Hanztschia amphioxys	3.4	0.0	0.0	0.8	0.0	0.7	0.0	0.3	0.5	0.0	0.0	0.2	0.0	1.3
Melosira varians	0.0	4.4	0.0	3.3	1.8	0.0	5.8	2.3	18.5	0.4	0.8	0.0	0.0	0.0
Navicula cryptocephala	0.4	0.0	1.7	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0
N. halophila	0.0	4.8	0.0	0.0	6.4	0.0	0.0	5.4	0.5	2.1	1.6	0.2	1.7	0.4
N. radiosa	0.4	10.4	6.2	1.7	0.4	0.0	4.2	1.7	1.0	3.0	0.0	0.4	0.0	0.0
N. rhynchocephala	3.0	0.0	0.0	3.3	4.3	0.7	0.0	0.3	12.0	0.0	4.4	4.9	15.0	0.9
Nitzschia thermalis	0.4	3.6	0.3	0.0	0.0	0.5	5.0	0.0	0.0	2.1	0.0	0.0	0.0	0.4
Planothidium lanceolata	8.9	0.0	0.0	12.5	0.0	3.5	0.0	1.7	6.5	0.0	0.0	3.6	0.0	0.0
Reimeria sinuata	0.0	3.2	0.0	9.2	0.7	0.0	0.0	0.0	0.0	1.3	0.0	0.2	2.5	3.0
Surirella sp.	0.4	0.0	4.0	0.0	3.9	2.1	1.7	0.6	0.5	0.0	0.0	0.0	0.0	0.0
Synedra sp.	0.0	0.4	0.0	0.0	0.7	0.0	0.0	0.9	0.0	3.4	0.0	0.4	0.0	2.2
Total No of Taxa	**31.0**	**24.0**	**28.0**	**24.0**	**28.0**	**27.0**	**20.0**	**36.0**	**22.0**	**31.0**	**21.0**	**21.0**	**21.0**	**24.0**
November														
Achnanthidium affinis	5.0	0.0	5.1	0.0	4.3	3.7	4.1	3.9	0.4	6.1	0.0	7.4	0.0	7.1
A. *biasolettiana*	13.9	0.0	0.0	4.3	0.0	0.0	0.0	6.2	0.0	8.7	1.0	0.0	0.0	21.4
A. *exigua*	0.7	1.6	0.9	0.0	7.2	0.0	7.3	0.0	8.1	11.2	2.0	0.0	0.0	3.6
A. *fragilaroides*	5.3	0.0	8.4	0.0	0.0	8.9	0.0	1.9	0.0	0.0	3.0	2.9	0.0	7.1
A. *lanceolata*	0.7	0.0	0.9	13.0	0.0	0.0	3.6	5.4	0.0	10.6	4.0	0.0	0.0	14.3
A. *linearis*	0.0	2.5	14.5	0.0	0.0	0.0	8.4	3.2	3.3	0.0	5.0	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
A. *microcephala*	2.3	0.0	0.0	0.0	0.0	2.5	0.4	4.5	0.0	0.0	6.0	0.0	10.9	0.0
A. *minutissima*	0.0	17.2	12.6	0.4	6.7	0.0	0.0	3.7	0.7	5.1	7.0	23.5	18.8	0.0
A. minutissima var. *inconspicua*	0.3	0.0	18.2	0.0	0.0	15.6	6.7	0.0	0.0	0.0	8.0	20.6	0.0	0.0
A. saccula	0.0	1.6	0.5	7.6	0.0	0.0	0.0	1.9	0.0	1.6	9.0	0.0	10.1	0.0
A. undata	3.0	0.0	0.0	0.0	0.0	1.5	0.0	4.7	0.0	1.9	10.0	0.0	0.0	0.0
Amphora sp.	0.0	0.0	0.0	0.0	10.6	0.0	0.0	0.0	10.8	0.0	11.0	0.0	2.9	0.0
Cocconeis placentula	1.7	21.3	3.3	0.0	0.0	0.3	0.0	4.7	0.0	0.3	12.0	0.0	0.0	3.6
C. *placentula* var. euglypta	10.9	0.0	3.7	0.4	0.0	0.3	0.9	5.0	2.9	0.0	13.0	0.0	0.0	0.0
Cymbella affinis	0.0	0.0	0.0	0.0	17.3	2.2	0.0	1.1	0.0	2.9	14.0	0.0	0.0	0.0
C. amphicephala	0.0	1.6	5.1	0.0	0.0	2.8	0.4	1.7	0.2	0.0	15.0	0.0	0.0	14.3
C. gracile	1.0	0.0	0.0	1.8	0.0	0.0	0.0	1.1	2.4	1.6	16.0	0.0	0.0	0.0
C. hanztschiana	0.0	0.0	0.0	0.0	0.0	0.0	8.1	0.0	0.0	0.0	17.0	0.0	3.6	0.0
C. hungarica	1.3	6.6	4.7	0.0	0.0	4.6	0.4	0.0	0.0	0.6	18.0	0.0	0.0	3.6
C. Hustedii	0.0	0.0	0.0	0.0	0.0	11.7	0.0	1.1	0.4	0.0	19.0	7.4	0.0	0.0
C. nagpurensis	0.0	2.5	5.6	0.7	0.0	0.3	4.7	0.0	0.0	0.3	20.0	0.0	0.7	0.0
C. ventricosa	1.7	0.0	0.0	0.0	3.9	5.8	0.0	1.1	0.0	1.9	21.0	0.0	0.7	0.0
Diatoma hiemale	0.0	0.0	4.2	0.0	2.4	0.0	0.0	2.2	3.3	0.0	22.0	0.0	0.0	0.0
var. *mesodon*	0.0	4.1	0.0	0.0	0.0	0.0	3.9	1.1	0.0	2.6	23.0	0.0	0.0	0.0
Eunotia sp.	1.3	0.0	3.7	3.2	4.3	0.6	0.0	3.7	0.2	0.0	24.0	11.8	0.0	0.0
Fragilaria construens	0.0	0.0	0.0	0.0	2.4	0.0	3.9	0.0	0.0	2.9	25.0	0.0	0.7	0.0
F. vaucheriae	0.0	4.1	2.8	0.0	5.3	0.0	0.0	0.0	0.2	0.0	26.0	0.0	0.0	0.0
Gomphonema angustatum	0.0	0.0	0.0	2.5	1.0	2.5	1.7	0.0	4.8	6.7	27.0	0.0	0.0	0.0
G. bohemicum	0.3	0.0	0.0	1.4	0.0	0.0	0.0	5.4	0.0	0.0	28.0	13.2	0.0	0.0
G. gracile	0.0	4.9	1.9	0.4	6.7	0.0	0.2	0.0	6.8	0.6	29.0	0.0	0.0	0.0
G. lanceolata	0.0	0.0	0.0	0.0	0.0	10.1	2.3	0.0	1.1	8.3	30.0	0.0	1.5	0.0
G. lanceolatum	3.6	0.0	0.0	9.0	3.9	0.0	0.0	6.0	1.3	0.0	31.0	2.9	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
G. olivaceoides	0.0	0.8	0.0	0.0	2.4	0.6	0.4	0.0	0.0	0.0	32.0	0.0	0.0	0.0
G. olivaceum	0.0	0.0	0.0	9.7	4.3	0.0	0.0	0.0	0.0	5.8	33.0	0.0	13.0	3.6
G. parvulum	2.7	13.9	0.5	0.0	0.5	0.0	11.1	4.5	1.1	0.0	34.0	0.0	14.5	0.0
G. sphaerophorum	0.0	0.0	0.0	0.4	0.0	2.2	0.0	3.9	0.0	1.6	35.0	0.0	2.2	0.0
Gomphonema sp.	14.6	9.8	0.0	1.4	0.0	0.0	0.4	0.0	8.6	0.0	36.0	2.9	0.0	0.0
Gyrosigma sp.	2.7	0.0	0.5	0.0	0.5	0.0	0.0	1.1	7.9	0.0	37.0	0.0	8.0	0.0
Hannaea arcus	0.0	0.0	0.0	8.3	0.0	0.0	2.1	1.3	1.1	4.8	38.0	0.0	0.0	0.0
Hanztschia amphioxys	2.0	1.6	0.0	0.4	2.4	1.8	0.0	1.5	1.5	0.0	39.0	0.0	0.7	0.0
Melosira varians	0.0	0.0	0.9	4.0	0.0	0.0	1.5	2.6	5.0	0.0	40.0	0.0	0.0	0.0
Navicula cryptocephala	0.0	0.0	0.0	0.0	5.8	0.0	0.0	0.9	6.8	0.0	41.0	2.9	8.0	0.0
N. halophila	4.0	0.0	0.0	4.3	0.0	1.2	2.1	0.7	0.0	0.6	42.0	0.0	0.0	0.0
N. linearis	0.0	1.6	0.5	0.0	2.4	0.3	0.0	1.7	2.4	0.0	43.0	0.0	0.0	7.1
N. radiosa	0.0	0.0	0.0	0.7	0.0	1.2	0.0	6.2	0.0	3.5	44.0	1.5	0.0	0.0
N. rhynchocephala	4.6	0.0	0.0	4.0	4.3	0.0	2.8	0.0	15.8	0.0	45.0	0.0	2.2	0.0
Navicula sp.	0.0	0.8	0.5	1.4	0.0	18.7	0.0	0.4	0.0	1.9	46.0	0.0	0.0	0.0
Nitzschia thermalis	0.0	0.0	0.0	0.0	0.5	0.0	0.0	2.8	0.0	0.0	47.0	1.5	0.0	7.1
Planothidium lanceolata	15.9	0.0	0.0	11.9	0.0	0.6	3.4	0.0	2.9	0.0	48.0	1.5	0.0	0.0
Reimeria sinuata	0.0	3.3	0.5	7.6	1.0	0.0	0.0	0.0	0.0	5.8	49.0	0.0	1.5	3.6
Synedra sp.	0.7	0.0	0.5	1.4	0.0	0.0	0.4	3.0	0.0	1.9	50.0	0.0	0.0	3.6
No of Taxa	**23.0**	**18.0**	**24.0**	**25.0**	**22.0**	**23.0**	**21.0**	**26.0**	**24.0**	**24.0**	**50.0**	**12.0**	**14.0**	**13.0**
December														
Achnanthidium affinis	5.1	0.0	9.1	0.0	4.4	0.0	9.1	7.0	0.0	9.0	0.0	0.0	0.0	7.9
A. *biasolettiana*	35.9	0.0	0.0	20.0	0.0	0.0	0.0	9.1	0.0	17.9	0.0	0.0	0.0	21.1
A. *exigua*	0.0	0.0	0.0	0.0	8.7	0.0	12.1	0.0	18.8	6.0	0.0	0.0	0.0	0.0
A. *fragilaroides*	5.1	0.0	13.6	0.0	0.0	5.9	0.0	2.8	0.0	0.0	35.7	0.0	0.0	5.3
A. *lanceolata*	0.0	0.0	0.0	20.0	0.0	0.0	6.1	4.2	0.0	7.5	0.0	0.0	0.0	26.3

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
A. *linearis*	0.0	0.0	18.2	0.0	0.0	0.0	15.2	5.6	0.0	0.0	0.0	0.0	0.0	0.0
A. *microcephala*	2.6	0.0	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0	0.0	0.0	66.7	0.0
A. *minutissima*	0.0	33.3	13.6	0.0	8.7	0.0	0.0	8.4	0.0	6.0	0.0	###	0.0	0.0
A. minutissima var. *inconspicua*	0.0	0.0	18.2	0.0	0.0	17.7	12.1	0.0	0.0	0.0	21.4	0.0	0.0	0.0
A. saccula	0.0	0.0	0.0	10.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0
A. undata	2.6	0.0	9.1	0.0	0.0	0.0	0.0	4.2	0.0	1.5	0.0	0.0	0.0	0.0
Amphora sp.	0.0	0.0	0.0	0.0	13.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	0.0
Cocconeis placentula	0.0	16.7	0.0	0.0	0.0	0.0	0.0	1.4	0.0	6.0	0.0	0.0	0.0	0.0
C. *placentula* var. *euglypta*	7.7	0.0	9.1	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0
Cymbella affinis	0.0	0.0	0.0	0.0	17.4	0.0	0.0	3.5	0.0	3.0	0.0	0.0	0.0	0.0
C. amphicephala	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	7.9
C. excisa var. *procera*	0.0	0.0	0.0	0.0	0.0	0.0	9.1	0.0	0.0	0.0	28.6	0.0	0.0	0.0
C. excisiformis	2.6	0.0	0.0	0.0	0.0	17.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. exigua	0.0	0.0	0.0	0.0	0.0	0.0	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. gracile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0
C. hanztschiana	0.0	0.0	0.0	0.0	0.0	0.0	12.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. hungarica	0.0	0.0	0.0	0.0	0.0	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. Hustedii	0.0	0.0	0.0	0.0	0.0	11.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. nagpurensis	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. ventricosa	0.0	0.0	0.0	0.0	0.0	5.9	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0
Diatoma hiemale	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D. hiemale var. *mesodon*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	1.5	0.0	0.0	0.0	0.0
Eunotia sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0
Fragilaria construens	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0
F. vaucheriae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	0.0
Gomphonema angustatum	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	7.5	0.0	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
G. bohemicum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	14.3	0.0	0.0	0.0
G. gracile	0.0	0.0	0.0	0.0	13.0	0.0	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0
G. intricatum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0
G. lanceolata	0.0	0.0	0.0	0.0	0.0	11.8	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0
G. lanceolatum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0
G. nagpurensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceoides	0.0	0.0	0.0	0.0	13.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceum	0.0	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0
G. parvulum	0.0	50.0	0.0	0.0	4.4	0.0	6.1	3.5	0.0	0.0	0.0	0.0	33.3	0.0
G. sphaerophorum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	1.5	0.0	0.0	0.0	0.0
Gomphonema sp.	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0
Gyrosigma sp.	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	0.0
Hannaea arcus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	4.5	0.0	0.0	0.0	10.5
Hanztschia amphioxys	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0
Hanztschia sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0
Melosira varians	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	18.8	0.0	0.0	0.0	0.0	0.0
Navicula cryptocephala	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0
N. halophila	0.0	0.0	0.0	0.0	8.7	0.0	0.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0
N. linearis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0
N. radiosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0
N. rhynchocephala	2.6	0.0	0.0	0.0	4.4	0.0	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0
Navicula sp.	0.0	0.0	0.0	0.0	0.0	23.5	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0
Nitzschia thermalis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	5.3
Planothidium lanceolata	23.1	0.0	0.0	20.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	0.0
Reimeria sinuata	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	13.2
Surirella sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Synedra sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	3.0	0.0	0.0	0.0	2.6
Total No of Taxa	**11.0**	**3.0**	**6.0**	**6.0**	**8.0**	**8.0**	**4.0**	**30.0**	**9.0**	**19.0**	**4.0**	**1.0**	**2.0**	**7.0**
January														
Achnanthes affinis	2.3	9.2	9.1	0.0	10.0	2.2	0.0	5.3	0.0	4.3	0.0	0.0	24.1	0.0
A. biasolettiana	15.8	15.3	0.0	0.0	0.0	13.0	10.0	0.0	20.8	0.0	0.0	0.0	6.9	11.1
A. conspicua	0.0	1.5	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0
A. Hauckiana	9.0	0.0	11.4	0.0	0.0	3.3	0.0	13.2	0.0	8.5	0.0	0.0	0.0	27.8
A. lanceolata	0.0	4.6	0.0	0.0	13.3	0.0	4.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0
A. lanceolata var. *lanceolata*	9.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	10.6	0.0	0.0	10.3	0.0
A. linearis	0.0	11.5	6.8	0.0	0.0	5.4	0.0	7.9	0.0	0.0	0.0	0.0	0.0	22.2
A. micoscopica	7.5	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.1	0.0	0.0
A. minutissima	13.5	0.0	0.0	0.0	16.7	5.4	0.0	0.0	0.0	12.8	0.0	0.0	0.0	0.0
Amphora veneta	0.0	0.0	4.6	10.7	0.0	0.0	0.0	13.2	0.0	0.0	0.0	0.0	24.1	0.0
Anomoneis sp.	0.8	0.0	0.0	0.0	0.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cocconeis placentula	3.0	0.0	0.0	0.0	6.7	0.0	4.0	0.0	16.7	0.0	0.0	0.0	0.0	11.1
C. placentula var. *euglypta*	1.5	0.0	9.1	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0
C. placentula var. *linearis*	1.5	0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0
Cymbella affinis	0.0	1.5	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0
C. amphicephala	0.0	0.0	2.3	0.0	0.0	5.4	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.0
C. excisa	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	6.4	0.0	0.0	0.0	0.0
C. exigua	0.0	3.1	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. gracile	0.0	0.0	0.0	0.0	0.0	3.3	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. hungarica	0.0	2.3	0.0	3.6	0.0	0.0	0.0	0.0	0.0	8.5	0.0	0.0	0.0	0.0
C. Hustedii	1.5	0.0	4.6	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.1
C. kolbei	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0
C. kolbei var. *angusta*	0.0	0.0	0.0	0.0	0.0	2.2	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
C. laevis	0.8	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. lata	0.0	0.8	6.8	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0
C. perpusila	0.0	2.3	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. pusila	1.5	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cymbella sp.	0.0	0.8	4.6	0.0	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0
C. superparva	0.0	1.5	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. tumida	0.8	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0
C. turgidula	0.0	1.5	6.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. ventricosa	0.0	0.8	0.0	0.0	0.0	0.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cymbells affinis	3.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0
Diatoma hiemale	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6
Diatoma sp.	0.8	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0
Epithema sp.	0.0	0.0	0.0	0.0	0.0	1.1	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eunotia arcus	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.0
Fragilaria sp.	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. vaucheriae	0.0	1.5	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geissleria accetata	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0
Gomphonema affine var. *affine*	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0
G. angustatum	5.3	0.0	0.0	7.1	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. bohemicum	0.0	1.5	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. bohemicum ssp. Angustiminus	1.5	0.0	0.0	0.0	6.7	0.0	0.0	0.0	20.8	0.0	0.0	0.0	0.0	0.0
G. bohemicum ssp. Bohemicum	0.0	3.1	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. eriguga	2.3	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6
G. gracile	1.5	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. insigniforme	0.0	1.5	4.6	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0
G. intricatum	4.5	0.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
G. lanceolata	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. micropus var. micropus	1.5	0.0	0.0	0.0	0.0	2.2	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceoides	0.0	0.0	0.0	0.0	0.0	4.4	6.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6
G. olivaceum	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0
G. parvulum	6.0	0.0	0.0	0.0	10.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0
G. pseudobohemicum	0.0	0.0	0.0	0.0	0.0	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. sphaerophorum	1.5	0.0	0.0	3.6	0.0	0.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. sphenovertex	0.0	3.1	0.0	0.0	0.0	0.0	0.0	7.9	0.0	0.0	0.0	0.0	0.0	0.0
Hannaea arcus	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0
H. arcus var. *amphioxys*	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0
Navicula cincta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0
N. cryptocephala	0.0	0.0	0.0	10.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. cryptotenella	0.0	3.1	0.0	0.0	0.0	0.0	0.0	7.9	0.0	0.0	0.0	0.0	13.8	0.0
N. cryptotenelloides	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. dicephala	0.0	2.3	0.0	0.0	0.0	0.0	8.0	0.0	0.0	0.0	0.0	15.8	0.0	0.0
N. grimmei	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. leptostriata	0.0	1.5	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0
N. microcari	0.0	0.0	0.0	0.0	0.0	2.2	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. microdigitoradiata	0.0	1.5	0.0	3.6	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0
N. radiosa	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	0.0	6.9	0.0
N. rhyncocephala	0.0	3.1	0.0	0.0	6.7	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0
N. salinicola	2.3	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0
Navicula sp.	0.0	0.0	0.0	0.0	0.0	2.2	4.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0
Nitzschia linearis	0.0	0.8	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitzschia sp.	0.8	0.0	2.3	7.1	0.0	0.0	0.0	7.9	0.0	6.4	0.0	0.0	0.0	0.0
Pinnularia sp.	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Planothidium lanceolata	0.0	2.3	6.8	17.9	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0
Reimeria sinuata	0.0	3.1	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Surirella sp.	0.8	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	2.1	0.0	0.0	6.9	0.0
Synedra sp.	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0
Total No of Taxa	**22.0**	**29.0**	**16.0**	**12.0**	**11.0**	**22.0**	**20.0**	**13.0**	**5.0**	**16.0**	**0.0**	**5.0**	**8.0**	
February, 2015														
Achnanthes affinis	5.2	6.8	9.7	12.0	7.1	14.4	4.6	0.0	25.9	4.3	0.0	0.0	6.1	12.0
A. biasolettiana	1.0	3.2	5.4	9.6	0.0	5.9	2.3	0.0	7.4	0.0	0.0	0.0	2.4	0.0
A. grischuma	3.5	0.0	4.9	0.0	13.3	0.0	0.0	13.0	0.0	5.7	0.0	0.0	0.0	8.0
A. Hauckiana	0.0	4.0	0.0	10.8	0.0	4.2	4.6	0.0	0.0	4.3	0.0	0.0	0.0	0.0
A. holsatica	0.8	0.0	4.3	0.0	0.0	2.5	0.0	8.7	0.0	0.0	0.0	0.0	0.0	10.0
A. lanceolata	4.5	1.2	0.0	0.0	0.0	0.0	6.8	0.0	7.4	0.0	0.0	0.0	3.7	0.0
A. lanceolata var. lanceolata	3.5	0.0	2.7	0.0	9.7	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	6.0
A. lemmarmanii	0.8	2.0	0.0	8.4	0.0	0.0	0.0	8.7	0.0	5.7	0.0	0.0	0.0	0.0
A. linearis	3.0	0.0	1.6	0.0	21.2	0.0	2.3	0.0	11.1	0.0	0.0	0.0	0.0	10.0
Achnanthidium affine	2.7	2.0	0.0	7.2	12.4	0.0	0.0	13.0	0.0	4.3	43.8	14.3	0.0	0.0
A. arcus	0.0	2.8	0.5	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. minutissimum	2.5	0.0	1.6	0.0	0.0	6.8	0.0	4.4	0.0	5.7	0.0	28.6	0.0	0.0
A. pyrenaicum	0.0	2.0	0.0	3.6	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0	6.0
A. subsalsum	3.0	1.6	0.0	0.0	0.0	8.5	0.0	0.0	3.7	0.0	12.5	0.0	0.0	0.0
Anomoneis sp.	0.5	1.2	0.0	8.4	0.0	2.5	0.0	4.4	0.0	0.0	0.0	14.3	0.0	0.0
Cocconeis placentula	0.0	0.8	0.5	0.0	0.0	0.0	3.4	0.0	0.0	2.9	0.0	0.0	0.0	2.0
Cymbella affinis	3.0	0.4	0.0	0.0	2.7	0.0	0.0	8.7	0.0	0.0	0.0	0.0	1.2	0.0
C. amphicephala	0.0	1.2	1.6	0.0	0.0	4.2	0.0	0.0	11.1	0.0	0.0	0.0	0.0	4.0
C. excisa	2.0	0.4	0.0	1.8	0.0	0.0	2.3	0.0	0.0	4.3	0.0	21.4	0.0	0.0
C. exigua	1.3	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	2.4	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
C. gracile	0.0	2.0	4.3	0.0	0.0	1.7	0.0	0.0	3.7	0.0	0.0	7.1	0.0	0.0
C. hungarica	1.8	0.0	1.1	0.0	0.0	0.0	3.4	0.0	0.0	1.4	0.0	0.0	0.0	2.0
C. Hustedii	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	7.4	0.0	0.0	0.0	1.2	0.0
C. kolbei	2.2	3.2	2.2	0.0	0.0	0.0	3.4	0.0	0.0	2.9	0.0	0.0	0.0	0.0
C. kolbei var. *angusta*	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. ventricosa	0.5	0.0	1.6	0.0	4.4	0.0	2.3	0.0	0.0	1.4	0.0	0.0	0.0	0.0
C. hungarica	0.0	4.0	0.0	0.0	0.0	1.7	0.0	0.0	3.7	0.0	0.0	0.0	2.4	0.0
C. kolbei Hustedt	1.0	3.6	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0
C. laevis Nägeli	0.0	4.8	0.0	0.0	0.0	0.0	1.1	0.0	7.4	0.0	0.0	14.3	3.7	0.0
C. lancettula	1.5	0.8	3.8	0.0	0.0	0.9	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0
C. nagpurensis	0.0	2.4	0.0	1.2	0.0	0.0	0.0	8.7	0.0	0.0	0.0	0.0	0.0	4.0
C. parva Kirchner	0.8	0.0	0.0	0.0	0.0	0.9	2.3	0.0	11.1	0.0	0.0	0.0	1.2	0.0
C. perparva Krammer	0.0	0.0	1.1	0.0	0.0	0.0	0.0	4.4	0.0	2.9	0.0	0.0	0.0	0.0
Cymbells affinis	0.0	1.2	1.1	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Encyonema sp.	3.5	0.0	0.5	0.0	0.0	0.0	1.1	0.0	0.0	4.3	0.0	0.0	2.4	0.0
E. subminisculus	0.0	1.6	0.0	0.6	0.0	0.0	1.1	0.0	0.0	0.0	6.3	0.0	0.0	0.0
E. gracile Kirchner	3.2	0.0	0.0	0.0	3.5	1.7	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0
E. jemtlandicum var. *venezolana*	0.0	0.4	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	4.0
Fragilaria sp.	3.0	0.0	0.0	0.0	4.4	3.4	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0
Fragilaria vaucheriae	0.0	1.2	0.0	0.6	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	2.0
Geissleria sp.	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0
Gomphonema acuminatum	0.0	1.6	0.0	1.2	0.0	0.0	0.0	8.7	0.0	0.0	0.0	0.0	0.0	0.0
G. aff bohemicum ssp. *angustatum*	1.5	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	6.0
G. bohemicum	0.0	1.6	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	12.5	0.0	0.0	0.0
G. gracile	2.2	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	3.7	0.0
G. insigniforme	0.0	2.0	0.0	0.0	0.0	0.0	0.0	8.7	0.0	0.0	0.0	0.0	0.0	4.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
G. intricatum	0.0	0.8	0.0	0.0	0.0	1.7	0.0	0.0	0.0	5.7	0.0	0.0	0.0	0.0
G. intricatum var. *subclavata*	0.0	0.0	3.2	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	2.0
G. lacus var. *vulcari*	0.0	1.6	0.0	1.2	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	0.0
G. lanceolata	0.0	1.2	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. loglinear	0.0	0.8	0.0	0.6	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. micropus	0.8	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceoides	0.0	0.4	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceum	0.0	0.0	2.2	0.0	0.0	1.7	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceum var. *olivaceoides*	0.0	0.4	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. parvulum	2.2	1.6	0.0	0.0	0.9	3.4	4.6	0.0	0.0	7.1	12.5	0.0	0.0	0.0
G. parvulum var. *pumilum*	0.0	0.8	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. perpusila	2.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. sphaerophorum	0.0	2.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0
G. auritum	0.5	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0
G. balatonis	0.0	1.2	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. bohemicum	0.0	2.8	0.0	0.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7	0.0
G. clavatulum	0.5	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. clavatum	0.0	0.8	0.0	2.4	0.0	0.0	2.3	0.0	0.0	1.4	0.0	0.0	0.0	0.0
G. cymbelliclinum	1.0	0.0	4.3	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	4.9	0.0
G. grovei var. *lingulatum*	0.0	1.2	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	2.0
G. grunowii	0.0	0.4	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. helveticum	5.2	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. innocens	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	7.3	0.0
G. insigniforme	2.2	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. intricatum	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	3.7	2.0
G. intricatum var. *pumilum*	1.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
G. intricatum var. *vibrio*	0.8	0.0	0.0	0.0	4.4	1.7	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0
G. longiceps	1.3	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	4.9	0.0
G. longiceps var. *subclavata*	1.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. micropus	1.3	0.0	0.0	0.0	2.7	1.7	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0
G. micropus var. *aequale*	0.0	0.0	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. minutum	0.8	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceum	0.0	1.6	0.0	0.0	0.9	3.4	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0
G. olivaceum var. *minutissimum*	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hannaea arcus	0.3	0.0	0.0	0.0	0.9	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hannaea arcus var. *amphioxys*	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula cincta	0.5	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
N. cryptocephala	0.8	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. cryptotenella	1.8	1.2	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. cryptotenelloides	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7	0.0
N. grimmei	2.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. radiosa	0.5	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. rhyncocephala	1.0	0.0	0.0	4.8	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0	4.9	0.0
N. salinicola	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitzschia sp.	0.3	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0
Pinnularia sp.	0.3	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Planothidium lanceolata	0.0	0.0	0.0	0.0	0.0	15.3	0.0	0.0	0.0	0.0	0.0	0.0	11.0	2.0
P. lanceolata for. ventricosa	2.7	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P. ellipticum	0.0	0.0	0.0	0.0	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P. hauckianum var. *rostratum*	0.0	6.0	0.0	11.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Psammothidium grischunum	2.5	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0
Psammothidium levanderi	0.0	1.2	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Reimeria sinuata	3.2	0.0	0.0	4.8	0.0	0.0	6.8	0.0	0.0	0.0	0.0	0.0	9.8	0.0
Surirella sp.	0.3	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Synedra amphirhynchus	0.0	2.4	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S. capitata	1.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	2.0
S. danica	0.8	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0
S. oxyrhynchus	0.8	0.4	0.0	1.8	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.9	2.0
Total number of taxa	**57.0**	**54.0**	**41.0**	**24.0**	**20.0**	**26.0**	**32.0**	**13 .0**	**11.0**	**27.0**	**7 .0**	**6 .0**	**26 .0**	**22 .0**
March, 2015														
Achnanthes affinis	0.0	5.1	11.9	0.0	0.0	15.8	0.0	10.7	0.0	11.8	0.0	7.0	4.6	0.0
A. conspicua	0.0	3.8	0.0	0.0	0.0	0.0	19.1	0.0	5.9	0.0	10.0	0.0	2.3	0.0
A. gibberula var. *genuina*	25.0	0.0	1.7	0.0	0.0	10.5	0.0	7.1	0.0	0.0	0.0	4.2	6.8	0.0
A. Grimmei	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.9	0.0	5.6	0.0	0.0
A. kryophila	0.0	2.5	6.8	0.0	0.0	10.5	0.0	0.0	11.8	0.0	15.0	0.0	9.1	80.0
A. linearis	0.0	0.0	5.1	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0	4.6	0.0
A. lanceolata	0.0	1.3	23.7	28.6	0.0	0.0	0.0	0.0	0.0	5.9	0.0	1.4	0.0	0.0
A. lanceolata var. *elliptica*	0.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0	17.7	0.0	5.0	0.0	6.8	0.0
A. minutissima	0.0	3.8	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	4.6	0.0
Cocconeis placentula	0.0	2.5	0.0	0.0	0.0	15.8	0.0	0.0	0.0	0.0	20.0	0.0	9.1	0.0
Cymbella affinis	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	5.9	0.0	5.6	0.0	0.0
C. amphicephala	50.0	0.0	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	5.0	0.0	6.8	0.0
C. oxyrhynchus	0.0	5.1	0.0	42.9	0.0	0.0	0.0	0.0	5.9	0.0	0.0	2.8	0.0	0.0
C. gracile	0.0	2.5	0.0	0.0	0.0	0.0	9.5	0.0	0.0	0.0	10.0	0.0	4.6	0.0
C. laevis	0.0	0.0	5.1	0.0	0.0	15.8	0.0	0.0	0.0	17.7	0.0	4.2	2.3	0.0
C. sp.	0.0	3.8	3.4	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0	4.2	6.8	0.0
C. nagpurensis	0.0	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0	0.0	4.6	0.0
C. lata	0.0	2.5	0.0	0.0	0.0	10.5	0.0	0.0	11.8	0.0	0.0	2.8	2.3	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
C. turgida	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0
C. ventricosa	25.0	0.0	0.0	0.0	0.0	0.0	0.0	10.7	0.0	11.8	0.0	0.0	6.8	0.0
Diatoma hiemale	0.0	1.3	0.0	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	4.2	2.3	0.0
D. hiemale var. *mesodon*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	4.6	0.0
Fragilaria construens	0.0	3.8	0.0	0.0	0.0	0.0	9.5	0.0	0.0	0.0	0.0	5.6	0.0	20.0
Fragilaria sp.	0.0	0.0	3.4	0.0	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. vaucherae	0.0	0.0	0.0	28.6	0.0	0.0	0.0	3.6	0.0	17.7	0.0	0.0	0.0	0.0
Gomphonema gracile	0.0	2.5	5.1	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	2.8	0.0	0.0
G. intricatum	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. longiceps	0.0	5.1	1.7	0.0	0.0	0.0	9.5	0.0	0.0	0.0	0.0	4.2	0.0	0.0
G. longiceps var. *subclavata*	0.0	2.5	0.0	0.0	0.0	5.3	0.0	0.0	0.0	11.8	0.0	0.0	4.6	0.0
G. olivaceum	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0
G. olivaceoides	0.0	3.8	0.0	0.0	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	2.3	0.0
G. parvulum	0.0	0.0	6.8	0.0	0.0	0.0	0.0	0.0	0.0	5.9	0.0	1.4	0.0	0.0
G. sphaerophorum	0.0	2.5	0.0	0.0	0.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. tergestinum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.8	0.0	10.0	0.0	0.0	0.0
Navicula cincta	0.0	1.3	0.0	0.0	0.0	0.0	9.5	0.0	0.0	0.0	0.0	4.2	0.0	0.0
N. cryptocephala	0.0	0.0	5.1	0.0	0.0	0.0	0.0	3.6	0.0	0.0	5.0	0.0	0.0	0.0
N. exigua	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.1	0.0	0.0	0.0	2.8	0.0	0.0
N. halophila	0.0	0.0	0.0	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. gracilis	0.0	2.5	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0	2.8	0.0	0.0
N. radiosa	0.0	3.8	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	2.8	0.0	0.0
N. radiosa var. *tenella*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.1	17.7	0.0	0.0	5.6	0.0	0.0
N. rhyncocephala	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	5.9	0.0	0.0	0.0	0.0	0.0
Navicula sp.	0.0	0.0	0.0	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	4.2	0.0	0.0
Nitzschia sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	2.3	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Pinnularia sp.	0.0	2.5	3.4	0.0	0.0	0.0	0.0	0.0	11.8	0.0	0.0	2.8	0.0	0.0
Planothidium lanceolata	0.0	6.3	0.0	0.0	0.0	0.0	0.0	3.6	0.0	5.9	0.0	0.0	2.3	0.0
Synedra acus	0.0	2.5	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0
Synedra ulna	0.0	1.3	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	0.0	0.0
Synedra ulna var. aequalis	0.0	2.5	0.0	0.0	0.0	0.0	9.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Synedra ulna var. amphirhynchus	0.0	5.1	5.1	0.0	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	0.0
Total number of taxa	**3.0**	**30.0**	**18.0**	**3.0**	**3.0**	**5.0**	**11.0**	**24.0**	**9.0**	**10.0**	**10.0**	**25.0**	**21.0**	**2.0**

Table-8.4 Macro-invertebrates of Teestaand Rangit Rivers

	Sampling Sites														
Family	**Genus**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
April															
Heptageniidae	*Cinygmula*	100	78	56	11	0	44	22	0	0	0	0	0	0	0
	Cinygma	100	0	0	0	0	0	0	0	0	0	0	0	0	0
Baetidae	*Baetis*	189	11	0	33	0	0	22	0	0	0	0	0	0	0
Hydroptilidae	*Hydroptila*	0	0	0	11	0	0	0	0	0	0	0	0	0	0
	Ochrotrichia	0	0	0	0	11	0	22	0	0	0	0	0	0	0
Hydropsychidae	*Hydropsyche*	33	0	0	0	0	11	0	0	0	0	0	0	0	0
Glossosomatidae	*Glossosoma*	0	0	0	44	0	11	0	33	0	378	0	0	0	0
Chironomidae	*Ablabesmyia*	33	22	0	22	0	11	0	11	0	0	0	0	0	0
	Chironomus	0	0	0	0	0	22	0	0	0	0	0	0	0	0
Limnocharidae	*Limnochares*	22	0	0	0	0	0	0	0	0	0	0	0	0	0
May															
Heptageniidae	*Cinygmula*	0	0	0	0	0	22	211	0	0	44	0	0	0	0
	Cinygma	0	0	0	0	0	0	389	0	0	0	0	0	0	0
Ephemerellidae	*Ephemerella excrucians*	0	0	0	0	0	0	22	0	0	0	0	0	0	0

	Sampling Sites														
Family	**Genus**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
	Ephemerella subvaria	0	0	0	0	0	0	11	0	0	0	0	0	0	0
Baetidae	*Baetis*	0	0	0	0	0	0	356	0	0	0	0	0	0	0
Perlidae	*Acroneuria*	0	0	0	0	0	0	11	0	0	0	0	0	0	0
Curculionidae	*Sphenus*	0	0	0	0	0	0	167	0	0	0	0	0	0	0
Hydroptilidae	*Hydroptila*	0	0	0	0	0	0	22	0	0	0	0	0	0	0
	Ochrotrichia	0	0	0	0	0	0	33	0	0	0	0	0	0	0
Hydropsychidae	*Hydropsyche*	0	0	0	0	0	0	178	0	0	0	0	0	0	0
Glossosomatidae	*Glossosoma*	0	0	0	0	0	0	33	0	0	0	0	0	0	0
Chironomidae	*Ablabesmyia*	0	0	0	0	0	11	56	0	0	0	0	0	0	0
	Chironomus	0	0	0	0	0	0	22	0	0	0	0	0	0	0
Tipulidae	*Antocha saxicola*	0	0	0	0	0	0	44	0	0	0	0	0	0	0
	Antocha pupa	0	0	0	0	0	0	22	0	0	0	0	0	0	0
Limnocharidae	*Limnochares*	0	0	0	0	0	0	22	0	0	0	0	0	0	0
June															
Heptageniidae	*Cinygmula*	78	0	0	0	0	33	0	0	0	0	0	0	0	0
	Epeorus	0	0	0	0	0	44	0	0	0	0	0	0	0	0
Baetidae	*Baetis*	0	0	0	0	0	22	0	0	0	0	0	0	0	0
Perlidae	*Acroneuria*	11	0	0	0	0	0	0	0	0	0	0	0	0	0
	Perlesta	11	0	0	0	0	0	0	0	0	0	0	0	0	0
July															
Heptageniidae	*Cinygmula*	45	0	0	0	0	0	0	0	0	0	0	0	0	0
	Epeorus	0	0	0	0	0	0	0	0	0	0	0	0	22	
	Perlesta	0	0	0	0	0	11	0	0	0	0	0	0	0	0
	Hydropsychidae sp.	0	0	0	0	0	0	11	0	0	0	0	0	0	0
September															

	Sampling Sites														
Family	**Genus**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Heptageniidae	*Cinygmula*	0	0	11	0	22	44	0	56	0	0	0	11	0	0
Baetidae	*Baetis*	0	0	33	0	0	11	0	0	0	0	0	0	0	0
Caenidae	*Caenis latipennis*	0	0	0	0	0	0	0	11	0	0	0	0	0	
Chironomidae	*Ablabesmyia*	0	0	0	0	0	0	0	22	0	0	0	0	0	0
October															
Heptageniidae	*Cinygmula*	33	67	44	11	22	78	121	44	11	0	11	22	44	33
Baetidae	*Baetis*	33	22	44	44	22	44	44	46	0	0	11	0	0	0
Caenidae	*Caenis latipennis*	11	0	0	11	0	0	22	0	0	22	22	0	22	11
Ephemerellidae	*Ephemerella*	22	11	0	11	0	44	11	0	0	0	0	0	0	0
	Hydropsychidae Sp.	0	0	0	44	0	0	0	0	0	0	0	0	0	0
Perlidae	*Acroneuria*	0	0	0	0	11	11	33	0	0	33	0	22	0	
	Perlesta	11		22	0	11	11	11	0	0	11	0	0	22	22
Simulidae	*Simuliums*	0	11	0	0	11	22	11	33	22	0	0	0	0	0
	Ablabesmyia	0	11	11	0	0	0	0	22	0	0	0	0	0	0
Chironomidae	*Chironomus*	0	22	11	0	0	11	22	11	11	11	44	22	33	11
November															
Heptageniidae	*Cinygmula*	211	533	44	0	178	89	78	111	0	0	0	0	0	0
	Epeorus	0	711	0	0	0	0	0	0	0	0	0	0	0	0
Baetidae	*Baetis*	389	133	222	0	1933	78	67	178	0	0	0	0	0	0
Caenidae	*Caenis*	0	0	0	0	44	0	0	78	0	0	0	0	0	0
Leptophlebiidae	*Leptophlebia*	0	0	0	0	0	0	0	44	0	0	0	0	0	0
Perlidae	*Acroneuria*	0	11	0	0	0	0	0	0	0	0	0	0	0	0
Elmidae	*Heterlimnius*	0	0	0	0	0	0	0	11	0	0	0	0	0	0
Hydroptilidae	*Ochrotrichia*	0	0	0	0	78	22	11	11	0	0	0	0	0	0
Hydropsychidae	*Hydropsyche*	11	0	0	0	78	11	0	0	0	0	0	0	0	0
Glossosomatidae	*Glossosoma*	0	0	0	0	11	0	0	0	0	0	0	0	0	0

	Sampling Sites														
Family	**Genus**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Chironomidae	*Ablabesmyia*	800	1178	78	0	522	111	89	467	0	0	0	0	0	0
	Chironomus	0	11	0	0	11	0	0	0	0	0	0	0	0	0
Tipulidae	*Antocha saxicola*	0	11	0	0	11	0	0	0	0	0	0	0	0	0
Muscidae	*Limnophora aequifrons*	0	0	0	0	11	0	0	0	0	0	0	0	0	0
Limnocharidae	*Limnochares*	11	0	0	0	11	0	0	11	0	0	0	0	0	0
December															
	Heptagenia	0	0	0	0	0	22	22	33	0	0	0	0	11	0
	Epeorus	33	167	167	0	33	11	0	78	0	0	0	0	0	0
Baetidae	*Baetis*	178	300	133	133	311	78	56	100	0	0	22	33	33	0
Caenidae	*Caenis*	67	111	33	0	33	0	0	22	0	22	0	11	0	0
Leptophlebiidae	*Leptophlebia*	0	11	0	11	22	0	0	11	0	0	0	0	0	0
Psephenidae	*Psephenus herricki*	56	67	0	0	11	0	0	0	0	0	0	0	0	0
Eulichadidae	*Stenocolus*	244	133	22	0	89	22	0	0	0	0	0	33	0	0
Hydroptilidae	*Hydroptila*	78	67	78	11	11	0	33	67	0	0	0	78	0	0
	Ochrotrichia	33	33	22	0	0	0	0	67	0	0	0	0	0	0
	Leucotrichia	44	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydropsychidae	*Hydropsyche*	178	178	100	22	233	22	22	122	0	22	0	0	0	33
Glossosomatidae	*Glossosoma*	0	0	11	0	33	67	33	11	0	0	0	0	0	0
Chironomidae	*Ablabesmyia*	200	300	67	33	211	67	122	189	0	0	0	0	33	22
	Chironomus	22	33	0	11	122	0	0	78	0	67	11	22	22	77
Tipulidae	*Antocha saxicola*	0	0	33	22	22	11	0	144	11	0	0	0	0	0
Muscidae	*Limnophora aequifrons*	0	0	11	0	22	0	0	11	0	11	0	0	0	0
Limnocharidae	*Limnochares*	22	0	0	0	0	0	0	11	0	0	0	0	11	0
January															
Heptageniidae	*Cinygmula*	422	67	644	0	33	0	0	0	0	0	33	0	0	0
Baetidae	*Baetis*	178	0	33	0	44	33	0	11	0	0	78	0	0	0

	Sampling Sites														
Family	**Genus**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Caenidae	*Caenis*	0	0	0	0	0	22	0	0	0	0	0	0	0	0
Leptophlebiidae	*Leptophlebia*	0	11	0	0	0	0	0	0	0	0	0	0	0	0
Psephenidae	*Psephenus herricki*	0	0	0	0	0	22	0	0	0	0	0	0	0	0
Eulichadidae	*Stenocolus*	0	0	0	0	0	0	0	11	0	0	0	0	0	0
Hydroptilidae	*Hydroptila*	0	0	0	0	0	0	0	22	0	0	0	0	0	0
	Ochrotrichia	0	0	0	0	0	0	0	11	0	0	33	0	0	0
	Leucotrichia	0	0	0	0	0	0	0	11	0	0	0	0	0	0
Hydropsychidae	*Hydropsyche*	0	0	0	0	22	300	0	67	0	0	0	0	0	0
Chironomidae	*Ablabesmyia*	111	11	344	0	467	589	0	267	0	0	89	0	0	0
	Chironomus	0	0	0	0	67	0	0	33	0	0	0	0	0	0
Ceratopogonidae	*Culicoides variipennis*	0	0	0	0	267	0	0	0	0	0	0	0	0	0
Tipulidae	*Antocha saxicola*	0	0	0	0	67	100	0	144	0	0	0	0	0	0
Muscidae	*Limnophora aequifrons*	0	0	0	0	0	22	0	0	0	0	0	0	0	0
Limnocharidae	*Limnochares*	0	0	0	0	0	11	0	0	0	0	0	0	0	0
February															
Heptageniidae	*Cinygmula*	111	133	544	0	0	300	0	78	0	0	0	0	0	0
	Other	0	0	111	0	0	11	0	0	0	0	0	0	0	0
Baetidae	*Baetis*	0	44	33	0	0	100	0	311	0	0	0	0	0	0
Caenidae	*Caenis*	0	0	0	0	0	0	0	44	0	0	0	0	0	0
Psephenidae	*Psephenus herricki*	0	0	0	0	0	0	0	33	0	0	0	11	0	0
Hydroptilidae	*Hydroptila*	0	0	0	0	0	0	0	78	0	0	0	0	0	0
	Ochrotrichia	0	0	0	0	0	67	0	67	0	0	0	0	0	0
Hydropsychidae	*Hydropsyche*	0	0	0	0	0	111	0	89	0	0	0	0	0	0
Glossosomatidae	*Glossosoma*	0	0	0	0	0	33	0	144	0	0	0	0	0	0
Chironomidae	*Ablabesmyia*	0	11	178	0	0	56	0	244	0	189	0	0	0	0
Tabanidae	*Tabanus*	0	0	0	0	0	0	0	11	0	0	0	0	0	0

	Sampling Sites														
Family	**Genus**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Tipulidae	*Antocha saxicola*	0	0	11	0	0	122	0	278	0	0	0	0	0	0
-	-	0	0	0	0	0	0	0	267	0	0	0	0	0	0
March															
Heptageniidae	*Cinygmula*	11	0	0	0	111	0	0	0	0	11	0	0	0	0
Baetidae	*Baetis*	0	0	0	0	11	0	0	0	0	0	0	0	0	0
Hydroptilidae	*Ochrotrichia*	0	0	0	0	22	0	0	0	0	0	0	0	0	0
Chironomidae	*Ablabesmyia*	11	0	0	0	0	0	0	0	0	0	0	0	0	0

Table-8.5 Macroinvertebrates of Riyang Khola

Family	Taxa	May	June	July	Aug.	Sept.	Oct.	Nov	Dec.	Jan	Feb	Mar
Heptageniidae	*Cinygmula*	33	0	0	11	78	144	33	189	22	22	111
	Cinygma	0	0	0	0	0	0	0	0	0	44	178
Ephemerellidae	*Ephemerella excrucians*	33	0	0	11	0	78	0	33	0	22	222
Baetidae	*Baetis*	11	56	0	0	56	67	311	78	44	0	22
Leptophlebiidae	*Leptophlebia*	67	0	0	0	0	0	11	0	33	289	167
Caenidae	*Caenis latipennis*	11	0	0	0	22	11	33	56	11	33	56
	Other	0	0	0	0	0	0	0	11	0	0	0
Coenagrionidae	*Enallagma*	0	0	0	0	0	22	33	0	0	0	11
Perlidae	*Neoperla*	0	0	11	0	0	11	0	0	0		
Psephenidae	*Psephenus herricki*	311	0	0	0	0	11	11	0	33	533	111
	Other	0	0	0	0	0	0	0	0	0	11	0
Hydroptilidae	*Hydroptila*	0	0	0	0	0	0	0	0	0		
	Ochrotrichia	11	0	0	0	0	0	22	0	144	122	133
Hydropsychidae	*Hydropsyche*	78	0	0	11	0	89	0	56	0	44	156
Glossosomatidae	*Glossosoma*	33	0	0	0	0	33	0	33	22	33	11
Chironomidae	*Ablabesmyia*	111	0	0	33	11	11	56	33	256	767	233

Family	Taxa	May	June	July	Aug.	Sept.	Oct.	Nov	Dec.	Jan	Feb	Mar
	Chironomus	0	0	0	0	0	0	0	0	0	0	56
Tipulidae	*Antocha saxicola*	33	0	0	0	11	0	0	22	0	33	44
Simuliidae	*Simulium pictipes*	0	0	0	0	0	11	0	22	0	0	0
Blephariceridae	*Horaia*	0	0	0	0	0	0	0	11	0	0	0
Ceratopogonidae	*Culicoides variipennis*	0	0	0	0	0	0	0	0	11	0	44
Tabanidae	*Tabanus*	0	22	0	0	0	11	0	22	0	0	0
Limnocharidae	*Limnochares*	0	0	0	0	0	0	0	0	0	0	0
	Density (indiv./m^2)	**732**	**78**	**11**	**66**	**178**	**500**	**510**	**567**	**576**	**1953**	**1555**

8.5 AQUATIC ECOLOGY FOR RAMMAM SUB-BASIN

As a part of CEIA Report reparation, sampling of aquatic ecology was done in the winter (January 2006), summer (April 2006) and post-monsoon (October 2006) seasons. The location covered are given as below

- Barrage/dam site
- Between barrage/dam and power house site
- Near Power house site

The findings of the aquatic ecological survey are summarized in the following parameters.

The list of phytoplanktons species observed at various sampling sites is given in Table-8.6.

Table-8.6:List of phytoplankton species observed in river Rammam at various sampling sites

Species	Class
Navicula sp.	Bacillariophyta
Neidium affinis	Bacillariophyta
Penium simplex	Chulorophyta
Pinnularia nobilis	Bacillariophyta
Stauroneis phoenicentron	Bacillariophyta
Ulothrix zonata	Chlorophyta
Oscillatoria tenuis	Myxophyceae

A total of 5 phytoplankton species were reported at the three sampling locations during winter and summer seasons. In post-monsoon season 7 phytoplankton species were reported at the three sampling locations. The density ranged from 8 to 18 no./litre during winter season, 24 to 31 no./litre during summer season and 9 to 40 no./litre during post-monsoon season which indicates very low phytoplankton density in the project area.

The density observed at various sampling locations ranged from 8 to 40 no./litre for the three seasons which is an indicator of low phytoplankton productivity. Since phytoplankton are first link in a food chain, the phytoplankton density is an indicator of low primary productivity of river water at the project site.

Zooplankton

The list of zooplankton species observed during the surveys conducted in summer, winter and post-monsoon is given in Table-8.7.

Table-8.7:Diversity of zooplankton in river Rammam at various sampling sites

Species	Class
Diffugia lebes	Rhizopoda
Diffugia sp.	Rhizopoda
Lecane signifera	Rotifera
Trichocera spp.	Rotifera
Daphnia spp.	Cladocera

A total of 5 zooplankton species were observed at various sampling sites covered as a part of field studies during survey conducted in winter, summer and post-monsoon seasons. The density ranged from 2 to 3 no./litre during winter season, summer season, the density ranged from 3 to 4 no./litre. Likewise in the post-monsoon season, the density ranged from 3 to 10 no./litre

Macro-Benthic Biota

The macro-benthic communities consists of invertebrate & vertebrates. Among the invertebrates insects contribute nearly 80% of the total biota. There are four orders of insects and certain families of benthic fish species whose representatives in some stage are found in water and that all of them are met with in greater or lesser numbers as clear and rapid flowing waters in project area. The insect reported in the areas belonged to Plecoptera, Ephimero-ptera, Trichoptera and Diptera.

During the survey of macro-benthic insects, nymphs of Trichoptera were commonly observed in rapid flowing streams. Among Plecoptera, nymphs of Isoperlidae (*Ietimes*) recorded from swift flowing streams. The nymphs of Ephemerid insects recorded belonged to *Heptogenidae Ephemerellidae Bactidae*. The most abundant were Ecohyonurus, Epeorus, Iron, Heptogenia and Rithrogena. The species recorded amongst Bactidae were represented by Bactinae (*Bactis*) and Ephemerellinae (*Ephemerella*). The larvae of *Diptera* which have been recorded belonged to *Clucidae* and *Chiromidae*.

The macro-benthic vertebrates recorded include *Acrossocheilus hexgonalepis* in pools; Schizothorax, Barilius living permanently in swift water and Garra, Naemacherilus, Glyptothorax and Pseudechneis living attached to substratum.

Aquatic macrophytes belonging to species namely *Equisetum* spp., *Adiantum* spp. and *Selanginella* spp. were recorded along the bank of river Rammam.

8.6 PHYTODIVERSITY ASPECTS

The study was carried out in Teesta river and its tributaries flowing in the hilly terrain of West Bengal. The sampling was conducted at 15 sites in Teesta, Rangit and Riyang Khola rivers. The sampling was carried out at a monthly interval at all sites from April 2014 to March 2015. Details of sampling sites are given in Table-8.8. The elevation of sampling sites covered as a part of the study ranged from 134 m to 281 m. The list of Filamentous algae recorded from Lower Teesta basin is given in Table-8.9. The List and Relative abundance of Phytobenthos (diatoms) in Teesta and Rangit rivers of West Bengal is given in Table-8.10.The Relative abundance of Phytobenthos (diatoms) in Riyang Khola, West Bengal is given in Table-8.11. The List and relative abundance of phytoplankton (Diatom) in Teesta and Rangit rivers in West

Bengal is given in Table-8.12. The relative abundance of phytoplankton (Diatom) in Riyang Khola, West Bengal is given in Table-8.13.

Table-8.8 : Details of sampling locations in in Teesta basin of West Bengal

Site	Coordinates Lat/Long	River	Elevation (m)	Description of sites
S1	$27^0$09'59"N $88^0$31'43"E	Teesta	281	Upstream of Powerhouse of Teesta Stage VI
S2	$27^0$07'55"N $88^0$30'05"E	Teesta	245	Proposed Powerhouse of Teesta Stage VI
S3	$27^0$07'12"N $88^0$28'31"E	Teesta	223	Upstream of Teesta Intermediate dam
S4	$27^0$05'42"N $88^0$27'42"E	Teesta	219	Downstream of Teesta Intermediate dam
S5	$27^0$07'13"N $88^0$19'10"E	Rangit	270	Upstream of Proposed Powerhouse of Jorethang Loop HEP
S6	$27^0$05'44"N $88^0$23'06"E	Rangit	227	Downstream powerhouse of Jorethang Loop HEP
S7	$27^0$05'23"N $88^0$24'10"E	Rangit	220	Upstream of Teesta Low Dam I & II
S8	$27^0$04'52"N $88^0$25'50"E	Rangit	209	Downstream of Teesta Low Dam I & II
S9	$27^0$02'59"N $88^0$25'36"E	Teesta	208	Upstream of Teesta Low Dam III
S10	$26^0$59'53"N $88^0$26'10"E	Teesta	188	Downstream of Teesta Low Dam III
S11	$26^0$56'10"N $88^0$27'05"E	Teesta	158	Upstream of Teesta Low Dam IV
S12	$26^0$55'16"N $88^0$27'41"E	Teesta	150	Downstream of Teesta Low Dam IV
S13	$26^0$53'19"N $88^0$28'28"E	Teesta	144	Teesta Low dam V
S14	$26^0$52'50"N $88^0$28'36"E	Teesta	134	Downstream of Teesta Low dam stage V (near Sevok)
S15	$26^0$59'36"N $88^0$25'42"E	Riyang	187	Riyang is a tributary of Teesta, joins on right bank downstream Teesta Low dam III

Table-8.9: List of Filamentous algae recorded from Lower Teesta basin

Family	Species	Plankton	Benthos
Cyanophyceae	*Aphanocapsa pulchra*	*	
Cyanophyceae	*Chlorogloea simplex*	*	*
Cyanophyceae	*Chroococcus* sp	*	
Cyanophyceae	*Gloeotrichia* sp.	*	
Cyanophyceae	*Lyngbya purpurea*	*	*
Cyanophyceae	*Merismopedia elegans*	*	
Cyanophyceae	Microcystis robusta	*	
Cyanophyceae	*Ocillatoria nigra*	*	*
Cyanophyceae	*Phormidium uncinatum*	*	*
Cyanophyceae	*Stigonema mamillosum*	*	

Family	**Species**	**Plankton**	**Benthos**
Cyanophyceae	*Stigonema* sp.	*	*
Chlorophyceae	*Chlorogonium* sp.	*	
Chlorophyceae	*Cladophora glomerata*	*	*
Chlorophyceae	*Closterium acerosum*	*	*
Chlorophyceae	*Cosmarium pseudogranatum*	*	*
Chlorophyceae	*Dictyospherim* sp.	*	
Chlorophyceae	Gonatozygon monotaenium	*	
Chlorophyceae	*Microspora* sp.	*	
Chlorophyceae	*Netrium digitus*	*	
Chlorophyceae	*Oedogonium* spp	*	*
Chlorophyceae	*Pediastrum* spp.	*	*
Chlorophyceae	*Rivularia* sp.	*	
Chlorophyceae	*Scenedesmus* sp.	*	
Chlorophyceae	*Spirogyra nitida*	*	*
Chlorophyceae	*Spirogyra rhizobrachialis*	*	
Chlorophyceae	*Spirotaenia* sp.	*	*
Chlorophyceae	*Staurastrum pachyrhynchum*	*	
Chlorophyceae	*Ulothrix zonata*	*	*
Chlorophyceae	*Zygnema*sp.	*	*
Dinophyceae	*Ceratium* sp.	*	*
Dinophyceae	*Glenodinium* spp.	*	*

Source: Primary survey

None of the species is endemic to Teesta basin and Threateend

Table-8.10: List and Relative abundance of Phytobenthos (diatoms) in Teesta and Rangit rivers of West Bengal

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
April														
Achnanthidium affinis	3.5	0.0	33.3	0.0	4.5	6.8	0.0	14.3	0.0	25.0	0.0	0.0	0.0	0.0
A. biasolettiana	0.0	0.0	0.0	14.3	4.5	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. conspicua	6.7	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. exigua	0.0	0.0	0.0	0.0	5.6	4.5	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. exilis	0.0	0.0	0.0	0.0	1.1	0.0	1.9	0.0	10.0	0.0	0.0	0.0	0.0	0.0
A. gibberula var. *genuina*	0.0	0.0	0.0	0.0	1.1	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. Grimmei	8.8	0.0	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. kryophila	0.0	0.0	33.3	0.0	0.0	2.3	1.9	0.0	0.0	50.0	0.0	0.0	0.0	0.0
A. linearis	0.0	20.0	0.0	0.0	14.0	11.3	11.7	7.1	0.0	0.0	0.0	0.0	0.0	50.0
A. lanceolata	5.1	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. lanceolata var. *elliptica*	0.0	0.0	0.0	0.0	5.6	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. minutissima	6.1	0.0	0.0	0.0	0.0	4.5	11.7	0.0	20.0	0.0	0.0	0.0	0.0	50.0
A. plonensis	0.0	0.0	0.0	14.3	4.5	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. subsalsa	0.0	0.0	0.0	0.0	1.1	1.1	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cocconeis placentula	6.1	0.0	0.0	0.0	0.0	2.3	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cocconeis placentula var. euglypta	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cymbella affinis	0.0	0.0	0.0	0.0	5.6	3.4	7.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. amphicephala	5.1	0.0	0.0	0.0	0.0	1.1	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0
C. oxyrhynchus	0.0	0.0	0.0	0.0	4.5	2.3	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. gracile	8.8	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. laevis	0.0	0.0	0.0	0.0	2.2	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cymbella sp.	0.0	0.0	0.0	0.0	0.0	1.1	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. nagpurensis	8.8	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. lata	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
C. turgida	3.5	0.0	0.0	0.0	0.0	2.3	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. ventricosa	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diatoma hiemale	0.0	0.0	0.0	0.0	0.0	2.8	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D. hiemale var. *mesodon*	0.0	30.0	33.3	0.0	5.6	1.1	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0
Fragilaria construens	0.0	0.0	0.0	0.0	0.0	2.3	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. intermedia	6.1	0.0	0.0	0.0	1.1	1.1	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. rumpens	0.0	0.0	0.0	0.0	2.2	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fragilaria sp.	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. vaucherae	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema gracile	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. intricatum	0.0	0.0	0.0	0.0	0.0	1.1	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. longiceps	3.5	0.0	0.0	0.0	2.2	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0
G. longiceps var. subclavata	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceum	5.2	0.0	0.0	0.0	5.6	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceoides	0.0	0.0	0.0	0.0	0.0	1.1	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. parvulum	6.1	0.0	0.0	57.1	0.0	1.1	1.9	14.3	10.0	0.0	0.0	0.0	50.0	0.0
G. sphaerophorum	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema sp.	0.0	30.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. tergestinum	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula cincta	3.5	0.0	0.0	0.0	2.2	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. cryptocephala	0.0	10.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. exigua	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. halophila	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. gracilis	3.5	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. radiosa	6.1	0.0	0.0	0.0	1.1	1.1	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. radiosa var. *tenella*	0.0	10.0	0.0	0.0	0.0	2.8	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
N. rhyncocephala	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula sp.	0.0	0.0	0.0	0.0	2.2	0.0	1.9	7.1	0.0	0.0	0.0	0.0	0.0	0.0
Nitzschia sp.	*3.5*	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pinnularia sp.	9.5	0.0	0.0	14.3	0.0	1.1	0.0	0.0	0.0	25.0	0.0	0.0	0.0	0.0
Planothidium lanceolata	0.0	0.0	0.0	0.0	1.1	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Synedra acus	3.5	0.0	0.0	0.0	2.2	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S. ulna	0.0	0.0	0.0	0.0	0.0	1.1	5.8	0.0	20.0	0.0	0.0	0.0	0.0	0.0
S. ulna var. *aequalis*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	50.0	0.0
S. ulna var. *amphirhynchus*	6.1	0.0	0.0	0.0	2.2	2.3	3.9	0.0	10.0	0.0	0.0	0.0	0.0	0.0
Total No of taxa	**21.0**	**5.0**	**3.0**	**4.0**	**31.0**	**39.0**	**28.0**	**23.0**	**7.0**	**3.0**	0.0	0.0	**2.0**	**2.0**
May														
Achnanthidium affinis	0.0	7.1	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	4.3	0.0	0.0	0.0
A. austriaca	0.0	3.6	0.0	0.0	0.0	0.0	0.0	2.7	0.0	0.0	4.3	0.0	0.0	0.0
A. conspicua	25.0	0.0	0.0	0.0	0.0	18.8	0.0	2.7	0.0	0.0	0.0	0.0	0.0	3.5
A. exilis	0.0	0.0	0.0	11.8	0.0	0.0	1.7	4.1	0.0	0.0	0.0	0.0	0.0	3.5
A. gibberula var. genuina	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0	0.0	0.0	3.5
A. lanceolata	0.0	0.0	0.0	17.7	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. lanceolata var. elliptica	0.0	0.0	0.0	0.0	0.0	12.5	0.0	2.7	0.0	0.0	0.0	0.0	0.0	3.5
A. linearis	0.0	17.9	0.0	11.8	0.0	0.0	12.8	0.0	0.0	0.0	8.5	0.0	0.0	8.6
A. minutissima	0.0	7.1	0.0	0.0	0.0	0.0	5.1	6.8	0.0	0.0	12.8	0.0	0.0	0.0
A. subsalsa	0.0	0.0	0.0	11.8	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Amphora delicatula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0
Amphora sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	5.2
Cocconeis placentula	0.0	3.6	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	4.3	0.0	0.0	0.0
Cymbella affinis	50.0	0.0	0.0	0.0	0.0	0.0	3.4	2.7	0.0	0.0	0.0	0.0	0.0	6.9
C. amphicephala	0.0	3.6	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	6.4	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
C. hebridica	0.0	0.0	0.0	0.0	0.0	12.5	0.0	2.7	0.0	0.0	0.0	0.0	0.0	3.5
C. laevis	0.0	3.6	0.0	0.0	0.0	0.0	3.4	4.1	0.0	0.0	8.5	0.0	0.0	0.0
C. nagpurensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	6.9
C. perpusila	0.0	0.0	0.0	0.0	8.3	0.0	2.6	0.0	0.0	0.0	6.4	0.0	0.0	0.0
C. ventricosa	0.0	7.1	0.0	0.0	0.0	0.0	0.0	5.4	0.0	0.0	0.0	0.0	0.0	1.7
Diatoma hiemale	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diatoma hiemale var. *mesodon*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	3.5
Fragilaria capucina	0.0	0.0	0.0	0.0	8.3	0.0	1.7	5.4	0.0	0.0	0.0	0.0	0.0	10.3
F. construens	25.0	0.0	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	4.3	0.0	0.0	0.0
F. intermedia	0.0	0.0	0.0	11.8	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	1.7
Fragilaria sp.	0.0	0.0	0.0	0.0	16.7	0.0	3.4	4.1	0.0	50.0	0.0	0.0	0.0	0.0
F. vaucherae	0.0	0.0	0.0	11.8	0.0	0.0	1.7	4.1	0.0	0.0	4.3	0.0	0.0	0.0
Gomphonema angustatum	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	3.5
G. gracile	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	2.1	0.0	0.0	0.0
G. intricatum var. *pumila*	0.0	3.6	0.0	0.0	0.0	0.0	0.0	5.4	0.0	0.0	0.0	0.0	0.0	0.0
G. intricatum var. *vibrio*	0.0	0.0	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	2.1	0.0	0.0	0.0
G. longiceps	0.0	0.0	0.0	0.0	8.3	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	5.2
G. olivaceoids	0.0	0.0	0.0	0.0	0.0	0.0	2.6	5.4	0.0	0.0	0.0	0.0	0.0	3.5
G. olivaceum	0.0	7.1	0.0	0.0	0.0	0.0	3.4	0.0	0.0	50.0	0.0	0.0	0.0	0.0
G. parvulum	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
Gomphonema sp.	0.0	0.0	0.0	17.7	0.0	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	3.5
G. sphaerophorum	0.0	0.0	0.0	5.9	0.0	0.0	0.0	6.8	0.0	0.0	8.5	0.0	0.0	0.0
Navicula construens	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	5.2
N. gracilis	0.0	0.0	0.0	0.0	0.0	12.5	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0
N. grimmei	0.0	0.0	0.0	0.0	0.0	25.0	0.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0
N. halophila	0.0	0.0	0.0	0.0	0.0	18.8	0.0	5.4	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
N. microcephala	0.0	0.0	0.0	0.0	16.7	0.0	1.7	5.4	0.0	0.0	0.0	0.0	0.0	3.5
N. radiosa	0.0	7.1	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	8.5	0.0	0.0	0.0
N. rhyncocephala	0.0	7.1	0.0	0.0	0.0	0.0	3.4	4.1	0.0	0.0	0.0	0.0	0.0	1.7
N. similis	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	6.9
Navicula sp.	0.0	0.0	0.0	0.0	8.3	0.0	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Planothidium lanceolata	0.0	7.1	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Synedra acus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	0.0	0.0	6.4	0.0	0.0	0.0
S. ulna	0.0	0.0	0.0	0.0	33.3	0.0	1.7	4.1	0.0	0.0	0.0	0.0	0.0	5.2
S. ulna var. *aequalis*	0.0	14.3	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	4.3	0.0	0.0	0.0
Total No of species	**3.0**	**14.0**	0.0	**8.0**	**7.0**	**6.0**	**32.0**	**26.0**	0.0	**2.0**	**17.0**	0.0	0.0	**22.0**
July														
Achnanthidium affinis	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	7.7	0.0	0.0
A. austriaca	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0
A. exilis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.5	0.0	0.0
A. gibberula var. *genuina*	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. lanceolata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	0.0	0.0	0.0
A. lanceolata var. *elliptica*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	3.9	0.0	0.0
A. linearis	0.0	0.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	7.7	0.0	0.0
A. minutissima	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.9	0.0	0.0	0.0
Amphora delicatula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0
Cocconeis placentula	0.0	0.0	7.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7	0.0	0.0
Cymbella affinis	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0
C. amphicephala	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7	0.0	0.0
C. hebridica	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. laevis	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. nagpurensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
C. perpusila	0.0	0.0	7.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0
C. ventricosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0
Diatoma hiemale	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0
Fragilaria capucina	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	0.0	0.0	0.0
F. construens	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. intermedia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7	0.0	0.0
Fragilaria sp.	0.0	0.0	7.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7	0.0	0.0
F. vaucherae	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema angustatum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0
G. gracile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0
G. intricatum var. *pumila*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0
G. intricatum var. *vibrio*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0
G. olivaceoids	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7	0.0	0.0
G. olivaceum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0
G. parvulum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0
Gomphonema sp.	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0
G. sphaerophorum	0.0	0.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5	0.0	0.0	0.0
Navicula halophila	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0
N. microcephala	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	0.0	0.0	0.0
N. radiosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0
N. rhyncocephala	0.0	0.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. similis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0
Navicula sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0
Planothidium lanceolata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0
Synedra acus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5	0.0	0.0	0.0
S. ulna	0.0	0.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
S. ulna var. *aequalis*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	3.9	0.0	0.0
Total No of taxa	**0.0**	**0.0**	**17.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**22.0**	**17.0**	**0.0**	**0.0**
August														
Achnanthidium biasolettiana	0.0	0.0	17.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cymbella ventricosa	0.0	0.0	17.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema lanceolatum	0.0	0.0	8.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula cryptocephala	0.0	0.0	8.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula rhynchocephala	0.0	0.0	21.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Surirella sp.	0.0	0.0	26.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total No of taxa	**0.0**	**0.0**	**6.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
September														
Achnanthidium affinis	6.3	0.0	9.6	0.0	0.0	8.9	0.0	0.0	0.0	5.3	0.0	3.2	0.0	0.0
A. *biasolettiana*	0.0	13.3	7.7	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. *exigua*	3.1	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	15.4	6.4	0.0	0.0
A. *fragilaroides*	3.1	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0
A. *lanceolata*	6.3	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	0.0	6.4	0.0	0.0
A. *linearis*	0.0	0.0	7.7	0.0	0.0	11.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. *microcephala*	0.0	33.3	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0
A. *minutissima*	6.3	0.0	0.0	0.0	0.0	0.0	0.0	57.1	0.0	0.0	0.0	0.0	0.0	0.0
Amphora sp.	3.1	0.0	0.0	0.0	0.0	8.9	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0
Cocconeis placentula	0.0	6.7	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0
C. *placentula* var. *euglypta*	6.3	0.0	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0
Cymbella affinis	0.0	0.0	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	0.0	0.0
C. amphicephala	3.1	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
C. nagpurensis	0.0	0.0	3.9	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0
C. ventricosa	3.1	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

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Diatoma hiemale	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D. hiemale var. *mesodon*	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
Eunotia sp.	0.0	0.0	1.9	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0
Fragilaria construens	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. vaucheriae	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0
Gomphonema angustatum	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
G. bohemicum	0.0	0.0	0.0	0.0	0.0	8.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. gracile	0.0	0.0	7.7	0.0	0.0	0.0	0.0	28.6	0.0	0.0	0.0	6.4	0.0	0.0
G. intricatum	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0
G. lanceolata	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	9.5	0.0	0.0
G. lanceolatum	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
G. nagpurensis	0.0	0.0	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0
G. olivaceoides	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	7.9	0.0	0.0
G. olivaceum	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
G. parvulum	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.8	0.0	0.0	0.0
G. sphaerophorum	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
Gomphonema sp.	0.0	0.0	0.0	0.0	0.0	8.9	0.0	0.0	0.0	0.0	0.0	6.4	0.0	0.0
Gyrosigma sp.	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0	0.0	0.0
Hannaea arcus	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.2	0.0	0.0	0.0	0.0
Hanztschia amphioxys	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.0	7.7	3.2	0.0	0.0
Hanztschia sp.	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0
Melosira varians	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0
Navicula cryptocephala	0.0	0.0	0.0	0.0	28.6	0.0	0.0	0.0	0.0	10.5	0.0	0.0	0.0	0.0
Navicula halophila	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0
Navicula linearis	3.1	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0
Navicula radiosa	0.0	0.0	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.4	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Navicula rhynchocephala	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.2	0.0	0.0	0.0	0.0
Navicula sp.	0.0	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	0.0	6.4	0.0	0.0
Nitzschia thermalis	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	15.4	0.0	0.0	0.0
Reimeria sinuata	0.0	0.0	7.7	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	7.9	0.0	0.0
Surirella sp.	3.1	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0
Synedra ulna	0.0	26.7	7.7	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	6.4	0.0	0.0
Synedra sp.	6.3	20.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	15.4	0.0	0.0	0.0
Total No of taxa	**19.0**	**5.0**	**18.0**	**0.0**	**8.0**	**19.0**	**0.0**	**3.0**	**0.0**	**14.0**	**5.0**	**21.0**	**0.0**	**0.0**
October														
Achnanthidium affinis	2.6	0.8	6.8	1.7	4.3	2.6	7.5	2.0	0.5	4.7	2.8	14.0	4.2	9.6
A. *biasolettiana*	2.6	0.0	0.0	5.0	0.0	0.0	0.0	10.3	0.0	5.1	0.0	9.3	0.0	19.6
A. *exigua*	0.9	0.0	0.9	0.0	7.9	0.0	8.3	1.1	18.0	6.8	0.0	0.0	0.8	0.0
A. *fragilaroides*	5.1	2.0	11.3	0.0	0.0	4.7	0.0	4.0	0.0	8.9	4.4	5.1	0.0	7.0
A. *lanceolata*	0.0	0.0	0.0	7.5	0.0	0.0	3.3	4.3	0.5	0.4	7.2	0.0	0.8	19.6
A. *linearis*	0.9	2.8	9.6	0.0	0.4	0.5	9.2	8.0	0.0	0.0	11.2	10.2	0.0	0.0
A. *minutissima*	0.0	9.6	11.0	0.8	9.3	0.0	0.0	2.9	0.0	6.4	0.0	31.6	4.2	1.7
A. minutissima var. *inconspicua*	9.8	0.0	17.0	0.0	0.0	14.7	10.0	0.0	0.0	0.0	18.4	0.2	0.0	0.0
A. saccula	0.9	2.0	0.6	7.5	2.5	0.0	3.3	2.6	0.0	0.0	7.6	0.0	0.8	2.2
A. undata	0.0	0.0	6.5	0.0	0.0	1.9	0.0	4.0	0.0	2.6	0.0	0.0	5.8	0.0
Amphora sp.	0.9	0.0	0.9	0.8	12.5	0.0	0.0	0.0	6.5	0.0	0.0	0.0	0.0	0.0
Cocconeis placentula	0.9	10.4	0.6	0.0	0.0	1.9	4.2	2.3	0.0	7.7	4.4	0.9	5.0	0.0
C. *placentula* var. *euglypta*	7.2	0.0	7.6	4.2	0.0	0.0	0.0	2.0	0.5	0.0	0.0	0.0	0.0	3.5
Cymbella affinis	4.7	2.4	0.3	1.7	9.6	1.6	1.7	0.9	0.0	3.8	2.0	0.0	0.8	0.0
C. amphicephala	0.0	0.0	4.5	0.0	0.0	0.0	0.0	3.1	0.0	1.3	0.0	13.6	0.0	6.5
C. excisiformis	3.0	0.8	0.6	2.5	0.7	12.6	0.0	0.6	0.5	0.4	0.0	0.0	0.8	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
C. exigua	0.0	0.0	0.6	0.0	0.0	0.0	7.5	0.0	0.0	0.0	3.2	1.1	0.0	0.0
C. gracile	0.0	0.0	0.0	4.2	2.1	1.9	0.0	4.3	0.5	0.4	0.0	0.0	4.2	0.4
C. hanztschiana	0.4	1.6	0.6	0.0	0.0	0.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. hungarica	0.0	0.0	0.0	0.0	0.0	3.5	0.0	1.4	0.0	2.1	0.0	0.4	4.2	0.0
C. Hustedii	2.1	2.0	0.0	0.8	1.8	7.7	5.8	0.0	2.0	0.0	2.0	0.0	0.0	5.7
C. nagpurensis	0.0	0.0	1.1	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0
C. ventricosa	2.1	3.2	0.0	0.0	0.0	4.7	0.0	0.0	0.0	3.4	0.0	0.0	9.2	0.0
Diatoma hiemale	0.0	0.0	3.7	4.2	0.0	0.0	0.8	1.1	0.0	0.0	0.0	0.0	0.0	0.4
D. hiemale var. *mesodon*	2.1	0.0	0.0	0.0	1.4	0.5	0.0	3.7	0.0	3.0	2.8	0.4	0.0	0.4
Eunotia sp.	0.9	3.2	0.3	0.0	0.7	0.0	0.0	2.3	0.0	0.4	0.0	0.0	1.7	0.0
Fragilaria construens	0.0	0.0	0.0	3.3	5.0	0.0	0.0	0.0	0.0	4.7	2.4	0.0	0.0	1.7
F. vaucheriae	0.4	2.0	0.6	0.0	0.0	0.0	0.0	1.1	6.0	0.0	0.0	0.0	0.0	0.0
Gomphonema angustatum	0.0	0.0	0.0	0.0	0.4	6.5	0.0	3.7	0.0	5.1	0.0	0.0	5.0	0.0
G. bohemicum	3.4	0.4	0.0	3.3	0.0	0.0	0.0	0.3	0.5	0.0	17.6	0.9	0.0	2.2
G. gracile	0.0	0.0	0.0	0.0	9.3	0.0	0.0	0.0	6.5	0.9	2.0	0.0	0.0	0.0
G. intricatum	0.0	2.0	0.0	0.0	0.0	0.0	6.7	4.0	0.0	0.0	0.0	0.0	5.8	0.0
G. lanceolata	2.1	0.0	0.0	0.0	0.4	9.6	0.0	0.0	1.0	6.4	0.0	0.9	0.0	1.7
G. lanceolatum	0.0	1.6	1.1	0.0	0.0	0.0	4.2	2.6	0.0	0.0	0.0	0.0	0.0	1.7
G. nagpurensis	0.0	0.0	0.0	1.7	0.4	1.2	0.0	4.9	0.0	6.4	2.8	0.0	1.7	0.0
G. olivaceoides	1.7	4.0	0.0	0.0	5.4	0.2	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0
G. olivaceum	0.0	0.0	0.6	13.3	0.0	1.4	0.0	0.0	3.5	0.4	1.6	0.0	0.0	2.2
G. parvulum	11.9	19.2	0.3	0.0	3.9	1.6	1.7	2.6	0.0	0.0	0.0	0.0	22.5	0.0
G. sphaerophorum	0.0	0.0	0.0	3.3	0.0	1.2	0.0	0.9	0.0	0.9	0.0	0.0	0.0	0.0
Gomphonema sp.	14.5	1.6	0.6	0.0	2.1	0.0	0.0	0.0	6.5	0.0	0.0	0.2	0.0	0.9

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Gyrosigma sp.	2.1	0.0	0.0	0.0	0.0	8.2	1.7	0.0	7.5	2.6	0.0	0.0	3.3	0.0
Hannaea arcus	0.0	1.6	0.6	3.3	1.8	0.0	0.0	3.4	0.0	3.0	0.4	0.0	0.0	4.8
Hanztschia amphioxys	3.4	0.0	0.0	0.8	0.0	0.7	0.0	0.3	0.5	0.0	0.0	0.2	0.0	1.3
Melosira varians	0.0	4.4	0.0	3.3	1.8	0.0	5.8	2.3	18.5	0.4	0.8	0.0	0.0	0.0
Navicula cryptocephala	0.4	0.0	1.7	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0
N. halophila	0.0	4.8	0.0	0.0	6.4	0.0	0.0	5.4	0.5	2.1	1.6	0.2	1.7	0.4
N. radiosa	0.4	10.4	6.2	1.7	0.4	0.0	4.2	1.7	1.0	3.0	0.0	0.4	0.0	0.0
N. rhynchocephala	3.0	0.0	0.0	3.3	4.3	0.7	0.0	0.3	12.0	0.0	4.4	4.9	15.0	0.9
Nitzschia thermalis	0.4	3.6	0.3	0.0	0.0	0.5	5.0	0.0	0.0	2.1	0.0	0.0	0.0	0.4
Planothidium lanceolata	8.9	0.0	0.0	12.5	0.0	3.5	0.0	1.7	6.5	0.0	0.0	3.6	0.0	0.0
Reimeria sinuata	0.0	3.2	0.0	9.2	0.7	0.0	0.0	0.0	0.0	1.3	0.0	0.2	2.5	3.0
Surirella sp.	0.4	0.0	4.0	0.0	3.9	2.1	1.7	0.6	0.5	0.0	0.0	0.0	0.0	0.0
Synedra sp.	0.0	0.4	0.0	0.0	0.7	0.0	0.0	0.9	0.0	3.4	0.0	0.4	0.0	2.2
Total No of Taxa	**31.0**	**24.0**	**28.0**	**24.0**	**28.0**	**27.0**	**20.0**	**36.0**	**22.0**	**31.0**	**21.0**	**21.0**	**21.0**	**24.0**
November														
Achnanthidium affinis	5.0	0.0	5.1	0.0	4.3	3.7	4.1	3.9	0.4	6.1	0.0	7.4	0.0	7.1
A. *biasolettiana*	13.9	0.0	0.0	4.3	0.0	0.0	0.0	6.2	0.0	8.7	1.0	0.0	0.0	21.4
A. *exigua*	0.7	1.6	0.9	0.0	7.2	0.0	7.3	0.0	8.1	11.2	2.0	0.0	0.0	3.6
A. *fragilaroides*	5.3	0.0	8.4	0.0	0.0	8.9	0.0	1.9	0.0	0.0	3.0	2.9	0.0	7.1
A. *lanceolata*	0.7	0.0	0.9	13.0	0.0	0.0	3.6	5.4	0.0	10.6	4.0	0.0	0.0	14.3
A. *linearis*	0.0	2.5	14.5	0.0	0.0	0.0	8.4	3.2	3.3	0.0	5.0	0.0	0.0	0.0
A. *microcephala*	2.3	0.0	0.0	0.0	0.0	2.5	0.4	4.5	0.0	0.0	6.0	0.0	10.9	0.0
A. *minutissima*	0.0	17.2	12.6	0.4	6.7	0.0	0.0	3.7	0.7	5.1	7.0	23.5	18.8	0.0
A. minutissima var. *inconspicua*	0.3	0.0	18.2	0.0	0.0	15.6	6.7	0.0	0.0	0.0	8.0	20.6	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
A. saccula	0.0	1.6	0.5	7.6	0.0	0.0	0.0	1.9	0.0	1.6	9.0	0.0	10.1	0.0
A. undata	3.0	0.0	0.0	0.0	0.0	1.5	0.0	4.7	0.0	1.9	10.0	0.0	0.0	0.0
Amphora sp.	0.0	0.0	0.0	0.0	10.6	0.0	0.0	0.0	10.8	0.0	11.0	0.0	2.9	0.0
Cocconeis placentula	1.7	21.3	3.3	0.0	0.0	0.3	0.0	4.7	0.0	0.3	12.0	0.0	0.0	3.6
C. *placentula* var. euglypta	10.9	0.0	3.7	0.4	0.0	0.3	0.9	5.0	2.9	0.0	13.0	0.0	0.0	0.0
Cymbella affinis	0.0	0.0	0.0	0.0	17.3	2.2	0.0	1.1	0.0	2.9	14.0	0.0	0.0	0.0
C. amphicephala	0.0	1.6	5.1	0.0	0.0	2.8	0.4	1.7	0.2	0.0	15.0	0.0	0.0	14.3
C. gracile	1.0	0.0	0.0	1.8	0.0	0.0	0.0	1.1	2.4	1.6	16.0	0.0	0.0	0.0
C. hanztschiana	0.0	0.0	0.0	0.0	0.0	0.0	8.1	0.0	0.0	0.0	17.0	0.0	3.6	0.0
C. hungarica	1.3	6.6	4.7	0.0	0.0	4.6	0.4	0.0	0.0	0.6	18.0	0.0	0.0	3.6
C. Hustedii	0.0	0.0	0.0	0.0	0.0	11.7	0.0	1.1	0.4	0.0	19.0	7.4	0.0	0.0
C. nagpurensis	0.0	2.5	5.6	0.7	0.0	0.3	4.7	0.0	0.0	0.3	20.0	0.0	0.7	0.0
C. ventricosa	1.7	0.0	0.0	0.0	3.9	5.8	0.0	1.1	0.0	1.9	21.0	0.0	0.7	0.0
Diatoma hiemale	0.0	0.0	4.2	0.0	2.4	0.0	0.0	2.2	3.3	0.0	22.0	0.0	0.0	0.0
var. *mesodon*	0.0	4.1	0.0	0.0	0.0	0.0	3.9	1.1	0.0	2.6	23.0	0.0	0.0	0.0
Eunotia sp.	1.3	0.0	3.7	3.2	4.3	0.6	0.0	3.7	0.2	0.0	24.0	11.8	0.0	0.0
Fragilaria construens	0.0	0.0	0.0	0.0	2.4	0.0	3.9	0.0	0.0	2.9	25.0	0.0	0.7	0.0
F. vaucheriae	0.0	4.1	2.8	0.0	5.3	0.0	0.0	0.0	0.2	0.0	26.0	0.0	0.0	0.0
Gomphonema angustatum	0.0	0.0	0.0	2.5	1.0	2.5	1.7	0.0	4.8	6.7	27.0	0.0	0.0	0.0
G. bohemicum	0.3	0.0	0.0	1.4	0.0	0.0	0.0	5.4	0.0	0.0	28.0	13.2	0.0	0.0
G. gracile	0.0	4.9	1.9	0.4	6.7	0.0	0.2	0.0	6.8	0.6	29.0	0.0	0.0	0.0
G. lanceolata	0.0	0.0	0.0	0.0	0.0	10.1	2.3	0.0	1.1	8.3	30.0	0.0	1.5	0.0
G. lanceolatum	3.6	0.0	0.0	9.0	3.9	0.0	0.0	6.0	1.3	0.0	31.0	2.9	0.0	0.0
G. olivaceoides	0.0	0.8	0.0	0.0	2.4	0.6	0.4	0.0	0.0	0.0	32.0	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
G. olivaceum	0.0	0.0	0.0	9.7	4.3	0.0	0.0	0.0	0.0	5.8	33.0	0.0	13.0	3.6
G. parvulum	2.7	13.9	0.5	0.0	0.5	0.0	11.1	4.5	1.1	0.0	34.0	0.0	14.5	0.0
G. sphaerophorum	0.0	0.0	0.0	0.4	0.0	2.2	0.0	3.9	0.0	1.6	35.0	0.0	2.2	0.0
Gomphonema sp.	14.6	9.8	0.0	1.4	0.0	0.0	0.4	0.0	8.6	0.0	36.0	2.9	0.0	0.0
Gyrosigma sp.	2.7	0.0	0.5	0.0	0.5	0.0	0.0	1.1	7.9	0.0	37.0	0.0	8.0	0.0
Hannaea arcus	0.0	0.0	0.0	8.3	0.0	0.0	2.1	1.3	1.1	4.8	38.0	0.0	0.0	0.0
Hanztschia amphioxys	2.0	1.6	0.0	0.4	2.4	1.8	0.0	1.5	1.5	0.0	39.0	0.0	0.7	0.0
Melosira varians	0.0	0.0	0.9	4.0	0.0	0.0	1.5	2.6	5.0	0.0	40.0	0.0	0.0	0.0
Navicula cryptocephala	0.0	0.0	0.0	0.0	5.8	0.0	0.0	0.9	6.8	0.0	41.0	2.9	8.0	0.0
N. halophila	4.0	0.0	0.0	4.3	0.0	1.2	2.1	0.7	0.0	0.6	42.0	0.0	0.0	0.0
N. linearis	0.0	1.6	0.5	0.0	2.4	0.3	0.0	1.7	2.4	0.0	43.0	0.0	0.0	7.1
N. radiosa	0.0	0.0	0.0	0.7	0.0	1.2	0.0	6.2	0.0	3.5	44.0	1.5	0.0	0.0
N. rhynchocephala	4.6	0.0	0.0	4.0	4.3	0.0	2.8	0.0	15.8	0.0	45.0	0.0	2.2	0.0
Navicula sp.	0.0	0.8	0.5	1.4	0.0	18.7	0.0	0.4	0.0	1.9	46.0	0.0	0.0	0.0
Nitzschia thermalis	0.0	0.0	0.0	0.0	0.5	0.0	0.0	2.8	0.0	0.0	47.0	1.5	0.0	7.1
Planothidium lanceolata	15.9	0.0	0.0	11.9	0.0	0.6	3.4	0.0	2.9	0.0	48.0	1.5	0.0	0.0
Reimeria sinuata	0.0	3.3	0.5	7.6	1.0	0.0	0.0	0.0	0.0	5.8	49.0	0.0	1.5	3.6
Synedra sp.	0.7	0.0	0.5	1.4	0.0	0.0	0.4	3.0	0.0	1.9	50.0	0.0	0.0	3.6
No of Taxa	**23.0**	**18.0**	**24.0**	**25.0**	**22.0**	**23.0**	**21.0**	**26.0**	**24.0**	**24.0**	**50.0**	**12.0**	**14.0**	**13.0**
December														
Achnanthidium affinis	5.1	0.0	9.1	0.0	4.4	0.0	9.1	7.0	0.0	9.0	0.0	0.0	0.0	7.9
A. *biasolettiana*	35.9	0.0	0.0	20.0	0.0	0.0	0.0	9.1	0.0	17.9	0.0	0.0	0.0	21.1
A. *exigua*	0.0	0.0	0.0	0.0	8.7	0.0	12.1	0.0	18.8	6.0	0.0	0.0	0.0	0.0
A. *fragilaroides*	5.1	0.0	13.6	0.0	0.0	5.9	0.0	2.8	0.0	0.0	35.7	0.0	0.0	5.3

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
A. *lanceolata*	0.0	0.0	0.0	20.0	0.0	0.0	6.1	4.2	0.0	7.5	0.0	0.0	0.0	26.3
A. *linearis*	0.0	0.0	18.2	0.0	0.0	0.0	15.2	5.6	0.0	0.0	0.0	0.0	0.0	0.0
A. *microcephala*	2.6	0.0	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0	0.0	0.0	66.7	0.0
A. *minutissima*	0.0	33.3	13.6	0.0	8.7	0.0	0.0	8.4	0.0	6.0	0.0	###	0.0	0.0
A. minutissima var. *inconspicua*	0.0	0.0	18.2	0.0	0.0	17.7	12.1	0.0	0.0	0.0	21.4	0.0	0.0	0.0
A. saccula	0.0	0.0	0.0	10.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0
A. undata	2.6	0.0	9.1	0.0	0.0	0.0	0.0	4.2	0.0	1.5	0.0	0.0	0.0	0.0
Amphora sp.	0.0	0.0	0.0	0.0	13.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	0.0
Cocconeis placentula	0.0	16.7	0.0	0.0	0.0	0.0	0.0	1.4	0.0	6.0	0.0	0.0	0.0	0.0
C. *placentula* var. *euglypta*	7.7	0.0	9.1	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0
Cymbella affinis	0.0	0.0	0.0	0.0	17.4	0.0	0.0	3.5	0.0	3.0	0.0	0.0	0.0	0.0
C. amphicephala	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	7.9
C. excisa var. *procera*	0.0	0.0	0.0	0.0	0.0	0.0	9.1	0.0	0.0	0.0	28.6	0.0	0.0	0.0
C. excisiformis	2.6	0.0	0.0	0.0	0.0	17.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. exigua	0.0	0.0	0.0	0.0	0.0	0.0	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. gracile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0
C. hanztschiana	0.0	0.0	0.0	0.0	0.0	0.0	12.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. hungarica	0.0	0.0	0.0	0.0	0.0	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. Hustedii	0.0	0.0	0.0	0.0	0.0	11.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. nagpurensis	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. ventricosa	0.0	0.0	0.0	0.0	0.0	5.9	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0
Diatoma hiemale	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D. hiemale var. *mesodon*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	1.5	0.0	0.0	0.0	0.0
Eunotia sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Fragilaria construens	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0
F. vaucheriae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	0.0
Gomphonema angustatum	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	7.5	0.0	0.0	0.0	0.0
G. bohemicum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	14.3	0.0	0.0	0.0
G. gracile	0.0	0.0	0.0	0.0	13.0	0.0	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0
G. intricatum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0
G. lanceolata	0.0	0.0	0.0	0.0	0.0	11.8	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0
G. lanceolatum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0
G. nagpurensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceoides	0.0	0.0	0.0	0.0	13.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceum	0.0	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0
G. parvulum	0.0	50.0	0.0	0.0	4.4	0.0	6.1	3.5	0.0	0.0	0.0	0.0	33.3	0.0
G. sphaerophorum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	1.5	0.0	0.0	0.0	0.0
Gomphonema sp.	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0
Gyrosigma sp.	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	0.0
Hannaea arcus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	4.5	0.0	0.0	0.0	10.5
Hanztschia amphioxys	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0
Hanztschia sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0
Melosira varians	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	18.8	0.0	0.0	0.0	0.0	0.0
Navicula cryptocephala	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0
N. halophila	0.0	0.0	0.0	0.0	8.7	0.0	0.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0
N. linearis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0
N. radiosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0
N. rhynchocephala	2.6	0.0	0.0	0.0	4.4	0.0	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Navicula sp.	0.0	0.0	0.0	0.0	0.0	23.5	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0
Nitzschia thermalis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	5.3
Planothidium lanceolata	23.1	0.0	0.0	20.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	0.0
Reimeria sinuata	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	13.2
Surirella sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0
Synedra sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	3.0	0.0	0.0	0.0	2.6
Total No of Taxa	**11.0**	**3.0**	**6.0**	**6.0**	**8.0**	**8.0**	**4.0**	**30.0**	**9.0**	**19.0**	**4.0**	**1.0**	**2.0**	**7.0**
January														
Achnanthes affinis	2.3	9.2	9.1	0.0	10.0	2.2	0.0	5.3	0.0	4.3	0.0	0.0	24.1	0.0
A. biasolettiana	15.8	15.3	0.0	0.0	0.0	13.0	10.0	0.0	20.8	0.0	0.0	0.0	6.9	11.1
A. conspicua	0.0	1.5	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0
A. Hauckiana	9.0	0.0	11.4	0.0	0.0	3.3	0.0	13.2	0.0	8.5	0.0	0.0	0.0	27.8
A. lanceolata	0.0	4.6	0.0	0.0	13.3	0.0	4.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0
A. lanceolata var. *lanceolata*	9.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	10.6	0.0	0.0	10.3	0.0
A. linearis	0.0	11.5	6.8	0.0	0.0	5.4	0.0	7.9	0.0	0.0	0.0	0.0	0.0	22.2
A. micoscopica	7.5	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.1	0.0	0.0
A. minutissima	13.5	0.0	0.0	0.0	16.7	5.4	0.0	0.0	0.0	12.8	0.0	0.0	0.0	0.0
Amphora veneta	0.0	0.0	4.6	10.7	0.0	0.0	0.0	13.2	0.0	0.0	0.0	0.0	24.1	0.0
Anomoneis sp.	0.8	0.0	0.0	0.0	0.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cocconeis placentula	3.0	0.0	0.0	0.0	6.7	0.0	4.0	0.0	16.7	0.0	0.0	0.0	0.0	11.1
C. placentula var. *euglypta*	1.5	0.0	9.1	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0
C. placentula var. *linearis*	1.5	0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0
Cymbella affinis	0.0	1.5	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0
C. amphicephala	0.0	0.0	2.3	0.0	0.0	5.4	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
C. excisa	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	6.4	0.0	0.0	0.0	0.0
C. exigua	0.0	3.1	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. gracile	0.0	0.0	0.0	0.0	0.0	3.3	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. hungarica	0.0	2.3	0.0	3.6	0.0	0.0	0.0	0.0	0.0	8.5	0.0	0.0	0.0	0.0
C. Hustedii	1.5	0.0	4.6	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.1
C. kolbei	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0
C. kolbei var. *angusta*	0.0	0.0	0.0	0.0	0.0	2.2	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. laevis	0.8	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. lata	0.0	0.8	6.8	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0
C. perpusila	0.0	2.3	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. pusila	1.5	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cymbella sp.	0.0	0.8	4.6	0.0	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0
C. superparva	0.0	1.5	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. tumida	0.8	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0
C. turgidula	0.0	1.5	6.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. ventricosa	0.0	0.8	0.0	0.0	0.0	0.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cymbells affinis	3.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0
Diatoma hiemale	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6
Diatoma sp.	0.8	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0
Epithema sp.	0.0	0.0	0.0	0.0	0.0	1.1	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eunotia arcus	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.0
Fragilaria sp.	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. vaucheriae	0.0	1.5	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geissleria accetata	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Gomphonema affine var. *affine*	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0
G. angustatum	5.3	0.0	0.0	7.1	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. bohemicum	0.0	1.5	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. bohemicum ssp. Angustiminus	1.5	0.0	0.0	0.0	6.7	0.0	0.0	0.0	20.8	0.0	0.0	0.0	0.0	0.0
G. bohemicum ssp. Bohemicum	0.0	3.1	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. eriguga	2.3	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6
G. gracile	1.5	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. insigniforme	0.0	1.5	4.6	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0
G. intricatum	4.5	0.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. lanceolata	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. micropus var. micropus	1.5	0.0	0.0	0.0	0.0	2.2	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceoides	0.0	0.0	0.0	0.0	0.0	4.4	6.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6
G. olivaceum	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0
G. parvulum	6.0	0.0	0.0	0.0	10.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0
G. pseudobohemicum	0.0	0.0	0.0	0.0	0.0	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. sphaerophorum	1.5	0.0	0.0	3.6	0.0	0.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. sphenovertex	0.0	3.1	0.0	0.0	0.0	0.0	0.0	7.9	0.0	0.0	0.0	0.0	0.0	0.0
Hannaea arcus	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0
H. arcus var. *amphioxys*	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0
Navicula cincta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0
N. cryptocephala	0.0	0.0	0.0	10.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. cryptotenella	0.0	3.1	0.0	0.0	0.0	0.0	0.0	7.9	0.0	0.0	0.0	0.0	13.8	0.0
N. cryptotenelloides	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. dicephala	0.0	2.3	0.0	0.0	0.0	0.0	8.0	0.0	0.0	0.0	0.0	15.8	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
N. grimmei	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. leptostriata	0.0	1.5	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0
N. microcari	0.0	0.0	0.0	0.0	0.0	2.2	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. microdigitoradiata	0.0	1.5	0.0	3.6	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0
N. radiosa	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	0.0	6.9	0.0
N. rhyncocephala	0.0	3.1	0.0	0.0	6.7	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0
N. salinicola	2.3	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0
Navicula sp.	0.0	0.0	0.0	0.0	0.0	2.2	4.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0
Nitzschia linearis	0.0	0.8	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitzschia sp.	0.8	0.0	2.3	7.1	0.0	0.0	0.0	7.9	0.0	6.4	0.0	0.0	0.0	0.0
Pinnularia sp.	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0
Planothidium lanceolata	0.0	2.3	6.8	17.9	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0
Reimeria sinuata	0.0	3.1	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Surirella sp.	0.8	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	2.1	0.0	0.0	6.9	0.0
Synedra sp.	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0
Total No of Taxa	**22.0**	**29.0**	**16.0**	**12.0**	**11.0**	**22.0**	**20.0**	**13.0**	**5.0**	**16.0**	**0.0**	**5.0**	**8.0**	
February, 2015														
Achnanthes affinis	5.2	6.8	9.7	12.0	7.1	14.4	4.6	0.0	25.9	4.3	0.0	0.0	6.1	12.0
A. biasolettiana	1.0	3.2	5.4	9.6	0.0	5.9	2.3	0.0	7.4	0.0	0.0	0.0	2.4	0.0
A. grischuma	3.5	0.0	4.9	0.0	13.3	0.0	0.0	13.0	0.0	5.7	0.0	0.0	0.0	8.0
A. Hauckiana	0.0	4.0	0.0	10.8	0.0	4.2	4.6	0.0	0.0	4.3	0.0	0.0	0.0	0.0
A. holsatica	0.8	0.0	4.3	0.0	0.0	2.5	0.0	8.7	0.0	0.0	0.0	0.0	0.0	10.0
A. lanceolata	4.5	1.2	0.0	0.0	0.0	0.0	6.8	0.0	7.4	0.0	0.0	0.0	3.7	0.0
A. lanceolata var. lanceolata	3.5	0.0	2.7	0.0	9.7	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	6.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
A. lemmarmanii	0.8	2.0	0.0	8.4	0.0	0.0	0.0	8.7	0.0	5.7	0.0	0.0	0.0	0.0
A. linearis	3.0	0.0	1.6	0.0	21.2	0.0	2.3	0.0	11.1	0.0	0.0	0.0	0.0	10.0
Achnanthidium affine	2.7	2.0	0.0	7.2	12.4	0.0	0.0	13.0	0.0	4.3	43.8	14.3	0.0	0.0
A. arcus	0.0	2.8	0.5	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. minutissimum	2.5	0.0	1.6	0.0	0.0	6.8	0.0	4.4	0.0	5.7	0.0	28.6	0.0	0.0
A. pyrenaicum	0.0	2.0	0.0	3.6	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0	6.0
A. subsalsum	3.0	1.6	0.0	0.0	0.0	8.5	0.0	0.0	3.7	0.0	12.5	0.0	0.0	0.0
Anomoneis sp.	0.5	1.2	0.0	8.4	0.0	2.5	0.0	4.4	0.0	0.0	0.0	14.3	0.0	0.0
Cocconeis placentula	0.0	0.8	0.5	0.0	0.0	0.0	3.4	0.0	0.0	2.9	0.0	0.0	0.0	2.0
Cymbella affinis	3.0	0.4	0.0	0.0	2.7	0.0	0.0	8.7	0.0	0.0	0.0	0.0	1.2	0.0
C. amphicephala	0.0	1.2	1.6	0.0	0.0	4.2	0.0	0.0	11.1	0.0	0.0	0.0	0.0	4.0
C. excisa	2.0	0.4	0.0	1.8	0.0	0.0	2.3	0.0	0.0	4.3	0.0	21.4	0.0	0.0
C. exigua	1.3	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	2.4	0.0
C. gracile	0.0	2.0	4.3	0.0	0.0	1.7	0.0	0.0	3.7	0.0	0.0	7.1	0.0	0.0
C. hungarica	1.8	0.0	1.1	0.0	0.0	0.0	3.4	0.0	0.0	1.4	0.0	0.0	0.0	2.0
C. Hustedii	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	7.4	0.0	0.0	0.0	1.2	0.0
C. kolbei	2.2	3.2	2.2	0.0	0.0	0.0	3.4	0.0	0.0	2.9	0.0	0.0	0.0	0.0
C. kolbei var. *angusta*	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. ventricosa	0.5	0.0	1.6	0.0	4.4	0.0	2.3	0.0	0.0	1.4	0.0	0.0	0.0	0.0
C. hungarica	0.0	4.0	0.0	0.0	0.0	1.7	0.0	0.0	3.7	0.0	0.0	0.0	2.4	0.0
C. kolbei Hustedt	1.0	3.6	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0
C. laevis Nägeli	0.0	4.8	0.0	0.0	0.0	0.0	1.1	0.0	7.4	0.0	0.0	14.3	3.7	0.0
C. lancettula	1.5	0.8	3.8	0.0	0.0	0.9	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0
C. nagpurensis	0.0	2.4	0.0	1.2	0.0	0.0	0.0	8.7	0.0	0.0	0.0	0.0	0.0	4.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
C. parva Kirchner	0.8	0.0	0.0	0.0	0.0	0.9	2.3	0.0	11.1	0.0	0.0	0.0	1.2	0.0
C. perparva Krammer	0.0	0.0	1.1	0.0	0.0	0.0	0.0	4.4	0.0	2.9	0.0	0.0	0.0	0.0
Cymbells affinis	0.0	1.2	1.1	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Encyonema sp.	3.5	0.0	0.5	0.0	0.0	0.0	1.1	0.0	0.0	4.3	0.0	0.0	2.4	0.0
E. subminisculus	0.0	1.6	0.0	0.6	0.0	0.0	1.1	0.0	0.0	0.0	6.3	0.0	0.0	0.0
E. gracile Kirchner	3.2	0.0	0.0	0.0	3.5	1.7	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0
E. jemtlandicum var. *venezolana*	0.0	0.4	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	4.0
Fragilaria sp.	3.0	0.0	0.0	0.0	4.4	3.4	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0
Fragilaria vaucheriae	0.0	1.2	0.0	0.6	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	2.0
Geissleria sp.	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0
Gomphonema acuminatum	0.0	1.6	0.0	1.2	0.0	0.0	0.0	8.7	0.0	0.0	0.0	0.0	0.0	0.0
G. aff bohemicum ssp. *angustatum*	1.5	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	6.0
G. bohemicum	0.0	1.6	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	12.5	0.0	0.0	0.0
G. gracile	2.2	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	3.7	0.0
G. insigniforme	0.0	2.0	0.0	0.0	0.0	0.0	0.0	8.7	0.0	0.0	0.0	0.0	0.0	4.0
G. intricatum	0.0	0.8	0.0	0.0	0.0	1.7	0.0	0.0	0.0	5.7	0.0	0.0	0.0	0.0
G. intricatum var. *subclavata*	0.0	0.0	3.2	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	2.0
G. lacus var. *vulcari*	0.0	1.6	0.0	1.2	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	0.0
G. lanceolata	0.0	1.2	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. loglinear	0.0	0.8	0.0	0.6	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. micropus	0.8	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceoides	0.0	0.4	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceum	0.0	0.0	2.2	0.0	0.0	1.7	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceum var. *olivaceoides*	0.0	0.4	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
G. parvulum	2.2	1.6	0.0	0.0	0.9	3.4	4.6	0.0	0.0	7.1	12.5	0.0	0.0	0.0
G. parvulum var. *pumilum*	0.0	0.8	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. perpusila	2.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. sphaerophorum	0.0	2.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0
G. auritum	0.5	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0
G. balatonis	0.0	1.2	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. bohemicum	0.0	2.8	0.0	0.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7	0.0
G. clavatulum	0.5	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. clavatum	0.0	0.8	0.0	2.4	0.0	0.0	2.3	0.0	0.0	1.4	0.0	0.0	0.0	0.0
G. cymbelliclinum	1.0	0.0	4.3	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	4.9	0.0
G. grovei var. *lingulatum*	0.0	1.2	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	2.0
G. grunowii	0.0	0.4	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. helveticum	5.2	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. innocens	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	7.3	0.0
G. insigniforme	2.2	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. intricatum	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	3.7	2.0
G. intricatum var. *pumilum*	1.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. intricatum var. *vibrio*	0.8	0.0	0.0	0.0	4.4	1.7	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0
G. longiceps	1.3	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	4.9	0.0
G. longiceps var. *subclavata*	1.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. micropus	1.3	0.0	0.0	0.0	2.7	1.7	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0
G. micropus var. *aequale*	0.0	0.0	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. minutum	0.8	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceum	0.0	1.6	0.0	0.0	0.9	3.4	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
G. olivaceum var. *minutissimum*	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hannaea arcus	0.3	0.0	0.0	0.0	0.9	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hannaea arcus var. *amphioxys*	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula cincta	0.5	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
N. cryptocephala	0.8	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. cryptotenella	1.8	1.2	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. cryptotenelloides	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7	0.0
N. grimmei	2.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. radiosa	0.5	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. rhyncocephala	1.0	0.0	0.0	4.8	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0	4.9	0.0
N. salinicola	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitzschia sp.	0.3	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0
Pinnularia sp.	0.3	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Planothidium lanceolata	0.0	0.0	0.0	0.0	0.0	15.3	0.0	0.0	0.0	0.0	0.0	0.0	11.0	2.0
P. lanceolata for. ventricosa	2.7	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P. ellipticum	0.0	0.0	0.0	0.0	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P. hauckianum var. *rostratum*	0.0	6.0	0.0	11.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Psammothidium grischunum	2.5	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0
Psammothidium levanderi	0.0	1.2	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reimeria sinuata	3.2	0.0	0.0	4.8	0.0	0.0	6.8	0.0	0.0	0.0	0.0	0.0	9.8	0.0
Surirella sp.	0.3	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Synedra amphirhynchus	0.0	2.4	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S. capitata	1.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	2.0
S. danica	0.8	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
S. oxyrhynchus	0.8	0.4	0.0	1.8	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.9	2.0
Total number of taxa	**57.0**	**54.0**	**41.0**	**24.0**	**20.0**	**26.0**	**32.0**	**13 .0**	**11.0**	**27.0**	**7 .0**	**6 .0**	**26 .0**	**22 .0**
March, 2015														
Achnanthes affinis	0.0	5.1	11.9	0.0	0.0	15.8	0.0	10.7	0.0	11.8	0.0	7.0	4.6	0.0
A. conspicua	0.0	3.8	0.0	0.0	0.0	0.0	19.1	0.0	5.9	0.0	10.0	0.0	2.3	0.0
A. gibberula var. *genuina*	25.0	0.0	1.7	0.0	0.0	10.5	0.0	7.1	0.0	0.0	0.0	4.2	6.8	0.0
A. Grimmei	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.9	0.0	5.6	0.0	0.0
A. kryophila	0.0	2.5	6.8	0.0	0.0	10.5	0.0	0.0	11.8	0.0	15.0	0.0	9.1	80.0
A. linearis	0.0	0.0	5.1	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0	4.6	0.0
A. lanceolata	0.0	1.3	23.7	28.6	0.0	0.0	0.0	0.0	0.0	5.9	0.0	1.4	0.0	0.0
A. lanceolata var. *elliptica*	0.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0	17.7	0.0	5.0	0.0	6.8	0.0
A. minutissima	0.0	3.8	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	4.6	0.0
Cocconeis placentula	0.0	2.5	0.0	0.0	0.0	15.8	0.0	0.0	0.0	0.0	20.0	0.0	9.1	0.0
Cymbella affinis	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	5.9	0.0	5.6	0.0	0.0
C. amphicephala	50.0	0.0	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	5.0	0.0	6.8	0.0
C. oxyrhynchus	0.0	5.1	0.0	42.9	0.0	0.0	0.0	0.0	5.9	0.0	0.0	2.8	0.0	0.0
C. gracile	0.0	2.5	0.0	0.0	0.0	0.0	9.5	0.0	0.0	0.0	10.0	0.0	4.6	0.0
C. laevis	0.0	0.0	5.1	0.0	0.0	15.8	0.0	0.0	0.0	17.7	0.0	4.2	2.3	0.0
C. sp.	0.0	3.8	3.4	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0	4.2	6.8	0.0
C. nagpurensis	0.0	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0	0.0	4.6	0.0
C. lata	0.0	2.5	0.0	0.0	0.0	10.5	0.0	0.0	11.8	0.0	0.0	2.8	2.3	0.0
C. turgida	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0
C. ventricosa	25.0	0.0	0.0	0.0	0.0	0.0	0.0	10.7	0.0	11.8	0.0	0.0	6.8	0.0
Diatoma hiemale	0.0	1.3	0.0	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	4.2	2.3	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
D. hiemale var. *mesodon*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	4.6	0.0
Fragilaria construens	0.0	3.8	0.0	0.0	0.0	0.0	9.5	0.0	0.0	0.0	0.0	5.6	0.0	20.0
Fragilaria sp.	0.0	0.0	3.4	0.0	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. vaucherae	0.0	0.0	0.0	28.6	0.0	0.0	0.0	3.6	0.0	17.7	0.0	0.0	0.0	0.0
Gomphonema gracile	0.0	2.5	5.1	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	2.8	0.0	0.0
G. intricatum	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. longiceps	0.0	5.1	1.7	0.0	0.0	0.0	9.5	0.0	0.0	0.0	0.0	4.2	0.0	0.0
G. longiceps var. *subclavata*	0.0	2.5	0.0	0.0	0.0	5.3	0.0	0.0	0.0	11.8	0.0	0.0	4.6	0.0
G. olivaceum	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0
G. olivaceoides	0.0	3.8	0.0	0.0	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	2.3	0.0
G. parvulum	0.0	0.0	6.8	0.0	0.0	0.0	0.0	0.0	0.0	5.9	0.0	1.4	0.0	0.0
G. sphaerophorum	0.0	2.5	0.0	0.0	0.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. tergestinum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.8	0.0	10.0	0.0	0.0	0.0
Navicula cincta	0.0	1.3	0.0	0.0	0.0	0.0	9.5	0.0	0.0	0.0	0.0	4.2	0.0	0.0
N. cryptocephala	0.0	0.0	5.1	0.0	0.0	0.0	0.0	3.6	0.0	0.0	5.0	0.0	0.0	0.0
N. exigua	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.1	0.0	0.0	0.0	2.8	0.0	0.0
N. halophila	0.0	0.0	0.0	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. gracilis	0.0	2.5	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0	2.8	0.0	0.0
N. radiosa	0.0	3.8	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	2.8	0.0	0.0
N. radiosa var. *tenella*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.1	17.7	0.0	0.0	5.6	0.0	0.0
N. rhyncocephala	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	5.9	0.0	0.0	0.0	0.0	0.0
Navicula sp.	0.0	0.0	0.0	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	4.2	0.0	0.0
Nitzschia sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	2.3	0.0
Pinnularia sp.	0.0	2.5	3.4	0.0	0.0	0.0	0.0	0.0	11.8	0.0	0.0	2.8	0.0	0.0

	Sampling sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Planothidium lanceolata	0.0	6.3	0.0	0.0	0.0	0.0	0.0	3.6	0.0	5.9	0.0	0.0	2.3	0.0
Synedra acus	0.0	2.5	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0
Synedra ulna	0.0	1.3	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	0.0	0.0
Synedra ulna var. aequalis	0.0	2.5	0.0	0.0	0.0	0.0	9.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Synedra ulna var. amphirhynchus	0.0	5.1	5.1	0.0	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	0.0
Total number of taxa	**3.0**	**30.0**	**18.0**	**3.0**	**3.0**	**5.0**	**11.0**	**24.0**	**9.0**	**10.0**	**10.0**	**25.0**	**21.0**	**2.0**

Table-8.11: Relative abundance of Phytobenthos (diatoms) in Riyang Khola, West Bengal

Taxa	Months								
	May	**June**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**
Achnanthes affinis	37.50	0.00	11.11	3.51	0.00	2.86	1.47	3.33	4.29
A. Hauckiana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.67	0.00
A. holsatica	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.67	0.00
A. linearis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	0.00
A. arcus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.00
A. subsalsum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.33	0.00
A. austriaca	0.00	0.00	0.00	0.00	2.44	0.00	1.96	0.00	0.00
A. biasolettiana	25.00	0.00	14.81	7.02	0.00	2.86	0.00	2.67	0.00
var. subatomus	0.00	0.00	0.00	0.00	3.66	0.00	1.47	0.00	0.00
A. biasolettiana var. *thienemanii*	0.00	0.00	7.41	0.00	0.00	1.90	2.45	0.00	0.00
A. Boyei	0.00	0.00	0.00	5.26	0.00	0.00	1.47	0.00	0.00
A. brevipes	0.00	0.00	0.00	0.00	4.88	3.81	0.00	0.00	0.00
A. brevipes var. *intermedia*	0.00	0.00	0.00	0.00	0.00	0.00	0.98	0.00	2.86
A. conspicua	0.00	0.00	11.11	0.00	0.00	0.00	3.43	0.00	0.00
A. construens	0.00	0.00	0.00	1.75	0.00	1.90	2.94	0.00	0.00

Taxa	Months								
	May	June	Sep	Oct	Nov	Dec	Jan	Feb	Mar
A. cranulata	0.00	0.00	0.00	8.77	0.00	0.00	0.49	0.00	0.00
A. exigua	0.00	0.00	0.00	0.00	3.66	0.00	5.39	0.00	0.00
A. exilis	0.00	0.00	0.00	0.00	0.00	2.86	6.86	0.00	0.00
A. gibberula var. *genuina*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43
A. kryophila	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.29
A. grischuma	0.00	0.00	0.00	5.26	0.00	0.95	0.00	2.00	0.00
A. lanceolata	0.00	0.00	0.00	0.00	2.44	0.00	1.96	8.67	5.71
A. lanceolata var. lanceolata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.33	2.86
A. Lapidosa	0.00	0.00	0.00	3.51	0.00	0.00	1.47	0.00	0.00
A. lapponica	0.00	0.00	7.41	0.00	0.00	3.81	0.00	0.00	0.00
A. laterostrata	0.00	0.00	0.00	3.51	0.00	0.00	1.47	0.00	0.00
A. Lemmermanni	0.00	0.00	0.00	5.26	0.00	2.86	0.00	2.00	0.00
Achnanthidium minutissima	37.50	100.00	0.00	0.00	3.66	0.00	10.29	2.00	7.14
Achnanthidium affine	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.33	0.00
Cocconeis placentula var . *lineata*	0.00	0.00	0.00	0.00	0.00	0.00	2.45	0.00	0.00
C. placentula var. *euglypta*	0.00	0.00	0.00	0.00	0.00	3.81	0.00	0.00	1.43
Cymbella affinis	0.00	0.00	0.00	0.00	4.88	0.00	1.96	2.60	4.29
C. amphicephala	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.86
C. lata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43
C. turgida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.29
C. gracile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.33	5.71
C. hungarica	0.00	0.00	0.00	3.51	0.00	1.90	1.47	2.67	0.00
C. kolbei var. *angusta*	0.00	0.00	0.00	3.51	0.00	2.86	1.96	0.00	0.00
C. laevis Nägeli	0.00	0.00	0.00	1.75	0.00	0.00	0.00	0.00	0.00
C. lancettula	0.00	0.00	3.70	0.00	4.88	0.00	0.98	2.00	0.00
C. nagpurensis	0.00	0.00	0.00	5.26	0.00	0.95	0.00	0.00	4.29

Taxa	Months								
	May	June	Sep	Oct	Nov	Dec	Jan	Feb	Mar
C. parva	0.00	0.00	0.00	1.75	0.00	0.00	0.49	2.00	0.00
C. perparva Krammer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.00
C. excisa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00
C. exigua	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.33	0.00
C. Hustedii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.33	0.00
C. kolbei	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.67	0.00
C. ventricosa	0.00	0.00	0.00	0.00	2.44	0.00	0.00	4.67	0.00
Diatoma hiemale	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.86
D. hiemale var. *mesodon*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43
Encyonema sp.	0.00	0.00	0.00	0.00	1.22	0.00	0.00	0.00	0.00
E. gracile	0.00	0.00	0.00	0.00	6.10	0.00	1.96	0.00	0.00
E. hebridicum	0.00	0.00	0.00	0.00	0.00	1.90	0.00	0.00	0.00
E. subminisculus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.00
Fragilaria sp.	0.00	0.00	0.00	0.00	3.66	0.00	1.96	4.29	0.00
F. vaucheriae	0.00	0.00	0.00	0.00	0.00	0.95	0.00	2.86	0.00
Gomphonema acuminatum	0.00	0.00	0.00	0.00	4.88	0.00	3.92	0.00	0.00
G. angustatum	0.00	0.00	0.00	3.51	0.00	0.00	1.47	0.00	0.00
G. bohemicum	0.00	0.00	0.00	0.00	0.00	1.90	0.00	1.33	0.00
G. gracile	0.00	0.00	0.00	0.00	6.10	0.00	3.43	0.00	0.00
G. intricatum	0.00	0.00	0.00	0.00	0.00	0.00	1.96	0.00	1.43
G. intricatum var. *pumilum*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.67	0.00
G. grovei var. *lingulatum*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00
G. balatonis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00
G. lacus var. *vulcari*	0.00	0.00	0.00	0.00	0.00	2.86	0.00	0.00	0.00
G. lanceolata	0.00	0.00	0.00	0.00	0.00	0.00	1.47	0.00	0.00
G. loglinear	0.00	0.00	0.00	0.00	3.66	0.00	0.00	1.33	0.00

Taxa	Months								
	May	June	Sep	Oct	Nov	Dec	Jan	Feb	Mar
G. micropus	0.00	0.00	0.00	0.00	0.00	1.90	0.00	0.00	0.00
G. olivaceoides	0.00	0.00	0.00	0.00	2.44	0.00	0.00	0.00	2.86
G. olivaceum	0.00	0.00	0.00	0.00	0.00	2.86	0.00	0.00	0.00
G. parvulum	0.00	0.00	0.00	0.00	3.66	0.00	0.98	0.00	0.00
G. perpusila	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00
Gomphonema sp.	0.00	0.00	0.00	0.00	1.22	0.00	1.96	0.00	0.00
G. sphaerophorum	0.00	0.00	0.00	0.00	0.00	1.90	0.00	0.00	4.29
G. auritum	0.00	0.00	11.11	0.00	0.00	2.86	0.00	0.00	0.00
G. bohemicum	0.00	0.00	0.00	0.00	3.66	0.00	1.47	0.00	0.00
G. clavatum	0.00	0.00	7.41	0.00	0.00	3.81	0.00	1.33	0.00
G. cymbelliclinum	0.00	0.00	0.00	3.51	0.00	1.90	1.47	0.00	0.00
G. grovei	0.00	0.00	0.00	0.00	2.44	0.00	2.45	0.00	0.00
G. helveticum	0.00	0.00	7.41	0.00	0.00	2.86	0.00	1.33	0.00
G. innocens	0.00	0.00	0.00	0.00	4.88	0.00	1.47	0.00	0.00
G. intricatum	0.00	0.00	0.00	7.02	0.00	3.81	0.00		0.00
G. longiceps	0.00	0.00	0.00	0.00	2.44	0.00	0.00	2.00	0.00
G. longiceps var. subclavata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.86
G. micropus	0.00	0.00	0.00	3.51	0.00	3.81	0.98	0.00	0.00
G. olivaceum	0.00	0.00	0.00	0.00	3.66	0.00	1.96	0.00	0.00
Hannaea arcus	0.00	0.00	0.00	0.00	0.00	4.76	0.00	0.00	0.00
H. arcus var. *amphioxys*	0.00	0.00	0.00	5.26	0.00	2.86	0.00	0.00	0.00
Navicula cincta	0.00	0.00	0.00	0.00	3.66	0.00	1.47	0.00	7.14
N. cryptocephala	0.00	0.00	0.00	0.00	0.00	4.76	0.00	0.00	0.00
N. grimmei	0.00	0.00	0.00	0.00	0.00	5.71	2.94	0.67	0.00
N. radiosa	0.00	0.00	0.00	1.75	0.00	1.90	0.00	0.00	2.86
N. rhyncocephala	0.00	0.00	0.00	0.00	3.66	0.00	1.47	0.00	2.86

Taxa	Months								
	May	June	Sep	Oct	Nov	Dec	Jan	Feb	Mar
N. salinicola	0.00	0.00	0.00	3.51	0.00	1.90	0.00	0.00	0.00
N. gracilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.29
Navicula sp.	0.00	0.00	0.00	7.02	0.00	0.00	0.98	0.00	0.00
Nitzschia sp.	0.00	0.00	0.00	0.00	2.44	0.00	1.47	0.00	0.00
Pinnularia sp.	0.00	0.00	0.00	0.00	0.00	1.90	0.00	0.00	0.00
Planothidium lanceolata	0.00	0.00	0.00	0.00	3.66	0.00	2.45	4.00	2.86
P. lanceolata for. ventricosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.33	0.00
P. hauckianum var. rostratum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00
Reimeria sinuata	0.00	0.00	0.00	0.00	0.00	0.95	0.00	1.33	0.00
Surirella sp.	0.00	0.00	0.00	0.00	0.00	2.86	0.00	0.00	0.00
Synedra ulna	0.00	0.00	3.70	0.00	3.66	0.00	2.94	0.00	1.43
S. amphirhynchus	0.00	0.00	0.00	5.26	0.00	3.81	1.47	0.67	0.00
S. oxyrhynchus	0.00	0.00	14.81	0.00	0.00	0.95	2.45	0.00	0.00

Source: Primary survey

None of the species is endemic and threatened and listed in CITES

Table-8.12: List and Relative abundance of phytoplankton (Diatom) in Teesta and Rangit rivers in West Bengal

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
April														
Achnanthidium affinis	0.0	0.0	0.0	0.0	0.0	9.7	0.0	10.3	0.0	57.1	0.0	0.0	0.0	16.7
A. biasolettiana	0.0	0.0	0.0	0.0	11.2	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. conspicua	0.0	0.0	0.0	0.0	0.0	2.9	0.0	7.7	0.0	0.0	0.0	0.0	0.0	0.0
A. exilis	0.0	0.0	0.0	0.0	0.0	1.0	2.4	0.0	16.7	0.0	0.0	0.0	0.0	0.0
A. gibberula var. genuina	0.0	0.0	0.0	0.0	3.7	2.9	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. Grimmei	0.0	0.0	0.0	0.0	2.8	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
A. kryophila	0.0	0.0	10.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. linearis	75.0	12.5	10.0	0.0	19.6	24.3	14.3	35.9	16.7	0.0	50.0	0.0	50.0	12.5
A. lanceolata	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0
A. lanceolata var. elliptica	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. minutissima	0.0	25.0	0.0	0.0	0.0	4.9	14.3	0.0	0.0	42.9	25.0	0.0	0.0	0.0
A. plonensis	0.0	0.0	13.3	0.0	4.7	1.0	4.8	0.0	16.7	0.0	0.0	0.0	0.0	0.0
A. subsalsa	0.0	0.0	0.0	18.2	0.0	1.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cocconeis placentula	0.0	0.0	0.0	0.0	0.0	2.9	6.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0
C. placentula var. *euglypta*	0.0	0.0	0.0	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.3
Cymbella affinis	0.0	0.0	6.7	0.0	5.6	1.9	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. amphicephala	0.0	0.0	0.0	0.0	4.7	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0
C. hebridica	0.0	0.0	0.0	0.0	0.0	1.9	2.4	0.0	0.0	0.0	0.0	33.3	0.0	0.0
C. kerkevarensis	0.0	0.0	0.0	0.0	0.0	4.9	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0
C. laevis	0.0	0.0	0.0	0.0	2.8	0.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. perpusila	0.0	0.0	0.0	0.0	0.0	1.0	2.4	0.0	0.0	0.0	25.0	0.0	0.0	0.0
C. Reinhardtii	0.0	0.0	10.0	0.0	0.9	0.0	2.4	5.1	0.0	0.0	0.0	0.0	0.0	0.0
C. sinuata	0.0	0.0	0.0	0.0	0.0	2.9	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. turgida	0.0	0.0	0.0	0.0	2.8	0.0	6.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0
C. ventricosa	0.0	0.0	0.0	0.0	3.7	1.9	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diatoma hiemale	0.0	0.0	0.0	0.0	0.0	4.9	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fragilaria sp.	0.0	37.5	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0
F. construens	0.0	0.0	0.0	9.1	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0	0.0	8.3
F. capucina	0.0	0.0	6.7	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. intermedia	0.0	0.0	0.0	9.1	0.9	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0
F. pinnata	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. rumpens	0.0	0.0	10.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Gomphonema gracile	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
G. intricatum var. *vibrio*	0.0	0.0	0.0	9.1	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. intricatum var. *pumila*	0.0	0.0	6.7	0.0	0.0	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0
G. longiceps	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. longiceps var. *subclavata*	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceum	0.0	0.0	6.7	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceum var. *minutissima*	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. parvulum	25.0	0.0	0.0	0.0	0.0	1.9	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0
G. tergestinum	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema sp.	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula cincta	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. cryptocephala	0.0	0.0	10.0	0.0	0.0	1.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0
N. cryptocephala	0.0	0.0	0.0	0.0	1.9	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. cryptocephala var. *veneta*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	8.3
N. gracilis	0.0	0.0	0.0	9.1	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. microcephala	0.0	0.0	6.7	0.0	0.0	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0
N. radiosa	0.0	0.0	0.0	0.0	0.9	1.9	0.0	2.6	0.0	0.0	0.0	0.0	0.0	8.3
N. radiosa var. *tenella*	0.0	0.0	0.0	0.0	1.9	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula sp.	0.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitzschia heufloriana	0.0	0.0	0.0	18.2	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pinnularia appendiculata	0.0	0.0	0.0	0.0	1.9	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pinnularia sp.	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Planothidium lanceolata	0.0	0.0	0.0	18.2	0.0	0.0	0.0	0.0	33.3	0.0	0.0	0.0	0.0	0.0
Synedra acus	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S. ulna	0.0	0.0	3.3	0.0	1.9	1.0	7.1	0.0	0.0	0.0	0.0	0.0	50.0	20.8
S. ulna var. *aequalis*	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
S. ulna var. *amphirhynchus*	0.0	0.0	0.0	0.0	1.9	1.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	16.7
Total No. of Taxa	**3.0**	**4.0**	**12.0**	**8.0**	**30.0**	**32.0**	**20.0**	**16.0**	**5.0**	**2.0**	**3.0**	**4.0**	**2.0**	**9.0**
May														
Achnanthidium exilis	0.0	42.9	0.0	0.0	0.0	2.9	4.2	4.1	0.0	25.0	0.0	0.0	0.0	0.0
A. linearis	28.6	0.0	0.0	0.0	0.0	11.4	0.0	10.2	66.7	0.0	50.0	0.0	0.0	50.0
A. lanceolata	0.0	0.0	0.0	0.0	8.3	2.9	6.3	6.1	0.0	0.0	0.0	66.7	0.0	0.0
A. lanceolata var. *elliptica*	0.0	0.0	0.0	0.0	0.0	2.9	0.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0
A. minutissima	0.0	0.0	0.0	0.0	11.1	17.1	8.3	4.1	33.3	50.0	0.0	0.0	0.0	0.0
Cymbella affinis	0.0	0.0	0.0	0.0	5.6	2.9	2.1	0.0	0.0	0.0	25.0	0.0	0.0	0.0
C. laevis	0.0	14.3	0.0	0.0	0.0	5.7	8.3	4.1	0.0	0.0	0.0	0.0	0.0	0.0
C. ventricosa	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fragilaria sp.	0.0	0.0	50.0	0.0	0.0	5.7	8.3	2.0	0.0	0.0	12.5	0.0	100.0	0.0
F. capucina	0.0	0.0	0.0	100.0	0.0	0.0	4.2	2.0	0.0	0.0	0.0	0.0	0.0	0.0
F. intermedia	0.0	0.0	0.0	0.0	0.0	5.7	4.2	4.1	0.0	0.0	0.0	33.3	0.0	0.0
Gomphonema parvulum	28.6	0.0	0.0	0.0	8.3	5.7	0.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0
G. tergestinum	0.0	0.0	0.0	0.0	11.1	0.0	8.3	2.0	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceum	0.0	0.0	0.0	0.0	5.6	0.0	0.0	8.2	0.0	25.0	0.0	0.0	0.0	0.0
Gomphonema sp.	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula cryptocephala	0.0	0.0	0.0	0.0	0.0	5.7	8.3	2.0	0.0	0.0	0.0	0.0	0.0	0.0
N. gracilis	0.0	42.9	0.0	0.0	0.0	0.0	0.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0
N. microcephala	0.0	0.0	0.0	0.0	0.0	5.7	10.4	8.2	0.0	0.0	0.0	0.0	0.0	0.0
N. radiosa	0.0	0.0	0.0	0.0	11.1	0.0	4.2	6.1	0.0	0.0	0.0	0.0	0.0	0.0
N. radiosa var. *tenella*	0.0	0.0	0.0	0.0	5.6	0.0	4.2	4.1	0.0	0.0	0.0	0.0	0.0	0.0
Navicula sp.	14.3	0.0	0.0	0.0	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Planothidium lanceolata	0.0	0.0	0.0	0.0	13.9	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	50.0
Synedra ulna	0.0	0.0	50.0	0.0	0.0	8.6	4.2	10.2	0.0	0.0	12.5	0.0	0.0	0.0
S. ulna var. *aequalis*	0.0	0.0	0.0	0.0	11.1	5.7	4.2	2.0	0.0	0.0	0.0	0.0	0.0	0.0
S.ulna var.*amphirhynchus*	28.6	0.0	0.0	0.0	0.0	11.4	2.1	8.2	0.0	0.0	0.0	0.0	0.0	0.0
Total No of Taxa	**4.0**	**3.0**	**2.0**	**1.0**	**12.0**	**15. 0**	**18.0**	**20.0**	**2.0**	**3.0**	**4.0**	**2.0**	**1.0**	**2.0**
July														
Achnanthidium linearis	0.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cymbella affinis	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. ventricosa	0.0	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fragilaria sp.	0.0	0.0	25.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. capucina	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema parvulum	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. tergestinum	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. microcephala	0.0	0.0	0.0	0.0	0.0	28.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. radiosa	0.0	0.0	0.0	0.0	0.0	28.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S. ulna var. *aequalis*	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S.ulna var. *amphirhynchus*	0.0	0.0	0.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total No of Taxa	**0.0**	**0.0**	**4.0**	**3.0**	**0.0**	**5.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
August														
Achnanthidium affinis	0.0	7.1	0.0	0.0	0.0	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. lanceolata	15.4	0.0	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. linearis	0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. minutissima	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diatoma hiemale	23.1	0.0	11.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*Gomphonema angustatum*0	28.6	0.0	0.0	0.0	0.0	15.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
G. parvulum	0.0	0.0	17.7	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. sphaerophorum	0.0	21.4	0.0	0.0	0.0	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema sp.	23.1	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
Hannaea arcus	0.0	0.0	17.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula radiosa	15.4	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
Navicula rhynchocephala	0.0	0.0	0.0	0.0	0.0	83.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula sp.	0.0	28.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitzschia thermalis	0.0	0.0	23.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Surirella sp.	23.1	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
Synedra ulna	0.0	0.0	0.0	0.0	0.0	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Synedra sp.	0.0	0.0	23.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total No of Taxa	**6.0**	**4.0**	**6.0**	0.0	**2.0**	**5.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
September														
Achnanthidium affinis	10.5	0.0	0.0	0.0	8.3	3.5	0.0	9.5	0.0	7.7	0.0	0.0	0.0	0.0
A. lanceolata	0.0	0.0	0.0	0.0	6.7	0.0	0.0	7.1	19.2	0.0	14.3	13.3	0.0	0.0
A. linearis	0.0	0.0	15.6	0.0	8.3	8.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.3
A. minutissima	0.0	27.3	0.0	0.0	8.3	7.0	0.0	0.0	15.4	0.0	0.0	0.0	0.0	0.0
Amphora sp.	0.0	0.0	12.5	0.0	0.0	7.0	0.0	7.1	0.0	0.0	5.7	0.0	0.0	8.3
Cocconeis placentula	5.3	0.0	0.0	0.0	3.3	3.5	0.0	11.9	0.0	0.0	0.0	0.0	0.0	0.0
Cymbella affinis	0.0	9.1	6.3	0.0	0.0	3.5	0.0	0.0	19.2	0.0	0.0	0.0	0.0	16.7
Diatoma hiemale	0.0	0.0	0.0	0.0	3.3	3.5	0.0	4.8	0.0	0.0	8.6	0.0	0.0	0.0
Fragilaria sp.	0.0	18.2	0.0	0.0	6.7	3.5	0.0	0.0	15.4	0.0	0.0	0.0	0.0	8.3
Gomphonema angustatum	15.8	0.0	0.0	0.0	6.7	3.5	0.0	4.8	0.0	0.0	11.4	0.0	0.0	0.0
G. intricatum	0.0	0.0	12.5	0.0	0.0	8.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. parvulum	0.0	0.0	0.0	0.0	8.3	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.5
G. sphaerophorum	0.0	18.2	0.0	0.0	0.0	0.0	0.0	9.5	7.7	0.0	11.4	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Gomphonema sp.	0.0	0.0	6.3	0.0	0.0	8.8	0.0	0.0	0.0	0.0	0.0	26.7	0.0	0.0
Gyrosigma sp.	0.0	0.0	0.0	0.0	6.7	1.8	0.0	4.8	0.0	23.1	0.0	0.0	0.0	12.5
Hannaea arcus	0.0	0.0	6.3	0.0	0.0	1.8	0.0	0.0	7.7	0.0	14.3	0.0	0.0	0.0
Navicula linearis	0.0	0.0	9.4	0.0	0.0	7.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0	8.3
Navicula radiosa	15.8	0.0	0.0	0.0	0.0	3.5	0.0	0.0	0.0	15.4	5.7	0.0	0.0	0.0
Navicula rhynchocephala	0.0	0.0	0.0	0.0	6.7	1.8	0.0	9.5	0.0	0.0	0.0	20.0	0.0	0.0
Navicula sp.	0.0	0.0	0.0	0.0	8.3	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitzschia subtilis	0.0	0.0	6.3	0.0	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	8.3
Nitzschia thermalis	0.0	9.1	0.0	0.0	0.0	5.3	0.0	0.0	0.0	15.4	0.0	13.3	0.0	0.0
Reimeria sinuata	21.1	0.0	0.0	0.0	6.7	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0	0.0
Surirella sp.	0.0	0.0	6.3	0.0	0.0	3.5	0.0	4.8	15.4	0.0	11.4	0.0	0.0	0.0
Synedra ulna	0.0	18.2	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	26.7	0.0	0.0
Synedra sp.	31.6	0.0	18.8	0.0	8.3	5.3	0.0	9.5	0.0	38.5	17.1	0.0	0.0	16.7
Total No. of Taxa	**6.0**	**6.0**	**9.0**	**0.0**	**15.0**	**21.0**		**14.0**	**7.0**	**5.0**	**8.0**	**4.0**		**9.0**
October														
Achnanthes affinis	10.0	0.0	0.0	29.4	10.0	5.1	2.0	2.3	8.0	1.2	8.4	4.8	0.0	11.5
A. Hauckiana	10.0	0.0	10.7	0.0	0.9	1.6	0.0	8.6	1.1	10.1	0.0	1.5	22.5	0.0
A. minutissima	0.0	31.4	0.0	0.0	8.3	0.9	6.0	1.4	10.7	8.3	8.4	16.2	0.0	0.7
A. minutissima var. *cryptocephala*	26.7	0.0	0.0	7.1	0.0	7.6	0.0	1.4	0.5	1.8	20.0	0.3	0.0	21.6
Cocconeis placentula	0.0	0.0	3.6	0.0	0.9	1.6	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0
Cymbella affinis	6.7	17.1	0.0	3.5	0.0	1.0	0.0	0.0	1.6	6.6	0.0	18.6	0.0	8.7
C. laevis	0.0	0.0	1.8	1.2	0.9	1.2	0.0	7.3	0.0	1.2	0.0	6.0	0.0	0.7
C. exigua	0.0	0.0	0.0	0.0	0.0	2.8	1.0	0.0	12.3	0.0	0.0	0.0	0.0	0.0
C. hungarica	0.0	0.0	3.6	2.4	0.4	0.0	0.0	1.8	0.0	1.2	0.0	0.2	1.7	3.8

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
C. Hustedii	0.0	5.7	0.0	0.0	0.0	1.8	0.0	8.2	1.1	0.0	0.0	9.4	0.0	0.0
C. ventricosa	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	1.1
Cymbella sp.	0.0	0.0	7.1	8.2	0.0	5.1	2.0	0.0	3.7	0.0	8.0	0.9	4.2	4.5
C. turgidula	0.0	2.9	14.3	0.0	3.5	0.3	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0
F. brevistriata	0.0	0.0	0.0	5.9	0.0	7.6	8.0	1.8	1.1	0.0	2.4	0.0	0.0	0.4
F. vaucheriae	10.0	0.0	5.4	0.0	2.2	1.2	3.0	0.0	0.0	0.0	3.6	1.7	0.0	0.0
Gomphonema bohemicum	0.0	0.0	0.0	2.4	0.4	0.0	0.0	2.3	2.1	1.2	0.0	0.0	0.8	2.4
G. gracile	0.0	0.0	3.6	2.4	0.9	1.8	3.0	0.0	0.0	0.0	2.8	2.3	0.0	4.9
G. insigniforme	0.0	20.0	5.4	0.0	11.3	0.0	2.0	0.9	17.1	0.0	3.6	0.0	51.7	2.4
G. intricatum	3.3	0.0	0.0	0.0	0.0	5.1	8.0	2.3	0.0	0.0	0.0	0.5	0.0	2.8
G. lanceolata	3.3	0.0	0.0	1.2	4.8	0.0	0.0	5.0	1.6	0.0	0.0	2.0	0.0	5.2
G. micropus	0.0	0.0	3.6	0.0	3.9	1.9	7.0	6.4	1.1	0.0	3.2	1.7	0.0	1.4
G. olivaceoides	6.7	0.0	5.4	1.2	2.2	1.8	0.0	5.9	0.0	0.0	0.0	1.9	0.0	1.7
G. parvulum	0.0	5.7	7.1	3.5	9.1	10.5	8.0	10.5	2.1	18.5	6.8	2.6	2.5	4.9
Hannaea arcus	6.7	0.0	0.0	8.2	10.9	5.2	4.0	6.8	3.2	14.3	9.6	3.4	3.3	4.9
N. cryptocephala	0.0	8.6	0.0	0.0	0.0	7.0	0.0	0.5	1.1	6.6	0.0	2.9	0.0	0.7
N. cryptotenella	0.0	0.0	3.6	5.9	3.9	4.8	5.0	6.8	10.7	0.0	4.4	3.5	3.3	1.7
N. radiosa	0.0	0.0	8.9	1.2	3.0	4.8	0.0	5.0	0.0	5.4	7.2	2.6	1.7	1.1
N. rhyncocephala	0.0	0.0	0.0	1.2	7.8	0.0	12.0	0.9	3.7	0.0	0.0	6.5	0.0	0.0
Navicula sp.	0.0	0.0	16.1	2.4	0.9	3.8	0.0	5.9	0.0	4.2	2.4	2.9	2.5	4.2
Pinnularia sp.	0.0	0.0	0.0	0.0	0.4	9.3	0.0	0.0	1.1	0.0	0.0	1.4	0.0	0.0
Planothidium lanceolata	16.7	0.0	0.0	0.0	11.3	0.0	11.0	0.0	15.5	13.1	6.4	3.2	1.7	0.0
Reimeria sinuata	0.0	8.6	0.0	8.2	0.4	5.7	9.0	7.3	0.0	3.0	0.0	0.0	1.7	8.7
Surirella sp.	0.0	0.0	0.0	4.7	1.3	0.9	9.0	0.9	0.5	3.0	2.8	0.8	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Total No of Taxa	**10.0**	**8.0**	**13.0**	**18.0**	**23.0**	**21.0**	**17.0**	**22.0**	**12.0**	**16.0**	**16.0**	**26.0**	**13.0**	**21.0**
November														
Achnanthes affinis	12.8	6.1	1.3	8.3	8.7	0.0	0.0	0.0	14.7	0.0	0.0	0.0	0.0	0.0
A. biasolettiana	15.7	0.0	0.0	0.0	12.3	7.8	0.0	6.0	1.0	5.3	30.7	0.0	8.3	0.0
A. grischuma	0.0	0.0	0.0	0.0	9.4	0.0	5.5	3.6	5.9	0.0	0.0	0.0	0.0	15.2
A. linearis	1.0	0.0	15.4	0.8	0.0	5.6	0.0	4.0	0.0	0.0	0.0	0.0	5.6	0.0
A. minutissima	0.0	39.4	0.0	0.0	0.0	9.1	1.4	0.0	8.8	27.6	0.0	22.8	0.0	6.1
A. minutissima var. cryptocephala	3.9	0.0	0.0	9.1	0.0	6.5	0.0	2.0	0.0	0.0	27.7	0.0	2.8	31.8
Cocconeis placentula	0.0	0.0	0.0	0.0	2.9	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cymbella affinis	2.0	0.0	2.6	6.1	0.0	0.0	0.0	4.8	0.0	6.6	0.0	0.0	0.0	0.0
C. amphicephala	10.8	0.0	0.0	0.0	2.2	3.0	4.1	0.8	0.0	0.0	0.0	0.0	16.7	0.0
C. excisa	0.0	0.0	0.0	1.5	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	12.5	7.6
C. exigua	2.9	0.0	0.0	0.0	0.0	5.6	4.8	0.0	5.9	1.3	0.6	3.7	0.0	0.0
C. hungarica	0.0	0.0	6.4	0.0	5.1	5.2	0.0	1.2	0.0	0.0	0.6	0.0	0.0	0.0
C. Hustedii	4.9	0.0	0.0	0.0	0.0	0.0	5.5	2.0	2.0	1.3	0.0	0.0	0.0	0.0
C. ventricosa	0.0	12.1	0.0	0.0	1.5	0.0	0.0	2.0	0.0	0.0	0.0	5.2	5.6	0.0
Cymbella sp.	2.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0	2.0	0.0	0.0	0.0	0.0	7.6
Fragilaria sp.	0.0	0.0	3.9	0.0	2.9	0.0	5.5	0.0	0.0	1.3	2.4	0.0	0.0	0.0
F. vaucheriae	0.0	0.0	0.0	3.8	0.0	5.6	6.2	0.8	0.0	2.6	0.0	3.7	2.8	0.0
Gomphonema bohemicum	12.8	6.1	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. gracile	0.0	0.0	1.3	11.4	0.0	0.0	5.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. insigniforme	7.8	0.0	0.0	0.0	9.4	0.9	0.0	0.0	14.7	0.0	2.4	0.0	4.2	3.0
G. intricatum	0.0	7.6	0.0	0.0	0.0	0.0	6.9	2.8	7.8	4.0	0.0	0.0	0.0	0.0
G. micropus	0.0	0.0	0.0	2.3	0.0	2.6	0.7	2.0	0.0	0.0	0.0	15.4	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
G. olivaceum	0.0	0.0	26.9	11.4	2.2	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0	4.6
G. parvulum	2.0	0.0	0.0	0.0	0.0	14.2	3.4	0.8	0.0	14.5	0.0	2.9	1.4	0.0
Gomphonema sp.	0.0	16.7	2.6	9.1	2.2	0.0	0.0	0.4	8.8	0.0	0.0	0.0	0.0	1.5
G. sphaerophorum	0.0	0.0	0.0	0.0	0.0	0.9	1.4	3.6	0.0	1.3	1.2	0.0	0.0	0.0
Hannaea arcus	2.0	0.0	0.0	18.2	1.5	0.4	0.0	3.6	0.0	11.8	0.0	0.0	0.0	0.0
Navicula cincta	0.0	0.0	6.4	0.0	0.0	0.0	0.7	1.6	2.0	0.0	0.0	16.9	0.0	4.6
N. cryptocephala	2.9	3.0	0.0	0.0	0.0	6.9	0.0	1.2	0.0	2.6	3.6	0.0	9.7	0.0
N. cryptotenella	2.9	0.0	5.1	5.3	0.0	0.0	0.0	0.0	8.8	0.0	0.0	0.0	0.0	0.0
N. cryptotenelloides	0.0	0.0	2.6	0.0	4.4	0.0	10.3	1.2	7.8	0.0	1.2	0.0	0.0	12.1
N. radiosa	2.9	0.0	0.0	0.0	0.0	7.3	0.0	0.0	0.0	2.6	0.0	10.3	0.0	0.0
N. rhyncocephala	0.0	0.0	0.0	3.8	8.7	0.0	0.0	2.0	1.0	0.0	0.0	0.0	0.0	3.0
Navicula sp.	1.0	0.0	21.8	0.0	0.0	0.0	2.7	5.2	0.0	0.0	0.0	5.9	0.0	0.0
Pinnularia sp.	0.0	0.0	0.0	0.8	0.0	6.0	2.7	0.8	0.0	0.0	7.2	0.0	25.0	0.0
Planothidium lanceolata	4.9	0.0	2.6	1.5	13.0	2.2	14.4	0.4	7.8	15.8	0.0	11.8	0.0	1.5
Reimeria sinuata	3.9	9.1	0.0	0.0	0.0	5.6	9.6	2.8	0.0	0.0	0.0	0.0	0.0	0.0
Surirella sp.	0.0	0.0	0.0	0.0	12.3	0.4	5.5	0.8	1.0	1.3	0.0	1.5	5.6	1.5
Synedra sp.	1.0	0.0	1.3	6.8	0.0	0.4	0.0	0.0	0.0	0.0	22.3	0.0	0.0	0.0
Total No of Taxa	**19.0**	**4.0**	**14.0**	**13.0**	**15.0**	**18.0**	**19.0**	**27.0**	**16.0**	**15.0**	**10.0**	**10.0**	**12.0**	**10.0**
December														
Achnanthes affinis	9.1	0.0	0.0	25.0	12.5	0.0	0.0	2.3	15.6	0.0	0.0	0.0	0.0	0.0
A. biasolettiana	22.7	0.0	0.0	0.0	18.8	9.4	0.0	10.3	0.0	11.1	41.7	0.0	14.3	0.0
A. grischuma	0.0	0.0	0.0	0.0	12.5	0.0	7.1	12.6	6.3	0.0	0.0	0.0	0.0	50.0
A. lemmarmanii	0.0	0.0	0.0	0.0	0.0	12.5	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0
A. linearis	0.0	0.0	33.3	0.0	0.0	0.0	0.0	13.8	0.0	0.0	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
A. minutissima	0.0	50.0	0.0	0.0	0.0	6.3	0.0	3.5	9.4	33.3	0.0	50.0	0.0	0.0
A. minutissima														
var. minutissima	13.6	0.0	0.0	25.0	0.0	15.6	0.0	2.3	0.0	0.0	33.3	0.0	0.0	50.0
Cocconeis placentula	4.6	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
Cymbella affinis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.6	0.0	5.6	0.0	0.0	0.0	0.0
C. amphicephala	0.0	0.0	0.0	0.0	0.0	3.1	3.6	1.2	0.0	0.0	0.0	0.0	42.9	0.0
C. excisa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0
C. exigua	0.0	0.0	0.0	0.0	0.0	6.3	3.6	0.0	6.3	0.0	0.0	0.0	0.0	0.0
C. hungarica	0.0	0.0	0.0	0.0	6.3	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0
C. Hustedii	0.0	0.0	0.0	0.0	0.0	0.0	7.1	2.3	0.0	0.0	0.0	0.0	0.0	0.0
C. ventricosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0
Cymbella sp.	0.0	0.0	0.0	0.0	0.0	3.1	0.0	0.0	3.1	0.0	0.0	0.0	0.0	0.0
Fragilaria sp.	0.0	0.0	16.7	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. brevistriata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0
F. vaucheriae	0.0	0.0	0.0	0.0	0.0	6.3	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema bohemicum	4.6	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
G. gracile	0.0	0.0	0.0	12.5	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G. insigniforme	0.0	0.0	0.0	0.0	12.5	0.0	0.0	0.0	21.9	0.0	0.0	0.0	42.9	0.0
G. intricatum	0.0	0.0	0.0	0.0	0.0	0.0	10.7	3.5	0.0	0.0	0.0	0.0	0.0	0.0
G. lanceolata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0
G. micropus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceoides	9.1	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
G. olivaceum	0.0	0.0	16.7	0.0	0.0	0.0	0.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0
G. parvulum	4.6	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	22.2	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Gomphonema sp.	0.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	9.4	0.0	0.0	0.0	0.0	0.0
G. sphaerophorum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0
Hannaea arcus	0.0	0.0	0.0	25.0	0.0	0.0	0.0	1.2	0.0	16.7	0.0	0.0	0.0	0.0
Navicula cincta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0
N. cryptocephala	0.0	0.0	0.0	0.0	0.0	3.1	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0
N. cryptotenella	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.4	0.0	0.0	0.0	0.0	0.0
N. cryptotenelloides	0.0	0.0	0.0	0.0	0.0	0.0	7.1	1.2	6.3	0.0	0.0	0.0	0.0	0.0
N. radiosa	9.1	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. rhyncocephala	0.0	0.0	0.0	0.0	12.5	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0
Navicula sp.	0.0	0.0	33.3	0.0	0.0	0.0	3.6	1.2	0.0	0.0	0.0	0.0	0.0	0.0
Nitzschia sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0	0.0
Pinnularia sp.	0.0	0.0	0.0	0.0	0.0	6.3	3.6	2.3	0.0	0.0	0.0	0.0	0.0	0.0
Planothidium lanceolata	13.6	0.0	0.0	0.0	18.8	0.0	17.9	0.0	9.4	11.1	0.0	50.0	0.0	0.0
Reimeria sinuata	9.1	25.0	0.0	0.0	0.0	12.5	14.3	6.9	0.0	0.0	0.0	0.0	0.0	0.0
Surirella sp.	0.0	0.0	0.0	0.0	6.3	0.0	3.6	1.2	0.0	0.0	25.0	0.0	0.0	0.0
Synedra sp.	0.0	0.0	0.0	12.5	0.0	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total No of Taxa	**8.0**	**3.0**	**4.0**	**5.0**	**8.0**	**14.0**	**13.0**	**27.0**	**11.0**	**6.0**	**3.0**	**2.0**	**3.0**	**2.0**
January														
Achnanthes affinis	1.6	0.0	0.0	2.4	3.6	8.0	4.4	3.3	2.5	0.0	1.2	0.0	0.0	0.0
A. biasolettiana	0.0	22.5	4.7	3.6	2.9	24.0	7.3	7.6	9.9	12.6	13.4	24.2	0.0	0.0
A. grischuma	0.0	2.8	0.0	0.0	1.4	0.0	6.5	0.0	4.1	2.1	0.0	0.0	0.0	25.0
A. Hauckiana	0.0	5.6	0.0	3.6	2.9	14.0	0.0	1.1	0.0	0.0	1.2	0.0	0.0	0.0
A. holsatica	0.0	0.0	0.0	4.8	0.0	0.0	4.4	0.0	4.1	3.2	0.0	0.0	0.0	0.0
A. lanceolata	4.8	0.0	0.0	0.0	3.6	12.0	0.0	6.0	0.0	0.0	2.4	12.1	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
A. lanceolata														
var. lanceolata	0.0	4.2	0.0	6.0	2.9	0.0	2.2	0.0	5.0	4.2	0.0	0.0	0.0	0.0
A. lemmarmanii	0.0	7.0	2.3	0.0	4.3	0.0	2.9	3.3	0.0	0.0	2.4	15.2	0.0	8.3
A. linearis	3.2	0.0	0.0	7.2	5.0	6.0	0.0	6.5	5.0	0.0	0.0	0.0	18.2	0.0
A. minutissima	23.8	12.7	10.5	6.0	2.9	0.0	3.6	8.2	2.5	2.1	0.0	0.0	0.0	0.0
Anomoneis sp.	0.0	0.0	0.0	1.2	0.7	8.0	0.0	0.5	0.0	0.0	3.7	0.0	0.0	0.0
Cocconeis placentula	7.9	0.0	4.7	3.6	0.0	0.0	2.9	1.1	3.3	1.1	0.0	0.0	0.0	16.7
Cymbella affinis	3.2	0.0	0.0	2.4	0.7	4.0	0.0	1.6	4.1	0.0	2.4	0.0	0.0	0.0
C. amphicephala	0.0	4.2	0.0	2.4	1.4	6.0	4.4	2.7	1.7	3.2	0.0	0.0	0.0	0.0
C. excisa	0.0	0.0	2.3	1.2	0.0	0.0	3.6	0.0	4.1	0.0	1.2	0.0	0.0	0.0
C. exigua	0.0	1.4	0.0	0.0	1.4	8.0	5.8	1.6	0.0	2.1	0.0	0.0	0.0	0.0
C. gracile	0.0	0.0	2.3	0.0	2.1	0.0	2.9	1.1	1.7	0.0	2.4	0.0	0.0	0.0
C. hungarica	4.8	0.0	0.0	4.8	0.0	10.0	0.0	1.1	0.0	4.2	0.0	0.0	0.0	0.0
C. Hustedii	0.0	1.4	3.5	0.0	1.4	0.0	2.2	1.6	4.1	0.0	0.0	0.0	0.0	0.0
C. kolbei	0.0	0.0	2.3	3.6	0.0	0.0	2.9	0.0	2.5	2.1	0.0	0.0	0.0	0.0
C. kolbei var. *angusta*	3.2	0.0	1.2	3.6	0.0	0.0	0.0	1.1	0.8	0.0	0.0	0.0	0.0	0.0
C. ventricosa	0.0	0.0	5.8	0.0	2.9	0.0	3.6	0.0	2.5	0.0	0.0	0.0	0.0	0.0
Cymbella sp.	0.0	2.8	0.0	2.4	2.1	0.0	0.0	1.1	0.0	3.2	0.0	0.0	0.0	0.0
Fragilaria sp.	3.2	0.0	2.3	0.0	1.4	0.0	2.2	0.0	3.3	0.0	0.0	0.0	0.0	0.0
Fragilaria vaucheriae	0.0	0.0	7.0	0.0	2.1	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0
Geissleria sp.	1.6	0.0	1.2	0.0	1.4	0.0	2.9	0.0	1.7	3.2	0.0	0.0	0.0	0.0
Gomphonema bohemicum	0.0	4.2	2.3	0.0	2.9	0.0	0.0	1.6	0.0	0.0	2.4	12.1	0.0	0.0
G. gracile	3.2	0.0	0.0	3.6	0.0	0.0	3.6	1.1	0.0	5.3	0.0	0.0	0.0	0.0
G. insigniforme	0.0	0.0	3.5	0.0	2.1	0.0	0.7	2.2	0.0	0.0	3.7	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
G. intricatum	0.0	4.2	0.0	2.4	0.0	0.0	0.0	1.1	4.1	4.2	0.0	0.0	36.4	0.0
G. lanceolata	4.8	0.0	4.7	0.0	2.9	0.0	1.5	1.6	0.0	0.0	6.1	15.2	0.0	0.0
G. micropus	0.0	0.0	2.3	0.0	3.6	0.0	0.0	2.2	2.5	4.2	0.0	0.0	18.2	0.0
G. olivaceoides	3.2	2.8	0.0	1.2	0.0	0.0	2.2	1.6	0.0	0.0	4.9	12.1	0.0	0.0
G. olivaceum	0.0	0.0	3.5	0.0	2.1	0.0	0.0	2.2	1.7	3.2	0.0	0.0	27.3	0.0
G. parvulum	4.8	0.0	0.0	0.0	8.6	0.0	2.9	4.4	0.0	0.0	4.9	3.0	0.0	33.3
*Gomphonema*sp.	0.0	2.8	2.3	0.0	2.1	0.0	0.0	3.3	2.5	5.3	0.0	6.1	0.0	0.0
G. sphaerophorum	3.2	0.0	1.2	3.6	0.0	0.0	1.5	3.8	0.0	0.0	2.4	0.0	0.0	0.0
Hannaea arcus	0.0	0.0	1.2	0.0	1.4	0.0	0.0	1.6	1.7	2.1	0.0	0.0	0.0	0.0
Hannaea arcus var. *amphioxys*	3.2	1.4	0.0	2.4	0.0	0.0	2.9	2.2	0.0	0.0	3.7	0.0	0.0	0.0
Navicula cincta	0.0	0.0	2.3	0.0	2.1	0.0	1.5	0.0	4.1	4.2	0.0	0.0	0.0	0.0
N. cryptocephala	6.4	0.0	3.5	1.2	0.0	0.0	0.0	2.7	0.0	2.1	2.4	0.0	0.0	0.0
N. cryptotenella	0.0	4.2	0.0	2.4	0.0	0.0	3.6	1.1	1.7	1.1	2.4	0.0	0.0	0.0
N. cryptotenelloides	0.0	0.0	2.3	0.0	1.4	0.0	2.2	0.0	3.3	3.2	0.0	0.0	0.0	0.0
N. grimmei	0.0	1.4	2.3	0.0	1.4	0.0	0.0	2.2	0.0	1.1	6.1	0.0	0.0	0.0
N. radiosa	4.8	0.0	4.7	0.0	5.0	0.0	2.9	1.1	0.0	0.0	4.9	0.0	0.0	0.0
N. rhyncocephala	0.0	2.8	3.5	4.8	2.1	0.0	0.0	1.6	2.5	4.2	3.7	0.0	0.0	0.0
N. salinicola	0.0	0.0	2.3	0.0	2.9	0.0	1.5	1.1	0.0	0.0	6.1	0.0	0.0	0.0
Navicula sp.	0.0	2.8	0.0	2.4	0.0	0.0	0.0	2.2	3.3	2.1	4.9	0.0	0.0	16.7
Nitzschia sp.	0.0	0.0	2.3	1.2	1.4	0.0	0.7	0.0	4.1	0.0	1.2	0.0	0.0	0.0
Pinnularia sp.	6.4	0.0	0.0	2.4	0.0	0.0	0.0	2.7	0.0	2.1	1.2	0.0	0.0	0.0
Planothidium lanceolata	3.2	0.0	3.5	7.2	5.0	0.0	5.8	0.0	2.5	8.4	2.4	0.0	0.0	0.0
Reimeria sinuata	0.0	5.6	0.0	3.6	3.6	0.0	0.0	1.1	0.0	3.2	6.1	0.0	0.0	0.0
Surirella sp.	0.0	0.0	2.3	1.2	0.7	0.0	1.5	4.4	0.8	1.1	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Synedra sp.	0.0	2.8	0.0	1.2	1.4	0.0	0.7	0.5	2.5	0.0	0.0	0.0	0.0	0.0
Total No of Taxa	**20.0**	**20.0**	**30.0**	**29.0**	**39.0**	**10.0**	**33.0**	**29.0**	**32.0**	**25.0**	**27.0**	**6.0**	**4.0**	**5.0**
February, 2015														
Achnanthes affinis	5.8	0.0	6.6	2.6	2.7	0.0	3.6	4.2	0.0	7.4	0.0	0.0	0.0	0.0
Achnanthes biasolettiana	5.3	4.5	0.0	4.6	1.1	0.9	2.1	0.0	0.0	0.0	0.0	12.5	0.0	0.0
Achnanthes grischuma	0.0	1.8	0.0	0.0	2.1	0.0	2.1	5.1	0.0	2.7	0.0	0.0	0.0	0.0
Achnanthes lanceolata var. *lanceolata*	0.0	2.7	0.0	3.9	0.0	1.8	0.6	0.0	9.1	0.0	0.0	0.0	0.0	17.1
Achnanthes lemmarmanii	4.5	5.4	0.0	0.0	4.0	0.0	1.5	0.0	0.0	3.4	0.0	16.7	0.0	0.0
Achnanthes linearis	0.0	5.4	0.0	5.4	2.1	0.0	1.5	9.3	0.0	0.0	4.4	0.0	8.5	0.0
Achnanthidium arcus	0.0	0.0	1.8	0.0	3.2	0.0	1.2	0.0	0.0	6.7	0.0	0.0	0.0	0.0
Achnanthidium minutissimum	7.8	0.0	4.4	6.3	0.0	2.7	0.9	0.0	3.8	0.0	0.0	0.0	0.0	12.9
Achnanthidium affine	0.0	4.5	0.0	1.7	4.3	0.0	1.8	5.9	0.0	3.4	0.0	0.0	0.0	0.0
Anomoneis sp.	0.0	0.0	2.2	0.0	0.0	1.4	0.6	0.0	9.1	0.0	8.7	0.0	0.0	0.0
Cocconeis placentula	1.8	0.0	6.2	0.0	3.5	0.0	0.0	5.5	0.0	4.0	0.0	0.0	0.0	0.0
Cocconeis placentula var *lineata*	0.0	4.1	0.0	0.2	0.0	1.8	1.8	0.0	8.3	0.0	0.0	0.0	0.0	0.0
Cocconeis placentula var. *euglypta*	0.0	3.2	0.0	0.7	1.1	0.0	0.0	5.9	0.0	4.7	0.0	25.0	0.0	0.0
Cymbella affinis	1.0	0.0	1.3	0.0	4.0	0.0	1.5	0.0	0.0	2.0	0.0	0.0	7.8	0.0
Cymbella gracile	2.0	0.0	3.1	2.6	0.0	0.0	0.0	0.0	0.0	2.7	0.0	0.0	0.0	8.6
Cymbella kolbei var. angusta	0.0	2.3	0.0	0.0	1.9	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cymbella ventricosa	1.8	0.0	2.7	2.2	0.0	0.0	1.2	0.0	3.0	0.0	0.0	0.0	0.0	0.0
Cymbella hungarica	2.3	2.3	0.0	0.0	2.7	0.9	0.0	0.0	0.0	4.0	0.0	8.3	0.0	0.0
Cymbella laevis Nägeli	0.0	0.0	4.4	3.0	0.8	0.0	3.0	0.0	0.0	2.0	0.0	0.0	0.0	5.7
Cymbella lancettula	0.0	3.2	0.0	0.0	3.8	2.3	0.0	4.7	0.0	1.3	0.0	0.0	0.0	0.0
Cymbella nagpurensis	3.0	0.0	3.1	0.0	0.8	0.0	0.0	5.9	0.0	0.0	21.7	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Cymbella parva	0.0	2.3	0.0	0.7	1.1	3.2	3.6	0.0	0.0	0.0	4.4	0.0	0.0	0.0
Cymbells affinis	0.0	1.4	0.0	0.0	1.6	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0
Encyonema sp.	2.5	0.0	2.2	1.1	0.3	0.9	4.5	0.9	0.0	5.4	0.0	0.0	4.3	0.0
Encyonema subminisculus	0.0	4.5	0.0	0.0	4.0	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0
Encyonema elginense	0.0	5.9	0.0	0.0	3.8	0.0	4.2	0.0	0.0	6.0	17.4	0.0	0.0	0.0
Encyonema gracile	0.0	6.3	0.0	1.3	3.2	5.9	0.0	0.9	0.0	0.0	0.0	0.0	0.0	10.0
Encyonema hebridicum	2.0	0.0	5.3	0.0	0.0	0.0	3.9	0.0	3.8	0.0	0.0	0.0	0.0	0.0
Encyonema jemtlandicum var. *venezolana*	0.0	2.7	0.0	3.0	0.5	5.4	0.0	1.3	0.0	2.0	0.0	0.0	0.0	0.0
Fragilaria sp.	2.5	0.0	0.0	0.0	1.1	0.0	2.7	0.0	2.3	0.0	0.0	0.0	0.0	5.7
Fragilaria vaucheriae	0.0	1.8	0.0	0.0	0.0	4.1	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema acuminatum	0.0	2.3	0.0	0.0	0.0	0.0	2.4	0.0	4.6	0.0	13.0	0.0	0.0	0.0
Gomphonema aff bohemicum ssp. *angustatum*	4.5	0.0	0.0	2.4	0.0	0.0	0.0	5.9	0.0	4.7	0.0	0.0	0.0	8.6
Gomphonema bohemicum	0.0	2.7	0.0	0.0	1.3	5.9	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema gracile	0.8	0.0	0.0	3.0	0.0	0.0	0.9	5.1	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema insigniforme	0.0	4.5	1.3	0.0	1.9	0.0	3.9	0.0	0.0	1.3	0.0	0.0	0.0	0.0
Gomphonema intricatum	0.0	5.4	0.0	3.7	0.0	1.8	0.6	3.4	0.0	0.0	0.0	20.8	0.0	7.1
Gomphonema intricatum var. *subclavata*	0.0	0.0	2.2	0.0	1.1	0.0	3.3	0.9	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema lacus var. vulcari	0.0	3.6	0.0	2.6	0.0	1.8	0.9	0.0	0.0	0.7	0.0	0.0	0.0	0.0
Gomphonema lanceolata	3.8	0.0	0.0	0.0	3.2	0.0	3.0	2.1	0.0	0.0	0.0	0.0	0.0	5.7
Gomphonema loglinear	0.0	5.4	0.0	2.8	0.0	0.5	0.0	0.4	0.0	8.1	0.0	0.0	0.0	0.0
Gomphonema micropus	4.5	0.0	4.4	0.0	0.0	6.3	2.7	0.0	0.0	0.0	13.0	0.0	0.0	0.0
Gomphonema olivaceoides	0.0	2.3	0.0	2.0	3.0	0.0	0.6	0.9	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema olivaceum	3.8	0.0	0.0	2.2	0.0	5.9	2.4	0.0	0.0	6.7	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Gomphonema olivaceum var. *olivaceoides*	2.5	0.0	5.3	2.6	0.0	0.0	2.1	1.3	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema parvulum	0.0	1.8	0.0	0.0	3.5	0.0	0.9	0.0	3.0	0.0	0.0	0.0	0.0	4.3
Gomphonema parvulum var. *pumilum*	2.3	0.0	0.0	0.9	0.0	5.4	0.3	0.0	0.0	0.0	0.0	0.0	8.5	0.0
Gomphonema perpusila	0.0	1.4	0.0	1.7	0.0	0.0	1.5	0.0	4.6	0.0	0.0	0.0	0.0	0.0
Gomphonema sp.	1.3	0.0	4.0	0.0	3.8	0.0	0.0	0.9	0.0	0.0	0.0	0.0	10.6	0.0
Gomphonema sphaerophorum	0.0	0.0	0.0	2.8	0.0	5.0	0.9	3.4	0.0	5.4	0.0	0.0	0.0	2.9
Gomphonema auritum	0.0	0.0	3.5	0.0	4.3	0.0	3.6	0.0	0.0	0.0	0.0	0.0	9.9	0.0
Gomphonema bohemicum	0.0	0.0	0.0	0.0	0.0	5.9	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema clavatum	0.8	0.0	0.0	2.2	0.0	0.0	2.7	0.0	0.0	3.4	0.0	0.0	8.5	0.0
Gomphonema cymbelliclinum	0.0	0.0	2.7	0.0	3.5	1.4	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema grovei var. *lingulatum*	1.8	0.0	0.0	2.6	0.0	1.4	0.6	0.0	3.0	0.0	0.0	0.0	0.0	0.0
Gomphonema helveticum	0.0	0.0	3.1	0.0	2.7	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0
Gomphonema innocens	0.0	2.3	0.0	0.7	0.0	3.6	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0
Gomphonema intricatum	3.8	0.0	2.2	0.0	0.8	0.0	1.5	0.0	0.0	1.3	0.0	0.0	0.0	0.0
Gomphonema intricatum var. *pumilum*	0.0	0.0	0.0	1.3	0.0	0.0	0.9	0.0	1.5	0.0	0.0	0.0	0.0	0.0
Gomphonema intricatum var. *vibrio*	4.5	0.0	4.4	0.0	0.0	3.2	0.0	1.3	0.0	0.0	17.4	8.3	0.0	0.0
Gomphonema longiceps	0.0	2.3	0.0	0.0	3.2	0.0	2.1	0.0	0.0	2.0	0.0	0.0	0.0	0.0
Gomphonema micropus	3.5	0.0	0.0	2.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	8.5	0.0
Gomphonema micropus var. *aequale*	0.0	0.0	2.7	0.0	0.0	0.0	1.8	1.7	0.0	0.7	0.0	0.0	0.0	0.0
Gomphonema olivaceum var. *minutissi mum*	2.5	0.0	0.0	2.2	0.0	0.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	4.3
Hannaea arcus	0.0	0.0	3.1	0.0	0.0	2.3	1.8	0.0	0.0	0.7	0.0	0.0	1.4	0.0
Hannaea arcus var. *amphioxys*	0.0	0.0	0.0	2.6	0.0	1.4	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0
Navicula cincta	4.0	1.8	0.0	0.0	0.0	0.0	0.9	0.0	0.0	1.3	0.0	0.0	0.0	1.4

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Navicula cryptocephala	0.0	0.0	0.0	2.0	0.0	1.8	0.0	0.0	15.9	0.0	0.0	0.0	0.0	0.0
Navicula grimmei	0.0	0.0	3.1	0.0	3.2	0.0	1.2	2.5	0.0	0.0	0.0	0.0	3.6	0.0
Navicula radiosa	2.3	0.0	0.0	3.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0
Navicula rhyncocephala	0.0	0.0	4.0	0.0	0.0	2.7	0.6	0.0	0.0	2.7	0.0	0.0	5.0	0.0
Navicula salinicola	2.0	0.0	0.0	0.0	4.0	0.0	1.2	0.0	3.0	0.0	0.0	0.0	0.0	0.0
Navicula sp.	0.0	0.5	0.0	2.8	0.0	2.3	0.0	0.9	0.0	0.7	0.0	8.3	0.0	0.0
Nitzschia sp.	0.0	0.0	0.0	2.6	0.0	0.0	1.8	0.0	3.0	0.0	0.0	0.0	0.0	0.0
Pinnularia sp.	1.3	0.0	5.3	1.7	0.0	3.2	0.0	1.3	0.0	0.0	0.0	0.0	1.4	0.0
Planothidium lanceolata	0.0	0.0	0.0	0.0	5.6	0.0	0.9	0.0	4.6	0.0	0.0	0.0	0.0	4.3
Planothidium lanceolata														
for. *ventricosa*	5.3	0.0	0.0	2.6	0.0	0.5	0.6	0.0	0.0	2.0	0.0	0.0	8.5	0.0
Psammothidium levanderi	0.0	0.0	4.4	0.0	0.0	0.0	2.1	0.0	5.3	0.0	0.0	0.0	11.4	0.0
Reimeria sinuata	0.0	0.0	0.0	2.2	0.0	0.9	0.0	1.7	0.0	0.0	0.0	0.0	2.1	1.4
Surirella sp.	0.8	0.0	0.9	0.0	0.3	0.0	1.5	0.0	2.3	0.0	0.0	0.0	0.0	0.0
Synedra amphirhynchus	0.0	0.0	0.0	1.7	0.0	1.4	0.0	0.9	0.0	0.7	0.0	0.0	0.0	0.0
Synedra oxyrhynchus	2.5	0.0	0.0	2.0	1.1	0.0	0.6	0.0	3.8	0.0	0.0	0.0	0.0	0.0
Synedra sp.	1.5	0.0	5.3	3.3	0.0	0.5	0.9	0.4	1.5	0.0	0.0	0.0	0.0	0.0
Total no. of taxa	**35.0**	**31.0**	**30.0**	**43.0**	**40.0**	**38.0**	**55.0**	**36.0**	**22.0**	**31.0**	**8.0**	**6.0**	**14.0**	**15.0**
March, 2015														
Achnanthes affinis	12.2	26.9	35.9	0.0	2.5	8.6	2.2	0.0	20.8	0.0	12.5	20.0	7.7	15.4
A. biasolettiana	0.0	7.7	0.0	7.1	30.0	2.5	0.0	12.5	0.0	15.4	0.0	3.3	0.0	0.0
A. conspicua	4.8	0.0	7.7	0.0	0.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A. exilis	1.4	0.0	0.0	10.7	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	30.8	0.0
A. linearis	40.8	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

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
Achnanthidium lanceolata	0.0	0.0	12.8	0.0	5.0	4.9	0.0	0.0	0.0	3.9	0.0	6.7	0.0	15.4
A. lanceolata var. elliptica	4.8	0.0	0.0	0.0	5.0	0.0	0.0	0.0	8.3	0.0	12.5	0.0	0.0	0.0
A. minutissima	9.5	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	7.7	0.0
A. plonensis	8.2	0.0	0.0	3.6	0.0	3.7	0.0	0.0	0.0	11.5	0.0	3.3	0.0	0.0
A. subsalsa	0.0	0.0	0.0	0.0	2.5	0.0	13.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0
Cocconeis placentula	5.4	0.0	0.0	0.0	0.0	4.9	2.2	0.0	16.7	0.0	0.0	0.0	0.0	23.1
Achnanthes sp.	0.0	0.0	0.0	0.0	7.5	0.0	0.0	0.0	0.0	7.7	0.0	0.0	0.0	0.0
C. placentula var. *euglypta*	0.0	0.0	0.0	0.0	0.0	2.5	6.5	0.0	0.0	0.0	0.0	13.3	0.0	0.0
Cymbella affinis	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0
C. amphicephala	0.0	0.0	0.0	0.0	0.0	0.0	8.7	0.0	0.0	15.4	0.0	0.0	15.4	0.0
C. hebridica	0.0	0.0	0.0	0.0	0.0	6.2	0.0	0.0	0.0	0.0	4.2	0.0	0.0	0.0
C. kerkevarensis	1.4	0.0	0.0	0.0	0.0	0.0	10.9	0.0	0.0	7.7	0.0	3.3	0.0	0.0
C. laevis	0.0	0.0	0.0	0.0	5.0	2.5	6.5	0.0	12.5	0.0	0.0	0.0	0.0	23.1
C. perpusila	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. Reinhardtii	2.0	0.0	0.0	0.0	2.5	2.5	6.5	0.0	0.0	0.0	16.7	0.0	0.0	0.0
C. sinuata	0.0	0.0	0.0	10.7	7.5	4.9	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0
C. turgida	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
C. ventricosa	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	15.4
Diatoma hiemale	4.1	0.0	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fragilaria sp.	0.0	0.0	0.0	0.0	5.0	4.9	10.9	0.0	0.0	15.4	0.0	0.0	15.4	0.0
F. construens	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.5	0.0	0.0	0.0
F. capucina	0.0	7.7	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. intermedia	0.0	0.0	10.3	0.0	0.0	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F. pinnata	0.0	3.9	0.0	7.1	0.0	0.0	4.4	0.0	12.5	0.0	0.0	3.3	0.0	0.0
F. rumpens	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0
Gomphonema gracile	0.0	0.0	0.0	10.7	5.0	3.7	0.0	0.0	0.0	3.9	0.0	0.0	0.0	0.0

	Sampling Sites													
Taxa	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**
G. longiceps var. *subclavata*	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	3.3	0.0	0.0
G. olivaceum	0.0	23.1	0.0	0.0	0.0	2.5	0.0	18.8	0.0	0.0	0.0	0.0	0.0	0.0
G. olivaceum var. *minutissima*	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	11.5	0.0	13.3	0.0	7.7
G. parvulum	0.0	0.0	0.0	3.6	0.0	1.2	0.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0
G. tergestinum	0.0	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula cincta	0.0	3.9	5.1	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	6.7	0.0	0.0
N. cryptocephala var. *veneta*	2.0	0.0	0.0	10.7	0.0	4.9	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0
N. gracilis	0.0	0.0	0.0	3.6	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. microcephala	0.0	7.7	2.6	0.0	0.0	3.7	2.2	0.0	0.0	0.0	0.0	0.0	15.4	0.0
N. radiosa	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0
N. radiosa var. tenella	0.0	0.0	2.6	0.0	0.0	2.5	0.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula sp.	0.0	11.5	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pinnularia appendiculata	0.0	0.0	0.0	0.0	0.0	1.2	4.4	0.0	8.3	0.0	0.0	10.0	0.0	0.0
Pinnularia sp.	0.0	0.0	5.1	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reimeria sinuata	0.0	0.0	0.0	7.1	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Planothidium lanceolata	0.0	0.0	0.0	0.0	0.0	7.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Synedra acus	0.7	0.0	2.6	0.0	0.0	1.2	2.2	0.0	0.0	0.0	8.3	0.0	0.0	0.0
Synedra ulna	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0	7.7	0.0	0.0	0.0	0.0
Synedra ulna var. aequalis	0.0	0.0	2.6	0.0	0.0	2.5	0.0	6.3	0.0	0.0	0.0	0.0	7.7	0.0
Synedra ulna var. amphirhynchus	0.0	0.0	0.0	3.6	0.0	0.0	8.7	0.0	8.3	0.0	4.2	0.0	0.0	0.0
Total no. of taxa	**13.0**	**9.0**	**11.0**	**9.0**	**15.0**	**26.0**	**13.0**	**7.0**	**7.0**	**10.0**	**9.0**	**13.0**	**6.0**	**6.0**

Table-8.13: Relative abundance of phytoplankton (Diatom) in Riyang Khola, West Bengal

Taxa	Months									
	May	July	August	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Achnanthes affinis	66.67	0.00	6.25	0.00	2.50	2.33	6.35	2.13	12.40	10.00
A. arcus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.65	0.00
A. austriaca	0.00	12.50	0.00	0.00	0.00	0.00	4.76	0.00	1.00	0.00
A. biasolettiana	0.00	25.00	0.00	0.00	5.00	4.65	0.00	6.38	2.00	0.00
A. biasolettiana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.65	8.57
var. subatomus	0.00	0.00	12.50	0.00	0.00	0.00	3.17	0.00	0.00	0.00
A. biasolettiana var. *thienemanii*	0.00	0.00	0.00	8.70	0.00	0.00	0.00	5.32	0.00	0.00
A. Boyei	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.00	0.00
A. brevipes	0.00	0.00	0.00	0.00	5.00	4.65	0.00	3.19	0.00	0.00
A. brevipes var. *intermedia*	0.00	0.00	0.00	0.00	0.00	0.00	4.76	0.00	0.00	0.00
A. conspicua	0.00	0.00	0.00	21.74	0.00	0.00	0.00	0.00	0.00	0.00
A. construens	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.00	0.00
A. cranulata	0.00	0.00	0.00	0.00	0.00	0.00	6.35	0.00	0.00	0.00
A. exigua	0.00	0.00	18.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A. exilis	0.00	0.00	12.50	0.00	10.00	9.30	0.00	4.26	0.00	9.29
A. grischuma	0.00	0.00	0.00	0.00	2.50	2.33	0.00	0.00	2.48	0.00
A. lanceolata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.19	0.00	0.00
A. lanceolata var. *elliptica*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.29
A. Lapidosa	0.00	0.00	0.00	0.00	5.00	4.65	0.00	0.00	0.00	0.00
A. Lemmermanni	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	2.48	0.00
Achnanthidium minutissima	33.33	62.50	25.00	0.00	0.00	0.00	11.11	0.00	0.00	2.86
Achnanthidium affine	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.61	0.00
A. plonensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.29
Anomoneis sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.83	5.00
C. placentula var. *lineata*	0.00	0.00	0.00	0.00	0.00	0.00	1.59	0.00	4.96	0.00
C. placentula var. *euglypta*	0.00	0.00	0.00	0.00	0.00	0.00	3.17	0.00	0.00	1.43
Cymbella affinis	0.00	0.00	0.00	0.00	5.00	4.65	3.17	0.00	1.65	2.14
C. turgida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71

Taxa	Months									
	May	July	August	Sep	Oct	Nov	Dec	Jan	Feb	Mar
C. gracile	0.00	0.00	0.00	0.00	0.00	0.00	1.59	1.06	0.00	0.00
C. hungarica	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.00	0.00
C. kolbei var. angusta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.65	0.00
C. lancettula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.19	2.48	0.00
C. parva	0.00	0.00	0.00	0.00	2.50	2.33	0.00	2.13	1.65	0.00
C. ventricosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.65	0.00
C. hebridica	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.86
C. kerkevarensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.57
C. perpusila	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.29
Encyonema sp.	0.00	0.00	0.00	8.70	0.00	0.00	0.00	1.06	0.00	0.00
E. gracile	0.00	0.00	0.00	0.00	0.00	0.00	1.59	0.00	0.00	0.00
E. hebridicum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	3.31	0.00
E. subminisculus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.13	0.00
Fragilaria sp.	0.00	0.00	0.00	4.35	0.00	0.00	3.17	0.00	0.00	2.86
F. vaucheriae	0.00	0.00	0.00	8.70	0.00	0.00	3.17	4.26	0.00	0.00
F. capucina	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.14
F. intermedia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.86
F. pinnata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.57
F. rumpens	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71
Gomphonema acuminatum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.65	0.00
G. bohemicum	0.00	0.00	0.00	0.00	5.00	4.65	1.59	5.32	0.00	0.00
G. gracile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.31	0.00
G. insigniforme	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.19	1.65	0.00
G. intricatum	0.00	0.00	0.00	0.00	0.00	0.00	3.17	4.26	0.00	0.00
G. lacus var. *vulcari*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.32	2.48	0.00
G. lanceolata	0.00	0.00	0.00	0.00	7.50	6.98	0.00	3.19	0.00	0.00
G. loglinear	0.00	0.00	0.00	0.00	0.00	0.00	1.59	3.19	0.00	
G. micropus	0.00	0.00	0.00	0.00	5.00	4.65	0.00	0.00	3.31	0.00
G. olivaceoides	0.00	0.00	0.00	0.00	0.00	0.00	3.17	2.13	1.65	0.00

Taxa	Months									
	May	July	August	Sep	Oct	Nov	Dec	Jan	Feb	Mar
G. olivaceum	0.00	0.00	0.00	0.00	2.50	2.33	0.00	1.06	0.00	0.71
G. parvulum	0.00	0.00	18.75	0.00	0.00	0.00	1.59	0.00	0.00	0.00
Gomphonema sp.	0.00	0.00	0.00	0.00	2.50	2.33	0.00	0.00	0.00	0.00
G. sphaerophorum	0.00	0.00	6.25	8.70	0.00	0.00	0.00	2.13	0.00	0.00
G. auritum	0.00	0.00	0.00	0.00	0.00	0.00	1.59	0.00	0.00	0.00
G. bohemicum	0.00	0.00	0.00	4.35	5.00	4.65	0.00	0.00	0.00	0.00
G. clavatum	0.00	0.00	0.00	0.00	0.00	0.00	1.59	1.06	0.00	0.00
G. cymbelliclinum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.44	0.00
G. grovei	0.00	0.00	0.00	0.00	0.00	0.00	3.17	0.00	0.00	0.00
G. helveticum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.00	0.00
G. intricatum	0.00	0.00	0.00	8.70	0.00	0.00	4.76	0.00	0.00	0.00
G. longiceps	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.06	3.31	0.00
G. longiceps var. *subclavata*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71
G. micropus	0.00	0.00	0.00	0.00	0.00	0.00	4.76	0.00	0.00	0.00
G. olivaceum	0.00	0.00	0.00	0.00	5.00	4.65	0.00	0.00	0.00	0.00
G. tergestinum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.14
Gomphonema auritum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.48	0.00
Hannaea arcus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.00	0.00
Hannaea arcus var. *amphioxys*	0.00	0.00	0.00	0.00	0.00	0.00	6.35	0.00	2.48	0.00
N. cryptocephala	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.19	4.96	0.00
N. cryptocephala var. veneta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.86
N. grimmei	0.00	0.00	0.00	0.00	0.00	0.00	3.17	0.00	0.00	0.00
N. rhyncocephala	0.00	0.00	0.00	0.00	2.50	2.33	0.00	2.13	0.00	0.00
Navicula sp.	0.00	0.00	0.00	0.00	5.00	4.65	0.00	0.00	0.00	0.00
N. microcephala	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43
Navicula sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.48	
Nitzschia sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.06	0.00	0.00
Pinnularia sp.	0.00	0.00	0.00	0.00	5.00	4.65	0.00	0.00	0.00	0.00
Pinnularia appendiculata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43

Taxa	**Months**									
	May	**July**	**August**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**
Planothidium lanceolata	0.00	0.00	0.00	13.04	15.00	13.95	0.00	3.19	0.00	0.00
P. lanceolata for. *ventricosa*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.14
Reimeria sinuata	0.00	0.00	0.00	4.35	0.00	0.00	3.17	0.00	0.00	2.86
Surirella sp.	0.00	0.00	0.00	0.00	2.50	2.33	0.00	0.00	1.65	2.86
Synedra ulna	0.00	0.00	0.00	8.70	0.00	0.00	0.00	2.13	0.00	2.86
S. amphirhynchus	0.00	0.00	0.00	0.00	0.00	0.00	6.35	0.00	0.00	0.71
S. oxyrhynchus	0.00	0.00	0.00	0.00	7.50	6.98	0.00	5.32	3.31	0.00
S. ulna var. aequalis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43

Source: Primary survey

None of the species is endemic and threatened and listed in CITES

CHAPTER 9
FISHERIES

CHAPTER - 9
FISHERIES

9.1 INTRODUCTION

Drainage area, drainage pattern and relief of Teesta basin provide a fair scope of high diversity of ichthyo fauna. Teesta river originates as ChhomboChhu from a glacial lake Khangchung Chho at an elevation of 5,280 m in the northeastern corner of Sikkim state. The glacial lake lies at the snout of the Teesta Khangse glacier descending from Pauhunri peak (7,056 m) in north western direction (http://www.sikkimforest.gov.in/). The catchment area of West Bengal can further be divided into hilly region (1121 sq km) and flood plain region (2104 sq Km). This contribution pertains to the baseline data to assess the cumulative impacts of cascade development on fish and fisheries of Teesta river basin in West Bengal. All projects of cascade development are located exclusively in hilly region of West Bengal having a catchment area of 1121 sq km.

Fish fauna occupies top trophic level in the aquatic ecosystem of Himalaya. Fish fauna are highly dependent on the characteristics of habitat and are highly sensitive to change in the flow pattern. Degree of impacts of river regulation essentially relies on the ecological niches that vary from species to species. Some of the species are bottom dwellers while others are column feeders. Also, a few species perform migration for a specific purpose. The cascade development in lower reaches of Teesta basin is certainly expected to alter the habitat directly. River regulation essentially results into alteration of natural flow regime, reduced frequency of flood flows, changes in the river levels, increased rate of fall of river levels and hampered fish movement due to dam/barrage/weir bodies. River regulation, thus, has major impacts on the fish migration and drastic change in the habitat characteristics. Studies indicated that the impounded stretches of a river do not provide the conducive environment for native species, generally favour the alien species (Gehrke et al., 1995). Himalayan rivers show rhythmic pattern in flow, in winter season, rivers carry minimum flow while in monsoon flood flows are prevalent. Such temporal and spatial variations in flows for long time have evolved life history strategies in the organisms. The flood regimes are considered as natural disturbances, which are important for ecological integrity and habitat connectivity and survival of organisms like fish fauna.

The river regulation disrupts the intensity, frequency and timing of the natural disturbance that is responsible for maintaining the ecological integrity of these dynamic systems (Ward and Stanford, 1995). This contribution is focused around the impacts of cascade development on fish fauna, fish migration, fisheries and livelihood of local people.

9.2 AFFINITIES

A part of the river flows through hilly terrain and is known for its coldwater fisheries. A few species inhabiting upper reaches of basin shows its strong affinities with Palaearctic region. ichthyofauna of the river drains the plain area of West Bengal and Bangla Desh is similar to fish fauna of Assam, Malayan region and Gangetic plains.

9.3 SPECIES COMPOSITION

The Teesta river basin area of 3225 sq km in West Bengal harbours more than 100 species of fresh water fish. Out of these species hilly region under the cascade development is inhabited by about 67 species of 10 families. Cyprinidae is largest family accounting for 46% of total fish species in hilly area and 44% in the total basin. The details are given in Table-9.1. Majority of fish species makes their fair appearance in the study area while *Barilius barna*, *Barilius bendelisis*, *Garra gotyla gotyla*, *Schizothorax richardsonii*, *Neolissocheilushexagonolepis*, *Nemacheiluss caturigina*, *Schistura devdevi* are abundant species. A few species like *Barilius barila*, *Puntius ticto*, *Pangio pangia*, Botialoha chata, *Parachiloglanis hodgarti* and *Olyralongi caudata* are rare species in Teesta.

The species like *Barilius* spp. *Schizothorax* spp. *Garra* sp. *Nemacheilus* spp. *Schistura* spp, *Glyptothorax* spp. etc. are widely distributed in the Teesta basin and are found in upper reaches above 200 m. While some of the species like *Canthophrys gongota*, *Pangio pangia*, *Balitora brucei*, *Bagarius bagarius*, *Gagata cenia*, *Olyralongi caudata*, *Amblyceps mangois*, *Sisorrhabdo phorus*, show narrow range of distribution up to 200 m and are restricted to floodplains mainly. The species like *Tor putitora*, *Tor tor*, *Labeopungusia*, *Labeoboga*, etc. generally inhabit foothill stretch and show seasonal migration up to 850 m in the tributaries.

Table 9.1 Fish species composition in the study area of Teesta Lower Basin

Family /Scientific name	Vernacular	Conservation Status (IUCN)	Occurrence
Cyprinidae			
Barilius barna	Pothi/Ghol	LC	A
Barilius barila	Koksa	LC	R
Barilius bendelisis	Khabti/Joia	LC	A
Barilius shacra	Koksa	LC	F
Barilius tileo	Faketa/Koksa	LC	F
Barilius vagra	Koksa	LC	C
Cabdio m orar	Boroli	LC	F
Raiamas bola	Bhola/Ghol	LC	F
Devario devario	Bans Patta	LC	R
Devarioa equipinnatus	Chhebli	LC	F
Salmophasia bacaila	Chilwa/Chela	LC	F
Garra annandalei	Budhna	LC	F
Garra gotyla gotyla	Budhna/Patthar Chata	LC	A

Family /Scientific name	Vernacular	Conservation Status (IUCN)	Occurrence
Garralamta	Budhna	LC	R
Crossocheilus latius	Kala bata	LC	C
Schizothorax progastus	Chuche Asla	LC	F
Schizothorax richardsonii	Asla	VU	A
Chagunius chagunio	Darangi/Pathakati	LC	F
Cyprinion semiplotum	Chepti/Khurpe	VU	F
Bangana dero	Tikauli	LC	F
Labeo boga	Ghorea	LC	F
Labeo dyocheilus	Degra	LC	F
Labeo pungusia	Darangi	-	F
*Neolissocheilus hexagonolepis*Katle	-	A	
Neolissocheilus hexastichus	Katle	-	F
Torputi tora	Shahar/Mahseer	EN	F
Tor tor	Shahar/Mahseer	NT	R
Puntius conchonius	KanchanPunti	LC	R
Puntius gelius	GiliPunti	-	R
Puntius ticto	Tit Punti	LC	R
Psilorhynchidae			
Psilorhynchus balitora	Patharchati	LC	F
Psilorhynchus sucatio	Titae/Titari	LC	F
Psilorhynchus homaloptera	Patharchati	LC	R
Cobitidae			
Lepidocephalus guntea	Lata/Gethu	LC	R
Pangio pangia	Daria	LC	R
Canthophrys gongota	Jaguar Loach	LC	F
Botia lohachata	Rani Mach	-	R
Balitoridae			
Balitora brucei	TitaKabre	NT	F
Aborichthys elongatus	Bami Gadelo	LC	R
Acanthocobitis botia	Gadela	LC	R
Acanthocobtis botiaaureus	Gadela	-	F
Schistura beavani	Gadela/Bibhan Khorkey	LC	R
Schistura rupicola	Gadela/RupaliKhorkey	LC	F
Nemacheilus scaturigina	Gadela/Dari	LC	A
Nemacheilus corica	Gadela	LC	A
Schistura devdevi	Gadela/Khorkey	NT	A
Schistura multifasciatus	Gadela/Kharika	LC	C
Bagridae			
Batasio batasio	Batasi/Bajero	LC	F
Schilbeidae			
Clupisoma garua	Jalkapoor	LC	F
Clupisoma montana	Jalkapoor	LC	F
Ailia coila	Kajri/Kajoli	NT	F
Sisoridae			
Bagarius bagarius	Goonch/Bagha	LC	F
Parachiloglanis hodgarti	Til-Kabri	LC	R
Gagata cenia	Gong-Tengra	LC	F
Glyptothorax telchitta	Telchitta	LC	F
Glyptothorax cavia	Kani Tengra	LC	F

Family /Scientific name	Vernacular	Conservation Status (IUCN)	Occurrence
Glyptothorax conirostris	Kani Tengra	DD	F
Glyptothorax pectinopterus	Kani Tengra	LC	F
Gogangra viridescens	Gong Tengra	LC	F
Nangra nangra	Gong Tengra	LC	F
Pseudecheneis sulcata	Gotel/Kabre	LC	F
Pseudolaguvia shawi	Kani Tengra	LC	F
Sisor rhabdophorus	Chenua/Sisor	-	F
Amblyciptidae			
Amblyceps mangois	Bot Singhi	LC	R
Olyridae			
Olyra longicaudata	Bot Singhi	LC	R
Anguillidae			
Anguilla bengalensis	Banehara	NT	F
Mastacembelidae			
Mastacembelus armatus	Chisi Bam	LC	F

LC = Least Concerned, NT = Near Threatened, Vu = Vulnerable, EN – Endangered,
A = Abundant, C = Common, F = Fair, R = Rare

The study area under discussion is restricted in the hilly catchment of Teesta river in West Bengal, However, description of ichthyo fauna in lower stretch of Teesta river would be imperative because the impacts of cascade development would be prominent in the downstream area especially in case of ichthyo fauna. About 35 fish species are restricted in their occupancy in the flood plain of Teesta and its tributaries (Table 9.2). The fishing activities are well organised in the plains of Teesta basin as compared to that in hilly area. The important fish which are captured in downstream area are *Labeo pungusia*, *Labeo dyocheilus*, *Labeo boga*, *Bagarius bagarius*, *Cirrhinus reba*, *Cirrhinus mrigala*, *Mystus* spp., *Wallago attu*, *Glossogobius giuris*, *Chanda nama Channa* spp. etc., in which *Cirrhinus reba*, *Cirrhinus mrigala*, *Mystus* spp., *Wallago attu*, *Glossogobius giuris*, *Chanda nama Channa* are restricted in the plain area. Any activity related to the river regulation in hilly area would certainly affect the fish fauna in plain area and which in turn would affect the livelihood of the people.

Table-9.2 Fish species restricted to Teesta plains in West Bengal

Family /Scientific name	Conservation Status (IUCN)
Cyprinidae	
Danioregina	LC
Daniorerio	LC
Rasborarasbora	LC
Esomusdanricus	LC
Amblypharyngodonmola	LC
Salmostomaphulo	LC
Puntiuschola	LC
Puntiusshalynius	VU
Puntiussophore	LC
Puntiusvittatus	LC

Family /Scientific name	Conservation Status (IUCN)
Puntiuspuntio	LC
Osteobramacotiocotio	LC
Cirrhinusreba	LC
Cirrhinusmrigala	LC
Balitoridae	
Schistura Savona	LC
Bagridae	
Mystusbleekeri	LC
Mystustengara	LC
Chacidae	
Chacachaca	LC
Siluridae	
Wallagoattu	NT
Erethistidae	
Erethistoidesmontana	DD
Gobiidae	
Glossogobiusgiuris	LC
Ambassidae	
Chandanama	LC
Pseudambassisranga	LC
Anabantidae	
Colisafasciatus	-
Badidae	
Badisbadis	LC
Channidae	
Channagachua	LC
Channastewartii	LC
Channamarulius	LC
Channastriata	LC
Channapunctata	LC
Notopteridae	
Notopterusnotopterus	LC
Belonidae	
Xenentodoncancila	LC
Mastacembeliade	
Macrognathusaral	LC
Macrognathuspancalus	LC
Tetraodontidae	
Tetraodoncutcutia	LC

LC = least concerned, NT = near threatened, Vu = vulnerable, DD = Data deficient

Most of the species mentioned in Table 7.2 have been categorised as ‘least concerned’ in the IUCN’s redlist except *Puntius shalynius*, *Wallago attu*, and *Erethistoides montana*. *Puntius shalynius*is ‘vulnerable’ but is not of fishery interest. *Wallago attu* is a large fish, categorised as ‘near threatened’. This species is largely landed by fishermen in the Teesta plains. *Erethistoides montana* is ‘data deficient’ species but not preferred by fishermen.

9.4 FIELD STUDIES

Primary surveys were carried out in the influence zone of each project (Table 9.3). It was divided into 4 parts, viz. Teesta river in West Bengal, Teesta river in Sikkim-West Bengal, Rangit river and Riyang Khola. In Teesta river in West Bengal a total of 26 species of 4 families were recorded during field studies. Cyprinidae was predominant family comprising of 17 species. Monsoon season recorded considerable low richness as compared to the pre-monsoon and Post-monsoon seasons. *Schizothorax richardsonii*, *Barilius barna*, *Barilius bendelisis* and *Labeoboga* were widely distributed in the Teesta river. *Schizothorax richardsonii* was most common species, recorded at all sites in all seasons. *Hemibagrus* sp. and *Chagunius chagunio* were confined to the floodplains while *Neolissicheilus hexagonolepis* (Copper Mahseer) was absent in the lower reaches.

A total of 8 species were recorded in Teesta river in Sikkim and West Bengal between Melii and Rangpo. Teesta – Rangpo confluence is the main fishing centre of this stretch. *Barilius shacra*, *Schizothorax richardsonii* and *Neolissicheilus hexagonolepis* were common and abundant species of this area. Fish fauna of Rangit river, where Teesta Lower dam Stage I & II are proposed comprised of a total of 14 species belonging to 4 families. *Crossocheilus latius*, *Schizothorax richardsonii*, *Schizothoraicthys progastus* and *Neolissicheilus hexagonolepis* constituted major part of capture fishery. Also Rangit river provided good habitat for small loaches and cat fish. RiyangKhola is small right bank tributary of Teesta river in West Bengal. It confluences with Teesta river in downstream of power house of Teesta Lower Dam Stage III. It was studied to find out the potential breeding grounds of fish species. A total of 12 fish species were recorded from RiyangKhola. The fish fauna comprises, *Labeo dyecheilus*, *Schizothorax richardsonii*, *Neolissicheilus hexagonolepis*, *Tor putitora*, etc. Fingerlings of the species mentioned here were recorded from Riyang Khola indicating that this tributary is used as breeding ground by many species.

The details of presence of fish species at various sampling sites in various seasons is given in Table-9.3 and 9.4.

9.5 CONSERVATION STATUS

Majority of the species distributed along the hilly catchment of Teesta river in West Bengal are categorised as 'Least Concerned' under the IUCN (2015) red list. *Schizothorax richardsonii* and *Cyprinion semiplotum* are 'Vulnerable'. Both species are abundantly distributed in the basin, of which *Schizothorax richardsonii* dominates the capture fishery in the basin. *Tor putitora* is categorised as 'endangered' species. Adults are confined to the foothill stretch of Teesta river and takes upstream migration in the tributaries and upstream stretch of Teesta in monsoon seasons. Its juveniles and fingerlings can be observed in tributaries like Riyang Khola throughout the year. The species like *Tor tor*, *Balitora brucei*, *Schistura devdevi*, *Ailiacoila* and *Anguilla bengalensis* have been categorised under 'Near Threatened' category of IUCN (2015). These species are commonly distributed in the basin.

Similarly, majority of fish species confined to the foothills and flood plains of Teesta river are categorised as 'least concerned' (IUCN, 2015). *Puntius shalynius* is only 'vulnerable' species while *Wallago attu* is categorised as 'near threatened' species. *Wallago attu* constitutes the important fishery in this region.

Table 9.3 Fish species observed during the primary surveys in Teesta river in West Bengal

S.N.	Family/species	Common Name	Teesta Low Dam -V HEP			Teesta Low Dam -IV HEP			Teesta Low Dam -III HEP		
	Cyprinidae		PrM	M	PM	PrM	M	PM	PrM	M	PM
1	*BariliusBarna*	BarnaBaril	+	-	-	+	-		+	-	-
2	*Bariliusbendelisis*	Hamilton’s Baril	+	-	-	+	-		+	-	-
3	*Bariliusshacra*	ShacraBaril	-	-	-	+	-	+	-	-	-
4	*Labeoboga*	BogaLabeo	+	-	+	+	-	+	-	-	-
5	*Labeopangusia*	PangasiaLabeo	+	+	+	-	-	+	-	-	+
6	*Salmophusiabacaila*	Razor Belly Minow	+	-	+	-	-	-	-	+	+
7	*Schizothoraxrichardsonii*	Snow trout	+	+	+	+	+	+	+	+	+
8	*Schizothoraicthysprogastus*	Snow trout	-	-	-	-	-	+	+	+	+
9	*Neolissicheilushexagonolepis*	Copper Mahseer	-	-	-	+	+	+	+	+	+
10	*Tor putitora*	Golden Mahseer	-	-	-	+	+	-	-	+	-
11	*Garralamta*	LamtaGarra	-	-	-	+	-	+	+	-	+
12	*Garragotylagotyla*	Garra	-	-	-	-	-	+	+	-	-
13	*Devariodevario*	Sind danio	-	-	-	-	-	-	+	-	-
14	*Cyprinionsemiplotum*	King Fish	-	-	-	-	-	-	+	-	-
15	*Crossocheiluslatius*	Kala bata	-	-	-	-	-	+	-	-	+
16	*Chaguniuschagunio*	Darangi/Pathakati	-	+	-	-	-	-	-	-	-
17	*Puntiusconchonius*	KanchanPunti	-	-	+	-	-	+	-	-	-
18	**Bagridae**					-					
19	*Hemibagrus*sp.	Cat fish	+	+	+	-	-	-	-	-	-
20	**Sisoridae**										
21	*Bagariusbagarius*	Goonch	+	-	+	-	+	-	-	-	-
22	**Balitoridae**										
23	*Schisturabeavani*	Creek Loach	-	-	-	+	-	+	+	-	-
24	*Acanthocobitisbotia*	Leipard Loach	-	-	-	-	-	-	+	-	+
25	*Nemacheilusdevdevi*	Olivaceous Loach	-	-	-	-	-	+	+	-	+
	Schilbeidae										
26	*Clupisomamontana*	Jalkapoor	-	-	-	-	+	-	+	-	+

Table 9.4 Fish species observed during the primary surveys in Rangit river, Teesta river in Sikkim and RiyangKhola

S. N.	Species	Common Name	Teesta Low Dam -I & II HEP			Teesta Intermediate HEP			Teesta Stage-VI HEP			Jorthang Loop HEP		
	Cyprinidae		**PrM**	**M**	**PM**	**PrM**	**M**	**PM**	**PrM**	**M**	**PM**	**PrM**	**M**	**PM**
1	*BariliusBarna*	BarnaBaril	-	+	+	-	-	-	-	-	-	+	-	-
2	*Bariliusbendelisis*	Hamilton's Baril	-	-	+	-	-	-	-	-	-	+	+	+
3	*Bariliusshacra*	ShacraBaril	-	+	+	+	+	+	-	+	+	-	+	+
4	*Labeodyecheilus*	Labeo	+	-	-	-	-	-	-	-	+	+	-	+
5	*Crossocheiluslatius*	Gangeticlatia	+	+	-	+	-	+	-	-	-	-	-	-
6	*Schizothoraxrichardsonii*	Snow trout	+	+	-	+	-	+	+	+	+	+	+	+
7	*Schizothoraicthysprogastus*	Snow trout	+	-	-	+	-	-	-	+	+	-	-	-
8	*Neolissicheilushexagonolepis*	Copper Mahseer	+	+	+	+	-	-	+	+	-	+	+	-
9	*Tor putitora*	Golden Mahseer	-	-	-	-	-	-	-	+	-	+	-	+
10	*Garraannandalei*	Garra	+	-	-	+	-	+	-	-	-	+	-	+
11	*Devarioaequipinnatus*	Devario	-	-	-	+	-	-	-	-	-	-	-	-
	Sisoridae													
12	*Glyptothorax* sp.	Cat fish	+	-		-	-	-	-	-	-	-	-	+
13	*Pseudeecheneissulcata*	Sucker fish	+	-	-	-	-	-	-	-	-	+	-	+
	Balitoridae													
14	*Schisturabeavani*	Creek Loach	-	-	+	-	-	-	-	-	-	-	-	+
15	*Nemacheilusdevdevi*	Olivaceous Loach	-	-	+	-	-		-	-	-	-	-	-
16	*Nemacheiluscorica*	Common Loach	-		+	-		-	-	-	-	-	-	+

TL I & II = Teesta Low Dam –I and II; TL IM = Teesta intermediate; TVI Teesta stage VI; RK = Riyang Khola; PrM = Pre-monsoon, M = Monsoon; PM = Post-monsoon

9.6 FISHERIES

Fisheries is well organized in West Bengal especially in Plain areas. Districts Darjeeling and Jalpaiguri depend mainly on Teestariver and its tributaries for the inland capture fisheries. Fisheries is well organized in Jalpaiguri district as compared to that of Darjeeling because major plains drained by Teesta river fall under the jurisdiction of Jalpaiguri district. Total inland fish production of Jalpaiguri was 26900 tons during 2010-11 in contrast of 1658 tons of Darjeeling (mainly from Siliguri area). A total of 12 cooperatives for the same period were engaged in fishery activities whereas in Darjeeling there was only one cooperative (http://www.wbfisheries.gov.in/).

Subsistence fishery is lacking in the hilly areas, however, small fishing practices were observed during the field surveys. The important fishing centres in the catchment are Sevok in Teesta river, Riyang Khola (a tributary of Teesta in the downstream of TL III project), the confluence of Rangit and Teesta river near Melli, Rangit river near Jorethang and Rangpo at confluence of Rangpo and Teesta. Fish catch in this basin is given in Table-9.5. Sevok is junction between flood plain and hilly catchment of Teestariver. This is one of the important fishing centres in the hilly landscape of Teesta basin. Random fish catch at this site ranged from nil to 1.2 kg./fisherman/hour. Regular fluctuation in the water level due hydro-electric projects in upstream led to adverse impacts of the fishery activities. The catch included rare large fishes. The catch mainly comprises fingerlings and juveniles. The important fish comprising the catch were *Hemibagrus* sp., *Chagunius chagunio*, *Schizothorax richardsonii* and *Labeo pangusia*.

Table 9.5 Catch composition (catch in kg) in the different fishing centres in study area.

Months	Total catch	Total fishermen	Average fish catch per fisherman/ hour				
			Sevok	Riyang K	Rangit confluence	Rangit	Rangpo
April	5.30	14	0.40	0.40	0.60	0.30	0.20
May	3.40	19	0.30	0.30	0.20	00	0.10
June	6.70	13	0.20	0.30	0.40	1.20	0.50
July	0.60	06	-	0.40	00	00	0.10
August	0.80	05	0.35	0.45	00	00	0.15
September	3.20	08	1.20	ND	1.00	0.50	0.50
October	NR	NR	NR	NR	NR	NR	NR
November	1.70	05	0.40	0.30	0.50	0.50	00
December	4.20	09	0.50	0.20	1.50	1.50	0.50
January	2.90	07	0.50	00	1.00	1.00	0.40
February	2.55	09	0.80	ND	0.75	0.50	0.50
March	2.65	09	0.50	0.25	1.50	0.40	00

RiyangKhola is a small right bank tributary of Teestariver in West Bengal. The river was observed as breeding grounds of many fish species like *Schizothorax richardsonii*, *Neolissocheilus hexagolepis*, *Labeopangusia* and *Tor puti tora*. The low water discharge makes this stream access to fish for active fishermen as well as children. Annual fish catch ranged from nil to 0.45 kg/fisherman/hour (Refer Table 9.5).

Teesta – Rangit confluence is another important fish landing centre in the basin. This site is also known for game fishing. The fishermen are interested to land Golden Mahseer (*Tor puti tora*) and Copper Mahseer (*Neolissocheilus hexagonolepis*) at this site. Annual fish catch ranged from nil to 1.5 kg/fisherman/hour with maximum in December. Fish catch comprised mainly of *Schizothorax richardsonii* and *Neolissocheilus hexagonolepis*.

The downstream of Jorethang is main fishing centre in Rangitriver. Fish catch in Rangitriver ranged from nil to 1.5 kg/fisherman/hour; the catch comprises mainly of *Schizothorax richardsonii, Neolissocheilus hexagolepis, Nemacheilus* spp., and *Garra* spp. Regular fluctuation in the water level due to upstream projects makes this river prone to destructive fishing. Children easily accessed to land juveniles by hammering. Teesta – Rangpo confluence near Rangpo is also an important fish landing centre. Annual fish catch ranged from nil to 0.5 kg./fisherman/hour. Fish catch comprised of *Schizothorax richardsonii, Schizothorax progastus*, and *Barilius* spp. Considering the fish catch, it can be concluded that fisheries is not a source of livelihood of the people in the surrounding villages. However, a little game fishing was recorded at the confluence of Rangit and Teesta rivers, where fishermen fish mainly for mahseer (*Tor putitora* and *Neollisochilus hexagonolepis*). Fishermen generally use cast net and rod to land fish.

9.7 FISH MIGRATION AND SPAWNING

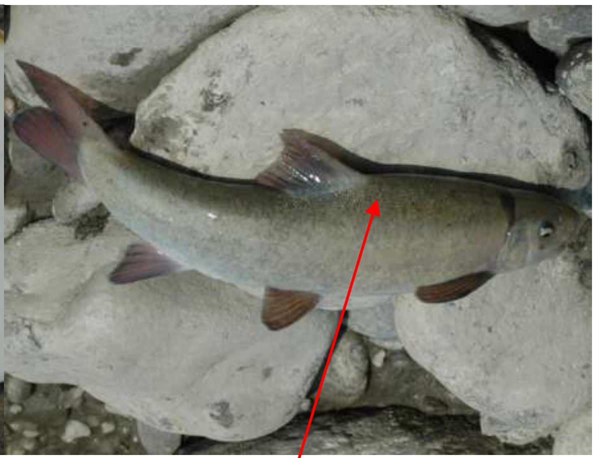
The studies on the fish migration in Teesta basin are quite lacking. Many species like *Torputitora*, *Tor tor*, *Neolissochilu*s, *Labeopungusia*, *Labeodyochilus*, *Schizothoraxprogastus*, *Schizothoraxrichardsonii* and *Anguilla bengalensis* are known to travel a long distance in different seasons for spawning. However, here, the term migration is being used only for those species which are known to migrate from one habitat to other for a specific purpose in a specific period. For this reason *Tor putitora*, *Tor tor* and *Anguilla bengalensis* can be considered as true migratory fish.

In Teesta basin *Tor putitora* and *Tor tor* inhabit foothill stretch and found abundantly near Teesta barrage. In the hilly area, the adults and adolescent make their presence from April to August indicating that these species including *Tor putitora* ascends in the month of April (e.g. Nautiyal, 1994). The presence of fingerling and juveniles in RiyangKhola and adolescents in Rangit rivers were spotted during the field surveys. The presence of fingerlings and juveniles in Riyang river indicated that *Tor* spp. prefer this stream as spawning ground. As far as Rangit river concerns, during the field survey, only adolescents of *Tor putitora* are reported earlier during monsoon season, therefore, it could not be confirmed as spawning grounds. Nautiyal (1994) mentioned that Mahseer migrates beyond the breeding grounds and he attributed this phenomenon with the learning behaviour. It is quite possible in Teesta basin that mahseer perform their learning behaviour in Rangit river.

Small rivers with all types of boulders, turbulent flow and relatively high temperature seem conducive for the spawning of mahseer. After spawning they descend to foothills in the month of September. *Anguilla bengalensis* (Freshwater Eel) is another species of Teesta basin, which performs catadromous migration (Rahimullah, 1944). However, its migratory habit is not studied in Teesta river. *Anguilla bengalensis* are considered to spawn in estuaries and sea waters because their gonads mature in salty waters only. After the hatching of ova, fry prefer to enter in freshwaters. The same migratory phenomenon of freshwater can be considered in Teesta basin. Rangitriver is largely used by adults, juvenile fresh water Eels.

Other species like *Neolissochilus hexagonolepis*, *Labeo*spp. and *Schizothorax* spp. are also known to perform local migration. They prefer to spawn in small tributaries. *Labeo* spp. are widely distributed in the lower reaches of basin. They make their presence up to 500 m in Teesta basin. *Neollissochilus hexagonolepis* is one of the most common species in Teesta basin, and is distributed up to 800 m. Rangit river is best site for adult *Neolissochilus* while juveniles and fingerlings prefer to inhabit small streams like Riyang Khola. *Schizothorax* spp. are widely distributed in Teesta basin up to 2000 m. They descend in peak winter season and prefer to breed in small tributaries.

Salmophusia bacaila



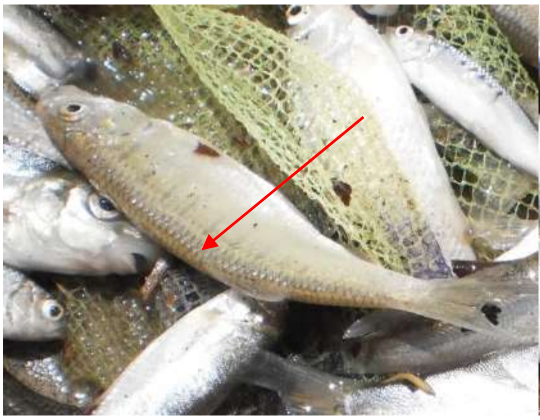
Schizothorax richardsoni

Neolissocheilus hexagonolepis
(Copper Mahseer)

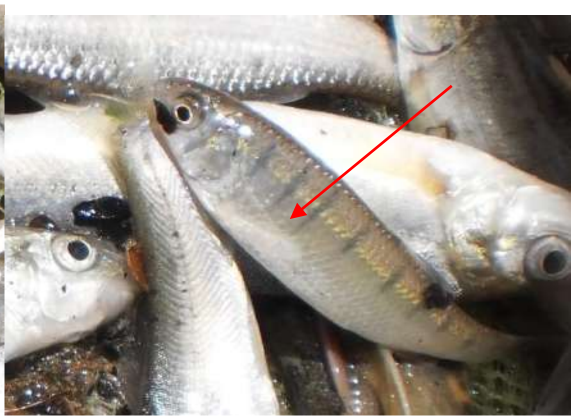
***Tor putitora* (Golden Mahsser)**

Labeo boga

Barilius shacra



Barilius bendelisis

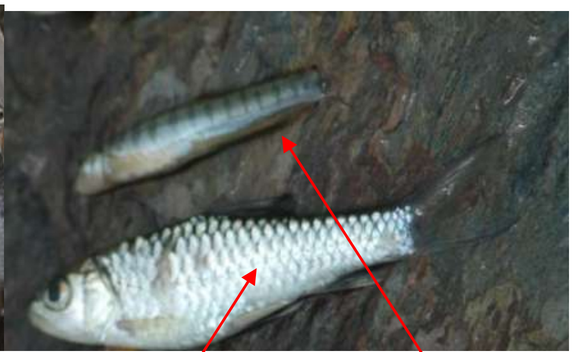


Barilius barna

Devarioa equipinnatus

Garra annandalei

Crossocheilus latius



Neolissochilus hexagonolepis & Schisturabeavani

Pseudecheneis sulcata

***Hemibagrus* sp. (Cat fish)**

Nemacheilus corica

Common fish species of Teesta river basin in West Bengal

Fish catch in Rangit river

Game fishing at confluence of Rangit and Teesta

Fisherman using rod to land fish

Destructive fishing in Rangit river

Fisheries activities in the study area

9.8 FISHERIES IN RAMMAM SUB-BASIN

Fish is one of the most important species of the aquatic fauna as well as the important source of proteinaceus food for human beings. No scientific documentation on fish life is available on river Rammam. However, some published account of Teesta-Rangeet river system is available. A total of 61 species have been recorded by different authors for Teesta-Rangeet river. This list is outlined in Table-9.6.

Table-9.6: List of fish species recorded from Teesta Rangeet river system

S.No.	Species
1.	*Chela laubuca* (Hamilton)
2.	*Salmostoma bacaila* (Hamilton)
3.	*Barilius bacaila* (Hamilton)
4.	*B. barna* (Hamilton)
5.	*B. bendelisis* (Hamilton)
6.	*B. bola* (Hamilton)
7.	*B. schacra* (Hamilton)
8.	*B. tileo* (Hamilton)
9.	*B. vagra* (Hamilton)
10.	*Danio. (Danio) acquipinnatus* (McClelland)
11.	*Danio (Danio) dangila* (Hamilton)
12.	*Danio (Danio) davario* (Hamilton)
13.	*Danio (Brachydanio) rerio* (Hamilton)
14.	*Esomus danrica* (Hamilton)
15.	*Rasbora daniconius* (Hamilton)
16.	*Amblypharyngodon mola* (Hamilton)
17.	*Aspidopario jaya* (Hamilton)
18.	*Puntius caschonius* (Hamilton)
19.	*P. stigma* (Cuvierand valencrneo)
20.	*P. tieto* (Hamilton)
21.	*Cirrhina reba* (Hamilton)
22.	*Crossocheilus latius latius* (Hamilton)
23.	*Garra lamta* (Hamilton)
24.	*G. annandalei* (Hora)
25.	*G. gotyla gotyla* (Gray)
26.	*Labeo boga* (Hamilton)
27.	*L. dero* (Heekal)
28.	*L. dyocheilus* (McClelland)
29.	*L. pangusia* (Hamilton)
30.	*Tor putitora* (Hamilton) (M)
31.	*Acrossocheilus hexagonolepis (*McClelland) (M)
32.	*Semiplotus semiplotus* (McClelland)
33.	*Schizothorax richardsonii* (Grary) (M)
34.	*Schizopyge progastus* (McClelland)
35.	*Psilorhynchus balitora* (Hamilton)
36.	*P. sneatio* (Hamilton)
37.	*Aborichtys elongatus* Hora
38.	*Lepidocephalus annandalei* Chandhuri
39.	*Lepidocephalus guntea* (Hamilton)
40.	*Naemacheilus botia* (Hamilton)
41.	*N. cosiea* (Hamilton)
42.	*N. devdevi* (Hora)
43.	*N. rupecola rupecola* (McClelland)
44.	*N. Schebbearei* (Hora)
45.	*Somileptis gongota* (Hamilton)
46.	*Mystus bleekeri* (Day)
47.	*M. vittatus* (Block)
48.	*Amblyceps mangois* (Hora)
49.	*Bagarius bagarius* (Hamilton)
50.	*Hora hora*(Hamilton)
51.	*Euchiloglanis hodgarti* (Hora)

S.No.	Species
52.	*Glyptothorax horavi* (Shaw and Schebbeare)
53.	*G. lineatus* (Day)
54.	*Pseudeehneis suleatus* (McClelland)
55.	*Sisore rhabdophorus* (Hamilton)
56.	Xenentodon cancila (Hamilton)
57.	*Channa gachua* (Hamilton)
58.	*C. merulius* (Bloch)
59.	*Macrognathus aevleatus* (Bloch)
60.	*Mastacembelus armatus* (Lacepedi)
61.	*M. pancalus* (Hamilton)

(M) - Migratory species

Of the 61 species recorded in Teesta–Rangit river system, 10 species were recorded in river Rammam as a part of field studies for preparation of CEIA Report for Rammam Stage-III hydroelectric project. The list of the fish species observed in river Rammam is given in Table-9.7.

Table-9.7:Fish species recorded in Rammam river

Scientific Name	Local Name
Schizothorax richardsonii	Asala
Schizothorax progastus	Asala
Semiplotus semiplotus	Chepti
Acrossacheilus hexagonalepis	Katlay
Gara anandolei	Buduna
Glyptothorax stiatus	Kavry
Glyptothorax sp.	Dhodray
Pseudochneis suleatus	Kabray
Barilius barna	Khasray
Naemacheilus sikkimensis	Godela

The physiographic feature of the river Rammam signals that occurrence of fish life in the river is typical of a mountain torrent. Sample netting with local cast net was done at various locations i.e. upstream of barrage/dam site, downstream of power house site, between barrage/dam site and power house in river Rammam and its tributaries. The cast method (1 cm mesh size) carried out in rapid stretch and pool was carried out.

A gill net was also put overnight across the river at barrage site. The various fish species caught confirm the presence of *Schizothorax* sp. and *Pseudocheneis* sp. To understand the fish composition and distribution pattern sample netting with local cast net was also done at various locations i.e. upstream of barrage/dam site, downstream of power house site, between barrage/dam site and power house in river Rammam and its tributaries during various seasons. The cast method (1 cm mesh size) carried out in rapid stretch and pool confirm that *Schizothorax* contributes about 62.5% of total catch followed by *Acrossocheilus hexagonolepis* (14.5%) Gara (14.6%) and others (8.4%). However, during winter season the catch dominated by *Schizothorax* sp. (60%) followed by *Pseudocheneis* sp. (20.5%) and others (19.5%). The size of *Schizothorax* ranged 50-100 mm in total length and 20 to 150 gm in weight.

CHAPTER-10
ENVIRONMENTAL SENSITIVITY

CHAPTER-10
ENVIRONMENTAL SENSITIVITY

10.1 GENERAL

The responses of environmental components (flora, fauna, air quality, water quality etc.) when exposed to the certain anthropogenic activities are measures of environmental sensitivity. Carrying capacity of an area essentially relies on the environmental sensitivity of that region. From the ecological point of view Meentemeyer and Box (1987) define environmental sensitivity "as the ability of an ecosystem to withstand alterations or changes caused by human actions, without suffering drastic alterations that prevent you from achieving a dynamic balance that maintains an acceptable level in structure and function; their identification and measurement depend on the scale of observation". The present study deals with the carrying capacity of Teesta basin in West Bengal with respect to the proposed/commissioned/under construction hydro-electric projects. The ecological significance and rich biodiversity of this area can be attributed to the presence of many protected areas, viz. Mahananda Wildlife Sanctuary, Senchal Wildlife Sanctuary, Singhalia National Park and Kittam Bird Sanctuary within the boundary of basin. This area is categorised as part of Khanchenjunga Landscape and many conservation corridors have been proposed by ICIMOD (2008). A total of 7 hydroelectric projects are proposed/commissioned/under construction within Lower Teesta basin, which are anticipated to lead huge impacts on the environmental components of this region. In addition to the developmental activities, this landscape is under the agro-forestry type of land use where commercial production of large cardamom and tea is main socio-economic activities. The new developmental activities with the traditional activities would have cumulative impacts on the biodiversity and is anticipated to decrease the assimilative capacity of the basin. It would be notable to mention that all the projects and their influence zones fall under more or less same climatic zone, thus, is difficult to differentiate. However, sensitivity of each area with respect to the developmental project has been described in the following sections.

10.2 TEESTA STAGE-VI

Teesta stage-VI H. E. Project is located across Teesta river in Sikkim and West Bengal. The close proximity of the project component area is highly populated as compared to that of other projects on Teesta river. The influence area is predominantly covered with tropical forests having a relief from about 200 m to 2000 m. A patchy tropical mixed deciduous forest was observed in the upstream of proposed powerhouse site. Some tree species such as *Bombax ceiba, Callicarpa arborea, Dysoxylum binectarifolium, Gmelina arborea,* *Lagerstroemia lanceifolia, Schima wallichii, Tectona grandis, Wrightea arborea*, etc are the habitats for canopy dwelling arboreal mammals like monkeys, squirrel and flying fox. Some rare taxa of low elevational zone such as *Begonia rubella, Lagerstroemia minuticarpa, Ohiorrhiza lurida,* etc. are located exclusively in the surrounding area of Lower Teesta valley, which also found in the surrounding area of Teesta Stage VI project.

Its middle and upper pats of influence area includes various threatened (15) and schedule faunal species (11) like Asian Golden Cat (*Catopuma temminckii*), Leopard Cat (*Prionailurus bengalensis*), Fishing Cat (*Prionailurus viverrinus*), Clouded Leopard (*Neofelis nebulosa*), Leopard or Panther (*Panthera pardus*), Rufous- necked Hornbill (*Aceros nipalensis*) Great Hornbill (*Buceros bicornis*), Red-headed Vulture (*Sarcogyps calvus*), Indian Egg Eating Snake (*Elachistodon westermanni*), King Cobra (*Ophiophagus Hannah*), etc. (Table 10.1). The valley area is highly disturbed due to various anthropogenic activities like settlements, vehicular movement, etc.

In the influence zone of Teesta VI Power house site NDVI having value greater than 0.10 is spread on an area of 80% of the total area. Majority of the influence area is covered with vegetation. Forest is spread on an area of 41 km^2 (see Table 10.2). However, there is no protected area in the influence zone of Teesta VI Power house site.

Comparing with the areas of influence of other hydro-electric projects, influence zone of Teesta Stage VI is considered less environmental sensitive. Within 10 km radius, no protected area is located. However, upper reaches particularly on the left bank (West Bengal) is rich in biodiversity (**Figure- 10.1**).

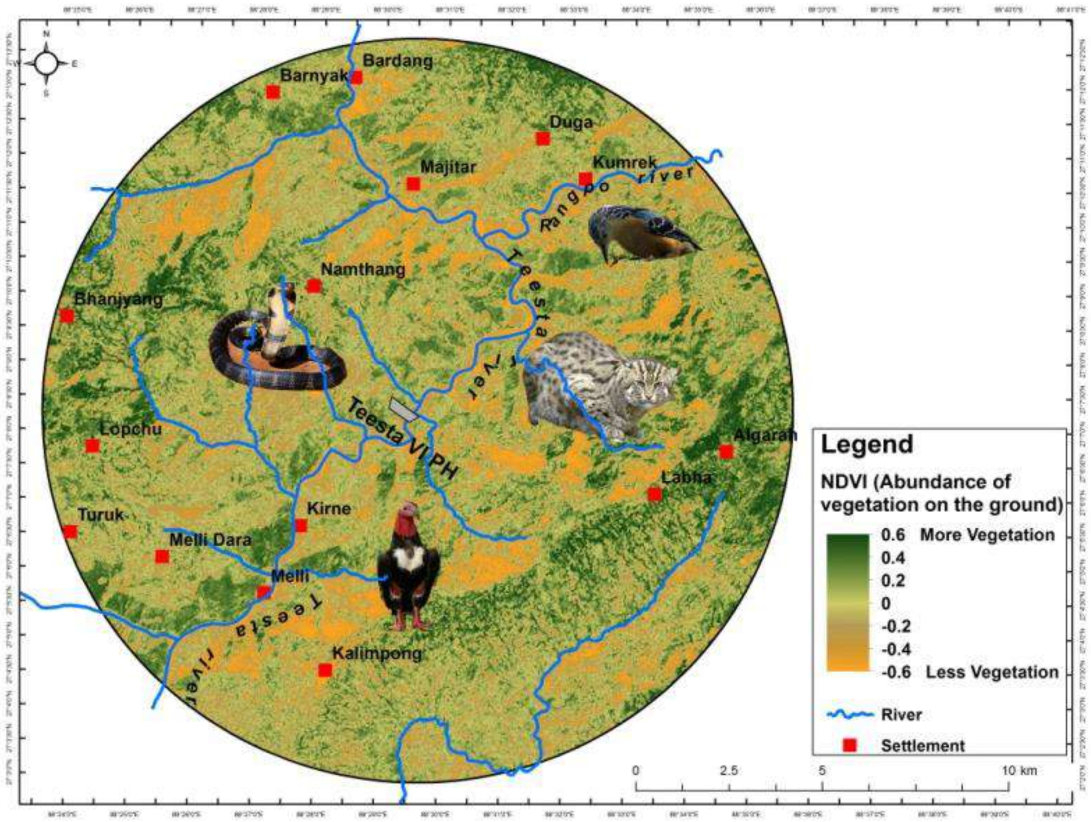


Figure: 10.1 Influence area of Teesta stage VI. It shows NDVI of the region. The animal species are symbolic. Animal species in the figure do not depict their exact locations.

10.3 TEESTA INTERMEDIATE H.E. PROJECT

The zone of influence of Teesta Intermediate H.E. project extends nearly from 200 m to 1900 m. The area is relatively more populated with townships, villages and agricultural land cover. The area is covered with Kalimpong Dansong Forests and Melli-Ralu-Sumbuk forests. The influence area may be covered by a part of South Sikkim Important Bird Area (IN-SK -07). This area covers patchy mixed semi-evergreen and moist mixed deciduous forest in the lower reaches. Because of relatively slow growth of dominant trees and poor soil on steep unstable slopes, these forests have low resilience to human disturbances. Some tall and useful timber trees viz., *Ailanthus integrifolia, Albizia procera, Anthocephalus cadamba, Canarium strictum, Engelhardtia spicata, Magnolia hodgsonii, Neonauclea griffithii, Schima wallichii,* and *Shorea robusta* form habitats for large varieties of epiphytic orchids and climbers. This area is favourable to growth of some endemic and threatened epiphytic orchids. However, due to construction of new roads in the surrounding project area may promote easy access to forests for different resources such as timber, fuel-wood, orchids and other economically important plant species. Many of rare taxa especially herbs have narrow distribution ranges.

Few epiphytic rare taxa such as *Cymbidium eburnum* and *Paphiopedilum* spp are reported exclusively on particular tree species from this area.

The key mammalian species of this area are Golden Jackal (*Canis aureus*), Leopard Cat (*Prionailurus bengalensis*), Himalayan Crestless Porcupine (*Hystrix brachyura*, Assamese Macaque (*Macaca assamensis*), Barking Deer (*Muntiacus muntjak)*, Tree Shrew (*Tupaia belangeri*), Small Indian Mongoose (*Herpestes auropunctatus*), Leopard or Panther (*Panthera pardus*), Indian Wild Boar (*Sus scrofa cristatus*), Orange-bellied Himalayan Squirrel (*Dremomys lokriah lokriah*), Himalayan Striped Squirrel (*Tamiops macclellandi*), etc. Herpetofauna includes Indian Rock Python (*Python molurus*) along with many species of snakes and frogs. The area is inhabited by a large number of bird species, however the species of conservation concern are Rufous- necked Hornbill (*Aceros nipalensis*), White-rumped Vulture (*Gyps bengalensis*), Slender-billed Vulture (*Gyps tenuirostris*), Red-headed Vulture (*Sarcogyps calvus*) etc. The forest fires, the spread of weeds and exotic snails, urbanization and use of pesticides are major environmental issues and threats to this area in present scenario. The magnitude of disturbances is higher in the low land and valley areas, which triggers the habitat fragmentation.

Vegetation in the influence zone of Teesta intermediate is spread on an area of 80% of the total area whereas forest cover an area of 38 km^2. The influence zone of Teesta IV is also devoid of protected area. No protected area is covered within the influence area of this project (**Figure 10.2**; Table 10.2).

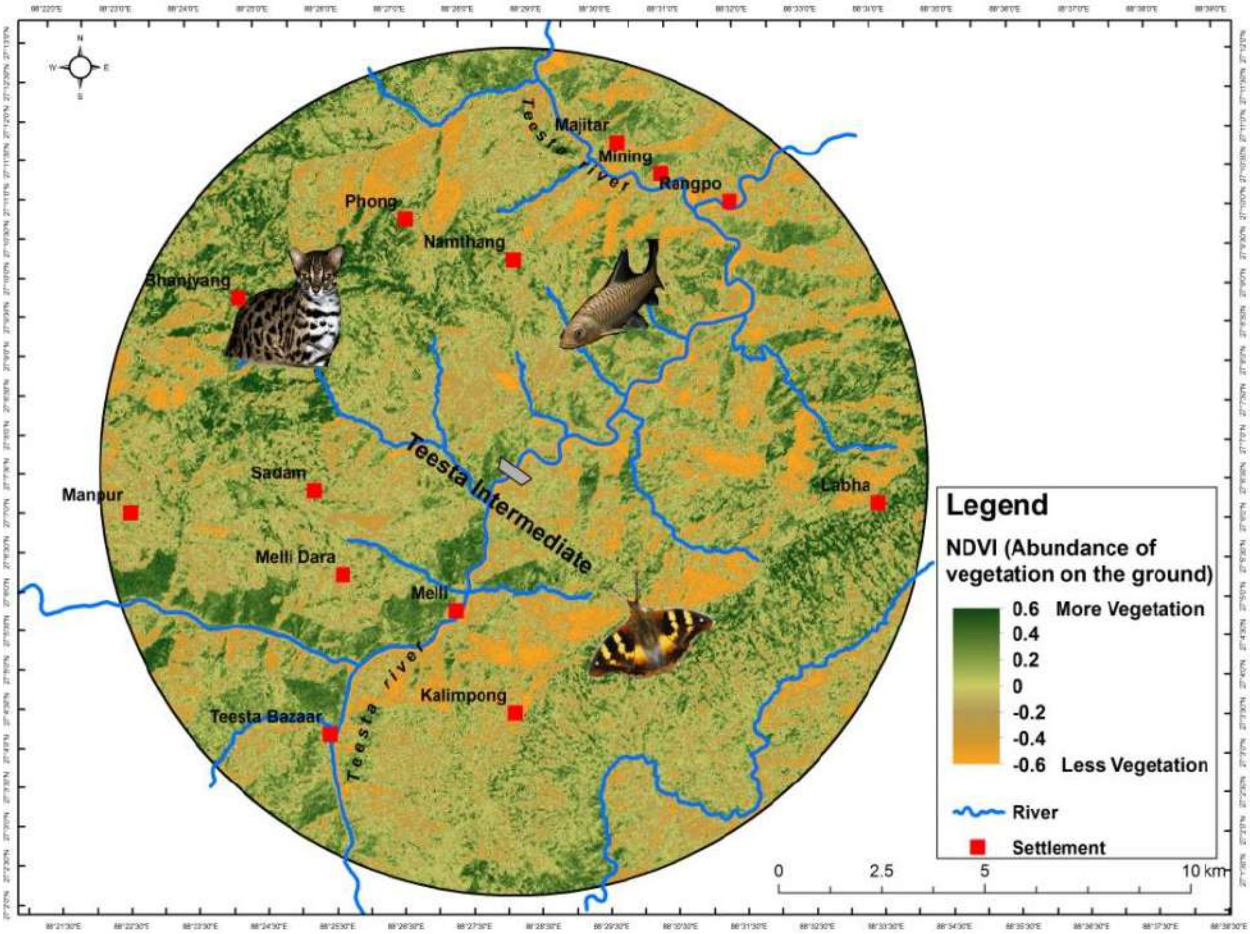


Figure 10.2: Influence area of Teesta Intermediate Project VI. It shows NDVI of the region. The animal species are symbolic. Animal species do not depict their exact locations

10.4 JORETHANG LOOP HEP

The project area represents a mixed degraded East Himalayan sal and riverine semi-evergreen forest on the lower reaches. The main associates of tree layer include *Albizia chinensis, Bridelia retusa, Bombax ceiba, Callicarpa arborea, Garuga pinnata, Lagerstroemia lanceolata, Lannea coromandelica, Macaranga denticulata,* and *Shorea robusta*. However, adverse impacts to some endemic and rare plants are occurring in the surrounding sub-tropical low land reserved forest area along the Rangit river valley. Few plant taxa within the Sambuk and Kitam area appear to be threatened or going to critically endangered categories on account of human activities prevailing in the area. Some weeds and flowering plants viz., *Ageratum conyzoides, Clerodednrum japonicum, Lantana camara, Mussaenda roxburghii, Sida rhombifolia, Urena lobata* , etc are important flowering plants that attracts butterflies. Access to forest by roads in the surrounding influence area may promote easy access to forests for different resources such as timber, fuel-wood, orchids and other economically important plant species.

In the surrounding, *Shorea robusta* shows an unique combination with chir pine (*Pinus roxburghii*) especially near Kitam Bird Sanctuary area, a reserved forest located in Rangit valley of South Sikkim. These lowland forests are home to several threatened species of birds viz., Rufous-necked Hornbill, the Great Pied Hornbill and the Chestnut-breasted Partridge. Other lowland fauna within forest includes python, geckos, and Barking Deer and many species of butterflies.

Around Sambuk area, a forest patch vegetated with mixed moist deciduous forest, and *Begonia satrapis* an endemic species of Sikkim and Darjeeling Himalaya was mapped and various threats faced by this species was assessed. Regular collection of fodder and fuel-wood from the forest floors by humans seems to be serious threat to the survival of this species in its natural habitat.

Influence area of this project cover two protected area, however, it is relatively most prone to man induced activities like tea plantation on the right bank of Rangit river and human habitation on the left bank. There is another protected areas Senchal Wildlife Sanctuary located in the extreme temperate zone. It covers an area of 38 sq and is about 11 km south-east of the Darjeeling town. The forests of this protected area are dense broad-leaved and mixed coniferous type. The fringe region is dotted with villages and tea gardens. Surroundings of Senchal Reserve forest is characterized by dense montane wet temperate forests. The important trees includes *Acer hookeri, A. laevigatum, Cryptomeria japonica, Dodecadenia grandiflora, Elaeocarpus lanceifolius, Lindera assamica, Litsea kingii, Quercus serrata*, etc. Among shrubs are species of *Berberis, Cotoneaster, Hydrangea, Leea, Leucosceptrum, Pteridium, Rubus, Viburnum*, etc.

10.5 TEESTA LOW DAM PROJECT STAGE-I & II

Teesta Low Dam Project Stage-I & II is proposed on Rangit river, the zone of influence covers a part of Sikkim (left bank of Rangit river) and a part of West Bengal (right bank of Rangit river). The influence area is relatively sparsely populated, however, right bank is slightly disturbed with tea plantation practices. The influence area extends nearly from 200 n to 2100 m along the elevational gradient. The Kitam, Tukdah, and Mangwa forests constitute the part of influence area and are known as rich in floral and faunal diversity. Kitam forest has been declared as Kitam Bird Sanctuary in Sikkim, which entirely falls within the influence zone of the project. Also a part of Senchal Wildlife Sanctuary falls on the edge of the influence area of the project. Thus surroundings of Teesta Low Dam Project Stage I & II can be considered as ecological sensitive zone (**Figure 10.3**).

The surrounding area of Teesta Low Dam Project Stage I & II project harbours a unique association of Sal (*Shorea robusta*) and Chir Pine (*Pinus roxburghi*) forests with many other plant species like Sal (*Tectona grandis*), Semal (*Bombax ceiba*), *Terminalia myriocarpa*, *Walsura tubulata*, *Callicarpa arborea*, *Duabanga grandiflora*, *Endospermum chinense, Phoebe lanceolata, Phyllanthus emblica* etc. A dense tropical semi-evergreen forest was observed in the upstream and near proposed project. Some tall trees like *Ailanthus integrifolia, Anthocephalus cadamba, Bischofia javanica, Bombax ceiba, Duabanga grandiflora, Harpulia capanioides, Lepisanthes rubiginosa, Mallotus philippinensis, Samanea saman, Sapium baccatum, Spondias pinnata, Terminalia myriocarpa, Walsura tubulata,* etc forms unique and dense vegetation in the forest. However, construction of project will lead to modernization of the area and this in turn will cause degradation of the natural beauty of the valley. Adverse impacts are going to be far more significant on some habitat specific herb species which require typical micro-habitat in this valley. In the upstream area and adjoining Darjeeling hills, some threatened plant species such as *Acer hookeri, Begonia rubella, B. scutata, B. satrapis, Calamus inermis, Codonopsis affinis, Ophiorrhiza lurida, Plectocomia himalayana,* etc may be wiped out by project activities like road construction, sand mining and fuel-wood collection, etc. To save these species from being lost, there is an urgent need for carrying out detailed biological and ecological studies on rich habitats of these species for proper conservation. In addition, some of the orchid flora, which prefer rocky habitats and distributed along the different elevation zones is commercially valuable. Increased access to forested habitats facilitated by new proposed roads and changes in land use pattern may have adverse impacts on orchid species. Downstream area is disturbed and consists of few mixed deciduous and riverine species. Shrubs and climbers viz., *Cassia mimosoides*, *Chromolaeana odoratum, Colebrookea oppositifolia, Leea asiatica,* and *woodfordia fruticosa* are common spreading and xerophytic type.

The surrounding areas harbour about 23 threatened species and 17 schedule I species (Table 10.1). The area is home of a variety of threatened animal species like Leopard Cat (*Prionailurus bengalensis*), Fishing Cat (*Prionailurus viverrinus*), Leopard or Panther (*Panthera pardus*), Hog Badger (*Arctonyx collaris collaris*), Indian Peafowl (*Pavo cristatus*), Chestnut-breasted Partridge (*Arborophila mandellii*, Rufous- necked Hornbill (*Aceros nipalensis*), Great Hornbill (*Buceros bicornis*), White-rumped Vulture (*Gyps bengalensis*), Slender-billed Vulture (*Gyps tenuirostris*), Yellow-headed Tortoise (*Indotestudo elongata*), Burmese Python (*Python molurus*), King Cobra (*Ophiophagus Hannah*), Common Pierrot (*Castalius rosimon*) etc.

Rangit river is also know as good habitat of some threatened fish species viz. *Schizothorax richardsonii, Neolissocheilus haxagonolepis* and *Tor putitora*. *Tor putitora* (Golden Mahseer) is a migratory fish and Rangit river has been reported to be a potential breeding grounds (Anonymous sources). Our earlier study (prior to impoundment of Teesta river) also recorded *Tor putitora* from this river. However, during present study *Tor putitota* could not be landed from Rangit river. Though, river regulation (Teesta Low Dam Project Stage III) may be one of the possible explanations, which is supposed to hamper the fish migration. Though, *Tor putitora* was recorded from Teesta river in the upstream of Stage III. It can be attributed to be a fragmented population. Human – Wildlife conflict is one of the major problem in the surroundings of proposed projet. The important species encountered in conflict are Wild Boar, Barking Deer, Rhesus Macaque, India Peafowl, Jungle Fowl etc. (Pradhan et al., 2012).

The forest in the influence zone is spread on an area of ~47 km^2. The higher NDVI values (NDVI > 0.1) is spread on an area of 83% of the total area. An small part of Senchal Wildlife Sanctuary forms the part of influence area of Teesta Low Dam Stage I & II on right bank side of Rangit and Teesta river. Kittam Bird Sanctuary in Sikkim is located within the influence area of the project on left bank of Rangit river. Both protected areas are known to harbour many threatened and unique faunal species (**Figure 10.3**; Table 10.2).

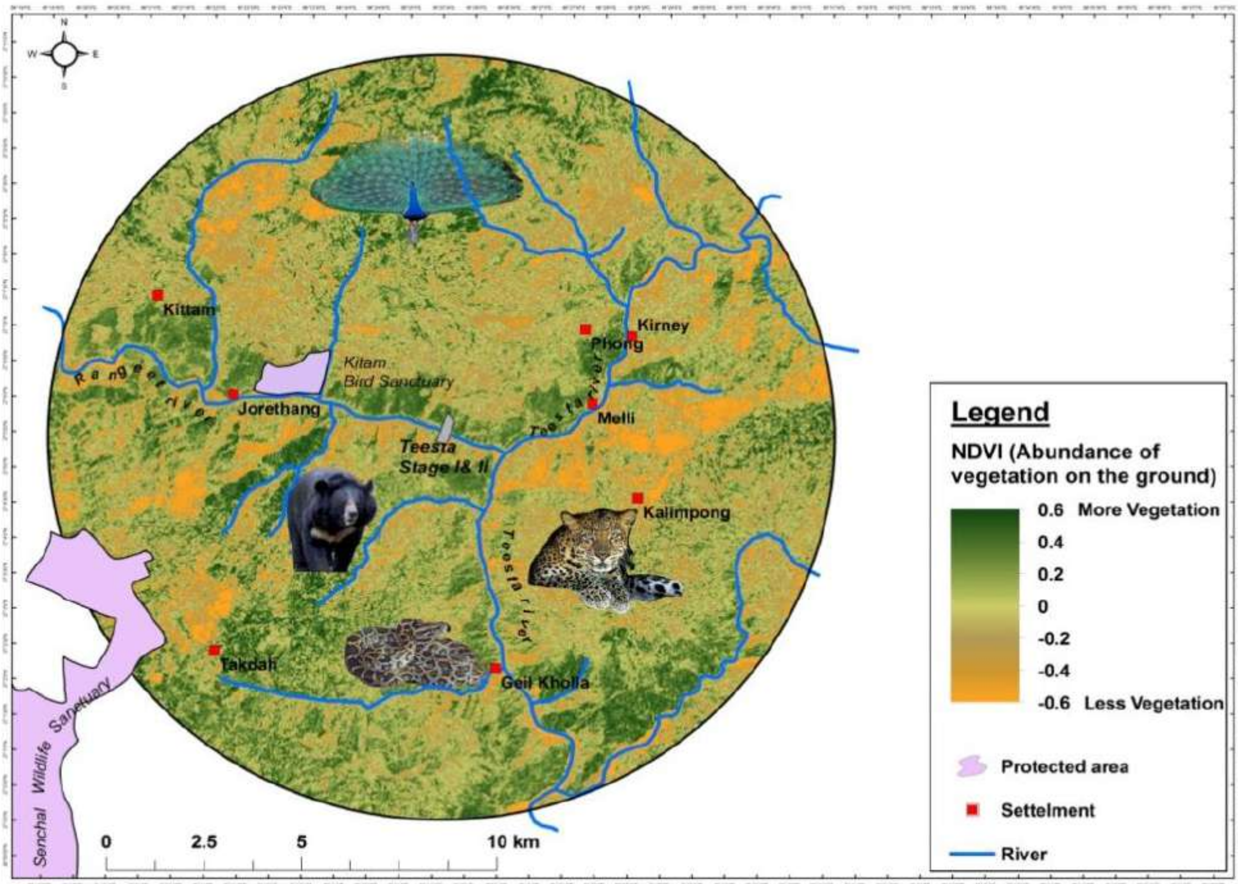


Figure 10.3 Influence area of Teesta Low Dam stage I & II. It shows NDVI of the region. The animal species are symbolic. Protected area boundary is not to scale and animal species do not depict their exact locations.

10.6 TEESTA LOW DAM PROJECT STAGE III

Influence zone of Teesta Low Dam Project Stage III comprises of a part of Kalimpong and Darjeeling hills. Likewise Teesta Intermediate project, this area is also relatively populated with townships and villages, dense forests and farming practices like tea cultivation. The area extends from nearly 180 m to 2000 m on the elevational gradient. A very small part of Senchal Wildlife Sanctuary comes within the zone of influence of Teesta Low Dam Project Stage III. Tropical Moist Deciduous Forests, Sub tropical Wet Hill Forests, and Temperate Wet Broadleaved Forests are forest types of influence zone. These forests types retain diverse plant species like *Bischofia javanica, Castanopsis indica, Cryptomeria japonica, Gmelina arborea, Neonauclea griffithii, Schima wallichii, Shorea robusta, Tectona robusta, Terminalia myriocarpa, T. Bellirica,* etc. Some rare and threatened plant species of the area are *Begonia rubella, B. Satrapis, Cymbidium eburnum, C. whiteanum, Vanda* sp, etc.

The area is rich in faunal diversity and inhabited by various threatened and endemic species especially in the limit of Senchal Wildlife sanctuary and ridges. It harbours about 21 threatened species and 16 schedule I species (Table 10.1). The important species found in the limits of Teesta Low Dam Project stage III H.E. Project are Fishing Cat (*Prionailurus viverrinus*), Clouded Leopard (*Neofelis nebulosa*), Hog Badger (*Arctonyx collaris collaris*), Red Panda (*Ailurus fulgens*), Sloth Bear (*Melursus ursinus*, Asiatic Black Bear (*Ursus thibetanus*), Chestnut-breasted Partridge (*Arborophila mandellii*), Rufous- necked Hornbill (*Aceros nipalensis*), Great Hornbill (*Buceros bicornis*) etc.

The vegetation in the influence area of TLDP Stage III is spread on 84% of the total area. It is slightly greater than the influence area of Teesta intermediate and Teesta VI power house site respectively (Table 10.2). A part of Mahananda wildlife Sanctuary falls in the influence area of TLDP stage III. Besides, the influence area is very close to the Senchal Wildlife sanctuary in the west. Lower part of the influence zone is covered by Mahanada Wildlife Sanctuary, which is known to harbour many threatened species. However, only hilly parts of sanctuary come within the influence area (**Figure 10.4**)

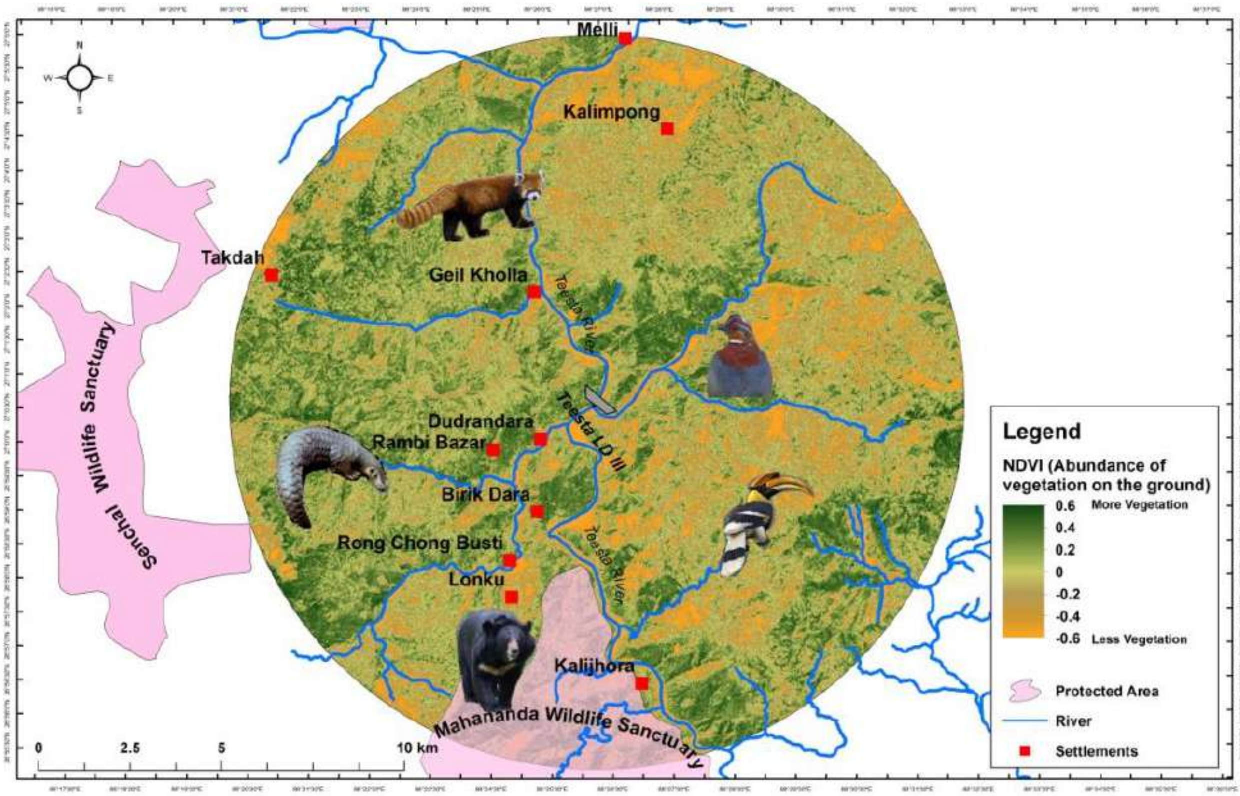


Figure 10.4 Influence area of Teesta Low Dam stage III. It shows NDVI of the region. The animal species are symbolic. Protected area boundary is not to scale and animal species do not depict their exact locations.

10.7 TEESTA LOW DAM PROJECT STAGE-IV

Teesta Low Dam Project Stage IV H.E. project is located on Teesta river between Teesta Low Dam Project Stage III and Teesta Low Dam Project Stage V. The area of influence zone extends approximately from 150 m to 1600 m. The influence area of Teesta Low Dam Project Stage IV HEP is a transition zone of Western Duars and Darjeeling hill forests, covered with Northern Sub-Tropical Broad-Leaved Wet Hill forests and Northern Sub-Tropical Semi-Evergreen Forests.

Albizia chinensis, A. lucida, Beilschmiedia roxburghiana, Ficus spp., *Garcinia cowa, Macaranga denticulata, Neoneuclea griffithii, Pterospermum acerifolium, Sterculia villosa, Syzygium formosum, Terminalia myriocarpa*, etc. are important species of riverine project area habitat. There are some other useful trees such as *Bassia latifolia, Dillinia pterocarpa, Eleocarpus* spp., *Garcinia cowa, Magnolia hodgsonii, Phyllanthus emblica*, etc found to occur in the surrounding forest. The surroundings are sparsely populated, with relatively low agricultural practices including tea gardens.

The area is inhabited nearly by 21 threatened and 12 schedule I species. Important faunal elements inhabiting the surroundings are Asian Golden Cat (*Catopuma temminckii*), Leopard Cat (*Prionailurus bengalensis*), Fishing Cat (*Prionailurus viverrinus*), Leopard or Panther (*Panthera pardus*), Sambar (*Rusa unicolor*), Rufous- necked Hornbill (*Aceros nipalensis*), Great Hornbill (*Buceros bicornis*), Slender-billed Vulture (*Gyps tenuirostris*), Slender-billed Babbler (*Turdoides longirostris*), Indian Egg Eating Snake (*Elachistodon westermanni*), King Cobra (*Ophiophagus Hannah*), Walnut Kukri Snake (*Oligodon juglandifer*) etc. In the present scenario vehicular movement, construction of dam and migrant workers seem main threats to the biodiversity of the area. Major part of the lower part of Influence area is covered by the Mahanada Wildlife Sanctuary (**Figure-10.5**). The higher NDVI value (NDVI >0.1) in Teesta IV is spread on an area of 84 % of the total area. Besides the Teesta IV influence area has the largest forest cover i.e., 74 km^2 (see Table 10.2).

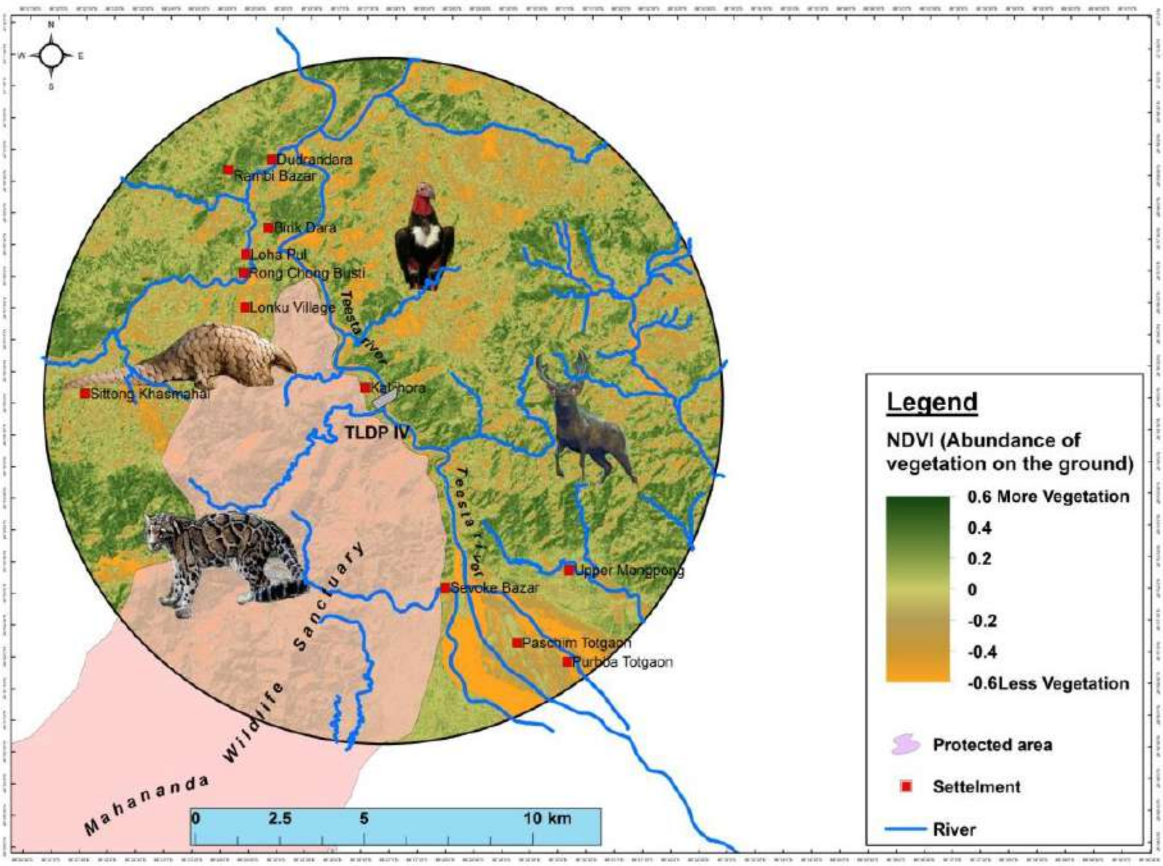


Figure 10.5 Influence area of Teesta Low Dam stage IV. It shows NDVI of the region. The protected area and animal species are symbolic. Protected area boundary is not to scale and animal species do not depict their exact locations.

10.8 TEESTA LOW DAM PROJECT STAGE-V

Teesta Low Dam Project Stage V H.E. project is located on Teesta river in the downstream of Stage IV in cascade. The area of influence zone extends approximately from 100 m to

1500 m. The lower part of the influence zone begins with flood plains, the land use /land cover of which comprises of dense forests of Mahananda Wildlife Sanctuary on right bank and agricultural and cultivation with tea plantation on either banks. Lower zone of the project is also considered as animal especially elephant corridors. Upper part of the influence zone is essentially hilly terrain covered with **Northern Sub-Tropical Broad-Leaved Wet Hill forests and Northern Sub-Tropical Semi-Evergreen Forests. The area is inhabited predominantly by *Shorea robusta*, *Michelia champaca*, *Lagerstroemia parviflora*, *Terminalia belerica*, Tectona grandis, *T. Tomentosa*, *Boswellia serrata*, *Schima wallichi*, *Castanopsis indica*, *C. tribuloide*s etc.**

It harbours highest number of Threatened (28 species) and schedule I (18 species) (Table 10.1). The faunal elements having conservation significance and inhabit the area under discussion are Asian Golden Cat (*Catopuma temminckii*), Leopard Cat (*Prionailurus bengalensis*), Clouded Leopard (*Neofelis nebulosa*), Tiger (*Panthera tigris*), Sloth Bear (*Melursus ursinus*), Indian Elephant (*Elephas maximus indicus*), Asiatic Black Bear (*Ursus thibetanus*), Mountain Goat (*Capricornis sumatraensis*), Indian Bison (*Bos gaurus*), Rufous-necked Hornbill (*Aceros nipalensis*), Great Hornbill (*Buceros bicornis*), White-rumped Vulture (*Gyps bengalensis*), Slender-billed Vulture (*Gyps tenuirostris*), Slender-billed Babbler (*Turdoides longirostris*), Burmese Python (*Python molurus*), King Cobra (*Ophiophagus hannah*), Walnut Kukri Snake (*Oligodon juglandifer*) etc. A large portion of the influence area is covered by Mahananda Wildlife Sanctuary. This protected area is known to harbour some highly threatened and Scheduled animal species (**Figure 10.6**). Vegetation is spread over an area of 81% of the total influence area (Table 10.2). Forest is spread over an area of ~66 km^2.

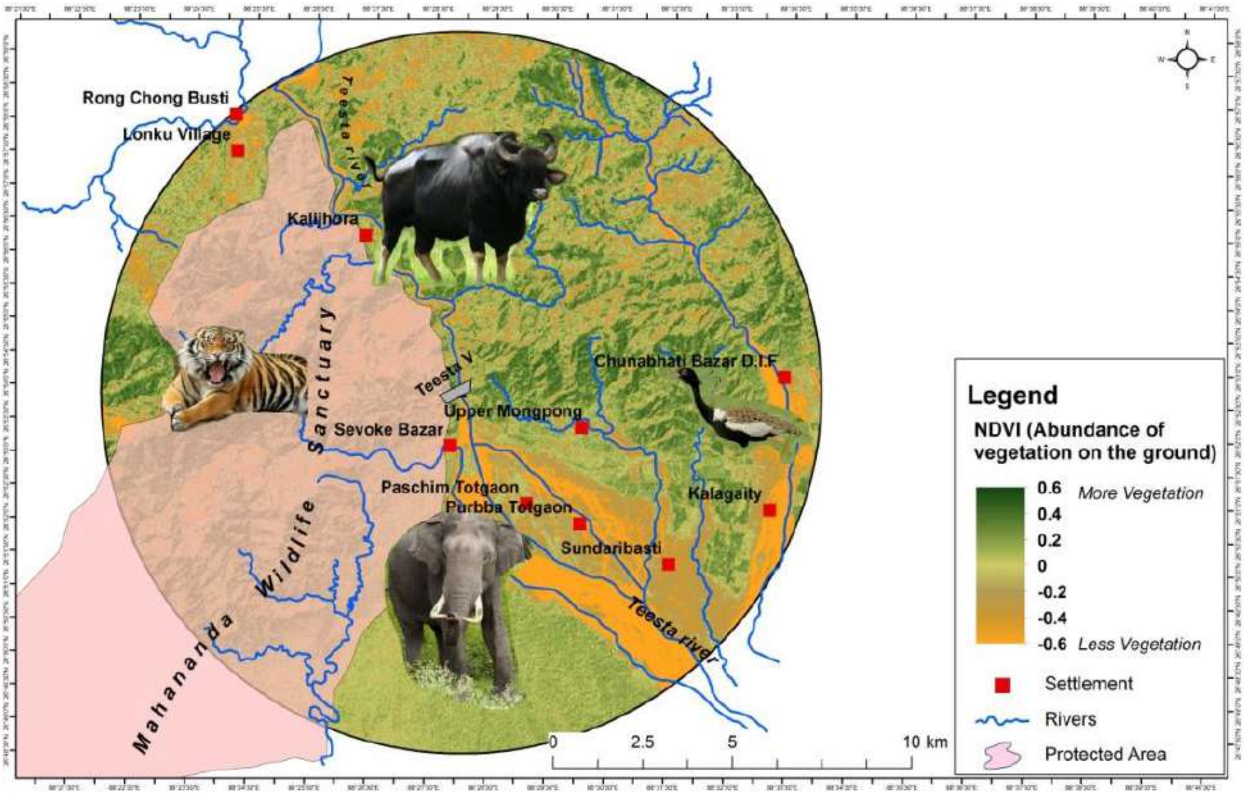


Figure: 10.6 Influence area of Teesta Low Dam stage V. It shows NDVI of the region. The protected area and animal species are symbolic. Protected area boundary is not to scale and animal species do not depict their exact locations.

Table-10.1: Number of threatened plant and animal species and Schedule-I species in the influence areas of different projects

Project	No. of threatened plants*	No. of Threatened animals**	No. of Schedule I species
Teesta Stage VI	3	15	11
Teesta Intermediate	3	15	11
Jorethang Loop HEP	6	23	17
TLDP Stage I & II	6	23	17
TLDP Stage III	7	21	16
TLDP Stage IV	5	21	12
TLDP Stage V	5	28	18

**base on Red Data Book of India ; ** Based on IUCN (2015)*

Table-10.2: NDVI values for Influence areas of different projects of Lower Teesta basin

S. No.	Projects	Forest-NDVI > 0.3 (in km$^{2)}$	Productivity -NDVI>0.1 (in km ^{2})
1	Teesta VI PH	41.39	251.40
2	Teesta Intermediate	38.03	250.50
3	Rangeet I & II	48.39	262.37
4	Teesta III	55.45	263.22
5	Teesta IV	74.19	264.26
6	Teesta V	66.10	256.84

CHAPTER-11
PREDICTION OF IMPACTS

CHAPTER-11

PREDICTION OF IMAPCTS

11.1 INTRODUCTION

Prediction is essentially a process to forecast the future environmental conditions of the project area that might be expected to occur because of implementation of the project. Impact of project activities has been predicted using mathematical models and overlay technique (super-imposition of activity on environmental parameter). For intangible impacts qualitative assessment has been done.

11.2 LENGTH OF RIVER WITH NORMAL FLOW

The biggest impact on hydrologic regime is on account of change in the free flowing condition of the river. With the construction of the proposed hydroelectric projects, the free flowing river in Teesta & Rammam shall be available on an intermittent basis only for a length of 27.97 km in a stretch of 51.55 km in River Teesta and 10.3 Km in a stretch of 31.6 km in River Rammam. The details are given in Table-11.1.

Table-11.1: Details of length of free flow of river in the study area

S. No.	Projects	Length of free flow of river (km)
A.	**River Teesta**	
1.	TWL of Teesta VI HEP & FRL Teesta Intermediate HEP	1.40
2.	TWL of Teesta intermediate HEP and FRL of Teesta Low Dam III HEP	6.00
3.	TWL of Low Dam III HEP and FRL of Teesta IV Low Dam HEP	4.47
4.	TWL of Teesta IV Low Dam HEP and FRL of Teesta V Low Dam HEP	1.10
5.	TWL of Teesta Low Dam V HEP and FRL of Teesta Barrage	15.0
B.	**River Great Rangit**	
6.	TWL of Jorthang Loop HEP & FRL of Teesta Low dam (I&II) HEP	1.124
7.	TWL of TLDP (I & II) HEP & Confluence of Bari Rangit &Teesta River	3.0
C.	**River Rammam**	
8.	TWL of Rammam-I HEP & FRL of Rammam Intermediate HEP	1.0
8.	TWL of Rammam Intermediate HEP and Trench Weir of Rammam-II HEP	1.0
10.	TWL of Rammam-II HEP & FRL of Rammam-III HEP	1.60
11.	TWL of Rammam-III to confluence with Great Rangit River	6.70

The current norms of Ministry of Environment Forest and Climate Change are that atleast 1 km free river stretch should be available between TWL of upstream and FRL of downstream hydroelectric projects. These norms are followed in all the hydroelectric projects in the study area. The details are depicted in Figure 11.1, 11.2 and 11.3.

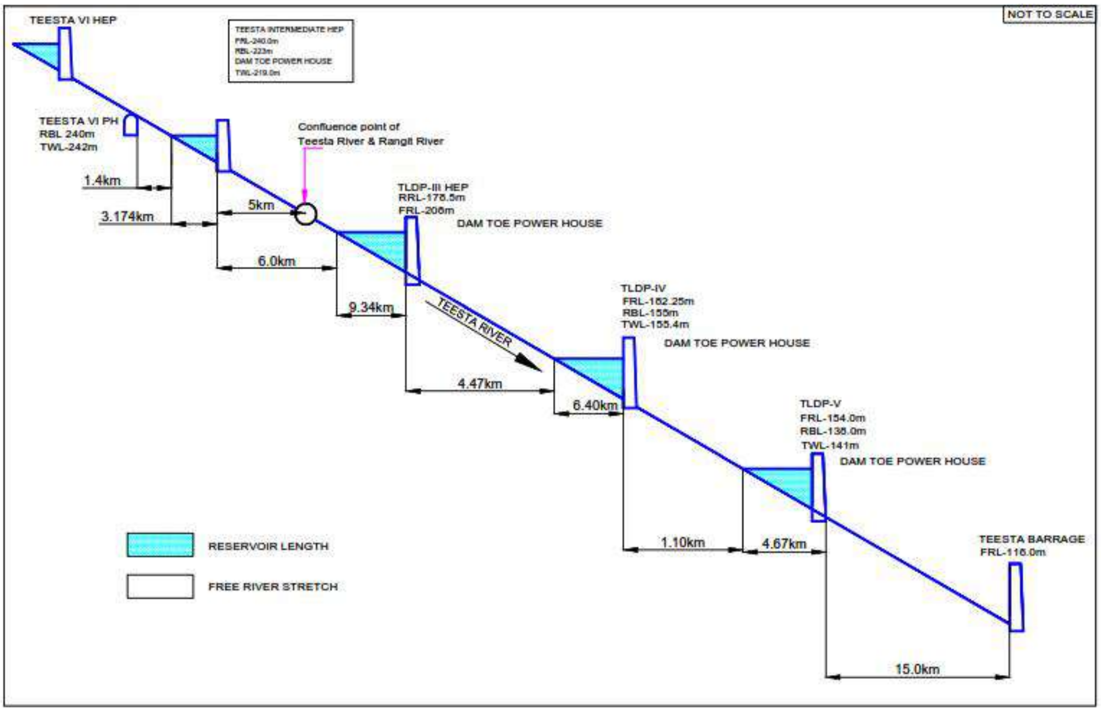


Figure-11.1: Details of free stretch available after development of Hydro-electric projects in Teesta River

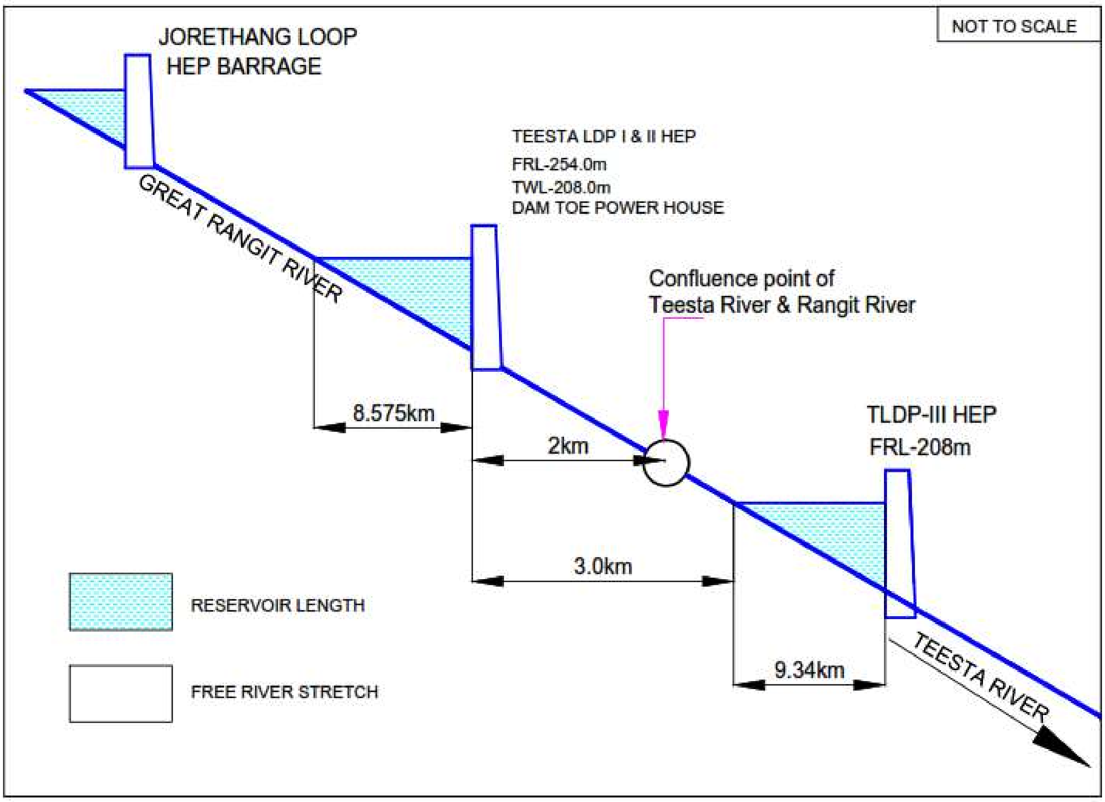


Figure-11.2: Details of free stretch available after development of Hydro-electric projects in Great Rangit River

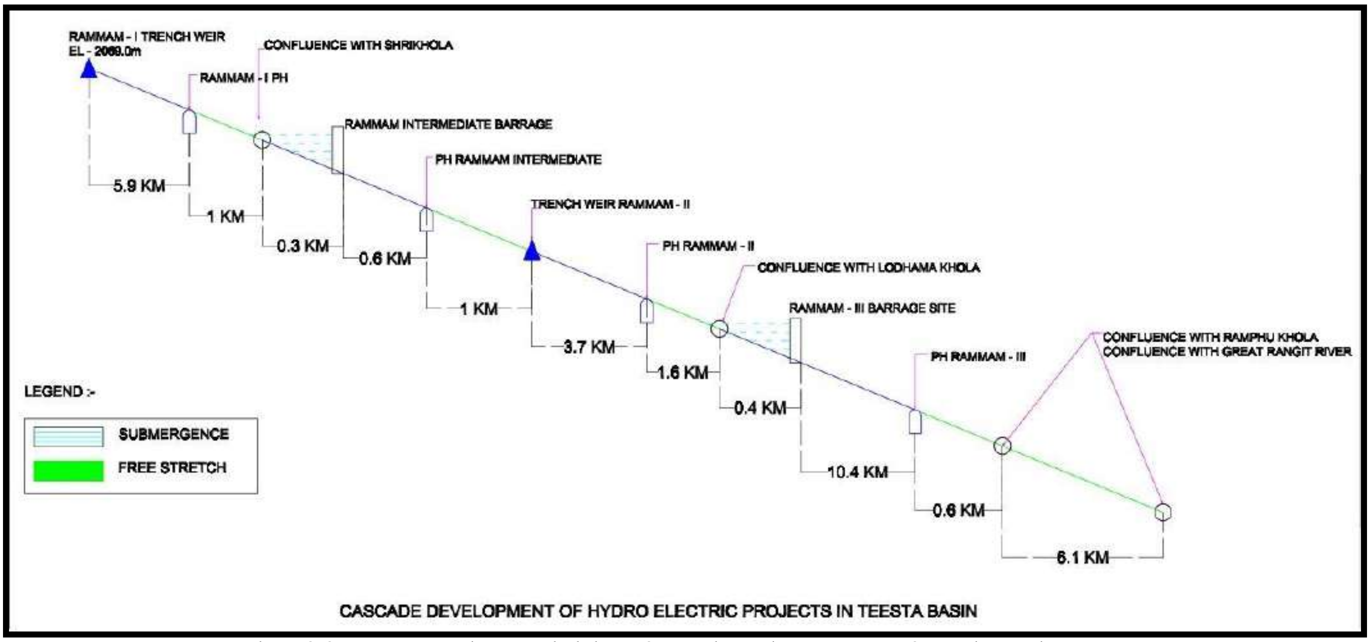


Figure-11.3: Details of free stretch available after development of Hydro-electric projects in Rammam River

11.3 MODIFICATION IN HYDROLOGIC REGIME

Out of 7(seven) hydroelectric projects being covered under the study, 5(five) hydroelectric projects are on main Teesta and 2 (two) projects are located on great Rangit. Out of seven hydroelectric projects, 90% dependable year data is available for six projects. The hydrological data is not available for Teesta VI HEP. The proposed hydroelectric project would require filling up of reservoir upto its live storage capacity, which would then be used for peaking power. The discharge for 90% dependable year for hydroelectric projects on main river Teesta and Great Rangit are given in Tables-11.2. The number of hours of peaking operation for various hydroelectric projects on river Teesta and great Rangit tributaries is given in Tables-11.3 to 11.8.

Table-11.2: 90% Dependable Year for HEPs rivers Teesta and Great Rangit

Month		Teesta Intermediate HEP	Teesta Low Dam -I and II HEP	Teesta Low Dam -III HEP	Teesta Low Dam -IV HEP	Teesta Low Dam -V HEP	Jorethang Loop HEP
June	I	656.09	79.26	416.09	341.20	440.5	111.4
	II	925.97	130.44	699.31	410.08	740.3	189.3
	III	823.73	274.99	657.65	735.26	696.2	163.9
July	I	1187.40	594.87	745.70	833.39	789.5	221.7
	II	785.20	480.05	808.17	808.08	855.6	197.1
	III	663.99	382.00	981.79	967.24	1039.4	150.1
August	I	669.65	258.83	772.33	798.59	817.6	170.8
	II	651.29	520.54	867.84	684.34	918.8	246.6
	III	804.86	332.21	854.72	723.44	904.9	214.5
September	I	547.50	240.51	648.70	649.03	686.8	170.8
	II	493.27	197.06	471.16	879.92	498.8	122.4
	III	644.40	207.63	583.07	673.76	617.3	214.5
October	I	371.00	196.58	515.41	608.68	545.7	103.4
	II	396.64	154.89	518.05	510.59	548.4	84.9
	III	350.08	120.96	488.15	430.61	516.8	65.6
November	I	294.64	88.84	284.85	242.42	301.6	50.8
	II	278.71	64.98	159.07	221.51	168.4	47.8
	III	239.18	49.25	135.53	196.92	143.5	39.9
December	I	204.83	43.79	192.12	178.92	203.4	31.1
	II	187.43	39.04	176.95	171.99	187.3	27.3
	III	206.73	36.92	126.22	154.91	133.6	24.3
January	I	177.22	35.57	177.76	141.25	188.2	24.3
	II	105.50	28.33	164.43	134.40	174.1	24.9
	III	107.97	26.98	157.45	127.96	166.7	24.6
February	I	94.53	30.95	132.62	156.72	140.4	24.3
	II	93.18	34.21	131.44	151.28	139.2	24.0
	III	89.09	9.35	128.49	151.11	136.0	23.7
March	I	106.94	4.79	160.94	126.81	170.4	22.7
	II	175.82	7.97	168.79	137.64	178.7	27.5

Month		Teesta Intermediate HEP	Teesta Low Dam -I and II HEP	Teesta Low Dam -III HEP	Teesta Low Dam -IV HEP	Teesta Low Dam -V HEP	Jorethang Loop HEP
	III	231.53	15.85	179.37	160.48	189.9	24.7
April	I	215.38	24.00	151.19	223.07	160.1	43.6
	II	275.14	15.15	190.90	215.28	202.1	44.7
	III	314.46	33.65	316.33	244.11	334.9	41.1
May	I	491.19	30.87	226.82	423.01	240.1	70.2
	II	724.76	78.18	231.66	281.28	245.3	45.6
	III	745.81	156.18	400.69	312.90	424.2	51.8

Table-11.3: Number of hours of peaking available in 90% dependable year for Teesta Intermediate HEP

Month		Discharge in 90% Dependable year (cumec)	Rated discharge (cumec)	Time available for peaking power (hrs.)
June	I	416.09	541	24.0
	II	699.31	541	24.0
	III	657.65	541	24.0
July	I	745.70	541	24.0
	II	808.17	541	24.0
	III	981.79	541	24.0
August	I	772.33	541	24.0
	II	867.84	541	24.0
	III	854.72	541	24.0
September	I	648.70	541	24.0
	II	471.16	541	21.9
	III	583.07	541	24.0
October	I	515.41	541	16.5
	II	518.05	541	17.6
	III	488.15	541	15.5
November	I	284.85	541	13.1
	II	159.07	541	12.4
	III	135.53	541	10.6
December	I	192.12	541	9.1
	II	176.95	541	8.3
	III	126.22	541	9.2
January	I	177.76	541	7.9
	II	164.43	541	4.7
	III	157.45	541	4.8
February	I	132.62	541	4.2
	II	131.44	541	4.1
	III	128.49	541	4.0
March	I	160.94	541	4.7
	II	168.79	541	7.8
	III	179.37	541	10.3

Month		Discharge in 90% Dependable year (cumec)	Rated discharge (cumec)	Time available for peaking power (hrs.)
April	I	151.19	541	9.6
	II	190.90	541	12.2
	III	316.33	541	14.0
May	I	226.82	541	21.8
	II	231.66	541	24.0
	III	400.69	541	24.0

Table-11.4: Number of hours of peaking available in 90% dependable year for Teesta Low Dam-I and II HEP

Month		Discharge in 90% Dependable year (cumec)	Rated discharge (cumec)	Time available for peaking power (hrs.)
June	I	79.26	207.1	9.2
	II	130.44	207.1	15.1
	III	274.99	207.1	24.0
July	I	594.87	207.1	24.0
	II	480.05	207.1	24.0
	III	382.00	207.1	24.0
August	I	258.83	207.1	24.0
	II	520.54	207.1	24.0
	III	332.21	207.1	24.0
September	I	240.51	207.1	24.0
	II	197.06	207.1	24.0
	III	207.63	207.1	24.0
October	I	196.58	207.1	22.8
	II	154.89	207.1	17.9
	III	120.96	207.1	14.0
November	I	88.84	207.1	10.3
	II	64.98	207.1	7.5
	III	49.25	207.1	5.7
December	I	43.79	207.1	5.1
	II	39.04	207.1	4.5
	III	36.92	207.1	4.3
January	I	35.57	207.1	4.1
	II	28.33	207.1	3.3
	III	26.98	207.1	3.1
February	I	30.95	207.1	3.6
	II	34.21	207.1	4.0
	III	9.35	207.1	1.1

Month		Discharge in 90% Dependable year (cumec)	Rated discharge (cumec)	Time available for peaking power (hrs.)
March	I	4.79	207.1	0.6
	II	7.97	207.1	0.9
	III	15.85	207.1	1.8
April	I	24.00	207.1	2.8
	II	15.15	207.1	1.8
	III	33.65	207.1	3.9
May	I	30.87	207.1	3.6
	II	78.18	207.1	9.1
	III	156.18	1112.27	18.1

Table-11.5: Number of hours of peaking available in 90% dependable year for Teesta Low Dam-III HEP

Month		Discharge in 90% Dependable year (cumec)	Rated discharge (cumec)	Time available for peaking power (hrs.)
June	I	416.09	693.6	14.4
	II	699.31	693.6	24.0
	III	657.65	693.6	22.8
July	I	745.70	693.6	24.0
	II	808.17	693.6	24.0
	III	981.79	693.6	24.0
August	I	772.33	693.6	24.0
	II	867.84	693.6	24.0
	III	854.72	693.6	24.0
September	I	648.70	693.6	22.4
	II	471.16	693.6	16.3
	III	583.07	693.6	20.2
October	I	515.41	693.6	17.8
	II	518.05	693.6	17.9
	III	488.15	693.6	16.9
November	I	284.85	693.6	9.9
	II	159.07	693.6	5.5
	III	135.53	693.6	4.7
December	I	192.12	693.6	6.6
	II	176.95	693.6	6.1
	III	126.22	693.6	4.4
January	I	177.76	693.6	6.2
	II	164.43	693.6	5.7
	III	157.45	693.6	5.4
	I	132.62	693.6	4.6

Month		Discharge in 90% Dependable year (cumec)	Rated discharge (cumec)	Time available for peaking power (hrs.)
February	II	131.44	693.6	4.5
	III	128.49	693.6	4.4
March	I	160.94	693.6	5.6
	II	168.79	693.6	5.8
	III	179.37	693.6	6.2
April	I	151.19	693.6	5.2
	II	190.90	693.6	6.6
	III	316.33	693.6	10.9
May	I	226.82	693.6	7.8
	II	231.66	693.6	8.0
	III	400.69	693.6	13.9

Table-11.6: Number of hours of peaking available in 90% dependable year for Teesta Low Dam-IV HEP

Month		Discharge in 90% Dependable year (cumec)	Rated discharge (cumec)	Time available for peaking power (hrs.)
June	I	341.20	716	11.4
	II	410.08	716	13.7
	III	735.26	716	24.0
July	I	833.39	716	24.0
	II	808.08	716	24.0
	III	967.24	716	24.0
August	I	798.59	716	24.0
	II	684.34	716	22.9
	III	723.44	716	24.0
September	I	649.03	716	21.8
	II	879.92	716	24.0
	III	673.76	716	22.6
October	I	608.68	716	20.4
	II	510.59	716	17.1
	III	430.61	716	14.4
November	I	242.42	716	8.1
	II	221.51	716	7.4
	III	196.92	716	6.6
December	I	178.92	716	6.0
	II	171.99	716	5.8
	III	154.91	716	5.2
	I	141.25	716	4.7

Month		Discharge in 90% Dependable year (cumec)	Rated discharge (cumec)	Time available for peaking power (hrs.)
January	II	134.40	716	4.5
	III	127.96	716	4.3
February	I	156.72	716	5.3
	II	151.28	716	5.1
	III	151.11	716	5.1
March	I	126.81	716	4.3
	II	137.64	716	4.6
	III	160.48	716	5.4
April	I	223.07	716	7.5
	II	215.28	716	7.2
	III	244.11	716	8.2
May	I	423.01	716	14.2
	II	281.28	716	9.4
	III	312.90	716	10.5

Table-11.7: Number of hours of peaking available in 90% dependable year for Teesta Low Dam-V HEP

Month		Discharge in 90% Dependable year (cumec)	Rated discharge (cumec)	Time available for peaking power (hrs.)
June	I	440.5	699.84	15.1
	II	740.3	699.84	24.0
	III	696.2	699.84	23.9
July	I	789.5	699.84	24.0
	II	855.6	699.84	24.0
	III	1039.4	699.84	24.0
August	I	817.6	699.84	24.0
	II	918.8	699.84	24.0
	III	904.9	699.84	24.0
September	I	686.8	699.84	23.6
	II	498.8	699.84	17.1
	III	617.3	699.84	21.2
October	I	545.7	699.84	18.7
	II	548.4	699.84	18.8
	III	516.8	699.84	17.7
November	I	301.6	699.84	10.3
	II	168.4	699.84	5.8
	III	143.5	699.84	4.9
	I	203.4	699.84	7.0

Month		**Discharge in 90% Dependable year (cumec)**	**Rated discharge (cumec)**	**Time available for peaking power (hrs.)**
December	II	187.3	699.84	6.4
	III	133.6	699.84	4.6
January	I	188.2	699.84	6.5
	II	174.1	699.84	6.0
	III	166.7	699.84	5.7
February	I	140.4	699.84	4.8
	II	139.2	699.84	4.8
	III	136.0	699.84	4.7
March	I	170.4	699.84	5.8
	II	178.7	699.84	6.1
	III	189.9	699.84	6.5
April	I	160.1	699.84	5.5
	II	202.1	699.84	6.9
	III	334.9	699.84	11.5
May	I	240.1	699.84	8.2
	II	245.3	699.84	8.4
	III	424.2	699.84	14.5

Table-11.8: Number of hours of peaking available in 90% dependable year for Jorethang Loop HEP

.Month		**Discharge in 90% Dependable year (cumec)**	**Discharge (cumec)**	**Time available for peaking power (hrs.)**
June	I	111.4	140	24.0
	II	189.3	140	24.0
	III	163.9	140	24.0
July	I	221.7	140	24.0
	II	197.1	140	24.0
	III	150.1	140	24.0
August	I	170.8	140	24.0
	II	246.6	140	24.0
	III	214.5	140	24.0
September	I	170.8	140	24.0
	II	122.4	140	21.0
	III	214.5	140	24.0
October	I	103.4	140	17.7
	II	84.9	140	14.6
	III	65.6	140	11.2
	I	50.8	140	8.7

.Month		Discharge in 90% Dependable year (cumec)	Discharge (cumec)	Time available for peaking power (hrs.)
November	II	47.8	140	8.2
	III	39.9	140	6.8
December	I	31.1	140	5.3
	II	27.3	140	4.7
	III	24.3	140	4.2
January	I	24.3	140	4.2
	II	24.9	140	4.3
	III	24.6	140	4.2
February	I	24.3	140	4.2
	II	24.0	140	4.1
	III	23.7	140	4.1
March	I	22.7	140	3.9
	II	27.5	140	4.7
	III	24.7	140	4.2
April	I	43.6	140	7.5
	II	44.7	140	7.7
	III	41.1	140	7.0
May	I	70.2	140	12.0
	II	45.6	140	7.8
	III	51.8	140	8.9

Teesta Intermediate Hydroelectric Project

It can be seen from Table-11.3 that number of hours for which peaking power will be available, in 90% dependable year shall range from 21.4 to 24.0 hours in the monsoon season from June to September. In the months of October and April, peaking will be available for a period of 13.1 to 17.6 hours and 9.6 to 24 hours respectively.

In lean season, from November to March peaking will be available for a period of 4.0 to 12.4 hours in 90% dependable year. It can be observed that in lean season, river water will be stored for a period of 12 to 20 hours. As a result, downstream stretch of river from the dam site will be remain dry for a period of 12 to 20 hours, which will be followed by a continuous flow equal to rated discharge of 541 cumec for a period of 4 to 12 hours.

Teesta Low Dam I & II

In Teesta Low Dam I & II hydroelectric project, peaking power will be available for a period of 9.2 hours to 24 hours for 90% dependable year in monsoon season. In the months of October and April-May, peaking power is available for a period of 10.3 to 17.9 hours and

1.8 to 18.1 hours respectively. In lean season, peaking power is available for a period of 0.6 to 7.5 hours in 90% dependable year. Thus, in lean season river water will be stored for a period of 16 to 23 hours. As a result, downstream stretch of river from the dam site will remain dry for a period of 16 to 23 hours. This will be followed by a continuous flow of 207.1 cumec (rated discharge) for a period of about 1 to 8 hours. The details are given in Table-11.4.

Teesta Low Dam-III HEP

As per the details given in Table-11.5, peaking power will be available for a period of 14.4 to 24 hours for 90% dependable year in monsoon season. In lean season, peaking power will be available for a period of 4.4 to 6.6 hours. Thus, in lean season, river water will be stored in the reservoir for a period of 17.4 to 19.6 hours. As a result, river will remain dry for the corresponding period downstream of dam site. This will be followed by a continuous discharge of 693.6 cumec (rated discharge) for a period of 4.4 to 6.6 hours.

Teesta Low Dam-IV HEP

The details of number of hours of availability of peaking power available in 90% dependable year in monsoon season for Teesta Low Dam-IV Hydroelectric Project shall range from 11 to 24 hours. In lean season, the number of hours for which peaking power will be available shall range from 4.3 to 7.4 hours. Thus, river water will be stored for a period of 16.6 to 19.7 hours, resulting in drying of river Teesta downstream of dam site. This will be following by a continuous discharge of $\geq$6 cumec for a period of 4.3 to7.4 hours. The details are given in Table-11.6.

Teesta Low Dam-V Hydroelectric Project

The number of hours of availability of peaking power for Teesta Low Dam-IV hydroelectric project in 90% dependable year is expected to be 17.1 to 24 hours in monsoon season. On the other hand, peaking power will be available for 4.7 to 6.5 hours in lean season. Thus, river flow will be used to fill up the reservoir in lean season for 17.5 to 19.3 hours. Thus, river will remain dry for this period in lean season. This will be followed by a continuous discharge of 699.84 cumec of about 4.7 to 6.5 hours. The details are given in Table-11.7.

Jorethang Loop Hydroelectric Project

The details of number of hours of availability of peaking power for Jorethang Loop hydroelectric project are given in Table-11.8. The number of peaking power availability in monsoon and lean season shall be 21 to 24 hours and 3.9 to 8.7 hours respectively. As a result in lean season the river will remain dry for a period of 15.3 to 20.1 hours followed by 3.9 to 8.7 hours of design discharge (140 cumec).

Out of 4 hydroelectric projects on Rammam river being covered under the study, Rammam-II hydroelectric project is under operation and Rammam-III hydroelectric project is under construction and two project namely Rammam-I and Rammam intermediate are at DPR stage. The discharge for 90% dependable year for hydroelectric projects on main river Rammam is given in Tables-11.9. The number of hours of peaking operation for various hydroelectric projects on river Rammam is given in Tables-11.10 to 11.13.

Table-11.9: 90% Dependable Year for HEPs rivers Rammam

Month		Rammam-I HEP(combined discharge of 90% dependable year flow)	Rammam Intermediate HEP (75% dependable year flow)	Rammam-II HEP (combined discharge of 90% dependable year flow)	Rammam–III HEP (90% dependable year flow)
June	I	24.58	10.82	7.95	8.62
	II	10.1	14.22	16.66	11.24
	III	18.78	21.48	14.43	21.02
July	I	19.76	19.24	17.48	30.99
	II	46.52	33.93	22.87	30.92
	III	15.76	64.04	24.02	44.26
August	I	19.16	34.21	16.36	43.96
	II	18.77	25.74	19.83	38.1
	III	17.83	24.66	18.45	38.38
September	I	20.26	37.93	17.12	43.12
	II	17.21	44.36	16.16	33.38
	III	35.56	37.52	17.19	28.49
October	I	15.88	24.88	13.62	22.87
	II	14.99	18.6	12.98	17.21
	III	9.15	10.48	10.91	13.38
November	I	7.12	7.48	10.14	12.61
	II	5.97	7.26	9.39	10.93
	III	4.19	6.44	8.49	9.04
December	I	2.72	5.8	10.51	8.33
	II	2.43	5.7	7.38	7.62
	III	2.18	5.51	6.89	6.29
January	I	2.5	5.26	6.71	5.42
	II	2.43	4.96	6.19	5.77
	III	2.09	4.82	5.68	5.31
February	I	2.56	5.34	5.33	5.24
	II	2.27	4.13	4.76	4.81
	III	2.53	3.58	4.25	4.67
March	I	2.43	2.79	3.89	4.49
	II	2.92	2.58	4.46	4.72
	III	2.9	2.53	3.57	4.99
April	I	1.83	2.49	3.36	5.01
	II	1.86	2.49	4.03	5.15
	III	1.81	2.6	4.1	6.63

Month		Rammam-I HEP(combined discharge of 90% dependable year flow)	Rammam Intermediate HEP (75% dependable year flow)	Rammam-II HEP (combined discharge of 90% dependable year flow)	Rammam–III HEP (90% dependable year flow)
May	I	2.17	3.02	6.24	7.17
	II	2.2	3.04	4.83	7.4
	III	2.51	3.02	7.22	11.12

Table-11.10: Number of hours of peaking available in 90% dependable year for Rammam-I HEP

Month		Discharge in 90% Dependable year (cumec)	Rated discharge (cumec)	Time available for peaking power (hrs.)
June	I	24.58	12.9	24.0
	II	10.1	12.9	18.8
	III	18.78	12.9	24.0
July	I	19.76	12.9	24.0
	II	46.52	12.9	24.0
	III	15.76	12.9	24.0
August	I	19.16	12.9	24.0
	II	18.77	12.9	24.0
	III	17.83	12.9	24.0
September	I	20.26	12.9	24.0
	II	17.21	12.9	24.0
	III	35.56	12.9	24.0
October	I	15.88	12.9	24.0
	II	14.99	12.9	24.0
	III	9.15	12.9	17.0
November	I	7.12	12.9	13.2
	II	5.97	12.9	11.1
	III	4.19	12.9	7.8
December	I	2.72	12.9	5.1
	II	2.43	12.9	4.5
	III	2.18	12.9	4.1
January	I	2.5	12.9	4.7
	II	2.43	12.9	4.5
	III	2.09	12.9	3.9
February	I	2.56	12.9	4.8
	II	2.27	12.9	4.2
	III	2.53	12.9	4.7
March	I	2.43	12.9	4.5
	II	2.92	12.9	5.4

Month		Discharge in 90% Dependable year (cumec)	Rated discharge (cumec)	Time available for peaking power (hrs.)
	III	2.9	12.9	5.4
April	I	1.83	12.9	3.4
	II	1.86	12.9	3.5
	III	1.81	12.9	3.4
May	I	2.17	12.9	4.0
	II	2.2	12.9	4.1
	III	2.51	12.9	4.7

Table-11.11: Number of hours of peaking available in 75% dependable year for Rammam Intermediate HEP

Month		Discharge in 75% Dependable year (cumec)	Rated discharge (cumec)	Time available for peaking power (hrs.)
June	I	10.82	16.87	15.4
	II	14.22	16.87	20.2
	III	21.48	16.87	24.0
July	I	19.24	16.87	24.0
	II	33.93	16.87	24.0
	III	64.04	16.87	24.0
August	I	34.21	16.87	24.0
	II	25.74	16.87	24.0
	III	24.66	16.87	24.0
September	I	37.93	16.87	24.0
	II	44.36	16.87	24.0
	III	37.52	16.87	24.0
October	I	24.88	16.87	24.0
	II	18.6	16.87	24.0
	III	10.48	16.87	14.9
November	I	7.48	16.87	10.6
	II	7.26	16.87	10.3
	III	6.44	16.87	9.2
December	I	5.8	16.87	8.3
	II	5.7	16.87	8.1
	III	5.51	16.87	7.8
January	I	5.26	16.87	7.5
	II	4.96	16.87	7.1
	III	4.82	16.87	6.9
February	I	5.34	16.87	7.6
	II	4.13	16.87	5.9

Month		Discharge in 75% Dependable year (cumec)	Rated discharge (cumec)	Time available for peaking power (hrs.)
	III	3.58	16.87	5.1
March	I	2.79	16.87	4.0
	II	2.58	16.87	3.7
	III	2.53	16.87	3.6
April	I	2.49	16.87	3.5
	II	2.49	16.87	3.5
	III	2.6	16.87	3.7
May	I	3.02	16.87	4.3
	II	3.04	16.87	4.3
	III	3.02	16.87	4.3

Table-11.12: Number of hours of peaking available in 90% dependable year for Rammam-II HEP

Month		Discharge in 90% Dependable year (cumec)	Rated discharge (cumec)	Time available for peaking power (hrs.)
June	I	7.95	12.46	15.3
	II	16.66	12.46	24
	III	14.43	12.46	24
July	I	17.48	12.46	24
	II	22.87	12.46	24
	III	24.02	12.46	24
August	I	16.36	12.46	24
	II	19.83	12.46	24
	III	18.45	12.46	24
September	I	17.12	12.46	24
	II	16.16	12.46	24
	III	17.19	12.46	24
October	I	13.62	12.46	24
	II	12.98	12.46	24
	III	10.91	12.46	21.0
November	I	10.14	12.46	19.5
	II	9.39	12.46	18.1
	III	8.49	12.46	16.4
December	I	10.51	12.46	20.2
	II	7.38	12.46	14.2
	III	6.89	12.46	13.3
January	I	6.71	12.46	12.9
	II	6.19	12.46	11.9
	III	5.68	12.46	10.9

Month		Discharge in 90% Dependable year (cumec)	Rated discharge (cumec)	Time available for peaking power (hrs.)
February	I	5.33	12.46	10.3
	II	4.76	12.46	9.2
	III	4.25	12.46	8.2
March	I	3.89	12.46	7.5
	II	4.46	12.46	8.6
	III	3.57	12.46	6.9
April	I	3.36	12.46	6.5
	II	4.03	12.46	7.8
	III	4.1	12.46	7.9
May	I	6.24	12.46	12.0
	II	4.83	12.46	9.3
	III	7.22	12.46	13.9

Table-11.13: Number of hours of peaking available in 90% dependable year for Rammam-III HEP

Month		Discharge in 90% Dependable year (cumec)	Rated discharge (cumec)	Time available for peaking power (hrs.)
June	I	8.62	28	7.4
	II	11.24	28	9.6
	III	21.02	28	18.0
July	I	30.99	28	24.0
	II	30.92	28	24.0
	III	44.26	28	24.0
August	I	43.96	28	24.0
	II	38.1	28	24.0
	III	38.38	28	24.0
September	I	43.12	28	24.0
	II	33.38	28	24.0
	III	28.49	28	24.0
October	I	22.87	28	19.6
	II	17.21	28	14.8
	III	13.38	28	11.5
November	I	12.61	28	10.8
	II	10.93	28	9.4
	III	9.04	28	7.7
December	I	8.33	28	7.1
	II	7.62	28	6.5
	III	6.29	28	5.4

Month		Discharge in 90% Dependable year (cumec)	Rated discharge (cumec)	Time available for peaking power (hrs.)
January	I	5.42	28	4.6
	II	5.77	28	4.9
	III	5.31	28	4.6
February	I	5.24	28	4.5
	II	4.81	28	4.1
	III	4.67	28	4.0
March	I	4.49	28	3.8
	II	4.72	28	4.0
	III	4.99	28	4.3
April	I	5.01	28	4.3
	II	5.15	28	4.4
	III	6.63	28	5.7
May	I	7.17	28	6.1
	II	7.4	28	6.3
	III	11.12	28	9.5

Rammam-I Hydroelectric Project

It can be seen from Table-11.10 that number of hours for which peaking power will be available, in 90% dependable year shall range from 18.8 to 24.0 hours in the monsoon season from June to September. In the months of October-November and April-May, peaking will be available for a period of 7.8 to 24.0 hours and 3.4 to 4.7 hours respectively. In lean season, from December to March peaking will be available for a period of 3.9 to 5.4 hours in 90% dependable year.

Rammam Intermediate Hydroelectric Project

In Rammam Intermediate hydroelectric project, peaking power will be available for a period of 15.4 hours to 24 hours for 75% dependable year in monsoon season. In the months of October-November and April-May, peaking power is available for a period of 9.2 to 24.0 hours and 2.49 to 3.04 hours respectively. In lean season, peaking power is available for a period of 3.6 to 8.3 hours in 75% dependable year. Thus, in lean season river water will be stored for a period of 16 to 21 hours. As a result, downstream stretch of river from the Barrage site will remain dry for a period of 16 to 21 hours. This will be followed by a continuous flow of 12.9 cumec (rated discharge) for a period of about 3 to 8 hours. The details are given in Table-11.11.

Rammam-II Hydroelectric Project

As per the details given in Table-11.12, peaking power will be available for a period of 15.3 to 24 hours for 90% dependable year in monsoon season. In the months of October-November and April-May, peaking power is available for a period of 16.4 to 24.0 hours and 6.5 to 13.9 hours respectively. In lean season, peaking power will be available for a period of 6.9 to 20.2 hours.

Rammam-III Hydroelectric Project

In Rammam-III hydroelectric project, peaking power will be available for a period of 7.4 hours to 24 hours for 90% dependable year in monsoon season. In the months of October-November and April-May, peaking power is available for a period of 7.7 to 19.6 hours and 4.3 to 9.5 hours respectively. In lean season, peaking power is available for a period of 3.8 to 7.1 hours in 90% dependable year. Thus, in lean season river water will be stored for a period of 16.9 to 20.2 hours. As a result, downstream stretch of river from the Barrage site will remain dry for a period of 16.9 to 20.2 hours. This will be followed by a continuous flow of 28.0 cumec (rated discharge) for a period of about 3.8 to 7.1 hours. The details are given in Table-11.13.

11.4 IMPACTS ON AQUATIC ECOLOGY DUE TO MODIFICATION LOW REGIME

As mentioned earlier in section 11.3, the commissioning of a hydroelectric project, significantly affects the hydrologic regime. The proposed hydroelectric projects in the basin area too will have similar impacts on hydrologic regime, with a corresponding impact on riverine ecology including fisheries.

Except for the period from June to September, river Teesta, Rammam and Great Rangit will have dry periods quaying from 5 to 20 hours. This storage period will result in drying up of the river, downstream of the dam/Barrage sites. The dry period will be followed by a wet or flow period with uniform flow corresponding to the number of units/turbines generating hydropower. Thus, the riverine ecology will be severely affected on account of modification in hydrologic regime. This change can have significant impact on the riverine fisheries affecting physiological readiness to migrate, mature and spawn.

The dry phase in the river stretch will result in stranding of fish in temporary pools. Similarly, drying of the river bed will lead to exposure of spawning substrates resulting in exposure and desiccation of fish eggs as well. The increased discharge especially in the lean season on account of flow of rated discharge will sweep the larvae past their suitable habitat.

The presence of variety of species makes it impossible to consider flow needs individually, it is convenient to operate at some level of aggregation, the most convenient of which is a simple behavioural, ecological or functional guild structure. Ecological guilds have been defined differently in various parts of the world. Regier, Welcomme, Steedman & Henderson (1989) proposed an early classification based on the traditional South East Asian usage for tropical systems, and Bain, Finn and Booke (1988) developed a classification of functional groupings for US rivers. Aarts, Van den Brink and Nienhuis (2004) summarize the classification for major European rivers. The combined elements of these together with some of Balon's (1975) reproductive guilds to illustrate the way in which each of the guilds responds to characteristic changes in the river that result from changes in flow is given in Table-11.14. The three main groups of fish and their sub-groups respond to changes to natural hydrographs that result from increased control over water in very different ways, which generally favour eurytopic species at the expense of the limnophilic and rheophilic ones.

Table – 11.14: Response of the main behavioural guilds to changes in flow regimes

<table>
<tr><th rowspan="2">Behavioural guild</th><th colspan="2">Typical behavior</th><th rowspan="2">Reaction to changes in hydrograph</th></tr>
<tr><th>General</th><th>Specific</th></tr>
<tr><td rowspan="2">Black fish - limnophilic species</td><td rowspan="2">• Floodplain residents move little between floodplain pools, swamps and inundated floodplain.
• Repeat breeders with specialised reproductive behaviour.
• Predominantly polyphils, nest builders, parental carers or live bearers.
• Tolerant of low dissolved oxygen or anoxia (auxiliary breathing adaptations)</td><td>A
• Tolerant of low dissolved oxygen tensions only</td><td>• Tend to disappear when floodplain disconnected and desiccated through poldering and levee construction.
• May increase in number in shallow, isolated wetlands, rice-fields and drainage ditches.</td></tr>
<tr><td>B
• Tolerant of Complete Anoxia</td><td>• Persist in residual floodplain water bodies
• Principal component of rice field and ditch faunas</td></tr>
<tr><td>White fish - rheophilic species</td><td>• Long distance migrants
• One breeding season a year
• Intolerant of low oxygen.</td><td>A
• Main channel residents not entering floodplain
• Predominantly psammophils, lithophils or pelagophils.
• Often have drifting eggs and larvae</td><td>• Tend to disappear when river dammed to prevent migration,
• When timing of flood inappropriate to their breeding seasonality and
• If flow excessive or too slow for the needs of drifting larvae.</td></tr>
</table>

Behavioural guild	Typical behavior: General	Typical behavior: Specific	Reaction to changes in hydrograph
		B • Use floodplain for breeding, nursery grounds and feeding of juvenile and adult fish • Predominantly phytophils • Usually spawn at floodplain margin or on floodplain; sometimes have drifting eggs and larvae	• Tend to disappear when river dammed to prevent migration, • Damaged when access to floodplain denied to developing fry and juveniles.
Grey fish - eurytopic species	• Tolerant of low dissolved oxygen • Repeat breeders • Predominantly phytophils but some nesters or parental carers • Short distance migrants often with local populations.	A • Occupy main channel generally benthic	• Able to adapt behaviourally to altered hydrograph • Generally increase in number as other species decline • Impacted negatively to flows that change depositional siltation processes and alter the nature of the bottom
		B • Occupy riparian vegetation	• Able to adapt behaviourally to altered hydrograph • Generally increase in number as other species decline • Impacted negatively by flows and management that changes riparian structure

Behavioural guild	Typical behavior		Reaction to changes in hydrograph
	General	Specific	
		C • Occupy larger and better oxygenated floodplain water bodies	• Sensitive to isolation of floodplain water body but can colonise river if flow slowed sufficiently • Often form basic colonisers of reservoirs and dams

As rivers change in response to human efforts to control flow they pass through a series of stages that can be characterized according to the degree of modification. The degree of modification is summarized in Table-11.15

Table- 11.15: Characteristics of various developmental stages of a river, impacts on flood regimes and form of lowland rivers

Development stage	Flood regime	State of river channel	State of floodplain	Human habitation
Unmodified	Natural hydrograph with seasonal alternation of flood and dry seasons. Water quality is good	Freely meandering or anastomosing often with islands. Diverse	Usually forested interspersed with floodplain water bodies.	Migratory human settlement in temporary camps, on high ground only or in stilt houses
Slightly modified	Natural hydrograph with seasonal alternation of flood and dry seasons. Water quality is good	Freely meandering or anastomosing often with islands. Obstructions removed from channel. Some simplification of channels. Diverse	Some forests usually savannah with floodplain grasses	Human settlement in temporary camps on floodplain, villages on levees or stilt houses.

Development stage	**Flood regime**	**State of river channel**	**State of floodplain**	**Human habitation**
Modified	Natural hydrograph persists in many reaches of river but can be locally modified below dams with reduced amplitude and duration of seasonal floods. Can also be modified around poldered areas. Water quality affected around settlements.	Locally regulated with some damming and leveeing but with some reaches still relatively unregulated. Tendency to suppress branches in favour of a single main channel. Some backwaters persist.	Floodplain partially modified, deforested: floodplain water bodies sometimes isolated. Local poldering and flood control structures	Human settlement beginning to intensify on artificially constructed mounds or areas protected by flood defences.
Highly modified	Hydrograph completely modified suppressing and altering timing of flood peaks and quantity of water in system. Water quality often severely reduced in whole river	Often heavily dammed sometimes in cascades: Fully regulated and channelised often with revetted banks and dredged navigation channels, Backwaters eliminated. Habitat diversity low.	Floodplain dry or completely controlled with extensive drainage and irrigation canals. Off channel water bodies largely eliminated or isolated Maybe heavily poldered	Heavy human settlement of whole former floodplain area.

On completion of the proposed hydroelectric projects in the basin, would render rivers Teesta and Great Rangit as highly modified, on account of :

- Hydrographs getting completely modified
- Modification of floods including suppression and alteration of flood peaks.
- Conversion of free flowing stretch of river into reservoir.

However, no major impact on water quality is anticipated on account of modification in hydrologic regime, as there are no major sources of water pollution in the study area.

The modification of downstream river flow characteristics (regime) by an impoundment can have a variety of negative effects upon fish species. These include:

- loss of stimuli for migration
- loss of migration routes and spawning grounds
- decreased survival of eggs and juveniles
- diminished food production.

Regulation of stream flow during the migratory period can alter the seasonal and daily dynamics of migration. Regulation of a river can lead to a sharp decrease in a migratory population, or even to its complete elimination.

11.5 IMPACTS ON FISHERIES DUE TO FLUCTUATIONS IN WATER LEVEL

Variable flow regime resulting from operation of hydroelectric power-dams can have significant consequences for fish fauna. Based on the Study Area fisheries in Colorado river below the Glen Canyon dam have confirmed to the decline in endemic fish (Petts, 1988). The native species have been replaced by the introduced species and spawning of the native species is restricted to tributaries.

Walker *et al*. (1979) related the disappearance of *Tandanus tandanus* in the Murray river, Australia to short-term fluctuations in water level caused by reservoir releases in response to downstream water user requirements. In the proposed hydroelectric projects, releases on account of peaking power requirement shall result in fluctuations in water level. This could result in significant reduction in native species.

The fluctuations of water-level and velocities due to power demand could have disastrous effects on fish: spawning behavior could be inhibited, juveniles could be swept downstream by high flows, sudden reductions in flow could leave eggs or juveniles stranded (Petts, 1988). Although, experimental data on the impacts on fish species present in river Teesta is not available but it can be concluded that daily fluctuation in water level will have significant adverse impacts on fisheries.

11.6 IMPACTS ON FISH MIGRATION

Fish populations are highly dependent upon the characteristics of the aquatic habitat which supports all their biological functions. This dependence is most marked in migratory fish which require discrete environments for the main phases of their life cycle which are reproduction, production of juveniles, growth and sexual maturation. The species has to move from one environment to another in order to survive. The fish composition in the project area are represented by potadromous species i.e. the species which occur only in freshwater system and their reproduction and feeding zones are separated by distances that could vary from few meters to hundreds of kilometers.

The building of a dam generally has a major impact on fish populations: migrations and other fish movements can be stopped or delayed, the quality, quantity and accessibility of their habitat, which plays an important role in population sustainability. Fish can suffer major damage during their transit through hydraulic turbines or over spillways. Changes in discharge regime or water quality can also have indirect impacts on fish species. Increased upstream and downstream predation on migratory fish is also linked to dams, fish being delayed and concentrated due to the presence of the dam and the habitat becoming more favourable to certain predatory species.

One of the major effects of the construction of a dam on fish populations is the decline of migratory fish species. The dam prevents migration between feeding and breeding zones. The effect can become severe, leading to the extinction of species, where no spawning grounds are present in the river or its tributary downstream of the dam.

The impact of river valley projects has been extensively studied for river Bees as a result of damming at pong and Pandoh under the Beas-Sutlej Link Project. Sehgal and Sar (1989) and Sehgal (1990) have found subtle and irreversible changes in abiotic and biotic parameters. The migratory routes of *Tor putitora* and *Schizothorax richardsonii* have been obstructed due to construction of various dams. These species which were migrating to higher elevation, were obstructed. *Schizothorax richardsonii* which used to migrate from higher reaches to lower reaches was unable to do so on account of construction of dam at Pandoh. The contribution of *Schizothorax richardsonii* in the river Beas reduced from

10.2– 13.5% between Mandi and Nodomn towns prior to construction of project reduced to 0.5 – 1% after project.

The Teesta river basin has quite a few migratory species as listed below:

- *Tor putitora*
- *Tor tor*
- *Neolissochilu*s
- *Labeo pungusia*
- *Labeo dyochilus*
- *Schizothorax progastus*
- *Schizothorax richardsonii*
- *Anguilla bengalensis*

These species are known to travel a long distance in different seasons for spawning. However, here, the term migration is being used only for those species which are known to migrate from one habitat to other for a specific purpose in a specific period. For this reason, *Tor putitora*, *Tor tor* and *Anguilla bengalensis* can be considered as true migratory fish.

In Teesta basin *Tor putitora* and *Tor tor* inhabit foothill stretch and found abundantly near Teesta barrage. In the hilly area, the adults and adolescent make their presence from April to August indicating that these species including *Tor putitora* ascends in the month of April (e.g. Nautiyal, 1994). The presence of fingerling and juveniles in Riyang Khola and adolescents in Rangit rivers were spotted during the field surveys. The presence of fingerlings and juveniles in Riyang river indicated that *Tor* spp. prefer this stream as spawning ground. As far as Great Rangit river is concerned, during the field survey, only adolescents of *Tor putitora* are reported earlier during monsoon season, therefore, it could not be confirmed as spawning grounds. Nautiyal (1994) mentioned that Mahseer migrates beyond the breeding grounds and this phenomenon can be attributed with the learning behaviour. It is quite possible in Teesta basin that Mahseer perform their learning behaviour in Rangit river.

Small rivers with all types of boulders, turbulent flow and relatively high temperature seem conducive for the spawning of mahseer. After spawning they descend to foothills in the month of September. *Anguilla bengalensis* (Freshwater Eel) is another species of Teesta basin, which performs catadromous migration (Rahimullah, 1944). However, its migratory habit is not studied in Teesta river. *Anguilla bengalensis* are considered to spawn in estuaries and sea waters because their gonads mature in salty waters only. After the hatching of ova, fry prefer to enter in freshwaters. The same migratory phenomenon of freshwater can be considered in Teesta basin. Rangit river is largely used by adults, juvenile fresh water Eels.

Other species like *Neolissochilus hexagonolepis, Labeo* spp. and *Schizothorax* spp. are also known to perform local migration. They prefer to spawn in small tributaries. *Labeo* spp. are widely distributed in the lower reaches of basin. They make their presence up to 500 m in Teesta basin. *Neollissochilus hexagonolepis* is one of the most common species in Teesta basin, and is distributed up to 800 m. Rangit river is best site for adult *Neolissochilus* while juveniles and fingerlings prefer to inhabit small streams like Riyang Khola. *Schizothorax* spp. are widely distributed in Teesta basin up to 2000 m. They descend in peak winter season and prefer to breed in small tributaries.

At present, Jorthang Loop HEP, Teesta Low Dam-III HEP and Teesta Low Dam-IV HEP are under operation. Thus, in the present scenario, the riverine ecology is adjusted to the hydrologic regime which has developed due to operation of the above referred three hydroelectric project. Teesta Stage-VI HEP is under construction. The only projects which are yet to be commissioned are listed as below:

- Teesta Low Dam I&II HEP
- Teesta Intermediate HEP
- Teesta Low Dam V HEP.

The following migratory species are reported in and around the above referred three hydroelectric projects:

- Labeo pangusia
- Schizothorax richardsoni

The migration characteristics of these two fish species are given in Table-11.11.

Thus the construction of the above referred hydroelectric projects would lead to blockage of migratory routes of Snow Trout and Pangasia Labeo.

11.7 IMPACTS ON FISHERIES DUE TO HYDRAULIC TURBINES

Fish can suffer major damage during their transit through hydraulic turbines or over spillways. Fish passing through hydraulic turbines are subject to various forms of stress likely to cause high mortality i.e., probability of shocks from moving or stationary parts of the turbine (guide vanes, vanes or blades on the wheel), sudden acceleration or deceleration, very sudden variations in pressure and cavitation. Passage through spillways may be a direct cause of injury or mortality, or an indirect cause (increased susceptibility of disorientated or shocked fish to predation). Mortality in migrating fishes could be due to shearing effects, abrasion against spillway surfaces, turbulence in the stilling basin at the base of the dam, sudden variations in velocity and pressure as the fish hits the water, physical impact against energy dissipators.

Fish passing through hydraulic turbines are subject to various forms of stress likely to cause high mortality: probability of shocks from moving or stationary parts of the turbine (guide vanes, vanes or blades on the wheel), sudden acceleration or deceleration, very sudden variations in pressure and cavitation. The impacts of hydraulic turbines on snow trout, , Mahaseer etc. have not been studied. However, numerous experiments have been conducted in various countries (USA, Canada, Sweden, Netherlands, Germany and France), mainly on juvenile salmonids and less frequently on clupeids and eels, to determine the mortality rate due to their passage through the main types of turbine (Bell, 1981; Monten, 1985; Eicher, 1987; Larinier and Dartiguelongue, 1989; EPRI, 1992).

The mortality rate for juvenile salmonids in Francis and Kaplan turbines varies greatly, depending on the properties of the wheel (diameter, speed of rotation, etc), their conditions of operation, the head, and the species and size of the fish concerned. The mortality rate varies from under 5% to over 90% in Francis turbines. On an average, it is lower in Kaplan turbines, from under 5% to approximately 20%. The difference between the two types of turbines is due to the fact that Francis turbines are generally installed under higher heads.

The mortality rate may be 4 to 5 times higher than in juvenile salmonids, reaching a minimum of 10% to 20% in large low-head turbines (as against a few per cent in juvenile salmonids). (Desrochers, 1994; Hadderingh and Bakker, 1998; Monten, 1985; Larinier and Dartiguelongue, 1989). Similar impacts, i.e. fish mortality is anticipated in the proposed hydroelectric projects as well. However, in absence of experimental data, quantification of impacts on this account cannot be made.

11.8 IMPACTS ON FISHERIES DUE TO SPILLWAYS

Passage through spillways may be a direct cause of injury or mortality, or an indirect cause (increased susceptibility of disorientated or shocked fish to predation). The mortality rate varies greatly from one location to another: between 0% and 4% for the Bonneville, McNary and John Day dams (about 30 m high spillways) on the Columbia River, 8% at the Glines dam (60 m high spillway) and 37% at the Lower Elwha dam (30 m high spillway) on the Elwha river for juvenile salmonids (Bell and Delacy, 1972; Ruggles and Murray, 1983).

Mortalities have several causes: shearing effects, abrasion against spillway surfaces, turbulence in the stilling basin at the base of the dam, sudden variations in velocity and pressure as the fish hits the water, physical impact against energy dissipators. The manner in which energy is dissipated in the spillway can have a determinant effect on fish mortality rates.

Experiments have shown that significant damage occurs (with injuries to gills, eyes and internal organs) when the impact velocity of the fish on the water surface in the downstream pool exceeds 16 m/s, whatever its size (Bell & Delacy, 1972). A column of water reaches the critical velocity for fish after a drop of 13 m. Beyond this limit injuries may become significant and mortality will increase rapidly in proportion to the drop (100% mortality for a drop of 50-60 m). In the proposed hydroelectric projects, except for Hutong hydroelectric project, stage 1, the fall in water is more than 50-60 m in the other projects. Passage through a spillway under free-fall conditions (i.e. free from the column of water) is always less hazardous for small fish, insofar as their terminal velocity is less than the critical velocity. For larger fish, the hazards are identical whether they pass under free-fall conditions or are contained in the column of water.

11.9 IMPACTS ON FEEDING BIOLOGY AND GROWTH RATES OF FISH SPECIES

Studies on Golden Mahaseers in rivers Alaknanda, Nayar and Saung in Uttarakhand have seen that in extensively regulated river stretches of river Ganga, Mahaseer was found to consume relatively lesser animal matter (40-100%) as compared to fish species in free flowing rivers, e.g. Nayar (72.1 – 89.8%) or Saung (74.3 – 90%). Insects generally occur as macrozoobenthic community, the density of which was found to be lower in rivers with regulated flows. However, the food habits did not get altered to the extent of showing a shift from carnivorous to omnivorous diet. Similar impacts are envisaged in the study area as well. The fish species in the river with regulated flow will be forced to eat higher percentage of plant matter, as a result of decrease in macro-zoobenthic community.

Another impact envisaged is that large sized fish species which are potential brooders may migrate in the tributaries for breeding. Thus, large sized fish may become virtually absent in the breeding season from the regulated stretches of river flows.

11.10 IMPACTS ON ECONOMICALLY IMPORTANT PLANTS

11.10.1 Medicinal plants

Teesta valley is rich in medicinal plants though some areas are distributed in various climatic zones. Some of the medicinally important plants like *Berberis aristata, Bergenia ciliata, Lycopodium clavatum, Mahonia nepaulensis, Rhododendron arboreum, Rubia manjith, Valeriana hardwickii, Viola betonicifolia,* and *Zanthoxylum alatum* are quite common in the temperate and sub-temperate zones. Tropical zone is also rich in medicinal flora wherein plants such as *Abroma angusta, Cymbidium aloifolium, Cissampelos pariera, Costus speciosus, Cuscuta reflexa, Dendrobium formosum, Hollarhena pubescens, Jatropa curcas, Oroxylum indicum, Rauvolfia serpentina, Terminalia chebula, Vitex negundo,* etc. grow abundantly. The hills of Teesta valley is inhabited by different ethnic groups with their different system of practice. The practice of using herbs here are broadly two types i. e. the Nepalese and Tibetan system.

11.10.2 Wild Edible Plants

There are number of wild flowering plants and pteridophytes found in diverse localities of the state and which may serve as life saving food products. These include : rhizomes of *Diosorea* spp. (Tarul); tubers of *Colocasia esculenta* (Arbi); twigs of *Gerardiana diversifolia* (Dholan) and *Urtica dioica* (Chhota sisnu); fruits of *Spondias pinnata* (Amra), *Phyllanthus emblica* (Aonla), *Terminalia chebula* (Harad); leaves of *Fagopyrum esculentum* (Kaunlya), *Houttuynia cordata* and flowers and flower buds of *Rhododendron arboretum* and *Bauhinia* spp. are used in the area.

11.10.3 Fibre Yielding Plants

Apart from the traditional fibre plants like Jute, cotton, Sunhemp, Coconut there are other plants whose parts can be utilized for extacting fibre from this region. *Abutilon indicum, Agave sislana, Cannabis sativa, Gerardiana diversifolia, Grewia optiva, Kydia calycina, Sida* *acuta, Urtica dioca, Urena lobata,* etc. are some soft and hard fibre yielding plants.

11.10.4 Fodder plants

Fodder comprises of tree leaves, fodder grasses, agricultural crop residues, fodder crops followed by occasional grazing. Although a large number of species are used for feeding the livestock, the preferred ones include *Celtis tetrandra, Ficus auriculata, F. hirta, Grewia optiva, Morus alba, Quercus glauca, Saurauria nepaulensis*, etc. Some grasses also grown for fodder purposes such as *Echinochloa frumentacea*, *Panicum miliacum*, *Paspalum dilatatum*, *Pennisetum americanum*, *Pseudosorghum fasiculare, Rottboelia cochinchinensis, Saccharum officinarum, Setaria palmifolia, Thysolaena latifolia,* etc.

11.10.5 Timber trees and fuelwood

In lower altitudes, the local people uses *Alnus nepalensis, Castanopsis indica, Canarium bengalense, Dalbergia sissoo, Engelhardtia spicata, Michelia champaca, Schima wallichii, Shorea robusta, Terminalia myriocarpa,* and *Tectona grandis* for the purpose of timber, fuelwood and making agricultural implements (Rai & Rai 1994; Singh & Das 2002). At higher altitudes various Oak and coniferous species such as *Cryptomeria japonica, Pinus wallichiana,* and *Tsuga dumosa* are used. In addition to these trees, many tall and woody bamboos (*Bambusa arundinacea, B. tulda, Dendrocalamus hamitonii and D. sikkimensis*) also used for these purposes.

The economically important plant species are likely to be acquired as a result of land acquisition for various project appurtenances.

11.11 FLORA UNDER THREATENED CATEGORY

The flora of North Bengal is under great pressure due to biotic factors like various developmental projects viz., many hydro power projects, road construction, heavy deforestation and encroachment for agricultural fields, tourist bunglows, etc. As result many plant species have become rare and threatened. Nayar and Sastry (1987, 1988 & 1990) have discussed the rare and endangered plant species of lower and higher groups (flowering plants) in Red Data Book of Indian Plants from Sikkim Himalaya (includes Adjacent Darjeeling Himalaya and Bhutan) and Eastern Himalaya. Some of the rare and threatened taxa of the Lower Teesta valley and Rangit valley of Kalimpong division are *Begonia rubella, Calamus inermis, Cissus spectabilis, Livistona jenkinsiana* and *Ophiorrhiza lurida* (Refer Table 11.16).

Table-11.16 Rare and endangered plants of the Lower Teesta Basin (as per Nayar & Sastry)

Name of species	Status	Distribution
Thelypteridaceae		
Christella clarkia	VU	Darjeeling
Ranunculaceae		
Aconitum ferox	VU	Darjeeling
Aceraceae		
Acer hookeri var. *Major*	EN	Darjeeling
A. osmastonii	EN	Darjeeling
Begoniaceae		
Begonia rubella	Rare	Darjeeling
Begonia satrapis	Rare	Darjeeling
Vitaceae		
Cissus spectabilis	Rare	Siliguri
Apiaceae		
Pimpinella tongloensis	EN	Darjeeling
Rubiaceae		
Hedyotis scabra	Rare	Darjeeling
Ophiorrhiza lurida	Rare	Darjeeling
Campnulaceae		
Codonopsis affinis	Rare	Darjeeling
Ericaceae		
Rhododendron edgeworthii	Rare	Darjeeling
Orchidaceae		
Bulleyia yunnanensis	Rare	Darjeeling
Cymbidium eburnum		
Diplomeris hirsute	VU	Darjeeling
Cocalvulaceae		
Tricarpelema giganteum	*Rare*	
Arecaceae		
Calamus inermis	EN	Kurseong
Phoenix rupícola	Rare	Teesta valley

EN =Endangered ; VU= Vulnerable

11.12 IMPACTS ON WILDLIFE

The land acquisition for various project appurtenances could lead to adverse impacts on wildlife. Effects needs to be made for identification of non-location specific project requirements lead to minimum impacts on flora and fauna. The sites selected for various project appurtenances, e.g. project colony, labour camps, muck disposal sites, roads, waste disposal sites, etc. should be:

- Free from dense vegetation
- Away from wildlife habitats including breeding sites
- Water holes for wildlife
- Away from river banks

11.13 IMPACTS ON PROTECTED AREAS

Mahananda Wildlife Sanctuary is located on the foothills of the Himalayas, between the Teesta and Mahananda rivers. It is situated in the Darjeeling district of West Bengal and comes under Darjeeling Wildlife division. The area of sanctuary is 159 km^2 of reserve forest and was started as a game sanctuary in 1955. In 1959, it got the status of a sanctuary mainly to protect the Indian bison and royal Bengal tiger, which were facing the threat of extinction.

The forest type in Mahananda Wildlife Sanctuary varies from riverain forests like Khayer-Sisoo to dense mixed-wet forest in the higher elevation in 'Latpanchar' area of Kurseong hills. The variation in altitude and forest types helps the existence of a large number of species of mammals, birds and reptiles.

The important mammal species observed in the Mahananda Wildlife Sanctuary is include majestic Royal Bengal Tiger, gigantic elephants, sturdy Indian bison, timid spotted and barking deer, many species of lesser cat, Himalayan black bear, leopard including clouded leopard and many other smaller animals. The Sanctuary also holds hundreds of avi-faunal species including fairy blue bird, Himalayan pied hornbill, etc. Among the others; swallow, swift, thrush, babbler, warbler, roller, minivet, sunbird can be found in abundance in the sanctuary.

CHAPTER-12
ENVIRONMENTAL AUDIT

CHAPTER-12

ENVIRONMENTAL AUDIT

12.1 INTRODUCTION

The aim of the Environmental Audit (EA) is to assess the status of implementation of environmental management measures recommended in Environmental Clearance of Teesta Low Dam-III & Teesta Low Dam-IV. The most reliable way to achieve the above objective is to review the environmental compliance reports with respect to the Compliance conditions mentioned in the Environmental Clearance as well as the comparison of baseline status of EIA and Basin study for both the projects.

12.2 PRESENT STATUS OF TEESTA LOW DAM-III

Presently, Teesta Low Dam-III is an operational project of NHPC Limited, which received the Environmental Clearance vide their letter no. J-12011/44/2002-IA-I dated 16.07.2003 based on the EIA Report prepared by University of North Bengal, Darjeeling, West Bengal.

As a part of EIA Study prepared by University of North Bengal for Teesta Low Dam-III; the primary data was collected during the year 2001-2002.

The base line was collected for various seasons for EIA study and currently for Teesta Basin study and same data has been compared for the Environmental Audit and the details are given in the following Paragraphs.

12.3 ENVIRONMENTAL AUDIT FOR TEESTA LOW DAM-III

12.3.1 Water Quality

12.3.1.1 Water quality as per EIA Study

Water samples were collected from two locations in Teesta River for two seasons. The data generated is presented in Table-12.1. The sampling locations in the catchment of the project are:

(A) 29th Mile (On the River Teesta)
(B) Near SAMCO Ropeway (Barrage site on the River Teesta).

Table-12.1 Chemical Analyses of Water Samples

	Monsoon		Post Monsoon	
Parameters	**Site A**	**Site B**	**Site A**	**Site B**
Temp,°C	14.5	15.0	18	20
pH	6.8	6.8	7.5	7.5
TDS, mg/l	153.0	140.0	66	54
TSS, mg/l	61.0	58.0	10	25
Alkalinity, mg/l of $CaCO_3$	22.5	20.5	19.5	25.5
Total Hardness, mg/l of $CaCO_3$	42.5	42.5	31.5	33
Calcium Hardness (mg/l)	22.8	24.0	20	19
Magnesium Hardness (mg/l)	10.4	11.8	11.5	14
Dissolved Oxygen (mg/l)	10.42	9.84	9.54	9.17
COD, mg/l	10.0	11.0	21.0	21.0
BOD, mg/l	1.9	1.7	1.2	1.20

	Monsoon		Post Monsoon	
Parameters	**Site A**	**Site B**	**Site A**	**Site B**
Chloride, mg/l	1.6	1.4	1	1.10
Nitrates (mg/l)	0.14	0.16	0.18	0.26
Phosphates (mg/l)	18.0	20.54	32.21	52.80
Silicates (mg/l)	5.8	6.2	7.5	4
Detergent Cation, mg/l	ND	ND	1	1.25
Detergent anionic, mg/l	ND	ND	1	1
Total Iron, mg/l	ND	ND	ND	ND
Aluminum, mg/l	ND	ND	1	1
Zinc, mg/l	ND	ND	ND	ND
Cobalt, mg/l	ND	ND	ND	ND

ND: Not Detected

The pH of water samples at both locations was 6.8 and 7.5 during monsoon and post monsoon seasons respectively, indicating neutral nature of the waters. The TDS is 66 & 54 mg/l and TSS is 10 and 25 mg/l during post monsoon season. But during monsoon season, the highest values of TDS and TSS are 153 and 61 mg/l respectively. Low TSS in the area is good for the health of the turbine blades and hence the quality of water is fit to be used for hydropower generation.

The alkalinity, hardness, Calcium & Magnesium values indicate that their source is mainly from weathering of catchment rocks. The low hardness levels indicate the water is soft in quality.

The Dissolved Oxygen (DO) level in the river is fairly good which indicates the absence of pollutants and also impart self-cleansing property to the river. The BOD values are also <2 mg/l, indicating that the water is fit for drinking purpose after mild chlorination and filtration. This also indicates that there is no organic pollution of the river water.

The concentrations of metals as iron, aluminum, zinc and cobalt, was observed to be low. Overall, the status of water quality of Teesta River in the project area was very good and fit for drinking purposes after chlorination and filtration.

12.3.1.2 Water Quality as per Teesta Basin Study

Detailed monthly data on physical and chemical characteristics for various projects in study area. Water quality of study area including Teesta and Rangit rivers was assessed using various physical and chemical characteristics at spatial and temporal scales. The water sampling results for location in Teesta Low Dam-II project area are given in Table-12.2.

Table-12.2 Water Quality of Teesta River near Project Site Teesta Low Dam-III as Teesta Basin Study

	April,14		May,14		June,14		July,14		August,14		September,14		October, 14		November,14		December,14		January,15		February, 15		March, 15	
Parameters	**S9**	**S10**	**S9**	**S10**	**S9**	**S10**	**S9**	**S10**	**S9**	**S10**	**S9**	**S10**	**S9**	**S10**	**S9**	**S10**	**S9**	**S10**	**S9**	**S10**	**S9**	**S10**	**S9**	**S10**
Water Temperature (°C)	17	19	21	22	19	19	20	20	17	19	21	19	21	19.5	19.5	18.5	16	17	12	17	12	17	24	19
Colour	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less
Odour	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less
Turbidity (ntu)	12.98	25	760	8.88	431	535	303	411	12.98	25	2.24	10.49	2.38	4.56	2.14	3.28	1.15	1.8	1.6	1.69	1.6	1.69	10.83	2.07
pH	7.93	8.3	7.78	7.77	8.04	7.95	8.02	8.15	7.9	7.8	8.07	7.82	7.89	7.95	8.01	7.91	8.21	7.51	8.23	7.63	8.23	7.63	8.07	8.03
Dissolved Oxygen (mg/l)	7.76	6.87	5.6	5.4	7.8	7.4	7.6	6.4	6.4	6.3	7.1	5.33	8.12	7.23	8.02	7.76	7.83	6.6	8.27	7.87	8.27	7.87	7.07	7.5
BOD, mg/l	1.5	1.6	1.5	1.6	1.2	1.1	1.2	1.3	1.3	1.2	1.3	1.2	1.8	1.8	1.7	1.8	1.6	1.8	1.7	1.6	1.7	1.6	1.3	1.5
COD, mg/l	2.9	3.1	3.2	2.9	2.6	2.6	2.1	2.3	2.6	2.3	2.6	2.3	3.6	3.2	3.5	3.6	3.2	3.5	3.3	3.2	3.3	3.2	2.7	3.1
Electric Conductivity (μs)	77.06	83.2	51.1	73.1	52.8	53.8	46.27	44.1	49.45	49.8	60.67	50.03	71.25	62.97	73.62	71.68	73.63	76.73	75.5	81.37	75.5	81.37	75.07	104.27
Total Dissolved Solid (mg/l)	58.3	62.9	38.1	54.8	40.3	41.3	43.18	51.48	37.25	36.45	45.8	37.87	49.8	38.53	54.69	46.39	56.4	59.03	57.1	60.37	57.1	60.37	46.27	63.17
Alkalinity (mg/l)	54	54	52	56	72	74	36	40	38	32	62	40	54	44	62	44	52	50	50	48	50	48	53	55
Total Hardness (mg/l)	64	70	62	86	90	72	92	76	52	46	68	69	66	71	67	67	66	66	102	90	102	90	63	78
Calcium Hardness (mg/l)	58.8	58.8	37.8	52.5	46.2	46.2	42	54.6	35.7	37.8	39.9	42	45.68	52.38	50.87	50.43	50.4	60.9	48.3	63	48.3	63	48.3	55.65
Calcium ions	23.	23.	15.	21.	18.	18.	16.	21.	14.	15.	15.	16.	18.	21.	20.	20.	20.	24.	19.	25.	19.	25.	19.	22.

	April,14		**May,14**		**June,14**		**July,14**		**August,14**		**September,14**		**October, 14**		**November,14**		**December,14**		**January ,15**		**February, 15**		**March, 15**	
Parameters	**S9**	**S10**	**S9**	**S10**	**S9**	**S10**	**S9**	**S10**	**S9**	**S10**	**S9**	**S10**	**S9**	**S10**	**S9**	**S10**	**S9**	**S10**	**S9**	**S10**	**S9**	**S10**	**S9**	**S10**
(mg/l)	55	55	14	03	5	5	82	87	3	14	98	82	35	04	43	25	19	39	34	23	34	23	32	26
Magnesium Hardness (mg/l)	5.2	11.2	24.2	33.5	43.8	25.8	50	21.4	16.3	8.2	28.1	27	20.32	18.62	16.13	16.57	15.6	5.1	53.7	27	53.7	27	14.7	22.35
Magnesium Ions (mg/l)	1.26	2.72	5.88	8.14	10.64	6.27	12.15	5.2	3.96	1.99	6.83	6.56	4.94	4.53	3.92	4.03	3.79	1.24	13.05	6.56	13.05	6.56	3.57	5.43
Chloride (mg/l)	33	29	36	29	3.12	2.54	40	44	15	19	13	12	15	15	16	17	25	19	17	14	17	14	34.5	29
Sodium (mg/l)	3.51	3.49	2.89	2.67	2.13	2.02	2.97	2.78	3.16	3.09	4.56	4.23	3.64	3.16	5.05	4.63	4.21	4.12	3.85	3.78	3.85	3.78	5.12	5.11
Potassium (mg/l)	1.39	1.54	1.32	1.44	50	44	1.99	1.89	1.81	1.66	2.09	2.02	1.39	1.3	1.55		1.32	1.22	1.16	1.38	1.16	1.38	2	2.23
Nitrates (mg/l)	0.11	0.06	0.24	0.21	0.6	0.1	ND	6.63	0.91	0.55	1.64	0.12	0.04	0.06	ND	0.08	ND	0.94	ND	0.12	ND	0.12	0.53	0.05
Phosphates (mg/l)	0.23	0.32	0.26	0.43	0.09	0.09	0.1	0.31	0.16	0.43	0.11	0.08	0.12	0.03	ND	0.03	ND	0.16	ND	ND	ND	ND	0.05	0.19
Silicates (mg/l)	0.6	10.66	3.34	8.39	7.36	0.75	4.94	5.53	5.81	9	5.62	4.4	7.22	6.48	12.87	14.14	23.71	18.49	33.4	26.35	33.4	26.35	15.46	11.55
Iron (Fe; mg/l)	0.14	0.09	0.11	0.12	0.13	0.11	0.12	0.09	0.15	0.19	0.18	0.17	0.22	0.19	0.01	0.01	ND	ND	0.13	0.15	0.13	0.15	0.19	0.21
Copper (mg/l)	ND	ND	ND	ND	ND	ND	0.004	0.002	0.0031	0.0081	ND	ND	ND	ND	0.001	ND	ND	ND	0.02	ND	0.02	ND	0.009	0.008
Total Chromium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Lead, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL			BDL	BDL	BDL	BDL	BDL	BDL
Mercury, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc, mg/l	0.2	0.4	0.2	0.4	0.3	0.2	0.3	0.4	0.2	0.2	0.2	0.3	0.3	0.5	0.2	0.2	BDL	BDL	0.2	0.2	0.2	0.2	0.4	0.4

12.3.1.3 Comaprision of water quality

The water quality monitored near the Teesta Low Dam-III during the EIA study(2001-2002) and Teesta Basin Study (2014-2015) are compared in Table-12.3.

Table-12.3: Comparison of water quality parameters

Parameters	**Ranges Of parameters monitored during EIA Study**	**Ranges Of parameters monitored during Teeta Basin Study**
Temp,°C	14.5-20	12-22
pH	6.8-7.5	7.51-8.3
TDS, mg/l	54-153	36.45-63.17
TSS, mg/l	10-61	
Alkalinity, mg/l of $CaCO_3$	19.5-25.5	32-74
Total Hardness, mg/l of $CaCO_3$	31.5-42.5	46-102
Calcium Hardness (mg/l)	19-24.0	37.8-63
Magnesium Hardness (mg/l)	10.4-11.8	5.1-53.7
Dissolved Oxygen (mg/l)	9.17-10.42	6.3-8.3
COD, mg/l	10-21	2.1-3.6
BOD, mg/l	1.2-1.9	1.1-1.8
Chloride, mg/l	1-1.6	2.54-44
Nitrates (mg/l)	0.14-0.26	ND-0.63
Phosphates (mg/l)	18-52.8	ND-0.43
Silicates (mg/l)	4-7.5	0.6-33.4
Detergent Cation, mg/l	ND-1.25	-
Detergent anionic, mg/l	ND-1	-
Total Iron, mg/l	ND	ND-0.2
Aluminum, mg/l	ND-1	-
Zinc, mg/l	ND	ND-0.4
Cobalt, mg/l	ND	-

The TDS level ranged from 17.57 to 75.1 mg/l which is well below the permissible limit of 500 mg/l specified for drinking water. The TDS level was found to be lower in monsoon season as compared to summer season. This trend was observed for various cations and anions monitored as a part of the study. This could be attributed to higher discharges in monsoon months.

The hardness level ranged from 47 to 54 mg/l indicating soft nature which was slightly higher than the hardness levels observed as per the field studies conducted as a part of EIA study. The hardness level was well below the permissible limit of 200 mg/l specified for drinking water. The low levels of calcium and magnesium are mainly responsible for the soft nature of water.

The chlorides level ranged from 2.54 to 46 mg/l, which are well below the permissible limit of 200 mg/l, specified for meeting drinking water requirements. The concentration of chlorides level in monsoon season were comparable to the chlorides level observed as a part of EIA study.

The concentration of various cations, e.g. sodium, potassium, calcium and magnesium was observed to be quite low which is also reflected by the low TDS level. Iron was found to be ranged from 0.01 to 1.15 mg/l.

The concentration of various heavy metals was found to be below permissible limits in both EIA as well as basin studies. The BOD and DO values were observed to be of similar level in both EIA and basin studies. This is mainly due to the low population density and absence of water polluting industries in the area.

12.3.2 FLORA

12.3.2.1 Terrestrial Ecological Survey as per the EIA Study

A detailed study of the flora in the study area was undertaken as a part of EIA study. Most of the forests in the catchment of the project are semi-deciduous forests with patches of leak, sal and tea plantations. The natural forests in the area are, at places, degraded due to excessive extraction and conversion of forest for cultivation and developing human settlements. The local population is dependent on these forests for firewood and numerous other minor forest produce.

Vegetation Types of Project Area

Western bank of the reservoir is occupied by plantation forest and on the Eastern side the forests are natural as well as planted. The water level of the reservoir will remain much below the National High Way TJA, where almost no natural forest is seen. However, naturally occurring bushes, climbers, grasses and epiphytes are abundant. Following types of vegetation was recognized in the area:

I.Herbs: This vegetation grows in the riverbed when the same dries up in the lean period. Nevertheless, during the peak period (mainly monsoon) the riverbed remains covered with water. During lean period, a large number of herbaceous plants, both annuals and perennials are found to grow in the riverbed.

II. Shrubs: Shrubby vegetation has developed at some places on both sides of the river especially at places where original forested vegetation was damaged, may be by floodwater or due to landslide or deforestation etc.

III. Forested Vegetation: The forests on both sides of the river are growing above the flood level. Basically, following two types of forests are found in the area.

(A) ***Natural Forests*** They are mainly tropical semi-deciduous type.

Forests on the western side appear to be more affecled by fire and grazing. But, at places, vegetalion is quite dense with trees, shrubs, woody climbers and epiphytic associations.

(B) ***Plantation Forests*** in this area are forests formed by plantations of teak*(Teaoua graudis), Tenuiualia* sp., *Cntelina orborea* and *Ellcalyptlls* sp., but most of these are situated outside the reservoir area.

Dominant Species of Plants

The dominant species in the area vary with the variation of the vegetation structure. In the canopy, plants like *Shorea robusta, Bombax ceiba, Terminalia myriocarpa, Duabanga sonneratioides, Lagerstroemia paruiflora* are dominant ones. Among the climbers, plants like *Bauhinia vahlii, Natsiatum herpeticum, Ichnocarpus jrutescens, Dalbergia stipulacea, Thunbergia fragrance* dominate. In the riverbed, there are patches of *Chenopodium ambrosoides, Euphorbia hypericifolia, Pouzolzia zeylanica, Hyptis suaveolens,* as dominants. Shrubs like *Woodfordia jruticosa, Clerodendrum serratum, Tephrosia candida, Casearia graveolens,* etc are dominants. However, this is the overall picture, which varies at different sites and in different seasons.

Distribution of Endemic Flora

Following endemic species of higher-plants recorded are given in Table-12.4.

Table-12.4 :Endemic species of plants recorded from the surrounding forest area

Names of Plants	Families	Endemic to	Availability
Argyria roxburghii	Convolvulaceae	Eastern Himalaya	Common
Boehmeria macrophylla var. canescens	Urticaceae	Eastern Himalaya	Common
Bulbophyllum reptans	Orchidaceae	Eastern Himalaya to N.E. India	Abundant
Elatostema reptans	Urticaceae	Eastern Himalaya to N.E. India	Common
Gynocardia odoraia		Eastern Himalaya to N.E. India	Common
Neroilia falcata	Orchidaceae	Eastern Himalaya	Common
Oberonia fulcata	Orchidaceae	Eastern Himalaya	Common
Phoebe attenuata	Lauraceae	Eastern Himalaya to N.E. India	Common
Pueraria lobata var. thomsonii	Papilionaceae	Eastern Himalaya to N.E. India	Common
Sauropus quadrangularis	Euphorbiaceae	Eastern Himalaya	Common

Economically Important Plants

Cultivated plants, harvestable wild plants and ethnobotanically useful plants, are regarded as economically important plants. Plants purely in cultivation, unless escaped, are not included in the general enumeration of the flora. But, now, all recorded economically important plants are recorded and given in Table. 12.5.

Table-12.5: Economically Important Plants

Name of the crop	Scientific name	Extent of cultivation
A.CEREALS & MILLETS		
Paddy	*Oryza sativa*	In small terraces
Corn	*Zea mays*	Common near habitations
Kudo	*Elusine corneana*	Common
B. VEGETABLES & SPICES		
Potato	*Solanum tuberosum*	Common
Tomato	*Lycopersicon esculentum*	Common near habitations
Brinjal	*Solanum melangona*	Common near habitations
Chillies	*Capsicum annum*	Common near habitations
Amaranthus	*Amaranthus spp.*	Common
Spinach	*Spinacea oleracea*	Common
Rye	*Brassica campestris*	Common near habitations
Cabbage	*Brassica oleracea var. capitata*	Less common
Cauliflower	*Brassica oleracea var. botrytis*	Less common
Beat	*Beeta vulgaris*	Rare
Goard Pumpkin	*Cucurbita maxima & C. pepo Benincasa hispidia*	Common near habitations
Coriander	*Coriandrum sativum*	Common near habitations
Squash	*Sechium edule*	Less common
Beans	*Phaseolus lunatus*	Common
Lablab	*Lablab purpurea*	Common
Pigeon pea	*Cajanus Cajun*	Less common
Curry pata	*Murraya koenigii*	Common
Mushrooms	*Mainly oister mushroom is cultivated in this region. Some local species are also edible.*	Rare in cultivation
Pea	*Pisum sativum*	Common near habitations
Drum stick	*Moringa pterigosperma*	Common
Zinger	*Zingiber officinale*	Common
Halud	*Curcum longa*	Less common
Chalta	*Dillenia indica*	Rare
Cucumber	*Cucumis salcons*	Less common
Bothua	*Chenopodium album*	Common
C. FRUITS		
Guava	*Psidium guajava*	Common near habitations
Mango	*Mangifera indica*	Less common
Bor	*Zizplus mauritiana*	Less common
Aru	*Prunus persica*	Less common
Lemon	*Citrus medica*	Less common
Orange	*Citrus auranticum*	Common
Shaddock	*Citrus maxima*	Less common
Beatle nut	*Areca catecha*	Common
Jamun	*Syzygium cumini*	Less common
Gulab jamun	*Syzygium*	Rare
Ambake	*Syzygium formosum*	Rare
Rose apple	*Syzygium jambos*	Rare
Papaya	*Carica papaya*	Common near habitations
Banana	*Musa bulbisiana*	Common

Name of the crop	Scientific name	Extent of cultivation
Pine apple	*Ananas comosus*	Less common
Jack fruit	*Arlocarpus heterophylla*	Common
Nona	*Annona reticulata*	Less common
Borhar	*Artocarpus lacucha*	Less common
Kabra	*Ficus infectoria*	Less common
D.FODDER		
Khanium	*Ficus semicordata*	Common
Koksa	*Ficus hispida*	Common
Kabra	*Ficus infectoria*	Less common
Subabul	*Leucaena leucocephala*	Common
Dinanath ghas	*Penisetum pedicellateum*	Less common
Kali lahara	*Combretum decundrum*	Common
Phul-jharu	*Thysanolena maxima*	Common
Bonsum	*Litsea monopetala*	Common
Kubinde	*Nayarophyton ziziphifolia*	Common
Borhar	*Artocarpus lacucha*	Less common
Jamuna	*Syzygium cumini*	Less common
Kamli	*Boehmeria macrophylla*	Less common
Phutta	*Brassiopsis mitis*	Rare
Bans	*Bambus spp.*	Common
Tama bans	*Dendrocalamus spp.*	Rare
Chokti-phul	*Saccharum arundinaceum*	Common
Nevaro	*Ficus hookeri*	Rare
E. COMMON & POTENTIAL ORNAMENTALS		
Marygold	*Tagetes patula*	Common near habitations
Rose	*Rosa centrifolia*	Common near habitations
Dianthus	*Many species of dianthus are in cultivation, some are found here.*	Less common
Hansuhana	*Cestrum nocturnum*	Rare
China -rose	*Hibiscus rosa- sinensis*	Less common
Cacli & Succulents	*Many species are in their collections*	Common
Cock's comb	*Celosia cristata*	Less common
Canna	*Canna indica*	Less common
Salvia	*Salvia coccinea*	Common
Calendula	*Calendula officinalis*	Common
Zinnia	*Zinnia spp.*	Less common
Crotons	*Coedium variagnatum*	Less common
Jacaranda	*Jacaranda mimosaetoha*	Common
Kolke	*Thevetia peruviana*	Rare
Oleander	*Nerium indicum*	Less common
Rangan	*Lxora coccinea, l. japonica & l. singaporensis*	Common
Debdaru, Ashok	*Polyalthia longifolia*	Common
Asparagus	*Asparagus spp.*	Less common
Chinese hat	*Holmskioldia sanguinea*	Less common
	Ophiopogon sp.	Less common
	Paliosan macrophylla	Rare
	Hoya spp.	Common
Taki	*Bauhinia Variegate*	Common

Name of the crop	Scientific name	Extent of cultivation
Gham-pul	*Tithonia diversifolia*	Less common
Asare	*Clerodendrum japonicum*	Common
F. MEDICINAL		
Kalmegh	*Andrographis paniculata*	Common
Ghritakumari	*Aloevera*	Rare
Tilepate	*Artemisia indica*	Common
Punarnava	*Boerhavia diffusa*	Common
Boch, Bojo	*Acorus calamus*	Less common
Sarpangandha	*Rauvolfia serpentia*	Rare
Satamuli	*Asparagus racemosus*	Less common
Bon-tarul	*Dioscorea spp.*	Common
Anantamul	*Hemidesmus indicus*	Rare
	Tylophora asthamatica	Rare
Boherha	*Terminalia belerica*	Common
Arjun	*Terminalia arjuna*	Less common
Hingcha	*Enhydra fluctuenus*	Common
Sakupaani	*Costus speciosus*	Common
Amloki	*Phyllanthus embelicus*	Rare
Neem	*Azadirachta indica*	Less common
Tamarkey	*Stephania glandulosum*	Less common
Khayer	*Acacia catechu*	Less common
Bel	*Aegle marmelos*	Rare
Bun-mara	*Tephrosia candida*	Common
Pipla	*Piper longum*	Less common
Dala karbo	*Piper mullesua*	Less common
Thankuni	*Centella asiatica*	Common
G. TIMBER, BAMBOO & CANE		
Segun , Teak	*Tectona grandis*	Common
Sal	*Shrea robusta*	Common
Panisaj	*Terminalia myriocarpa*	Common
Toon	*Toona ciliata*	Common
Aule dabdabe	*Garuga pinnata*	Less common
Dalne katus	*Castanopsis hystrix*	Less common
Ramphal,Gantley	*Gynocardia odoranta*	Less common
Bans	*Bambusa spp.*	Common
Champ	*Michelia champaca*	Less common
Chikrassi	*Chukrasia tabularis*	Common
	Albizia chinesis	Less common
Siris	*Albizia odoratissima*	Common
Siris seto	*Albizia procera*	Common
Bet	*Calamus erectus*	Less common
Kudum	*Anthocephalus chimensus*	Common
Gokul	*Ailanthus integrifolia*	Less common
Chilanue	*Schima wallichii*	Common
Jangli aam	*Mangifera sylvetica*	Rare
Gamar	*Gmelina arborea*	Common
Maina	*Tetra meles nudlifora*	Less common
Kaijral	*Bischofia javanica*	Less common
Chipley kan	*Cratavea unilocularis*	Less common
Jamuna	*Syzygium tetragonal*	Less common
Odal	*Sterculia villosa*	Common

Name of the crop	Scientific name	Extent of cultivation
Lali	*Aphanamixis polystachya*	Common
Gokul	*Ailanthus integrifolia*	Less common

Rare and Threatened Species of Plants

A few endemic, rare and threatened species of plants have been observed in the study area. The list of such identified species is presented in Table-12.6.

Table-12.6: Rare and threatened species of plants growing in the study area

Botanical Names	Family	Habit
Arundina graminifolia	Orchidaceae	Shrub
Bauhinia scandens	Caesalpiniaceae	Woody climber
Burmannia coelestis	Burmanniaceae	Annual Herb
Luisia teretifoli	Orchidaceae	Epiphyte
Oryza meyeriana	Gramineae	Annual Herb
Neroilia faicata	*Orchidaceae*	Epiphyte
Cyathea spinulosa	*Cyatheaceae*	Tree
Angiopteris salicifolia	Marattiaceae	Shrub

Arundina graminifolia is a ground orchid, which is also available under cultural condition. It grows nicely on the moist hill slopes. However, the distribution of this orchid is not restricted and hence need no conservation.

The distribution of *Bauhinia scandens* is also not restricted, however, mature plants of this species are now extremely rare. *Burmannia coelestis* is a minute herb with beautiful blue flowers. It grows among the small grasses and in very small and restricted patches. *Luisia teretifolia* is an epiphytic orchid,though quite rare, but can be easily rehabilitated on many host species in the green belt. *Oryza meyeriana* is an endemic wild relative of cultivated paddy. The species need to be preserved because, in future, it may be useful in improving the quality of paddy *(Oryzn sntivn)*. *Neroilia fnlenla* is also a rare and endangered species of orchid. This species has been recorded from the Eastern bank of Teesta. These plants can be spotted in proper season and can be shifted to the green belt.

12.3.2.2 Terrestrial Ecological Survey as per the Teesta Basin Study

Floral Composition in the Vicinity of Teesta Low Dam (TLD) III HEP

A patchy riverine and moist deciduous forest is noticed in the vicinity of project. Top storey is represented by few trees like *Albizia, Dalbergia, Canarium, Duabanga, Elaeocarpus, Engelhardtia, Erythrina, Garcinia, Gmelina,* and *Pterospermum*. Second storey consists of trees like *Bauhinia, Caraya, Ficus, Glochidion, Mallotus* and *Oroxylum*. Shrubs are represented by species of *Chromolaena, Cassia, Lantana, Rubus*, etc. Few tall reed grasses viz., *Arundo donax, Saccharum longisetosum, Thysanolaena latifolia*, etc.

were observed with dense patches along the river bank. In the downstream area very thin growth of few trees were observed on lower reaches. Upper reaches consists of fairly dense mixed teak and deciduous forest. The common trees are species of *Albizia, Altsonia, Dalbergia, Erythrina, Macaranga* and *Persia*. Undergrowth is disturbed and covered with few tall shrubs and undershrubs.

Community Structure

At near Teesta Low Dam III (right bank of Teesta), the tree stratum was dominated by *Albizia procera* having maximum frequency (60%) and density (90 trees/ha). The associated species in the canopy were *Glochidion oblatum, Dalbergia sissoo, Duabanga grandiflora, Callicarpa arborea, Terminalia bellerica, Mallotus philippinensis, Phoebe hainesiana, Gmelina arborea* and *Pterospermum heterophyllum*. In the sapling layer, *Callicapa arborea* was found to be the most dominant species having high density. In the shrub layer *Chromolaena odoratum* was found as the most dominant species with high density. Other competing species in the layer were *Bambusa tulda, Cassia mimosoides, Boehmeria platyphylla, Lanatana camara, Cudrania javanensi*s and *Clerodendrum japonicum*.

At downstream of Teesta low dam III (right bank of Teesta), the tree and sapling strata were dominated by *Callicarpa arborea* having maximum frequency and density. The associated species in the tree canopy were *Ficus semicordata, Dalbergia sissoo, Albizia chinensis, Macaranga denticulata, Albizia lucida,* and *Engelhardtia spicata*. In the shrub layer *Chromolaena odoratum* was found to be the most dominant species followed by *Lantana camara* in terms of density.

Herbs

Pre-monsoon season

At near Teesta Low Dam IIIrd site, *Thysanolaena latifolia* was the most dominant species, followed by *Saccharum longisetosum*. *Saccharum narenga* by *Thysanolaena latifolia* and *Saccharum longisetosum* were also observed.

On downstream of Teesta Low Dam III site, *Saccharum longisetosum* was the most dominant species followed by *Arundinella decempedalis,* Oplismenus composites, *Saccharum longisetosum* followed by *Thysanolaena latifolia, Saccharum narenga*.

Monsoon Season

At near Teesta Low Dam III site, *Saccharum narenga* was the dominant species, followed by *Isachne albens*, *Setaria palmifolia* and *Bothriochloa pertusa, Saccharum narenga, Isachne albens* and *Setaria palmifolia*.

On downstream of Teesta Low Dam III site, *Saccharum longisetosum* was the dominant species followed by *Saccharum narenga*, *Mikania macrantha* and *Thysanolaena latifolia* in

Saccharum longisetosum, *Saccharum narenga*, *Mikania macrantha* and *Thysanolaena latifolia*.

12.3.2.3 Comparision of Terrestrail Ecological Survey

The findings of the field studies conducted as a part of EIA study for Teesta Low Dam-III HEP are given below:

- **Dominant tree species**- *Shorea robusta, Bombax ceiba, Terminalia myriocarpa, Duabanga sonneratioides, Lagerstroemia parviflora* etc.
- **Dominant shrub species-** *Woodfordia fruticosa, Clerodendrum, serratum, Tephrosia candida, Casearia graveolens,* etc.
- **Dominant herb species-** *Chenopodium ambrosoides, Euphorbia hypericifolia, Pouzolzia zeylanica, Hyptis suaveolens,* etc.

The findings of the terrestrial ecological study conducted as a part of basin study are given as below:

- **Dominant tree species-** *Albizia procera, Pterospermum acerifolium, Glochidion oblatum, Duabanga grandiflora, Callicarpa arborea, Terminalia bellerica* and *Glochidion oblatum.*
- **Dominant shrub species-** *Chromolaena odoratum, Bambusa tulda, Cassia mimosoides, Boehmeria platyphylla, Woodfordia fruticosa, Lanatana camara, Clerodendrum serratun, Cudrania javanensi*s, etc.
- **Dominant herb species-** *Saccharum narenga, Thysanolaena latifolia, Arundinella decempedalis, Oplismenus composites,* etc.

<u>**Economically Important Plants**</u>

According to the field studies conducted as a part of EIA study, following economically important plants were observed.

- **Fibre yielding plants**- Abutilon indicum, Agave sislana, Cannabis sativa, Gerardiana diversifolia, Grewia optiva, Kydia calycina, Sida acuta, Urtica dioca, Urena lobata, etc.
- **Fodder plants**- Ficus semicordata, F. hispida, F. infectoria, Litsia monopetala, Syzygium comunii, Brassiopsis mitis, Dendrocalamus, Thysolaena latifolia, Saccharum sp, Penisetum pediocllatum, leucaena sp etc.
- **Timber trees and fuelwood**- Tectona grandis, Shorea robusta, Terminalia myriocarpa, Castanopsis hystrix, Albizia chinensis, A. odoratissima, Bischofia javanica, Sterculia villosa,Ailanthus integrifolia,mangifera sylvelion, Garunga piñata, Toona ciliate Michelia champaca, Schima wallichii etc.

Several economically important plants have been recorded during field study conducted as a part of Basin Study.

- **Wild edible plants-** Rhizomes of *Diosorea* spp. (Tarul); tubers of *Colocasia esculenta* (Arbi); twigs of *Gerardiana diversifolia* (Dholan) and *Urtica dioica* (Chhota sisnu);
- **Fruits edible plants-** *Spondias pinnata* (Amra), *Phyllanthus emblica* (Aonla), *Terminalia chebula* (Harad); leaves of *Fagopyrum esculentum* (Kaunlya), *Houttuynia cordata* etc.
- **Fibre yielding plants-** *Abutilon indicum, Agave sislana, Cannabis sativa, Gerardiana diversifolia, Grewia optiva, Kydia calycina, Sida acuta, Urtica dioca, Urena lobata,* etc.
- **Fodder plants-** *Celtis tetrandra, Ficus auriculata, F. hirta, Grewia optiva, Morus alba, Quercus glauca, Saurauria nepaulensis, Echinochloa frumentacea, Panicum miliacum, Paspalum dilatatum, Pennisetum americanum, Pseudosorghum fasiculare, Rottboelia cochinchinensis, Saccharum officinarum, Setaria palmifolia,Thysolaena latifolia, etc.*
- **Timber trees and fuelwood-** *Alnus nepalensis, Castanopsis indica, Canarium bengalense, Dalbergia sissoo, Engelhardtia spicata, Michelia champaca, Schima wallichii, Shorea robusta, Terminalia myriocarpa, and Tectona grandis, Bambusa arundinacea, B. tulda, Dendrocalamus hamitonii and D. sikkimensis etc.*

Medicinally Important Plants

During the field study conducted as a part of EIA study, a total of 20 medicinal plant species were recorded which include:

Andrographis paniculata, Aloe vera, Artemisia indica, Boerhavia diffusa, Acorus calamus, Rauvolvia serpentine, Asparagus racomosus, Dioscrea sp, Terminelia belerica, T. arjuna, Phyllanthus emblica, Azadirachta indica, Aegle marmelos, Piper longum, P.mullesum,Stephania sp, *Centella asiatica, Acacia catechu, Tepherosia* sp, *Solanum* sp. and *Costus speciosus.*

During the field survey conducted by WAPCOS Ltd, the medicinally important plants observed in the study area are listed as below:

Asparagus racemosus, Cymbidium aloifolium, Berberis aristata, Bergenia ciliata, Lycopodium clavatum, Mahonia nepalensis, Rubia manjith, Valeriana hardwickii, Viola *betonicifolia, Costus speciosus, Oroxylum indicum, Rauvolfia serpentina, Phyllanthus emblica, Equisetum ramosissimum, Vitex nigundo* and *Zanthoxylum alatum.*

Endemic Species

The Endemic species reported from the study area as a part of EIA study were *Argyria roxburghii*, *Boehmeria macrophylla, Bulbophyllum reptans, Elatostema reptans, Gynocardia odoraia, Neroilia falcate, Oberonia fulcata* and *Phoebe attenuate*.

While species like *Acer campbeli, A. hookeri, Calamus inermis, Capparis sikkimensis, Casearia glomerata, Hypericum monanthenum, Hydrocotyle himalaica, Pandanus nepalensis, Plectocomia himalayana* and *Sterculia kingia* were recorded during field studies conducted as a part of Basin Study.

Rare and Threatened Flora

As per the field studies done as a part of EIA study, *Arundina graminifolia, Bauhinia scandens, Burmannia coelestis, Luisia teretifolia, Neroilia faicata*, *Cyathea spinulosa* and *Angiopteris salicifolia* were Threatened plant species in the study area.

Species like *Christella clarkia, Aconitum ferox, Acer hookeri, Begonia rubella, Pimpinella tongloensis, Calamus inermis, Phoenix rupicola, Diplomeris hirsute, Bulleyia yunnanensis Rhododendron edgeworthii, Hedyotis scabra, Ophiorrhiza lurida* were found to be Threatened plant species in Lower Teesta valley and Rangit valley of Kalimpong division as per the field studies conducted as a part of Basin Study.

12.3.3 Terrestrial Fauna

12.3.3.1 Terrestrial Fauna as per EIA Study

As per EIA report for Teesta Low Dam-III, the details of terrestrial fauna are given in following paragraphs:

The Important mammalian wildlife found in the nearby forest area of the study area are given in Table-12.7.

Table-12.7: Different mammalian species spotted in the near by forest area

Scientific name	Common name	Local name
Monkeys		
Macaca mulata	Rhesus macaque	Bandor
Cats		
Felis marmorata	Marbled cat	-----
Civets		
Tariomodon pardicolor	Tiger civets	Kattas

Scientific name	Common name	Local name
Mongoose		
Herpestes javanicus	Small Indian mongoose	Neol
H. edwordsii	Indian mongoose	-----
Dog tribe		
Vulpes bengalensis	Bengal fox	Lomri
Insectivores		
Suncus caeruleus	Common shrew musk	chachunder
Bats		
Pteropus gigunticus	Indian fruits bats	
Rodents		
Rattus rattus	Common house rat	
Funambulus pennanti	Five striped palm squirrel	Gilbon
Bandicota bengalensis	Indian mole rat	
Lepus ruficandatus	Common Indian hare	Khorgosh
Deer		
Rosa unicolor nigra	The samber	Samber
Axis axis	Spotted deer	Cheetal
Muntiacus muntjak vaginalis	Barking deer	Karkar
Pigs		
Sus crietatus	Indian wild boar	Suar

Except for some monkeys no wildlife species were reported from the project area.

Bird species

No long-distance migratory birds are found near the project area, because normally they do not prefer the lotic regions. The list of imporatant bird species recorded in the nearby forest area is given in Table-12.8.

Table-12.8: List of Birds recorded in the near by forest area

Scientific Name	Common name	Local name
Ardea alba	Large egret	Bada bok
Pavo cristatus	Common peafowl	Mayur
Corvus splendens	House crow	Desi kawwa
C. macrorhynchos	Jungle crow	Ban kawwa
Copsychus saularis	Magpie robin	Dhaiyal
C. malabaricus	Shama	Shama
Streptopelia chinensis	Spotted dove	Chhite ghughu
S. decaocto	Ring dove	Par ghughu
Columba livia	Blue rock pigeon	Gola payra
Psittacula himalayana	Himalayan slaty-headed parakeet	Madana suga
Halcyon smyrnensis	White breasted Kingfisher	Sandabuk machhranga
Orthotomus sutorius	Tailor bird	Darzee
Pycnonotus cafer	Red vented bulbul	Bulbul
Anthracoceros malabaricus (R)	Indian pied horn bill	Dhanesh
Bubo coromandus	Owl	Pancha

(R) = Rare

Reptilian species

Low metabolic rate and high reproductive potential characterize reptiles. Various ethnic communities consume some species of reptiles. The consumption of reptiles, however,is not popular in this area and is usually associated with medical and religious beliefs. Different types of reptiles as recorded in the surrounding forest area are given in Table-12.9.

Table-12.9: Reptiles of different Orders

Scientific name	**Common name**
Order-Squamata (Lizard)	
Hemidactylus flaviviridis	Yellow belled house gecko
H. frenatus	South Asian waif gecko
Calotes rouxi	Forest blood sucker
C. versicolor	Blood sucker
Riopa panctata	Dotted garden skink
Ophisaurus gracilis	Burmese glass snake
Varanus bengalensis (E)	Indian monitor
Order-Ophidia (Non-poisonous Snakes)	
Typhlops diadri	Dard'sblind snakes
T. *porrectus*	Slender blind snakes
Python morulus. (R)	Indian python
Amphiesma stoluta	Striped keel back
Boiga multifaciata	Himalayan cat snakes
B. triganata	Indian gomma
Chrysofelea ornata	Golden tree snakes
Dendrelaphis ahaetulla	Painted bronze back
Elaphe cantoris	Ring tailed / rinket snakes
Lycodon aulicus	Common wolf snakes
Oligodon albocinctus	Lader back kukri snakes
Poisonous snakes	
Bungarus fasciatus	Banded krait
Naja naja kaoutchia	Indian cobra
Ophiophagus hannah	King cobra
Trimeresurus gramineus	Bamboo pit viper
Vipera russelli	Russell's viper

Amphibian species

Amphibian populations are mostly found in moist places near water bodies. Some amphibian species observed in the surrounding forest area of the project are given in Table-12.10.

Table-12.10:Amphibians recorded

Scientific name	**Common name**
Bufo stomaticus	---
B. melanostictus	---
Microhyla ornate	---
Kaloula palchra	Painted frog

Scientific name	Common name
Rana cyanophlyctus	Skipping frog
R.tigrina	Indian bull frog
R. crassa	Jerdon's bull frog
R. limnocharis	Cricket frog
Tomopterna breviceps	Burrowing frog
Philautus jerdonii	---

12.3.3.2 Terrestrial Fauna as per Teesta Basin Study

Mammals

The information was also collected to find the trophies as indirect evidence of the presence of mammalian species. During 3 season surveys none of the trophies could be located in the surveyed households. Local people were interviewed during the survey to confirm the presence mammalian species in the study area. Local people confirmed the presence of most of the species listed in Table 12.11 in the study area.

Table 12.11 Mammalian species recorded during the primary surveys in the study area during pre-monsoon, monsoon and post-monsoon seasons near TLDP-III

Species	PrM	M	PoM
Assamese Macaque (*Macaca assamensis*)	+	-	-
The Rhesus Macaque (*Macaca mulatta*)	+	+	-
Golden Jackal (*Canis aureus*)	+	-	-
Himalayan Palm Civet (*Paguma larvata*)	-	-	+
Himalayan Squirrel (*Dremomys lokriah*)	+	-	-
Himalayan Striped Squirrel (*Tamiops macclellandi*)	-	+	+

PrM = pre-monsoon, M = Monsoon, PoM = Post-monsoon

Avifauna

The inventory of avifauna is based mainly on the primary surveys, however, a few species reported from the study area by different sources (http://ibcn.in/) were included in the list outlined in Table-12.12 in nearby area of Teeta Low Dam-III.

Table-12.12 Avifaunal species composition, their distribution habit and conservation status in study area of Teesta basin

Family/Common Name	Scientific Name	Distribution Habit	IUCN (2015)	IWPA (1972)	Seasonal Distribution		
					PrM	M	PoM
Threskiornithidae							
Oriental White Ibis	*Threskiornis melanocephalus*	R	NT	IV	+	+	-
Rallidae							
Common Moorhen	*Gallinula chloropus*	R	LC	IV	+	+	+
White-breasted Water Hen	*Amaurornis phoenicurus*	R	LC	IV	-	+	-
Ardeidae							
Pond Heron	*Ardeola grayii*	R	LC	IV	-	-	+
Intermediate Egret	*Mesophoyx intermedia*	R	-	IV	+	+	+
Phalacrococorax							
Great Cormorant	*Phalacrocorax carbo*	RW	LC	IV	+	+	-
Small Cormorant	*Microcarbo niger*	R	LC	IV	-	+	+
Phasianidae							

Family/Common Name	Scientific Name	Distribution Habit	IUCN (2015)	IWPA (1972)	Seasonal Distribution		
					PrM	M	PoM
Red Jungle fowl	*Gallus gallus*	R	LC	IV	-	-	+
Indian Peafowl	*Pavo cristatus*	R	LC	I	-	+	+
Chestnut-breasted Partridge	Arborophila mandellii	r	VU	IV	-	-	-
Kaleej Pheasant	*Lophora leucomelanos*	R	LC	IV	-	-	+
Picidae							
Grey-capped Pygmy Woodpecker	Picoides *canicapillus*	R	LC	IV	+	-	-
Grey-headed Woodpecker	*Picus canus*	r		IV	-	+	-
Fulvous-breasted Woodpecker	*Dendrocopos macei*	R	LC	IV	+	-	-
Darjeeling Woodpecker	*Dendrocopos darjellensis*	R	LC	IV	+	+	-
Megalaimidae							
Blue-throated Barbet	*Megalaima asiatica*	R	-	IV	+	-	-
Great Barbet	*Megalaima virens*	R	LC	IV	+	+	+
Bucerotidae							
Great Hornbill*	*Buceros bicornis*	R	NT	I	-	-	-
Upupidae							
Hoopoe	*Upupa epops*	RW	LC	IV	+	+	-
Coracidae							
Indian Roller	*Coracias benghalensis*	R	LC	IV	+	+	-
Alcedinidae							
Common Kingfisher	*Alcedo atthis*	R	LC	IV	+	-	+
White-throated Kingfisher	*Halcyon smyrnensis*	R	LC	IV	+	+	-
Cerylidae							
Crested Kingfisher	*Megaceryle lugubris*	R	LC	IV	-	-	+
Pied Kingfisher	*Ceryle rudis*	r		IV	-	+	-
Meropidae							
Green Bee-eater	*Merops orientalis*	R	LC	IV	+	-	+
Chestnut-headed Bee-eater	*Merops leschenaulti*	R	LC	IV	+	+	-
Cuculidae							
Asian Koel	*Eudynamys scolopacea*	R	LC	IV	+	-	-
Lesser Coucal	*Centropus bengalensis*	r	LC	IV	+	+	-
Crow pheasant	*Centropus sinensis*	R	LC	IV	+	-	-
Common Cuckoo	*Cuculus canorus*	p	LC	IV	-	-	+
Psitticidae							
Alexandrine Parakeet	*Psittacula eupatria*	R	LC	IV	+	-	-
Slaty-headed Parakeet	*Psittacula himalayana*	R	LC	IV	-	+	-
Accipitridae							
Northern Sparrowhawk	*Accipiter gentilis*	rw	LC	IV	+	+	-
Falconidae							
Common Kestrel	*Falco tinnunculus*	RW	LC	IV	-	+	+
Amur Falcon	*Falco amurensis*	p	LC	IV	+	+	-
Trogonidae							
Ward's Trogon	Harpactes wardi	r	NT	IV	+	-	-
Strigidae							
Asian Barred Owlet	*Glaucidium cuculoides*	r	LC	IV	+	+	-
Columbidae							
Rock Pigeon	*Columba livia*	R	LC	IV	+	+	+
Emerald Dove	*Chalcophaps indica*	r	LC	IV	+	-	-
Oriental Turtle Dove	*Streptopelia orientalis*	RW	LC	IV	+	+	+
Spotted Dove	*Streptopelia chinensis*	R	-	IV	+	+	+
Yellow-footed Green Pigeon	*Treron phoenicoptera*	R	LC	IV	+	-	-
Ashy Wood Pigeon	*Columba pulchricollis*	R	LC	IV	+	-	-
Hirundinidae							
Barn Swallow	*Hirundo rustica*	RW	LC	IV	+	+	+
Nepal House Martin	*Delichon nipalensis*	r	LC	IV	+	-	-
Pittidae							
Hooded Pitta	*Pitta sordida*	R	LC	IV	-	+	-
Irenidae							
Orange-bellied Leaf Bird	*Chloropsis hardwickii*	r	LC	IV	-	+	+
Golden Fronted Leaf Bird	*Chloropsis aurifrons*	r	LC	IV	-	-	+

Family/Common Name	Scientific Name	Distribution Habit	IUCN (2015)	IWPA (1972)	Seasonal Distribution		
					PrM	M	PoM
Lanidae							
Long-tailed Shrike	*Lanius schach*	R	LC	IV	-	-	+
Corvidae							
House Crow	*Corvus splendens*	R	LC	IV	+	+	+
Jungle Crow	*Corvus macrorhynchos*	R	LC	IV	+	+	+
Yellow-billed Blue Magpie	*Urocissa flavirostris*	R	LC	IV	+	-	-
Himalayan Treepie	*Dendrocitta formosae*	R	LC	IV	+	+	+
Green Magpie	*Cissa chinensis*	R	LC	IV	-	+	-
Dicruridae							
Ashy Drongo	*Dicrurus leucophaeus*	R	LC	IV	+	+	-
Bronzed Drongo	*Dicrurus aeneus*	r	LC	IV	+	-	-
Black Drongo	*Dicrurus adsimilis*	R	LC	IV	+	+	+
Spangled Drongo	*Dicrurus hottentottus*	p	LC	IV	-	-	+
Campephagidae							
Longtailed Minivet	*Pericrocotus ethologos*	R	LC	IV	+	-	+
Cinclidae							
Brown Dipper	*Cinclus pallasii*	R	LC	IV	+	+	-
Muscicapidae							
Golden Bush Robin	*Tarsiger chrysaeus*	r	LC	IV	-	+	-
Oriental Magpie Robin	*Copsychus saularis*	R	LC	IV	+	-	-
Plumbeous Water Redstart	*Phoenicurus fuliginosus*	r	LC	IV	+	+	+
White-capped Water Redstart	*Chaimarrornis leucocephalus*	r	LC	IV	+	+	+
Small Niltava	*Niltava macgrigoriae*	r	LC	IV	+	+	+
Verditer Flycatcher	*Eumyias thalassina*	R	LC	IV	-	+	-
Little Forktail	*Enicurus scouleri*	r	LC	IV	-	-	+
Spotted Forktail	*Enicurus maculatus*	R	LC	IV	+	+	-
Rusty-bellied Shortwing	Brachypteryx hyperythra	r	NT	IV	-	-	-
Sturnidae							
Common Myna	*Acridotheres tristis*	R	LC	IV	+	+	+
Hill Mynah	*Gracula religiosa*	r	LC	IV	-	-	+
Pied myna	*Sturnus contra*	R	LC	IV	+	+	+
Pycnonotidae							
Himalayan Bulbul	*Pycnonotus leucogenys*	R	LC	IV	+	+	+
Red-vented Bulbul	*Pycnonotus cafer*	R	LC	IV	+	+	+
Black-creasted Bulbul	*Pycnonotus flaviventris*	R	LC	IV	+	+	+
Timalidae							
Rufous-capped Babbler	*Stachyris ruficeps*	r	LC	IV	-	+	-
Whiskered Yuhina	*Yuhina flavicollis*	R	LC	IV	+	+	+
White-naped Yuhina	Yuhina bakeri	r	LC	IV	-	+	+
Sylviidae							
Lemon-rumped Warbler	*Phylloscopus chloronotus*	rW	LC	IV	+	+	-
Greenish Warbler	*Phylloscopus trochiloides*	rW	LC	IV	+	-	+
Grey hooded Warbler	*Seicercus xanthoschistos*	R	LC	IV	+	+	+
Spectacled Warbler	*Seicercus burkii*	R	LC	IV	-	+	-
Leiothricidae							
Jungle Babbler	*Turdoides striatus*	r	LC	IV	+	+	+
Black-yeared Shrike Babbler	*Pteruthius melanotis*	r	LC	IV	-	+	-
Striated Laughingthrush	*Garrulax striatus*	r	LC	IV	+	+	-
White-crested Laughingthrush	*Garrulax leucolophus*	R	LC	IV	+	-	-
Grey Sibia	*Heterophasia gracilis*	r	LC	IV	+	-	-
Cisticolidae							
Grey-crowned Prinia	Prinia cinereocapilla	R	VU	IV	-	+	-
Dark-necked Tailor Bird	*Orthotomus atrogularis*	R	LC	IV	-	-	+
Sittidae							
Chestnut nuthatch	*Sitta castanea*	R	LC	IV	+	-	+
Beautiful Nuthatch	*Sittaformosa*	r	VU	IV	+	+	+
Wall Creeper	*Tichodroma muraria*	R	LC	IV	-	-	+
Paridae							
Great Tit	*Parus major*	R	LC	IV	+	+	-

Family/Common Name	Scientific Name	Distribution Habit	IUCN (2015)	IWPA (1972)	Seasonal Distribution		
					PrM	M	PoM
Green-backed Tit	*Parus monticolus*	R	LC	IV	+	+	+
Yellow cheeked Tit	*Parus spilonotus*	r	LC	IV	-	-	+
Passeridae							
Tree Sparrow	*Passer montanus*	R	LC	IV	+	+	+
House sparrows	*Passer domesticus*	R	LC	IV	+	+	+
	Richard's Pipit	*Anthus richardi*	p	LC	IV	+	-
Olive-Black Pipit	*Anthus hogsonii*	r	LC	IV	-	+	-
Motacillidae							
Grey Wagtail	*Motacilla cinerea*	rW	LC	IV	+	+	-
Yellow Wagtail	*Motacilla flava*	W	LC	IV	+	-	+
White Browed Wagtail	*Motacilla maderaspatensis*		LC	IV	+	+	+
Nectariniidae							
Mrs Gould's Sun bird	*Aethopyga gouldiae*	r	LC	IV	+	-	-
Streaked Spider Hunter	*Arachnothera magna*	r	LC	IV	-	-	+
Certhidae							
Tree Creper	*Certhia familiaris*	R	LC	IV	+	+	+
Rusty-flanked Tree Creeper	*Certhia nipalensis*	r	LC	IV	+	-	-

R = widespread resident, r = sparse resident, W = widespread winter visitor, w = sparse winter visitor; s= summer visitor; p = passage migrant; v = vagrant; LC = least concerned, NT = near threatened; VU = vulnerable, EN = endangered; CR = critically endangered

Reptiles

The list of reptilian species spotted during field studies in various seasons is given in Table-12.13. Local people revealed the presence of many other reptilian species in the area.

Table 12.13 Reptilian species spotted during different seasons in Teesta Basin in West Bengal

Species	TLIII		
	PrM	M	PoM
Common House Gecko (*Hemidactylus frenatus*)	+	-	-
Oriental Garden Lizard (*Calotes versicolor*)	-	+	-
Jerdon's Forest Lizard (*Calotes jerdoni*)	+	-	-
Three Keeled Mountain Lizard (*Japalura tricarinata*)	-	+	-
Water Snake(*Amphiesma* sp.)	-	-	+
Darjeeling Slender Snake (*Trachischium fuscum*)	-	-	+
Common Cat Snake (*Boiga trigonata*)	-	+	-
Trinket Snake (*Coelognathus Helena*)	+	-	-

Amphibians

The species composition of amphibians in the Study Area along with their conservation study near by area of Teeta Low Dam III is given in Table-12.14.

Table-12.14: Species composition in the Amphibians in Lower Teesta basin in West Bengal

Family/Common Name	Scientific name	Conservation status	
		IUCN (2015)	IWPA (1972)
Bufonidae			
Common Toad	*Duttaphrynus melanostictus*	LC	-
The Himalayan Toad	*Duttaphrynushimalayanus*	LC	-

Family/Common Name	**Scientific name**	**Conservation status**	
		IUCN (2015)	**IWPA (1972)**
-	*Bufo abatus*	-	-
Megophryidae			
Little Spadefoot Toad	*Megophrys parva* a	-	-
Large Spadefoot Toad	*Megophrys robusta*	-	-
Ranidae			
Torrent Frog	*Amolops formosus*	LC	IV
Sikkim Frog	*Chaparana sikkimensis*	-	IV
Common Frog	Odorr*ana livida*	DD	IV
Skipping Frog	*Euphlyctis cyanophlyct*is	LC	IV
Rhacophoridae			
East Himalayan Bush Frog	*Raorchestes annandalii*	LC	-
Darjeeling Bubble-nest Frog	*Philautus dubius*	DD	-
Jerdon's Bush Frog	*Philautus jerdonii*	DD	-
East Asian Tree Frog	*Polypedates leucomystax*	LC	-

12.3.3.3 Comparision of Terrestrial Faunal Survey

Terrestrial Fauna

Mammals: The findings of the faunal species recorded from the study area by University of North Bengal, a total of 16 Mammalian species were recorded during field study. Common species were Rhesus macaque, Common Langur, Indian wild boar, Spotted deer, Barking deer, Samber, Common shrew musk, Bengal fox, Indian mongoose, Five striped palm squirrel etc. were the most common. Only single species (Samber) was found to be vulnerable species as per IUCN status and rest were fall into least concern category.

The results of the same study of WAPCOS Ltd. reveals the presence of 6 mammalian species in the study area which were mainly represented by Assamese Macaque (*Macaca assamensis*), Rhesus Macaque (*Macaca mulatta*), Golden Jackal (*Canis aureus*), Himalayan Palm Civet (*Paguma larvata*), Himalayan Squirrel (*Dremomys lokriah*) and Himalayan Striped Squirrel (*Tamiops macclellandi*). All the species were considered to be least concern.

Reptilians: As per the field studies conducted as a part of EIA Study, a total of 23 reptilian species were recorded from the study area. Out of which 7 species are Lizards and 16 species are snakes. Some of the common species are Indian monitor, South Asian waif gecko, Yellow belled house gecko, Forest blood sucker, Dotted garden skink, Indian gomma, Dard'sblind snakes, Himalayan cat snakes, Indian cobra, Common wolf snakes, King cobra etc.

A total of 8 reptilian species have been recorded as a part of Basin Study, which include Common House Gecko, Oriental Garden Lizard, Jerdon's Forest Lizard, Three Keeled Mountain Lizard, Water Snake, Darjeeling Slender Snake, Common Cat Snake and Trinket Snake.

Amphibians: According to the EIA study, a total of 8 Amphibian species were observed in the surrounding forest area of the project site. Common species were *Bufo stomaticus, B. melanostictus, Kaloula palchra, Rana cyanophlyctus, R.tigrina, R. crassa, R. limnocharis, Tomopterna breviceps* etc.

As per the findings of our study, 12 amphibian species were recorded which represents Common Toad, The Himalayan Toad, Little Spadefoot Toad, Torrent Frog, Common Frog, East Himalayan Bush Frog etc.

Avifauna: A total of 15 bird species were recorded during the field study conducted as a part of EIA study. The commonly recorded bird species were Ring dove, Blue rock pigeon, White breasted Kingfisher, Tailor bird, Red vented bulbul, Indian pied horn bill, Owl etc. No long-distance migratory birds were found near the project area.
As per Basin Study, occurrence of 110 bird species belongs to 39 families were recorded. Species like Red Jungle fowl, Great Barbet, Hoopoe, Indian Roller, Common Kingfisher, Green Bee-eater, Common Cuckoo, Amur Falcon, Spotted Dove, Oriental Turtle Dove, Hooded Pitta, Orange-bellied Leaf Bird, House Crow, Jungle Crow, Ashy Drongo, Common Myna, Pied myna, Himalayan Bulbul, Red-vented Bulbul, Greenish Warbler, Great Tit and Grey wagtail were commonly observed in the study area.

12.3.4 Fish Species

12.3.4.1 Fisheries survey as per the EIA Report

Fishes are the most dominant group in the lotic waters of the Teesta both in bio diversity as well as in biomass. The fish fauna in the course of the Teesta belongs to three major orders and is clearly dominated by Cypreiniformes, which alone accounts for 18 species (under two families i.e. Cyprinidae and Psilorhynchidae) of a total of 24 species found in the area. The two other orders i.e. Siluriformes includes 4 species (under two families: Sisoridae and Bagridae)and order Perciformes includes 2 species (under a single family i.e. Mustacembelidae).Some of the important species are given in Table-12.15. Likewise, the List of commercially important and migratory fishes of Teesta is given in Table-12.16 & Table-12.17 respectively.

Table-12.15: List of fishes recorded from Teesta River

Scientific Name	Local Name
Barillius barila	Koksha
B. bendclisis	Juia
B. bola	Bhola
Puntius dukai	Bhorkol
P. ticto ticto	Tilii-pulhi
*Gara gotyla gotyla**	Ghorpoiii
*Gara lamla**	Ghorpoia
*G. mullya **	Ghorpoiii
Noeuiacliiclus beavani	Biohan-Khorkey
N. rupicola inglisi	Khorkey
N.scaturigina	Khorkey
Balilorn brucei	
Batasio batasio	Balashi
Glyptothorax horai	-------
G. *telchitta*	......
Mastacembelus pancalus	Pankal
Oricncs molesworthii	Asia

*Predominantly Predacious

Table-12.16: List of commercially important fishes of Teesta

Scientific Name	Local Name
Labeo boga	Boga bata
L. dero	Kursha
L. genius	Kurchi
Tor tor	Mahashol/Mahasheer
Crossochcihis latius latius	Kala-bata
Psilorhynchus balitora	Balitora
*Mystus villatus**	Tengra
*Glyptothorax telchitta telchitta **	------
*Mastacembelus pancalus **	Pankal

*Predominantly Predacious

Table-12.17: List of migratory fishes recorded in Teesta

Scientific name	**Common name**
Labeo dero	Kursha
Tor tor	Mahashol /Mahasheer
Acrssochcilus hexagonolepis	Buluk
Bagarius bagarius	-----
Labeo dyocheilus	-----

12.3.4.2 Fisheries survey as per the Teesta Basin Report

The details of presence of fish species at various sampling sites in various seasons near the Teeta Low dam-III influence zone is given in Table-12.18.

Table 12.18: Fish species observed during the primary surveys in Teesta river in West Bengal

S.N.	Family/species	Common Name	Teesta Low Dam -III HEP		
	Cyprinidae		PrM	M	PM
1	*Barilius Barna*	BarnaBaril	+	-	-
2	*Barilius bendelisis*	Hamilton's Baril	+	-	-
3	*Labeo pangusia*	PangasiaLabeo	-	-	+
4	*Salmophusia bacaila*	Razor Belly Minow	-	+	+
5	*Schizothorax richardsonii*	Snow trout	+	+	+
6	*Schizothoraicthys progastus*	Snow trout	+	+	+
7	*Neolissicheilus hexagonolepis*	Copper Mahseer	+	+	+
8	*Tor putitora*	Golden Mahseer	-	+	-
9	*Garralamta*	LamtaGarra	+	-	+
10	*Garra gotyla gotyla*	Garra	+	-	-
11	*Devario devario*	Sind danio	+	-	-
12	*Cyprinion semiplotum*	King Fish	+	-	-
13	*Crossocheilus latius*	Kala bata	-	-	+
14	*Schisturabeavani*	Creek Loach	+	-	-
15	*Acanthocobitis botia*	Leipard Loach	+	-	+
16	*Nemacheilus devdevi*	Olivaceous Loach	+	-	+
	Schilbeidae				
17	*Clupisoma montana*	Jalkapoor	+	-	+

PrM = Pre-monsoon, M = Monsoon; PM = Post-monsoon

12.3.4.3 Comparision of Fisheries Survey

As per the study conducted by the University of North Bengal, the study area comprised of 24 fish species. Out of these 9 species are commercially important and 5 species are migratory species.

A total of 17 species of 2 families were recorded during field studies conducted as a part of Basin Study. Cyprinidae was predominant family comprising of 16 species. *Schizothorax richardsonii*, *Schizothoraicthys progastus*, *Neolissicheilus hexagonolepis*, *Labeo pangusia*, *arilius barna* and *Barilius bendelisis* widely distributed in the Teesta river. *Schizothorax richardsonii* was most common species at the study site. Majority of fish species recorded from the project site are categorised as 'least concerned' (IUCN, 2015).

Presence of migratory fish species Golden Mahaseer and copper Mahaseer was recorded as a part of Basin Study.

12.4 TEESTA LOW DAM-IV

Presently, Teesta Low Dam-IV is an operational project of NHPC Limited, which received the Environmental Clearance vide their letter no. J-12011/46/2004-IA-I dated: 31/03/2005 based on the EIA Report prepared by University of North Bengal, Darjeeling, West Bengal.

As a part of EIA Study prepared by University of North Bengal for Teesta Low Dam-III; the primary data was collected during the year 2001-2002.

The base line was collected for various seasons for EIA study and currently for Teesta Basin study and same data has been compared for the Environmental Audit and the details are given in the following Paragraphs.

12.5 ENVIRONMENTAL AUDIT OF TEESTA LOW DAM-IV

12.5.1 Water Quality

12.5.1.1 Water Quality as per EIA Study

Detailed monthly data on physical and chemical characteristics for various projects in study area. Water quality of study area including Teesta and Rangit rivers was assessed using various physical and chemical characteristics at spatial and temporal scales.

The sampling locations in the project are:

(A) Under the bridge (Hanuman Jhora)
(B) Under the bridge (River Kalijhora)
(C) Near Sevok (River Teesta)

The water quality details are given Table-12.19.

Table-12.19: Chemical Analyses of Water Samples

Parameters	Site A	Site B	Site C
Temp,°C	20	22	20
pH	7.8	7.9	7.5
TDS, mg/l	49.0	66.0	98
TSS, mg/l	3	3.0	25
Alkalinity, mg/l of $CaCO_3$	20.0	18.0	8
Total Hardness, mg/l of $CaCO_3$	28.0	43.0	43
Calcium Hardness (mg/l)	17.0	30.5	20
Magnesium Hardness (mg/l)	11.0	12.5	23
Dissolved Oxygen (mg/l)	8.83	8.83	8.25
COD, mg/l	42.5	62.46	52
BOD, mg/l	0.8	1.1	1.1
Chloride, mg/l	1.0	0.2	1.2
Nitrates (mg/l)	0.21	0.32	0.59
Phosphates (mg/l)	1.019	0.672	0.841
Silicates (mg/l)	2.8	7.5	4.0
Detergent Cation, mg/l	0.25	0.5	1
Detergent anionic, mg/l	0.75	0.5	1
Total Iron, mg/l	ND	ND	ND
Aluminum, mg/l	1	1	1
Zinc, mg/l	ND	ND	ND
Cobalt, mg/l	ND	ND	ND

ND: Not Detected

The pH of water samples ranges from 7.5 to 7.9, indicating neutral nature of the river waters. The TDS ramges from 49 to 98 mg/l and TSS from 3 to 25 mg/l. Low TSS in the area is good for the health of the turbine blades and hence the quality of water is fit to be used for hydropower generation.

The alkalinity, hardness, Ca & Mg values indicate that their source is mainly from weathering of catchment rocks. The low hardness levels indicate the water is soft in quality.

The Dissolved Oxygen (DO) in the river ranges from 8.25 to 8.83 mg/l. The maximum DO in water is 14 mg/l at 4^0C which decrease to 0 mg/l at 100 ^{0}C or highly polluted systems. The DO of Teesta river is fairly good and hence impart self cleansing property to the river. The BOD values are also < 2 mg/l, indicating that the water is fit for drinking purpose after mild chlorination and filtration. .

The presence of detergent in the water of Teesta river indicates that the waters of Teesta river especially its tributaries is used by human settlements and hence the detergent finds its way into Teesta river.

The low concentrations of metals as iron, aluminum, zinc and cobalt, indicates that there is no mining or industrial use of the river water. Overall, the present status of water quality of Teesta River in the project area is very good and is fit for drinking purposes after mild chlorination and filtration. Since the project is a run-of-the river scheme. No actual stagnation of water is expected and hence no changes in water quality.

12.5.1.2 Water Quality as per Teesta Basin Study

Detailed monthly data on physical and chemical characteristics for various projects in study area. Water quality of study area including Teesta and Rangit rivers was assessed using various physical and chemical characteristics at spatial and temporal scales. The water sampling results from April,2014 to March, 2015 are given in Table-12.20.

Table-12.20: Water Quality of Teesta River near Project Site Teesta Low Dam-IV as Teesta Basin Study

	April,14		**May,14**		**June,14**		**July,14**		**August,14**		**September,14**		**October, 14**		**November,14**		**December,14**		**January ,15**		**February, 15**		**March, 15**	
Parameters	**S11**	**S12**	**S11**	**S12**	**S11**	**S12**	**S11**	**S12**	**S11**	**S12**	**S11**	**S12**	**S11**	**S12**	**S11**	**S12**	**S11**	**S12**	**S11**	**S12**	**S11**	**S12**	**S11**	**S12**
Water Temperature (˚C)	18	19	19	19	20	20	20	20	18	19	20.5	19.5	20	19	19.5	17.5	17	16	17	13	14.91	17.1	20	19
Colour	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less	Colour-less
Odour	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less	Odour-less
Turbidity (ntu)	23.9	51.5	43.5	260	513	463	378	419	23.9	51.5	9.72	12.81	12.58	7.58	2.27	3.11	1.71	4.01	7.52	2.75	1.43	0.94	0.72	1.14
pH	8.34	8.1	8.05	8.04	8.17	8.22	7.9	8.04	8.04	7.66	7.99	7.91	8.11	8.04	8.01	8.14	8.23	8.38	8.26	8.21	8.34	8.29	8.36	8.32
Dissolved Oxygen (mg/l)	7.9	8.26	6.5	6.8	7.6	8.3	7.4	8	6.43	7.55	5.9	7.67	6.49	7.88	7.45	8.12	7.5	8.57	7.5	7.33	5.5	5.65	5	6.17
BOD, mg/l	1.6	1.7	1.5	1.7	1.3	1.2	1.3	1.2	1.2	1.3	1.3	1.1	1.7	1.9	2	1.9	1.6	1.6	1.5	1.7	1.5	1.6	1.5	1.5
COD, mg/l	3.4	3.1	2.9	3.1	2.4	2.2	2.3	2.3	2.3	2.6	2.3	2.4	3.6	3.5	3.9	3.8	3.5	3.5	3.2	3.2	3.4	3.5	3.2	3.3
Electric Conductivity (µs)	85.2	77	58.9	57.3	53.9	49.3	43.4	44.43	48.17	53.2	51.7	51.63	65.38	64.52	70.33	73.64	98.97	77.5	84.27	80.3	87.6	97.5	90.3	93.47
Total Dissolved Solid (mg/l)	64.4	58.86	45.1	43.2	41.7	37.3	48.44	52.25	36.45	38.25	39.53	39.13	41.35	41.13	48.69	44.33	75.1	58.4	63.87	59.53	62.63	71.67	54.9	56.07
Alkalinity (mg/l)	50	48	56	48	82	60	36	48	32	28	56	62	52	54	54	59	56	44	54	52	108	100	53	48
Total Hardness (mg/l)	74	72	84	78	84	74	120	152	50	48	66	68	67	66	72	67	94	68	82	102	88	134.8	79	75
Calcium Hardness (mg/l)	63	56.7	44.1	42	42	42	54.6	84	33.6	44.1	39.9	35.7	49.58	46.12	55.89	51.02	71.4	52.5	69.3	60.9	45.15	76.54	53.55	49.35
Calcium ions (mg/l)	25.23	22.71	17.66	16.82	16.82	16.82	21.87	33.64	13.46	17.66	15.98	14.3	19.91	18.52	22.45	20.49	28.6	21.03	27.75	24.39	18.08	23.55	21.42	19.74

	April,14		**May,14**		**June,14**		**July,14**		**August,14**		**September,14**		**October, 14**		**November,14**		**December,14**		**January,15**		**February, 15**		**March, 15**	
Parameters	**S11**	**S12**	**S11**	**S12**	**S11**	**S12**	**S11**	**S12**	**S11**	**S12**	**S11**	**S12**	**S11**	**S12**	**S11**	**S12**	**S11**	**S12**	**S11**	**S12**	**S11**	**S12**	**S11**	**S12**
Magnesium Hardness (mg/l)	11	15.3	39.9	36	42	32	65.4	68	16.4	3.9	26.1	32.3	17.42	19.88	16.11	15.98	22.6	15.5	12.7	41.1	42.85	58.26	25.45	25.65
Magnesium Ions (mg/l)	2.67	3.72	9.7	8.75	10.21	7.78	15.89	16.52	3.99	0.95	6.34	7.85	4.24	4.84	3.92	3.89	5.49	3.77	3.09	9.99	10.41	14.15	6.18	6.23
Chloride (mg/l)	29	26	27	31	2.28	2.21	40	46	14	16	13	13	16	14	16	14	19	18	16	18	14	13	28	28.5
Sodium (mg/l)	3.47	3.52	2.72	2.69	2.13	2.01	2.58	2.52	2.85	2.77	3.27	3.72	3.52	3.71	4.16	3.98	4.22	3.18	0	4.32	4.29	5.09	4.89	5.54
Potassium (mg/l)	1.62	1.73	1.46	1.46	46	47	1.89	1.91	1.52	1.51	1.93	1.97	1.21	1.44	2.01	1.89	1.98	1.59	1.68	1.4	2.11	1.96	2.42	2.28
Nitrates (mg/l)	0.44	1.18	1.06	0.86	0.79	0.73	ND	5.97	0.71	0.78	0.98	0.54	0.08	0.07	0.11	0.03	1.26	ND	0.27	0.2	ND	ND	0.13	0.09
Phosphates (mg/l)	0.21	0.1	0.42	0.42	0.11	0.12	0.48	0.04	0.43	0.41	0.07	0.18	0.06	0.1	0.04	ND	0.17	ND	ND	ND	ND	ND	0.18	0.03
Silicates (mg/l)	0.75	0.89	4.7	0.96	6.86	2.4	2.71	2.11	6.24	8.21	4.2	4.36	7.32	5.39	7.36	18.69	15.22	29.19	18.41	25.68	14.27	10.44	11.64	9.51
Iron (Fe; mg/l)	0.11	0.12	0.08	0.12	0.09	0.09	0.1	1.15	0.21	0.2	0.2	0.2	0.17	0.14	0.01	0.03	ND	0.03	0.13	0.11	0.19	0.18	0.22	0.23
Copper (mg/l)	ND	ND	ND	ND	ND	ND	0.002	0.003	0.0093	0.002	ND	0.02	ND	0.002	0.005	ND	ND	ND	ND	ND	0.006	0.003	0.007	0.006
Total Chromium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Lead, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL			BDL	BDL	BDL	BDL	BDL	BDL
Mercury, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium, mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc, mg/l	0.3	0.2	0.3	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	BDL	BDL	0.5	0.3	0.3	0.2	0.4	0.3

In general, water quality parameters show gradual changes along the spatial and temporal scales. However, in this study no considerable changes in the water quality parameters were observed at spatial scale except in water temperature and turbidity. In Teesta river average values of different parameters did not show significant variations between different sites. However, slight variations were observed in a few parameters like water temperature, dissolved oxygen etc. at Sites S11 and S12. Both sites pertained to the downstream of Teesta Low Dam IV. This stretch of the river received water directly from dam body. In Teesta river spatial variation was less prominent as compared to the temporal variation. In general all parameters showed a temporal trend in their magnitude except current velocity, nitrate, phosphate and copper.

The TDS level ranged from 36.45 to 75.1 mg/l which is well below the permissible limit of 500 mg/l specified for drinking water. The TDS level was found to be lower in monsoon season as compared to summer season. This trend was observed for various cations and anions monitored as a part of the study. This could be attributed to higher discharges in monsoon months.

Hardness is caused by divalent metallic cations. The principal hardness causing cations are calcium, magnesium, strontium and ferrous and iron. The hardness level ranged from 48 to 152 mg/l indicating soft nature. The hardness level was well below the permissible limit of 200 mg/l specified for drinking water. The low levels of calcium and magnesium are mainly responsible for the soft nature of water.

The chlorides level ranged from 2.21 to 46 mg/l, which are well below the permissible limit of 200 mg/l, specified for meeting drinking water requirements. The concentration of nitrates and phosphates at various sampling locations was observed to be ranging from ND to 5.97 mg/l and ND to 0.48 mg/l respectively.

The concentration of various cations, e.g. sodium, potassium, calcium and magnesium was observed to be quite low which is also reflected by the low TDS level. Iron was found to be ranged from ND to 1.15 mg/l.

The concentration of various heavy metals was found to be well below the permissible limits. The BOD values ranged from 1.1 to 1.9 mg/l and are well within the permissible limits, which indicates the absence of organic pollution loading. This is mainly due to the low population density and absence of water polluting industries in the area. The low COD values also indicate the absence of chemical pollution loading in the area. The DO level ranged from 5.0 to 8.57 mg/l at various sampling locations monitored on a monthly basis during the study period.

12.5.1.3 Comaprision of water quality

The water quality monitored near the Teesta Low Dam-IV during the EIA study(2001-2002) and Teesta Basin Study (2014-2015) are compared in Table-12.21.

Table-12.21: Comparison of water quality parameters

Parameters	Ranges Of parameters monitored during EIA Study	Ranges Of parameters monitored during Teeta Basin Study
Temp,°C	20-22	13-20.5
pH	7.5-7.9	7.66-8.38
TDS, mg/l	49-98	36.45-64.4
TSS, mg/l	2-25	
Alkalinity, mg/l of $CaCO_3$	8-20	28-108
Total Hardness, mg/l of $CaCO_3$	28.0-43.0	48-152
Calcium Hardness (mg/l)	17-30.5	33.6-84
Magnesium Hardness (mg/l)	11-23	11-65.4
Dissolved Oxygen (mg/l)	8.25-8.83	5.0-8.26
COD, mg/l	42.5-62.46	2.2-3.9
BOD, mg/l	0.8-1.1	1.1-2.0
Chloride, mg/l	0.2-1.0	2.21-46
Nitrates (mg/l)	0.21-0.59	ND-5.97
Phosphates (mg/l)	0.672-1.019	ND-0.48
Silicates (mg/l)	2.8-7.5	0.75-29.19
Detergent Cation, mg/l	0.25-1	-
Detergent anionic, mg/l	0.5-1	-
Total Iron, mg/l	ND	ND-1.15
Aluminum, mg/l	1	-
Zinc, mg/l	ND	ND-0.4
Cobalt, mg/l	ND	-

As per the comparision, the hardness level ranged from 28.0-43.0 mg/l and 48-152 mg/l indicating soft nature. The hardness level was well below the permissible limit of 200 mg/l specified for drinking water in both monitoring.

The chlorides level ranged from 0.2-1.0 mg/l and 2.21-46 mg/l, which are well below the permissible limit of 200 mg/l, specified for meeting drinking water requirements.

The concentration of various cations, e.g. sodium, potassium, calcium and magnesium was observed to be quite low which is also reflected by the low TDS level.

The concentration of various heavy metals was found to be well below the permissible limits. The BOD values ranged from 0.8-1.1 mg/l and 1.1 to 2.0 mg/l and are well within the permissible limits, which indicates the absence of organic pollution loading. This is mainly due to the low population density and absence of water polluting industries in the area. The

DO level ranged from 8.25-8.83 mg/l and 5.0 to 8.26 mg/l at various sampling locations. The monitoring as a part of EIA study was conducted in monsoon season, and water quality results were comparable in both the studies.

12.5.2 Terrestrial Flora

12.5.2.1 Terrestrail Flora as per EIA Study

Vegetation Types of Project Area

The Western slopes of river Teeta are covered with dense natural forests. Following types of vegetaions were recognized in the area:

I.Herbls: This vegetation grows in the riverbed when the same dries up in the lean period. Nevertheless, during the peak period (mainly monsoon) the riverbed remains covered with water. During lean period, a large number of herbaceous plants, both annuals and perennials are found to grow in the riverbed.

II. Shrubs: Shrubby vegetation has developed at some places on both sides of the river especially at places where original forested vegetation was damaged, may be by floodwater or due to landslide or deforestation etc.

III. Forested Vegetation: The forests on both sides of the river are growing above the flood level. Basically, following two types of forests are found in the area.

(A) *Natural Forests* They are mainly tropical semi-deciduous type.

Forests on the western side appear to be more affecled by fire and grazing. But, at places, vegetalion is quite dense with trees, shrubs, woody climbers and epiphytic associations.

(B) *Plantation Forests* in this area are forests formed by plantations of teak*(Teaoua graudis), Tenuiualia* sp., Gm*elina orborea* and *Ellcalyptlls* sp., but most of these are situated outside the reservoir area.

Dominant Species of Plants

The dominant species in the area vary with the variation of the vegetation structure. In the canopy, plants like *Shorea robusta, Bombax ceiba, Terminalia myriocarpa, Duabanga sonneratioides, Lagerstroemia paruiflora* are dominant ones. Among the climbers, plants like *Bauhinia vahlii, Natsiatum herpeticum, Ichnocarpus jrutescens, Dalbergia stipulacea, Thunbergia fragrance* dominate. In the riverbed, there are patches of *Chenopodium ambrosoides, Euphorbia hypericifolia, Pouzolzia zeylanica, Hyptis suaveolens,* as dominants.

Shrubs like *Woodfordia jruticosa, Clerodendrum serratum, Tephrosia candida, Casearia graveolens*, etc are dominants. However, this is the overall picture, which varies at different sites and in different seasons.

Distribution of Endemic Flora

The endemic species of higher-plants recorded are given in Table-12.22.

Table-12.22 :Endemic species of plants recorded from the surrounding forest area

Names of Plants	Families	Endemic to
Argyria roxburghii	Convolvulaceae	Eastern Himalaya
Boehmeria macrophylla var. canescens	Urticaceae	Eastern Himalaya
Bulbophyllum reptans	Orchidaceae	Eastern Himalaya to N.E. India
Diplomeris hirusta	Orchidaceae	Eastern Himalaya to N.E. India
Gynocardia odoraia	Flacourtiaceae	Eastern Himalaya to N.E. India
Neroilia falcata	Orchidaceae	Eastern Himalaya
Oryza meyeriana	Gramineae	Darjeeling & Sikkim
Phoebe attenuata	Lauraceae	Eastern Himalaya to N.E. India
Pueraria lobata var. thomsonii	Papilionaceae	Eastern Himalaya to N.E. India
Sauropus quadrangularis	Euphorbiaceae	Eastern Himalaya

Economically Important Plants

Cultivated plants, harvestable wild plants and ethnobotanically useful plants, are regarded as economically important plants. Plants purely in cultivation, unless escaped, are not included in the general enumeration of the flora. But, now, all recorded economically important plants are recorded and given in Table-12.23.

Table-12.23 Economically Important Plants

Name of the crop	Scientific name	Extent of cultivation
A.CEREALS & MILLETS		
Paddy	*Oryza sativa*	In small terraces
Corn	*Zea mays*	Common near habitation
Kudo	*Eleusine coracana*	Common
B.VEGETABLES & SPICES		
Potato	*Solanum tuberosum*	Common
Tomato	*Lycopersicon esculentum*	Common near habitation
Brinjal	*Solanum melangona*	Common near habitation
Chillies	*Capsicum annum*	Common near habitation
Amaranths	*Amaranthus spp.*	Common
Spinach	*Spinacea aleracca*	Common
Rye	*Brassica campestris*	Common near habitation
Cabbage	*Brassica oleracea var.capitata*	Less Common
Cauliflower	*Brassica oleracea var.botrytis*	Less Common

Name of the crop	Scientific name	Extent of cultivation
Beat	*Beeta vulgaris*	Rare
Goard	*Cucurbita maxima &C.pepo*	Common near habitation
Pumpkin	*Benincasa hispida*	Common near habitation
Corainder	*Coriandrum sativum*	Common near habitation
Squash	*Sechium edule*	Less Common
Beans	*Phaseolus lunatus*	Common
Lablab	*Lablab purpurea*	Common
Pigeon pea	*Cajanus cajun*	Common
Curry pata	*Murraya koenigii*	
Mushrooms Pea	*Prsum satvum*	Common near habitation
Drum-stick	*Moringa pterigosperma*	Common
Zinger	*Zingiber officinale*	Common
Halud	*Curcuma longa*	Less common
Chalta	*Dillenia indica*	Rare
Cucumber	*Cucumis sativus*	Less common
Bothua	*Chenopodium album*	Common
C.FRUITS		
Guava	*Psidium guajava*	Common near habitation
Mango	*Mangifera indica*	Less common
bor	*Ziziphus mauritiana*	Less common
Aru	*Prunus persica*	Less common
Lemon	*Citrus medica*	Less common
Orange	*Citrus aurantiacum*	common
Shaddock	*Citrus maxima*	Less common
Beatle nut	*Areca catechu*	Common
Jamun	*Syzygium cumini*	Less common
Ambake	*Syzygium formosum*	Rare
Rose apple	*Syzygium jambos*	Rare
Papaya	*Carica papaya*	Common near habitation
Banana	*Musa bulbisiana*	Common
Pine -apple	*Ananas comosus*	Less common
Jack-fruit	*Arocarpus heterophylla*	common
Nona	*Annona reticulata*	Less common
Borhar	*Artocarpus lacucha*	Less common
Kabra	*Ficus infectoria*	Less common
D.FODDER		
Khanium	*Ficus semicordata*	Common
Koksa	*Ficus hispida*	Common
Kabra	*Ficus infectoria*	Less common
Subabul	*Leucaena leucocephala*	Common
Dinanath ghas	*Pennisetum pedicellatum*	Less common
Kali Lahara	*Combretum decundrum*	Common
Phul-jharu	*Thysanolena maxima*	Common
Bonsum	*Litsea monopetala*	Common
Kubinde	*Nayariophyton ziziphifolia*	Common
Borhar	*Artocarpus lacucha*	Less common
Jamuna	*Syzygium cumini*	Less common

Name of the crop	Scientific name	Extent of cultivation
Kamli	*Boehmeria macrophylla*	Less common
Phutta	*Brassiopsis mitis*	Rare
Tama Bans	*Dendrocalamus sp.*	Rare
Chokti-phul	*Saccharum arundinaceum*	Common
E.COMMON & POTENTIAL ORNAMENTS		
Marygold	*Tagetes patula*	Common near habitation
Rose	*Rosa centrifolia*	Common near habitation
Dianthus	*Many species of Dianthus are in cultivation*	Less common
Hasnuhana	*Cestrum nocturnum*	Rare
China-rose	*Hibiscus rosa-sinensis*	Less common
Cacti-Succulents	*Many species are in their collections*	Common
Cocks comb	*Celosia cristata*	Less common
Canna	*Canna indica*	Less common
Salvia	*Salvia coccinea*	common
Calendula	*Calendulaofficinalis*	common
Zinnia	*Zinnia*	Less common
Crotons	*Coedium variagatum*	Less common
Jacaranda	*Jacaranda mimosaefolia*	common
Kolke	*Thevetia peruviana*	Rare
Oleander	*Nerium indicum*	Less common
Rangan	*Lxora coccinea,I.Japonica and I.singaporensis*	Common
Debdaru,Ashok	*Polyalthia longifolia*	Common
Asparagus	*Asparagus spp.*	Less common
Chinese hat	*Holmskioldia sanguinea*	Less common
	Ophiopogon sp.	Less common
	Paliosanthes macrophylla	Rare
	Hoya spp.	Common
Taki	*Bauhinia variegala*	Common
Gham-Phul	*Tithonia diversifolia*	Less common
Asare	*Clerodendrum japonicum*	Common
F.MEDICINAL		
	Tylophora asthamatica	Rare
Amolki	*Phyllanthus embelicus*	Rare
Anantamul	*Hemidesmus indicus*	Rare
Arjun	*Terminalia arjuna*	Less common
Bel	*Aegle marmelos*	Rare
Boch,Bojo	*Acorus calamus*	Less common
Boherha	*Terminalia belerica*	Common
Bon-Begun	*Solanum myriacanthum*	Common
Bon-tarul	*Dioscoreaspp.*	Common
Bun-mara	*Tephrosia candida*	Common
Dala karbo	*Piper mullesua*	Less common
Ghritakumari	*Aloe vera*	Rare

Name of the crop	Scientific name	Extent of cultivation
Hingcha	*Enhydra fluctuens*	Common
Kalmegh	*Andrographis paniculate*	Common
Khayer	*Acacia catechu*	Less common
Neem	*Azadirachta indica*	Less common
Pipla	*Piper longum*	Less common
Punarnava	*Boerhavia diffusa*	Common
Sakupaani	*Costus speciosus*	Common
Sarpagandha	*Rauvolfia serpentina*	Rare
Satamuli	*Asparagus racemosus*	Less common
Tamarkey	*Stephania glandulosum*	Less common
Thankuni	*Centella asiatica*	Common
Tatepate	*Artennsa muluca*	Common
G. TIMBER,BAMBOO&CANE		
Aule Dabdabe	*Garuga pinnala*	Less common
Bans	*Bambusa spp.*	Common
Bet	*Calamus crectus*	Less common
Champ	*Michelia champaca*	Less common
Chikrassi	*Chukrasia tabularis*	Common
Chilaune	*Schima wallichii*	Common
Chipley kan	*Cruleva unilocularis*	Less common
Dalne katus	*Castanopsis hystrix*	Less common
Gamar	*Gmelina arborea*	Common
Gokul	*Ailanthus integrifolia*	Less common
Jamuna	*Syzygium tetragonal*	Less common
Jangli Aam	*Mangifera sylvetica*	Rare
Kadam	*Anthocephalus chinensis*	Common
Kairjal	*Bischofia javanica*	Less common
Lali	*Aphanamixis polystachya*	Common
Maina	*Tetraneles nudiflora*	Less common
Odal	*Sterculia villosa*	Common
Panisaj	*Terminalia myriocarpa*	Common
Ramphal,Gantey	*Gynocardia odorata*	Less common
Sal	*Shorea robusta*	Common
Segun,Teak	*Tectona grandis*	Common
Siris	*Albizia chinensis*	Less common
Siris	*Albizia odoratissima*	Common
Siris Seto	*Albizia procera*	Common
Toon	*Toona ciliata*	Common

Rare and Threatened Species of Plants

A few endemic, rare and threatened species of plants have been observed in the study area. The list of such identified species is presented in Table-12.24.

Table-12.24: Rare and threatened species of plants growing in the study area.

Botanical Names	Family	Habit
Arundina graminifolia	Orchidaceae	Shrub
Bauhinia scandens	Caesalpiniaceae	Woody climber
Burmannia coelestis	Burmanniaceae	Annual Herb
Diplomeris hirsute	Orchidaceae	Annual Herb
Luisia teretifoli	Orchidaceae	Epiphyte
Oryza meyeriana	Gramineae	Annual Herb
Neroilia faicata	*Orchidaceae*	Epiphyte
Cyathea spinulosa	*Cyatheaceae*	Tree

Arundina graminifolia is a ground orchid, which is also available under cultural condition. It grows nicely on the moist hill slopes. However, the distribution of this orchid is not restricted and hence need no conservation.

The distribution of *Bauhinia scandens* is also not restricted, however, mature plants of this species are now extremely rare. *Burmannia coelestis* is a minute herb with beautiful blue flowers. It grows among the small grasses and in very small and restricted patches. Diplomeris hirusta is an endangered species and presently known to gro only in very few small patches. *Luisia teretifolia* is an epiphytic orchid,though quite rare, but can be easily rehabilitated on many host species in the green belt. *Oryza meyeriana* is an endemic wild relative of cultivated paddy. The species need to be preserved because, in future, it may be useful in improving the quality of paddy *(Oryzn sntivn)*. *Neroilia fnlenla* is also a rare and endangered species of orchid. This species has been recorded from the Eastern bank of Teesta. These plants can be spotted in proper season and can be shifted to the green belt.

12.5.2.2 Terrestrial Ecological Survey as per the Teesta Basin Study

Floral Composition in the Vicinity of Teesta Low Dam (TLD) IV HEP

A patchy tropical riverine semi-evergreen forest is observed on lower reaches of project area. The main associates of top storey include species like *Albizia lucida, Altsonia scholaris, Callophyllum polyanthum, Neoneuclea griffithii, Pterospermum acerifolium, Syzygium formosum,* and *Toona ciliata*. Second storey consists of *Brassiopsis, Callicarpa, Flacourtia, Macropanax, Pandanus, Trema*, etc. Shrubs and twiners are not common. *Boehmeria macrophylla, Bambusa tulda, Cassia ternifolia, Clerodendrum japonicum, Leea asiatica, Maesa chisia*, etc. are some tall shrubs. Among twiners species of *Dioscorea, Mikania, Piper, Puraria,* and *Thunbergia* are observed.

In the downstream area, a fairly dense mixed semi-evergreen forest is noticed on the lower reaches. The dominant trees include *Albizia procera, Engelhardtia spicata, Macaranga denticulata, Terminalia myriocarpa,* etc.

Trees, Shrubs & Saplings

At near Teesta Low Dam IV (right bank of Teesta), tree and sapling strata were dominated by *Heteropanax fragrans* having maximum frequency and density. The associated species in the tree canopy were *Pandanus nepalensis, Altsonia scholaris, Flacoutia jangomas, Gmelina arborea, Garcinia cowa, Bombax ceiba, Pterospermum acerifolium* and *Callicarpa arborea*. In the shrub layer, *Boehmeria macrophylla* was found to be the most dominant species followed by *Bambusa tulda, Chromolaena odoratum* and *Boehmeria glomerulifera* in terms of density.

At downstream of Teesta Low Dam IV (right bank of Teesta), tree strata was dominated by *Erythrina stricta* having maximum frequency (40%) and density (90 trees/ha). The associated species in the tree layer were *Engelhardtia spicata, Macaranga denticulata, Beilschmiedia roxburghiana, Alangium chinense, Griwia eriocarpa, Neonauclea griffithii, Oroxylum indicum, Sterculia villosa, Albizia procera* and *Salix tetrasperma*. The sapling layer was dominated by *Casearia vareca* and followed by *Bridelia retusa* and *Engelhardtia spicata* in terms of density. In the shrub layer *Chromolaena odoratum, Ficus hederacea* and *Boehmeria platyphylla* were found dominant species in terms of density.

Herbs

Pre-monsoon season

At near Teesta Low Dam IVth, *Oplismenus compositus,* followed by *Mikania macrantha, Achyranthes aspera, Oplismenus compositus, Mikania macrantha.*

On downstream of Teesta Low Dam IV site, *Capillipedium assimile, Gompherina globosa* were the dominant species followed by *Persicaria chinensis, Mikania macrantha.*

Monsoon Season

At near Teesta Low Dam IV site, *Oplismenus compositus* was the dominant species followed by *Cyrtococcum accrescens, Thysanolaena latifolia, Thysanolaena latifolia, Oplismenus compositus* and *Cyrtococcum accrescens.*

On downstream of Teesta Low Dam IV site, *Mikania macrantha* was the dominant species followed by *Pogonatherum paniceum, Mikania macranth, Commelina bengalensis* and *Pogonatherum paniceum.*

Post-monsoon Season

At near Teesta Low Dam IV site, *Oplismenus compositus* was the dominant species, followed by *Mikania macrantha*, *Thysanolaena latifolia, Cyrtococcum accrescens, Thysanolaena latifolia, Oplismenus compositus* and *Mikania macrantha*.

On downstream of Teesta Low Dam IV site, *Equisetum ramosissimum* was the dominant species, followed by *Mikania macrantha, Ageratum conyzoides, Saccharum longisetosum, Mikania macrantha* and *Thysanolaena latifolia*.

At near Teesta Low Dam V site, *Oplismenus compositus* was the dominant species followed by *Achyranthes aspera* and *Saccharum narenga, Achyranthes aspera, Oplismenus compositus* and *Cyperus cyperoides*.

12.5.2.3 Comparision of Terrestrial Ecological Survey

Flora

During the preparation of EIA report for Teesta Low Dam-IV by University of North Bengal District Darjeeling, the findings of the field study are as follow:-

- **Dominant tree species-** *Shorea robusta, myriocarpa, Duabanga sonneratioides, Lagerstroemia parviflora, Bombax ceiba, Terminalia* etc.
- **Dominant shrub species**- *Woodfordia fruticosa, Clerodendrum, serratum, Tephrosia candida, Casearia graveolens* etc.
- **Dominant herb species-** *Chenopodium ambrosoides, Euphorbia hypericifolia, Pouzolzia zeylanica, Hyptis suaveolens* etc.

The findings of the same study done as a part of Basin study are as follow:

- **Dominant tree species**- *Heteropanax fragrans, Pandanus nepalensis, Erythrina stricta, Macaranga denticulate, Alangium chinense, Sterculia villosa, Flacoutia jangomas, Gmelina arborea, Pterospermum acerifolium, Callicarpa arborea* etc.
- **Dominant shrub species**- *Boehmeria macrophylla, Chromolaena odoratum, Boehmeria glomerulifera, Bambusa tulda, Ficus hederacea, Boehmeria platyphylla* etc.
- **Dominant herb species-** *Oplismenus compositus, Mikania macrantha, Capillipedium assimile, Gompherina globosa, Cyrtococcum accrescens, Persicaria chinensis, Thysanolaena latifolia, Pogonatherum paniceum, Commelina benghalensis* etc.

Economically Important Plants

According to the field study of University of North Bengal, following economically important plants were observed.

- ***Timber trees and fuelwood-*** *Tectona grandis, Shorea robusta, Terminalia myriocarpa, Castanopsis hystrix, Albizia chinensis, A. odoratissima, Bischofia javanica, Sterculia villosa,Ailanthus integrifolia,mangifera sylvelion, Garunga piñata, Toona ciliate Michelia champaca, Schima wallichii etc.*
- **Fibre yielding plants-** *Abutilon indicum, Agave sislana, Cannabis sativa, Gerardiana diversifolia, Grewia optiva, Kydia calycina, Sida acuta, Urtica dioca, Urena lobata,* etc.

- ***Fodder plants-*** *Ficus semicordata, F. hispida, F. infectoria, Litsia monopetala, Syzygium comunii, Brassiopsis mitis, Dendrocalamus, Thysolaena latifolia, Saccharum sp, Penisetum pediocllatum, Leucaena sp etc.*

As per field studies conducted as a part of following economically important plants have been recorded.

- ***Timber trees and fuelwood-*** *Alnus nepalensis, Castanopsis indica, Canarium bengalense, Dalbergia sissoo, Engelhardtia spicata, Michelia champaca, Schima wallichii, Shorea robusta, Terminalia myriocarpa, and Tectona grandis, Bambusa arundinacea, B. tulda, Dendrocalamus hamitonii and D. sikkimensis etc.*
- **Fruits edible plants-** *Spondias pinnata* (Amra), *Phyllanthus emblica* (Aonla), *Terminalia chebula* (Harad); leaves of *Fagopyrum esculentum* (Kaunlya), *Houttuynia cordata* etc.
- **Fibre yielding plants-** *Abutilon indicum, Agave sislana, Cannabis sativa, Gerardiana diversifolia, Grewia optiva, Kydia calycina, Sida acuta, Urtica dioca, Urena lobata,* etc.
- ***Fodder plants-*** *Celtis tetrandra, Ficus auriculata, F. hirta, Grewia optiva, Morus alba, Quercus glauca, Saurauria nepaulensis, Echinochloa frumentacea, Panicum miliacum, Paspalum dilatatum, Pennisetum americanum, Pseudosorghum fasiculare, Rottboelia cochinchinensis, Saccharum officinarum, Setaria palmifolia,Thysolaena latifolia, etc.*
- **Wild edible plants-** Rhizomes of *Diosorea* spp. (Tarul); tubers of *Colocasia esculenta* (Arbi); twigs of *Gerardiana diversifolia* (Dholan) and *Urtica dioica* (Chhota sisnu);

Medicinally Important Plants

During the field study conducted as a part of EIA Study, a total of 24 medicinal plant species were recorded which include *Andrographis paniculata, Aloe vera, Artemisia indica, Boerhavia diffusa, Acorus calamus, Rauvolvia serpentine, Asparagus racomosa, Dioscrea sp, Terminelia belerica, T. arjuna, Phyllanthus emblica, Azadirachta indica, Aegle marmelos, Piper longum, P.mullesum,Stephania* sp, *Centella asiatica, Acacia catechu, Tepherosia* sp, *Solanum* sp. and *Costus speciosus.*

During the field survey conducted as a part of Basin study, the following medicinally important plants were observed in the study area.

Berberis aristata, Bergenia ciliata, Lycopodium clavatum, Mahonia nepaulensis, Rubia manjith, Valeriana hardwickii, Viola betonicifolia, Asparagus racemosus, Cymbidium aloifolium, Costus speciosus,Oroxylum indicum, Rauvolfia serpentina, Phyllanthus emblica, Equisetum ramosissimum, Vitex nigundo and *Zanthoxylum alatum.*

Endemic Species

The Endemic species reported from the study area by University of North Bengal District Darjeeling were *Pueraria thomsonii, Sauropus quadrangularis, Bulbophyllum reptans, Elatostema reptans, Gynocardia odoraia, Argyria roxburghii*, *Boehmeria macrophylla, Neroilia falcate, Oberonia fulcata* and *Phoebe attenuate.*

Species like *Acer campbeli, A. hookeri, Calamus inermis, Capparis sikkimensis, Casearia glomerata, Hypericum monanthenum, Hydrocotyle himalaica, Pandanus nepalensis, Plectocomia himalayana* and *Sterculia kingia* were recorded as a part of Basin Study.

Rare and Threatened Flora

As per the field studies conducted as a part of EIA study, *Arundina graminifolia, Bauhinia scandens, Burmannia coelestis, Luisia teretifolia, Neroilia faicata*, *Cyathea spinulosa* and *Angiopteris salicifolia* were Threatened plant species in the study area. As a part of Basin Study, various threatened species namely, *Christella clarkia, Aconitum ferox, Acer hookeri, Begonia rubella, Pimpinella tongloensis, Calamus inermis, Phoenix rupícola, Diplomeris hirsute, Bulleyia yunnanensis Rhododendron edgeworthii, Hedyotis scabra, Ophiorrhiza lurida* were reported.

12.5.3 Terrestrial Fauna

12.5.3.1 Terrestrial Fauna as per EIA Study

Mammalian species

Important mammalian wildlife found in the nearby forest area of the study area are given in Table-12.25.

Table-12.25: Different mammalian species spotted in the near by forest area

Scientific name	Common name	Local name
Monkeys		
Macaca mulata	Rhesus macaque	Bandor
Cats		
Felis marmorata	Marbled cat	-----
Civets		
Tariomodon pardicolor	Tiger civets	Kattas
Mongoose		
Herpestes javanicus	Small Indian mongoose	Neol
Dog tribe		
Vulpes bengalensis	Bengal fox	Lomri
Insectivores		
Suncus caeruleus	Common shrew musk	chachunder
Bats		
Pteropus gigunticus	Indian fruits bats	
Rodents		
Rattus rattus	Common house rat	
Bandicota bengalensis	Indian mole rat	
Lepus ruficandatus	Common Indian hare	Khorgosh
Elephants		
Elephus maximus	Indain Elephant	Hathi
Wild Oxen		
Bibos gaurus	Gaur	Gaur/gamgai
Pigs		
Sus crietatus	Indian wild boar	Suar

Avi-Faunal species

Birds have been aptly called 'Feathered-Biped'. They work as scavengers, help in pollination and as seed dispersal agents. They also provide guano and also serve as a source of food. Some of the Important birds observed in this area are listed in Table-12.26. No long-distance migratory birds are found near the project area, because normally they do not prefer the lotic regions. However, the new dam and reservoir thus developed will attract several migratory birds.

Table-12.26: List of Birds recorded in the near by forest area

Scientific Name	Common name	Local name
Ardea alba	Large egret	Bada bok
Corvus splendens	House crow	Desi kawwa
C. macrorhynchos	Jungle crow	Ban kawwa
Copsychus saularis	Magpie robin	Dhaiyal
C. malabaricus	Shama	Shama
S. decaocto	Ring dove	Par ghughu
Columba livia	Blue rock pigeon	Gola payra
Psittacula himalayana	Himalayan slaty-headed parakeet	Madana suga
Halcyon smyrnensis	White breasted Kingfisher	Sandabuk machhranga
Orthotomus sutorius	Tailor bird	Darzee
Pycnonotus cafer	Red vented bulbul	Bulbul

(R) = Rare

Reptilian species

Low metabolic rate and high reproductive potential characterize reptiles. Various ethnic communities consume some species of reptiles. The consumption of reptiles, however, is not popular in this area and is usually associated with medical and religious beliefs.Different types of reptiles as recorded in the surrounding forest area are given in Table-12.27.

Table-12.27: Reptiles of different Orders

Scientific name	Common name
Order-Squamata (Lizard)	
Hemidactylus flaviviridis	Yellow belled house gecko
H. frenatus	South Asian waif gecko
Calotes rouxi	Forest blood sucker
C. versicolor	Blood sucker
Ophisaurus gracilis	Burmese glass snake
Varanus bengalensis (E)	Indian monitor
Order-Ophidia (Non-poisonous Snakes)	
Typhlops diadri	Dard'sblind snakes
T. *porrectus*	Slender blind snakes
Python morulus. (R)	Indian python
Boiga multifaciata	Himalayan cat snakes
B. triganata	Indian gomma
Chrysofelea ornata	Golden tree snakes
Elaphe cantoris	Ring tailed / rinket snakes
Lycodon aulicus	Common wolf snakes
Oligodon albocinctus	Lader back kukri snakes
Poisonous snakes	
Naja naja kaoutchia	Indian cobra

Scientific name	Common name
Ophiophagus hannah	King cobra
Trimeresurus gramineus	Bamboo pit viper
Vipera russelli	Russell's viper

Amphibian

Amphibian populations are mostly found in moist places near water bodies. Some amphibian species observed in the surrounding forest area of the project are given in Table-12.28.

Table-12.28: Amphibians recorded

Scientific name	Common name
Bufo stomaticus	---
B. melanostictus	---
Kaloula palchra	Painted frog
Rana cyanophlyctus	Skipping frog
R. limnocharis	Cricket frog
Tomopterna breviceps	Burrowing frog
Philautus jerdonii	---

12.5.3.2 Terrestrial Fauna as per Teesta Basin

The information was also collected to find the trophies as indirect evidence of the presence of mammalian species. During 3 season surveys none of the trophies could be located in the surveyed households. Local people were interviewed during the survey to confirm the presence mammalian species in the study area. Locals confirmed the presence of most of the species listed in Table 12.29.

Table 12.29: Mammalian species recorded during the primary surveys in the study area during pre-monsoon, monsoon and post-monsoon seasons near TLDP-IV

Species	PrM	M	PoM
Assamese Macaque (*Macaca assamensis*)	+	+	-
The Rhesus Macaque (*Macaca mulatta*)	-	-	+
Grey Langur (*Semnopithecus hector*)	-	-	+
Indian Grey Mongoose (*Herpestes edwardsii*)	-	+	-
Himalayan Squirrel (*Dremomys lokriah*)	+	+	+
Grey-headed Flying Squirrel (*Petaurista elegans*)	-	+	-
Himalayan Striped Squirrel (*Tamiops macclellandi*)	+	-	-

PrM = pre-monsoon, M = Monsoon, PoM = Post-monsoon

Avifauna

The inventory of avifauna is based mainly on the primary surveys, however, a few species reported from the study area by different sources (http://ibcn.in/) were included in the list outlined in Table-12.30.

Table-12.30 Avifaunal species composition, their distribution habit and conservation status in study area of Teesta basin

Family/Common Name	Scientific Name	Distribution Habit	IUCN (2015)	IWPA (1972)	Seasonal Distribution		
					PrM	M	PoM
Threskiornithidae							
Oriental White Ibis	*Threskiornis melanocephalus*	R	NT	IV	+	+	-
Rallidae							
Common Moorhen	*Gallinula chloropus*	R	LC	IV	+	+	+
White-breasted Water Hen	*Amaurornis phoenicurus*	R	LC	IV	-	+	-
Ardeidae							
Pond Heron	*Ardeola grayii*	R	LC	IV	-	-	+
Intermediate Egret	*Mesophoyx intermedia*	R	-	IV	+	+	+
Phalacrococorax							
Great Cormorant	*Phalacrocorax carbo*	RW	LC	IV	+	+	-
Small Cormorant	*Microcarbo niger*	R	LC	IV	-	+	+
Phasianidae							
Red Jungle fowl	*Gallus gallus*	R	LC	IV	-	-	+
Indian Peafowl	*Pavo cristatus*	R	LC	I	-	+	+
Chestnut-breasted Partridge	Arborophila mandellii	r	VU	IV	-	-	-
Kaleej Pheasant	*Lophora leucomelanos*	R	LC	IV	-	-	+
Picidae							
Grey-capped Pygmy Woodpecker	Picoides *canicapillus*	R	LC	IV	+	-	-
Grey-headed Woodpecker	*Picus canus*	r		IV	-	+	-
Fulvous-breasted Woodpecker	*Dendrocopos macei*	R	LC	IV	+	-	-
Darjeeling Woodpecker	*Dendrocopos darjellensis*	R	LC	IV	+	+	-
Megalaimidae							
Blue-throated Barbet	*Megalaima asiatica*	R	-	IV	+	-	-
Great Barbet	*Megalaima virens*	R	LC	IV	+	+	+
Bucerotidae							
Great Hornbill*	*Buceros bicornis*	R	NT	I	-	-	-
Upupidae							
Hoopoe	*Upupa epops*	RW	LC	IV	+	+	-
Coracidae							
Indian Roller	*Coracias benghalensis*	R	LC	IV	+	+	-

Family/Common Name	Scientific Name	Distribution Habit	IUCN (2015)	IWPA (1972)	Seasonal Distribution		
					PrM	M	PoM
Alcedinidae							
Common Kingfisher	*Alcedo atthis*	R	LC	IV	+	-	+
White-throated Kingfisher	*Halcyon smyrnensis*	R	LC	IV	+	+	-
Cerylidae							
Crested Kingfisher	*Megaceryle lugubris*	R	LC	IV	-	-	+
Pied Kingfisher	*Ceryle rudis*	r		IV	-	+	-
Meropidae							
Green Bee-eater	*Merops orientalis*	R	LC	IV	+	-	+
Chestnut-headed Bee-eater	*Merops leschenaulti*	R	LC	IV	+	+	-
Cuculidae							
Asian Koel	*Eudynamys scolopacea*	R	LC	IV	+	-	-
Lesser Coucal	*Centropus bengalensis*	r	LC	IV	+	+	-
Crow pheasant	*Centropus sinensis*	R	LC	IV	+	-	-
Common Cuckoo	*Cuculus canorus*	p	LC	IV	-	-	+
Psitticidae							
Alexandrine Parakeet	*Psittacula eupatria*	R	LC	IV	+	-	-
Slaty-headed Parakeet	*Psittacula himalayana*	R	LC	IV	-	+	-
Accipitridae							
Northern Sparrowhawk	*Accipiter gentilis*	rw	LC	IV	+	+	-
Falconidae							
Common Kestrel	*Falco tinnunculus*	RW	LC	IV	-	+	+
Amur Falcon	*Falco amurensis*	p	LC	IV	+	+	-
Trogonidae							
Ward's Trogon	Harpactes wardi	r	NT	IV	+	-	-
Strigidae							
Asian Barred Owlet	*Glaucidium cuculoides*	r	LC	IV	+	+	-
Columbidae							
Rock Pigeon	*Columba livia*	R	LC	IV	+	+	+
Emerald Dove	*Chalcophaps indica*	r	LC	IV	+	-	-
Oriental Turtle Dove	*Streptopelia orientalis*	RW	LC	IV	+	+	+
Spotted Dove	*Streptopelia chinensis*	R	-	IV	+	+	+
Yellow-footed Green Pigeon	*Treron phoenicoptera*	R	LC	IV	+	-	-
Ashy Wood Pigeon	*Columba pulchricollis*	R	LC	IV	+	-	-
Hirundinidae							
Barn Swallow	*Hirundo rustica*	RW	LC	IV	+	+	+
Nepal House Martin	*Delichon nipalensis*	r	LC	IV	+	-	-
Pittidae							
Hooded Pitta	*Pitta sordida*	R	LC	IV	-	+	-
Irenidae							
Orange-bellied Leaf Bird	*Chloropsis hardwickii*	r	LC	IV	-	+	+
Golden Fronted Leaf Bird	*Chloropsis aurifrons*	r	LC	IV	-	-	+

Family/Common Name	**Scientific Name**	**Distribution Habit**	**IUCN (2015)**	**IWPA (1972)**	**Seasonal Distribution**		
					PrM	**M**	**PoM**
Lanidae							
Long-tailed Shrike	*Lanius schach*	R	LC	IV	-	-	+
Corvidae							
House Crow	*Corvus splendens*	R	LC	IV	+	+	+
Jungle Crow	*Corvus macrorhynchos*	R	LC	IV	+	+	+
Yellow-billed Blue Magpie	*Urocissa flavirostris*	R	LC	IV	+	-	-
Himalayan Treepie	*Dendrocitta formosae*	R	LC	IV	+	+	+
Green Magpie	*Cissa chinensis*	R	LC	IV	-	+	-
Dicruridae							
Ashy Drongo	*Dicrurus leucophaeus*	R	LC	IV	+	+	-
Bronzed Drongo	*Dicrurus aeneus*	r	LC	IV	+	-	-
Black Drongo	*Dicrurus adsimilis*	R	LC	IV	+	+	+
Spangled Drongo	*Dicrurus hottentottus*	p	LC	IV	-	-	+
Campephagidae							
Longtailed Minivet	*Pericrocotus ethologos*	R	LC	IV	+	-	+
Cinclidae							
Brown Dipper	*Cinclus pallasii*	R	LC	IV	+	+	-
Muscicapidae							
Golden Bush Robin	*Tarsiger chrysaeus*	r	LC	IV	-	+	-
Oriental Magpie Robin	*Copsychus saularis*	R	LC	IV	+	-	-
Plumbeous Water Redstart	*Phoenicurus fuliginosus*	r	LC	IV	+	+	+
White-capped Water Redstart	*Chaimarrornis leucocephalus*	r	LC	IV	+	+	+
Small Niltava	*Niltava macgrigoriae*	r	LC	IV	+	+	+
Verditer Flycatcher	*Eumyias thalassina*	R	LC	IV	-	+	-
Little Forktail	*Enicurus scouleri*	r	LC	IV	-	-	+
Spotted Forktail	*Enicurus maculatus*	R	LC	IV	+	+	-
Rusty-bellied Shortwing	Brachypteryx hyperythra	r	NT	IV	-	-	-
Sturnidae							
Common Myna	*Acridotheres tristis*	R	LC	IV	+	+	+
Hill Mynah	*Gracula religiosa*	r	LC	IV	-	-	+
Pied myna	*Sturnus contra*	R	LC	IV	+	+	+
Pycnonotidae							
Himalayan Bulbul	*Pycnonotus leucogenys*	R	LC	IV	+	+	+
Red-vented Bulbul	*Pycnonotus cafer*	R	LC	IV	+	+	+
Black-creasted Bulbul	*Pycnonotus flaviventris*	R	LC	IV	+	+	+
Timalidae							
Rufous-capped Babbler	*Stachyris ruficeps*	r	LC	IV	-	+	-
Whiskered Yuhina	*Yuhina flavicollis*	R	LC	IV	+	+	+
White-naped Yuhina	Yuhina bakeri	r	LC	IV	-	+	+
Sylviidae							
Lemon-rumped Warbler	*Phylloscopus chloronotus*	rW	LC	IV	+	+	-

Family/Common Name	Scientific Name	Distribution Habit	IUCN (2015)	IWPA (1972)	Seasonal Distribution		
					PrM	M	PoM
Greenish Warbler	*Phylloscopus trochiloides*	rW	LC	IV	+	-	+
Grey hooded Warbler	*Seicercus xanthoschistos*	R	LC	IV	+	+	+
Spectacled Warbler	*Seicercus burkii*	R	LC	IV	-	+	-
Leiothricidae							
Jungle Babbler	*Turdoides striatus*	r	LC	IV	+	+	+
Black-yeared Shrike Babbler	*Pteruthius melanotis*	r	LC	IV	-	+	-
Striated Laughingthrush	*Garrulax striatus*	r	LC	IV	+	+	-
White-crested Laughingthrush	*Garrulax leucolophus*	R	LC	IV	+	-	-
Grey Sibia	*Heterophasia gracilis*	r	LC	IV	+	-	-
Cisticolidae							
Grey-crowned Prinia	Prinia cinereocapilla	R	VU	IV	-	+	-
Dark-necked Tailor Bird	*Orthotomus atrogularis*	R	LC	IV	-	-	+
Sittidae							
Chestnut nuthatch	*Sitta castanea*	R	LC	IV	+	-	+
Beautiful Nuthatch	*Sittaformosa*	r	VU	IV	+	+	+
Wall Creeper	*Tichodroma muraria*	R	LC	IV	-	-	+
Paridae							
Great Tit	*Parus major*	R	LC	IV	+	+	-
Green-backed Tit	*Parus monticolus*	R	LC	IV	+	+	+
Yellow cheeked Tit	*Parus spilonotus*	r	LC	IV	-	-	+
Passeridae							
Tree Sparrow	*Passer montanus*	R	LC	IV	+	+	+
House sparrows	*Passer domesticus*	R	LC	IV	+	+	+
	Richard's Pipit	*Anthus richardi*	p	LC	IV	+	-
Olive-Black Pipit	*Anthus hogsonii*	r	LC	IV	-	+	-
Motacillidae							
Grey Wagtail	*Motacilla cinerea*	rW	LC	IV	+	+	-
Yellow Wagtail	*Motacilla flava*	W	LC	IV	+	-	+
White Browed Wagtail	*Motacilla maderaspatensis*		LC	IV	+	+	+
Nectariniidae							
Mrs Gould's Sun bird	*Aethopyga gouldiae*	r	LC	IV	+	-	-
Streaked Spider Hunter	*Arachnothera magna*	r	LC	IV	-	-	+
Certhidae							
Tree Creper	*Certhia familiaris*	R	LC	IV	+	+	+
Rusty-flanked Tree Creeper	*Certhia nipalensis*	r	LC	IV	+	-	-

R = widespread resident, r = sparse resident, W = widespread winter visitor, w = sparse winter visitor; s= summer visitor; p = passage migrant; v = vagrant; LC = least concerned, NT = near threatened; VU = vulnerable, EN = endangered; CR = critically endangered

Reptiles

The list of reptilian species spotted during field studies in various seasons is given in Table-12.31. Local people revealed the presence of many other reptilian species in the area. Though, locals were not able to identify most of them at species level, however, a few species were confirmed with the help of their vernacular name.

Table 12.31: Reptilian species spotted during different seasons in Teesta Basin in West Bengal

Species	TLIV		
	PrM	M	PoM
Common House Gecko (*Hemidactylus frenatus*)	+	+	-
Common Gecko (*Hemidactylus bowringii*)	-	+	-
Oriental Garden Lizard (*Calotes versicolor*)	-	+	+
Jerdon's Forest Lizard (*Calotes jerdoni*)	-	-	+
Khasi Hills Gecko (*Cyrtodactylus khasiensis*)	+	-	-
Mountain Forest Agama (*Japalura variegata*)	+	-	+
Three Keeled Mountain Lizard (*Japalura tricarinata*)	-	+	-
Bronzed Back Snake (*Dendrelaphis pictus*)	-	+	-

Amphibians

The species composition of amphibians in the Study Area along with their conservation study is given in Table-12.32.

Table-12.32 Species composition in the Amphibians in Lower Teesta basin in West Bengal

Family/Common Name	Scientific name	Conservation status	
		IUCN (2015)	IWPA (1972)
Bufonidae			
Common Toad	*Duttaphrynus melanostictus*	LC	-
The Himalayan Toad	*Duttaphrynushimalayanus*	LC	-
-	*Bufo abatus*	-	-
Megophryidae			
Little Spadefoot Toad	*Megophrys parva* a	-	-
Large Spadefoot Toad	*Megophrys robusta*	-	-
Ranidae			
Torrent Frog	*Amolops formosus*	LC	IV
Sikkim Frog	*Chaparana sikkimensis*	-	IV
Common Frog	Odorr*ana livida*	DD	IV
Skipping Frog	*Euphlyctis cyanophlyct*is	LC	IV
Rhacophoridae			
East Himalayan Bush Frog	*Raorchestes annandalii*	LC	-
Darjeeling Bubble-nest Frog	*Philautus dubius*	DD	-
Jerdon's Bush Frog	*Philautus jerdonii*	DD	-
East Asian Tree Frog	*Polypedates leucomystax*	LC	-

12.5.3.3 Comparision of Terrestrial Faunal Survey

Mammals: The findings of the faunal species recorded from the study area conducted as a part of EIA study, a total of 13 Mammalian species were recorded during field study. Common species were Rhesus macaque, Indian wild boar, Gaur (*Bibos gaurus*), Tiger civets (*Tariomodon pardicolor*), Common shrew musk, Bengal fox, Indain Elephant (*Elephus maximus*), Indian mongoose, Five striped palm squirrel etc. were the most common.

The Basin study revealed the presence of 6 mammalian species in the study area which were mainly represented by Grey Langur (*Semnopithecus hector*), Indian Grey Mongoose (*Herpestes edwardsii*), Rhesus Macaque (*Macaca mulatta*), Grey-headed Flying Squirrel (*Petaurista elegans*), Himalayan Squirrel (*Dremomys lokriah,*) and Himalayan Striped Squirrel (*Tamiops macclellandi*). All the species were considered to be least concern.

Avifauna: A total of 11 bird species were recorded during the field study conducted as a part of EIA study. The commonly recorded bird species were Ring dove, Blue rock pigeon, White breasted Kingfisher, Tailor bird, Red vented bulbul, Jungle crow, House crow etc. No long-distance migratory birds were found near the project area.

As per Basin Study occurrence of 112 bird species belongs to 42 families was reported. Commonly spotted bird species were Common Myna, Pied myna, Himalayan Bulbul, Indian Roller, Common Kingfisher, Green Bee-eater, Red Jungle fowl, Great Barbet, Hoopoe, Common Cuckoo, Greenish Warbler, Great Tit and Grey wagtail, Amur Falcon, Spotted Dove, Oriental Turtle Dove, Hooded Pitta, Orange-bellied Leaf Bird, House Crow, Jungle Crow, Ashy Drongo, Red-vented Bulbul etc. Major bird species are schedul-IV as per IWPA, 1972.

Reptilians: As per the field studies conducted as a part of total of 19 reptilian species were recorded from the study area. Out of which 6 species were Lizards and 13 species were snakes. Some of the common species were Indian monitor, South Asian waif gecko, Yellow belled house gecko, Forest blood sucker, Indian gomma, Dard'sblind snakes, Himalayan cat snakes, Common wolf snakes, Indian cobra, Common wolf snakes, King cobra, Indian python etc.

A total of 8 reptilian species were recorded during the field studies conducted as a part of Basin Study, which include Common House Gecko, Oriental Garden Lizard, Jerdon's Forest Lizard, Three Keeled Mountain Lizard and Bronzed snake.

Amphibians: According to the study of University of North Bengal, a total of 7 Amphibian species were observed in the surrounding forest area of the project site. Common species were *Bufo stomaticus, B. melanostictus, Kaloula palchra, Rana cyanophlyctus, R. limnocharis, Tomopterna breviceps, Phulautus jerdoni* etc.

As per the findings of our study, 12 amphibian species were recorded which represents Common Toad, The Himalayan Toad, Little Spadefoot Toad, Torrent Frog, Common Frog, East Himalayan Bush Frog etc. Most of the species belonged to least concern as per IUCN classification.

12.5.4 Fisheries Survey

12.5.4.1 Fisheries Survey as per EIA Report

Fishes are the most dominant group in the lotic waters of the Teesta both in bio diversity as well as in biomass. Some 200 species and sub-species of fishes have been reported in Teesta. Some of the important species are listed in Table-12.33. Likewise the List of commercially important and migratory fishes are given in Table-12.34 and Table-12.35 respectively.

Table-12.33: List of fishes recorded from Teesta River

Scientific Name	Local Name
Barillius barila	Takataka
B. bendelisis	Khasray
B. bola	Bhola
Puntius dukai	Bhorkol
P. ticto ticto	Tita-puthi
Garra gotha(Gray)	Nak Katwa
*Gara lamla**	Buduna
*G. mullya **	Ghorpoia
Noeuiacliiclus beavani	Biohan-Khorkey
N. Botio botio	Khorkey-bata
N. savona	Savon Khorkey
N.scaturigina	Khorkey
Balilorn brucei	
Batasio batasio	Balashi
Glyptothorax horai	-------
G. *telchitta*	......
Mastacembelus pancalus	Pankal

*Predominantly Predacious

Table-12.34: List of commercially important fishes of Teesta

Scientific Name	Local Name
Labeo boga	Boga bata
L. dero	Kursha
L. genius	Kurchi
Tor tor	Mahashol/Mahasheer
Crossochcihis latius latius	Kala-bata

Psilorhynchus balitora	Balitora
*Mystus villatus**	Tengra
*Glyptothorax telchitta telchitta **	------
*Mastacembelus pancalus **	Pankal

*Predominantly Predacious

Table-12.35: List of migratory fishes recorded in Teesta

Scientific name	Common name
Labeo dero	Kursha
Tor tor	Mahashol /Mahasheer
Acrssochcilus hexagonolepis	Buluk
Bagarius bagarius	-----
Labeo dyocheilus	-----

12.5.4.2 Fisheries Survey as Per Teesta Basin

The details of presence of fish species at various sampling sites in various seasons is given in Table-12.36.

Table 12.36: Fish species observed during the primary surveys in Teesta river in West Bengal

S.N.	Family/species	Common Name	Teesta Low Dam -IV HEP		
	Cyprinidae		PrM	M	PM
1	*BariliusBarna*	BarnaBaril	+	-	
2	*Bariliusbendelisis*	Hamilton's Baril	+	-	
3	*Bariliusshacra*	ShacraBaril	+	-	+
4	*Labeoboga*	BogaLabeo	+	-	+
5	*Labeopangusia*	PangasiaLabeo	-	-	+
7	*Schizothoraxrichardsonii*	Snow trout	+	+	+
8	*Schizothoraicthysprogastus*	Snow trout	-	-	+
9	*Neolissicheilushexagonolepis*	Copper Mahseer	+	+	+
10	*Tor putitora*	Golden Mahseer	+	+	-
11	*Garralamta*	LamtaGarra	+	-	+
12	*Garragotylagotyla*	Garra	-	-	+
13	*Crossocheiluslatius*	Kala bata	-	-	+
14	*Puntiusconchonius*	KanchanPunti	-	-	+
15	*Bagariusbagarius*	Goonch	-	+	-
	Balitoridae				
16	*Schisturabeavani*	Creek Loach	+	-	+
17	*Nemacheilusdevdevi*	Olivaceous Loach	-	-	+
	Schilbeidae				
18	*Clupisomamontana*	Jalkapoor	-	+	-

PrM = Pre-monsoon, M = Monsoon; PM = Post-monsoon

12.5.4.3 Comparision of Fisheries Survey

As per the study conducted as a part of EIA study, the study area comprised of 28 fish species. Out of these 8 species are commercially important and 5 species are migratory species.

During the field study conducted as a part of Basin Study, a total of 18 species of 3 families were recorded. Cyprinidae was predominant family comprising of 15 species. *Schizothorax richardsonii*, *Schizothoraicthys progastus, Garra lamta, Neolissicheilus hexagonolepis, Labeo pangusia* and *Barilius bendelisis* widely distributed in the Teesta river. *Schizothorax richardsonii* was most common species at the study site. Majority of fish species recorded from the project site are categorised as 'least concerned' and *Schizothorax richardsonii* is considered as 'Vulnerable' species (IUCN, 2015).

12.6 COMPLIANCE REPORTS

The six monthly compliance Report of Environmental Clearnce condition for Teesta Low Dam-III and Teesta Low Dam-IV is enclosed as Annexures-I and II respectively.

CHAPTER-13
ENVIRONMENTAL MANAGEMENT PLAN

CHAPTER-13

ENVIRONMENTAL MANAGEMENT PLAN

13.1 INTRODUCTION

The aim of the Environmental Management Plan (EMP) is to ensure that the impacts due to stress/load on the ecosystem are ameliorated to the extent possible. The most reliable way to achieve the above objective is to incorporate the management plan into the overall planning and implementation of the proposed hydroelectric projects in the study area.

13.2 PROJECTS TO BE FURTHER STUDIED

Teesta Low Dam Project Stage V H.E. project is located on Teesta river in the downstream of Stage IV in cascade. The area of influence zone extends approximately from 100 m to 1500 m. The lower part of the influence zone begins with flood plains, the land use /land cover of which comprises of dense forests of Mahananda Wildlife Sanctuary on right bank and agricultural and cultivation with tea plantation on either banks. Downstream of the project beyond Sevoke Rail Bridge is also considered as animal especially elephant corridors. Upper part of the influence zone is essentially hilly terrain covered withNorthern Sub-Tropical Broad-Leaved Wet Hill forests and Northern Sub-Tropical Semi-Evergreen Forests. The area is inhabited predominantly by *Shorearobusta, Micheliachampaca, Lagerstroemia parviflora, Terminaliabelerica,*Tectonagrandis, *T. Tomentosa, Boswelliaserrata, Schimawallichi, Castanopsisindica, C. tribuloide*s etc.

Itharbours highest number of Threatened (28 species) and schedule I (18 species) (Table 10.1). The faunal elements having conservation significance and inhabit the area under discussion are Asian Golden Cat (*Catopumatemminckii*), Leopard Cat (*Prionailurusbengalensis*), Clouded Leopard (*Neofelisnebulosa*), Tiger (*Pantheratigris*), Sloth Bear (*Melursusursinus*), Indian Elephant (*Elephasmaximusindicus*), Asiatic Black Bear (*Ursusthibetanus*), Mountain Goat (*Capricornissumatraensis*), Indian Bison (*Bosgaurus*), Rufous- necked Hornbill (*Acerosnipalensis*), Great Hornbill (*Bucerosbicornis*), White-rumped Vulture (*Gyps bengalensis*), Slender-billed Vulture (*Gyps tenuirostris*), Slender-billed Babbler (*Turdoideslongirostris*), Burmese Python (*Python molurus*), King Cobra (*Ophiophagushannah*), Walnut Kukri Snake (*Oligodonjuglandifer*) etc. The submergence area of project on left bank fall under the Mahannda Wildlife Sanctuary. A large portion of the influence area is in closed vicinity of Mahananda Wildlife Sanctuary. Vegetation is spread over an area of 81% of the total influence area (Table 10.2). Forest is spread over an area of ~66 km^2. Thus considering above, it is proposed that additional studies to assess the impacts on Mahananda Wildlife Sanctuary should be considered, while appraising the project for TOR Clearance. Impacts on

Elephant migratory route is one such study. Likewise, special study on impacts on flora and fauna of the sanctuary during construction phase may also be taken up by the project proponent.

It is recommended to change the layout of Rammam Intermediate HEP to ensure that free stretch is available between TWL of Rammam-IHEP and FRL of Rammam Intermediate HEP.

13.3 RELEASE OF ENVIRONMENTAL FLOWS

The Building Block Methodology has been used in thepresent study to formulate a synthetic hydrograph which must satisfy the water requirements in the river for maintaining a desired condition. The hydrograph simulates the natural conditions in the river to fulfill the different flow regimes present throughout the year. The identification and incorporation of these important flow characteristics will help to maintain the river's channel structure, diversity of the physical biotopes and processes.

The diversion of water for hydropower generation in the proposed hydroelectric projects will lead to drying or reduction of flow river stretch of upto tailrace disposal. The effect will be more pronounced in the lean season. There are no major users of water in the intervening stretches, as river flows through a gorge and requires pumping for use at point of consumption. As a result, there are no major users of water of river Teesta and Great Rangit in the intervening stretch. Thus, no major adverse impacts are anticipated on downstream water users. However, there will be significant adverse impacts on riverine ecology, which needs to be ameliorated through the release of Environmental Flows.

The requirements of Environmental flows considered are:

- Irrigation water requirements
- Drinking water requirements
- Flow required to maintain water quality
- Flow required to sustain riverine ecology including fisheries

Irrigation and drinking water requirements

The proposed project is located in an area with low population density with no major sources of pollution. The major source of water for meeting irrigation and drinking requirements in the project area are rivers or nallahs which flow adjacent to the habitations. The water is conveyed to the point of consumption. Thus, no water is abstracted from river Teesta or Greta Rangit.

Flow required maintaining water quality

There are no sources of pollution in the area; hence, no flows are required to maintain water quality.

Flow required sustaining riverine ecology including fisheries

The river Teestaand Great rangitare typically hilly river, which has a fast water current with rich dissolved Oxygen.

Criteria for Sustenance of Mahaseer and Snow Trout

The minimum depth requirements are for Mahaseer and Snow Trout are given in Table-13.1.

Table-13.1: Minimum Depth Requirements

S.No.	Season	Depth Requirement (m)	
		Mahaseer Zone	Trout Zone
1.	Monsoon season	1.2 – 1.4	1.0
2.	Lean Season	0.5	0.4
3.	Non-monsoon Non-lean season	0.9 – 1.0	0.65 – 0.70

Reduction in water depth and flow width should not be more than 50% of pre-project levels. Pre-project water depth and water width are assessed by reviewing the results of 100% release scenario.

As a part of the study, four main seasons have been identified in a calendar. These are listed as below:

Season I: This season is considered as high flow season influenced by monsoon. It covers the months from June to September. The minimum flow during this period is assumed as 30% of average flow (10 daily or monthly).

Season II: This season is considered as average flow period. It covers the months from October to November in which the proposed minimum flow is taken as 25% of average flow. This period is a transitional period between the wet and dry period.

Season III: This season is considered as low or lean or dry flow season. It covers the months from December to March. The proposed minimum flow is taken as 20% of average flow during this period.

Season IV: This season is considered as average flow period and is same as that of season II. It covers the months from April to May in which the proposed minimum flow is taken as 25% of average flow. This period is a transitional period between the dry and wet period.

Out of 7 hydroelectric projects being covered under the present study, 5 projects are on main rive Teesta and 2 projects are on river Great Rangit.

The following projects are of dam toe type:

- Teesta Low Dam I & II HEP (Under Investigation)
- Teesta Intermediate HEP (Under Investigation)
- Teesta Low Dam Stage-III HEP (Under operation)
- Teesta Low Stage-IV HEP (Under operation)
- Teesta Low Dam V HEP(Further study may be consider during finalization of TOR)

The following projects are having HRT to convey water upto Power house:

- Jorthang Loop HEP (Under Operation)
- Teesta Stage-VI HEP (Under Construction)

The proposed hydroelectric project would require filling up reservoir upto its live storage capacity, which would then be used for peaking power. The discharges for 90% dependable year for hydroelectric projects being covered under the present study are given in Table-13.2.

Table-13.2: 90% Dependable Year for HEPs river Teestaand Great Rangit

Month		Teesta Intermediate HEP	Teesta Low Dam -I and II HEP	Teesta Low Dam -III HEP	Teesta Low Dam -IV HEP	Teesta Low Dam -V HEP	Jorthang Loop HEP
June	I	656.09	79.26	416.09	341.20	440.5	111.4
	II	925.97	130.44	699.31	410.08	740.3	189.3
	III	823.73	274.99	657.65	735.26	696.2	163.9
July	I	1187.40	594.87	745.70	833.39	789.5	221.7
	II	785.20	480.05	808.17	808.08	855.6	197.1
	III	663.99	382.00	981.79	967.24	1039.4	150.1
August	I	669.65	258.83	772.33	798.59	817.6	170.8
	II	651.29	520.54	867.84	684.34	918.8	246.6
	III	804.86	332.21	854.72	723.44	904.9	214.5
September	I	547.50	240.51	648.70	649.03	686.8	170.8
	II	493.27	197.06	471.16	879.92	498.8	122.4
	III	644.40	207.63	583.07	673.76	617.3	214.5
October	I	371.00	196.58	515.41	608.68	545.7	103.4
	II	396.64	154.89	518.05	510.59	548.4	84.9
	III	350.08	120.96	488.15	430.61	516.8	65.6
November	I	294.64	88.84	284.85	242.42	301.6	50.8
	II	278.71	64.98	159.07	221.51	168.4	47.8
	III	239.18	49.25	135.53	196.92	143.5	39.9
December	I	204.83	43.79	192.12	178.92	203.4	31.1
	II	187.43	39.04	176.95	171.99	187.3	27.3
	III	206.73	36.92	126.22	154.91	133.6	24.3
January	I	177.22	35.57	177.76	141.25	188.2	24.3
	II	105.50	28.33	164.43	134.40	174.1	24.9
	III	107.97	26.98	157.45	127.96	166.7	24.6
February	I	94.53	30.95	132.62	156.72	140.4	24.3
	II	93.18	34.21	131.44	151.28	139.2	24.0
	III	89.09	9.35	128.49	151.11	136.0	23.7
March	I	106.94	4.79	160.94	126.81	170.4	22.7
	II	175.82	7.97	168.79	137.64	178.7	27.5
	III	231.53	15.85	179.37	160.48	189.9	24.7
April	I	215.38	24.00	151.19	223.07	160.1	43.6
	II	275.14	15.15	190.90	215.28	202.1	44.7
	III	314.46	33.65	316.33	244.11	334.9	41.1

May	I	491.19	30.87	226.82	423.01	240.1	70.2
	II	724.76	78.18	231.66	281.28	245.3	45.6
	III	745.81	156.18	400.69	312.90	424.2	51.8

The current norms of Ministry of Environment Forest and Climate Change for release of Environmental Flows are:

- Monsoon Season - 30% of flows in 90% Dependable Year
- Lean Season - 20% of flows in 90% Dependable Year
- Non-Monsoon Non-Lean Season -25% of flows in 90% Dependable Year.

Environmental Flows for Teesta Intermediate HEP

The dry segment of river between barrage/dam site and tail race at certain places may have shallow water subjecting the fish to prey by birds and other animals. Such a condition will also enable the poachers to catch fish indiscriminately. It is therefore, recommended to maintain a minimum flow of to ensure survival and propagation of invertebrates and fish.

In case of proposed hydroelectric project, the Environmental Flows are recommended as below:

- June to September - 20%
- October to November - 23%
- December to March - 15%
- April-May - 20%

The Environmental flows are as estimated for Teesta Intermediate hydroelectric project are given in Table-13.3.

Table-13.3: Recommended Environmental Flows for Teesta Intermediate hydroelectric project

S.No.	Period	Average discharge (cumec)	Percentage of flow to be released as EF	Recommended Environmental Flows (Cumec)
1.	June to September	740.0	20%	147.56
2.	October to November	226.0	23%	34.13
3.	December to March	107.0	15%	69.12
4.	April-May	269.2	20%	64.34

Note: The above calculations are for 90% dependable year (2002-03)

Environmental Flows for Teesta Low Dam –III HEP

The Teesta Low Dam –III HEP is already commissioned, and no provision for Environmental Flows have been made. The discharge for 90% dependable year is given in Table-13.4.

Table-13.4 : 90% Dependable year flow for Teesta-III HEP (1988-89)

Month		Inflows (cumec)	Hours of peaking	Hours for which river will remain dry
June	I	416.09	13.9	10.1
	II	699.31	23.4	0.6
	III	657.65	22.0	2.0
July	I	745.70	24.0	0.0
	II	808.17	24.0	0.0
	III	981.79	24.0	0.0
August	I	772.33	24.0	0.0
	II	867.84	24.0	0.0
	III	854.72	24.0	0.0
September	I	648.70	21.7	2.3
	II	471.16	15.8	8.2
	III	583.07	19.5	4.5
October	I	515.41	17.3	6.7
	II	518.05	17.4	6.6
	III	488.15	16.4	7.6
November	I	284.85	9.5	14.5
	II	159.07	5.3	18.7
	III	135.53	4.5	19.5
December	I	192.12	6.4	17.6
	II	176.95	5.9	18.1
	III	126.22	4.2	19.8
January	I	177.76	6.0	18.0
	II	164.43	5.5	18.5
	III	157.45	5.3	18.7
February	I	132.62	4.4	19.6
	II	131.44	4.4	19.6
	III	128.49	4.3	19.7
March	I	160.94	5.4	18.6
	II	168.79	5.7	18.3
	III	179.37	6.0	18.0
April	I	151.19	5.1	18.9
	II	190.90	6.4	17.6
	III	316.33	10.6	13.4
May	I	226.82	7.6	16.4
	II	231.66	7.8	16.2
	III	400.69	13.4	10.6

Source: DPR

The rated discharge for the project is 716 cumec. It can be seen that in 90% dependable year spills, shall be released only in the two month period of July and August. Since, te proposed project is a dam toe power house, river will be dry for 0.6 hours to almost 19 hours in different months of the year.

Environmental Flows for Teesta Low Dam –IV HEP

The Teesta Low Dam –III HEP is already commissioned, and no provision for Environmental Flows have been made. The discharge fpr 90% dependable year is given in Table-13.5.

Table-13.5 : 90% Dependable year flow for Teesta-IV HEP (1988-89)

Month		Inflows (cumec)	Hours of peaking	Hours for which river will remain dry
June	I	341.20	11.4	12.6
	II	410.08	13.7	10.3
	III	735.26	24.0	0.0
July	I	833.39	24.0	0.0
	II	808.08	24.0	0.0
	III	967.24	24.0	0.0
August	I	798.59	24.0	0.0
	II	684.34	22.9	1.1
	III	723.44	24.0	0.0
September	I	649.03	21.8	2.2
	II	879.92	24.0	0.0
	III	673.76	22.6	1.4
October	I	608.68	20.4	3.6
	II	510.59	17.1	6.9
	III	430.61	14.4	9.6
November	I	242.42	8.1	15.9
	II	221.51	7.4	16.6
	III	196.92	6.6	17.4
December	I	178.92	6.0	18.0
	II	171.99	5.8	18.2
	III	154.91	5.2	18.8
January	I	141.25	4.7	19.3
	II	134.40	4.5	19.5
	III	127.96	4.3	19.7
February	I	156.72	5.3	18.7
	II	151.28	5.1	18.9
	III	151.11	5.1	18.9
March	I	126.81	4.3	19.7
	II	137.64	4.6	19.4
	III	160.48	5.4	18.6
April	I	223.07	7.5	16.5
	II	215.28	7.2	16.8
	III	244.11	8.2	15.8
May	I	423.01	14.2	9.8
	II	281.28	9.4	14.6
	III	312.90	10.5	13.5

Source: DPR

The rated discharge for the project is 716 cumec. It can be seen that in 90% dependable year spills spills shall be released in the period from IIIrd ten daily of June to September. Since, the proposed project is a dam toe power house, river will be dry for 1.4 hours to almost 20 hours in different months of the year.

Environmental Flows for Teesta Intermediate hydroelectric project

In the proposed hydroelectric project, the Environmental Flows are recommended as below:

- May III-October - 30%
- November to March - 20%
- April - 25%

The Environmental flows are as estimated for Teesta Intermediate hydroelectric project are given in Table-13.6.

Table-13.6: Recommended Environmental Flows for Teesta Intermediate HEP

S.No.	Period	Average discharge (cumec)	Percentage of flow to be released as EF	Recommended Environmental Flows (Cumec)
1.	May III-October	690.0	30%	207.0
3.	November to March	174.8	20%	35.0
4.	April –May I and II	236.5	25%	59.1

Environmental Flows for Teesta Low Dam Combined I and II HEP

In case of proposed hydroelectric project, the Environmental Flows are recommended as below:

- May to September - 30%
- October to November - 25%
- December to March - 20%
- April - 25%

The Environmental flows are as estimated for TeestaLow Dam(I&II) combined hydroelectric project are given in Table-13.7.

Table-13.7: Recommended Environmental Flows for Teesta Low Dam (I&II) Combined hydroelectric project

S.No.	Period	Average discharge (cumec)	Percentage of flow to be released as EF	Recommended Environmental Flows (Cumec)
1.	May to September	267.71	30%	80.31
2.	October to November	114.06	25%	28.52
3.	December to March	26.49	20%	5.3
4.	April	24.59	25%	6.15

13.4 HYDROLOGICAL MODELLING

Methodology

1-D mathematical model has been developed for assessing the changes in hydraulic parameters corresponding to design flood. The model is based on the solution of St. Venant's equation of continuity and momentum. US Army Corps of Engineers, Hydrologic Engineering Centre software HECRAS, which is in public domain, has been used to carry out the studies.

Boundary Conditions

Steady Flow Simulation has been done with normal depth at the downstream section as boundary condition.

Manning's 'N' Value

Bed of main channel at the study area is granular sand and that of flood plains are consisted of silt mixed with sand. Value of Manning's 'n' has been adopted as 0.04.

Model Studies

Steady state simulation runs have been carried out with the 1-D mathematical model with Environmental flows proposed to be released in various seasons. The results of steady simulation runs for average flow in various seasons for 90% dependable year are given in Table-13.8 to 13.17.

Table-13.8: Depth of flow for the proposed Minimum Flow on the basis of average flow during 90% dependable year for Teesta Low Dam (I&II) HEP

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
Dam axis	M(100%)	308.2	211.93	215.25	3.32	142.54	60.79
	M(30%)	92.46	211.93	213.73	1.8	56.84	50.67
	M(29%)	89.38	211.93	213.7	1.77	55.34	50.39
	M(28%)	86.3	211.93	213.67	1.74	53.82	50.12
	M(27%)	83.21	211.93	213.64	1.71	52.34	49.84
	M(26%)	80.13	211.93	213.61	1.68	50.8	49.56
	M(25%)	77.05	211.93	213.57	1.64	49.25	49.27
	M(24%)	73.97	211.93	213.54	1.61	47.7	48.99
	M(23%)	70.89	211.93	213.51	1.58	46.17	48.7
	M(22%)	67.8	211.93	213.48	1.55	44.59	48.4
	M(21%)	64.72	211.93	213.45	1.52	43.03	48.1
	M(20%)	61.64	211.93	213.41	1.48	41.46	47.8
	M(19%)	58.56	211.93	213.38	1.45	39.86	47.49
	M(18%)	55.48	211.93	213.35	1.42	38.25	47.18
	M(17%)	52.39	211.93	213.31	1.38	36.63	46.66
	M(16%)	49.31	211.93	213.28	1.35	35.01	45.2
	M(15%)	46.23	211.93	213.24	1.31	33.34	43.65
	NMNL1(100%)	112.58	211.93	213.91	1.98	66.38	52.36

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL1(30%)	33.77	211.93	213.07	1.14	26.27	38.82
	NMNL1(29%)	32.65	211.93	213.05	1.12	25.62	38.43
	NMNL1(28%)	31.52	211.93	213.03	1.1	24.95	38.03
	NMNL1(27%)	30.4	211.93	213.01	1.08	24.28	37.62
	NMNL1(26%)	29.27	211.93	213	1.07	23.61	37.21
	NMNL1(25%)	28.15	211.93	212.98	1.05	22.93	36.78
	NMNL1(24%)	27.02	211.93	212.96	1.03	22.24	36.35
	NMNL1(23%)	25.89	211.93	212.94	1.01	21.54	36.01
	NMNL1(22%)	24.77	211.93	212.92	0.99	20.89	35.69
	NMNL1(21%)	23.64	211.93	212.9	0.97	20.19	35.34
	NMNL1(20%)	22.52	211.93	212.88	0.95	19.52	35
	NMNL1(19%)	21.39	211.93	212.86	0.93	18.82	34.65
	NMNL1(18%)	20.26	211.93	212.84	0.91	18.1	34.28
	NMNL1(17%)	19.14	211.93	212.82	0.89	17.38	33.91
	NMNL1(16%)	18.01	211.93	212.8	0.87	16.65	33.53
	NMNL1(15%)	16.89	211.93	212.78	0.85	15.92	33.14
	NMNL2(100%)	56.34	211.93	213.36	1.43	38.7	47.27
	NMNL2(30%)	16.9	211.93	212.78	0.85	15.92	33.14
	NMNL2(29%)	16.34	211.93	212.77	0.84	15.55	32.95
	NMNL2(28%)	15.78	211.93	212.75	0.82	15.18	32.75
	NMNL2(27%)	15.21	211.93	212.74	0.81	14.79	32.54
	NMNL2(26%)	14.65	211.93	212.73	0.8	14.41	32.33
	NMNL2(25%)	14.09	211.93	212.72	0.79	14.03	32.12
	NMNL2(24%)	13.52	211.93	212.71	0.78	13.63	31.9
	NMNL2(23%)	12.96	211.93	212.69	0.76	13.24	31.69
	NMNL2(22%)	12.39	211.93	212.68	0.75	12.84	31.46
	NMNL2(21%)	11.83	211.93	212.67	0.74	12.43	31.24
	NMNL2(20%)	11.27	211.93	212.66	0.73	12.03	31.01
	NMNL2(19%)	10.7	211.93	212.64	0.71	11.62	25.77
	NMNL2(18%)	10.14	211.93	212.61	0.68	10.85	25.29
	NMNL2(17%)	9.58	211.93	212.59	0.66	10.24	24.91
	NMNL2(16%)	9.01	211.93	212.57	0.64	9.75	24.61
	NMNL2(15%)	8.45	211.93	212.55	0.62	9.31	24.32
	L(100%)	26.15	211.93	212.94	1.01	21.71	36.09
	L(30%)	7.85	211.93	212.53	0.6	8.84	24.02
	L(29%)	7.58	211.93	212.52	0.59	8.63	23.88
	L(28%)	7.32	211.93	212.51	0.58	8.43	23.75
	L(27%)	7.06	211.93	212.5	0.57	8.23	23.61
	L(26%)	6.8	211.93	212.5	0.57	8.02	23.48
	L(25%)	6.54	211.93	212.49	0.56	7.81	23.34
	L(24%)	6.28	211.93	212.48	0.55	7.6	23.19
	L(23%)	6.01	211.93	212.47	0.54	7.38	23.04
	L(22%)	5.75	211.93	212.46	0.53	7.16	22.9
	L(21%)	5.49	211.93	212.45	0.52	6.94	22.75

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L(20%)	5.23	211.93	212.44	0.51	6.72	22.59
	L(19%)	4.97	211.93	212.43	0.5	6.5	22.43
	L(18%)	4.71	211.93	212.42	0.49	6.27	22.27
	L(17%)	4.45	211.93	212.41	0.48	6.03	22.11
	L(16%)	4.18	211.93	212.4	0.47	5.79	21.93
	L(15%)	3.92	211.93	212.39	0.46	5.55	21.76
100 m D/S of dam axis	M(100%)	308.2	211.37	215.02	3.65	140.6	53.4
	M(30%)	92.46	211.37	213.46	2.09	63.25	45.22
	M(29%)	89.38	211.37	213.42	2.05	61.77	45.03
	M(28%)	86.3	211.37	213.39	2.02	60.27	44.84
	M(27%)	83.21	211.37	213.36	1.99	58.74	44.65
	M(26%)	80.13	211.37	213.32	1.95	57.19	44.45
	M(25%)	77.05	211.37	213.28	1.91	55.61	44.24
	M(24%)	73.97	211.37	213.25	1.88	54.02	44.04
	M(23%)	70.89	211.37	213.21	1.84	52.38	43.82
	M(22%)	67.8	211.37	213.17	1.8	50.72	43.61
	M(21%)	64.72	211.37	213.13	1.76	49.02	43.38
	M(20%)	61.64	211.37	213.09	1.72	47.29	43.15
	M(19%)	58.56	211.37	213.05	1.68	45.53	42.92
	M(18%)	55.48	211.37	213.01	1.64	43.73	42.68
	M(17%)	52.39	211.37	212.97	1.6	41.88	42.43
	M(16%)	49.31	211.37	212.92	1.55	40	42.17
	M(15%)	46.23	211.37	212.88	1.51	38.07	41.91
	NMNL1(100%)	112.58	211.37	213.66	2.29	72.44	46.37
	NMNL1(30%)	33.77	211.37	212.68	1.31	29.78	40.78
	NMNL1(29%)	32.65	211.37	212.66	1.29	28.98	40.67
	NMNL1(28%)	31.52	211.37	212.64	1.27	28.19	40.57
	NMNL1(27%)	30.4	211.37	212.62	1.25	27.37	40.46
	NMNL1(26%)	29.27	211.37	212.6	1.23	26.55	40.35
	NMNL1(25%)	28.15	211.37	212.58	1.21	25.73	40.24
	NMNL1(24%)	27.02	211.37	212.56	1.19	24.89	40.13
	NMNL1(23%)	25.89	211.37	212.53	1.16	24.03	40.01
	NMNL1(22%)	24.77	211.37	212.51	1.14	23.18	39.68
	NMNL1(21%)	23.64	211.37	212.49	1.12	22.32	38.57
	NMNL1(20%)	22.52	211.37	212.47	1.1	21.46	37.43
	NMNL1(19%)	21.39	211.37	212.44	1.07	20.57	36.21
	NMNL1(18%)	20.26	211.37	212.42	1.05	19.69	35.32
	NMNL1(17%)	19.14	211.37	212.39	1.02	18.78	34.46
	NMNL1(16%)	18.01	211.37	212.37	1	17.88	33.58
	NMNL1(15%)	16.89	211.37	212.34	0.97	16.97	32.66
	NMNL2(100%)	56.34	211.37	213.02	1.65	44.23	42.75
	NMNL2(30%)	16.9	211.37	212.34	0.97	16.98	32.67
	NMNL2(29%)	16.34	211.37	212.33	0.96	16.52	32.2

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL2(28%)	15.78	211.37	212.31	0.94	16.05	31.71
	NMNL2(27%)	15.21	211.37	212.3	0.93	15.58	31.27
	NMNL2(26%)	14.65	211.37	212.28	0.91	15.12	30.93
	NMNL2(25%)	14.09	211.37	212.27	0.9	14.65	30.57
	NMNL2(24%)	13.52	211.37	212.25	0.88	14.17	30.21
	NMNL2(23%)	12.96	211.37	212.23	0.86	13.69	29.84
	NMNL2(22%)	12.39	211.37	212.22	0.85	13.21	29.46
	NMNL2(21%)	11.83	211.37	212.2	0.83	12.73	29.08
	NMNL2(20%)	11.27	211.37	212.19	0.82	12.25	28.69
	NMNL2(19%)	10.7	211.37	212.17	0.8	11.76	28.29
	NMNL2(18%)	10.14	211.37	212.15	0.78	11.27	27.89
	NMNL2(17%)	9.58	211.37	212.13	0.76	10.78	27.48
	NMNL2(16%)	9.01	211.37	212.11	0.74	10.28	27.05
	NMNL2(15%)	8.45	211.37	212.1	0.73	9.78	26.62
	L(100%)	26.15	211.37	212.54	1.17	24.23	40.04
	L(30%)	7.85	211.37	212.07	0.7	9.22	25
	L(29%)	7.58	211.37	212.06	0.69	8.94	24.03
	L(28%)	7.32	211.37	212.05	0.68	8.66	23.01
	L(27%)	7.06	211.37	212.04	0.67	8.38	22.35
	L(26%)	6.8	211.37	212.03	0.66	8.1	22.11
	L(25%)	6.54	211.37	212.01	0.64	7.84	21.88
	L(24%)	6.28	211.37	212	0.63	7.58	21.64
	L(23%)	6.01	211.37	211.99	0.62	7.32	21.4
	L(22%)	5.75	211.37	211.98	0.61	7.07	21.17
	L(21%)	5.49	211.37	211.97	0.6	6.82	20.94
	L(20%)	5.23	211.37	211.95	0.58	6.57	20.71
	L(19%)	4.97	211.37	211.94	0.57	6.32	20.47
	L(18%)	4.71	211.37	211.93	0.56	6.07	20.2
	L(17%)	4.45	211.37	211.92	0.55	5.81	19.89
	L(16%)	4.18	211.37	211.9	0.53	5.54	19.56
	L(15%)	3.92	211.37	211.89	0.52	5.28	19.23
200 m D/S of Dam axis	M(100%)	308.2	210.76	214.69	3.93	125.46	45.74
	M(30%)	92.46	210.76	213.26	2.5	65.47	37.82
	M(29%)	89.38	210.76	213.23	2.47	64.29	37.63
	M(28%)	86.3	210.76	213.2	2.44	63.08	37.44
	M(27%)	83.21	210.76	213.16	2.4	61.86	37.24
	M(26%)	80.13	210.76	213.13	2.37	60.61	37.04
	M(25%)	77.05	210.76	213.1	2.34	59.35	36.83
	M(24%)	73.97	210.76	213.06	2.3	58.06	36.62
	M(23%)	70.89	210.76	213.03	2.27	56.74	36.41
	M(22%)	67.8	210.76	212.99	2.23	55.39	36.23
	M(21%)	64.72	210.76	212.95	2.19	54	36.04
	M(20%)	61.64	210.76	212.91	2.15	52.59	35.84

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M(19%)	58.56	210.76	212.87	2.11	51.14	35.64
	M(18%)	55.48	210.76	212.83	2.07	49.65	35.43
	M(17%)	52.39	210.76	212.78	2.02	48.11	35.21
	M(16%)	49.31	210.76	212.74	1.98	46.53	34.99
	M(15%)	46.23	210.76	212.69	1.93	44.9	34.75
	NMNL1(100%)	112.58	210.76	213.45	2.69	72.75	38.97
	NMNL1(30%)	33.77	210.76	212.48	1.72	37.63	33.7
	NMNL1(29%)	32.65	210.76	212.46	1.7	36.91	33.59
	NMNL1(28%)	31.52	210.76	212.44	1.68	36.16	33.48
	NMNL1(27%)	30.4	210.76	212.41	1.65	35.41	33.37
	NMNL1(26%)	29.27	210.76	212.39	1.63	34.65	33.25
	NMNL1(25%)	28.15	210.76	212.37	1.61	33.88	33.14
	NMNL1(24%)	27.02	210.76	212.34	1.58	33.08	33.02
	NMNL1(23%)	25.89	210.76	212.32	1.56	32.2	32.88
	NMNL1(22%)	24.77	210.76	212.29	1.53	31.36	32.76
	NMNL1(21%)	23.64	210.76	212.26	1.5	30.49	32.62
	NMNL1(20%)	22.52	210.76	212.24	1.48	29.6	32.49
	NMNL1(19%)	21.39	210.76	212.21	1.45	28.67	32.35
	NMNL1(18%)	20.26	210.76	212.18	1.42	27.74	32.2
	NMNL1(17%)	19.14	210.76	212.15	1.39	26.79	32.05
	NMNL1(16%)	18.01	210.76	212.12	1.36	25.79	31.9
	NMNL1(15%)	16.89	210.76	212.09	1.33	24.78	31.74
	NMNL2(100%)	56.34	210.76	212.84	2.08	50.07	35.49
	NMNL2(30%)	16.9	210.76	212.09	1.33	24.8	31.74
	NMNL2(29%)	16.34	210.76	212.07	1.31	24.28	31.66
	NMNL2(28%)	15.78	210.76	212.06	1.3	23.76	31.58
	NMNL2(27%)	15.21	210.76	212.04	1.28	23.21	31.49
	NMNL2(26%)	14.65	210.76	212.02	1.26	22.67	31.41
	NMNL2(25%)	14.09	210.76	212	1.24	22.12	31.32
	NMNL2(24%)	13.52	210.76	211.98	1.22	21.55	31.23
	NMNL2(23%)	12.96	210.76	211.97	1.21	20.98	31.14
	NMNL2(22%)	12.39	210.76	211.95	1.19	20.38	31.04
	NMNL2(21%)	11.83	210.76	211.93	1.17	19.78	30.95
	NMNL2(20%)	11.27	210.76	211.91	1.15	19.17	30.85
	NMNL2(19%)	10.7	210.76	211.89	1.13	18.53	30.74
	NMNL2(18%)	10.14	210.76	211.87	1.11	17.88	30.64
	NMNL2(17%)	9.58	210.76	211.84	1.08	17.21	30.53
	NMNL2(16%)	9.01	210.76	211.82	1.06	16.51	30.41
	NMNL2(15%)	8.45	210.76	211.8	1.04	15.8	30.3
	L(100%)	26.15	210.76	212.32	1.56	32.39	32.91
	L(30%)	7.85	210.76	211.77	1.01	15.01	30.17
	L(29%)	7.58	210.76	211.76	1	14.64	30.09
	L(28%)	7.32	210.76	211.75	0.99	14.28	29.98
	L(27%)	7.06	210.76	211.74	0.98	13.92	29.87

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L(26%)	6.8	210.76	211.72	0.96	13.55	29.75
	L(25%)	6.54	210.76	211.71	0.95	13.17	29.64
	L(24%)	6.28	210.76	211.7	0.94	12.78	29.52
	L(23%)	6.01	210.76	211.68	0.92	12.37	29.39
	L(22%)	5.75	210.76	211.67	0.91	11.96	29.26
	L(21%)	5.49	210.76	211.66	0.9	11.55	29.13
	L(20%)	5.23	210.76	211.64	0.88	11.12	29
	L(19%)	4.97	210.76	211.63	0.87	10.68	27.78
	L(18%)	4.71	210.76	211.61	0.85	10.24	26.18
	L(17%)	4.45	210.76	211.59	0.83	9.82	24.52
	L(16%)	4.18	210.76	211.57	0.81	9.39	23.26
	L(15%)	3.92	210.76	211.56	0.8	8.99	22.67
300 m D/S of Dam axis	M(100%)	308.2	210.71	214.21	3.5	105.5	49.28
	M(30%)	92.46	210.71	212.94	2.23	50.1	36.85
	M(29%)	89.38	210.71	212.91	2.2	49.12	36.53
	M(28%)	86.3	210.71	212.89	2.18	48.13	36.2
	M(27%)	83.21	210.71	212.86	2.15	47.13	35.86
	M(26%)	80.13	210.71	212.83	2.12	46.12	35.45
	M(25%)	77.05	210.71	212.8	2.09	45.1	35.01
	M(24%)	73.97	210.71	212.77	2.06	44.07	34.55
	M(23%)	70.89	210.71	212.74	2.03	43.01	34.09
	M(22%)	67.8	210.71	212.71	2	41.94	33.6
	M(21%)	64.72	210.71	212.68	1.97	40.85	33.23
	M(20%)	61.64	210.71	212.64	1.93	39.75	32.84
	M(19%)	58.56	210.71	212.61	1.9	38.62	32.44
	M(18%)	55.48	210.71	212.57	1.86	37.46	32.03
	M(17%)	52.39	210.71	212.54	1.83	36.27	31.6
	M(16%)	49.31	210.71	212.5	1.79	35.06	31.15
	M(15%)	46.23	210.71	212.46	1.75	33.82	30.7
	NMNL1(100%)	112.58	210.71	213.1	2.39	56.21	38.82
	NMNL1(30%)	33.77	210.71	212.27	1.56	28.36	28.65
	NMNL1(29%)	32.65	210.71	212.25	1.54	27.81	28.46
	NMNL1(28%)	31.52	210.71	212.23	1.52	27.23	28.26
	NMNL1(27%)	30.4	210.71	212.21	1.5	26.68	28.06
	NMNL1(26%)	29.27	210.71	212.19	1.48	26.13	27.87
	NMNL1(25%)	28.15	210.71	212.17	1.46	25.57	27.67
	NMNL1(24%)	27.02	210.71	212.15	1.44	24.97	27.46
	NMNL1(23%)	25.89	210.71	212.13	1.42	24.28	27.21
	NMNL1(22%)	24.77	210.71	212.1	1.39	23.66	26.99
	NMNL1(21%)	23.64	210.71	212.08	1.37	23	26.76
	NMNL1(20%)	22.52	210.71	212.05	1.34	22.33	26.52
	NMNL1(19%)	21.39	210.71	212.03	1.32	21.64	26.27
	NMNL1(18%)	20.26	210.71	212	1.29	20.95	26.02

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL1(17%)	19.14	210.71	211.97	1.26	20.25	25.77
	NMNL1(16%)	18.01	210.71	211.95	1.24	19.53	25.5
	NMNL1(15%)	16.89	210.71	211.92	1.21	18.81	25.23
	NMNL2(100%)	56.34	210.71	212.58	1.87	37.79	32.14
	NMNL2(30%)	16.9	210.71	211.92	1.21	18.81	25.23
	NMNL2(29%)	16.34	210.71	211.9	1.19	18.45	25.09
	NMNL2(28%)	15.78	210.71	211.89	1.18	18.07	24.95
	NMNL2(27%)	15.21	210.71	211.87	1.16	17.69	24.81
	NMNL2(26%)	14.65	210.71	211.86	1.15	17.31	24.66
	NMNL2(25%)	14.09	210.71	211.84	1.13	16.92	24.51
	NMNL2(24%)	13.52	210.71	211.83	1.12	16.52	24.36
	NMNL2(23%)	12.96	210.71	211.81	1.1	16.12	24.2
	NMNL2(22%)	12.39	210.71	211.79	1.08	15.7	24.04
	NMNL2(21%)	11.83	210.71	211.77	1.06	15.29	23.87
	NMNL2(20%)	11.27	210.71	211.76	1.05	14.87	23.71
	NMNL2(19%)	10.7	210.71	211.74	1.03	14.42	23.53
	NMNL2(18%)	10.14	210.71	211.72	1.01	13.98	23.35
	NMNL2(17%)	9.58	210.71	211.7	0.99	13.53	23.16
	NMNL2(16%)	9.01	210.71	211.68	0.97	13.05	22.97
	NMNL2(15%)	8.45	210.71	211.66	0.95	12.57	22.77
	L(100%)	26.15	210.71	212.13	1.42	24.42	27.26
	L(30%)	7.85	210.71	211.63	0.92	12.04	22.55
	L(29%)	7.58	210.71	211.62	0.91	11.8	22.45
	L(28%)	7.32	210.71	211.61	0.9	11.56	22.35
	L(27%)	7.06	210.71	211.6	0.89	11.32	22.24
	L(26%)	6.8	210.71	211.59	0.88	11.07	22.14
	L(25%)	6.54	210.71	211.58	0.87	10.82	22.03
	L(24%)	6.28	210.71	211.57	0.86	10.56	21.92
	L(23%)	6.01	210.71	211.56	0.85	10.29	21.8
	L(22%)	5.75	210.71	211.54	0.83	10.02	21.68
	L(21%)	5.49	210.71	211.53	0.82	9.74	21.56
	L(20%)	5.23	210.71	211.52	0.81	9.46	21.38
	L(19%)	4.97	210.71	211.5	0.79	9.17	21.19
	L(18%)	4.71	210.71	211.49	0.78	8.87	20.99
	L(17%)	4.45	210.71	211.47	0.76	8.55	20.78
	L(16%)	4.18	210.71	211.46	0.75	8.22	20.55
	L(15%)	3.92	210.71	211.44	0.73	7.88	20.31
400 m D/S of Dam axis	M(100%)	308.2	210.65	213.71	3.06	109.62	52.84
	M(30%)	92.46	210.65	212.45	1.8	48.15	44.55
	M(29%)	89.38	210.65	212.42	1.77	47.05	44.38
	M(28%)	86.3	210.65	212.39	1.74	45.92	44.21
	M(27%)	83.21	210.65	212.37	1.72	44.77	44.03
	M(26%)	80.13	210.65	212.34	1.69	43.64	43.85

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M(25%)	77.05	210.65	212.32	1.67	42.47	43.67
	M(24%)	73.97	210.65	212.29	1.64	41.37	43.49
	M(23%)	70.89	210.65	212.26	1.61	40.19	43.3
	M(22%)	67.8	210.65	212.24	1.59	38.96	43.11
	M(21%)	64.72	210.65	212.21	1.56	37.71	42.91
	M(20%)	61.64	210.65	212.18	1.53	36.57	42.72
	M(19%)	58.56	210.65	212.15	1.5	35.28	42.51
	M(18%)	55.48	210.65	212.12	1.47	33.95	42.3
	M(17%)	52.39	210.65	212.09	1.44	32.6	42.08
	M(16%)	49.31	210.65	212.05	1.4	31.24	41.85
	M(15%)	46.23	210.65	212.02	1.37	29.87	41.63
	NMNL1(100%)	112.58	210.65	212.6	1.95	54.96	45.6
	NMNL1(30%)	33.77	210.65	211.87	1.22	23.52	40.44
	NMNL1(29%)	32.65	210.65	211.85	1.2	22.8	40.12
	NMNL1(28%)	31.52	210.65	211.83	1.18	22.06	39.8
	NMNL1(27%)	30.4	210.65	211.81	1.16	21.42	39.51
	NMNL1(26%)	29.27	210.65	211.8	1.15	20.74	39.2
	NMNL1(25%)	28.15	210.65	211.78	1.13	19.97	38.85
	NMNL1(24%)	27.02	210.65	211.76	1.11	19.16	38.48
	NMNL1(23%)	25.89	210.65	211.73	1.08	18.31	38.08
	NMNL1(22%)	24.77	210.65	211.71	1.06	17.39	37.43
	NMNL1(21%)	23.64	210.65	211.69	1.04	16.52	35.55
	NMNL1(20%)	22.52	210.65	211.66	1.01	15.73	33.75
	NMNL1(19%)	21.39	210.65	211.64	0.99	14.96	31.9
	NMNL1(18%)	20.26	210.65	211.62	0.97	14.21	29.99
	NMNL1(17%)	19.14	210.65	211.59	0.94	13.5	28.05
	NMNL1(16%)	18.01	210.65	211.56	0.91	12.8	26.4
	NMNL1(15%)	16.89	210.65	211.54	0.89	12.18	25.76
	NMNL2(100%)	56.34	210.65	212.13	1.48	34.33	42.36
	NMNL2(30%)	16.9	210.65	211.54	0.89	12.19	25.77
	NMNL2(29%)	16.34	210.65	211.53	0.88	11.88	25.44
	NMNL2(28%)	15.78	210.65	211.52	0.87	11.57	25.12
	NMNL2(27%)	15.21	210.65	211.5	0.85	11.26	24.88
	NMNL2(26%)	14.65	210.65	211.49	0.84	10.94	24.63
	NMNL2(25%)	14.09	210.65	211.48	0.83	10.62	24.37
	NMNL2(24%)	13.52	210.65	211.47	0.82	10.29	24.11
	NMNL2(23%)	12.96	210.65	211.45	0.8	9.96	23.84
	NMNL2(22%)	12.39	210.65	211.44	0.79	9.63	23.56
	NMNL2(21%)	11.83	210.65	211.42	0.77	9.29	23.28
	NMNL2(20%)	11.27	210.65	211.41	0.76	8.95	22.91
	NMNL2(19%)	10.7	210.65	211.39	0.74	8.59	22.45
	NMNL2(18%)	10.14	210.65	211.38	0.73	8.24	21.98
	NMNL2(17%)	9.58	210.65	211.36	0.71	7.88	21.5
	NMNL2(16%)	9.01	210.65	211.34	0.69	7.51	20.99

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL2(15%)	8.45	210.65	211.33	0.68	7.15	20.48
	L(100%)	26.15	210.65	211.74	1.09	18.51	38.18
	L(30%)	7.85	210.65	211.31	0.66	6.75	19.91
	L(29%)	7.58	210.65	211.3	0.65	6.57	19.64
	L(28%)	7.32	210.65	211.29	0.64	6.4	19.38
	L(27%)	7.06	210.65	211.28	0.63	6.22	19.12
	L(26%)	6.8	210.65	211.27	0.62	6.05	18.84
	L(25%)	6.54	210.65	211.26	0.61	5.87	18.57
	L(24%)	6.28	210.65	211.25	0.6	5.69	18.28
	L(23%)	6.01	210.65	211.24	0.59	5.51	17.99
	L(22%)	5.75	210.65	211.23	0.58	5.33	17.71
	L(21%)	5.49	210.65	211.22	0.57	5.14	17.42
	L(20%)	5.23	210.65	211.21	0.56	4.96	17.13
	L(19%)	4.97	210.65	211.2	0.55	4.78	16.83
	L(18%)	4.71	210.65	211.19	0.54	4.59	16.51
	L(17%)	4.45	210.65	211.18	0.53	4.4	16.19
	L(16%)	4.18	210.65	211.16	0.51	4.2	15.85
	L(15%)	3.92	210.65	211.15	0.5	4.01	15.5
500 m D/S of Dam axis	M(100%)	308.2	209.68	213.08	3.4	100.58	49.94
	M(30%)	92.46	209.68	211.67	1.99	39.2	34.7
	M(29%)	89.38	209.68	211.64	1.96	38.14	34.15
	M(28%)	86.3	209.68	211.61	1.93	37.07	33.6
	M(27%)	83.21	209.68	211.57	1.89	35.96	33.2
	M(26%)	80.13	209.68	211.54	1.86	34.88	32.8
	M(25%)	77.05	209.68	211.51	1.83	33.8	32.4
	M(24%)	73.97	209.68	211.47	1.79	32.69	31.99
	M(23%)	70.89	209.68	211.44	1.76	31.58	31.57
	M(22%)	67.8	209.68	211.4	1.72	30.42	30.95
	M(21%)	64.72	209.68	211.36	1.68	29.29	30.3
	M(20%)	61.64	209.68	211.33	1.65	28.17	29.68
	M(19%)	58.56	209.68	211.29	1.61	27.05	29.08
	M(18%)	55.48	209.68	211.25	1.57	25.93	28.48
	M(17%)	52.39	209.68	211.21	1.53	24.8	27.86
	M(16%)	49.31	209.68	211.17	1.49	23.67	27.22
	M(15%)	46.23	209.68	211.13	1.45	22.54	26.57
	NMNL1(100%)	112.58	209.68	211.86	2.18	46.29	38.15
	NMNL1(30%)	33.77	209.68	210.95	1.27	17.96	24.23
	NMNL1(29%)	32.65	209.68	210.93	1.25	17.54	24.03
	NMNL1(28%)	31.52	209.68	210.91	1.23	17.1	23.83
	NMNL1(27%)	30.4	209.68	210.89	1.21	16.67	23.62
	NMNL1(26%)	29.27	209.68	210.87	1.19	16.23	23.41
	NMNL1(25%)	28.15	209.68	210.85	1.17	15.79	23.2
	NMNL1(24%)	27.02	209.68	210.84	1.16	15.34	22.98

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL1(23%)	25.89	209.68	210.82	1.14	14.89	22.76
	NMNL1(22%)	24.77	209.68	210.8	1.12	14.44	22.53
	NMNL1(21%)	23.64	209.68	210.77	1.09	13.98	22.3
	NMNL1(20%)	22.52	209.68	210.75	1.07	13.51	22.06
	NMNL1(19%)	21.39	209.68	210.73	1.05	13.03	21.82
	NMNL1(18%)	20.26	209.68	210.71	1.03	12.56	21.57
	NMNL1(17%)	19.14	209.68	210.69	1.01	12.07	21.32
	NMNL1(16%)	18.01	209.68	210.66	0.98	11.57	21.05
	NMNL1(15%)	16.89	209.68	210.64	0.96	11.07	20.78
	NMNL2(100%)	56.34	209.68	211.26	1.58	26.24	28.65
	NMNL2(30%)	16.9	209.68	210.64	0.96	11.08	20.78
	NMNL2(29%)	16.34	209.68	210.63	0.95	10.83	20.64
	NMNL2(28%)	15.78	209.68	210.62	0.94	10.57	20.51
	NMNL2(27%)	15.21	209.68	210.6	0.92	10.28	20.35
	NMNL2(26%)	14.65	209.68	210.59	0.91	10.02	20.2
	NMNL2(25%)	14.09	209.68	210.58	0.9	9.76	20.06
	NMNL2(24%)	13.52	209.68	210.56	0.88	9.49	19.9
	NMNL2(23%)	12.96	209.68	210.55	0.87	9.22	19.75
	NMNL2(22%)	12.39	209.68	210.53	0.85	8.95	19.59
	NMNL2(21%)	11.83	209.68	210.52	0.84	8.67	19.44
	NMNL2(20%)	11.27	209.68	210.51	0.83	8.4	19.27
	NMNL2(19%)	10.7	209.68	210.49	0.81	8.11	19.11
	NMNL2(18%)	10.14	209.68	210.48	0.8	7.82	18.94
	NMNL2(17%)	9.58	209.68	210.46	0.78	7.53	18.76
	NMNL2(16%)	9.01	209.68	210.44	0.76	7.23	18.58
	NMNL2(15%)	8.45	209.68	210.43	0.75	6.93	18.4
	L(100%)	26.15	209.68	210.82	1.14	15	22.81
	L(30%)	7.85	209.68	210.41	0.73	6.6	18.2
	L(29%)	7.58	209.68	210.4	0.72	6.44	18.1
	L(28%)	7.32	209.68	210.39	0.71	6.29	18.01
	L(27%)	7.06	209.68	210.38	0.7	6.13	17.89
	L(26%)	6.8	209.68	210.38	0.7	5.98	17.71
	L(25%)	6.54	209.68	210.37	0.69	5.81	17.52
	L(24%)	6.28	209.68	210.36	0.68	5.64	17.32
	L(23%)	6.01	209.68	210.35	0.67	5.47	17.11
	L(22%)	5.75	209.68	210.34	0.66	5.29	16.91
	L(21%)	5.49	209.68	210.33	0.65	5.12	16.7
	L(20%)	5.23	209.68	210.32	0.64	4.95	16.48
	L(19%)	4.97	209.68	210.3	0.62	4.77	16.26
	L(18%)	4.71	209.68	210.29	0.61	4.59	16.03
	L(17%)	4.45	209.68	210.28	0.6	4.4	15.8
	L(16%)	4.18	209.68	210.27	0.59	4.21	15.55
	L(15%)	3.92	209.68	210.26	0.58	4.02	15.27

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
620 m D/S of Dam axis	M(100%)	308.2	208.52	212.09	3.57	88.8	46.29
	M(30%)	92.46	208.52	210.7	2.18	38.32	28.6
	M(29%)	89.38	208.52	210.67	2.15	37.45	28.4
	M(28%)	86.3	208.52	210.64	2.12	36.58	28.2
	M(27%)	83.21	208.52	210.61	2.09	35.69	27.99
	M(26%)	80.13	208.52	210.58	2.06	34.79	27.77
	M(25%)	77.05	208.52	210.54	2.02	33.89	27.55
	M(24%)	73.97	208.52	210.51	1.99	32.97	27.33
	M(23%)	70.89	208.52	210.48	1.96	32.04	27.1
	M(22%)	67.8	208.52	210.44	1.92	31.09	26.87
	M(21%)	64.72	208.52	210.4	1.88	30.13	26.63
	M(20%)	61.64	208.52	210.37	1.85	29.15	26.39
	M(19%)	58.56	208.52	210.33	1.81	28.16	26.14
	M(18%)	55.48	208.52	210.29	1.77	27.15	25.88
	M(17%)	52.39	208.52	210.25	1.73	26.12	25.61
	M(16%)	49.31	208.52	210.21	1.69	25.08	25.34
	M(15%)	46.23	208.52	210.17	1.65	24.01	25.06
	NMNL1(100%)	112.58	208.52	210.89	2.37	43.74	30.06
	NMNL1(30%)	33.77	208.52	209.98	1.46	19.43	23.82
	NMNL1(29%)	32.65	208.52	209.96	1.44	18.99	23.69
	NMNL1(28%)	31.52	208.52	209.94	1.42	18.55	23.57
	NMNL1(27%)	30.4	208.52	209.92	1.4	18.1	23.44
	NMNL1(26%)	29.27	208.52	209.9	1.38	17.65	23.31
	NMNL1(25%)	28.15	208.52	209.89	1.37	17.19	23.18
	NMNL1(24%)	27.02	208.52	209.87	1.35	16.73	23.05
	NMNL1(23%)	25.89	208.52	209.84	1.32	16.26	22.91
	NMNL1(22%)	24.77	208.52	209.82	1.3	15.78	22.78
	NMNL1(21%)	23.64	208.52	209.8	1.28	15.3	22.63
	NMNL1(20%)	22.52	208.52	209.78	1.26	14.81	22.49
	NMNL1(19%)	21.39	208.52	209.76	1.24	14.31	22.34
	NMNL1(18%)	20.26	208.52	209.74	1.22	13.81	22.19
	NMNL1(17%)	19.14	208.52	209.71	1.19	13.29	22.04
	NMNL1(16%)	18.01	208.52	209.69	1.17	12.77	21.88
	NMNL1(15%)	16.89	208.52	209.66	1.14	12.24	21.72
	NMNL2(100%)	56.34	208.52	210.3	1.78	27.44	25.95
	NMNL2(30%)	16.9	208.52	209.66	1.14	12.24	21.72
	NMNL2(29%)	16.34	208.52	209.65	1.13	11.97	21.64
	NMNL2(28%)	15.78	208.52	209.64	1.12	11.7	21.55
	NMNL2(27%)	15.21	208.52	209.63	1.11	11.42	21.47
	NMNL2(26%)	14.65	208.52	209.61	1.09	11.14	21.38
	NMNL2(25%)	14.09	208.52	209.6	1.08	10.86	21.29
	NMNL2(24%)	13.52	208.52	209.59	1.07	10.57	21.2
	NMNL2(23%)	12.96	208.52	209.57	1.05	10.28	21
	NMNL2(22%)	12.39	208.52	209.56	1.04	9.98	20.72

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL2(21%)	11.83	208.52	209.54	1.02	9.67	20.43
	NMNL2(20%)	11.27	208.52	209.53	1.01	9.36	20.14
	NMNL2(19%)	10.7	208.52	209.51	0.99	9.03	19.82
	NMNL2(18%)	10.14	208.52	209.49	0.97	8.7	19.5
	NMNL2(17%)	9.58	208.52	209.48	0.96	8.36	19.17
	NMNL2(16%)	9.01	208.52	209.46	0.94	8.01	18.81
	NMNL2(15%)	8.45	208.52	209.44	0.92	7.66	18.45
	L(100%)	26.15	208.52	209.85	1.33	16.37	22.94
	L(30%)	7.85	208.52	209.42	0.9	7.27	18.05
	L(29%)	7.58	208.52	209.41	0.89	7.09	17.86
	L(28%)	7.32	208.52	209.4	0.88	6.92	17.67
	L(27%)	7.06	208.52	209.39	0.87	6.75	17.48
	L(26%)	6.8	208.52	209.38	0.86	6.57	17.29
	L(25%)	6.54	208.52	209.37	0.85	6.4	17.09
	L(24%)	6.28	208.52	209.36	0.84	6.22	16.89
	L(23%)	6.01	208.52	209.35	0.83	6.03	16.67
	L(22%)	5.75	208.52	209.34	0.82	5.84	16.46
	L(21%)	5.49	208.52	209.32	0.8	5.66	16.24
	L(20%)	5.23	208.52	209.31	0.79	5.47	16.02
	L(19%)	4.97	208.52	209.3	0.78	5.28	15.79
	L(18%)	4.71	208.52	209.29	0.77	5.08	15.55
	L(17%)	4.45	208.52	209.28	0.76	4.88	15.24
	L(16%)	4.18	208.52	209.26	0.74	4.67	14.74
	L(15%)	3.92	208.52	209.25	0.73	4.45	14.22
720 m D/S of Dam axis	M(100%)	308.2	207.96	211.35	3.39	93.39	48.31
	M(30%)	92.46	207.96	210.06	2.1	39.74	33.85
	M(29%)	89.38	207.96	210.04	2.08	38.82	33.49
	M(28%)	86.3	207.96	210.01	2.05	37.9	33.13
	M(27%)	83.21	207.96	209.98	2.02	36.95	32.76
	M(26%)	80.13	207.96	209.95	1.99	36	32.38
	M(25%)	77.05	207.96	209.92	1.96	35.04	31.99
	M(24%)	73.97	207.96	209.89	1.93	34.07	31.59
	M(23%)	70.89	207.96	209.86	1.9	33.08	31.18
	M(22%)	67.8	207.96	209.83	1.87	32.06	30.75
	M(21%)	64.72	207.96	209.79	1.83	31.03	30.27
	M(20%)	61.64	207.96	209.76	1.8	29.99	29.77
	M(19%)	58.56	207.96	209.72	1.76	28.94	29.26
	M(18%)	55.48	207.96	209.68	1.72	27.86	28.73
	M(17%)	52.39	207.96	209.65	1.69	26.77	28.18
	M(16%)	49.31	207.96	209.61	1.65	25.66	27.61
	M(15%)	46.23	207.96	209.57	1.61	24.54	27.01
	NMNL1(100%)	112.58	207.96	210.23	2.27	45.5	36.13
	NMNL1(30%)	33.77	207.96	209.38	1.42	19.71	24.4

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL1(29%)	32.65	207.96	209.36	1.4	19.25	24.2
	NMNL1(28%)	31.52	207.96	209.34	1.38	18.78	24
	NMNL1(27%)	30.4	207.96	209.32	1.36	18.3	23.79
	NMNL1(26%)	29.27	207.96	209.3	1.34	17.82	23.58
	NMNL1(25%)	28.15	207.96	209.28	1.32	17.34	23.37
	NMNL1(24%)	27.02	207.96	209.26	1.3	16.85	23.15
	NMNL1(23%)	25.89	207.96	209.24	1.28	16.35	22.92
	NMNL1(22%)	24.77	207.96	209.21	1.25	15.85	22.69
	NMNL1(21%)	23.64	207.96	209.19	1.23	15.34	22.46
	NMNL1(20%)	22.52	207.96	209.17	1.21	14.83	22.22
	NMNL1(19%)	21.39	207.96	209.14	1.18	14.3	21.97
	NMNL1(18%)	20.26	207.96	209.12	1.16	13.76	21.71
	NMNL1(17%)	19.14	207.96	209.09	1.13	13.22	21.45
	NMNL1(16%)	18.01	207.96	209.07	1.11	12.66	21.18
	NMNL1(15%)	16.89	207.96	209.04	1.08	12.09	20.9
	NMNL2(100%)	56.34	207.96	209.7	1.74	28.17	28.88
	NMNL2(30%)	16.9	207.96	209.04	1.08	12.1	20.9
	NMNL2(29%)	16.34	207.96	209.03	1.07	11.81	20.75
	NMNL2(28%)	15.78	207.96	209.01	1.05	11.52	20.61
	NMNL2(27%)	15.21	207.96	209	1.04	11.21	20.45
	NMNL2(26%)	14.65	207.96	208.98	1.02	10.91	20.3
	NMNL2(25%)	14.09	207.96	208.97	1.01	10.6	20.14
	NMNL2(24%)	13.52	207.96	208.95	0.99	10.28	19.97
	NMNL2(23%)	12.96	207.96	208.94	0.98	9.96	19.8
	NMNL2(22%)	12.39	207.96	208.92	0.96	9.63	19.58
	NMNL2(21%)	11.83	207.96	208.9	0.94	9.3	19.3
	NMNL2(20%)	11.27	207.96	208.88	0.92	8.96	19
	NMNL2(19%)	10.7	207.96	208.87	0.91	8.62	18.69
	NMNL2(18%)	10.14	207.96	208.85	0.89	8.28	18.37
	NMNL2(17%)	9.58	207.96	208.83	0.87	7.94	18.05
	NMNL2(16%)	9.01	207.96	208.81	0.85	7.6	17.72
	NMNL2(15%)	8.45	207.96	208.79	0.83	7.26	17.39
	L(100%)	26.15	207.96	209.24	1.28	16.47	22.97
	L(30%)	7.85	207.96	208.77	0.81	6.89	17.03
	L(29%)	7.58	207.96	208.76	0.8	6.73	16.92
	L(28%)	7.32	207.96	208.75	0.79	6.57	16.82
	L(27%)	7.06	207.96	208.74	0.78	6.41	16.71
	L(26%)	6.8	207.96	208.73	0.77	6.25	16.61
	L(25%)	6.54	207.96	208.72	0.76	6.08	16.5
	L(24%)	6.28	207.96	208.71	0.75	5.92	16.39
	L(23%)	6.01	207.96	208.7	0.74	5.74	16.28
	L(22%)	5.75	207.96	208.69	0.73	5.57	16.16
	L(21%)	5.49	207.96	208.68	0.72	5.4	16.05
	L(20%)	5.23	207.96	208.67	0.71	5.23	15.93

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L(19%)	4.97	207.96	208.66	0.7	5.05	15.81
	L(18%)	4.71	207.96	208.65	0.69	4.87	15.62
	L(17%)	4.45	207.96	208.63	0.67	4.68	15.33
	L(16%)	4.18	207.96	208.62	0.66	4.48	15.02
	L(15%)	3.92	207.96	208.61	0.65	4.27	14.71
820 m D/S of Dam axis	M(100%)	308.2	207.35	210.71	3.36	99.21	45.62
	M(30%)	92.46	207.35	209.39	2.04	44.37	37.38
	M(29%)	89.38	207.35	209.36	2.01	43.4	37.22
	M(28%)	86.3	207.35	209.34	1.99	42.41	37.05
	M(27%)	83.21	207.35	209.31	1.96	41.42	36.88
	M(26%)	80.13	207.35	209.28	1.93	40.41	36.71
	M(25%)	77.05	207.35	209.26	1.91	39.39	36.54
	M(24%)	73.97	207.35	209.23	1.88	38.36	36.36
	M(23%)	70.89	207.35	209.2	1.85	37.31	36.18
	M(22%)	67.8	207.35	209.16	1.81	36.1	35.6
	M(21%)	64.72	207.35	209.13	1.78	34.85	34.96
	M(20%)	61.64	207.35	209.09	1.74	33.59	34.29
	M(19%)	58.56	207.35	209.05	1.7	32.31	33.61
	M(18%)	55.48	207.35	209.02	1.67	31.01	32.9
	M(17%)	52.39	207.35	208.97	1.62	29.69	32.16
	M(16%)	49.31	207.35	208.93	1.58	28.36	31.4
	M(15%)	46.23	207.35	208.89	1.54	27	30.61
	NMNL1(100%)	112.58	207.35	209.55	2.2	50.46	38.39
	NMNL1(30%)	33.77	207.35	208.67	1.32	20.81	25.57
	NMNL1(29%)	32.65	207.35	208.65	1.3	20.22	25.01
	NMNL1(28%)	31.52	207.35	208.62	1.27	19.61	24.43
	NMNL1(27%)	30.4	207.35	208.6	1.25	19.01	23.84
	NMNL1(26%)	29.27	207.35	208.57	1.22	18.4	23.23
	NMNL1(25%)	28.15	207.35	208.55	1.2	17.89	22.99
	NMNL1(24%)	27.02	207.35	208.53	1.18	17.4	22.76
	NMNL1(23%)	25.89	207.35	208.5	1.15	16.88	22.54
	NMNL1(22%)	24.77	207.35	208.48	1.13	16.37	22.3
	NMNL1(21%)	23.64	207.35	208.46	1.11	15.84	22.06
	NMNL1(20%)	22.52	207.35	208.43	1.08	15.32	21.82
	NMNL1(19%)	21.39	207.35	208.41	1.06	14.78	21.57
	NMNL1(18%)	20.26	207.35	208.38	1.03	14.24	21.31
	NMNL1(17%)	19.14	207.35	208.36	1.01	13.69	21.05
	NMNL1(16%)	18.01	207.35	208.33	0.98	13.13	20.78
	NMNL1(15%)	16.89	207.35	208.3	0.95	12.57	20.5
	NMNL2(100%)	56.34	207.35	209.03	1.68	31.38	33.1
	NMNL2(30%)	16.9	207.35	208.3	0.95	12.57	20.5
	NMNL2(29%)	16.34	207.35	208.29	0.94	12.29	20.36
	NMNL2(28%)	15.78	207.35	208.28	0.93	12	20.21

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL2(27%)	15.21	207.35	208.26	0.91	11.7	20.06
	NMNL2(26%)	14.65	207.35	208.25	0.9	11.4	19.92
	NMNL2(25%)	14.09	207.35	208.23	0.88	11.11	19.76
	NMNL2(24%)	13.52	207.35	208.22	0.87	10.8	19.6
	NMNL2(23%)	12.96	207.35	208.2	0.85	10.5	19.45
	NMNL2(22%)	12.39	207.35	208.18	0.83	10.18	19.28
	NMNL2(21%)	11.83	207.35	208.17	0.82	9.87	19.12
	NMNL2(20%)	11.27	207.35	208.15	0.8	9.55	18.95
	NMNL2(19%)	10.7	207.35	208.13	0.78	9.22	18.77
	NMNL2(18%)	10.14	207.35	208.12	0.77	8.9	18.59
	NMNL2(17%)	9.58	207.35	208.1	0.75	8.56	18.41
	NMNL2(16%)	9.01	207.35	208.08	0.73	8.22	18.22
	NMNL2(15%)	8.45	207.35	208.06	0.71	7.88	18.03
	L(100%)	26.15	207.35	208.51	1.16	17	22.59
	L(30%)	7.85	207.35	208.04	0.69	7.5	17.8
	L(29%)	7.58	207.35	208.03	0.68	7.31	17.61
	L(28%)	7.32	207.35	208.02	0.67	7.13	17.42
	L(27%)	7.06	207.35	208.01	0.66	6.94	17.24
	L(26%)	6.8	207.35	208	0.65	6.76	17.05
	L(25%)	6.54	207.35	207.99	0.64	6.57	16.85
	L(24%)	6.28	207.35	207.97	0.62	6.38	16.65
	L(23%)	6.01	207.35	207.96	0.61	6.18	16.44
	L(22%)	5.75	207.35	207.95	0.6	5.99	16.24
	L(21%)	5.49	207.35	207.94	0.59	5.8	16.02
	L(20%)	5.23	207.35	207.93	0.58	5.6	15.8
	L(19%)	4.97	207.35	207.91	0.56	5.4	15.58
	L(18%)	4.71	207.35	207.9	0.55	5.2	15.35
	L(17%)	4.45	207.35	207.89	0.54	4.99	15.11
	L(16%)	4.18	207.35	207.87	0.52	4.78	14.85
	L(15%)	3.92	207.35	207.86	0.51	4.56	14.6

Note:

M – Monsoon Season
NMNL1 – Non Monsoon Non Lean Season (October & November)
L – Lean Season
NMNL2 – Non Monsoon Non Lean Season (April & May)

Table-13.9: Depth of flow for the proposed Minimum Flow on the basis of average flow during 90% dependable year for Teesta Intermediate HEP

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	**(m)**	**(m)**	**(m)**	**(m2)**	**(m)**
Dam axis	M(100%)	737.78	210.77	215.71	4.94	278.09	74.28
	M(30%)	221.33	210.77	214.04	3.27	159.41	67.84

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M(29%)	213.96	210.77	214.01	3.24	157.03	67.71
	M(28%)	206.58	210.77	213.97	3.2	154.65	67.57
	M(27%)	199.2	210.77	213.94	3.17	152.2	67.43
	M(26%)	191.82	210.77	213.9	3.13	149.72	67.29
	M(25%)	184.45	210.77	213.86	3.09	147.22	67.15
	M(24%)	177.07	210.77	213.82	3.05	144.65	67
	M(23%)	169.69	210.77	213.78	3.01	142.01	66.85
	M(22%)	162.31	210.77	213.74	2.97	139.32	66.69
	M(21%)	154.93	210.77	213.7	2.93	136.56	66.53
	M(20%)	147.56	210.77	213.66	2.89	133.74	66.34
	M(19%)	140.18	210.77	213.62	2.85	130.86	66.09
	M(18%)	132.8	210.77	213.57	2.8	127.89	65.83
	M(17%)	125.42	210.77	213.52	2.75	124.84	65.56
	M(16%)	118.04	210.77	213.48	2.71	121.71	65.29
	M(15%)	110.67	210.77	213.43	2.66	118.48	65
	NMNL1(100%)	321.71	210.77	214.46	3.69	188.25	69.46
	NMNL1(30%)	96.51	210.77	213.33	2.56	111.97	64.42
	NMNL1(29%)	93.3	210.77	213.3	2.53	110.41	64.29
	NMNL1(28%)	90.08	210.77	213.28	2.51	108.84	64.14
	NMNL1(27%)	86.86	210.77	213.25	2.48	107.21	64
	NMNL1(26%)	83.64	210.77	213.23	2.46	105.56	63.85
	NMNL1(25%)	80.43	210.77	213.2	2.43	103.87	63.7
	NMNL1(24%)	77.21	210.77	213.17	2.4	102.03	63.53
	NMNL1(23%)	73.99	210.77	213.14	2.37	100.26	63.37
	NMNL1(22%)	70.78	210.77	213.12	2.35	98.46	63.21
	NMNL1(21%)	67.56	210.77	213.09	2.32	96.61	63.04
	NMNL1(20%)	64.34	210.77	213.06	2.29	94.71	62.87
	NMNL1(19%)	61.12	210.77	213.02	2.25	92.77	62.69
	NMNL1(18%)	57.91	210.77	212.99	2.22	90.79	62.51
	NMNL1(17%)	54.69	210.77	212.96	2.19	88.62	62.31
	NMNL1(16%)	51.47	210.77	212.92	2.15	86.5	62.11
	NMNL1(15%)	48.26	210.77	212.89	2.12	84.32	61.91
	NMNL2(100%)	148.4	210.77	213.66	2.89	134.07	66.36
	NMNL2(30%)	44.52	210.77	212.85	2.08	81.67	61.67
	NMNL2(29%)	43.04	210.77	212.83	2.06	80.55	61.56
	NMNL2(28%)	41.55	210.77	212.81	2.04	79.42	61.46
	NMNL2(27%)	40.07	210.77	212.79	2.02	78.3	61.35
	NMNL2(26%)	38.58	210.77	212.77	2	77.15	61.24
	NMNL2(25%)	37.1	210.77	212.75	1.98	75.98	61.13
	NMNL2(24%)	35.62	210.77	212.73	1.96	74.75	61.02
	NMNL2(23%)	34.13	210.77	212.71	1.94	73.49	60.9
	NMNL2(22%)	32.65	210.77	212.69	1.92	72.26	60.7
	NMNL2(21%)	31.16	210.77	212.67	1.9	70.96	60.35
	NMNL2(20%)	29.68	210.77	212.65	1.88	69.65	59.99

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL2(19%)	28.2	210.77	212.63	1.86	68.3	59.62
	NMNL2(18%)	26.71	210.77	212.6	1.83	66.93	59.24
	NMNL2(17%)	25.23	210.77	212.58	1.81	65.52	58.85
	NMNL2(16%)	23.74	210.77	212.55	1.78	64.05	58.44
	NMNL2(15%)	22.26	210.77	212.53	1.76	62.58	58.03
	L(100%)	461.12	210.77	214.94	4.17	222.18	71.32
	L(30%)	138.34	210.77	213.61	2.84	130.12	66.02
	L(29%)	133.72	210.77	213.58	2.81	128.26	65.86
	L(28%)	129.11	210.77	213.55	2.78	126.38	65.7
	L(27%)	124.5	210.77	213.52	2.75	124.46	65.53
	L(26%)	119.89	210.77	213.49	2.72	122.5	65.36
	L(25%)	115.28	210.77	213.46	2.69	120.51	65.18
	L(24%)	110.67	210.77	213.43	2.66	118.48	65
	L(23%)	106.06	210.77	213.4	2.63	116.41	64.82
	L(22%)	101.45	210.77	213.36	2.59	114.29	64.63
	L(21%)	96.84	210.77	213.33	2.56	112.12	64.44
	L(20%)	92.22	210.77	213.29	2.52	109.89	64.24
	L(19%)	87.61	210.77	213.26	2.49	107.6	64.03
	L(18%)	83	210.77	213.22	2.45	105.23	63.82
	L(17%)	78.39	210.77	213.18	2.41	102.75	63.6
	L(16%)	73.78	210.77	213.14	2.37	100.14	63.36
	L(15%)	69.17	210.77	213.1	2.33	97.54	63.13
100 m D/S of Dam axis	M(100%)	737.78	211.01	215.52	4.51	283.32	82.82
	M(30%)	221.33	211.01	213.93	2.92	157.19	75.97
	M(29%)	213.96	211.01	213.9	2.89	154.67	75.8
	M(28%)	206.58	211.01	213.86	2.85	152.16	75.63
	M(27%)	199.2	211.01	213.83	2.82	149.57	75.46
	M(26%)	191.82	211.01	213.8	2.79	146.97	75.28
	M(25%)	184.45	211.01	213.76	2.75	144.34	75.1
	M(24%)	177.07	211.01	213.73	2.72	141.63	74.92
	M(23%)	169.69	211.01	213.69	2.68	138.86	74.71
	M(22%)	162.31	211.01	213.65	2.64	136.03	74.47
	M(21%)	154.93	211.01	213.61	2.6	133.13	74.23
	M(20%)	147.56	211.01	213.57	2.56	130.18	73.98
	M(19%)	140.18	211.01	213.53	2.52	127.16	73.72
	M(18%)	132.8	211.01	213.49	2.48	124.05	73.46
	M(17%)	125.42	211.01	213.44	2.43	120.85	73.18
	M(16%)	118.04	211.01	213.4	2.39	117.56	72.9
	M(15%)	110.67	211.01	213.35	2.34	114.18	72.61
	NMNL1(100%)	321.71	211.01	214.33	3.32	187.69	77.83
	NMNL1(30%)	96.51	211.01	213.26	2.25	107.34	72.01
	NMNL1(29%)	93.3	211.01	213.24	2.23	105.71	71.87
	NMNL1(28%)	90.08	211.01	213.21	2.2	104.05	71.73

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL1(27%)	86.86	211.01	213.19	2.18	102.34	71.48
	NMNL1(26%)	83.64	211.01	213.16	2.15	100.6	71.19
	NMNL1(25%)	80.43	211.01	213.14	2.13	98.82	70.9
	NMNL1(24%)	77.21	211.01	213.11	2.1	96.88	70.58
	NMNL1(23%)	73.99	211.01	213.09	2.08	95.02	70.27
	NMNL1(22%)	70.78	211.01	213.06	2.05	93.13	69.96
	NMNL1(21%)	67.56	211.01	213.03	2.02	91.2	69.63
	NMNL1(20%)	64.34	211.01	213	1.99	89.23	69.3
	NMNL1(19%)	61.12	211.01	212.97	1.96	87.21	68.94
	NMNL1(18%)	57.91	211.01	212.94	1.93	85.16	68.57
	NMNL1(17%)	54.69	211.01	212.91	1.9	82.91	68.17
	NMNL1(16%)	51.47	211.01	212.88	1.87	80.72	67.78
	NMNL1(15%)	48.26	211.01	212.85	1.84	78.49	67.37
	NMNL2(100%)	148.4	211.01	213.58	2.57	130.52	74.01
	NMNL2(30%)	44.52	211.01	212.8	1.79	75.77	66.88
	NMNL2(29%)	43.04	211.01	212.79	1.78	74.62	66.65
	NMNL2(28%)	41.55	211.01	212.77	1.76	73.46	66.41
	NMNL2(27%)	40.07	211.01	212.75	1.74	72.33	66.17
	NMNL2(26%)	38.58	211.01	212.74	1.73	71.16	65.92
	NMNL2(25%)	37.1	211.01	212.72	1.71	69.97	65.67
	NMNL2(24%)	35.62	211.01	212.7	1.69	68.72	65.4
	NMNL2(23%)	34.13	211.01	212.68	1.67	67.45	65.13
	NMNL2(22%)	32.65	211.01	212.66	1.65	66.2	64.86
	NMNL2(21%)	31.16	211.01	212.64	1.63	64.9	64.57
	NMNL2(20%)	29.68	211.01	212.62	1.61	63.57	64.24
	NMNL2(19%)	28.2	211.01	212.6	1.59	62.2	63.9
	NMNL2(18%)	26.71	211.01	212.58	1.57	60.81	63.55
	NMNL2(17%)	25.23	211.01	212.55	1.54	59.39	63.19
	NMNL2(16%)	23.74	211.01	212.53	1.52	57.89	62.81
	NMNL2(15%)	22.26	211.01	212.51	1.5	56.39	62.43
	L(100%)	461.12	211.01	214.78	3.77	223.71	79.79
	L(30%)	138.34	211.01	213.52	2.51	126.38	73.65
	L(29%)	133.72	211.01	213.49	2.48	124.44	73.49
	L(28%)	129.11	211.01	213.47	2.46	122.46	73.32
	L(27%)	124.5	211.01	213.44	2.43	120.45	73.15
	L(26%)	119.89	211.01	213.41	2.4	118.4	72.97
	L(25%)	115.28	211.01	213.38	2.37	116.3	72.79
	L(24%)	110.67	211.01	213.35	2.34	114.18	72.61
	L(23%)	106.06	211.01	213.32	2.31	112	72.42
	L(22%)	101.45	211.01	213.29	2.28	109.78	72.23
	L(21%)	96.84	211.01	213.26	2.25	107.5	72.03
	L(20%)	92.22	211.01	213.23	2.22	105.16	71.82
	L(19%)	87.61	211.01	213.19	2.18	102.74	71.54
	L(18%)	83	211.01	213.16	2.15	100.24	71.13

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L(17%)	78.39	211.01	213.12	2.11	97.64	70.7
	L(16%)	73.78	211.01	213.08	2.07	94.89	70.25
	L(15%)	69.17	211.01	213.04	2.03	92.17	69.79
200 m D/S of Dam axis	M(100%)	737.78	211.24	215.27	4.03	277.43	91.09
	M(30%)	221.33	211.24	213.78	2.54	146.82	82.89
	M(29%)	213.96	211.24	213.74	2.5	144.27	82.67
	M(28%)	206.58	211.24	213.71	2.47	141.73	82.45
	M(27%)	199.2	211.24	213.68	2.44	139.12	82.13
	M(26%)	191.82	211.24	213.65	2.41	136.51	81.81
	M(25%)	184.45	211.24	213.62	2.38	133.88	81.48
	M(24%)	177.07	211.24	213.59	2.35	131.18	81.15
	M(23%)	169.69	211.24	213.55	2.31	128.42	80.8
	M(22%)	162.31	211.24	213.52	2.28	125.61	80.45
	M(21%)	154.93	211.24	213.48	2.24	122.74	80.09
	M(20%)	147.56	211.24	213.44	2.2	119.81	79.72
	M(19%)	140.18	211.24	213.41	2.17	116.83	79.33
	M(18%)	132.8	211.24	213.37	2.13	113.76	78.92
	M(17%)	125.42	211.24	213.33	2.09	110.62	78.49
	M(16%)	118.04	211.24	213.29	2.05	107.4	78.06
	M(15%)	110.67	211.24	213.24	2	104.09	77.6
	NMNL1(100%)	321.71	211.24	214.14	2.9	177.84	85.3
	NMNL1(30%)	96.51	211.24	213.16	1.92	97.44	76.68
	NMNL1(29%)	93.3	211.24	213.14	1.9	95.85	76.46
	NMNL1(28%)	90.08	211.24	213.12	1.88	94.24	76.23
	NMNL1(27%)	86.86	211.24	213.09	1.85	92.57	76
	NMNL1(26%)	83.64	211.24	213.07	1.83	90.87	75.75
	NMNL1(25%)	80.43	211.24	213.05	1.81	89.13	75.49
	NMNL1(24%)	77.21	211.24	213.02	1.78	87.17	75.19
	NMNL1(23%)	73.99	211.24	213	1.76	85.34	74.91
	NMNL1(22%)	70.78	211.24	212.97	1.73	83.5	74.63
	NMNL1(21%)	67.56	211.24	212.95	1.71	81.6	74.34
	NMNL1(20%)	64.34	211.24	212.92	1.68	79.67	74.04
	NMNL1(19%)	61.12	211.24	212.89	1.65	77.68	73.73
	NMNL1(18%)	57.91	211.24	212.87	1.63	75.66	73.42
	NMNL1(17%)	54.69	211.24	212.84	1.6	73.39	73.01
	NMNL1(16%)	51.47	211.24	212.81	1.57	71.24	72.6
	NMNL1(15%)	48.26	211.24	212.78	1.54	69.03	72.18
	NMNL2(100%)	148.4	211.24	213.45	2.21	120.16	79.76
	NMNL2(30%)	44.52	211.24	212.74	1.5	66.36	71.66
	NMNL2(29%)	43.04	211.24	212.72	1.48	65.2	71.44
	NMNL2(28%)	41.55	211.24	212.71	1.47	64.05	71.22
	NMNL2(27%)	40.07	211.24	212.69	1.45	62.92	70.99
	NMNL2(26%)	38.58	211.24	212.67	1.43	61.77	70.68

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL2(25%)	37.1	211.24	212.66	1.42	60.59	70.37
	NMNL2(24%)	35.62	211.24	212.64	1.4	59.35	70.03
	NMNL2(23%)	34.13	211.24	212.62	1.38	58.08	69.68
	NMNL2(22%)	32.65	211.24	212.6	1.36	56.85	69.35
	NMNL2(21%)	31.16	211.24	212.59	1.35	55.58	69
	NMNL2(20%)	29.68	211.24	212.57	1.33	54.26	68.63
	NMNL2(19%)	28.2	211.24	212.55	1.31	52.89	68.25
	NMNL2(18%)	26.71	211.24	212.53	1.29	51.53	67.86
	NMNL2(17%)	25.23	211.24	212.51	1.27	50.14	67.45
	NMNL2(16%)	23.74	211.24	212.48	1.24	48.65	67.02
	NMNL2(15%)	22.26	211.24	212.46	1.22	47.18	66.59
	L(100%)	461.12	211.24	214.57	3.33	215.01	87.59
	L(30%)	138.34	211.24	213.4	2.16	116.06	79.23
	L(29%)	133.72	211.24	213.37	2.13	114.15	78.97
	L(28%)	129.11	211.24	213.35	2.11	112.2	78.71
	L(27%)	124.5	211.24	213.32	2.08	110.23	78.44
	L(26%)	119.89	211.24	213.3	2.06	108.22	78.17
	L(25%)	115.28	211.24	213.27	2.03	106.17	77.89
	L(24%)	110.67	211.24	213.24	2	104.09	77.6
	L(23%)	106.06	211.24	213.22	1.98	101.97	77.31
	L(22%)	101.45	211.24	213.19	1.95	99.81	77.01
	L(21%)	96.84	211.24	213.16	1.92	97.6	76.7
	L(20%)	92.22	211.24	213.13	1.89	95.31	76.38
	L(19%)	87.61	211.24	213.1	1.86	92.96	76.05
	L(18%)	83	211.24	213.07	1.83	90.52	75.7
	L(17%)	78.39	211.24	213.03	1.79	87.95	75.31
	L(16%)	73.78	211.24	213	1.76	85.22	74.89
	L(15%)	69.17	211.24	212.96	1.72	82.56	74.48
330 m D/S of Dam axis	M(100%)	737.78	211.57	214.56	2.99	220.38	98.4
	M(30%)	221.33	211.57	213.17	1.6	92.32	85.68
	M(29%)	213.96	211.57	213.15	1.58	90.25	85.42
	M(28%)	206.58	211.57	213.12	1.55	88.14	85.12
	M(27%)	199.2	211.57	213.1	1.53	85.75	84.78
	M(26%)	191.82	211.57	213.07	1.5	83.6	84.47
	M(25%)	184.45	211.57	213.05	1.48	81.76	84.21
	M(24%)	177.07	211.57	213.02	1.45	79.5	83.88
	M(23%)	169.69	211.57	212.99	1.42	77.22	83.55
	M(22%)	162.31	211.57	212.97	1.4	74.88	83
	M(21%)	154.93	211.57	212.94	1.37	72.52	82.41
	M(20%)	147.56	211.57	212.91	1.34	70.13	81.81
	M(19%)	140.18	211.57	212.88	1.31	67.74	81.21
	M(18%)	132.8	211.57	212.85	1.28	65.28	80.58
	M(17%)	125.42	211.57	212.82	1.25	62.79	79.95

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M(16%)	118.04	211.57	212.79	1.22	60.27	79.29
	M(15%)	110.67	211.57	212.75	1.18	57.7	78.62
	NMNL1(100%)	321.71	211.57	213.47	1.9	118.35	88.53
	NMNL1(30%)	96.51	211.57	212.69	1.12	52.62	77.24
	NMNL1(29%)	93.3	211.57	212.67	1.1	51.4	76.18
	NMNL1(28%)	90.08	211.57	212.66	1.09	50.2	75.12
	NMNL1(27%)	86.86	211.57	212.64	1.07	48.83	73.88
	NMNL1(26%)	83.64	211.57	212.62	1.05	47.45	72.62
	NMNL1(25%)	80.43	211.57	212.6	1.03	45.93	71.21
	NMNL1(24%)	77.21	211.57	212.56	0.99	43.53	64.16
	NMNL1(23%)	73.99	211.57	212.54	0.97	42.03	63.81
	NMNL1(22%)	70.78	211.57	212.52	0.95	40.7	63.51
	NMNL1(21%)	67.56	211.57	212.5	0.93	39.48	63.23
	NMNL1(20%)	64.34	211.57	212.48	0.91	38.25	62.94
	NMNL1(19%)	61.12	211.57	212.46	0.89	37.03	62.65
	NMNL1(18%)	57.91	211.57	212.44	0.87	35.78	62.36
	NMNL1(17%)	54.69	211.57	212.42	0.85	34.51	62.06
	NMNL1(16%)	51.47	211.57	212.4	0.83	33.22	61.75
	NMNL1(15%)	48.26	211.57	212.38	0.81	31.9	61.44
	NMNL2(100%)	148.4	211.57	212.91	1.34	70.41	81.88
	NMNL2(30%)	44.52	211.57	212.35	0.78	30.33	61.06
	NMNL2(29%)	43.04	211.57	212.34	0.77	29.69	60.91
	NMNL2(28%)	41.55	211.57	212.33	0.76	29.04	60.75
	NMNL2(27%)	40.07	211.57	212.32	0.75	28.39	60.6
	NMNL2(26%)	38.58	211.57	212.31	0.74	27.73	60.43
	NMNL2(25%)	37.1	211.57	212.3	0.73	27.06	60.27
	NMNL2(24%)	35.62	211.57	212.29	0.72	26.38	60.11
	NMNL2(23%)	34.13	211.57	212.28	0.71	25.68	59.94
	NMNL2(22%)	32.65	211.57	212.26	0.69	24.98	59.76
	NMNL2(21%)	31.16	211.57	212.25	0.68	24.26	59.59
	NMNL2(20%)	29.68	211.57	212.24	0.67	23.54	59.41
	NMNL2(19%)	28.2	211.57	212.23	0.66	22.81	59.23
	NMNL2(18%)	26.71	211.57	212.21	0.64	22.05	59.04
	NMNL2(17%)	25.23	211.57	212.2	0.63	21.29	58.85
	NMNL2(16%)	23.74	211.57	212.19	0.62	20.5	58.65
	NMNL2(15%)	22.26	211.57	212.17	0.6	19.7	58.45
	L(100%)	461.12	211.57	213.86	2.29	153.44	92.23
	L(30%)	138.34	211.57	212.87	1.3	67.13	81.05
	L(29%)	133.72	211.57	212.85	1.28	65.59	80.66
	L(28%)	129.11	211.57	212.83	1.26	64.04	80.27
	L(27%)	124.5	211.57	212.81	1.24	62.48	79.87
	L(26%)	119.89	211.57	212.79	1.22	60.91	79.46
	L(25%)	115.28	211.57	212.77	1.2	59.31	79.04
	L(24%)	110.67	211.57	212.75	1.18	57.7	78.62

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L(23%)	106.06	211.57	212.73	1.16	56.07	78.2
	L(22%)	101.45	211.57	212.71	1.14	54.43	77.76
	L(21%)	96.84	211.57	212.69	1.12	52.74	77.31
	L(20%)	92.22	211.57	212.67	1.1	50.98	75.8
	L(19%)	87.61	211.57	212.64	1.07	49.14	74.16
	L(18%)	83	211.57	212.62	1.05	47.17	72.37
	L(17%)	78.39	211.57	212.58	1.01	44.49	69.83
	L(16%)	73.78	211.57	212.54	0.97	41.91	63.79
	L(15%)	69.17	211.57	212.51	0.94	40.08	63.36
440 m D/S of Dam axis	M(100%)	737.78	210.4	214.17	3.77	248.56	94.78
	M(30%)	221.33	210.4	212.42	2.02	96.9	77.68
	M(29%)	213.96	210.4	212.39	1.99	94.26	77.29
	M(28%)	206.58	210.4	212.35	1.95	91.58	76.89
	M(27%)	199.2	210.4	212.32	1.92	88.89	76.49
	M(26%)	191.82	210.4	212.28	1.88	86.18	76.09
	M(25%)	184.45	210.4	212.25	1.85	83.45	75.67
	M(24%)	177.07	210.4	212.21	1.81	80.7	75.26
	M(23%)	169.69	210.4	212.17	1.77	77.98	74.85
	M(22%)	162.31	210.4	212.14	1.74	75.25	74.38
	M(21%)	154.93	210.4	212.1	1.7	72.52	73.85
	M(20%)	147.56	210.4	212.06	1.66	69.8	73.3
	M(19%)	140.18	210.4	212.03	1.63	67.07	72.76
	M(18%)	132.8	210.4	211.99	1.59	64.36	72.21
	M(17%)	125.42	210.4	211.95	1.55	61.65	71.66
	M(16%)	118.04	210.4	211.91	1.51	58.94	71.11
	M(15%)	110.67	210.4	211.87	1.47	56.24	70.56
	NMNL1(100%)	321.71	210.4	212.85	2.45	131.16	82.61
	NMNL1(30%)	96.51	210.4	211.8	1.4	51.04	69.48
	NMNL1(29%)	93.3	210.4	211.78	1.38	49.86	69.23
	NMNL1(28%)	90.08	210.4	211.77	1.37	48.67	68.98
	NMNL1(27%)	86.86	210.4	211.75	1.35	47.47	68.73
	NMNL1(26%)	83.64	210.4	211.73	1.33	46.27	68.47
	NMNL1(25%)	80.43	210.4	211.71	1.31	45.07	68.22
	NMNL1(24%)	77.21	210.4	211.7	1.3	43.86	67.96
	NMNL1(23%)	73.99	210.4	211.68	1.28	42.64	67.7
	NMNL1(22%)	70.78	210.4	211.66	1.26	41.41	67.44
	NMNL1(21%)	67.56	210.4	211.64	1.24	40.16	67.17
	NMNL1(20%)	64.34	210.4	211.62	1.22	38.91	66.9
	NMNL1(19%)	61.12	210.4	211.6	1.2	37.64	66.61
	NMNL1(18%)	57.91	210.4	211.58	1.18	36.35	66.31
	NMNL1(17%)	54.69	210.4	211.56	1.16	35.04	66.01
	NMNL1(16%)	51.47	210.4	211.54	1.14	33.71	65.69
	NMNL1(15%)	48.26	210.4	211.52	1.12	32.36	65.37

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL2(100%)	148.4	210.4	212.07	1.67	70.1	73.37
	NMNL2(30%)	44.52	210.4	211.5	1.1	30.9	65.01
	NMNL2(29%)	43.04	210.4	211.49	1.09	30.24	64.85
	NMNL2(28%)	41.55	210.4	211.48	1.08	29.57	64.69
	NMNL2(27%)	40.07	210.4	211.47	1.07	28.9	64.52
	NMNL2(26%)	38.58	210.4	211.46	1.06	28.14	64.28
	NMNL2(25%)	37.1	210.4	211.45	1.05	27.54	63.97
	NMNL2(24%)	35.62	210.4	211.44	1.04	26.83	63.61
	NMNL2(23%)	34.13	210.4	211.43	1.03	26.06	63.21
	NMNL2(22%)	32.65	210.4	211.41	1.01	25.18	62.75
	NMNL2(21%)	31.16	210.4	211.4	1	24.4	62.35
	NMNL2(20%)	29.68	210.4	211.38	0.98	23.01	61.61
	NMNL2(19%)	28.2	210.4	211.36	0.96	21.97	55.79
	NMNL2(18%)	26.71	210.4	211.33	0.93	20.57	52.94
	NMNL2(17%)	25.23	210.4	211.31	0.91	19.5	51.22
	NMNL2(16%)	23.74	210.4	211.28	0.88	18.04	48.58
	NMNL2(15%)	22.26	210.4	211.26	0.86	16.84	43.62
	L(100%)	461.12	210.4	213.35	2.95	174.1	87.42
	L(30%)	138.34	210.4	212.02	1.62	66.4	72.62
	L(29%)	133.72	210.4	211.99	1.59	64.7	72.28
	L(28%)	129.11	210.4	211.97	1.57	63	71.94
	L(27%)	124.5	210.4	211.95	1.55	61.31	71.59
	L(26%)	119.89	210.4	211.92	1.52	59.62	71.25
	L(25%)	115.28	210.4	211.9	1.5	57.93	70.9
	L(24%)	110.67	210.4	211.87	1.47	56.24	70.56
	L(23%)	106.06	210.4	211.85	1.45	54.55	70.21
	L(22%)	101.45	210.4	211.83	1.43	52.86	69.86
	L(21%)	96.84	210.4	211.8	1.4	51.17	69.5
	L(20%)	92.22	210.4	211.78	1.38	49.46	69.15
	L(19%)	87.61	210.4	211.75	1.35	47.75	68.79
	L(18%)	83	210.4	211.73	1.33	46.03	68.42
	L(17%)	78.39	210.4	211.7	1.3	44.3	68.06
	L(16%)	73.78	210.4	211.68	1.28	42.55	67.68
	L(15%)	69.17	210.4	211.65	1.25	40.79	67.3
530 m D/S of Dam axis	M(100%)	737.78	209.24	213.99	4.75	298.6	94.86
	M(30%)	221.33	209.24	212.17	2.93	139.72	78.23
	M(29%)	213.96	209.24	212.13	2.89	136.69	77.83
	M(28%)	206.58	209.24	212.09	2.85	133.59	77.43
	M(27%)	199.2	209.24	212.05	2.81	130.44	77.02
	M(26%)	191.82	209.24	212.01	2.77	127.21	76.59
	M(25%)	184.45	209.24	211.96	2.72	123.91	76.15
	M(24%)	177.07	209.24	211.92	2.68	120.5	75.69
	M(23%)	169.69	209.24	211.87	2.63	117.14	75.24

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M(22%)	162.31	209.24	211.83	2.59	113.74	74.78
	M(21%)	154.93	209.24	211.78	2.54	110.29	74.31
	M(20%)	147.56	209.24	211.73	2.49	106.78	73.83
	M(19%)	140.18	209.24	211.69	2.45	103.23	73.34
	M(18%)	132.8	209.24	211.64	2.4	99.62	72.84
	M(17%)	125.42	209.24	211.59	2.35	95.96	72.33
	M(16%)	118.04	209.24	211.53	2.29	92.23	71.84
	M(15%)	110.67	209.24	211.48	2.24	88.43	71.34
	NMNL1(100%)	321.71	209.24	212.63	3.39	177.04	82.96
	NMNL1(30%)	96.51	209.24	211.38	2.14	80.9	70.34
	NMNL1(29%)	93.3	209.24	211.35	2.11	79.15	70.11
	NMNL1(28%)	90.08	209.24	211.32	2.08	77.37	69.87
	NMNL1(27%)	86.86	209.24	211.3	2.06	75.57	69.63
	NMNL1(26%)	83.64	209.24	211.27	2.03	73.75	69.38
	NMNL1(25%)	80.43	209.24	211.25	2.01	71.91	69.14
	NMNL1(24%)	77.21	209.24	211.22	1.98	70.05	68.88
	NMNL1(23%)	73.99	209.24	211.19	1.95	68.16	68.62
	NMNL1(22%)	70.78	209.24	211.16	1.92	66.25	68.36
	NMNL1(21%)	67.56	209.24	211.14	1.9	64.3	68.1
	NMNL1(20%)	64.34	209.24	211.11	1.87	62.34	67.83
	NMNL1(19%)	61.12	209.24	211.08	1.84	60.33	67.55
	NMNL1(18%)	57.91	209.24	211.05	1.81	58.3	67.27
	NMNL1(17%)	54.69	209.24	211.02	1.78	56.22	66.97
	NMNL1(16%)	51.47	209.24	210.98	1.74	54.1	66.68
	NMNL1(15%)	48.26	209.24	210.95	1.71	51.94	66.37
	NMNL2(100%)	148.4	209.24	211.74	2.5	107.19	73.89
	NMNL2(30%)	44.52	209.24	210.91	1.67	49.33	66.01
	NMNL2(29%)	43.04	209.24	210.9	1.66	48.28	65.86
	NMNL2(28%)	41.55	209.24	210.88	1.64	47.21	65.71
	NMNL2(27%)	40.07	209.24	210.86	1.62	46.13	65.56
	NMNL2(26%)	38.58	209.24	210.85	1.61	45.03	65.4
	NMNL2(25%)	37.1	209.24	210.83	1.59	43.91	65.24
	NMNL2(24%)	35.62	209.24	210.81	1.57	42.76	65.08
	NMNL2(23%)	34.13	209.24	210.79	1.55	41.58	64.91
	NMNL2(22%)	32.65	209.24	210.78	1.54	40.37	64.74
	NMNL2(21%)	31.16	209.24	210.75	1.51	39.06	64.55
	NMNL2(20%)	29.68	209.24	210.73	1.49	37.66	64.35
	NMNL2(19%)	28.2	209.24	210.71	1.47	35.87	64.1
	NMNL2(18%)	26.71	209.24	210.68	1.44	34.07	58.17
	NMNL2(17%)	25.23	209.24	210.65	1.41	32.63	56.7
	NMNL2(16%)	23.74	209.24	210.62	1.38	31.18	55.17
	NMNL2(15%)	22.26	209.24	210.6	1.36	29.71	53.58
	L(100%)	461.12	209.24	213.16	3.92	222.04	88.3
	L(30%)	138.34	209.24	211.67	2.43	102.34	73.22

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L(29%)	133.72	209.24	211.64	2.4	100.08	72.9
	L(28%)	129.11	209.24	211.61	2.37	97.8	72.59
	L(27%)	124.5	209.24	211.58	2.34	95.49	72.26
	L(26%)	119.89	209.24	211.55	2.31	93.17	71.96
	L(25%)	115.28	209.24	211.51	2.27	90.81	71.65
	L(24%)	110.67	209.24	211.48	2.24	88.43	71.34
	L(23%)	106.06	209.24	211.45	2.21	86.01	71.02
	L(22%)	101.45	209.24	211.41	2.17	83.57	70.7
	L(21%)	96.84	209.24	211.38	2.14	81.08	70.37
	L(20%)	92.22	209.24	211.34	2.1	78.55	70.03
	L(19%)	87.61	209.24	211.31	2.07	75.99	69.69
	L(18%)	83	209.24	211.27	2.03	73.38	69.33
	L(17%)	78.39	209.24	211.23	1.99	70.73	68.98
	L(16%)	73.78	209.24	211.19	1.95	68.03	68.61
	L(15%)	69.17	209.24	211.15	1.91	65.28	68.23
630 m D/S of Dam axis	M(100%)	737.78	209.03	213.78	4.75	300.97	96.41
	M(30%)	221.33	209.03	211.98	2.95	141.24	79.99
	M(29%)	213.96	209.03	211.94	2.91	138.16	79.53
	M(28%)	206.58	209.03	211.9	2.87	135.01	79.07
	M(27%)	199.2	209.03	211.86	2.83	131.79	78.59
	M(26%)	191.82	209.03	211.82	2.79	128.48	78.09
	M(25%)	184.45	209.03	211.78	2.75	125.08	77.57
	M(24%)	177.07	209.03	211.73	2.7	121.55	77.04
	M(23%)	169.69	209.03	211.69	2.66	118.1	76.52
	M(22%)	162.31	209.03	211.64	2.61	114.62	76
	M(21%)	154.93	209.03	211.59	2.56	111.09	75.47
	M(20%)	147.56	209.03	211.55	2.52	107.51	74.93
	M(19%)	140.18	209.03	211.5	2.47	103.87	74.37
	M(18%)	132.8	209.03	211.45	2.42	100.18	73.8
	M(17%)	125.42	209.03	211.4	2.37	96.45	73.25
	M(16%)	118.04	209.03	211.35	2.32	92.64	72.7
	M(15%)	110.67	209.03	211.29	2.26	88.75	72.13
	NMNL1(100%)	321.71	209.03	212.44	3.41	178.93	84.94
	NMNL1(30%)	96.51	209.03	211.18	2.15	81.07	71
	NMNL1(29%)	93.3	209.03	211.16	2.13	79.29	70.73
	NMNL1(28%)	90.08	209.03	211.13	2.1	77.47	70.46
	NMNL1(27%)	86.86	209.03	211.11	2.08	75.64	70.19
	NMNL1(26%)	83.64	209.03	211.08	2.05	73.78	69.91
	NMNL1(25%)	80.43	209.03	211.05	2.02	71.92	69.63
	NMNL1(24%)	77.21	209.03	211.03	2	70.02	69.35
	NMNL1(23%)	73.99	209.03	211	1.97	68.11	69.06
	NMNL1(22%)	70.78	209.03	210.97	1.94	66.17	68.76
	NMNL1(21%)	67.56	209.03	210.94	1.91	64.2	68.46

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL1(20%)	64.34	209.03	210.91	1.88	62.2	68.15
	NMNL1(19%)	61.12	209.03	210.88	1.85	60.17	67.84
	NMNL1(18%)	57.91	209.03	210.85	1.82	58.12	67.52
	NMNL1(17%)	54.69	209.03	210.82	1.79	56.02	67.2
	NMNL1(16%)	51.47	209.03	210.79	1.76	53.88	66.87
	NMNL1(15%)	48.26	209.03	210.76	1.73	51.7	66.53
	NMNL2(100%)	148.4	209.03	211.55	2.52	107.91	74.99
	NMNL2(30%)	44.52	209.03	210.72	1.69	49.01	66.11
	NMNL2(29%)	43.04	209.03	210.7	1.67	47.94	65.94
	NMNL2(28%)	41.55	209.03	210.68	1.65	46.84	65.76
	NMNL2(27%)	40.07	209.03	210.67	1.64	45.73	65.59
	NMNL2(26%)	38.58	209.03	210.65	1.62	44.58	65.41
	NMNL2(25%)	37.1	209.03	210.63	1.6	43.41	65.22
	NMNL2(24%)	35.62	209.03	210.61	1.58	42.2	65.03
	NMNL2(23%)	34.13	209.03	210.59	1.56	40.88	64.82
	NMNL2(22%)	32.65	209.03	210.57	1.54	39.51	64.6
	NMNL2(21%)	31.16	209.03	210.54	1.51	37.8	64.33
	NMNL2(20%)	29.68	209.03	210.52	1.49	36.06	59.25
	NMNL2(19%)	28.2	209.03	210.49	1.46	34.68	58.04
	NMNL2(18%)	26.71	209.03	210.47	1.44	33.29	56.96
	NMNL2(17%)	25.23	209.03	210.44	1.41	31.89	55.86
	NMNL2(16%)	23.74	209.03	210.42	1.39	30.45	54.7
	NMNL2(15%)	22.26	209.03	210.39	1.36	29	53.51
	L(100%)	461.12	209.03	212.96	3.93	224.17	89.89
	L(30%)	138.34	209.03	211.49	2.46	102.96	74.23
	L(29%)	133.72	209.03	211.45	2.42	100.65	73.88
	L(28%)	129.11	209.03	211.42	2.39	98.32	73.52
	L(27%)	124.5	209.03	211.39	2.36	95.97	73.19
	L(26%)	119.89	209.03	211.36	2.33	93.6	72.84
	L(25%)	115.28	209.03	211.33	2.3	91.19	72.49
	L(24%)	110.67	209.03	211.29	2.26	88.75	72.13
	L(23%)	106.06	209.03	211.26	2.23	86.29	71.77
	L(22%)	101.45	209.03	211.22	2.19	83.79	71.4
	L(21%)	96.84	209.03	211.19	2.16	81.25	71.02
	L(20%)	92.22	209.03	211.15	2.12	78.67	70.64
	L(19%)	87.61	209.03	211.11	2.08	76.07	70.25
	L(18%)	83	209.03	211.08	2.05	73.42	69.86
	L(17%)	78.39	209.03	211.04	2.01	70.72	69.45
	L(16%)	73.78	209.03	211	1.97	67.98	69.04
	L(15%)	69.17	209.03	210.96	1.93	65.19	68.61
730 m D/S of Dam axis	M(100%)	737.78	208.83	213.57	4.74	303.3	97.85
	M(30%)	221.33	208.83	211.8	2.97	142.79	81.81
	M(29%)	213.96	208.83	211.76	2.93	139.67	81.28

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M(28%)	206.58	208.83	211.72	2.89	136.48	80.73
	M(27%)	199.2	208.83	211.68	2.85	133.19	80.17
	M(26%)	191.82	208.83	211.64	2.81	129.81	79.59
	M(25%)	184.45	208.83	211.59	2.76	126.29	78.97
	M(24%)	177.07	208.83	211.55	2.72	122.62	78.33
	M(23%)	169.69	208.83	211.5	2.67	119.08	77.75
	M(22%)	162.31	208.83	211.45	2.62	115.51	77.15
	M(21%)	154.93	208.83	211.41	2.58	111.89	76.54
	M(20%)	147.56	208.83	211.36	2.53	108.22	75.92
	M(19%)	140.18	208.83	211.31	2.48	104.51	75.29
	M(18%)	132.8	208.83	211.26	2.43	100.74	74.67
	M(17%)	125.42	208.83	211.21	2.38	96.91	74.05
	M(16%)	118.04	208.83	211.16	2.33	93.01	73.42
	M(15%)	110.67	208.83	211.1	2.27	89.03	72.77
	NMNL1(100%)	321.71	208.83	212.25	3.42	180.81	86.88
	NMNL1(30%)	96.51	208.83	210.99	2.16	81.16	71.48
	NMNL1(29%)	93.3	208.83	210.97	2.14	79.34	71.18
	NMNL1(28%)	90.08	208.83	210.94	2.11	77.48	70.87
	NMNL1(27%)	86.86	208.83	210.91	2.08	75.61	70.55
	NMNL1(26%)	83.64	208.83	210.89	2.06	73.71	70.24
	NMNL1(25%)	80.43	208.83	210.86	2.03	71.81	69.91
	NMNL1(24%)	77.21	208.83	210.83	2	69.88	69.59
	NMNL1(23%)	73.99	208.83	210.8	1.97	67.92	69.25
	NMNL1(22%)	70.78	208.83	210.78	1.95	65.95	68.91
	NMNL1(21%)	67.56	208.83	210.75	1.92	63.94	68.57
	NMNL1(20%)	64.34	208.83	210.72	1.89	61.91	68.22
	NMNL1(19%)	61.12	208.83	210.69	1.86	59.85	67.87
	NMNL1(18%)	57.91	208.83	210.66	1.83	57.77	67.51
	NMNL1(17%)	54.69	208.83	210.62	1.79	55.64	67.14
	NMNL1(16%)	51.47	208.83	210.59	1.76	53.47	66.76
	NMNL1(15%)	48.26	208.83	210.56	1.73	51.26	66.38
	NMNL2(100%)	148.4	208.83	211.36	2.53	108.64	75.99
	NMNL2(30%)	44.52	208.83	210.51	1.68	48.4	65.88
	NMNL2(29%)	43.04	208.83	210.5	1.67	47.26	65.69
	NMNL2(28%)	41.55	208.83	210.48	1.65	46.08	65.48
	NMNL2(27%)	40.07	208.83	210.46	1.63	44.87	65.26
	NMNL2(26%)	38.58	208.83	210.44	1.61	43.58	65.04
	NMNL2(25%)	37.1	208.83	210.42	1.59	42.22	64.8
	NMNL2(24%)	35.62	208.83	210.4	1.57	40.73	64.53
	NMNL2(23%)	34.13	208.83	210.37	1.54	38.89	64.2
	NMNL2(22%)	32.65	208.83	210.34	1.51	37.43	58.97
	NMNL2(21%)	31.16	208.83	210.32	1.49	36.04	57.86
	NMNL2(20%)	29.68	208.83	210.3	1.47	34.66	56.83
	NMNL2(19%)	28.2	208.83	210.27	1.44	33.25	55.77

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL2(18%)	26.71	208.83	210.25	1.42	31.82	54.66
	NMNL2(17%)	25.23	208.83	210.22	1.39	30.37	53.52
	NMNL2(16%)	23.74	208.83	210.19	1.36	28.87	52.19
	NMNL2(15%)	22.26	208.83	210.16	1.33	27.39	50.41
	L(100%)	461.12	208.83	212.76	3.93	226.33	91.54
	L(30%)	138.34	208.83	211.3	2.47	103.57	75.13
	L(29%)	133.72	208.83	211.27	2.44	101.21	74.74
	L(28%)	129.11	208.83	211.23	2.4	98.83	74.36
	L(27%)	124.5	208.83	211.2	2.37	96.43	73.97
	L(26%)	119.89	208.83	211.17	2.34	93.99	73.58
	L(25%)	115.28	208.83	211.14	2.31	91.53	73.18
	L(24%)	110.67	208.83	211.1	2.27	89.03	72.77
	L(23%)	106.06	208.83	211.07	2.24	86.51	72.36
	L(22%)	101.45	208.83	211.03	2.2	83.95	71.94
	L(21%)	96.84	208.83	210.99	2.16	81.35	71.51
	L(20%)	92.22	208.83	210.96	2.13	78.72	71.07
	L(19%)	87.61	208.83	210.92	2.09	76.05	70.63
	L(18%)	83	208.83	210.88	2.05	73.34	70.17
	L(17%)	78.39	208.83	210.84	2.01	70.59	69.71
	L(16%)	73.78	208.83	210.8	1.97	67.79	69.23
	L(15%)	69.17	208.83	210.76	1.93	64.95	68.74
830 m D/S of Dam axis	M(100%)	737.78	208.63	213.36	4.73	305.66	99.16
	M(30%)	221.33	208.63	211.62	2.99	144.42	83.75
	M(29%)	213.96	208.63	211.58	2.95	141.27	83.13
	M(28%)	206.58	208.63	211.54	2.91	138.04	82.48
	M(27%)	199.2	208.63	211.5	2.87	134.7	81.81
	M(26%)	191.82	208.63	211.46	2.83	131.25	81.1
	M(25%)	184.45	208.63	211.41	2.78	127.61	80.36
	M(24%)	177.07	208.63	211.36	2.73	123.78	79.59
	M(23%)	169.69	208.63	211.32	2.69	120.14	78.92
	M(22%)	162.31	208.63	211.27	2.64	116.48	78.23
	M(21%)	154.93	208.63	211.22	2.59	112.76	77.53
	M(20%)	147.56	208.63	211.17	2.54	109.01	76.82
	M(19%)	140.18	208.63	211.12	2.49	105.21	76.11
	M(18%)	132.8	208.63	211.07	2.44	101.34	75.41
	M(17%)	125.42	208.63	211.02	2.39	97.41	74.69
	M(16%)	118.04	208.63	210.97	2.34	93.41	73.96
	M(15%)	110.67	208.63	210.91	2.28	89.33	73.22
	NMNL1(100%)	321.71	208.63	212.06	3.43	182.72	88.8
	NMNL1(30%)	96.51	208.63	210.8	2.17	81.25	71.73
	NMNL1(29%)	93.3	208.63	210.77	2.14	79.38	71.38
	NMNL1(28%)	90.08	208.63	210.75	2.12	77.47	71.02
	NMNL1(27%)	86.86	208.63	210.72	2.09	75.54	70.66

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL1(26%)	83.64	208.63	210.69	2.06	73.6	70.29
	NMNL1(25%)	80.43	208.63	210.66	2.03	71.64	69.91
	NMNL1(24%)	77.21	208.63	210.64	2.01	69.66	69.54
	NMNL1(23%)	73.99	208.63	210.61	1.98	67.65	69.15
	NMNL1(22%)	70.78	208.63	210.58	1.95	65.63	68.76
	NMNL1(21%)	67.56	208.63	210.55	1.92	63.58	68.36
	NMNL1(20%)	64.34	208.63	210.52	1.89	61.5	67.97
	NMNL1(19%)	61.12	208.63	210.49	1.86	59.39	67.56
	NMNL1(18%)	57.91	208.63	210.45	1.82	57.25	67.15
	NMNL1(17%)	54.69	208.63	210.42	1.79	55.07	66.73
	NMNL1(16%)	51.47	208.63	210.39	1.76	52.84	66.3
	NMNL1(15%)	48.26	208.63	210.35	1.72	50.55	65.85
	NMNL2(100%)	148.4	208.63	211.18	2.55	109.44	76.9
	NMNL2(30%)	44.52	208.63	210.3	1.67	47.19	65.18
	NMNL2(29%)	43.04	208.63	210.28	1.65	45.85	64.92
	NMNL2(28%)	41.55	208.63	210.26	1.63	44.39	64.63
	NMNL2(27%)	40.07	208.63	210.23	1.6	42.79	64.3
	NMNL2(26%)	38.58	208.63	210.21	1.58	40.95	63.93
	NMNL2(25%)	37.1	208.63	210.18	1.55	39.43	58.65
	NMNL2(24%)	35.62	208.63	210.16	1.53	37.99	57.1
	NMNL2(23%)	34.13	208.63	210.13	1.5	36.58	55.49
	NMNL2(22%)	32.65	208.63	210.11	1.48	35.2	53.98
	NMNL2(21%)	31.16	208.63	210.08	1.45	33.85	52.44
	NMNL2(20%)	29.68	208.63	210.05	1.42	32.52	50.9
	NMNL2(19%)	28.2	208.63	210.03	1.4	31.23	49.35
	NMNL2(18%)	26.71	208.63	210	1.37	29.96	47.78
	NMNL2(17%)	25.23	208.63	209.98	1.35	28.76	46.24
	NMNL2(16%)	23.74	208.63	209.95	1.32	27.6	44.73
	NMNL2(15%)	22.26	208.63	209.93	1.3	26.46	44.28
	L(100%)	461.12	208.63	212.56	3.93	228.53	93.21
	L(30%)	138.34	208.63	211.11	2.48	104.25	75.94
	L(29%)	133.72	208.63	211.08	2.45	101.83	75.5
	L(28%)	129.11	208.63	211.05	2.42	99.39	75.05
	L(27%)	124.5	208.63	211.01	2.38	96.92	74.6
	L(26%)	119.89	208.63	210.98	2.35	94.42	74.14
	L(25%)	115.28	208.63	210.95	2.32	91.9	73.68
	L(24%)	110.67	208.63	210.91	2.28	89.33	73.22
	L(23%)	106.06	208.63	210.88	2.25	86.74	72.74
	L(22%)	101.45	208.63	210.84	2.21	84.11	72.26
	L(21%)	96.84	208.63	210.8	2.17	81.44	71.76
	L(20%)	92.22	208.63	210.76	2.13	78.74	71.26
	L(19%)	87.61	208.63	210.73	2.1	75.99	70.74
	L(18%)	83	208.63	210.69	2.06	73.21	70.21
	L(17%)	78.39	208.63	210.65	2.02	70.39	69.67

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L(16%)	73.78	208.63	210.6	1.97	67.52	69.13
	L(15%)	69.17	208.63	210.56	1.93	64.61	68.56
930 m D/S of Dam axis	M(100%)	737.78	208.42	213.16	4.74	308.13	100.35
	M(30%)	221.33	208.42	211.43	3.01	146.1	85.93
	M(29%)	213.96	208.42	211.4	2.98	142.96	85.17
	M(28%)	206.58	208.42	211.36	2.94	139.7	84.38
	M(27%)	199.2	208.42	211.32	2.9	136.34	83.56
	M(26%)	191.82	208.42	211.28	2.86	132.83	82.68
	M(25%)	184.45	208.42	211.23	2.81	129.08	81.75
	M(24%)	177.07	208.42	211.18	2.76	125.07	80.81
	M(23%)	169.69	208.42	211.13	2.71	121.33	80.02
	M(22%)	162.31	208.42	211.09	2.67	117.57	79.22
	M(21%)	154.93	208.42	211.04	2.62	113.76	78.4
	M(20%)	147.56	208.42	210.99	2.57	109.93	77.58
	M(19%)	140.18	208.42	210.94	2.52	106.04	76.78
	M(18%)	132.8	208.42	210.89	2.47	102.08	75.96
	M(17%)	125.42	208.42	210.83	2.41	98.06	75.13
	M(16%)	118.04	208.42	210.78	2.36	93.95	74.29
	M(15%)	110.67	208.42	210.72	2.3	89.76	73.43
	NMNL1(100%)	321.71	208.42	211.87	3.45	184.66	90.7
	NMNL1(30%)	96.51	208.42	210.61	2.19	81.44	71.68
	NMNL1(29%)	93.3	208.42	210.58	2.16	79.51	71.27
	NMNL1(28%)	90.08	208.42	210.55	2.13	77.54	70.85
	NMNL1(27%)	86.86	208.42	210.53	2.11	75.55	70.42
	NMNL1(26%)	83.64	208.42	210.5	2.08	73.55	69.99
	NMNL1(25%)	80.43	208.42	210.47	2.05	71.53	69.55
	NMNL1(24%)	77.21	208.42	210.44	2.02	69.48	69.12
	NMNL1(23%)	73.99	208.42	210.41	1.99	67.41	68.68
	NMNL1(22%)	70.78	208.42	210.38	1.96	65.31	68.23
	NMNL1(21%)	67.56	208.42	210.35	1.93	63.19	67.77
	NMNL1(20%)	64.34	208.42	210.31	1.89	61.03	67.3
	NMNL1(19%)	61.12	208.42	210.28	1.86	58.83	66.82
	NMNL1(18%)	57.91	208.42	210.25	1.83	56.6	66.33
	NMNL1(17%)	54.69	208.42	210.21	1.79	54.3	65.82
	NMNL1(16%)	51.47	208.42	210.18	1.76	51.93	65.28
	NMNL1(15%)	48.26	208.42	210.14	1.72	49.46	64.6
	NMNL2(100%)	148.4	208.42	211	2.58	110.37	77.67
	NMNL2(30%)	44.52	208.42	210.06	1.64	44.64	62.64
	NMNL2(29%)	43.04	208.42	210.03	1.61	42.75	57.37
	NMNL2(28%)	41.55	208.42	210.01	1.59	41.3	55.66
	NMNL2(27%)	40.07	208.42	209.98	1.56	39.96	53.68
	NMNL2(26%)	38.58	208.42	209.96	1.54	38.69	51.75
	NMNL2(25%)	37.1	208.42	209.94	1.52	37.52	49.94

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL2(24%)	35.62	208.42	209.91	1.49	36.43	48.18
	NMNL2(23%)	34.13	208.42	209.89	1.47	35.38	47.41
	NMNL2(22%)	32.65	208.42	209.87	1.45	34.34	47.11
	NMNL2(21%)	31.16	208.42	209.85	1.43	33.28	46.8
	NMNL2(20%)	29.68	208.42	209.82	1.4	32.21	46.49
	NMNL2(19%)	28.2	208.42	209.8	1.38	31.14	46.17
	NMNL2(18%)	26.71	208.42	209.78	1.36	30.03	45.84
	NMNL2(17%)	25.23	208.42	209.75	1.33	28.92	45.51
	NMNL2(16%)	23.74	208.42	209.73	1.31	27.78	45.13
	NMNL2(15%)	22.26	208.42	209.7	1.28	26.63	44.75
	L(100%)	461.12	208.42	212.37	3.95	230.76	94.89
	L(30%)	138.34	208.42	210.93	2.51	105.06	76.58
	L(29%)	133.72	208.42	210.89	2.47	102.57	76.06
	L(28%)	129.11	208.42	210.86	2.44	100.08	75.54
	L(27%)	124.5	208.42	210.83	2.41	97.55	75.03
	L(26%)	119.89	208.42	210.79	2.37	94.99	74.5
	L(25%)	115.28	208.42	210.76	2.34	92.39	73.97
	L(24%)	110.67	208.42	210.72	2.3	89.76	73.43
	L(23%)	106.06	208.42	210.69	2.27	87.1	72.87
	L(22%)	101.45	208.42	210.65	2.23	84.39	72.31
	L(21%)	96.84	208.42	210.61	2.19	81.64	71.73
	L(20%)	92.22	208.42	210.57	2.15	78.85	71.13
	L(19%)	87.61	208.42	210.53	2.11	76.02	70.52
	L(18%)	83	208.42	210.49	2.07	73.15	69.9
	L(17%)	78.39	208.42	210.45	2.03	70.24	69.28
	L(16%)	73.78	208.42	210.41	1.99	67.27	68.65
	L(15%)	69.17	208.42	210.36	1.94	64.26	68
1030 m D/S of Dam axis	M(100%)	737.78	208.22	212.95	4.73	310.69	101.84
	M(30%)	221.33	208.22	211.25	3.03	147.82	88.23
	M(29%)	213.96	208.22	211.22	3	144.72	87.59
	M(28%)	206.58	208.22	211.18	2.96	141.5	86.59
	M(27%)	199.2	208.22	211.14	2.92	138.14	85.53
	M(26%)	191.82	208.22	211.1	2.88	134.6	84.41
	M(25%)	184.45	208.22	211.05	2.83	130.77	83.17
	M(24%)	177.07	208.22	211	2.78	126.57	82.01
	M(23%)	169.69	208.22	210.96	2.74	122.74	81.08
	M(22%)	162.31	208.22	210.91	2.69	118.9	80.13
	M(21%)	154.93	208.22	210.86	2.64	115.02	79.16
	M(20%)	147.56	208.22	210.81	2.59	111.12	78.23
	M(19%)	140.18	208.22	210.76	2.54	107.15	77.26
	M(18%)	132.8	208.22	210.71	2.49	103.13	76.32
	M(17%)	125.42	208.22	210.65	2.43	99.02	75.36
	M(16%)	118.04	208.22	210.6	2.38	94.83	74.37

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M(15%)	110.67	208.22	210.54	2.32	90.54	73.34
	NMNL1(100%)	321.71	208.22	211.68	3.46	186.68	92.57
	NMNL1(30%)	96.51	208.22	210.42	2.2	82.01	71.28
	NMNL1(29%)	93.3	208.22	210.39	2.17	80.02	70.81
	NMNL1(28%)	90.08	208.22	210.36	2.14	77.98	70.32
	NMNL1(27%)	86.86	208.22	210.33	2.11	75.94	69.83
	NMNL1(26%)	83.64	208.22	210.31	2.09	73.86	69.33
	NMNL1(25%)	80.43	208.22	210.27	2.05	71.77	68.82
	NMNL1(24%)	77.21	208.22	210.24	2.02	69.65	68.3
	NMNL1(23%)	73.99	208.22	210.21	1.99	67.49	67.77
	NMNL1(22%)	70.78	208.22	210.18	1.96	65.31	67.23
	NMNL1(21%)	67.56	208.22	210.15	1.93	63.08	66.67
	NMNL1(20%)	64.34	208.22	210.11	1.89	60.81	65.98
	NMNL1(19%)	61.12	208.22	210.08	1.86	58.51	65
	NMNL1(18%)	57.91	208.22	210.04	1.82	56.19	64.18
	NMNL1(17%)	54.69	208.22	210	1.78	53.79	63.32
	NMNL1(16%)	51.47	208.22	209.96	1.74	51.31	62.42
	NMNL1(15%)	48.26	208.22	209.92	1.7	48.67	61.45
	NMNL2(100%)	148.4	208.22	210.82	2.6	111.57	78.33
	NMNL2(30%)	44.52	208.22	209.83	1.61	43.57	49.67
	NMNL2(29%)	43.04	208.22	209.81	1.59	42.52	49.39
	NMNL2(28%)	41.55	208.22	209.79	1.57	41.47	49.11
	NMNL2(27%)	40.07	208.22	209.77	1.55	40.43	48.85
	NMNL2(26%)	38.58	208.22	209.75	1.53	39.37	48.58
	NMNL2(25%)	37.1	208.22	209.72	1.5	38.31	48.31
	NMNL2(24%)	35.62	208.22	209.7	1.48	37.23	48.03
	NMNL2(23%)	34.13	208.22	209.68	1.46	36.14	47.75
	NMNL2(22%)	32.65	208.22	209.66	1.44	35.06	47.46
	NMNL2(21%)	31.16	208.22	209.63	1.41	33.95	47.17
	NMNL2(20%)	29.68	208.22	209.61	1.39	32.83	46.88
	NMNL2(19%)	28.2	208.22	209.58	1.36	31.71	46.56
	NMNL2(18%)	26.71	208.22	209.56	1.34	30.56	46.22
	NMNL2(17%)	25.23	208.22	209.53	1.31	29.4	45.89
	NMNL2(16%)	23.74	208.22	209.51	1.29	28.22	45.54
	NMNL2(15%)	22.26	208.22	209.48	1.26	27.02	45.19
	L(100%)	461.12	208.22	212.17	3.95	233.06	96.58
	L(30%)	138.34	208.22	210.75	2.53	106.16	77.02
	L(29%)	133.72	208.22	210.71	2.49	103.63	76.43
	L(28%)	129.11	208.22	210.68	2.46	101.08	75.84
	L(27%)	124.5	208.22	210.65	2.43	98.51	75.24
	L(26%)	119.89	208.22	210.61	2.39	95.89	74.62
	L(25%)	115.28	208.22	210.58	2.36	93.23	73.99
	L(24%)	110.67	208.22	210.54	2.32	90.54	73.34
	L(23%)	106.06	208.22	210.5	2.28	87.81	72.69

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L(22%)	101.45	208.22	210.46	2.24	85.04	72.02
	L(21%)	96.84	208.22	210.42	2.2	82.22	71.33
	L(20%)	92.22	208.22	210.38	2.16	79.34	70.64
	L(19%)	87.61	208.22	210.34	2.12	76.42	69.95
	L(18%)	83	208.22	210.3	2.08	73.45	69.23
	L(17%)	78.39	208.22	210.26	2.04	70.43	68.5
	L(16%)	73.78	208.22	210.21	1.99	67.35	67.74
	L(15%)	69.17	208.22	210.16	1.94	64.2	66.95
1130 m D/S of Dam axis	M(100%)	737.78	208.02	212.75	4.73	313.3	103.35
	M(30%)	221.33	208.02	211.07	3.05	149.68	90.1
	M(29%)	213.96	208.02	211.04	3.02	146.55	89.75
	M(28%)	206.58	208.02	211	2.98	143.36	89.39
	M(27%)	199.2	208.02	210.97	2.95	140.08	88.11
	M(26%)	191.82	208.02	210.93	2.91	136.6	86.52
	M(25%)	184.45	208.02	210.88	2.86	132.77	84.76
	M(24%)	177.07	208.02	210.83	2.81	128.39	83.21
	M(23%)	169.69	208.02	210.78	2.76	124.5	82.07
	M(22%)	162.31	208.02	210.73	2.71	120.61	80.92
	M(21%)	154.93	208.02	210.69	2.67	116.69	79.8
	M(20%)	147.56	208.02	210.64	2.62	112.77	78.67
	M(19%)	140.18	208.02	210.59	2.57	108.78	77.58
	M(18%)	132.8	208.02	210.53	2.51	104.72	76.47
	M(17%)	125.42	208.02	210.48	2.46	100.58	75.33
	M(16%)	118.04	208.02	210.42	2.4	96.36	74.15
	M(15%)	110.67	208.02	210.36	2.34	92.04	72.93
	NMNL1(100%)	321.71	208.02	211.5	3.48	188.79	94.41
	NMNL1(30%)	96.51	208.02	210.24	2.22	83.41	70.58
	NMNL1(29%)	93.3	208.02	210.21	2.19	81.37	70.01
	NMNL1(28%)	90.08	208.02	210.18	2.16	79.29	69.43
	NMNL1(27%)	86.86	208.02	210.15	2.13	77.2	68.84
	NMNL1(26%)	83.64	208.02	210.12	2.1	75.08	68.24
	NMNL1(25%)	80.43	208.02	210.09	2.07	72.95	67.58
	NMNL1(24%)	77.21	208.02	210.06	2.04	70.78	66.64
	NMNL1(23%)	73.99	208.02	210.03	2.01	68.6	65.92
	NMNL1(22%)	70.78	208.02	209.99	1.97	66.4	65.19
	NMNL1(21%)	67.56	208.02	209.96	1.94	64.17	64.44
	NMNL1(20%)	64.34	208.02	209.92	1.9	61.9	63.66
	NMNL1(19%)	61.12	208.02	209.89	1.87	59.59	62.86
	NMNL1(18%)	57.91	208.02	209.85	1.83	57.22	62.03
	NMNL1(17%)	54.69	208.02	209.81	1.79	54.75	60.91
	NMNL1(16%)	51.47	208.02	209.77	1.75	52.24	58.89
	NMNL1(15%)	48.26	208.02	209.72	1.7	49.73	56.82
	NMNL2(100%)	148.4	208.02	210.64	2.62	113.22	78.8

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL2(30%)	44.52	208.02	209.65	1.63	45.91	50.21
	NMNL2(29%)	43.04	208.02	209.63	1.61	44.79	49.95
	NMNL2(28%)	41.55	208.02	209.6	1.58	43.66	49.68
	NMNL2(27%)	40.07	208.02	209.58	1.56	42.55	49.42
	NMNL2(26%)	38.58	208.02	209.56	1.54	41.42	49.16
	NMNL2(25%)	37.1	208.02	209.54	1.52	40.29	48.89
	NMNL2(24%)	35.62	208.02	209.51	1.49	39.13	48.62
	NMNL2(23%)	34.13	208.02	209.49	1.47	37.95	48.34
	NMNL2(22%)	32.65	208.02	209.46	1.44	36.79	48.05
	NMNL2(21%)	31.16	208.02	209.44	1.42	35.6	47.75
	NMNL2(20%)	29.68	208.02	209.41	1.39	34.41	47.45
	NMNL2(19%)	28.2	208.02	209.39	1.37	33.2	47.13
	NMNL2(18%)	26.71	208.02	209.36	1.34	31.97	46.81
	NMNL2(17%)	25.23	208.02	209.34	1.32	30.74	46.49
	NMNL2(16%)	23.74	208.02	209.31	1.29	29.47	46.16
	NMNL2(15%)	22.26	208.02	209.28	1.26	28.18	45.81
	L(100%)	461.12	208.02	211.98	3.96	235.42	98.27
	L(30%)	138.34	208.02	210.57	2.55	107.78	77.3
	L(29%)	133.72	208.02	210.54	2.52	105.23	76.61
	L(28%)	129.11	208.02	210.51	2.49	102.67	75.91
	L(27%)	124.5	208.02	210.47	2.45	100.07	75.19
	L(26%)	119.89	208.02	210.44	2.42	97.43	74.45
	L(25%)	115.28	208.02	210.4	2.38	94.75	73.7
	L(24%)	110.67	208.02	210.36	2.34	92.04	72.93
	L(23%)	106.06	208.02	210.32	2.3	89.28	72.17
	L(22%)	101.45	208.02	210.29	2.27	86.47	71.42
	L(21%)	96.84	208.02	210.25	2.23	83.61	70.63
	L(20%)	92.22	208.02	210.2	2.18	80.68	69.82
	L(19%)	87.61	208.02	210.16	2.14	77.69	68.98
	L(18%)	83	208.02	210.12	2.1	74.66	68.12
	L(17%)	78.39	208.02	210.07	2.05	71.57	66.96
	L(16%)	73.78	208.02	210.02	2	68.46	65.88
	L(15%)	69.17	208.02	209.98	1.96	65.29	64.81
1340 m D/S of Dam axis	M(100%)	737.78	207.57	212.32	4.75	319.24	106.72
	M(30%)	221.33	207.57	210.69	3.12	154.79	94.2
	M(29%)	213.96	207.57	210.66	3.09	151.61	93.86
	M(28%)	206.58	207.57	210.62	3.05	148.36	93.5
	M(27%)	199.2	207.57	210.59	3.02	145.03	93.13
	M(26%)	191.82	207.57	210.55	2.98	141.62	92.75
	M(25%)	184.45	207.57	210.51	2.94	138.07	92.36
	M(24%)	177.07	207.57	210.47	2.9	134.22	86.25
	M(23%)	169.69	207.57	210.43	2.86	130.46	84.3
	M(22%)	162.31	207.57	210.38	2.81	126.82	82.37

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M(21%)	154.93	207.57	210.34	2.77	123.19	80.65
	M(20%)	147.56	207.57	210.29	2.72	119.54	79.06
	M(19%)	140.18	207.57	210.24	2.67	115.86	77.42
	M(18%)	132.8	207.57	210.2	2.63	112.13	75.76
	M(17%)	125.42	207.57	210.15	2.58	108.36	74.28
	M(16%)	118.04	207.57	210.09	2.52	104.49	72.73
	M(15%)	110.67	207.57	210.04	2.47	100.54	71.11
	NMNL1(100%)	321.71	207.57	211.1	3.53	194.14	98.41
	NMNL1(30%)	96.51	207.57	209.92	2.35	92.58	68.5
	NMNL1(29%)	93.3	207.57	209.9	2.33	90.67	67.93
	NMNL1(28%)	90.08	207.57	209.87	2.3	88.7	67.34
	NMNL1(27%)	86.86	207.57	209.84	2.27	86.73	66.75
	NMNL1(26%)	83.64	207.57	209.81	2.24	84.73	66.14
	NMNL1(25%)	80.43	207.57	209.78	2.21	82.73	65.52
	NMNL1(24%)	77.21	207.57	209.75	2.18	80.68	64.88
	NMNL1(23%)	73.99	207.57	209.71	2.14	78.61	64.23
	NMNL1(22%)	70.78	207.57	209.68	2.11	76.53	63.6
	NMNL1(21%)	67.56	207.57	209.65	2.08	74.41	62.97
	NMNL1(20%)	64.34	207.57	209.61	2.04	72.24	62.33
	NMNL1(19%)	61.12	207.57	209.58	2.01	70.03	61.67
	NMNL1(18%)	57.91	207.57	209.54	1.97	67.78	60.99
	NMNL1(17%)	54.69	207.57	209.5	1.93	65.49	60.29
	NMNL1(16%)	51.47	207.57	209.46	1.89	63.15	59.57
	NMNL1(15%)	48.26	207.57	209.42	1.85	60.76	58.82
	NMNL2(100%)	148.4	207.57	210.3	2.73	119.96	79.24
	NMNL2(30%)	44.52	207.57	209.37	1.8	57.93	57.92
	NMNL2(29%)	43.04	207.57	209.35	1.78	56.78	57.55
	NMNL2(28%)	41.55	207.57	209.33	1.76	55.58	52.28
	NMNL2(27%)	40.07	207.57	209.31	1.74	54.37	52.03
	NMNL2(26%)	38.58	207.57	209.28	1.71	53.13	51.78
	NMNL2(25%)	37.1	207.57	209.26	1.69	51.88	51.53
	NMNL2(24%)	35.62	207.57	209.24	1.67	50.59	51.27
	NMNL2(23%)	34.13	207.57	209.21	1.64	49.27	51
	NMNL2(22%)	32.65	207.57	209.18	1.61	47.99	50.73
	NMNL2(21%)	31.16	207.57	209.16	1.59	46.69	50.46
	NMNL2(20%)	29.68	207.57	209.13	1.56	45.38	50.19
	NMNL2(19%)	28.2	207.57	209.11	1.54	44.07	49.92
	NMNL2(18%)	26.71	207.57	209.08	1.51	42.73	49.63
	NMNL2(17%)	25.23	207.57	209.05	1.48	41.38	49.35
	NMNL2(16%)	23.74	207.57	209.02	1.45	39.98	49.05
	NMNL2(15%)	22.26	207.57	208.99	1.42	38.54	48.74
	L(100%)	461.12	207.57	211.57	4	241.1	101.98
	L(30%)	138.34	207.57	210.23	2.66	114.94	77.01
	L(29%)	133.72	207.57	210.2	2.63	112.6	75.94

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L(28%)	129.11	207.57	210.17	2.6	110.26	75.03
	L(27%)	124.5	207.57	210.14	2.57	107.88	74.09
	L(26%)	119.89	207.57	210.11	2.54	105.47	73.12
	L(25%)	115.28	207.57	210.07	2.5	103.02	72.13
	L(24%)	110.67	207.57	210.04	2.47	100.54	71.11
	L(23%)	106.06	207.57	210	2.43	98.01	70.08
	L(22%)	101.45	207.57	209.96	2.39	95.42	69.34
	L(21%)	96.84	207.57	209.93	2.36	92.77	68.56
	L(20%)	92.22	207.57	209.89	2.32	90.01	67.74
	L(19%)	87.61	207.57	209.84	2.27	87.2	66.89
	L(18%)	83	207.57	209.8	2.23	84.34	66.02
	L(17%)	78.39	207.57	209.76	2.19	81.44	65.12
	L(16%)	73.78	207.57	209.71	2.14	78.48	64.19
	L(15%)	69.17	207.57	209.66	2.09	75.47	63.29
1440 m D/S of Dam axis	M(100%)	737.78	207.59	212.06	4.47	296.25	102.94
	M(30%)	221.33	207.59	210.49	2.9	144.53	89.96
	M(29%)	213.96	207.59	210.46	2.87	141.61	89.37
	M(28%)	206.58	207.59	210.43	2.84	138.66	88.74
	M(27%)	199.2	207.59	210.39	2.8	135.67	88.1
	M(26%)	191.82	207.59	210.36	2.77	132.63	87.45
	M(25%)	184.45	207.59	210.32	2.73	129.55	86.79
	M(24%)	177.07	207.59	210.29	2.7	126.39	86.1
	M(23%)	169.69	207.59	210.25	2.66	123.01	84.47
	M(22%)	162.31	207.59	210.21	2.62	119.66	83.29
	M(21%)	154.93	207.59	210.17	2.58	116.28	82.08
	M(20%)	147.56	207.59	210.12	2.53	112.87	80.84
	M(19%)	140.18	207.59	210.08	2.49	109.4	79.56
	M(18%)	132.8	207.59	210.04	2.45	105.88	78.33
	M(17%)	125.42	207.59	209.99	2.4	102.32	77.13
	M(16%)	118.04	207.59	209.94	2.35	98.67	75.33
	M(15%)	110.67	207.59	209.89	2.3	94.94	73.43
	NMNL1(100%)	321.71	207.59	210.89	3.3	180.6	93.83
	NMNL1(30%)	96.51	207.59	209.79	2.2	87.36	69.91
	NMNL1(29%)	93.3	207.59	209.76	2.17	85.51	69.02
	NMNL1(28%)	90.08	207.59	209.73	2.14	83.62	68.11
	NMNL1(27%)	86.86	207.59	209.71	2.12	81.71	67.43
	NMNL1(26%)	83.64	207.59	209.68	2.09	79.79	66.74
	NMNL1(25%)	80.43	207.59	209.65	2.06	77.86	66.05
	NMNL1(24%)	77.21	207.59	209.62	2.03	75.9	65.33
	NMNL1(23%)	73.99	207.59	209.59	2	73.92	64.6
	NMNL1(22%)	70.78	207.59	209.56	1.97	71.94	63.87
	NMNL1(21%)	67.56	207.59	209.52	1.93	69.92	63.11
	NMNL1(20%)	64.34	207.59	209.49	1.9	67.87	62.32

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL1(19%)	61.12	207.59	209.46	1.87	65.77	61.56
	NMNL1(18%)	57.91	207.59	209.42	1.83	63.65	60.78
	NMNL1(17%)	54.69	207.59	209.39	1.8	61.48	59.97
	NMNL1(16%)	51.47	207.59	209.35	1.76	59.28	59.14
	NMNL1(15%)	48.26	207.59	209.31	1.72	57.03	58.34
	NMNL2(100%)	148.4	207.59	210.13	2.54	113.26	80.99
	NMNL2(30%)	44.52	207.59	209.27	1.68	54.39	57.4
	NMNL2(29%)	43.04	207.59	209.25	1.66	53.31	57.01
	NMNL2(28%)	41.55	207.59	209.23	1.64	52.22	56.62
	NMNL2(27%)	40.07	207.59	209.21	1.62	51.11	56.22
	NMNL2(26%)	38.58	207.59	209.19	1.6	49.98	55.75
	NMNL2(25%)	37.1	207.59	209.17	1.58	48.8	53.67
	NMNL2(24%)	35.62	207.59	209.14	1.55	47.55	51.36
	NMNL2(23%)	34.13	207.59	209.12	1.53	46.27	50.7
	NMNL2(22%)	32.65	207.59	209.09	1.5	45.02	50.38
	NMNL2(21%)	31.16	207.59	209.07	1.48	43.78	50.06
	NMNL2(20%)	29.68	207.59	209.04	1.45	42.54	49.73
	NMNL2(19%)	28.2	207.59	209.02	1.43	41.3	49.39
	NMNL2(18%)	26.71	207.59	208.99	1.4	40.04	49.05
	NMNL2(17%)	25.23	207.59	208.97	1.38	38.77	48.71
	NMNL2(16%)	23.74	207.59	208.94	1.35	37.46	48.35
	NMNL2(15%)	22.26	207.59	208.91	1.32	36.11	47.97
	L(100%)	461.12	207.59	211.33	3.74	223.58	97.87
	L(30%)	138.34	207.59	210.07	2.48	108.53	79.24
	L(29%)	133.72	207.59	210.04	2.45	106.32	78.48
	L(28%)	129.11	207.59	210.01	2.42	104.11	77.74
	L(27%)	124.5	207.59	209.99	2.4	101.87	76.92
	L(26%)	119.89	207.59	209.96	2.37	99.6	75.79
	L(25%)	115.28	207.59	209.92	2.33	97.28	74.62
	L(24%)	110.67	207.59	209.89	2.3	94.94	73.43
	L(23%)	106.06	207.59	209.86	2.27	92.53	72.33
	L(22%)	101.45	207.59	209.83	2.24	90.07	71.19
	L(21%)	96.84	207.59	209.79	2.2	87.54	69.99
	L(20%)	92.22	207.59	209.75	2.16	84.88	68.72
	L(19%)	87.61	207.59	209.71	2.12	82.16	67.58
	L(18%)	83	207.59	209.67	2.08	79.41	66.6
	L(17%)	78.39	207.59	209.63	2.04	76.62	65.6
	L(16%)	73.78	207.59	209.59	2	73.79	64.56
	L(15%)	69.17	207.59	209.54	1.95	70.93	63.49
1540 m D/S of Dam axis	M(100%)	737.78	207.61	211.73	4.12	273.42	99.85
	M(30%)	221.33	207.61	210.25	2.64	133.98	87.16
	M(29%)	213.96	207.61	210.22	2.61	131.35	86.8
	M(28%)	206.58	207.61	210.19	2.58	128.69	86.44

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M(27%)	199.2	207.61	210.16	2.55	125.97	86.06
	M(26%)	191.82	207.61	210.13	2.52	123.19	85.68
	M(25%)	184.45	207.61	210.1	2.49	120.36	85.29
	M(24%)	177.07	207.61	210.06	2.45	117.43	84.88
	M(23%)	169.69	207.61	210.03	2.42	114.41	83.87
	M(22%)	162.31	207.61	209.99	2.38	111.38	83.01
	M(21%)	154.93	207.61	209.95	2.34	108.3	82.19
	M(20%)	147.56	207.61	209.91	2.3	105.18	81.35
	M(19%)	140.18	207.61	209.88	2.27	102	80.47
	M(18%)	132.8	207.61	209.83	2.22	98.75	79.55
	M(17%)	125.42	207.61	209.79	2.18	95.46	78.61
	M(16%)	118.04	207.61	209.75	2.14	92.07	77.64
	M(15%)	110.67	207.61	209.7	2.09	88.6	76.68
	NMNL1(100%)	321.71	207.61	210.62	3.01	166.82	91.41
	NMNL1(30%)	96.51	207.61	209.61	2	81.55	73.33
	NMNL1(29%)	93.3	207.61	209.59	1.98	79.78	72.31
	NMNL1(28%)	90.08	207.61	209.56	1.95	77.95	71.33
	NMNL1(27%)	86.86	207.61	209.54	1.93	76.11	70.34
	NMNL1(26%)	83.64	207.61	209.51	1.9	74.26	69.32
	NMNL1(25%)	80.43	207.61	209.48	1.87	72.4	68.29
	NMNL1(24%)	77.21	207.61	209.45	1.84	70.51	67.22
	NMNL1(23%)	73.99	207.61	209.43	1.82	68.61	66.38
	NMNL1(22%)	70.78	207.61	209.4	1.79	66.72	65.54
	NMNL1(21%)	67.56	207.61	209.37	1.76	64.81	64.66
	NMNL1(20%)	64.34	207.61	209.34	1.73	62.86	63.77
	NMNL1(19%)	61.12	207.61	209.31	1.7	60.88	62.83
	NMNL1(18%)	57.91	207.61	209.27	1.66	58.88	61.84
	NMNL1(17%)	54.69	207.61	209.24	1.63	56.85	60.87
	NMNL1(16%)	51.47	207.61	209.21	1.6	54.78	59.89
	NMNL1(15%)	48.26	207.61	209.17	1.56	52.69	58.87
	NMNL2(100%)	148.4	207.61	209.92	2.31	105.54	81.44
	NMNL2(30%)	44.52	207.61	209.13	1.52	50.25	57.84
	NMNL2(29%)	43.04	207.61	209.11	1.5	49.26	57.42
	NMNL2(28%)	41.55	207.61	209.09	1.48	48.24	57
	NMNL2(27%)	40.07	207.61	209.08	1.47	47.22	56.57
	NMNL2(26%)	38.58	207.61	209.06	1.45	46.17	56.12
	NMNL2(25%)	37.1	207.61	209.04	1.43	45.11	55.66
	NMNL2(24%)	35.62	207.61	209.02	1.41	44	54.96
	NMNL2(23%)	34.13	207.61	209	1.39	42.84	53.89
	NMNL2(22%)	32.65	207.61	208.98	1.37	41.68	52.78
	NMNL2(21%)	31.16	207.61	208.95	1.34	40.51	51.63
	NMNL2(20%)	29.68	207.61	208.93	1.32	39.33	50.44
	NMNL2(19%)	28.2	207.61	208.91	1.3	38.14	49.95
	NMNL2(18%)	26.71	207.61	208.88	1.27	36.95	49.51

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL2(17%)	25.23	207.61	208.86	1.25	35.78	49.05
	NMNL2(16%)	23.74	207.61	208.83	1.22	34.55	48.59
	NMNL2(15%)	22.26	207.61	208.81	1.2	33.3	48.12
	L(100%)	461.12	207.61	211.05	3.44	206.24	94.81
	L(30%)	138.34	207.61	209.87	2.26	101.19	80.25
	L(29%)	133.72	207.61	209.84	2.23	99.15	79.67
	L(28%)	129.11	207.61	209.81	2.2	97.12	79.09
	L(27%)	124.5	207.61	209.79	2.18	95.04	78.49
	L(26%)	119.89	207.61	209.76	2.15	92.93	77.88
	L(25%)	115.28	207.61	209.73	2.12	90.78	77.28
	L(24%)	110.67	207.61	209.7	2.09	88.6	76.68
	L(23%)	106.06	207.61	209.68	2.07	86.38	76.01
	L(22%)	101.45	207.61	209.65	2.04	84.1	74.81
	L(21%)	96.84	207.61	209.61	2	81.73	73.43
	L(20%)	92.22	207.61	209.58	1.97	79.17	71.98
	L(19%)	87.61	207.61	209.54	1.93	76.54	70.57
	L(18%)	83	207.61	209.5	1.89	73.89	69.12
	L(17%)	78.39	207.61	209.46	1.85	71.21	67.6
	L(16%)	73.78	207.61	209.42	1.81	68.49	66.33
	L(15%)	69.17	207.61	209.38	1.77	65.77	65.1
1640 m D/S of Dam axis	M(100%)	737.78	207.62	211.33	3.71	249.42	95.44
	M(30%)	221.33	207.62	209.94	2.32	122.2	87.14
	M(29%)	213.96	207.62	209.92	2.3	119.8	86.87
	M(28%)	206.58	207.62	209.89	2.27	117.33	86.6
	M(27%)	199.2	207.62	209.86	2.24	114.8	86.32
	M(26%)	191.82	207.62	209.83	2.21	112.22	85.81
	M(25%)	184.45	207.62	209.8	2.18	109.63	85.23
	M(24%)	177.07	207.62	209.77	2.15	106.99	84.66
	M(23%)	169.69	207.62	209.73	2.11	104.32	84.11
	M(22%)	162.31	207.62	209.7	2.08	101.6	83.54
	M(21%)	154.93	207.62	209.67	2.05	98.83	82.95
	M(20%)	147.56	207.62	209.64	2.02	96.01	82.35
	M(19%)	140.18	207.62	209.6	1.98	93.14	81.7
	M(18%)	132.8	207.62	209.56	1.94	90.19	81
	M(17%)	125.42	207.62	209.53	1.91	87.23	80.28
	M(16%)	118.04	207.62	209.49	1.87	84.14	79.49
	M(15%)	110.67	207.62	209.45	1.83	80.95	78.66
	NMNL1(100%)	321.71	207.62	210.28	2.66	152.15	90.34
	NMNL1(30%)	96.51	207.62	209.36	1.74	74.38	76.96
	NMNL1(29%)	93.3	207.62	209.34	1.72	72.72	76.26
	NMNL1(28%)	90.08	207.62	209.32	1.7	70.98	75.17
	NMNL1(27%)	86.86	207.62	209.3	1.68	69.24	74.07
	NMNL1(26%)	83.64	207.62	209.27	1.65	67.48	72.99

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL1(25%)	80.43	207.62	209.25	1.63	65.73	71.92
	NMNL1(24%)	77.21	207.62	209.22	1.6	63.95	70.81
	NMNL1(23%)	73.99	207.62	209.2	1.58	62.16	69.68
	NMNL1(22%)	70.78	207.62	209.17	1.55	60.38	68.61
	NMNL1(21%)	67.56	207.62	209.14	1.52	58.58	67.63
	NMNL1(20%)	64.34	207.62	209.12	1.5	56.76	66.61
	NMNL1(19%)	61.12	207.62	209.09	1.47	54.92	65.57
	NMNL1(18%)	57.91	207.62	209.06	1.44	53.08	64.51
	NMNL1(17%)	54.69	207.62	209.03	1.41	51.21	63.46
	NMNL1(16%)	51.47	207.62	209	1.38	49.34	62.34
	NMNL1(15%)	48.26	207.62	208.97	1.35	47.47	61.36
	NMNL2(100%)	148.4	207.62	209.64	2.02	96.34	82.42
	NMNL2(30%)	44.52	207.62	208.94	1.32	45.23	60.38
	NMNL2(29%)	43.04	207.62	208.92	1.3	44.32	59.98
	NMNL2(28%)	41.55	207.62	208.91	1.29	43.39	59.53
	NMNL2(27%)	40.07	207.62	208.89	1.27	42.45	59.07
	NMNL2(26%)	38.58	207.62	208.87	1.25	41.47	58.6
	NMNL2(25%)	37.1	207.62	208.86	1.24	40.49	58.01
	NMNL2(24%)	35.62	207.62	208.84	1.22	39.48	57.35
	NMNL2(23%)	34.13	207.62	208.82	1.2	38.46	56.67
	NMNL2(22%)	32.65	207.62	208.8	1.18	37.44	55.97
	NMNL2(21%)	31.16	207.62	208.78	1.16	36.39	55.25
	NMNL2(20%)	29.68	207.62	208.76	1.14	35.33	54.51
	NMNL2(19%)	28.2	207.62	208.74	1.12	34.25	53.75
	NMNL2(18%)	26.71	207.62	208.72	1.1	33.14	52.96
	NMNL2(17%)	25.23	207.62	208.7	1.08	32.04	52.39
	NMNL2(16%)	23.74	207.62	208.68	1.06	30.89	51.82
	NMNL2(15%)	22.26	207.62	208.66	1.04	29.71	51.06
	L(100%)	461.12	207.62	210.67	3.05	188.14	92.39
	L(30%)	138.34	207.62	209.59	1.97	92.42	81.53
	L(29%)	133.72	207.62	209.57	1.95	90.56	81.09
	L(28%)	129.11	207.62	209.55	1.93	88.74	80.66
	L(27%)	124.5	207.62	209.52	1.9	86.85	80.18
	L(26%)	119.89	207.62	209.5	1.88	84.92	79.69
	L(25%)	115.28	207.62	209.47	1.85	82.95	79.18
	L(24%)	110.67	207.62	209.45	1.83	80.95	78.66
	L(23%)	106.06	207.62	209.42	1.8	78.88	78.13
	L(22%)	101.45	207.62	209.39	1.77	76.76	77.58
	L(21%)	96.84	207.62	209.37	1.75	74.54	77
	L(20%)	92.22	207.62	209.33	1.71	72.14	75.89
	L(19%)	87.61	207.62	209.3	1.68	69.65	74.33
	L(18%)	83	207.62	209.27	1.65	67.13	72.77
	L(17%)	78.39	207.62	209.23	1.61	64.61	71.22
	L(16%)	73.78	207.62	209.2	1.58	62.05	69.61

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L(15%)	69.17	207.62	209.16	1.54	59.48	68.12
1750 m D/S of Dam axis	M(100%)	737.78	207.65	210.52	2.87	198.68	89.93
	M(30%)	221.33	207.65	209.36	1.71	96.85	83.87
	M(29%)	213.96	207.65	209.34	1.69	94.86	83.64
	M(28%)	206.58	207.65	209.31	1.66	92.84	83.41
	M(27%)	199.2	207.65	209.29	1.64	90.74	83.16
	M(26%)	191.82	207.65	209.26	1.61	88.66	82.91
	M(25%)	184.45	207.65	209.24	1.59	86.55	82.67
	M(24%)	177.07	207.65	209.21	1.56	84.41	82.41
	M(23%)	169.69	207.65	209.18	1.53	82.32	82.16
	M(22%)	162.31	207.65	209.16	1.51	80.09	81.9
	M(21%)	154.93	207.65	209.13	1.48	77.83	81.63
	M(20%)	147.56	207.65	209.1	1.45	75.52	81.35
	M(19%)	140.18	207.65	209.07	1.42	73.16	81.07
	M(18%)	132.8	207.65	209.04	1.39	70.55	80.75
	M(17%)	125.42	207.65	209.01	1.36	68.34	80.48
	M(16%)	118.04	207.65	208.98	1.33	65.48	79.26
	M(15%)	110.67	207.65	208.94	1.29	62.59	77.55
	NMNL1(100%)	321.71	207.65	209.65	2	121.58	86.53
	NMNL1(30%)	96.51	207.65	208.85	1.2	56.12	73.4
	NMNL1(29%)	93.3	207.65	208.83	1.18	54.61	72.33
	NMNL1(28%)	90.08	207.65	208.81	1.16	53.14	71.27
	NMNL1(27%)	86.86	207.65	208.79	1.14	51.74	70.25
	NMNL1(26%)	83.64	207.65	208.77	1.12	50.39	69.67
	NMNL1(25%)	80.43	207.65	208.75	1.1	49.05	69.14
	NMNL1(24%)	77.21	207.65	208.74	1.09	47.7	68.59
	NMNL1(23%)	73.99	207.65	208.72	1.07	46.32	68.03
	NMNL1(22%)	70.78	207.65	208.69	1.04	44.93	67.46
	NMNL1(21%)	67.56	207.65	208.67	1.02	43.52	66.87
	NMNL1(20%)	64.34	207.65	208.65	1	42.09	66.27
	NMNL1(19%)	61.12	207.65	208.63	0.98	40.65	65.66
	NMNL1(18%)	57.91	207.65	208.61	0.96	39.17	65.04
	NMNL1(17%)	54.69	207.65	208.58	0.93	37.67	64.39
	NMNL1(16%)	51.47	207.65	208.56	0.91	36.15	63.73
	NMNL1(15%)	48.26	207.65	208.54	0.89	34.58	63.04
	NMNL2(100%)	148.4	207.65	209.1	1.45	75.79	81.38
	NMNL2(30%)	44.52	207.65	208.51	0.86	32.66	62.19
	NMNL2(29%)	43.04	207.65	208.49	0.84	31.86	61.83
	NMNL2(28%)	41.55	207.65	208.48	0.83	31	61.44
	NMNL2(27%)	40.07	207.65	208.46	0.81	30.09	60.68
	NMNL2(26%)	38.58	207.65	208.45	0.8	29.13	59.21
	NMNL2(25%)	37.1	207.65	208.43	0.78	28.19	57.73
	NMNL2(24%)	35.62	207.65	208.42	0.77	27.29	56.28

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL2(23%)	34.13	207.65	208.4	0.75	26.45	55.25
	NMNL2(22%)	32.65	207.65	208.39	0.74	25.64	54.84
	NMNL2(21%)	31.16	207.65	208.37	0.72	24.83	54.42
	NMNL2(20%)	29.68	207.65	208.36	0.71	24.01	53.91
	NMNL2(19%)	28.2	207.65	208.34	0.69	23.18	53.39
	NMNL2(18%)	26.71	207.65	208.32	0.67	22.34	52.85
	NMNL2(17%)	25.23	207.65	208.31	0.66	21.49	52.3
	NMNL2(16%)	23.74	207.65	208.29	0.64	20.61	51.73
	NMNL2(15%)	22.26	207.65	208.27	0.62	19.73	51.15
	L(100%)	461.12	207.65	209.98	2.33	150.82	87.84
	L(30%)	138.34	207.65	209.07	1.42	72.57	81
	L(29%)	133.72	207.65	209.04	1.39	70.85	80.79
	L(28%)	129.11	207.65	209.03	1.38	69.62	80.64
	L(27%)	124.5	207.65	209.01	1.36	68.01	80.44
	L(26%)	119.89	207.65	208.99	1.34	66.24	79.69
	L(25%)	115.28	207.65	208.96	1.31	64.35	78.59
	L(24%)	110.67	207.65	208.94	1.29	62.59	77.55
	L(23%)	106.06	207.65	208.91	1.26	60.55	76.32
	L(22%)	101.45	207.65	208.89	1.24	58.44	75.01
	L(21%)	96.84	207.65	208.86	1.21	56.27	73.51
	L(20%)	92.22	207.65	208.83	1.18	54.12	71.97
	L(19%)	87.61	207.65	208.8	1.15	52.06	70.48
	L(18%)	83	207.65	208.77	1.12	50.12	69.57
	L(17%)	78.39	207.65	208.74	1.09	48.19	68.79
	L(16%)	73.78	207.65	208.71	1.06	46.23	67.99
	L(15%)	69.17	207.65	208.68	1.03	44.23	67.17
1850 m D/S of Dam axis	M(100%)	737.78	206.7	209.77	3.07	208.96	100.15
	M(30%)	221.33	206.7	208.65	1.95	99.66	92.17
	M(29%)	213.96	206.7	208.62	1.92	97.45	91.67
	M(28%)	206.58	206.7	208.6	1.9	95.2	91.16
	M(27%)	199.2	206.7	208.58	1.88	92.93	90.65
	M(26%)	191.82	206.7	208.55	1.85	90.61	90.12
	M(25%)	184.45	206.7	208.52	1.82	88.28	89.58
	M(24%)	177.07	206.7	208.5	1.8	85.9	89.03
	M(23%)	169.69	206.7	208.47	1.77	83.48	88.47
	M(22%)	162.31	206.7	208.44	1.74	81.02	87.9
	M(21%)	154.93	206.7	208.41	1.71	78.49	87.31
	M(20%)	147.56	206.7	208.38	1.68	75.87	86.68
	M(19%)	140.18	206.7	208.35	1.65	73.04	85.95
	M(18%)	132.8	206.7	208.31	1.61	69.92	84.34
	M(17%)	125.42	206.7	208.27	1.57	66.41	82.36
	M(16%)	118.04	206.7	208.22	1.52	62.36	78.6
	M(15%)	110.67	206.7	208.17	1.47	58.55	72.02

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL1(100%)	321.71	206.7	208.94	2.24	127.1	96.05
	NMNL1(30%)	96.51	206.7	208.09	1.39	52.88	68.98
	NMNL1(29%)	93.3	206.7	208.07	1.37	51.54	68.25
	NMNL1(28%)	90.08	206.7	208.05	1.35	50.19	67.51
	NMNL1(27%)	86.86	206.7	208.03	1.33	48.98	66.83
	NMNL1(26%)	83.64	206.7	208.01	1.31	47.59	66.08
	NMNL1(25%)	80.43	206.7	207.99	1.29	46.18	65.44
	NMNL1(24%)	77.21	206.7	207.97	1.27	44.75	64.77
	NMNL1(23%)	73.99	206.7	207.94	1.24	43.23	64.06
	NMNL1(22%)	70.78	206.7	207.92	1.22	41.65	63.2
	NMNL1(21%)	67.56	206.7	207.89	1.19	40.03	61.99
	NMNL1(20%)	64.34	206.7	207.87	1.17	38.32	60.6
	NMNL1(19%)	61.12	206.7	207.84	1.14	36.59	58.79
	NMNL1(18%)	57.91	206.7	207.81	1.11	34.92	55.67
	NMNL1(17%)	54.69	206.7	207.78	1.08	33.43	54.5
	NMNL1(16%)	51.47	206.7	207.75	1.05	31.9	53.3
	NMNL1(15%)	48.26	206.7	207.72	1.02	30.4	52.46
	NMNL2(100%)	148.4	206.7	208.39	1.69	76.19	86.76
	NMNL2(30%)	44.52	206.7	207.69	0.99	28.54	51.12
	NMNL2(29%)	43.04	206.7	207.67	0.97	27.84	50.5
	NMNL2(28%)	41.55	206.7	207.66	0.96	27.13	49.85
	NMNL2(27%)	40.07	206.7	207.65	0.95	26.44	48.55
	NMNL2(26%)	38.58	206.7	207.63	0.93	25.7	47.44
	NMNL2(25%)	37.1	206.7	207.62	0.92	25.03	47.15
	NMNL2(24%)	35.62	206.7	207.6	0.9	24.33	46.83
	NMNL2(23%)	34.13	206.7	207.59	0.89	23.65	46.52
	NMNL2(22%)	32.65	206.7	207.57	0.87	22.97	46.21
	NMNL2(21%)	31.16	206.7	207.56	0.86	22.27	45.89
	NMNL2(20%)	29.68	206.7	207.54	0.84	21.57	45.57
	NMNL2(19%)	28.2	206.7	207.53	0.83	20.86	45.24
	NMNL2(18%)	26.71	206.7	207.51	0.81	20.13	44.9
	NMNL2(17%)	25.23	206.7	207.49	0.79	19.39	44.55
	NMNL2(16%)	23.74	206.7	207.48	0.78	18.63	44.19
	NMNL2(15%)	22.26	206.7	207.46	0.76	17.83	43.81
	L(100%)	461.12	206.7	209.26	2.56	158.04	97.62
	L(30%)	138.34	206.7	208.34	1.64	72.27	85.63
	L(29%)	133.72	206.7	208.32	1.62	70.34	84.57
	L(28%)	129.11	206.7	208.29	1.59	68.33	83.45
	L(27%)	124.5	206.7	208.27	1.57	65.93	82.02
	L(26%)	119.89	206.7	208.23	1.53	63.44	79.71
	L(25%)	115.28	206.7	208.2	1.5	60.8	73.73
	L(24%)	110.67	206.7	208.17	1.47	58.55	72.02
	L(23%)	106.06	206.7	208.14	1.44	56.69	71.03
	L(22%)	101.45	206.7	208.12	1.42	54.81	70.02

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L(21%)	96.84	206.7	208.09	1.39	53.02	69.05
	L(20%)	92.22	206.7	208.06	1.36	51.1	68
	L(19%)	87.61	206.7	208.04	1.34	49.29	67.01
	L(18%)	83	206.7	208.01	1.31	47.32	65.96
	L(17%)	78.39	206.7	207.98	1.28	45.27	65.01
	L(16%)	73.78	206.7	207.94	1.24	43.14	64.01
	L(15%)	69.17	206.7	207.91	1.21	40.87	62.62
1950 m D/S of Dam axis	M(100%)	737.78	205.76	209.02	3.26	217.14	109.92
	M(30%)	221.33	205.76	207.87	2.11	98.13	93.06
	M(29%)	213.96	205.76	207.85	2.09	95.93	92.43
	M(28%)	206.58	205.76	207.82	2.06	93.49	91.74
	M(27%)	199.2	205.76	207.79	2.03	90.78	90.96
	M(26%)	191.82	205.76	207.76	2	87.88	90.13
	M(25%)	184.45	205.76	207.73	1.97	84.76	89.23
	M(24%)	177.07	205.76	207.68	1.92	80.96	87.99
	M(23%)	169.69	205.76	207.64	1.88	76.88	85.95
	M(22%)	162.31	205.76	207.58	1.82	72.46	80.06
	M(21%)	154.93	205.76	207.54	1.78	69.14	71.99
	M(20%)	147.56	205.76	207.5	1.74	66.36	70.05
	M(19%)	140.18	205.76	207.46	1.7	63.63	68.54
	M(18%)	132.8	205.76	207.42	1.66	60.78	67.29
	M(17%)	125.42	205.76	207.37	1.61	57.8	65.43
	M(16%)	118.04	205.76	207.33	1.57	54.81	62.37
	M(15%)	110.67	205.76	207.28	1.52	51.95	59.98
	NMNL1(100%)	321.71	205.76	208.17	2.41	127.15	100.77
	NMNL1(30%)	96.51	205.76	207.19	1.43	46.67	54.38
	NMNL1(29%)	93.3	205.76	207.17	1.41	45.64	54
	NMNL1(28%)	90.08	205.76	207.15	1.39	44.62	53.76
	NMNL1(27%)	86.86	205.76	207.13	1.37	43.59	53.51
	NMNL1(26%)	83.64	205.76	207.11	1.35	42.54	53.25
	NMNL1(25%)	80.43	205.76	207.09	1.33	41.48	52.99
	NMNL1(24%)	77.21	205.76	207.07	1.31	40.4	52.73
	NMNL1(23%)	73.99	205.76	207.05	1.29	39.31	52.46
	NMNL1(22%)	70.78	205.76	207.03	1.27	38.21	52.18
	NMNL1(21%)	67.56	205.76	207.01	1.25	37.08	51.9
	NMNL1(20%)	64.34	205.76	206.99	1.23	35.94	51.61
	NMNL1(19%)	61.12	205.76	206.96	1.2	34.78	51.32
	NMNL1(18%)	57.91	205.76	206.94	1.18	33.59	51.02
	NMNL1(17%)	54.69	205.76	206.92	1.16	32.38	50.71
	NMNL1(16%)	51.47	205.76	206.89	1.13	31.15	50.39
	NMNL1(15%)	48.26	205.76	206.87	1.11	29.88	50.06
	NMNL2(100%)	148.4	205.76	207.5	1.74	66.69	70.28
	NMNL2(30%)	44.52	205.76	206.84	1.08	28.36	49.67

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL2(29%)	43.04	205.76	206.82	1.06	27.74	49.5
	NMNL2(28%)	41.55	205.76	206.81	1.05	27.11	49.34
	NMNL2(27%)	40.07	205.76	206.8	1.04	26.45	49.16
	NMNL2(26%)	38.58	205.76	206.78	1.02	25.78	48.99
	NMNL2(25%)	37.1	205.76	206.77	1.01	25.07	48.8
	NMNL2(24%)	35.62	205.76	206.75	0.99	24.34	48.6
	NMNL2(23%)	34.13	205.76	206.74	0.98	23.48	48.37
	NMNL2(22%)	32.65	205.76	206.72	0.96	22.59	47.5
	NMNL2(21%)	31.16	205.76	206.7	0.94	21.74	45.51
	NMNL2(20%)	29.68	205.76	206.68	0.92	20.94	43.79
	NMNL2(19%)	28.2	205.76	206.66	0.9	20.21	43.32
	NMNL2(18%)	26.71	205.76	206.65	0.89	19.46	42.85
	NMNL2(17%)	25.23	205.76	206.63	0.87	18.71	42.36
	NMNL2(16%)	23.74	205.76	206.61	0.85	17.95	41.86
	NMNL2(15%)	22.26	205.76	206.59	0.83	17.16	41.34
	L(100%)	461.12	205.76	208.5	2.74	160.93	105.32
	L(30%)	138.34	205.76	207.45	1.69	62.94	68.24
	L(29%)	133.72	205.76	207.42	1.66	61.11	67.44
	L(28%)	129.11	205.76	207.4	1.64	59.3	66.62
	L(27%)	124.5	205.76	207.37	1.61	57.38	65.06
	L(26%)	119.89	205.76	207.34	1.58	55.6	63.45
	L(25%)	115.28	205.76	207.31	1.55	53.77	60.94
	L(24%)	110.67	205.76	207.28	1.52	51.95	59.98
	L(23%)	106.06	205.76	207.25	1.49	50.03	59.07
	L(22%)	101.45	205.76	207.22	1.46	48.29	55.58
	L(21%)	96.84	205.76	207.19	1.43	46.78	54.46
	L(20%)	92.22	205.76	207.16	1.4	45.3	53.92
	L(19%)	87.61	205.76	207.14	1.38	43.83	53.56
	L(18%)	83	205.76	207.11	1.35	42.33	53.2
	L(17%)	78.39	205.76	207.08	1.32	40.8	52.82
	L(16%)	73.78	205.76	207.05	1.29	39.24	52.44
	L(15%)	69.17	205.76	207.02	1.26	37.65	52.04
2050 m D/S of Dam axis	M(100%)	737.78	204.81	208.27	3.46	225.95	117.13
	M(30%)	221.33	204.81	207.01	2.2	92.33	87.48
	M(29%)	213.96	204.81	206.96	2.15	88.25	79.77
	M(28%)	206.58	204.81	206.88	2.07	81.97	69.32
	M(27%)	199.2	204.81	206.85	2.04	79.95	68.77
	M(26%)	191.82	204.81	206.82	2.01	77.64	68.09
	M(25%)	184.45	204.81	206.78	1.97	75.26	67.34
	M(24%)	177.07	204.81	206.74	1.93	72.58	66.49
	M(23%)	169.69	204.81	206.7	1.89	69.71	65.56
	M(22%)	162.31	204.81	206.65	1.84	66.76	64.59
	M(21%)	154.93	204.81	206.61	1.8	64.35	59.68

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M(20%)	147.56	204.81	206.58	1.77	62.31	59.34
	M(19%)	140.18	204.81	206.54	1.73	60.28	59
	M(18%)	132.8	204.81	206.51	1.7	58.21	58.65
	M(17%)	125.42	204.81	206.47	1.66	56.17	58.31
	M(16%)	118.04	204.81	206.44	1.63	54.05	57.95
	M(15%)	110.67	204.81	206.4	1.59	51.86	57.57
	NMNL1(100%)	321.71	204.81	207.37	2.56	127.16	101.49
	NMNL1(30%)	96.51	204.81	206.32	1.51	47.55	56.82
	NMNL1(29%)	93.3	204.81	206.31	1.5	46.54	56.65
	NMNL1(28%)	90.08	204.81	206.29	1.48	45.52	56.47
	NMNL1(27%)	86.86	204.81	206.27	1.46	44.49	56.29
	NMNL1(26%)	83.64	204.81	206.25	1.44	43.44	56.1
	NMNL1(25%)	80.43	204.81	206.23	1.42	42.27	55.89
	NMNL1(24%)	77.21	204.81	206.21	1.4	41.08	55.68
	NMNL1(23%)	73.99	204.81	206.19	1.38	39.87	55.47
	NMNL1(22%)	70.78	204.81	206.16	1.35	38.58	55.23
	NMNL1(21%)	67.56	204.81	206.14	1.33	37.16	54.98
	NMNL1(20%)	64.34	204.81	206.11	1.3	35.46	54.67
	NMNL1(19%)	61.12	204.81	206.08	1.27	33.96	50
	NMNL1(18%)	57.91	204.81	206.05	1.24	32.68	49.41
	NMNL1(17%)	54.69	204.81	206.03	1.22	31.43	48.83
	NMNL1(16%)	51.47	204.81	206	1.19	30.15	48.22
	NMNL1(15%)	48.26	204.81	205.97	1.16	28.76	47.56
	NMNL2(100%)	148.4	204.81	206.58	1.77	62.55	59.38
	NMNL2(30%)	44.52	204.81	205.94	1.13	27.14	46.76
	NMNL2(29%)	43.04	204.81	205.92	1.11	26.42	46.39
	NMNL2(28%)	41.55	204.81	205.91	1.1	25.78	46.07
	NMNL2(27%)	40.07	204.81	205.89	1.08	24.88	45.6
	NMNL2(26%)	38.58	204.81	205.87	1.06	23.88	45.08
	NMNL2(25%)	37.1	204.81	205.85	1.04	22.97	44.6
	NMNL2(24%)	35.62	204.81	205.82	1.01	21.97	39.71
	NMNL2(23%)	34.13	204.81	205.8	0.99	21.28	39.14
	NMNL2(22%)	32.65	204.81	205.79	0.98	20.57	38.55
	NMNL2(21%)	31.16	204.81	205.77	0.96	19.86	37.95
	NMNL2(20%)	29.68	204.81	205.75	0.94	19.01	37.22
	NMNL2(19%)	28.2	204.81	205.72	0.91	18.15	36.46
	NMNL2(18%)	26.71	204.81	205.68	0.87	16.74	35.19
	NMNL2(17%)	25.23	204.81	205.62	0.81	14.87	27.99
	NMNL2(16%)	23.74	204.81	205.59	0.78	14.07	25.09
	NMNL2(15%)	22.26	204.81	205.57	0.76	13.47	24.73
	L(100%)	461.12	204.81	207.71	2.9	162.25	107.76
	L(30%)	138.34	204.81	206.53	1.72	59.77	58.92
	L(29%)	133.72	204.81	206.51	1.7	58.47	58.7
	L(28%)	129.11	204.81	206.49	1.68	57.16	58.48

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L(27%)	124.5	204.81	206.47	1.66	55.87	58.26
	L(26%)	119.89	204.81	206.45	1.64	54.59	58.04
	L(25%)	115.28	204.81	206.42	1.61	53.23	57.81
	L(24%)	110.67	204.81	206.4	1.59	51.86	57.57
	L(23%)	106.06	204.81	206.37	1.56	50.48	57.33
	L(22%)	101.45	204.81	206.35	1.54	49.07	57.09
	L(21%)	96.84	204.81	206.33	1.52	47.65	56.84
	L(20%)	92.22	204.81	206.3	1.49	46.2	56.59
	L(19%)	87.61	204.81	206.27	1.46	44.73	56.33
	L(18%)	83	204.81	206.25	1.44	43.19	56.06
	L(17%)	78.39	204.81	206.22	1.41	41.51	55.76
	L(16%)	73.78	204.81	206.19	1.38	39.78	55.45
	L(15%)	69.17	204.81	206.15	1.34	37.81	55.1
2180 m D/S of Dam axis	M(100%)	737.78	203.59	207.76	4.17	298.94	132.02
	M(30%)	221.33	203.59	206.32	2.73	130.23	100.69
	M(29%)	213.96	203.59	206.29	2.7	127.17	99.81
	M(28%)	206.58	203.59	206.22	2.63	120.26	91.48
	M(27%)	199.2	203.59	206.17	2.58	116.24	88.73
	M(26%)	191.82	203.59	206.13	2.54	112.1	85.81
	M(25%)	184.45	203.59	206.03	2.44	103.8	74.95
	M(24%)	177.07	203.59	205.99	2.4	100.94	74.3
	M(23%)	169.69	203.59	205.95	2.36	98.04	73.64
	M(22%)	162.31	203.59	205.91	2.32	95.11	72.97
	M(21%)	154.93	203.59	205.83	2.24	89.38	66.96
	M(20%)	147.56	203.59	205.79	2.2	86.63	66.64
	M(19%)	140.18	203.59	205.74	2.15	83.83	66.31
	M(18%)	132.8	203.59	205.7	2.11	80.98	65.97
	M(17%)	125.42	203.59	205.66	2.07	78.08	65.62
	M(16%)	118.04	203.59	205.61	2.02	75.12	65.26
	M(15%)	110.67	203.59	205.57	1.98	72.1	64.9
	NMNL1(100%)	321.71	203.59	206.7	3.11	170.04	111.9
	NMNL1(30%)	96.51	203.59	205.47	1.88	66.11	64.16
	NMNL1(29%)	93.3	203.59	205.45	1.86	64.71	63.99
	NMNL1(28%)	90.08	203.59	205.43	1.84	63.29	63.82
	NMNL1(27%)	86.86	203.59	205.41	1.82	61.85	63.64
	NMNL1(26%)	83.64	203.59	205.38	1.79	60.39	63.46
	NMNL1(25%)	80.43	203.59	205.36	1.77	58.92	63.27
	NMNL1(24%)	77.21	203.59	205.34	1.75	57.42	63.09
	NMNL1(23%)	73.99	203.59	205.31	1.72	55.91	62.9
	NMNL1(22%)	70.78	203.59	205.25	1.66	52.32	56.94
	NMNL1(21%)	67.56	203.59	205.22	1.63	50.68	56.38
	NMNL1(20%)	64.34	203.59	205.19	1.6	49	55.8
	NMNL1(19%)	61.12	203.59	205.16	1.57	47.31	55.21

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL1(18%)	57.91	203.59	205.13	1.54	45.6	54.61
	NMNL1(17%)	54.69	203.59	205.1	1.51	43.87	54
	NMNL1(16%)	51.47	203.59	205.07	1.48	42.1	53.36
	NMNL1(15%)	48.26	203.59	205.03	1.44	40.31	52.71
	NMNL2(100%)	148.4	203.59	205.79	2.2	86.94	66.68
	NMNL2(30%)	44.52	203.59	204.99	1.4	38.18	51.92
	NMNL2(29%)	43.04	203.59	204.94	1.35	35.51	45.57
	NMNL2(28%)	41.55	203.59	204.92	1.33	34.59	44.99
	NMNL2(27%)	40.07	203.59	204.9	1.31	33.67	44.42
	NMNL2(26%)	38.58	203.59	204.87	1.28	32.74	43.81
	NMNL2(25%)	37.1	203.59	204.85	1.26	31.8	43.2
	NMNL2(24%)	35.62	203.59	204.83	1.24	30.85	42.58
	NMNL2(23%)	34.13	203.59	204.81	1.22	29.89	41.93
	NMNL2(22%)	32.65	203.59	204.74	1.15	27.23	35.49
	NMNL2(21%)	31.16	203.59	204.72	1.13	26.42	35.3
	NMNL2(20%)	29.68	203.59	204.69	1.1	25.61	35.11
	NMNL2(19%)	28.2	203.59	204.67	1.08	24.78	34.92
	NMNL2(18%)	26.71	203.59	204.65	1.06	23.93	34.72
	NMNL2(17%)	25.23	203.59	204.62	1.03	23.06	34.52
	NMNL2(16%)	23.74	203.59	204.54	0.95	20.69	28.77
	NMNL2(15%)	22.26	203.59	204.51	0.92	19.8	28.42
	L(100%)	461.12	203.59	207.1	3.51	216.53	119.32
	L(30%)	138.34	203.59	205.73	2.14	83.12	66.22
	L(29%)	133.72	203.59	205.71	2.12	81.34	66.01
	L(28%)	129.11	203.59	205.68	2.09	79.52	65.79
	L(27%)	124.5	203.59	205.65	2.06	77.72	65.58
	L(26%)	119.89	203.59	205.62	2.03	75.87	65.35
	L(25%)	115.28	203.59	205.59	2	74	65.13
	L(24%)	110.67	203.59	205.57	1.98	72.1	64.9
	L(23%)	106.06	203.59	205.54	1.95	70.18	64.66
	L(22%)	101.45	203.59	205.51	1.92	68.22	64.42
	L(21%)	96.84	203.59	205.47	1.88	66.25	64.18
	L(20%)	92.22	203.59	205.44	1.85	64.24	63.93
	L(19%)	87.61	203.59	205.41	1.82	62.19	63.68
	L(18%)	83	203.59	205.38	1.79	60.1	63.42
	L(17%)	78.39	203.59	205.34	1.75	57.97	63.16
	L(16%)	73.78	203.59	205.31	1.72	55.81	62.88
	L(15%)	69.17	203.59	205.24	1.65	51.5	56.66

Note:

M - Monsoon Season
NMNL1 - Non Monsoon Non Lean Season (October & November)
L - Lean Season
NMNL2 - Non Monsoon Non Lean Season (April & May)

Table-13.10: Depth of flow for the proposed Minimum Flow on the basis of average flow during 90% dependable year for Teesta low dam III HEP

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
At Barrage axis	M (100%)	708.88	180.34	184.54	4.2	288.49	112.81
	M (30%)	212.66	180.34	182.8	2.46	130.86	74.82
	M (29%)	205.57	180.34	182.77	2.43	128.46	74.35
	M (28%)	198.49	180.34	182.73	2.39	126.05	73.87
	M (27%)	191.4	180.34	182.7	2.36	123.51	73.37
	M (26%)	184.31	180.34	182.67	2.33	121.04	72.87
	M (25%)	177.22	180.34	182.63	2.29	118.5	72.36
	M (24%)	170.13	180.34	182.59	2.25	115.88	71.83
	M (23%)	163.04	180.34	182.56	2.22	113.12	71.27
	M (22%)	155.95	180.34	182.51	2.17	110.26	70.66
	M (21%)	148.86	180.34	182.47	2.13	107.29	70.03
	M (20%)	141.78	180.34	182.43	2.09	104.36	69.39
	M (19%)	134.69	180.34	182.39	2.05	101.37	68.74
	M (18%)	127.6	180.34	182.34	2	98.32	68.07
	M (17%)	120.51	180.34	182.3	1.96	95.22	67.39
	M (16%)	113.42	180.34	182.25	1.91	92.05	66.68
	M (15%)	106.33	180.34	182.2	1.86	88.83	65.95
	NMNL-1 (100%)	350.18	180.34	183.38	3.04	177.07	83.4
	NMNL-1 (30%)	105.05	180.34	182.19	1.85	88.24	65.81
	NMNL-1 (29%)	101.55	180.34	182.17	1.83	86.6	65.44
	NMNL-1 (28%)	98.05	180.34	182.14	1.8	84.88	65.04
	NMNL-1 (27%)	94.55	180.34	182.11	1.77	83.1	64.63
	NMNL-1 (26%)	91.05	180.34	182.08	1.74	81.26	64.2
	NMNL-1 (25%)	87.54	180.34	182.05	1.71	79.35	63.75
	NMNL-1 (24%)	84.04	180.34	182.02	1.68	77.41	63.29
	NMNL-1 (23%)	80.54	180.34	181.99	1.65	75.53	62.84
	NMNL-1 (22%)	77.04	180.34	181.96	1.62	73.62	62.38
	NMNL-1 (21%)	73.54	180.34	181.93	1.59	71.7	61.92
	NMNL-1 (20%)	70.04	180.34	181.9	1.56	69.73	61.44
	NMNL-1 (19%)	66.53	180.34	181.87	1.53	67.71	60.95
	NMNL-1 (18%)	63.03	180.34	181.83	1.49	65.63	60.43
	NMNL-1 (17%)	59.53	180.34	181.8	1.46	63.49	59.9
	NMNL-1 (16%)	56.03	180.34	181.76	1.42	61.29	59.33
	NMNL-1 (15%)	52.53	180.34	181.72	1.38	58.97	58.73
	NMNL-2 (100%)	252.93	180.34	182.98	2.64	144.66	77.48
	NMNL-2 (30%)	75.88	180.34	181.95	1.61	72.98	62.23
	NMNL-2 (29%)	73.35	180.34	181.93	1.59	71.59	61.89
	NMNL-2 (28%)	70.82	180.34	181.91	1.57	70.17	61.55
	NMNL-2 (27%)	68.29	180.34	181.88	1.54	68.73	61.2
	NMNL-2 (26%)	65.76	180.34	181.86	1.52	67.26	60.84
	NMNL-2 (25%)	63.23	180.34	181.84	1.5	65.74	60.46
	NMNL-2 (24%)	60.7	180.34	181.81	1.47	64.21	60.08

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (23%)	58.17	180.34	181.78	1.44	62.64	59.68
	NMNL-2 (22%)	55.64	180.34	181.76	1.42	61.03	59.27
	NMNL-2 (21%)	53.12	180.34	181.73	1.39	59.37	58.84
	NMNL-2 (20%)	50.59	180.34	181.7	1.36	57.67	58.4
	NMNL-2 (19%)	48.06	180.34	181.67	1.33	55.95	57.94
	NMNL-2 (18%)	45.53	180.34	181.64	1.3	54.07	57.44
	NMNL-2 (17%)	43	180.34	181.6	1.26	51.98	56.88
	NMNL-2 (16%)	40.47	180.34	181.57	1.23	49.97	56.34
	NMNL-2 (15%)	37.94	180.34	181.53	1.19	48.01	55.8
	L (100%)	158.05	180.34	182.53	2.19	111.12	70.84
	L (30%)	47.41	180.34	181.66	1.32	55.49	57.82
	L (29%)	45.83	180.34	181.64	1.3	54.31	57.51
	L (28%)	44.25	180.34	181.62	1.28	53.02	57.16
	L (27%)	42.67	180.34	181.6	1.26	51.69	56.8
	L (26%)	41.09	180.34	181.57	1.23	50.44	56.47
	L (25%)	39.51	180.34	181.55	1.21	49.24	56.14
	L (24%)	37.93	180.34	181.53	1.19	48	55.8
	L (23%)	36.35	180.34	181.51	1.17	46.76	55.46
	L (22%)	34.77	180.34	181.49	1.15	45.5	55.11
	L (21%)	33.19	180.34	181.46	1.12	44.2	54.75
	L (20%)	31.61	180.34	181.44	1.1	42.76	54.35
	L (19%)	30.03	180.34	181.41	1.07	41.35	53.95
	L (18%)	28.45	180.34	181.38	1.04	39.92	53.54
	L (17%)	26.87	180.34	181.35	1.01	38.41	53.11
	L (16%)	25.29	180.34	181.33	0.99	36.91	52.67
	L (15%)	23.71	180.34	181.3	0.96	35.37	52.23
50 m d/s of Barrage axis	M (100%)	708.88	180.21	184.51	4.3	344.3	125.24
	M (30%)	212.66	180.21	182.73	2.52	154.23	93.35
	M (29%)	205.57	180.21	182.7	2.49	151.24	92.91
	M (28%)	198.49	180.21	182.67	2.46	148.24	92.46
	M (27%)	191.4	180.21	182.64	2.43	145.07	91.99
	M (26%)	184.31	180.21	182.6	2.39	141.99	91.52
	M (25%)	177.22	180.21	182.57	2.36	138.82	91.04
	M (24%)	170.13	180.21	182.53	2.32	135.55	90.55
	M (23%)	163.04	180.21	182.49	2.28	132.07	90.02
	M (22%)	155.95	180.21	182.45	2.24	128.44	89.46
	M (21%)	148.86	180.21	182.41	2.2	124.67	88.87
	M (20%)	141.78	180.21	182.37	2.16	120.95	88.29
	M (19%)	134.69	180.21	182.32	2.11	117.15	87.7
	M (18%)	127.6	180.21	182.28	2.07	113.28	87.05
	M (17%)	120.51	180.21	182.24	2.03	109.36	85.9
	M (16%)	113.42	180.21	182.19	1.98	105.37	84.71
	M (15%)	106.33	180.21	182.14	1.93	101.33	83.5

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (100%)	350.18	180.21	183.33	3.12	211.83	101.2
	NMNL-1 (30%)	105.05	180.21	182.13	1.92	100.59	83.27
	NMNL-1 (29%)	101.55	180.21	182.11	1.9	98.55	82.65
	NMNL-1 (28%)	98.05	180.21	182.08	1.87	96.4	81.98
	NMNL-1 (27%)	94.55	180.21	182.05	1.84	94.17	81.29
	NMNL-1 (26%)	91.05	180.21	182.03	1.82	91.86	80.57
	NMNL-1 (25%)	87.54	180.21	182	1.79	89.46	79.81
	NMNL-1 (24%)	84.04	180.21	181.96	1.75	87.03	79.03
	NMNL-1 (23%)	80.54	180.21	181.94	1.73	84.71	78.29
	NMNL-1 (22%)	77.04	180.21	181.9	1.69	82.34	77.52
	NMNL-1 (21%)	73.54	180.21	181.87	1.66	79.99	76.74
	NMNL-1 (20%)	70.04	180.21	181.84	1.63	77.59	75.95
	NMNL-1 (19%)	66.53	180.21	181.81	1.6	75.13	75.12
	NMNL-1 (18%)	63.03	180.21	181.78	1.57	72.58	74.26
	NMNL-1 (17%)	59.53	180.21	181.74	1.53	69.99	73.37
	NMNL-1 (16%)	56.03	180.21	181.7	1.49	67.32	72.44
	NMNL-1 (15%)	52.53	180.21	181.67	1.46	64.51	71.45
	NMNL-2 (100%)	252.93	180.21	182.92	2.71	171.46	95.87
	NMNL-2 (30%)	75.88	180.21	181.89	1.68	81.56	77.26
	NMNL-2 (29%)	73.35	180.21	181.87	1.66	79.86	76.7
	NMNL-2 (28%)	70.82	180.21	181.85	1.64	78.13	76.13
	NMNL-2 (27%)	68.29	180.21	181.83	1.62	76.37	75.54
	NMNL-2 (26%)	65.76	180.21	181.8	1.59	74.58	74.93
	NMNL-2 (25%)	63.23	180.21	181.78	1.57	72.73	74.31
	NMNL-2 (24%)	60.7	180.21	181.75	1.54	70.86	73.67
	NMNL-2 (23%)	58.17	180.21	181.73	1.52	68.96	73.01
	NMNL-2 (22%)	55.64	180.21	181.7	1.49	67.02	72.33
	NMNL-2 (21%)	53.12	180.21	181.67	1.46	64.99	71.62
	NMNL-2 (20%)	50.59	180.21	181.64	1.43	62.95	70.89
	NMNL-2 (19%)	48.06	180.21	181.61	1.4	60.86	70.14
	NMNL-2 (18%)	45.53	180.21	181.58	1.37	58.58	69.31
	NMNL-2 (17%)	43	180.21	181.54	1.33	55.99	68.36
	NMNL-2 (16%)	40.47	180.21	181.51	1.3	53.55	67.45
	NMNL-2 (15%)	37.94	180.21	181.47	1.26	51.19	66.56
	L (100%)	158.05	180.21	182.46	2.25	129.53	89.62
	L (30%)	47.41	180.21	181.61	1.4	60.31	69.94
	L (29%)	45.83	180.21	181.59	1.38	58.87	69.42
	L (28%)	44.25	180.21	181.56	1.35	57.28	68.83
	L (27%)	42.67	180.21	181.54	1.33	55.63	68.23
	L (26%)	41.09	180.21	181.52	1.31	54.12	67.66
	L (25%)	39.51	180.21	181.49	1.28	52.67	67.12
	L (24%)	37.93	180.21	181.47	1.26	51.18	66.55
	L (23%)	36.35	180.21	181.45	1.24	49.7	65.99
	L (22%)	34.77	180.21	181.43	1.22	48.21	65.41

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (21%)	33.19	180.21	181.4	1.19	46.65	64.8
	L (20%)	31.61	180.21	181.38	1.17	44.9	64.11
	L (19%)	30.03	180.21	181.35	1.14	43.22	63.41
	L (18%)	28.45	180.21	181.32	1.11	41.49	62.69
	L (17%)	26.87	180.21	181.29	1.08	39.67	61.92
	L (16%)	25.29	180.21	181.26	1.05	37.88	61.15
	L (15%)	23.71	180.21	181.23	1.02	36.04	60.35
100 m d/s of Barrage axis	M (100%)	708.88	180.07	184.5	4.43	474.45	225.25
	M (30%)	212.66	180.07	182.68	2.61	175.32	102.05
	M (29%)	205.57	180.07	182.65	2.58	172.1	101.53
	M (28%)	198.49	180.07	182.62	2.55	168.87	101
	M (27%)	191.4	180.07	182.58	2.51	165.45	100.43
	M (26%)	184.31	180.07	182.55	2.48	162.15	99.89
	M (25%)	177.22	180.07	182.52	2.45	158.74	99.32
	M (24%)	170.13	180.07	182.48	2.41	155.22	98.73
	M (23%)	163.04	180.07	182.44	2.37	151.46	98.09
	M (22%)	155.95	180.07	182.4	2.33	147.52	97.42
	M (21%)	148.86	180.07	182.36	2.29	143.43	96.72
	M (20%)	141.78	180.07	182.32	2.25	139.42	96.03
	M (19%)	134.69	180.07	182.27	2.2	135.32	95.32
	M (18%)	127.6	180.07	182.23	2.16	131.14	94.58
	M (17%)	120.51	180.07	182.19	2.12	126.9	93.83
	M (16%)	113.42	180.07	182.14	2.07	122.58	93.06
	M (15%)	106.33	180.07	182.09	2.02	118.19	92.28
	NMNL-1 (100%)	350.18	180.07	183.27	3.2	238.68	112.43
	NMNL-1 (30%)	105.05	180.07	182.08	2.01	117.38	92.13
	NMNL-1 (29%)	101.55	180.07	182.06	1.99	115.14	91.72
	NMNL-1 (28%)	98.05	180.07	182.03	1.96	112.77	91.29
	NMNL-1 (27%)	94.55	180.07	182.01	1.94	110.29	90.84
	NMNL-1 (26%)	91.05	180.07	181.98	1.91	107.7	90.36
	NMNL-1 (25%)	87.54	180.07	181.95	1.88	104.99	89.86
	NMNL-1 (24%)	84.04	180.07	181.92	1.85	102.23	89.35
	NMNL-1 (23%)	80.54	180.07	181.89	1.82	99.6	88.86
	NMNL-1 (22%)	77.04	180.07	181.86	1.79	96.93	88.36
	NMNL-1 (21%)	73.54	180.07	181.83	1.76	94.25	87.85
	NMNL-1 (20%)	70.04	180.07	181.79	1.72	91.52	87.33
	NMNL-1 (19%)	66.53	180.07	181.76	1.69	88.71	86.79
	NMNL-1 (18%)	63.03	180.07	181.73	1.66	85.78	86.05
	NMNL-1 (17%)	59.53	180.07	181.69	1.62	82.78	85.28
	NMNL-1 (16%)	56.03	180.07	181.66	1.59	79.71	84.49
	NMNL-1 (15%)	52.53	180.07	181.62	1.55	76.45	83.64
	NMNL-2 (100%)	252.93	180.07	182.86	2.79	194.09	105.07
	NMNL-2 (30%)	75.88	180.07	181.85	1.78	96.03	88.19

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (29%)	73.35	180.07	181.82	1.75	94.1	87.82
	NMNL-2 (28%)	70.82	180.07	181.8	1.73	92.13	87.45
	NMNL-2 (27%)	68.29	180.07	181.78	1.71	90.13	87.07
	NMNL-2 (26%)	65.76	180.07	181.76	1.69	88.08	86.63
	NMNL-2 (25%)	63.23	180.07	181.73	1.66	85.95	86.09
	NMNL-2 (24%)	60.7	180.07	181.71	1.64	83.79	85.54
	NMNL-2 (23%)	58.17	180.07	181.68	1.61	81.59	84.97
	NMNL-2 (22%)	55.64	180.07	181.65	1.58	79.36	84.4
	NMNL-2 (21%)	53.12	180.07	181.63	1.56	77.01	83.78
	NMNL-2 (20%)	50.59	180.07	181.6	1.53	74.6	83.15
	NMNL-2 (19%)	48.06	180.07	181.57	1.5	72.15	82.5
	NMNL-2 (18%)	45.53	180.07	181.53	1.46	69.42	81.77
	NMNL-2 (17%)	43	180.07	181.5	1.43	66.29	80.47
	NMNL-2 (16%)	40.47	180.07	181.46	1.39	63.41	78.89
	NMNL-2 (15%)	37.94	180.07	181.42	1.35	60.67	77.36
	L (100%)	158.05	180.07	182.41	2.34	148.7	97.62
	L (30%)	47.41	180.07	181.56	1.49	71.5	82.33
	L (29%)	45.83	180.07	181.54	1.47	69.77	81.87
	L (28%)	44.25	180.07	181.51	1.44	67.85	81.31
	L (27%)	42.67	180.07	181.49	1.42	65.86	80.24
	L (26%)	41.09	180.07	181.47	1.4	64.07	79.26
	L (25%)	39.51	180.07	181.45	1.38	62.39	78.32
	L (24%)	37.93	180.07	181.42	1.35	60.67	77.36
	L (23%)	36.35	180.07	181.4	1.33	58.95	76.38
	L (22%)	34.77	180.07	181.38	1.31	57.21	75.91
	L (21%)	33.19	180.07	181.35	1.28	55.38	75.56
	L (20%)	31.61	180.07	181.33	1.26	53.29	74.77
	L (19%)	30.03	180.07	181.3	1.23	51.29	73.61
	L (18%)	28.45	180.07	181.27	1.2	49.27	72.42
	L (17%)	26.87	180.07	181.24	1.17	47.12	71.13
	L (16%)	25.29	180.07	181.21	1.14	45.05	69.86
	L (15%)	23.71	180.07	181.18	1.11	42.94	68.55
150 m d/s of Barrage axis	M (100%)	708.88	179.94	184.45	4.51	477.01	222
	M (30%)	212.66	179.94	182.57	2.63	145.52	81.03
	M (29%)	205.57	179.94	182.54	2.6	143.19	80.49
	M (28%)	198.49	179.94	182.51	2.57	140.86	79.95
	M (27%)	191.4	179.94	182.48	2.54	138.38	79.37
	M (26%)	184.31	179.94	182.45	2.51	136.01	78.81
	M (25%)	177.22	179.94	182.42	2.48	133.56	78.23
	M (24%)	170.13	179.94	182.39	2.45	131.04	77.62
	M (23%)	163.04	179.94	182.35	2.41	128.31	76.96
	M (22%)	155.95	179.94	182.32	2.38	125.44	76.25
	M (21%)	148.86	179.94	182.28	2.34	122.45	75.5

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (20%)	141.78	179.94	182.24	2.3	119.52	74.76
	M (19%)	134.69	179.94	182.2	2.26	116.54	74
	M (18%)	127.6	179.94	182.16	2.22	113.51	73.21
	M (17%)	120.51	179.94	182.12	2.18	110.45	72.41
	M (16%)	113.42	179.94	182.07	2.13	107.33	71.59
	M (15%)	106.33	179.94	182.03	2.09	104.19	70.75
	NMNL-1 (100%)	350.18	179.94	183.15	3.21	211.64	164.89
	NMNL-1 (30%)	105.05	179.94	182.02	2.08	103.61	70.6
	NMNL-1 (29%)	101.55	179.94	182	2.06	102	70.16
	NMNL-1 (28%)	98.05	179.94	181.97	2.03	100.29	69.69
	NMNL-1 (27%)	94.55	179.94	181.95	2.01	98.49	69.2
	NMNL-1 (26%)	91.05	179.94	181.92	1.98	96.61	68.68
	NMNL-1 (25%)	87.54	179.94	181.89	1.95	94.63	68.13
	NMNL-1 (24%)	84.04	179.94	181.86	1.92	92.61	67.56
	NMNL-1 (23%)	80.54	179.94	181.83	1.89	90.73	67.03
	NMNL-1 (22%)	77.04	179.94	181.8	1.86	88.8	66.48
	NMNL-1 (21%)	73.54	179.94	181.77	1.83	86.9	65.93
	NMNL-1 (20%)	70.04	179.94	181.75	1.81	84.95	65.36
	NMNL-1 (19%)	66.53	179.94	181.71	1.77	82.96	64.77
	NMNL-1 (18%)	63.03	179.94	181.68	1.74	80.87	64.14
	NMNL-1 (17%)	59.53	179.94	181.65	1.71	78.73	63.5
	NMNL-1 (16%)	56.03	179.94	181.61	1.67	76.54	62.83
	NMNL-1 (15%)	52.53	179.94	181.58	1.64	74.21	62.1
	NMNL-2 (100%)	252.93	179.94	182.74	2.8	160.07	92.35
	NMNL-2 (30%)	75.88	179.94	181.79	1.85	88.16	66.29
	NMNL-2 (29%)	73.35	179.94	181.77	1.83	86.79	65.9
	NMNL-2 (28%)	70.82	179.94	181.75	1.81	85.38	65.49
	NMNL-2 (27%)	68.29	179.94	181.73	1.79	83.96	65.07
	NMNL-2 (26%)	65.76	179.94	181.71	1.77	82.5	64.63
	NMNL-2 (25%)	63.23	179.94	181.68	1.74	80.99	64.18
	NMNL-2 (24%)	60.7	179.94	181.66	1.72	79.45	63.72
	NMNL-2 (23%)	58.17	179.94	181.64	1.7	77.88	63.24
	NMNL-2 (22%)	55.64	179.94	181.61	1.67	76.29	62.75
	NMNL-2 (21%)	53.12	179.94	181.58	1.64	74.61	62.23
	NMNL-2 (20%)	50.59	179.94	181.56	1.62	72.89	61.69
	NMNL-2 (19%)	48.06	179.94	181.53	1.59	71.13	61.14
	NMNL-2 (18%)	45.53	179.94	181.49	1.55	69.15	60.51
	NMNL-2 (17%)	43	179.94	181.46	1.52	66.85	59.77
	NMNL-2 (16%)	40.47	179.94	181.42	1.48	64.75	59.09
	NMNL-2 (15%)	37.94	179.94	181.39	1.45	62.75	58.53
	L (100%)	158.05	179.94	182.33	2.39	126.31	76.47
	L (30%)	47.41	179.94	181.52	1.58	70.66	60.99
	L (29%)	45.83	179.94	181.5	1.56	69.41	60.59
	L (28%)	44.25	179.94	181.48	1.54	67.99	60.14

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (27%)	42.67	179.94	181.45	1.51	66.53	59.67
	L (26%)	41.09	179.94	181.43	1.49	65.23	59.24
	L (25%)	39.51	179.94	181.41	1.47	64	58.84
	L (24%)	37.93	179.94	181.39	1.45	62.74	58.52
	L (23%)	36.35	179.94	181.36	1.42	61.48	58.21
	L (22%)	34.77	179.94	181.34	1.4	60.19	57.89
	L (21%)	33.19	179.94	181.32	1.38	58.83	57.54
	L (20%)	31.61	179.94	181.29	1.35	57.23	57.14
	L (19%)	30.03	179.94	181.26	1.32	55.72	56.75
	L (18%)	28.45	179.94	181.24	1.3	54.17	56.35
	L (17%)	26.87	179.94	181.21	1.27	52.48	55.91
	L (16%)	25.29	179.94	181.18	1.24	50.85	55.48
	L (15%)	23.71	179.94	181.15	1.21	49.16	55.04
200 m d/s of Barrage axis	M (100%)	708.88	179.8	184.41	4.61	509.54	215.68
	M (30%)	212.66	179.8	182.43	2.63	130.54	153.95
	M (29%)	205.57	179.8	182.4	2.6	125.11	149.78
	M (28%)	198.49	179.8	182.36	2.56	119.8	145.56
	M (27%)	191.4	179.8	182.32	2.52	114.13	140.91
	M (26%)	184.31	179.8	182.28	2.48	109.03	135.18
	M (25%)	177.22	179.8	182.25	2.45	104.09	127.09
	M (24%)	170.13	179.8	182.21	2.41	99.46	118.14
	M (23%)	163.04	179.8	182.17	2.37	94.69	108.16
	M (22%)	155.95	179.8	182.12	2.32	90.24	98.09
	M (21%)	148.86	179.8	182.08	2.28	86.01	89.64
	M (20%)	141.78	179.8	182.03	2.23	82.07	85.66
	M (19%)	134.69	179.8	181.99	2.19	78.21	81.57
	M (18%)	127.6	179.8	181.94	2.14	74.51	78.94
	M (17%)	120.51	179.8	181.89	2.09	70.88	76.35
	M (16%)	113.42	179.8	181.85	2.05	67.34	73.74
	M (15%)	106.33	179.8	181.8	2	63.9	71.12
	NMNL-1 (100%)	350.18	179.8	183.11	3.31	246.85	180.36
	NMNL-1 (30%)	105.05	179.8	181.79	1.99	63.29	70.64
	NMNL-1 (29%)	101.55	179.8	181.77	1.97	61.61	69.31
	NMNL-1 (28%)	98.05	179.8	181.74	1.94	59.93	67.96
	NMNL-1 (27%)	94.55	179.8	181.72	1.92	58.32	66.57
	NMNL-1 (26%)	91.05	179.8	181.69	1.89	56.69	64.84
	NMNL-1 (25%)	87.54	179.8	181.67	1.87	55.08	63.11
	NMNL-1 (24%)	84.04	179.8	181.64	1.84	53.47	61.31
	NMNL-1 (23%)	80.54	179.8	181.62	1.82	51.87	59.48
	NMNL-1 (22%)	77.04	179.8	181.59	1.79	50.34	57.68
	NMNL-1 (21%)	73.54	179.8	181.56	1.76	48.81	55.81
	NMNL-1 (20%)	70.04	179.8	181.53	1.73	47.28	53.89
	NMNL-1 (19%)	66.53	179.8	181.51	1.71	45.77	51.92

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (18%)	63.03	179.8	181.48	1.68	44.28	49.9
	NMNL-1 (17%)	59.53	179.8	181.45	1.65	42.79	48.61
	NMNL-1 (16%)	56.03	179.8	181.42	1.62	41.31	47.73
	NMNL-1 (15%)	52.53	179.8	181.38	1.58	39.75	46.8
	NMNL-2 (100%)	252.93	179.8	182.64	2.84	165.42	171.63
	NMNL-2 (30%)	75.88	179.8	181.58	1.78	49.83	57.06
	NMNL-2 (29%)	73.35	179.8	181.56	1.76	48.72	55.71
	NMNL-2 (28%)	70.82	179.8	181.54	1.74	47.62	54.33
	NMNL-2 (27%)	68.29	179.8	181.52	1.72	46.52	52.91
	NMNL-2 (26%)	65.76	179.8	181.5	1.7	45.44	51.48
	NMNL-2 (25%)	63.23	179.8	181.48	1.68	44.36	50.01
	NMNL-2 (24%)	60.7	179.8	181.46	1.66	43.29	48.9
	NMNL-2 (23%)	58.17	179.8	181.43	1.63	42.21	48.27
	NMNL-2 (22%)	55.64	179.8	181.41	1.61	41.14	47.63
	NMNL-2 (21%)	53.12	179.8	181.39	1.59	40.01	46.96
	NMNL-2 (20%)	50.59	179.8	181.36	1.56	38.86	46.29
	NMNL-2 (19%)	48.06	179.8	181.34	1.54	37.68	45.61
	NMNL-2 (18%)	45.53	179.8	181.31	1.51	36.45	44.88
	NMNL-2 (17%)	43	179.8	181.28	1.48	35.22	44.15
	NMNL-2 (16%)	40.47	179.8	181.25	1.45	34	43.41
	NMNL-2 (15%)	37.94	179.8	181.23	1.43	32.72	42.61
	L (100%)	158.05	179.8	182.14	2.34	91.53	101.13
	L (30%)	47.41	179.8	181.33	1.53	37.37	45.42
	L (29%)	45.83	179.8	181.31	1.51	36.6	44.97
	L (28%)	44.25	179.8	181.3	1.5	35.82	44.51
	L (27%)	42.67	179.8	181.28	1.48	35.07	44.06
	L (26%)	41.09	179.8	181.26	1.46	34.3	43.59
	L (25%)	39.51	179.8	181.24	1.44	33.52	43.11
	L (24%)	37.93	179.8	181.23	1.43	32.72	42.61
	L (23%)	36.35	179.8	181.21	1.41	31.89	42.09
	L (22%)	34.77	179.8	181.19	1.39	31.05	41.55
	L (21%)	33.19	179.8	181.16	1.36	30.12	40.95
	L (20%)	31.61	179.8	181.14	1.34	29	40.21
	L (19%)	30.03	179.8	181.11	1.31	27.97	39.52
	L (18%)	28.45	179.8	181.08	1.28	26.93	38.81
	L (17%)	26.87	179.8	181.05	1.25	25.8	38.03
	L (16%)	25.29	179.8	181.02	1.22	24.69	37.24
	L (15%)	23.71	179.8	180.99	1.19	23.55	36.41
250 m d/s of Barrage axis	M (100%)	708.88	179.66	184.4	4.74	632.86	211.38
	M (30%)	212.66	179.66	182.35	2.69	219.48	176.87
	M (29%)	205.57	179.66	182.31	2.65	211.86	174.77
	M (28%)	198.49	179.66	182.26	2.6	203.98	172.57
	M (27%)	191.4	179.66	182.22	2.56	196.02	170.43

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (26%)	184.31	179.66	182.17	2.51	188.36	169.5
	M (25%)	177.22	179.66	182.13	2.47	180.28	168.52
	M (24%)	170.13	179.66	182.08	2.42	172.55	167.57
	M (23%)	163.04	179.66	182.03	2.37	164.55	166.57
	M (22%)	155.95	179.66	181.98	2.32	156.61	165.57
	M (21%)	148.86	179.66	181.93	2.27	148.48	164.54
	M (20%)	141.78	179.66	181.89	2.23	140.59	163.53
	M (19%)	134.69	179.66	181.84	2.18	132.57	162.5
	M (18%)	127.6	179.66	181.79	2.13	124.67	161.48
	M (17%)	120.51	179.66	181.74	2.08	116.58	160.44
	M (16%)	113.42	179.66	181.69	2.03	108.7	153.32
	M (15%)	106.33	179.66	181.64	1.98	101.22	142.39
	NMNL-1 (100%)	350.18	179.66	183.08	3.42	358.13	200.95
	NMNL-1 (30%)	105.05	179.66	181.63	1.97	99.91	140.37
	NMNL-1 (29%)	101.55	179.66	181.6	1.94	96.41	134.92
	NMNL-1 (28%)	98.05	179.66	181.58	1.92	93.06	129.53
	NMNL-1 (27%)	94.55	179.66	181.55	1.89	89.86	124.03
	NMNL-1 (26%)	91.05	179.66	181.53	1.87	86.73	118.45
	NMNL-1 (25%)	87.54	179.66	181.5	1.84	83.73	112.91
	NMNL-1 (24%)	84.04	179.66	181.47	1.81	80.78	107.19
	NMNL-1 (23%)	80.54	179.66	181.45	1.79	77.96	102.21
	NMNL-1 (22%)	77.04	179.66	181.42	1.76	75.26	100.48
	NMNL-1 (21%)	73.54	179.66	181.39	1.73	72.56	98.7
	NMNL-1 (20%)	70.04	179.66	181.37	1.71	69.87	96.91
	NMNL-1 (19%)	66.53	179.66	181.34	1.68	67.19	95.08
	NMNL-1 (18%)	63.03	179.66	181.31	1.65	64.53	93.24
	NMNL-1 (17%)	59.53	179.66	181.28	1.62	61.77	91.28
	NMNL-1 (16%)	56.03	179.66	181.25	1.59	59.02	89.29
	NMNL-1 (15%)	52.53	179.66	181.22	1.56	56.22	87.21
	NMNL-2 (100%)	252.93	179.66	182.59	2.93	263.46	190.01
	NMNL-2 (30%)	75.88	179.66	181.41	1.75	74.37	99.89
	NMNL-2 (29%)	73.35	179.66	181.39	1.73	72.41	98.6
	NMNL-2 (28%)	70.82	179.66	181.37	1.71	70.48	97.31
	NMNL-2 (27%)	68.29	179.66	181.35	1.69	68.54	96
	NMNL-2 (26%)	65.76	179.66	181.33	1.67	66.61	94.68
	NMNL-2 (25%)	63.23	179.66	181.31	1.65	64.69	93.34
	NMNL-2 (24%)	60.7	179.66	181.29	1.63	62.72	91.95
	NMNL-2 (23%)	58.17	179.66	181.27	1.61	60.7	90.51
	NMNL-2 (22%)	55.64	179.66	181.25	1.59	58.72	89.07
	NMNL-2 (21%)	53.12	179.66	181.22	1.56	56.69	87.57
	NMNL-2 (20%)	50.59	179.66	181.2	1.54	54.65	86.03
	NMNL-2 (19%)	48.06	179.66	181.17	1.51	52.6	84.47
	NMNL-2 (18%)	45.53	179.66	181.15	1.49	50.51	82.86
	NMNL-2 (17%)	43	179.66	181.12	1.46	48.36	81.19

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (16%)	40.47	179.66	181.1	1.44	46.2	79.46
	NMNL-2 (15%)	37.94	179.66	181.07	1.41	43.93	77.6
	L (100%)	158.05	179.66	182	2.34	158.97	165.87
	L (30%)	47.41	179.66	181.17	1.51	52.08	84.07
	L (29%)	45.83	179.66	181.15	1.49	50.76	83.06
	L (28%)	44.25	179.66	181.14	1.48	49.43	82.02
	L (27%)	42.67	179.66	181.12	1.46	48.08	80.97
	L (26%)	41.09	179.66	181.1	1.44	46.75	79.9
	L (25%)	39.51	179.66	181.09	1.43	45.39	78.8
	L (24%)	37.93	179.66	181.07	1.41	43.92	77.6
	L (23%)	36.35	179.66	181.05	1.39	42.51	76.42
	L (22%)	34.77	179.66	181.03	1.37	41.06	75.17
	L (21%)	33.19	179.66	181.01	1.35	39.45	72.91
	L (20%)	31.61	179.66	180.98	1.32	37.47	70.04
	L (19%)	30.03	179.66	180.95	1.29	35.6	67.23
	L (18%)	28.45	179.66	180.93	1.27	33.77	64.34
	L (17%)	26.87	179.66	180.89	1.23	31.85	58.09
	L (16%)	25.29	179.66	180.86	1.2	30.1	55.2
	L (15%)	23.71	179.66	180.83	1.17	28.34	53.14
300 m d/s of Barrage axis	M (100%)	708.88	179.53	184.39	4.86	686.63	188.55
	M (30%)	212.66	179.53	182.34	2.81	314.04	173.27
	M (29%)	205.57	179.53	182.29	2.76	306.48	172.91
	M (28%)	198.49	179.53	182.25	2.72	298.54	172.54
	M (27%)	191.4	179.53	182.2	2.67	290.42	172.15
	M (26%)	184.31	179.53	182.15	2.62	282.56	171.74
	M (25%)	177.22	179.53	182.11	2.58	274.23	171.3
	M (24%)	170.13	179.53	182.06	2.53	266.24	170.88
	M (23%)	163.04	179.53	182.01	2.48	257.87	170.44
	M (22%)	155.95	179.53	181.96	2.43	249.52	170.01
	M (21%)	148.86	179.53	181.91	2.38	240.96	169.55
	M (20%)	141.78	179.53	181.86	2.33	232.56	169.11
	M (19%)	134.69	179.53	181.81	2.28	223.95	168.65
	M (18%)	127.6	179.53	181.76	2.23	215.42	168.2
	M (17%)	120.51	179.53	181.71	2.18	206.61	167.73
	M (16%)	113.42	179.53	181.66	2.13	197.93	167.27
	M (15%)	106.33	179.53	181.6	2.07	189.1	166.36
	NMNL-1 (100%)	350.18	179.53	183.07	3.54	442.82	179.21
	NMNL-1 (30%)	105.05	179.53	181.59	2.06	187.49	166.11
	NMNL-1 (29%)	101.55	179.53	181.57	2.04	183.05	165.43
	NMNL-1 (28%)	98.05	179.53	181.54	2.01	178.61	164.74
	NMNL-1 (27%)	94.55	179.53	181.51	1.98	174.14	164.05
	NMNL-1 (26%)	91.05	179.53	181.48	1.95	169.61	163.35
	NMNL-1 (25%)	87.54	179.53	181.46	1.93	165.08	162.64

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (24%)	84.04	179.53	181.43	1.9	160.5	161.92
	NMNL-1 (23%)	80.54	179.53	181.4	1.87	155.88	161.19
	NMNL-1 (22%)	77.04	179.53	181.37	1.84	151.24	160.45
	NMNL-1 (21%)	73.54	179.53	181.34	1.81	146.48	159.69
	NMNL-1 (20%)	70.04	179.53	181.31	1.78	141.67	158.92
	NMNL-1 (19%)	66.53	179.53	181.28	1.75	136.76	158.13
	NMNL-1 (18%)	63.03	179.53	181.25	1.72	131.85	157.34
	NMNL-1 (17%)	59.53	179.53	181.22	1.69	126.74	156.42
	NMNL-1 (16%)	56.03	179.53	181.18	1.65	121.61	155.42
	NMNL-1 (15%)	52.53	179.53	181.15	1.62	116.52	144.32
	NMNL-2 (100%)	252.93	179.53	182.58	3.05	356.17	175.25
	NMNL-2 (30%)	75.88	179.53	181.36	1.83	149.67	160.2
	NMNL-2 (29%)	73.35	179.53	181.34	1.81	146.22	159.65
	NMNL-2 (28%)	70.82	179.53	181.32	1.79	142.76	159.1
	NMNL-2 (27%)	68.29	179.53	181.3	1.77	139.23	158.53
	NMNL-2 (26%)	65.76	179.53	181.27	1.74	135.7	157.96
	NMNL-2 (25%)	63.23	179.53	181.25	1.72	132.13	157.38
	NMNL-2 (24%)	60.7	179.53	181.23	1.7	128.5	156.76
	NMNL-2 (23%)	58.17	179.53	181.2	1.67	124.76	156.03
	NMNL-2 (22%)	55.64	179.53	181.18	1.65	121.04	154.76
	NMNL-2 (21%)	53.12	179.53	181.16	1.63	117.36	145.49
	NMNL-2 (20%)	50.59	179.53	181.13	1.6	113.71	142.2
	NMNL-2 (19%)	48.06	179.53	181.1	1.57	110	139.74
	NMNL-2 (18%)	45.53	179.53	181.08	1.55	106.06	137.07
	NMNL-2 (17%)	43	179.53	181.05	1.52	102.09	134.33
	NMNL-2 (16%)	40.47	179.53	181.02	1.49	98.04	131.47
	NMNL-2 (15%)	37.94	179.53	180.98	1.45	93.98	129.02
	L (100%)	158.05	179.53	181.98	2.45	252	170.14
	L (30%)	47.41	179.53	181.1	1.57	109.03	139.09
	L (29%)	45.83	179.53	181.08	1.55	106.52	137.39
	L (28%)	44.25	179.53	181.06	1.53	104.04	135.69
	L (27%)	42.67	179.53	181.04	1.51	101.58	133.97
	L (26%)	41.09	179.53	181.02	1.49	99.04	132.19
	L (25%)	39.51	179.53	181	1.47	96.5	130.53
	L (24%)	37.93	179.53	180.98	1.45	93.97	129.01
	L (23%)	36.35	179.53	180.96	1.43	91.43	127.48
	L (22%)	34.77	179.53	180.94	1.41	88.82	125.88
	L (21%)	33.19	179.53	180.92	1.39	85.76	123.97
	L (20%)	31.61	179.53	180.89	1.36	82.41	121.86
	L (19%)	30.03	179.53	180.86	1.33	79.05	119.69
	L (18%)	28.45	179.53	180.84	1.31	75.75	117.52
	L (17%)	26.87	179.53	180.81	1.28	72.38	115.27
	L (16%)	25.29	179.53	180.78	1.25	68.9	112.9
	L (15%)	23.71	179.53	180.74	1.21	65.23	110.34

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
350 m d/s of Barrage axis	M (100%)	708.88	179.4	184.37	4.97	635.67	182.09
	M (30%)	212.66	179.4	182.31	2.91	283.7	160.75
	M (29%)	205.57	179.4	182.27	2.87	276.66	160.32
	M (28%)	198.49	179.4	182.22	2.82	269.26	159.86
	M (27%)	191.4	179.4	182.18	2.78	261.69	159.4
	M (26%)	184.31	179.4	182.13	2.73	254.38	158.95
	M (25%)	177.22	179.4	182.08	2.68	246.62	158.47
	M (24%)	170.13	179.4	182.03	2.63	239.2	158
	M (23%)	163.04	179.4	181.98	2.58	231.39	157.52
	M (22%)	155.95	179.4	181.93	2.53	223.62	157.03
	M (21%)	148.86	179.4	181.88	2.48	215.65	156.53
	M (20%)	141.78	179.4	181.83	2.43	207.84	156.04
	M (19%)	134.69	179.4	181.78	2.38	199.83	155.49
	M (18%)	127.6	179.4	181.73	2.33	191.92	154.94
	M (17%)	120.51	179.4	181.68	2.28	183.72	154.37
	M (16%)	113.42	179.4	181.63	2.23	175.68	153.81
	M (15%)	106.33	179.4	181.57	2.17	167.49	153.23
	NMNL-1 (100%)	350.18	179.4	183.04	3.64	404	168.41
	NMNL-1 (30%)	105.05	179.4	181.56	2.16	165.99	153.13
	NMNL-1 (29%)	101.55	179.4	181.54	2.14	161.86	152.61
	NMNL-1 (28%)	98.05	179.4	181.51	2.11	157.75	151.74
	NMNL-1 (27%)	94.55	179.4	181.48	2.08	153.62	150.86
	NMNL-1 (26%)	91.05	179.4	181.45	2.05	149.43	149.97
	NMNL-1 (25%)	87.54	179.4	181.43	2.03	145.27	149.08
	NMNL-1 (24%)	84.04	179.4	181.4	2	141.05	148.17
	NMNL-1 (23%)	80.54	179.4	181.37	1.97	136.8	147.24
	NMNL-1 (22%)	77.04	179.4	181.34	1.94	132.55	146.31
	NMNL-1 (21%)	73.54	179.4	181.31	1.91	128.19	145.35
	NMNL-1 (20%)	70.04	179.4	181.28	1.88	123.79	144.38
	NMNL-1 (19%)	66.53	179.4	181.25	1.85	119.32	143.38
	NMNL-1 (18%)	63.03	179.4	181.22	1.82	114.85	142.37
	NMNL-1 (17%)	59.53	179.4	181.18	1.78	110.19	141.32
	NMNL-1 (16%)	56.03	179.4	181.15	1.75	105.52	140.25
	NMNL-1 (15%)	52.53	179.4	181.12	1.72	100.76	138.48
	NMNL-2 (100%)	252.93	179.4	182.56	3.16	322.98	163.13
	NMNL-2 (30%)	75.88	179.4	181.33	1.93	131.11	146
	NMNL-2 (29%)	73.35	179.4	181.31	1.91	127.95	145.3
	NMNL-2 (28%)	70.82	179.4	181.29	1.89	124.79	144.6
	NMNL-2 (27%)	68.29	179.4	181.26	1.86	121.56	143.88
	NMNL-2 (26%)	65.76	179.4	181.24	1.84	118.34	143.16
	NMNL-2 (25%)	63.23	179.4	181.22	1.82	115.1	142.43
	NMNL-2 (24%)	60.7	179.4	181.2	1.8	111.8	141.68
	NMNL-2 (23%)	58.17	179.4	181.17	1.77	108.38	140.91

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (22%)	55.64	179.4	181.15	1.75	105.01	140.14
	NMNL-2 (21%)	53.12	179.4	181.12	1.72	101.56	138.86
	NMNL-2 (20%)	50.59	179.4	181.1	1.7	98.03	136.17
	NMNL-2 (19%)	48.06	179.4	181.07	1.67	94.55	131.89
	NMNL-2 (18%)	45.53	179.4	181.04	1.64	90.98	127.37
	NMNL-2 (17%)	43	179.4	181.02	1.62	87.38	123.88
	NMNL-2 (16%)	40.47	179.4	180.99	1.59	83.71	120.41
	NMNL-2 (15%)	37.94	179.4	180.95	1.55	80.07	116.87
	L (100%)	158.05	179.4	181.95	2.55	225.94	157.18
	L (30%)	47.41	179.4	181.06	1.66	93.66	130.78
	L (29%)	45.83	179.4	181.05	1.65	91.4	127.91
	L (28%)	44.25	179.4	181.03	1.63	89.15	125.51
	L (27%)	42.67	179.4	181.01	1.61	86.91	123.44
	L (26%)	41.09	179.4	180.99	1.59	84.61	121.27
	L (25%)	39.51	179.4	180.97	1.57	82.33	119.07
	L (24%)	37.93	179.4	180.95	1.55	80.06	116.85
	L (23%)	36.35	179.4	180.94	1.54	77.81	114.61
	L (22%)	34.77	179.4	180.91	1.51	75.51	112.27
	L (21%)	33.19	179.4	180.89	1.49	72.8	109.43
	L (20%)	31.61	179.4	180.86	1.46	69.83	106.41
	L (19%)	30.03	179.4	180.83	1.43	66.89	103.33
	L (18%)	28.45	179.4	180.81	1.41	64.05	100.24
	L (17%)	26.87	179.4	180.78	1.38	61.19	97.02
	L (16%)	25.29	179.4	180.75	1.35	58.28	93.65
	L (15%)	23.71	179.4	180.71	1.31	55.24	90.43
400 m d/s of Barrage axis	M (100%)	708.88	179.26	184.35	5.09	647.14	179.08
	M (30%)	212.66	179.26	182.29	3.03	294.23	158.67
	M (29%)	205.57	179.26	182.25	2.99	287.25	157.93
	M (28%)	198.49	179.26	182.2	2.94	279.93	157.15
	M (27%)	191.4	179.26	182.16	2.9	272.44	156.34
	M (26%)	184.31	179.26	182.11	2.85	265.23	155.56
	M (25%)	177.22	179.26	182.06	2.8	257.59	154.73
	M (24%)	170.13	179.26	182.01	2.75	250.31	153.94
	M (23%)	163.04	179.26	181.96	2.7	242.66	153.1
	M (22%)	155.95	179.26	181.91	2.65	235.07	152.26
	M (21%)	148.86	179.26	181.86	2.6	227.28	151.39
	M (20%)	141.78	179.26	181.81	2.55	219.69	150.55
	M (19%)	134.69	179.26	181.76	2.5	211.91	149.62
	M (18%)	127.6	179.26	181.71	2.45	204.25	148.7
	M (17%)	120.51	179.26	181.66	2.4	196.34	147.75
	M (16%)	113.42	179.26	181.6	2.34	188.61	146.81
	M (15%)	106.33	179.26	181.55	2.29	180.77	145.3
	NMNL-1 (100%)	350.18	179.26	183.03	3.77	415.05	169.95

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (30%)	105.05	179.26	181.54	2.28	179.35	144.03
	NMNL-1 (29%)	101.55	179.26	181.51	2.25	175.5	140.55
	NMNL-1 (28%)	98.05	179.26	181.49	2.23	171.75	137.66
	NMNL-1 (27%)	94.55	179.26	181.46	2.2	168	136.84
	NMNL-1 (26%)	91.05	179.26	181.43	2.17	164.21	136.01
	NMNL-1 (25%)	87.54	179.26	181.4	2.14	160.44	135.18
	NMNL-1 (24%)	84.04	179.26	181.37	2.11	156.63	134.33
	NMNL-1 (23%)	80.54	179.26	181.35	2.09	152.78	133.47
	NMNL-1 (22%)	77.04	179.26	181.32	2.06	148.95	132.61
	NMNL-1 (21%)	73.54	179.26	181.29	2.03	145.03	131.73
	NMNL-1 (20%)	70.04	179.26	181.26	2	141.07	130.82
	NMNL-1 (19%)	66.53	179.26	181.23	1.97	137.04	129.9
	NMNL-1 (18%)	63.03	179.26	181.19	1.93	133.01	128.97
	NMNL-1 (17%)	59.53	179.26	181.16	1.9	128.81	127.99
	NMNL-1 (16%)	56.03	179.26	181.13	1.87	124.61	127.01
	NMNL-1 (15%)	52.53	179.26	181.09	1.83	120.31	125.99
	NMNL-2 (100%)	252.93	179.26	182.54	3.28	333.39	162.76
	NMNL-2 (30%)	75.88	179.26	181.31	2.05	147.66	132.32
	NMNL-2 (29%)	73.35	179.26	181.29	2.03	144.82	131.68
	NMNL-2 (28%)	70.82	179.26	181.26	2	141.97	131.03
	NMNL-2 (27%)	68.29	179.26	181.24	1.98	139.06	130.36
	NMNL-2 (26%)	65.76	179.26	181.22	1.96	136.16	129.7
	NMNL-2 (25%)	63.23	179.26	181.2	1.94	133.24	129.02
	NMNL-2 (24%)	60.7	179.26	181.17	1.91	130.26	128.33
	NMNL-2 (23%)	58.17	179.26	181.15	1.89	127.18	127.61
	NMNL-2 (22%)	55.64	179.26	181.13	1.87	124.14	126.9
	NMNL-2 (21%)	53.12	179.26	181.1	1.84	121.04	126.17
	NMNL-2 (20%)	50.59	179.26	181.08	1.82	117.86	125.41
	NMNL-2 (19%)	48.06	179.26	181.05	1.79	114.65	124.43
	NMNL-2 (18%)	45.53	179.26	181.02	1.76	111.29	123.25
	NMNL-2 (17%)	43	179.26	180.99	1.73	107.85	121.43
	NMNL-2 (16%)	40.47	179.26	180.97	1.71	104.29	119.53
	NMNL-2 (15%)	37.94	179.26	180.94	1.68	100.75	117.6
	L (100%)	158.05	179.26	181.93	2.67	237.33	152.51
	L (30%)	47.41	179.26	181.04	1.78	113.83	124.18
	L (29%)	45.83	179.26	181.03	1.77	111.7	123.46
	L (28%)	44.25	179.26	181.01	1.75	109.55	122.34
	L (27%)	42.67	179.26	180.99	1.73	107.39	121.19
	L (26%)	41.09	179.26	180.97	1.71	105.17	120
	L (25%)	39.51	179.26	180.95	1.69	102.95	118.8
	L (24%)	37.93	179.26	180.94	1.68	100.74	117.59
	L (23%)	36.35	179.26	180.92	1.66	98.54	114.41
	L (22%)	34.77	179.26	180.9	1.64	96.33	110.59
	L (21%)	33.19	179.26	180.87	1.61	93.73	105.91

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (20%)	31.61	179.26	180.85	1.59	90.94	100.63
	L (19%)	30.03	179.26	180.82	1.56	88.25	95.21
	L (18%)	28.45	179.26	180.79	1.53	85.73	92.46
	L (17%)	26.87	179.26	180.76	1.5	83.14	90.94
	L (16%)	25.29	179.26	180.73	1.47	80.45	89.34
	L (15%)	23.71	179.26	180.7	1.44	77.6	87.61
450 m d/s of Barrage axis	M (100%)	708.88	179.13	184.32	5.19	604.92	166.02
	M (30%)	212.66	179.13	182.28	3.15	291.99	140.15
	M (29%)	205.57	179.13	182.23	3.1	285.85	139.57
	M (28%)	198.49	179.13	182.19	3.06	279.38	138.95
	M (27%)	191.4	179.13	182.14	3.01	272.77	138.32
	M (26%)	184.31	179.13	182.09	2.96	266.41	137.69
	M (25%)	177.22	179.13	182.04	2.91	259.66	136.99
	M (24%)	170.13	179.13	182	2.87	253.22	136.32
	M (23%)	163.04	179.13	181.95	2.82	246.47	135.62
	M (22%)	155.95	179.13	181.9	2.77	239.75	134.91
	M (21%)	148.86	179.13	181.85	2.72	232.86	134.18
	M (20%)	141.78	179.13	181.8	2.67	226.16	133.47
	M (19%)	134.69	179.13	181.74	2.61	219.28	132.74
	M (18%)	127.6	179.13	181.69	2.56	212.51	132.01
	M (17%)	120.51	179.13	181.64	2.51	205.5	131.25
	M (16%)	113.42	179.13	181.59	2.46	198.66	130.35
	M (15%)	106.33	179.13	181.53	2.4	191.75	129.13
	NMNL-1 (100%)	350.18	179.13	183.01	3.88	397.76	149.33
	NMNL-1 (30%)	105.05	179.13	181.52	2.39	190.49	128.91
	NMNL-1 (29%)	101.55	179.13	181.5	2.37	187.05	128.28
	NMNL-1 (28%)	98.05	179.13	181.47	2.34	183.63	127.64
	NMNL-1 (27%)	94.55	179.13	181.44	2.31	180.18	126.99
	NMNL-1 (26%)	91.05	179.13	181.42	2.29	176.69	126.33
	NMNL-1 (25%)	87.54	179.13	181.39	2.26	173.23	125.67
	NMNL-1 (24%)	84.04	179.13	181.36	2.23	169.73	125
	NMNL-1 (23%)	80.54	179.13	181.33	2.2	166.18	124.32
	NMNL-1 (22%)	77.04	179.13	181.3	2.17	162.65	123.64
	NMNL-1 (21%)	73.54	179.13	181.27	2.14	159.06	122.94
	NMNL-1 (20%)	70.04	179.13	181.24	2.11	155.4	122.05
	NMNL-1 (19%)	66.53	179.13	181.21	2.08	151.69	120.93
	NMNL-1 (18%)	63.03	179.13	181.18	2.05	148	119.82
	NMNL-1 (17%)	59.53	179.13	181.15	2.02	144.17	118.65
	NMNL-1 (16%)	56.03	179.13	181.12	1.99	140.33	117.47
	NMNL-1 (15%)	52.53	179.13	181.08	1.95	136.41	116.25
	NMNL-2 (100%)	252.93	179.13	182.52	3.39	326.45	143.31
	NMNL-2 (30%)	75.88	179.13	181.29	2.16	161.47	123.41
	NMNL-2 (29%)	73.35	179.13	181.27	2.14	158.86	122.9

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (28%)	70.82	179.13	181.25	2.12	156.23	122.29
	NMNL-2 (27%)	68.29	179.13	181.23	2.1	153.55	121.49
	NMNL-2 (26%)	65.76	179.13	181.21	2.08	150.89	120.69
	NMNL-2 (25%)	63.23	179.13	181.18	2.05	148.22	119.88
	NMNL-2 (24%)	60.7	179.13	181.16	2.03	145.5	119.06
	NMNL-2 (23%)	58.17	179.13	181.14	2.01	142.68	118.19
	NMNL-2 (22%)	55.64	179.13	181.11	1.98	139.9	117.33
	NMNL-2 (21%)	53.12	179.13	181.09	1.96	137.08	116.45
	NMNL-2 (20%)	50.59	179.13	181.07	1.94	134.2	115.55
	NMNL-2 (19%)	48.06	179.13	181.04	1.91	131.28	114.63
	NMNL-2 (18%)	45.53	179.13	181.01	1.88	128.24	112.42
	NMNL-2 (17%)	43	179.13	180.99	1.86	125.2	107.08
	NMNL-2 (16%)	40.47	179.13	180.96	1.83	122.24	97.56
	NMNL-2 (15%)	37.94	179.13	180.93	1.8	119.42	95.67
	L (100%)	158.05	179.13	181.91	2.78	241.75	135.12
	L (30%)	47.41	179.13	181.03	1.9	130.54	114.4
	L (29%)	45.83	179.13	181.02	1.89	128.6	113.02
	L (28%)	44.25	179.13	181	1.87	126.69	109.78
	L (27%)	42.67	179.13	180.98	1.85	124.81	105.88
	L (26%)	41.09	179.13	180.96	1.83	122.95	99.92
	L (25%)	39.51	179.13	180.95	1.82	121.17	96.24
	L (24%)	37.93	179.13	180.93	1.8	119.41	95.67
	L (23%)	36.35	179.13	180.91	1.78	117.65	95.09
	L (22%)	34.77	179.13	180.89	1.76	115.83	94.48
	L (21%)	33.19	179.13	180.87	1.74	113.61	93.74
	L (20%)	31.61	179.13	180.84	1.71	111.12	92.9
	L (19%)	30.03	179.13	180.81	1.68	108.6	92.05
	L (18%)	28.45	179.13	180.79	1.66	106.15	91.21
	L (17%)	26.87	179.13	180.76	1.63	103.6	90.32
	L (16%)	25.29	179.13	180.73	1.6	100.94	89.39
	L (15%)	23.71	179.13	180.7	1.57	98.09	88.39
500 m d/s of Barrage axis	M (100%)	708.88	178.99	184.25	5.26	482.29	126.92
	M (30%)	212.66	178.99	182.24	3.25	243	110.03
	M (29%)	205.57	178.99	182.2	3.21	238.22	109.62
	M (28%)	198.49	178.99	182.15	3.16	233.19	109.17
	M (27%)	191.4	178.99	182.1	3.11	228.03	108.72
	M (26%)	184.31	178.99	182.06	3.07	223.08	108.28
	M (25%)	177.22	178.99	182.01	3.02	217.81	107.81
	M (24%)	170.13	178.99	181.96	2.97	212.8	107.37
	M (23%)	163.04	178.99	181.91	2.92	207.53	106.89
	M (22%)	155.95	178.99	181.86	2.87	202.29	106.42
	M (21%)	148.86	178.99	181.81	2.82	196.91	105.9
	M (20%)	141.78	178.99	181.76	2.77	191.69	105.35

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (19%)	134.69	178.99	181.71	2.72	186.32	104.79
	M (18%)	127.6	178.99	181.66	2.67	181.06	104.24
	M (17%)	120.51	178.99	181.61	2.62	175.61	103.66
	M (16%)	113.42	178.99	181.56	2.57	170.32	102.35
	M (15%)	106.33	178.99	181.51	2.52	165.02	100.76
	NMNL-1 (100%)	350.18	178.99	182.96	3.97	324.91	116.58
	NMNL-1 (30%)	105.05	178.99	181.5	2.51	164.06	100.47
	NMNL-1 (29%)	101.55	178.99	181.47	2.48	161.43	99.67
	NMNL-1 (28%)	98.05	178.99	181.44	2.45	158.84	98.65
	NMNL-1 (27%)	94.55	178.99	181.42	2.43	156.32	92.76
	NMNL-1 (26%)	91.05	178.99	181.39	2.4	153.92	86.87
	NMNL-1 (25%)	87.54	178.99	181.37	2.38	151.61	86.51
	NMNL-1 (24%)	84.04	178.99	181.34	2.35	149.27	86.14
	NMNL-1 (23%)	80.54	178.99	181.31	2.32	146.91	85.78
	NMNL-1 (22%)	77.04	178.99	181.28	2.29	144.55	85.41
	NMNL-1 (21%)	73.54	178.99	181.25	2.26	142.14	85.03
	NMNL-1 (20%)	70.04	178.99	181.23	2.24	139.71	84.65
	NMNL-1 (19%)	66.53	178.99	181.2	2.21	137.21	84.25
	NMNL-1 (18%)	63.03	178.99	181.17	2.18	134.71	83.85
	NMNL-1 (17%)	59.53	178.99	181.14	2.15	132.11	83.44
	NMNL-1 (16%)	56.03	178.99	181.1	2.11	129.49	83.01
	NMNL-1 (15%)	52.53	178.99	181.07	2.08	126.79	82.58
	NMNL-2 (100%)	252.93	178.99	182.48	3.49	269.78	112.35
	NMNL-2 (30%)	75.88	178.99	181.27	2.28	143.76	85.28
	NMNL-2 (29%)	73.35	178.99	181.25	2.26	142.01	85.01
	NMNL-2 (28%)	70.82	178.99	181.23	2.24	140.26	84.73
	NMNL-2 (27%)	68.29	178.99	181.21	2.22	138.46	84.45
	NMNL-2 (26%)	65.76	178.99	181.19	2.2	136.66	84.16
	NMNL-2 (25%)	63.23	178.99	181.17	2.18	134.85	83.87
	NMNL-2 (24%)	60.7	178.99	181.15	2.16	133	83.58
	NMNL-2 (23%)	58.17	178.99	181.12	2.13	131.1	83.27
	NMNL-2 (22%)	55.64	178.99	181.1	2.11	129.19	82.97
	NMNL-2 (21%)	53.12	178.99	181.08	2.09	127.25	82.65
	NMNL-2 (20%)	50.59	178.99	181.05	2.06	125.26	82.33
	NMNL-2 (19%)	48.06	178.99	181.03	2.04	123.25	82
	NMNL-2 (18%)	45.53	178.99	181	2.01	121.11	81.63
	NMNL-2 (17%)	43	178.99	180.98	1.99	118.92	81.25
	NMNL-2 (16%)	40.47	178.99	180.95	1.96	116.64	80.84
	NMNL-2 (15%)	37.94	178.99	180.92	1.93	114.32	80.43
	L (100%)	158.05	178.99	181.88	2.89	203.85	106.56
	L (30%)	47.41	178.99	181.02	2.03	122.72	81.92
	L (29%)	45.83	178.99	181.01	2.02	121.37	81.68
	L (28%)	44.25	178.99	180.99	2	120.01	81.44
	L (27%)	42.67	178.99	180.97	1.98	118.63	81.2

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (26%)	41.09	178.99	180.95	1.96	117.2	80.94
	L (25%)	39.51	178.99	180.94	1.95	115.76	80.69
	L (24%)	37.93	178.99	180.92	1.93	114.31	80.43
	L (23%)	36.35	178.99	180.9	1.91	112.86	80.17
	L (22%)	34.77	178.99	180.88	1.89	111.36	79.9
	L (21%)	33.19	178.99	180.86	1.87	109.5	79.57
	L (20%)	31.61	178.99	180.83	1.84	107.41	79.19
	L (19%)	30.03	178.99	180.8	1.81	105.28	78.81
	L (18%)	28.45	178.99	180.78	1.79	103.2	78.43
	L (17%)	26.87	178.99	180.75	1.76	101.03	78.05
	L (16%)	25.29	178.99	180.72	1.73	98.74	77.72
	L (15%)	23.71	178.99	180.69	1.7	96.27	77.36
550 m d/s of Barrage axis	M (100%)	708.88	178.86	184.05	5.19	320.35	111.48
	M (30%)	212.66	178.86	182.06	3.2	121.99	77.27
	M (29%)	205.57	178.86	182.01	3.15	118.7	76.87
	M (28%)	198.49	178.86	181.97	3.11	115.19	76.43
	M (27%)	191.4	178.86	181.92	3.06	111.76	76
	M (26%)	184.31	178.86	181.88	3.02	108.36	75.58
	M (25%)	177.22	178.86	181.83	2.97	104.69	75.11
	M (24%)	170.13	178.86	181.78	2.92	101.29	74.68
	M (23%)	163.04	178.86	181.73	2.87	97.63	74.22
	M (22%)	155.95	178.86	181.69	2.83	94.17	73.77
	M (21%)	148.86	178.86	181.64	2.78	90.48	73.29
	M (20%)	141.78	178.86	181.59	2.73	86.97	72.84
	M (19%)	134.69	178.86	181.54	2.68	83.35	72.36
	M (18%)	127.6	178.86	181.49	2.63	79.89	71.91
	M (17%)	120.51	178.86	181.44	2.58	76.32	71.43
	M (16%)	113.42	178.86	181.39	2.53	72.86	70.97
	M (15%)	106.33	178.86	181.34	2.48	69.4	70.5
	NMNL-1 (100%)	350.18	178.86	182.77	3.91	184.12	100.9
	NMNL-1 (30%)	105.05	178.86	181.33	2.47	68.78	70.42
	NMNL-1 (29%)	101.55	178.86	181.31	2.45	67.06	70.19
	NMNL-1 (28%)	98.05	178.86	181.29	2.43	65.39	69.96
	NMNL-1 (27%)	94.55	178.86	181.26	2.4	63.72	69.73
	NMNL-1 (26%)	91.05	178.86	181.24	2.38	62.03	69.49
	NMNL-1 (25%)	87.54	178.86	181.21	2.35	60.34	69.26
	NMNL-1 (24%)	84.04	178.86	181.19	2.33	58.64	69.03
	NMNL-1 (23%)	80.54	178.86	181.16	2.3	56.95	68.79
	NMNL-1 (22%)	77.04	178.86	181.14	2.28	55.25	68.55
	NMNL-1 (21%)	73.54	178.86	181.11	2.25	53.52	68.31
	NMNL-1 (20%)	70.04	178.86	181.09	2.23	51.78	68.07
	NMNL-1 (19%)	66.53	178.86	181.06	2.2	50	67.82
	NMNL-1 (18%)	63.03	178.86	181.04	2.18	48.22	67.56

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (17%)	59.53	178.86	181.01	2.15	46.35	67.3
	NMNL-1 (16%)	56.03	178.86	180.98	2.12	44.47	67.03
	NMNL-1 (15%)	52.53	178.86	180.95	2.09	42.53	66.75
	NMNL-2 (100%)	252.93	178.86	182.29	3.43	140.44	80.32
	NMNL-2 (30%)	75.88	178.86	181.13	2.27	54.68	68.47
	NMNL-2 (29%)	73.35	178.86	181.11	2.25	53.42	68.3
	NMNL-2 (28%)	70.82	178.86	181.1	2.24	52.17	68.12
	NMNL-2 (27%)	68.29	178.86	181.08	2.22	50.89	67.94
	NMNL-2 (26%)	65.76	178.86	181.06	2.2	49.61	67.76
	NMNL-2 (25%)	63.23	178.86	181.04	2.18	48.32	67.58
	NMNL-2 (24%)	60.7	178.86	181.02	2.16	47	67.39
	NMNL-2 (23%)	58.17	178.86	181	2.14	45.62	67.19
	NMNL-2 (22%)	55.64	178.86	180.98	2.12	44.26	67
	NMNL-2 (21%)	53.12	178.86	180.96	2.1	42.86	66.8
	NMNL-2 (20%)	50.59	178.86	180.94	2.08	41.42	66.59
	NMNL-2 (19%)	48.06	178.86	180.91	2.05	39.98	66.38
	NMNL-2 (18%)	45.53	178.86	180.89	2.03	38.4	66.16
	NMNL-2 (17%)	43	178.86	180.87	2.01	36.76	65.92
	NMNL-2 (16%)	40.47	178.86	180.84	1.98	35.03	65.67
	NMNL-2 (15%)	37.94	178.86	180.81	1.95	33.29	65.41
	L (100%)	158.05	178.86	181.7	2.84	95.19	73.9
	L (30%)	47.41	178.86	180.91	2.05	39.61	66.33
	L (29%)	45.83	178.86	180.89	2.03	38.6	66.18
	L (28%)	44.25	178.86	180.88	2.02	37.58	66.04
	L (27%)	42.67	178.86	180.86	2	36.55	65.89
	L (26%)	41.09	178.86	180.85	1.99	35.46	65.73
	L (25%)	39.51	178.86	180.83	1.97	34.37	65.57
	L (24%)	37.93	178.86	180.81	1.95	33.28	65.41
	L (23%)	36.35	178.86	180.8	1.94	32.19	65.25
	L (22%)	34.77	178.86	180.78	1.92	31.04	65.08
	L (21%)	33.19	178.86	180.75	1.89	29.44	63.38
	L (20%)	31.61	178.86	180.72	1.86	27.62	59.76
	L (19%)	30.03	178.86	180.69	1.83	25.89	56.12
	L (18%)	28.45	178.86	180.67	1.81	24.35	52.68
	L (17%)	26.87	178.86	180.64	1.78	22.84	49.07
	L (16%)	25.29	178.86	180.6	1.74	21.37	45.25
	L (15%)	23.71	178.86	180.57	1.71	19.9	41.19
600 m d/s of Barrage axis	M (100%)	708.88	178.71	183.99	5.28	347.65	117.1
	M (30%)	212.66	178.71	181.92	3.21	123.94	79.2
	M (29%)	205.57	178.71	181.88	3.17	120.48	76.72
	M (28%)	198.49	178.71	181.83	3.12	116.78	75.58
	M (27%)	191.4	178.71	181.78	3.07	113.18	75.02
	M (26%)	184.31	178.71	181.74	3.03	109.63	74.47

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (25%)	177.22	178.71	181.68	2.97	105.67	73.85
	M (24%)	170.13	178.71	181.63	2.92	102.04	73.28
	M (23%)	163.04	178.71	181.58	2.87	98.03	72.64
	M (22%)	155.95	178.71	181.53	2.82	94.29	72.04
	M (21%)	148.86	178.71	181.47	2.76	90.16	71.37
	M (20%)	141.78	178.71	181.41	2.7	86.27	70.74
	M (19%)	134.69	178.71	181.35	2.64	82.16	70.07
	M (18%)	127.6	178.71	181.3	2.59	78.3	69.43
	M (17%)	120.51	178.71	181.24	2.53	74.16	68.74
	M (16%)	113.42	178.71	181.18	2.47	70.22	68.06
	M (15%)	106.33	178.71	181.12	2.41	66.2	67.37
	NMNL-1 (100%)	350.18	178.71	182.66	3.95	198.54	108.61
	NMNL-1 (30%)	105.05	178.71	181.11	2.4	65.46	67.24
	NMNL-1 (29%)	101.55	178.71	181.08	2.37	63.45	66.89
	NMNL-1 (28%)	98.05	178.71	181.05	2.34	61.5	66.55
	NMNL-1 (27%)	94.55	178.71	181.02	2.31	59.58	66.16
	NMNL-1 (26%)	91.05	178.71	180.99	2.28	57.65	64.88
	NMNL-1 (25%)	87.54	178.71	180.96	2.25	55.73	63.58
	NMNL-1 (24%)	84.04	178.71	180.93	2.22	53.86	62.29
	NMNL-1 (23%)	80.54	178.71	180.91	2.2	52.06	61.02
	NMNL-1 (22%)	77.04	178.71	180.88	2.17	50.34	59.78
	NMNL-1 (21%)	73.54	178.71	180.85	2.14	48.65	58.53
	NMNL-1 (20%)	70.04	178.71	180.82	2.11	46.95	57.25
	NMNL-1 (19%)	66.53	178.71	180.79	2.08	45.31	55.99
	NMNL-1 (18%)	63.03	178.71	180.76	2.05	43.73	54.75
	NMNL-1 (17%)	59.53	178.71	180.73	2.02	42.2	53.58
	NMNL-1 (16%)	56.03	178.71	180.7	1.99	40.66	52.46
	NMNL-1 (15%)	52.53	178.71	180.67	1.96	39.09	51.29
	NMNL-2 (100%)	252.93	178.71	182.16	3.45	146.68	98.78
	NMNL-2 (30%)	75.88	178.71	180.87	2.16	49.78	59.37
	NMNL-2 (29%)	73.35	178.71	180.85	2.14	48.56	58.46
	NMNL-2 (28%)	70.82	178.71	180.83	2.12	47.32	57.54
	NMNL-2 (27%)	68.29	178.71	180.8	2.09	46.12	56.62
	NMNL-2 (26%)	65.76	178.71	180.78	2.07	44.96	55.72
	NMNL-2 (25%)	63.23	178.71	180.76	2.05	43.82	54.82
	NMNL-2 (24%)	60.7	178.71	180.74	2.03	42.71	53.95
	NMNL-2 (23%)	58.17	178.71	180.72	2.01	41.61	53.16
	NMNL-2 (22%)	55.64	178.71	180.7	1.99	40.49	52.34
	NMNL-2 (21%)	53.12	178.71	180.68	1.97	39.36	51.49
	NMNL-2 (20%)	50.59	178.71	180.66	1.95	38.18	50.6
	NMNL-2 (19%)	48.06	178.71	180.63	1.92	37	49.69
	NMNL-2 (18%)	45.53	178.71	180.61	1.9	35.7	48.67
	NMNL-2 (17%)	43	178.71	180.58	1.87	34.43	47.65
	NMNL-2 (16%)	40.47	178.71	180.55	1.84	32.91	46.39

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (15%)	37.94	178.71	180.51	1.8	31.32	45.05
	L (100%)	158.05	178.71	181.54	2.83	95.4	72.22
	L (30%)	47.41	178.71	180.63	1.92	36.68	49.44
	L (29%)	45.83	178.71	180.61	1.9	35.86	48.79
	L (28%)	44.25	178.71	180.59	1.88	35.06	48.15
	L (27%)	42.67	178.71	180.58	1.87	34.27	47.51
	L (26%)	41.09	178.71	180.56	1.85	33.3	46.72
	L (25%)	39.51	178.71	180.53	1.82	32.26	45.85
	L (24%)	37.93	178.71	180.51	1.8	31.31	45.05
	L (23%)	36.35	178.71	180.49	1.78	30.43	44.28
	L (22%)	34.77	178.71	180.47	1.76	29.52	43.48
	L (21%)	33.19	178.71	180.45	1.74	28.6	42.65
	L (20%)	31.61	178.71	180.43	1.72	27.67	41.8
	L (19%)	30.03	178.71	180.41	1.7	26.7	40.89
	L (18%)	28.45	178.71	180.38	1.67	25.75	39.98
	L (17%)	26.87	178.71	180.36	1.65	24.78	39.03
	L (16%)	25.29	178.71	180.33	1.62	23.79	38.04
	L (15%)	23.71	178.71	180.3	1.59	22.77	36.99
650 m d/s of Barrage axis	M (100%)	708.88	178.59	183.96	5.37	407.98	131.06
	M (30%)	212.66	178.59	181.83	3.24	150.29	107.79
	M (29%)	205.57	178.59	181.78	3.19	145.06	106.31
	M (28%)	198.49	178.59	181.73	3.14	139.83	104.81
	M (27%)	191.4	178.59	181.68	3.09	134.54	103.23
	M (26%)	184.31	178.59	181.63	3.04	129.19	101.53
	M (25%)	177.22	178.59	181.57	2.98	123.82	99.79
	M (24%)	170.13	178.59	181.52	2.93	118.44	98.02
	M (23%)	163.04	178.59	181.46	2.87	113.04	96.21
	M (22%)	155.95	178.59	181.41	2.82	107.6	94.34
	M (21%)	148.86	178.59	181.35	2.76	102.15	92.13
	M (20%)	141.78	178.59	181.29	2.7	96.7	85.8
	M (19%)	134.69	178.59	181.22	2.63	92.02	71.68
	M (18%)	127.6	178.59	181.16	2.57	87.63	70.79
	M (17%)	120.51	178.59	181.09	2.5	82.74	69.78
	M (16%)	113.42	178.59	181.03	2.44	78.11	68.81
	M (15%)	106.33	178.59	180.95	2.36	73.25	67.78
	NMNL-1 (100%)	350.18	178.59	182.61	4.02	238.87	117.7
	NMNL-1 (30%)	105.05	178.59	180.94	2.35	72.34	67.58
	NMNL-1 (29%)	101.55	178.59	180.9	2.31	69.81	67.03
	NMNL-1 (28%)	98.05	178.59	180.87	2.28	67.37	66.51
	NMNL-1 (27%)	94.55	178.59	180.83	2.24	64.96	65.98
	NMNL-1 (26%)	91.05	178.59	180.79	2.2	62.49	65.44
	NMNL-1 (25%)	87.54	178.59	180.75	2.16	59.94	64.87
	NMNL-1 (24%)	84.04	178.59	180.71	2.12	57.35	64.3

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (23%)	80.54	178.59	180.67	2.08	54.79	63.72
	NMNL-1 (22%)	77.04	178.59	180.63	2.04	52.18	63.13
	NMNL-1 (21%)	73.54	178.59	180.59	2	49.53	62.52
	NMNL-1 (20%)	70.04	178.59	180.55	1.96	46.84	61.9
	NMNL-1 (19%)	66.53	178.59	180.5	1.91	44.13	61.26
	NMNL-1 (18%)	63.03	178.59	180.46	1.87	41.41	60.62
	NMNL-1 (17%)	59.53	178.59	180.41	1.82	38.68	59.97
	NMNL-1 (16%)	56.03	178.59	180.37	1.78	35.87	58.44
	NMNL-1 (15%)	52.53	178.59	180.32	1.73	33.18	55.4
	NMNL-2 (100%)	252.93	178.59	182.08	3.49	178.65	111.46
	NMNL-2 (30%)	75.88	178.59	180.62	2.03	51.31	62.93
	NMNL-2 (29%)	73.35	178.59	180.59	2	49.39	62.49
	NMNL-2 (28%)	70.82	178.59	180.56	1.97	47.45	62.04
	NMNL-2 (27%)	68.29	178.59	180.53	1.94	45.49	61.58
	NMNL-2 (26%)	65.76	178.59	180.49	1.9	43.56	61.13
	NMNL-2 (25%)	63.23	178.59	180.46	1.87	41.56	60.66
	NMNL-2 (24%)	60.7	178.59	180.43	1.84	39.6	60.19
	NMNL-2 (23%)	58.17	178.59	180.4	1.81	37.61	59.72
	NMNL-2 (22%)	55.64	178.59	180.36	1.77	35.56	58.09
	NMNL-2 (21%)	53.12	178.59	180.33	1.74	33.63	55.92
	NMNL-2 (20%)	50.59	178.59	180.29	1.7	31.75	53.72
	NMNL-2 (19%)	48.06	178.59	180.26	1.67	29.88	51.44
	NMNL-2 (18%)	45.53	178.59	180.22	1.63	28.14	49.62
	NMNL-2 (17%)	43	178.59	180.19	1.6	26.51	48.08
	NMNL-2 (16%)	40.47	178.59	180.16	1.57	24.98	46.58
	NMNL-2 (15%)	37.94	178.59	180.12	1.53	23.44	45.03
	L (100%)	158.05	178.59	181.42	2.83	109.2	94.9
	L (30%)	47.41	178.59	180.25	1.66	29.42	50.86
	L (29%)	45.83	178.59	180.23	1.64	28.34	49.81
	L (28%)	44.25	178.59	180.2	1.61	27.29	48.82
	L (27%)	42.67	178.59	180.18	1.59	26.3	47.88
	L (26%)	41.09	178.59	180.16	1.57	25.32	46.92
	L (25%)	39.51	178.59	180.14	1.55	24.42	46.02
	L (24%)	37.93	178.59	180.12	1.53	23.44	45.02
	L (23%)	36.35	178.59	180.1	1.51	22.43	43.98
	L (22%)	34.77	178.59	180.08	1.49	21.45	42.93
	L (21%)	33.19	178.59	180.06	1.47	20.5	41.9
	L (20%)	31.61	178.59	180.03	1.44	19.64	40.93
	L (19%)	30.03	178.59	180.01	1.42	18.82	40.01
	L (18%)	28.45	178.59	179.99	1.4	18.01	39.1
	L (17%)	26.87	178.59	179.97	1.38	17.23	38.2
	L (16%)	25.29	178.59	179.95	1.36	16.47	37.2
	L (15%)	23.71	178.59	179.93	1.34	15.66	36.08

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
700 m d/s of Barrage axis	M (100%)	708.88	178.45	183.97	5.52	530.38	140.45
	M (30%)	212.66	178.45	181.82	3.37	250.07	121.7
	M (29%)	205.57	178.45	181.77	3.32	244.03	121.38
	M (28%)	198.49	178.45	181.72	3.27	237.92	121.07
	M (27%)	191.4	178.45	181.67	3.22	231.64	120.74
	M (26%)	184.31	178.45	181.62	3.17	225.23	120.41
	M (25%)	177.22	178.45	181.56	3.11	218.69	120.07
	M (24%)	170.13	178.45	181.51	3.06	212.01	119.72
	M (23%)	163.04	178.45	181.45	3	205.2	119.36
	M (22%)	155.95	178.45	181.39	2.94	198.22	118.99
	M (21%)	148.86	178.45	181.33	2.88	191.11	118.62
	M (20%)	141.78	178.45	181.27	2.82	183.83	118.23
	M (19%)	134.69	178.45	181.21	2.76	176.37	117.84
	M (18%)	127.6	178.45	181.14	2.69	168.73	117.43
	M (17%)	120.51	178.45	181.07	2.62	160.87	117.01
	M (16%)	113.42	178.45	181	2.55	152.67	116.57
	M (15%)	106.33	178.45	180.93	2.48	144.16	116.11
	NMNL-1 (100%)	350.18	178.45	182.61	4.16	348.44	127.81
	NMNL-1 (30%)	105.05	178.45	180.92	2.47	142.61	116.03
	NMNL-1 (29%)	101.55	178.45	180.88	2.43	138.28	115.79
	NMNL-1 (28%)	98.05	178.45	180.84	2.39	133.87	115.55
	NMNL-1 (27%)	94.55	178.45	180.8	2.35	129.5	114.27
	NMNL-1 (26%)	91.05	178.45	180.77	2.32	125.15	111.97
	NMNL-1 (25%)	87.54	178.45	180.73	2.28	120.7	109.41
	NMNL-1 (24%)	84.04	178.45	180.68	2.23	116.29	106.26
	NMNL-1 (23%)	80.54	178.45	180.64	2.19	111.92	103.06
	NMNL-1 (22%)	77.04	178.45	180.6	2.15	107.57	99.77
	NMNL-1 (21%)	73.54	178.45	180.56	2.11	103.28	96.4
	NMNL-1 (20%)	70.04	178.45	180.51	2.06	99.02	92.95
	NMNL-1 (19%)	66.53	178.45	180.47	2.02	94.78	89.41
	NMNL-1 (18%)	63.03	178.45	180.42	1.97	90.58	85.77
	NMNL-1 (17%)	59.53	178.45	180.37	1.92	86.45	81.31
	NMNL-1 (16%)	56.03	178.45	180.32	1.87	82.53	67.75
	NMNL-1 (15%)	52.53	178.45	180.26	1.81	79	66.73
	NMNL-2 (100%)	252.93	178.45	182.08	3.63	282.02	123.33
	NMNL-2 (30%)	75.88	178.45	180.59	2.14	106.15	98.66
	NMNL-2 (29%)	73.35	178.45	180.55	2.1	103.04	96.21
	NMNL-2 (28%)	70.82	178.45	180.52	2.07	99.96	93.71
	NMNL-2 (27%)	68.29	178.45	180.49	2.04	96.9	91.2
	NMNL-2 (26%)	65.76	178.45	180.45	2	93.85	88.62
	NMNL-2 (25%)	63.23	178.45	180.42	1.97	90.81	85.98
	NMNL-2 (24%)	60.7	178.45	180.38	1.93	87.83	83.29
	NMNL-2 (23%)	58.17	178.45	180.35	1.9	84.89	77.78
	NMNL-2 (22%)	55.64	178.45	180.31	1.86	82.14	67.64

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (21%)	53.12	178.45	180.27	1.82	79.6	66.91
	NMNL-2 (20%)	50.59	178.45	180.23	1.78	77.04	66.16
	NMNL-2 (19%)	48.06	178.45	180.19	1.74	74.32	65.36
	NMNL-2 (18%)	45.53	178.45	180.15	1.7	71.63	64.55
	NMNL-2 (17%)	43	178.45	180.11	1.66	68.83	63.71
	NMNL-2 (16%)	40.47	178.45	180.06	1.61	65.96	62.83
	NMNL-2 (15%)	37.94	178.45	180.02	1.57	63.01	61.93
	L (100%)	158.05	178.45	181.41	2.96	200.3	119.1
	L (30%)	47.41	178.45	180.18	1.73	73.64	65.16
	L (29%)	45.83	178.45	180.16	1.71	71.95	64.65
	L (28%)	44.25	178.45	180.13	1.68	70.23	64.13
	L (27%)	42.67	178.45	180.1	1.65	68.46	63.6
	L (26%)	41.09	178.45	180.07	1.62	66.67	63.05
	L (25%)	39.51	178.45	180.04	1.59	64.84	62.49
	L (24%)	37.93	178.45	180.02	1.57	63	61.92
	L (23%)	36.35	178.45	179.98	1.53	61.11	61.34
	L (22%)	34.77	178.45	179.95	1.5	59.19	60.74
	L (21%)	33.19	178.45	179.92	1.47	57.25	60.12
	L (20%)	31.61	178.45	179.89	1.44	55.26	59.49
	L (19%)	30.03	178.45	179.85	1.4	53.23	58.83
	L (18%)	28.45	178.45	179.82	1.37	51.15	58.15
	L (17%)	26.87	178.45	179.78	1.33	49	57.45
	L (16%)	25.29	178.45	179.74	1.29	46.83	56.72
	L (15%)	23.71	178.45	179.7	1.25	44.59	55.98
750 m d/s of Barrage axis	M (100%)	708.88	178.32	183.95	5.63	541.01	131.32
	M (30%)	212.66	178.32	181.81	3.49	277.47	114.34
	M (29%)	205.57	178.32	181.76	3.44	271.8	113.93
	M (28%)	198.49	178.32	181.71	3.39	266.07	113.52
	M (27%)	191.4	178.32	181.66	3.34	260.19	113.09
	M (26%)	184.31	178.32	181.6	3.28	254.18	112.65
	M (25%)	177.22	178.32	181.55	3.23	248.06	112.2
	M (24%)	170.13	178.32	181.49	3.17	241.81	111.74
	M (23%)	163.04	178.32	181.44	3.12	235.45	111.27
	M (22%)	155.95	178.32	181.38	3.06	228.95	110.79
	M (21%)	148.86	178.32	181.32	3	222.31	110.29
	M (20%)	141.78	178.32	181.26	2.94	215.54	109.78
	M (19%)	134.69	178.32	181.19	2.87	208.59	109.26
	M (18%)	127.6	178.32	181.13	2.81	201.5	108.72
	M (17%)	120.51	178.32	181.06	2.74	194.2	108.17
	M (16%)	113.42	178.32	180.99	2.67	186.6	107.59
	M (15%)	106.33	178.32	180.92	2.6	178.72	106.98
	NMNL-1 (100%)	350.18	178.32	182.6	4.28	370.2	120.81
	NMNL-1 (30%)	105.05	178.32	180.9	2.58	177.29	106.87

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (29%)	101.55	178.32	180.87	2.55	173.28	106.55
	NMNL-1 (28%)	98.05	178.32	180.83	2.51	169.2	106.23
	NMNL-1 (27%)	94.55	178.32	180.79	2.47	165.16	105.92
	NMNL-1 (26%)	91.05	178.32	180.75	2.43	161.07	105.6
	NMNL-1 (25%)	87.54	178.32	180.71	2.39	156.81	105.26
	NMNL-1 (24%)	84.04	178.32	180.67	2.35	152.48	104.92
	NMNL-1 (23%)	80.54	178.32	180.63	2.31	148.08	104.57
	NMNL-1 (22%)	77.04	178.32	180.58	2.26	143.58	104.21
	NMNL-1 (21%)	73.54	178.32	180.54	2.22	139	103.84
	NMNL-1 (20%)	70.04	178.32	180.49	2.17	134.32	103.47
	NMNL-1 (19%)	66.53	178.32	180.45	2.13	129.5	103.08
	NMNL-1 (18%)	63.03	178.32	180.4	2.08	124.58	102.68
	NMNL-1 (17%)	59.53	178.32	180.35	2.03	119.55	102.27
	NMNL-1 (16%)	56.03	178.32	180.3	1.98	114.37	101.85
	NMNL-1 (15%)	52.53	178.32	180.25	1.93	109.1	98.88
	NMNL-2 (100%)	252.93	178.32	182.07	3.75	307.54	116.48
	NMNL-2 (30%)	75.88	178.32	180.57	2.25	142.07	104.09
	NMNL-2 (29%)	73.35	178.32	180.54	2.22	138.75	103.82
	NMNL-2 (28%)	70.82	178.32	180.5	2.18	135.37	103.55
	NMNL-2 (27%)	68.29	178.32	180.47	2.15	131.94	103.27
	NMNL-2 (26%)	65.76	178.32	180.44	2.12	128.44	102.99
	NMNL-2 (25%)	63.23	178.32	180.4	2.08	124.86	102.7
	NMNL-2 (24%)	60.7	178.32	180.37	2.05	121.24	102.41
	NMNL-2 (23%)	58.17	178.32	180.33	2.01	117.55	102.11
	NMNL-2 (22%)	55.64	178.32	180.29	1.97	113.79	101.62
	NMNL-2 (21%)	53.12	178.32	180.26	1.94	109.99	99.41
	NMNL-2 (20%)	50.59	178.32	180.22	1.9	106.2	97.16
	NMNL-2 (19%)	48.06	178.32	180.18	1.86	102.33	94.98
	NMNL-2 (18%)	45.53	178.32	180.14	1.82	98.43	92.83
	NMNL-2 (17%)	43	178.32	180.09	1.77	94.46	90.37
	NMNL-2 (16%)	40.47	178.32	180.05	1.73	90.46	86.39
	NMNL-2 (15%)	37.94	178.32	180	1.68	86.48	83.1
	L (100%)	158.05	178.32	181.4	3.08	230.88	110.93
	L (30%)	47.41	178.32	180.17	1.85	101.34	94.44
	L (29%)	45.83	178.32	180.14	1.82	98.9	93.09
	L (28%)	44.25	178.32	180.11	1.79	96.44	91.71
	L (27%)	42.67	178.32	180.09	1.77	93.94	89.85
	L (26%)	41.09	178.32	180.06	1.74	91.44	87.38
	L (25%)	39.51	178.32	180.03	1.71	88.95	85.03
	L (24%)	37.93	178.32	180	1.68	86.46	83.08
	L (23%)	36.35	178.32	179.97	1.65	83.95	81.08
	L (22%)	34.77	178.32	179.94	1.62	81.43	79.48
	L (21%)	33.19	178.32	179.91	1.59	78.9	78.17
	L (20%)	31.61	178.32	179.87	1.55	76.33	76.82

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (19%)	30.03	178.32	179.84	1.52	73.72	75.42
	L (18%)	28.45	178.32	179.8	1.48	71.05	73.41
	L (17%)	26.87	178.32	179.77	1.45	68.38	70.5
	L (16%)	25.29	178.32	179.73	1.41	65.74	68.63
	L (15%)	23.71	178.32	179.69	1.37	63.02	67.51
800 m d/s of Barrage axis	M (100%)	708.88	178.18	183.92	5.74	507.95	124.74
	M (30%)	212.66	178.18	181.79	3.61	262.68	105.88
	M (29%)	205.57	178.18	181.74	3.56	257.45	105.44
	M (28%)	198.49	178.18	181.69	3.51	252.17	104.99
	M (27%)	191.4	178.18	181.64	3.46	246.75	104.53
	M (26%)	184.31	178.18	181.58	3.4	241.21	104.05
	M (25%)	177.22	178.18	181.53	3.35	235.58	103.57
	M (24%)	170.13	178.18	181.47	3.29	229.84	103.07
	M (23%)	163.04	178.18	181.42	3.24	223.99	102.57
	M (22%)	155.95	178.18	181.36	3.18	218.01	102.04
	M (21%)	148.86	178.18	181.3	3.12	211.92	101.51
	M (20%)	141.78	178.18	181.24	3.06	205.7	100.96
	M (19%)	134.69	178.18	181.17	2.99	199.33	100.39
	M (18%)	127.6	178.18	181.11	2.93	192.83	99.81
	M (17%)	120.51	178.18	181.04	2.86	186.17	98.61
	M (16%)	113.42	178.18	180.97	2.79	179.29	97.12
	M (15%)	106.33	178.18	180.9	2.72	172.22	95.58
	NMNL-1 (100%)	350.18	178.18	182.57	4.39	348.46	112.89
	NMNL-1 (30%)	105.05	178.18	180.89	2.71	170.94	95.3
	NMNL-1 (29%)	101.55	178.18	180.85	2.67	167.39	94.51
	NMNL-1 (28%)	98.05	178.18	180.81	2.63	163.79	93.7
	NMNL-1 (27%)	94.55	178.18	180.77	2.59	160.24	92.88
	NMNL-1 (26%)	91.05	178.18	180.73	2.55	156.7	91.02
	NMNL-1 (25%)	87.54	178.18	180.69	2.51	153.07	89.08
	NMNL-1 (24%)	84.04	178.18	180.65	2.47	149.46	87.2
	NMNL-1 (23%)	80.54	178.18	180.61	2.43	145.83	86.23
	NMNL-1 (22%)	77.04	178.18	180.57	2.39	142.16	85.24
	NMNL-1 (21%)	73.54	178.18	180.52	2.34	138.45	84.23
	NMNL-1 (20%)	70.04	178.18	180.48	2.3	134.69	83.2
	NMNL-1 (19%)	66.53	178.18	180.43	2.25	130.87	82.13
	NMNL-1 (18%)	63.03	178.18	180.39	2.21	126.99	81.03
	NMNL-1 (17%)	59.53	178.18	180.34	2.16	123.08	80.05
	NMNL-1 (16%)	56.03	178.18	180.29	2.11	119.08	79.09
	NMNL-1 (15%)	52.53	178.18	180.23	2.05	115	78.1
	NMNL-2 (100%)	252.93	178.18	182.05	3.87	290.43	108.2
	NMNL-2 (30%)	75.88	178.18	180.55	2.37	140.93	84.91
	NMNL-2 (29%)	73.35	178.18	180.52	2.34	138.25	84.18
	NMNL-2 (28%)	70.82	178.18	180.49	2.31	135.53	83.43

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (27%)	68.29	178.18	180.46	2.28	132.79	82.67
	NMNL-2 (26%)	65.76	178.18	180.42	2.24	130.03	81.89
	NMNL-2 (25%)	63.23	178.18	180.39	2.21	127.21	81.09
	NMNL-2 (24%)	60.7	178.18	180.35	2.17	124.39	80.36
	NMNL-2 (23%)	58.17	178.18	180.32	2.14	121.53	79.68
	NMNL-2 (22%)	55.64	178.18	180.28	2.1	118.63	78.98
	NMNL-2 (21%)	53.12	178.18	180.24	2.06	115.7	78.27
	NMNL-2 (20%)	50.59	178.18	180.21	2.03	112.73	77.52
	NMNL-2 (19%)	48.06	178.18	180.17	1.99	109.66	76.73
	NMNL-2 (18%)	45.53	178.18	180.12	1.94	106.52	75.92
	NMNL-2 (17%)	43	178.18	180.08	1.9	103.28	75.07
	NMNL-2 (16%)	40.47	178.18	180.04	1.86	99.94	74.19
	NMNL-2 (15%)	37.94	178.18	179.99	1.81	96.49	73.35
	L (100%)	158.05	178.18	181.38	3.2	219.79	102.2
	L (30%)	47.41	178.18	180.15	1.97	108.86	76.53
	L (29%)	45.83	178.18	180.13	1.95	106.9	76.02
	L (28%)	44.25	178.18	180.1	1.92	104.9	75.5
	L (27%)	42.67	178.18	180.08	1.9	102.85	74.96
	L (26%)	41.09	178.18	180.05	1.87	100.77	74.41
	L (25%)	39.51	178.18	180.02	1.84	98.64	73.84
	L (24%)	37.93	178.18	179.99	1.81	96.47	73.34
	L (23%)	36.35	178.18	179.96	1.78	94.26	72.88
	L (22%)	34.77	178.18	179.93	1.75	91.99	72.4
	L (21%)	33.19	178.18	179.9	1.72	89.69	71.91
	L (20%)	31.61	178.18	179.86	1.68	87.33	71.4
	L (19%)	30.03	178.18	179.83	1.65	84.9	70.88
	L (18%)	28.45	178.18	179.79	1.61	82.4	70.33
	L (17%)	26.87	178.18	179.76	1.58	79.81	69.77
	L (16%)	25.29	178.18	179.72	1.54	77.17	69.18
	L (15%)	23.71	178.18	179.68	1.5	74.43	68.57
850 m d/s of Barrage axis	M (100%)	708.88	178.04	183.8	5.76	387.56	118.34
	M (30%)	212.66	178.04	181.71	3.67	170.39	91.58
	M (29%)	205.57	178.04	181.66	3.62	165.89	91.07
	M (28%)	198.49	178.04	181.61	3.57	161.33	90.55
	M (27%)	191.4	178.04	181.56	3.52	156.66	90.02
	M (26%)	184.31	178.04	181.5	3.46	151.9	89.47
	M (25%)	177.22	178.04	181.45	3.41	147.04	88.91
	M (24%)	170.13	178.04	181.39	3.35	142.1	88.34
	M (23%)	163.04	178.04	181.34	3.3	137.08	87.75
	M (22%)	155.95	178.04	181.28	3.24	131.93	87.15
	M (21%)	148.86	178.04	181.22	3.18	126.7	86.35
	M (20%)	141.78	178.04	181.16	3.12	121.38	85.49
	M (19%)	134.69	178.04	181.09	3.05	115.94	84.61

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (18%)	127.6	178.04	181.03	2.99	110.4	83.71
	M (17%)	120.51	178.04	180.96	2.92	104.74	82.77
	M (16%)	113.42	178.04	180.89	2.85	98.83	81.78
	M (15%)	106.33	178.04	180.81	2.77	92.71	80.74
	NMNL-1 (100%)	350.18	178.04	182.48	4.44	244.71	100.3
	NMNL-1 (30%)	105.05	178.04	180.8	2.76	91.6	80.55
	NMNL-1 (29%)	101.55	178.04	180.76	2.72	88.55	78.13
	NMNL-1 (28%)	98.05	178.04	180.72	2.68	85.55	75.29
	NMNL-1 (27%)	94.55	178.04	180.68	2.64	82.65	74.28
	NMNL-1 (26%)	91.05	178.04	180.64	2.6	79.73	73.07
	NMNL-1 (25%)	87.54	178.04	180.6	2.56	76.81	71.16
	NMNL-1 (24%)	84.04	178.04	180.56	2.52	73.93	69.22
	NMNL-1 (23%)	80.54	178.04	180.52	2.48	71.07	67.23
	NMNL-1 (22%)	77.04	178.04	180.47	2.43	68.22	65.31
	NMNL-1 (21%)	73.54	178.04	180.43	2.39	65.4	63.61
	NMNL-1 (20%)	70.04	178.04	180.39	2.35	62.58	61.86
	NMNL-1 (19%)	66.53	178.04	180.34	2.3	59.77	60.07
	NMNL-1 (18%)	63.03	178.04	180.29	2.25	56.97	58.23
	NMNL-1 (17%)	59.53	178.04	180.24	2.2	54.21	56.35
	NMNL-1 (16%)	56.03	178.04	180.19	2.15	51.46	54.42
	NMNL-1 (15%)	52.53	178.04	180.14	2.1	48.72	52.43
	NMNL-2 (100%)	252.93	178.04	181.97	3.93	194.32	94.23
	NMNL-2 (30%)	75.88	178.04	180.46	2.42	67.29	64.75
	NMNL-2 (29%)	73.35	178.04	180.43	2.39	65.25	63.52
	NMNL-2 (28%)	70.82	178.04	180.4	2.36	63.21	62.26
	NMNL-2 (27%)	68.29	178.04	180.36	2.32	61.18	60.97
	NMNL-2 (26%)	65.76	178.04	180.33	2.29	59.16	59.67
	NMNL-2 (25%)	63.23	178.04	180.3	2.26	57.13	58.33
	NMNL-2 (24%)	60.7	178.04	180.26	2.22	55.13	56.98
	NMNL-2 (23%)	58.17	178.04	180.23	2.19	53.13	55.61
	NMNL-2 (22%)	55.64	178.04	180.19	2.15	51.15	54.2
	NMNL-2 (21%)	53.12	178.04	180.15	2.11	49.18	52.77
	NMNL-2 (20%)	50.59	178.04	180.11	2.07	47.23	51.31
	NMNL-2 (19%)	48.06	178.04	180.08	2.04	45.25	49.78
	NMNL-2 (18%)	45.53	178.04	180.04	2	43.27	48.21
	NMNL-2 (17%)	43	178.04	179.99	1.95	41.27	46.56
	NMNL-2 (16%)	40.47	178.04	179.95	1.91	39.25	44.84
	NMNL-2 (15%)	37.94	178.04	179.9	1.86	37.22	43.05
	L (100%)	158.05	178.04	181.3	3.26	133.46	87.33
	L (30%)	47.41	178.04	180.07	2.03	44.74	49.38
	L (29%)	45.83	178.04	180.04	2	43.5	48.4
	L (28%)	44.25	178.04	180.01	1.97	42.26	47.39
	L (27%)	42.67	178.04	179.99	1.95	41	46.34
	L (26%)	41.09	178.04	179.96	1.92	39.74	45.27

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (25%)	39.51	178.04	179.93	1.89	38.48	44.17
	L (24%)	37.93	178.04	179.9	1.86	37.22	43.04
	L (23%)	36.35	178.04	179.87	1.83	35.95	41.88
	L (22%)	34.77	178.04	179.84	1.8	34.69	40.69
	L (21%)	33.19	178.04	179.81	1.77	33.44	39.48
	L (20%)	31.61	178.04	179.78	1.74	32.19	38.22
	L (19%)	30.03	178.04	179.75	1.71	30.94	36.92
	L (18%)	28.45	178.04	179.71	1.67	29.68	35.45
	L (17%)	26.87	178.04	179.68	1.64	28.44	33.87
	L (16%)	25.29	178.04	179.64	1.6	27.2	33.02
	L (15%)	23.71	178.04	179.6	1.56	25.94	32.13
900 m d/s of Barrage axis	M (100%)	708.88	177.92	182.62	4.7	151.72	68.62
	M (30%)	212.66	177.92	180.77	2.85	54.78	35.69
	M (29%)	205.57	177.92	180.72	2.8	53.16	34.86
	M (28%)	198.49	177.92	180.67	2.75	51.44	33.96
	M (27%)	191.4	177.92	180.62	2.7	49.86	33.49
	M (26%)	184.31	177.92	180.58	2.66	48.34	33.03
	M (25%)	177.22	177.92	180.53	2.61	46.89	32.59
	M (24%)	170.13	177.92	180.49	2.57	45.46	32.14
	M (23%)	163.04	177.92	180.44	2.52	44	31.68
	M (22%)	155.95	177.92	180.4	2.48	42.61	31.24
	M (21%)	148.86	177.92	180.35	2.43	41.09	30.75
	M (20%)	141.78	177.92	180.3	2.38	39.56	30.24
	M (19%)	134.69	177.92	180.25	2.33	38.01	29.72
	M (18%)	127.6	177.92	180.2	2.28	36.44	29.19
	M (17%)	120.51	177.92	180.14	2.22	34.85	28.64
	M (16%)	113.42	177.92	180.1	2.18	33.54	28.17
	M (15%)	106.33	177.92	180.05	2.13	32.3	27.73
	NMNL-1 (100%)	350.18	177.92	181.47	3.55	84.36	48.42
	NMNL-1 (30%)	105.05	177.92	180.04	2.12	32.08	27.65
	NMNL-1 (29%)	101.55	177.92	180.02	2.1	31.49	27.43
	NMNL-1 (28%)	98.05	177.92	180	2.08	30.88	27.21
	NMNL-1 (27%)	94.55	177.92	179.98	2.06	30.27	26.98
	NMNL-1 (26%)	91.05	177.92	179.95	2.03	29.65	26.75
	NMNL-1 (25%)	87.54	177.92	179.93	2.01	29.01	26.51
	NMNL-1 (24%)	84.04	177.92	179.91	1.99	28.37	26.27
	NMNL-1 (23%)	80.54	177.92	179.88	1.96	27.71	26.01
	NMNL-1 (22%)	77.04	177.92	179.85	1.93	27.04	25.75
	NMNL-1 (21%)	73.54	177.92	179.83	1.91	26.35	25.5
	NMNL-1 (20%)	70.04	177.92	179.8	1.88	25.65	25.25
	NMNL-1 (19%)	66.53	177.92	179.77	1.85	24.93	24.98
	NMNL-1 (18%)	63.03	177.92	179.74	1.82	24.19	24.71
	NMNL-1 (17%)	59.53	177.92	179.71	1.79	23.43	24.43

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (16%)	56.03	177.92	179.68	1.76	22.65	24.13
	NMNL-1 (15%)	52.53	177.92	179.64	1.72	21.84	23.72
	NMNL-2 (100%)	252.93	177.92	181.01	3.09	63.89	40.04
	NMNL-2 (30%)	75.88	177.92	179.85	1.93	26.81	25.66
	NMNL-2 (29%)	73.35	177.92	179.83	1.91	26.31	25.49
	NMNL-2 (28%)	70.82	177.92	179.81	1.89	25.81	25.3
	NMNL-2 (27%)	68.29	177.92	179.79	1.87	25.29	25.12
	NMNL-2 (26%)	65.76	177.92	179.76	1.84	24.76	24.92
	NMNL-2 (25%)	63.23	177.92	179.74	1.82	24.23	24.72
	NMNL-2 (24%)	60.7	177.92	179.72	1.8	23.69	24.52
	NMNL-2 (23%)	58.17	177.92	179.7	1.78	23.13	24.31
	NMNL-2 (22%)	55.64	177.92	179.67	1.75	22.56	24.09
	NMNL-2 (21%)	53.12	177.92	179.65	1.73	21.98	23.79
	NMNL-2 (20%)	50.59	177.92	179.62	1.7	21.38	23.48
	NMNL-2 (19%)	48.06	177.92	179.6	1.68	20.77	23.16
	NMNL-2 (18%)	45.53	177.92	179.57	1.65	20.15	22.83
	NMNL-2 (17%)	43	177.92	179.54	1.62	19.51	22.48
	NMNL-2 (16%)	40.47	177.92	179.51	1.59	18.87	22.13
	NMNL-2 (15%)	37.94	177.92	179.48	1.56	18.19	21.76
	L (100%)	158.05	177.92	180.41	2.49	43.06	31.38
	L (30%)	47.41	177.92	179.59	1.67	20.61	23.07
	L (29%)	45.83	177.92	179.57	1.65	20.22	22.87
	L (28%)	44.25	177.92	179.56	1.64	19.83	22.65
	L (27%)	42.67	177.92	179.54	1.62	19.42	22.44
	L (26%)	41.09	177.92	179.52	1.6	19.03	22.22
	L (25%)	39.51	177.92	179.5	1.58	18.62	21.99
	L (24%)	37.93	177.92	179.48	1.56	18.19	21.76
	L (23%)	36.35	177.92	179.46	1.54	17.75	21.51
	L (22%)	34.77	177.92	179.44	1.52	17.3	21.25
	L (21%)	33.19	177.92	179.42	1.5	16.84	20.98
	L (20%)	31.61	177.92	179.4	1.48	16.37	20.71
	L (19%)	30.03	177.92	179.37	1.45	15.89	20.42
	L (18%)	28.45	177.92	179.35	1.43	15.39	20.12
	L (17%)	26.87	177.92	179.32	1.4	14.87	19.81
	L (16%)	25.29	177.92	179.3	1.38	14.35	19.48
	L (15%)	23.71	177.92	179.27	1.35	13.8	19.13
950 m d/s of Barrage axis	M (100%)	708.88	177.77	181.98	4.21	251.83	101.5
	M (30%)	212.66	177.77	180.45	2.68	114.76	76.53
	M (29%)	205.57	177.77	180.41	2.64	112.3	76
	M (28%)	198.49	177.77	180.38	2.61	109.85	75.51
	M (27%)	191.4	177.77	180.35	2.58	107.35	75.01
	M (26%)	184.31	177.77	180.31	2.54	104.8	74.5
	M (25%)	177.22	177.77	180.28	2.51	102.22	73.97

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (24%)	170.13	177.77	180.24	2.47	99.63	73.45
	M (23%)	163.04	177.77	180.21	2.44	96.98	72.9
	M (22%)	155.95	177.77	180.17	2.4	94.26	72.33
	M (21%)	148.86	177.77	180.13	2.36	91.54	71.77
	M (20%)	141.78	177.77	180.09	2.32	88.78	71.13
	M (19%)	134.69	177.77	180.06	2.29	85.98	70.38
	M (18%)	127.6	177.77	180.01	2.24	83.13	69.61
	M (17%)	120.51	177.77	179.97	2.2	80.23	68.72
	M (16%)	113.42	177.77	179.93	2.16	77.28	67.7
	M (15%)	106.33	177.77	179.88	2.11	74.29	66.65
	NMNL-1 (100%)	350.18	177.77	180.99	3.22	158.64	85.5
	NMNL-1 (30%)	105.05	177.77	179.88	2.11	73.75	66.46
	NMNL-1 (29%)	101.55	177.77	179.85	2.08	72.25	65.92
	NMNL-1 (28%)	98.05	177.77	179.83	2.06	70.73	65.38
	NMNL-1 (27%)	94.55	177.77	179.81	2.04	69.2	64.82
	NMNL-1 (26%)	91.05	177.77	179.78	2.01	67.66	64.25
	NMNL-1 (25%)	87.54	177.77	179.76	1.99	66.12	63.69
	NMNL-1 (24%)	84.04	177.77	179.73	1.96	64.54	63.1
	NMNL-1 (23%)	80.54	177.77	179.71	1.94	62.95	62.5
	NMNL-1 (22%)	77.04	177.77	179.68	1.91	61.33	61.84
	NMNL-1 (21%)	73.54	177.77	179.66	1.89	59.7	60.88
	NMNL-1 (20%)	70.04	177.77	179.63	1.86	58.06	59.89
	NMNL-1 (19%)	66.53	177.77	179.6	1.83	56.4	58.87
	NMNL-1 (18%)	63.03	177.77	179.57	1.8	54.72	57.83
	NMNL-1 (17%)	59.53	177.77	179.54	1.77	53.03	56.76
	NMNL-1 (16%)	56.03	177.77	179.51	1.74	51.31	55.66
	NMNL-1 (15%)	52.53	177.77	179.48	1.71	49.56	54.74
	NMNL-2 (100%)	252.93	177.77	180.62	2.85	128.27	79.4
	NMNL-2 (30%)	75.88	177.77	179.67	1.9	60.8	61.52
	NMNL-2 (29%)	73.35	177.77	179.66	1.89	59.61	60.82
	NMNL-2 (28%)	70.82	177.77	179.64	1.87	58.43	60.11
	NMNL-2 (27%)	68.29	177.77	179.62	1.85	57.23	59.39
	NMNL-2 (26%)	65.76	177.77	179.6	1.83	56.03	58.65
	NMNL-2 (25%)	63.23	177.77	179.57	1.8	54.82	57.89
	NMNL-2 (24%)	60.7	177.77	179.55	1.78	53.6	57.12
	NMNL-2 (23%)	58.17	177.77	179.53	1.76	52.36	56.33
	NMNL-2 (22%)	55.64	177.77	179.51	1.74	51.11	55.56
	NMNL-2 (21%)	53.12	177.77	179.49	1.72	49.86	54.9
	NMNL-2 (20%)	50.59	177.77	179.46	1.69	48.58	54.22
	NMNL-2 (19%)	48.06	177.77	179.44	1.67	47.29	53.53
	NMNL-2 (18%)	45.53	177.77	179.41	1.64	45.98	52.81
	NMNL-2 (17%)	43	177.77	179.39	1.62	44.66	52.07
	NMNL-2 (16%)	40.47	177.77	179.36	1.59	43.3	51.3
	NMNL-2 (15%)	37.94	177.77	179.34	1.57	41.91	50.5

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (100%)	158.05	177.77	180.18	2.41	95.09	72.51
	L (30%)	47.41	177.77	179.43	1.66	46.95	53.34
	L (29%)	45.83	177.77	179.42	1.65	46.13	52.9
	L (28%)	44.25	177.77	179.4	1.63	45.32	52.44
	L (27%)	42.67	177.77	179.39	1.62	44.48	51.97
	L (26%)	41.09	177.77	179.37	1.6	43.63	51.49
	L (25%)	39.51	177.77	179.35	1.58	42.78	51
	L (24%)	37.93	177.77	179.34	1.57	41.9	50.5
	L (23%)	36.35	177.77	179.32	1.55	40.97	49.95
	L (22%)	34.77	177.77	179.3	1.53	39.99	49.38
	L (21%)	33.19	177.77	179.28	1.51	39	48.78
	L (20%)	31.61	177.77	179.26	1.49	37.99	48.17
	L (19%)	30.03	177.77	179.23	1.46	36.95	47.53
	L (18%)	28.45	177.77	179.21	1.44	35.88	46.86
	L (17%)	26.87	177.77	179.19	1.42	34.76	46.16
	L (16%)	25.29	177.77	179.16	1.39	33.63	45.43
	L (15%)	23.71	177.77	179.14	1.37	32.45	44.66
1000 m d/s of Barrage axis	M (100%)	708.88	177.64	181.91	4.27	323.22	199.36
	M (30%)	212.66	177.64	180.31	2.67	129.06	90.16
	M (29%)	205.57	177.64	180.28	2.64	126.1	89.52
	M (28%)	198.49	177.64	180.25	2.61	123.18	88.89
	M (27%)	191.4	177.64	180.22	2.58	120.16	88.24
	M (26%)	184.31	177.64	180.18	2.54	117.11	87.57
	M (25%)	177.22	177.64	180.15	2.51	114.03	86.89
	M (24%)	170.13	177.64	180.11	2.47	110.92	86.2
	M (23%)	163.04	177.64	180.07	2.43	107.77	85.49
	M (22%)	155.95	177.64	180.03	2.39	104.51	84.76
	M (21%)	148.86	177.64	180	2.36	101.29	84.03
	M (20%)	141.78	177.64	179.96	2.32	98.04	83.28
	M (19%)	134.69	177.64	179.92	2.28	94.73	82.51
	M (18%)	127.6	177.64	179.88	2.24	91.37	81.73
	M (17%)	120.51	177.64	179.83	2.19	87.93	80.91
	M (16%)	113.42	177.64	179.79	2.15	84.43	80.08
	M (15%)	106.33	177.64	179.75	2.11	80.87	79.22
	NMNL-1 (100%)	350.18	177.64	180.87	3.23	182.14	100.82
	NMNL-1 (30%)	105.05	177.64	179.74	2.1	80.21	79.06
	NMNL-1 (29%)	101.55	177.64	179.71	2.07	78.42	78.62
	NMNL-1 (28%)	98.05	177.64	179.69	2.05	76.61	78.18
	NMNL-1 (27%)	94.55	177.64	179.67	2.03	74.77	77.72
	NMNL-1 (26%)	91.05	177.64	179.64	2	72.91	77.26
	NMNL-1 (25%)	87.54	177.64	179.62	1.98	71.09	76.81
	NMNL-1 (24%)	84.04	177.64	179.6	1.96	69.2	76.34
	NMNL-1 (23%)	80.54	177.64	179.57	1.93	67.28	75.85

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (22%)	77.04	177.64	179.54	1.9	65.34	75.36
	NMNL-1 (21%)	73.54	177.64	179.52	1.88	63.37	74.86
	NMNL-1 (20%)	70.04	177.64	179.49	1.85	61.37	74.35
	NMNL-1 (19%)	66.53	177.64	179.46	1.82	59.34	73.82
	NMNL-1 (18%)	63.03	177.64	179.44	1.8	57.27	73.29
	NMNL-1 (17%)	59.53	177.64	179.41	1.77	55.17	72.73
	NMNL-1 (16%)	56.03	177.64	179.38	1.74	53.04	72.17
	NMNL-1 (15%)	52.53	177.64	179.35	1.71	50.85	71.59
	NMNL-2 (100%)	252.93	177.64	180.49	2.85	145.4	93.57
	NMNL-2 (30%)	75.88	177.64	179.54	1.9	64.69	75.2
	NMNL-2 (29%)	73.35	177.64	179.52	1.88	63.26	74.83
	NMNL-2 (28%)	70.82	177.64	179.5	1.86	61.82	74.46
	NMNL-2 (27%)	68.29	177.64	179.48	1.84	60.36	74.09
	NMNL-2 (26%)	65.76	177.64	179.46	1.82	58.89	73.71
	NMNL-2 (25%)	63.23	177.64	179.44	1.8	57.39	73.32
	NMNL-2 (24%)	60.7	177.64	179.42	1.78	55.88	72.92
	NMNL-2 (23%)	58.17	177.64	179.4	1.76	54.35	72.52
	NMNL-2 (22%)	55.64	177.64	179.37	1.73	52.79	72.11
	NMNL-2 (21%)	53.12	177.64	179.35	1.71	51.22	71.69
	NMNL-2 (20%)	50.59	177.64	179.33	1.69	49.62	71.26
	NMNL-2 (19%)	48.06	177.64	179.31	1.67	48	70.82
	NMNL-2 (18%)	45.53	177.64	179.28	1.64	46.34	70.37
	NMNL-2 (17%)	43	177.64	179.26	1.62	44.68	69.92
	NMNL-2 (16%)	40.47	177.64	179.24	1.6	42.97	69.45
	NMNL-2 (15%)	37.94	177.64	179.21	1.57	41.21	68.96
	L (100%)	158.05	177.64	180.05	2.41	105.52	84.99
	L (30%)	47.41	177.64	179.3	1.66	47.57	70.71
	L (29%)	45.83	177.64	179.29	1.65	46.54	70.43
	L (28%)	44.25	177.64	179.27	1.63	45.52	70.15
	L (27%)	42.67	177.64	179.26	1.62	44.46	69.86
	L (26%)	41.09	177.64	179.24	1.6	43.39	69.57
	L (25%)	39.51	177.64	179.23	1.59	42.31	69.27
	L (24%)	37.93	177.64	179.21	1.57	41.2	68.96
	L (23%)	36.35	177.64	179.19	1.55	39.97	68.09
	L (22%)	34.77	177.64	179.17	1.53	38.64	66.91
	L (21%)	33.19	177.64	179.15	1.51	37.31	65.7
	L (20%)	31.61	177.64	179.13	1.49	35.96	64.44
	L (19%)	30.03	177.64	179.11	1.47	34.57	63.13
	L (18%)	28.45	177.64	179.09	1.45	33.19	61.81
	L (17%)	26.87	177.64	179.07	1.43	31.79	60.42
	L (16%)	25.29	177.64	179.04	1.4	30.36	58.98
	L (15%)	23.71	177.64	179.02	1.38	28.9	57.47

Table-13.11: Depth of flow for the proposed Minimum Flow on the basis of average flow during 90% dependable year for Teesta low dam-IV HEP

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
At Dam Axis	M (100%)	708.69	150.09	155.58	5.49	291.09	93.28
	M (30%)	212.61	150.09	153.68	3.59	143.89	61.63
	M (29%)	205.52	150.09	153.63	3.54	141.26	60.92
	M (28%)	198.43	150.09	153.59	3.5	138.63	60.19
	M (27%)	191.35	150.09	153.55	3.46	135.97	59.46
	M (26%)	184.26	150.09	153.5	3.41	133.29	58.7
	M (25%)	177.17	150.09	153.45	3.36	130.59	57.93
	M (24%)	170.09	150.09	153.41	3.32	127.84	57.13
	M (23%)	163	150.09	153.36	3.27	125.06	56.32
	M (22%)	155.91	150.09	153.31	3.22	122.25	55.48
	M (21%)	148.83	150.09	153.25	3.16	119.39	54.79
	M (20%)	141.74	150.09	153.2	3.11	116.48	54.17
	M (19%)	134.65	150.09	153.15	3.06	113.52	53.53
	M (18%)	127.56	150.09	153.09	3	110.48	52.87
	M (17%)	120.48	150.09	153.03	2.94	107.36	52.18
	M (16%)	113.39	150.09	152.97	2.88	104.21	51.47
	M (15%)	106.3	150.09	152.91	2.82	100.98	50.73
	NMNL-1 (100%)	368.46	150.09	154.45	4.36	196.35	74.47
	NMNL-1 (30%)	110.54	150.09	152.94	2.85	102.92	51.18
	NMNL-1 (29%)	106.85	150.09	152.91	2.82	101.23	50.79
	NMNL-1 (28%)	103.17	150.09	152.88	2.79	99.52	50.4
	NMNL-1 (27%)	99.48	150.09	152.84	2.75	97.78	50
	NMNL-1 (26%)	95.8	150.09	152.81	2.72	96	49.58
	NMNL-1 (25%)	92.11	150.09	152.77	2.68	94.22	49.16
	NMNL-1 (24%)	88.43	150.09	152.73	2.64	92.42	48.73
	NMNL-1 (23%)	84.74	150.09	152.7	2.61	90.58	48.29
	NMNL-1 (22%)	81.06	150.09	152.66	2.57	88.69	47.84
	NMNL-1 (21%)	77.38	150.09	152.62	2.53	86.78	47.37
	NMNL-1 (20%)	73.69	150.09	152.57	2.48	84.82	46.89
	NMNL-1 (19%)	70.01	150.09	152.53	2.44	82.84	46.39
	NMNL-1 (18%)	66.32	150.09	152.49	2.4	80.81	45.88
	NMNL-1 (17%)	62.64	150.09	152.44	2.35	78.74	45.35
	NMNL-1 (16%)	58.95	150.09	152.4	2.31	76.61	44.8
	NMNL-1 (15%)	55.27	150.09	152.35	2.26	74.42	44.23
	NMNL-2 (100%)	283.28	150.09	154.06	3.97	168.65	67.99
	NMNL-2 (30%)	84.98	150.09	152.7	2.61	90.7	48.32
	NMNL-2 (29%)	82.15	150.09	152.67	2.58	89.26	47.98
	NMNL-2 (28%)	79.32	150.09	152.64	2.55	87.79	47.62
	NMNL-2 (27%)	76.48	150.09	152.61	2.52	86.31	47.25
	NMNL-2 (26%)	73.65	150.09	152.57	2.48	84.8	46.88
	NMNL-2 (25%)	70.82	150.09	152.54	2.45	83.27	46.5
	NMNL-2 (24%)	67.99	150.09	152.51	2.42	81.73	46.12

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (23%)	65.15	150.09	152.47	2.38	80.16	45.72
	NMNL-2 (22%)	62.32	150.09	152.44	2.35	78.56	45.31
	NMNL-2 (21%)	59.49	150.09	152.4	2.31	76.92	44.89
	NMNL-2 (20%)	56.66	150.09	152.37	2.28	75.24	44.45
	NMNL-2 (19%)	53.82	150.09	152.33	2.24	73.55	44
	NMNL-2 (18%)	50.99	150.09	152.29	2.2	71.83	43.56
	NMNL-2 (17%)	48.16	150.09	152.25	2.16	70.06	43.25
	NMNL-2 (16%)	45.32	150.09	152.2	2.11	68.22	42.93
	NMNL-2 (15%)	42.49	150.09	152.16	2.07	66.34	42.6
	L (100%)	149.46	150.09	153.26	3.17	119.67	54.85
	L (30%)	44.84	150.09	152.2	2.11	67.9	42.88
	L (29%)	43.34	150.09	152.17	2.08	66.91	42.7
	L (28%)	41.85	150.09	152.15	2.06	65.9	42.52
	L (27%)	40.35	150.09	152.13	2.04	64.88	42.34
	L (26%)	38.86	150.09	152.1	2.01	63.84	42.16
	L (25%)	37.36	150.09	152.08	1.99	62.77	41.97
	L (24%)	35.87	150.09	152.05	1.96	61.69	41.77
	L (23%)	34.37	150.09	152.02	1.93	60.58	41.57
	L (22%)	32.88	150.09	152	1.91	59.45	41.37
	L (21%)	31.39	150.09	151.97	1.88	58.3	41.16
	L (20%)	29.89	150.09	151.94	1.85	57.11	40.94
	L (19%)	28.4	150.09	151.91	1.82	55.9	40.72
	L (18%)	26.9	150.09	151.88	1.79	54.65	40.49
	L (17%)	25.41	150.09	151.85	1.76	53.37	40.25
	L (16%)	23.91	150.09	151.81	1.72	52.04	40
	L (15%)	22.42	150.09	151.78	1.69	50.68	39.74
300 m d/s of Dam Axis	M (100%)	708.69	150.36	153.37	3.01	175.38	83.2
	M (30%)	212.61	150.36	152.19	1.83	81.8	75.8
	M (29%)	205.52	150.36	152.17	1.81	79.82	75.64
	M (28%)	198.43	150.36	152.14	1.78	77.85	75.03
	M (27%)	191.35	150.36	152.11	1.75	75.71	74.21
	M (26%)	184.26	150.36	152.08	1.72	73.51	73.35
	M (25%)	177.17	150.36	152.05	1.69	71.31	72.49
	M (24%)	170.09	150.36	152.02	1.66	69.14	71.62
	M (23%)	163	150.36	151.99	1.63	67.06	70.79
	M (22%)	155.91	150.36	151.95	1.59	64.44	69.72
	M (21%)	148.83	150.36	151.92	1.56	61.88	68.66
	M (20%)	141.74	150.36	151.88	1.52	59.21	67.53
	M (19%)	134.65	150.36	151.83	1.47	56.11	65.34
	M (18%)	127.56	150.36	151.79	1.43	53.16	62.57
	M (17%)	120.48	150.36	151.74	1.38	50.56	60.01
	M (16%)	113.39	150.36	151.7	1.34	48.02	57.43
	M (15%)	106.3	150.36	151.66	1.3	45.64	54.96

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (100%)	368.46	150.36	152.64	2.28	116.74	78.65
	NMNL-1 (30%)	110.54	150.36	151.68	1.32	47.05	56.4
	NMNL-1 (29%)	106.85	150.36	151.66	1.3	45.82	55.07
	NMNL-1 (28%)	103.17	150.36	151.64	1.28	44.71	54.64
	NMNL-1 (27%)	99.48	150.36	151.62	1.26	43.77	54.31
	NMNL-1 (26%)	95.8	150.36	151.6	1.24	42.62	53.9
	NMNL-1 (25%)	92.11	150.36	151.58	1.22	41.55	53.52
	NMNL-1 (24%)	88.43	150.36	151.56	1.2	40.3	53.07
	NMNL-1 (23%)	84.74	150.36	151.54	1.18	39.16	52.66
	NMNL-1 (22%)	81.06	150.36	151.52	1.16	38.01	52.24
	NMNL-1 (21%)	77.38	150.36	151.49	1.13	36.85	51.82
	NMNL-1 (20%)	73.69	150.36	151.47	1.11	35.66	51.38
	NMNL-1 (19%)	70.01	150.36	151.45	1.09	34.46	50.93
	NMNL-1 (18%)	66.32	150.36	151.42	1.06	33.24	50.47
	NMNL-1 (17%)	62.64	150.36	151.4	1.04	31.99	50
	NMNL-1 (16%)	58.95	150.36	151.37	1.01	30.73	49.51
	NMNL-1 (15%)	55.27	150.36	151.35	0.99	29.44	49.01
	NMNL-2 (100%)	283.28	150.36	152.42	2.06	98.97	77.21
	NMNL-2 (30%)	84.98	150.36	151.54	1.18	39.24	52.69
	NMNL-2 (29%)	82.15	150.36	151.52	1.16	38.36	52.37
	NMNL-2 (28%)	79.32	150.36	151.51	1.15	37.46	52.04
	NMNL-2 (27%)	76.48	150.36	151.49	1.13	36.56	51.71
	NMNL-2 (26%)	73.65	150.36	151.47	1.11	35.65	51.37
	NMNL-2 (25%)	70.82	150.36	151.45	1.09	34.73	51.03
	NMNL-2 (24%)	67.99	150.36	151.43	1.07	33.79	50.68
	NMNL-2 (23%)	65.15	150.36	151.41	1.05	32.84	50.32
	NMNL-2 (22%)	62.32	150.36	151.4	1.04	31.89	49.96
	NMNL-2 (21%)	59.49	150.36	151.38	1.02	30.92	49.58
	NMNL-2 (20%)	56.66	150.36	151.36	1	29.93	49.2
	NMNL-2 (19%)	53.82	150.36	151.34	0.98	28.93	48.81
	NMNL-2 (18%)	50.99	150.36	151.32	0.96	27.91	48.41
	NMNL-2 (17%)	48.16	150.36	151.29	0.93	26.88	48
	NMNL-2 (16%)	45.32	150.36	151.27	0.91	25.83	47.58
	NMNL-2 (15%)	42.49	150.36	151.25	0.89	24.75	47.15
	L (100%)	149.46	150.36	151.92	1.56	62.11	68.76
	L (30%)	44.84	150.36	151.27	0.91	25.65	47.51
	L (29%)	43.34	150.36	151.26	0.9	25.08	47.28
	L (28%)	41.85	150.36	151.24	0.88	24.51	47.05
	L (27%)	40.35	150.36	151.23	0.87	23.93	46.82
	L (26%)	38.86	150.36	151.22	0.86	23.35	46.58
	L (25%)	37.36	150.36	151.21	0.85	22.75	46.33
	L (24%)	35.87	150.36	151.19	0.83	22.2	46.1
	L (23%)	34.37	150.36	151.18	0.82	21.59	45.85
	L (22%)	32.88	150.36	151.17	0.81	20.97	45.59

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (21%)	31.39	150.36	151.15	0.79	20.34	45.23
	L (20%)	29.89	150.36	151.14	0.78	19.69	44.73
	L (19%)	28.4	150.36	151.12	0.76	19	44.21
	L (18%)	26.9	150.36	151.11	0.75	18.33	43.69
	L (17%)	25.41	150.36	151.09	0.73	17.69	43.18
	L (16%)	23.91	150.36	151.08	0.72	17	42.64
	L (15%)	22.42	150.36	151.06	0.7	16.3	42.08
600 m d/s of Dam Axis	M (100%)	708.69	143.64	149.55	5.91	174.05	49.58
	M (30%)	212.61	143.64	147.33	3.69	78.86	36.06
	M (29%)	205.52	143.64	147.28	3.64	77.13	35.77
	M (28%)	198.43	143.64	147.23	3.59	75.37	35.48
	M (27%)	191.35	143.64	147.18	3.54	73.59	35.18
	M (26%)	184.26	143.64	147.13	3.49	71.76	34.86
	M (25%)	177.17	143.64	147.07	3.43	69.89	34.54
	M (24%)	170.09	143.64	147.02	3.38	67.97	34.21
	M (23%)	163	143.64	146.96	3.32	66.01	33.86
	M (22%)	155.91	143.64	146.9	3.26	63.99	33.5
	M (21%)	148.83	143.64	146.84	3.2	61.91	33.11
	M (20%)	141.74	143.64	146.77	3.13	59.78	32.46
	M (19%)	134.65	143.64	146.7	3.06	57.6	31.77
	M (18%)	127.56	143.64	146.63	2.99	55.39	31.07
	M (17%)	120.48	143.64	146.56	2.92	53.16	30.33
	M (16%)	113.39	143.64	146.48	2.84	50.87	29.56
	M (15%)	106.3	143.64	146.4	2.76	48.55	28.76
	NMNL-1 (100%)	368.46	143.64	148.2	4.56	112.82	41.32
	NMNL-1 (30%)	110.54	143.64	146.45	2.81	49.94	29.24
	NMNL-1 (29%)	106.85	143.64	146.41	2.77	48.73	28.82
	NMNL-1 (28%)	103.17	143.64	146.37	2.73	47.51	28.39
	NMNL-1 (27%)	99.48	143.64	146.32	2.68	46.27	27.95
	NMNL-1 (26%)	95.8	143.64	146.28	2.64	45.02	27.5
	NMNL-1 (25%)	92.11	143.64	146.23	2.59	43.76	27.03
	NMNL-1 (24%)	88.43	143.64	146.18	2.54	42.49	26.55
	NMNL-1 (23%)	84.74	143.64	146.14	2.5	41.2	26.06
	NMNL-1 (22%)	81.06	143.64	146.09	2.45	39.91	25.55
	NMNL-1 (21%)	77.38	143.64	146.03	2.39	38.6	25.03
	NMNL-1 (20%)	73.69	143.64	145.98	2.34	37.28	24.5
	NMNL-1 (19%)	70.01	143.64	145.93	2.29	35.96	23.95
	NMNL-1 (18%)	66.32	143.64	145.87	2.23	34.63	23.38
	NMNL-1 (17%)	62.64	143.64	145.81	2.17	33.3	22.8
	NMNL-1 (16%)	58.95	143.64	145.75	2.11	31.98	22.21
	NMNL-1 (15%)	55.27	143.64	145.69	2.05	30.66	21.78
	NMNL-2 (100%)	283.28	143.64	147.76	4.12	95.05	38.66
	NMNL-2 (30%)	84.98	143.64	146.14	2.5	41.29	26.09

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (29%)	82.15	143.64	146.1	2.46	40.29	25.71
	NMNL-2 (28%)	79.32	143.64	146.06	2.42	39.29	25.31
	NMNL-2 (27%)	76.48	143.64	146.02	2.38	38.28	24.9
	NMNL-2 (26%)	73.65	143.64	145.98	2.34	37.27	24.49
	NMNL-2 (25%)	70.82	143.64	145.94	2.3	36.25	24.07
	NMNL-2 (24%)	67.99	143.64	145.9	2.26	35.23	23.64
	NMNL-2 (23%)	65.15	143.64	145.85	2.21	34.21	23.2
	NMNL-2 (22%)	62.32	143.64	145.81	2.17	33.19	22.75
	NMNL-2 (21%)	59.49	143.64	145.76	2.12	32.17	22.3
	NMNL-2 (20%)	56.66	143.64	145.72	2.08	31.16	21.92
	NMNL-2 (19%)	53.82	143.64	145.67	2.03	30.13	21.63
	NMNL-2 (18%)	50.99	143.64	145.62	1.98	29.09	21.33
	NMNL-2 (17%)	48.16	143.64	145.57	1.93	28.02	21.01
	NMNL-2 (16%)	45.32	143.64	145.52	1.88	26.94	20.68
	NMNL-2 (15%)	42.49	143.64	145.46	1.82	25.83	20.35
	L (100%)	149.46	143.64	146.84	3.2	62.1	33.16
	L (30%)	44.84	143.64	145.51	1.87	26.75	20.63
	L (29%)	43.34	143.64	145.48	1.84	26.16	20.45
	L (28%)	41.85	143.64	145.45	1.81	25.57	20.27
	L (27%)	40.35	143.64	145.42	1.78	24.97	20.08
	L (26%)	38.86	143.64	145.39	1.75	24.37	19.89
	L (25%)	37.36	143.64	145.36	1.72	23.75	19.7
	L (24%)	35.87	143.64	145.33	1.69	23.13	19.5
	L (23%)	34.37	143.64	145.3	1.66	22.49	19.3
	L (22%)	32.88	143.64	145.26	1.62	21.86	19.09
	L (21%)	31.39	143.64	145.23	1.59	21.21	18.87
	L (20%)	29.89	143.64	145.19	1.55	20.54	18.65
	L (19%)	28.4	143.64	145.16	1.52	19.87	18.43
	L (18%)	26.9	143.64	145.12	1.48	19.19	18.19
	L (17%)	25.41	143.64	145.08	1.44	18.49	17.95
	L (16%)	23.91	143.64	145.04	1.4	17.78	17.7
	L (15%)	22.42	143.64	145	1.36	17.05	17.45
900 m d/s of Dam Axis	M (100%)	708.69	142.71	148.03	5.32	200.14	59.14
	M (30%)	212.61	142.71	145.63	2.92	79.34	40.73
	M (29%)	205.52	142.71	145.58	2.87	77.34	40.22
	M (28%)	198.43	142.71	145.53	2.82	75.32	39.7
	M (27%)	191.35	142.71	145.48	2.77	73.3	39.18
	M (26%)	184.26	142.71	145.43	2.72	71.27	38.64
	M (25%)	177.17	142.71	145.37	2.66	69.22	38.09
	M (24%)	170.09	142.71	145.32	2.61	67.15	37.53
	M (23%)	163	142.71	145.26	2.55	65.07	36.96
	M (22%)	155.91	142.71	145.21	2.5	62.95	36.37
	M (21%)	148.83	142.71	145.15	2.44	60.79	35.75

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (20%)	141.74	142.71	145.08	2.37	58.62	35.12
	M (19%)	134.65	142.71	145.02	2.31	56.42	34.47
	M (18%)	127.56	142.71	144.96	2.25	54.19	33.8
	M (17%)	120.48	142.71	144.89	2.18	51.93	33.11
	M (16%)	113.39	142.71	144.82	2.11	49.64	32.39
	M (15%)	106.3	142.71	144.75	2.04	47.34	31.66
	NMNL-1 (100%)	368.46	142.71	146.55	3.84	120.25	48.33
	NMNL-1 (30%)	110.54	142.71	144.79	2.08	48.71	32.1
	NMNL-1 (29%)	106.85	142.71	144.75	2.04	47.52	31.71
	NMNL-1 (28%)	103.17	142.71	144.71	2	46.3	31.32
	NMNL-1 (27%)	99.48	142.71	144.67	1.96	45.09	31.07
	NMNL-1 (26%)	95.8	142.71	144.63	1.92	43.87	30.82
	NMNL-1 (25%)	92.11	142.71	144.6	1.89	42.67	30.58
	NMNL-1 (24%)	88.43	142.71	144.56	1.85	41.47	30.34
	NMNL-1 (23%)	84.74	142.71	144.52	1.81	40.25	30.09
	NMNL-1 (22%)	81.06	142.71	144.47	1.76	39.02	29.84
	NMNL-1 (21%)	77.38	142.71	144.43	1.72	37.78	29.58
	NMNL-1 (20%)	73.69	142.71	144.39	1.68	36.51	29.31
	NMNL-1 (19%)	70.01	142.71	144.35	1.64	35.23	29.04
	NMNL-1 (18%)	66.32	142.71	144.3	1.59	33.92	28.76
	NMNL-1 (17%)	62.64	142.71	144.25	1.54	32.59	28.48
	NMNL-1 (16%)	58.95	142.71	144.21	1.5	31.25	28.18
	NMNL-1 (15%)	55.27	142.71	144.16	1.45	29.87	27.88
	NMNL-2 (100%)	283.28	142.71	146.08	3.37	98.61	44.69
	NMNL-2 (30%)	84.98	142.71	144.52	1.81	40.33	30.11
	NMNL-2 (29%)	82.15	142.71	144.49	1.78	39.39	29.91
	NMNL-2 (28%)	79.32	142.71	144.46	1.75	38.43	29.71
	NMNL-2 (27%)	76.48	142.71	144.42	1.71	37.47	29.51
	NMNL-2 (26%)	73.65	142.71	144.39	1.68	36.5	29.31
	NMNL-2 (25%)	70.82	142.71	144.36	1.65	35.51	29.1
	NMNL-2 (24%)	67.99	142.71	144.32	1.61	34.51	28.89
	NMNL-2 (23%)	65.15	142.71	144.29	1.58	33.5	28.67
	NMNL-2 (22%)	62.32	142.71	144.25	1.54	32.47	28.45
	NMNL-2 (21%)	59.49	142.71	144.21	1.5	31.44	28.22
	NMNL-2 (20%)	56.66	142.71	144.18	1.47	30.39	27.99
	NMNL-2 (19%)	53.82	142.71	144.14	1.43	29.32	27.76
	NMNL-2 (18%)	50.99	142.71	144.1	1.39	28.24	27.52
	NMNL-2 (17%)	48.16	142.71	144.06	1.35	27.14	27.27
	NMNL-2 (16%)	45.32	142.71	144.02	1.31	26.01	27.01
	NMNL-2 (15%)	42.49	142.71	143.97	1.26	24.86	26.75
	L (100%)	149.46	142.71	145.15	2.44	60.99	35.81
	L (30%)	44.84	142.71	144.01	1.3	25.81	26.97
	L (29%)	43.34	142.71	143.99	1.28	25.2	26.83
	L (28%)	41.85	142.71	143.96	1.25	24.59	26.69

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (27%)	40.35	142.71	143.94	1.23	23.99	26.55
	L (26%)	38.86	142.71	143.92	1.21	23.35	26.4
	L (25%)	37.36	142.71	143.89	1.18	22.71	26.25
	L (24%)	35.87	142.71	143.87	1.16	22.07	26.1
	L (23%)	34.37	142.71	143.84	1.13	21.4	25.94
	L (22%)	32.88	142.71	143.82	1.11	20.73	25.78
	L (21%)	31.39	142.71	143.79	1.08	20.07	25.62
	L (20%)	29.89	142.71	143.76	1.05	19.37	25.45
	L (19%)	28.4	142.71	143.74	1.03	18.67	25.28
	L (18%)	26.9	142.71	143.71	1	17.93	25.1
	L (17%)	25.41	142.71	143.68	0.97	17.2	24.92
	L (16%)	23.91	142.71	143.65	0.94	16.42	24.72
	L (15%)	22.42	142.71	143.61	0.9	15.63	24.53
1200 m d/s of Dam Axis	M (100%)	708.69	140.42	145.74	5.32	146.78	42.76
	M (30%)	212.61	140.42	143.47	3.05	62.63	31.57
	M (29%)	205.52	140.42	143.43	3.01	61.16	31.34
	M (28%)	198.43	140.42	143.38	2.96	59.59	30.97
	M (27%)	191.35	140.42	143.32	2.9	58	30.58
	M (26%)	184.26	140.42	143.27	2.85	56.4	30.18
	M (25%)	177.17	140.42	143.22	2.8	54.78	29.77
	M (24%)	170.09	140.42	143.16	2.74	53.15	29.36
	M (23%)	163	140.42	143.11	2.69	51.49	28.93
	M (22%)	155.91	140.42	143.05	2.63	49.82	28.49
	M (21%)	148.83	140.42	142.99	2.57	48.14	28.03
	M (20%)	141.74	140.42	142.93	2.51	46.43	27.57
	M (19%)	134.65	140.42	142.86	2.44	44.7	27.09
	M (18%)	127.56	140.42	142.8	2.38	42.95	26.59
	M (17%)	120.48	140.42	142.73	2.31	41.18	26.08
	M (16%)	113.39	140.42	142.66	2.24	39.37	25.55
	M (15%)	106.3	140.42	142.59	2.17	37.53	25
	NMNL-1 (100%)	368.46	140.42	144.34	3.92	92.01	35.91
	NMNL-1 (30%)	110.54	140.42	142.63	2.21	38.64	25.33
	NMNL-1 (29%)	106.85	140.42	142.59	2.17	37.68	25.05
	NMNL-1 (28%)	103.17	140.42	142.56	2.14	36.71	24.75
	NMNL-1 (27%)	99.48	140.42	142.52	2.1	35.74	24.45
	NMNL-1 (26%)	95.8	140.42	142.48	2.06	34.76	24.15
	NMNL-1 (25%)	92.11	140.42	142.43	2.01	33.77	23.83
	NMNL-1 (24%)	88.43	140.42	142.39	1.97	32.77	23.51
	NMNL-1 (23%)	84.74	140.42	142.35	1.93	31.75	23.18
	NMNL-1 (22%)	81.06	140.42	142.3	1.88	30.73	22.85
	NMNL-1 (21%)	77.38	140.42	142.26	1.84	29.7	22.5
	NMNL-1 (20%)	73.69	140.42	142.21	1.79	28.65	22.15
	NMNL-1 (19%)	70.01	140.42	142.16	1.74	27.59	21.78

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (18%)	66.32	140.42	142.11	1.69	26.52	21.4
	NMNL-1 (17%)	62.64	140.42	142.06	1.64	25.43	21.01
	NMNL-1 (16%)	58.95	140.42	142.01	1.59	24.33	20.62
	NMNL-1 (15%)	55.27	140.42	141.96	1.54	23.23	20.27
	NMNL-2 (100%)	283.28	140.42	143.9	3.48	76.51	33.69
	NMNL-2 (30%)	84.98	140.42	142.35	1.93	31.82	23.2
	NMNL-2 (29%)	82.15	140.42	142.32	1.9	31.03	22.95
	NMNL-2 (28%)	79.32	140.42	142.28	1.86	30.24	22.68
	NMNL-2 (27%)	76.48	140.42	142.25	1.83	29.44	22.42
	NMNL-2 (26%)	73.65	140.42	142.21	1.79	28.64	22.14
	NMNL-2 (25%)	70.82	140.42	142.17	1.75	27.82	21.86
	NMNL-2 (24%)	67.99	140.42	142.14	1.72	27	21.57
	NMNL-2 (23%)	65.15	140.42	142.1	1.68	26.17	21.28
	NMNL-2 (22%)	62.32	140.42	142.06	1.64	25.33	20.98
	NMNL-2 (21%)	59.49	140.42	142.02	1.6	24.49	20.68
	NMNL-2 (20%)	56.66	140.42	141.98	1.56	23.65	20.4
	NMNL-2 (19%)	53.82	140.42	141.93	1.51	22.8	20.12
	NMNL-2 (18%)	50.99	140.42	141.89	1.47	21.95	19.84
	NMNL-2 (17%)	48.16	140.42	141.85	1.43	21.07	19.54
	NMNL-2 (16%)	45.32	140.42	141.8	1.38	20.18	19.23
	NMNL-2 (15%)	42.49	140.42	141.75	1.33	19.28	18.92
	L (100%)	149.46	140.42	142.99	2.57	48.29	28.07
	L (30%)	44.84	140.42	141.79	1.37	20.03	19.18
	L (29%)	43.34	140.42	141.77	1.35	19.55	19.01
	L (28%)	41.85	140.42	141.74	1.32	19.08	18.84
	L (27%)	40.35	140.42	141.72	1.3	18.59	18.67
	L (26%)	38.86	140.42	141.69	1.27	18.1	18.5
	L (25%)	37.36	140.42	141.66	1.24	17.61	18.32
	L (24%)	35.87	140.42	141.64	1.22	17.11	18.13
	L (23%)	34.37	140.42	141.61	1.19	16.6	17.94
	L (22%)	32.88	140.42	141.58	1.16	16.09	17.75
	L (21%)	31.39	140.42	141.55	1.13	15.58	17.56
	L (20%)	29.89	140.42	141.52	1.1	15.05	17.36
	L (19%)	28.4	140.42	141.49	1.07	14.53	17.15
	L (18%)	26.9	140.42	141.46	1.04	13.99	16.94
	L (17%)	25.41	140.42	141.43	1.01	13.44	16.73
	L (16%)	23.91	140.42	141.39	0.97	12.89	16.5
	L (15%)	22.42	140.42	141.36	0.94	12.33	16.27

Table-13.12: Depth of flow for release in the year 2013 for Teesta Low Dam -III HEP

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
At Barrage axis	M (100%)	910	180.34	185.08	4.74	351.13	120.18
	M (30%)	273	180.34	183.07	2.73	151.47	78.75
	M (29%)	263.9	180.34	183.03	2.69	148.39	78.18
	M (28%)	254.8	180.34	182.99	2.65	145.28	77.59
	M (27%)	245.7	180.34	182.95	2.61	142.26	77.02
	M (26%)	236.6	180.34	182.91	2.57	139.14	76.43
	M (25%)	227.5	180.34	182.87	2.53	135.99	75.82
	M (24%)	218.4	180.34	182.82	2.48	132.86	75.21
	M (23%)	209.3	180.34	182.78	2.44	129.73	74.6
	M (22%)	200.2	180.34	182.74	2.4	126.65	73.99
	M (21%)	191.1	180.34	182.7	2.36	123.41	73.35
	M (20%)	182	180.34	182.65	2.31	120.21	72.71
	M (19%)	172.9	180.34	182.61	2.27	116.91	72.04
	M (18%)	163.8	180.34	182.56	2.22	113.42	71.33
	M (17%)	154.7	180.34	182.51	2.17	109.74	70.55
	M (16%)	145.6	180.34	182.45	2.11	105.95	69.74
	M (15%)	136.5	180.34	182.4	2.06	102.13	68.91
	NMNL-1 (100%)	352.17	180.34	183.39	3.05	177.71	83.53
	NMNL-1 (30%)	105.65	180.34	182.2	1.86	88.51	65.87
	NMNL-1 (29%)	102.13	180.34	182.17	1.83	86.87	65.5
	NMNL-1 (28%)	98.61	180.34	182.15	1.81	85.16	65.11
	NMNL-1 (27%)	95.09	180.34	182.12	1.78	83.38	64.69
	NMNL-1 (26%)	91.56	180.34	182.09	1.75	81.54	64.26
	NMNL-1 (25%)	88.04	180.34	182.06	1.72	79.63	63.82
	NMNL-1 (24%)	84.52	180.34	182.03	1.69	77.66	63.35
	NMNL-1 (23%)	81	180.34	182	1.66	75.77	62.9
	NMNL-1 (22%)	77.48	180.34	181.97	1.63	73.86	62.44
	NMNL-1 (21%)	73.96	180.34	181.94	1.6	71.93	61.98
	NMNL-1 (20%)	70.43	180.34	181.9	1.56	69.95	61.5
	NMNL-1 (19%)	66.91	180.34	181.87	1.53	67.93	61
	NMNL-1 (18%)	63.39	180.34	181.84	1.5	65.84	60.48
	NMNL-1 (17%)	59.87	180.34	181.8	1.46	63.7	59.95
	NMNL-1 (16%)	56.35	180.34	181.76	1.42	61.5	59.39
	NMNL-1 (15%)	52.83	180.34	181.73	1.39	59.17	58.79
	NMNL-2 (100%)	369	180.34	183.45	3.11	183.14	84.61
	NMNL-2 (30%)	110.7	180.34	182.23	1.89	90.81	66.4
	NMNL-2 (29%)	107.01	180.34	182.21	1.87	89.14	66.02
	NMNL-2 (28%)	103.32	180.34	182.18	1.84	87.44	65.63
	NMNL-2 (27%)	99.63	180.34	182.15	1.81	85.67	65.22
	NMNL-2 (26%)	95.94	180.34	182.12	1.78	83.81	64.79
	NMNL-2 (25%)	92.25	180.34	182.09	1.75	81.9	64.35
	NMNL-2 (24%)	88.56	180.34	182.06	1.72	79.91	63.88
	NMNL-2 (23%)	84.87	180.34	182.03	1.69	77.84	63.39

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (22%)	81.18	180.34	182	1.66	75.88	62.93
	NMNL-2 (21%)	77.49	180.34	181.97	1.63	73.86	62.44
	NMNL-2 (20%)	73.8	180.34	181.94	1.6	71.84	61.95
	NMNL-2 (19%)	70.11	180.34	181.9	1.56	69.77	61.45
	NMNL-2 (18%)	66.42	180.34	181.87	1.53	67.65	60.93
	NMNL-2 (17%)	62.73	180.34	181.83	1.49	65.44	60.38
	NMNL-2 (16%)	59.04	180.34	181.79	1.45	63.19	59.82
	NMNL-2 (15%)	55.35	180.34	181.75	1.41	60.85	59.22
	L (100%)	128.5	180.34	182.35	2.01	98.71	68.16
	L (30%)	38.55	180.34	181.54	1.2	48.49	55.94
	L (29%)	37.27	180.34	181.52	1.18	47.48	55.66
	L (28%)	35.98	180.34	181.5	1.16	46.47	55.38
	L (27%)	34.7	180.34	181.48	1.14	45.44	55.1
	L (26%)	33.41	180.34	181.47	1.13	44.38	54.8
	L (25%)	32.13	180.34	181.44	1.1	43.25	54.48
	L (24%)	30.84	180.34	181.42	1.08	42.08	54.16
	L (23%)	29.56	180.34	181.4	1.06	40.93	53.83
	L (22%)	28.27	180.34	181.38	1.04	39.75	53.49
	L (21%)	26.99	180.34	181.36	1.02	38.52	53.14
	L (20%)	25.7	180.34	181.33	0.99	37.3	52.79
	L (19%)	24.42	180.34	181.31	0.97	36.07	52.43
	L (18%)	23.13	180.34	181.29	0.95	34.8	52.06
	L (17%)	21.85	180.34	181.26	0.92	33.52	51.68
	L (16%)	20.56	180.34	181.24	0.9	32.22	51.29
	L (15%)	19.28	180.34	181.21	0.87	30.87	50.89
50 m d/s of Barrage axis	M (100%)	910	180.21	185.06	4.85	414.81	130.21
	M (30%)	273	180.21	183	2.79	179.98	97.09
	M (29%)	263.9	180.21	182.97	2.76	176.12	96.54
	M (28%)	254.8	180.21	182.92	2.71	172.24	95.98
	M (27%)	245.7	180.21	182.89	2.68	168.47	95.43
	M (26%)	236.6	180.21	182.84	2.63	164.58	94.87
	M (25%)	227.5	180.21	182.8	2.59	160.63	94.29
	M (24%)	218.4	180.21	182.76	2.55	156.71	93.72
	M (23%)	209.3	180.21	182.72	2.51	152.81	93.14
	M (22%)	200.2	180.21	182.68	2.47	148.99	92.57
	M (21%)	191.1	180.21	182.63	2.42	144.93	91.97
	M (20%)	182	180.21	182.59	2.38	140.95	91.37
	M (19%)	172.9	180.21	182.55	2.34	136.84	90.74
	M (18%)	163.8	180.21	182.5	2.29	132.44	90.07
	M (17%)	154.7	180.21	182.44	2.23	127.77	89.35
	M (16%)	145.6	180.21	182.39	2.18	122.97	88.61
	M (15%)	136.5	180.21	182.34	2.13	118.12	87.85
	NMNL-1 (100%)	352.17	180.21	183.33	3.12	212.62	101.28

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (30%)	105.65	180.21	182.14	1.93	100.94	83.38
	NMNL-1 (29%)	102.13	180.21	182.11	1.9	98.9	82.75
	NMNL-1 (28%)	98.61	180.21	182.09	1.88	96.75	82.09
	NMNL-1 (27%)	95.09	180.21	182.06	1.85	94.52	81.4
	NMNL-1 (26%)	91.56	180.21	182.03	1.82	92.2	80.68
	NMNL-1 (25%)	88.04	180.21	182	1.79	89.81	79.92
	NMNL-1 (24%)	84.52	180.21	181.97	1.76	87.34	79.13
	NMNL-1 (23%)	81	180.21	181.94	1.73	85.01	78.38
	NMNL-1 (22%)	77.48	180.21	181.91	1.7	82.64	77.61
	NMNL-1 (21%)	73.96	180.21	181.88	1.67	80.27	76.84
	NMNL-1 (20%)	70.43	180.21	181.85	1.64	77.85	76.03
	NMNL-1 (19%)	66.91	180.21	181.81	1.6	75.4	75.21
	NMNL-1 (18%)	63.39	180.21	181.78	1.57	72.85	74.35
	NMNL-1 (17%)	59.87	180.21	181.74	1.53	70.24	73.45
	NMNL-1 (16%)	56.35	180.21	181.71	1.5	67.58	72.53
	NMNL-1 (15%)	52.83	180.21	181.67	1.46	64.76	71.54
	NMNL-2 (100%)	369	180.21	183.4	3.19	219.3	101.91
	NMNL-2 (30%)	110.7	180.21	182.17	1.96	103.81	84.24
	NMNL-2 (29%)	107.01	180.21	182.15	1.94	101.72	83.61
	NMNL-2 (28%)	103.32	180.21	182.12	1.91	99.6	82.97
	NMNL-2 (27%)	99.63	180.21	182.09	1.88	97.39	82.29
	NMNL-2 (26%)	95.94	180.21	182.06	1.85	95.05	81.57
	NMNL-2 (25%)	92.25	180.21	182.04	1.83	92.66	80.82
	NMNL-2 (24%)	88.56	180.21	182	1.79	90.16	80.03
	NMNL-2 (23%)	84.87	180.21	181.97	1.76	87.57	79.21
	NMNL-2 (22%)	81.18	180.21	181.94	1.73	85.13	78.42
	NMNL-2 (21%)	77.49	180.21	181.91	1.7	82.65	77.62
	NMNL-2 (20%)	73.8	180.21	181.88	1.67	80.16	76.8
	NMNL-2 (19%)	70.11	180.21	181.84	1.63	77.63	75.96
	NMNL-2 (18%)	66.42	180.21	181.81	1.6	75.05	75.09
	NMNL-2 (17%)	62.73	180.21	181.77	1.56	72.36	74.18
	NMNL-2 (16%)	59.04	180.21	181.74	1.53	69.62	73.24
	NMNL-2 (15%)	55.35	180.21	181.7	1.49	66.79	72.25
	L (100%)	128.5	180.21	182.29	2.08	113.78	87.16
	L (30%)	38.55	180.21	181.48	1.27	51.77	66.78
	L (29%)	37.27	180.21	181.46	1.25	50.56	66.32
	L (28%)	35.98	180.21	181.44	1.23	49.35	65.85
	L (27%)	34.7	180.21	181.43	1.22	48.14	65.38
	L (26%)	33.41	180.21	181.41	1.2	46.87	64.89
	L (25%)	32.13	180.21	181.39	1.18	45.5	64.35
	L (24%)	30.84	180.21	181.36	1.15	44.08	63.77
	L (23%)	29.56	180.21	181.34	1.13	42.71	63.2
	L (22%)	28.27	180.21	181.32	1.11	41.29	62.6
	L (21%)	26.99	180.21	181.3	1.09	39.81	61.97

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (20%)	25.7	180.21	181.27	1.06	38.34	61.35
	L (19%)	24.42	180.21	181.25	1.04	36.87	60.71
	L (18%)	23.13	180.21	181.22	1.01	35.37	60.06
	L (17%)	21.85	180.21	181.2	0.99	33.84	59.38
	L (16%)	20.56	180.21	181.17	0.96	32.29	58.69
	L (15%)	19.28	180.21	181.14	0.93	30.68	57.96
100 m d/s of Barrage axis	M (100%)	910	180.07	185.08	5.01	608.15	235.2
	M (30%)	273	180.07	182.95	2.88	203.43	106.54
	M (29%)	263.9	180.07	182.91	2.84	199.2	105.87
	M (28%)	254.8	180.07	182.87	2.8	194.95	105.2
	M (27%)	245.7	180.07	182.83	2.76	190.83	104.55
	M (26%)	236.6	180.07	182.79	2.72	186.58	103.87
	M (25%)	227.5	180.07	182.75	2.68	182.28	103.18
	M (24%)	218.4	180.07	182.71	2.64	178.02	102.49
	M (23%)	209.3	180.07	182.66	2.59	173.8	101.8
	M (22%)	200.2	180.07	182.62	2.55	169.68	101.13
	M (21%)	191.1	180.07	182.58	2.51	165.31	100.41
	M (20%)	182	180.07	182.54	2.47	161.02	99.7
	M (19%)	172.9	180.07	182.49	2.42	156.61	98.96
	M (18%)	163.8	180.07	182.45	2.38	151.86	98.16
	M (17%)	154.7	180.07	182.39	2.32	146.8	97.3
	M (16%)	145.6	180.07	182.34	2.27	141.59	96.4
	M (15%)	136.5	180.07	182.29	2.22	136.35	95.5
	NMNL-1 (100%)	352.17	180.07	183.28	3.21	239.57	112.58
	NMNL-1 (30%)	105.65	180.07	182.09	2.02	117.76	92.2
	NMNL-1 (29%)	102.13	180.07	182.06	1.99	115.53	91.79
	NMNL-1 (28%)	98.61	180.07	182.04	1.97	113.16	91.36
	NMNL-1 (27%)	95.09	180.07	182.01	1.94	110.68	90.91
	NMNL-1 (26%)	91.56	180.07	181.98	1.91	108.09	90.43
	NMNL-1 (25%)	88.04	180.07	181.95	1.88	105.39	89.94
	NMNL-1 (24%)	84.52	180.07	181.92	1.85	102.58	89.42
	NMNL-1 (23%)	81	180.07	181.89	1.82	99.94	88.92
	NMNL-1 (22%)	77.48	180.07	181.86	1.79	97.26	88.42
	NMNL-1 (21%)	73.96	180.07	181.83	1.76	94.57	87.91
	NMNL-1 (20%)	70.43	180.07	181.8	1.73	91.82	87.39
	NMNL-1 (19%)	66.91	180.07	181.77	1.7	89.02	86.85
	NMNL-1 (18%)	63.39	180.07	181.73	1.66	86.09	86.13
	NMNL-1 (17%)	59.87	180.07	181.7	1.63	83.08	85.36
	NMNL-1 (16%)	56.35	180.07	181.66	1.59	79.99	84.56
	NMNL-1 (15%)	52.83	180.07	181.62	1.55	76.74	83.71
	NMNL-2 (100%)	369	180.07	183.35	3.28	247.06	113.89
	NMNL-2 (30%)	110.7	180.07	182.12	2.05	120.89	92.76
	NMNL-2 (29%)	107.01	180.07	182.1	2.03	118.61	92.35

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (28%)	103.32	180.07	182.07	2	116.3	91.93
	NMNL-2 (27%)	99.63	180.07	182.04	1.97	113.87	91.49
	NMNL-2 (26%)	95.94	180.07	182.02	1.95	111.27	91.02
	NMNL-2 (25%)	92.25	180.07	181.99	1.92	108.6	90.53
	NMNL-2 (24%)	88.56	180.07	181.96	1.89	105.79	90.01
	NMNL-2 (23%)	84.87	180.07	181.92	1.85	102.84	89.46
	NMNL-2 (22%)	81.18	180.07	181.89	1.82	100.08	88.95
	NMNL-2 (21%)	77.49	180.07	181.86	1.79	97.27	88.42
	NMNL-2 (20%)	73.8	180.07	181.83	1.76	94.45	87.89
	NMNL-2 (19%)	70.11	180.07	181.8	1.73	91.57	87.34
	NMNL-2 (18%)	66.42	180.07	181.76	1.69	88.62	86.77
	NMNL-2 (17%)	62.73	180.07	181.73	1.66	85.52	85.98
	NMNL-2 (16%)	59.04	180.07	181.69	1.62	82.36	85.17
	NMNL-2 (15%)	55.35	180.07	181.65	1.58	79.09	84.33
	L (100%)	128.5	180.07	182.24	2.17	131.68	94.68
	L (30%)	38.55	180.07	181.43	1.36	61.35	77.74
	L (29%)	37.27	180.07	181.41	1.34	59.94	76.95
	L (28%)	35.98	180.07	181.4	1.33	58.55	76.17
	L (27%)	34.7	180.07	181.38	1.31	57.13	75.9
	L (26%)	33.41	180.07	181.36	1.29	55.65	75.61
	L (25%)	32.13	180.07	181.34	1.27	54.01	75.18
	L (24%)	30.84	180.07	181.31	1.24	52.32	74.21
	L (23%)	29.56	180.07	181.29	1.22	50.7	73.26
	L (22%)	28.27	180.07	181.27	1.2	49.04	72.28
	L (21%)	26.99	180.07	181.24	1.17	47.28	71.23
	L (20%)	25.7	180.07	181.22	1.15	45.58	70.2
	L (19%)	24.42	180.07	181.2	1.13	43.89	69.15
	L (18%)	23.13	180.07	181.17	1.1	42.16	68.06
	L (17%)	21.85	180.07	181.14	1.07	40.38	66.93
	L (16%)	20.56	180.07	181.12	1.05	38.61	65.78
	L (15%)	19.28	180.07	181.09	1.02	36.74	64.55
150 m d/s of Barrage axis	M (100%)	910	179.94	185.04	5.1	612.77	235.67
	M (30%)	273	179.94	182.83	2.89	168.22	99.37
	M (29%)	263.9	179.94	182.79	2.85	164.46	96.2
	M (28%)	254.8	179.94	182.75	2.81	160.8	93
	M (27%)	245.7	179.94	182.71	2.77	157.38	89.9
	M (26%)	236.6	179.94	182.67	2.73	153.95	86.67
	M (25%)	227.5	179.94	182.63	2.69	150.62	83.9
	M (24%)	218.4	179.94	182.6	2.66	147.5	81.49
	M (23%)	209.3	179.94	182.56	2.62	144.41	80.78
	M (22%)	200.2	179.94	182.52	2.58	141.45	80.09
	M (21%)	191.1	179.94	182.48	2.54	138.28	79.35
	M (20%)	182	179.94	182.44	2.5	135.2	78.62

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (19%)	172.9	179.94	182.4	2.46	132.04	77.86
	M (18%)	163.8	179.94	182.36	2.42	128.6	77.03
	M (17%)	154.7	179.94	182.31	2.37	124.93	76.12
	M (16%)	145.6	179.94	182.26	2.32	121.11	75.16
	M (15%)	136.5	179.94	182.21	2.27	117.29	74.19
	NMNL-1 (100%)	352.17	179.94	183.16	3.22	212.99	165.88
	NMNL-1 (30%)	105.65	179.94	182.02	2.08	103.88	70.67
	NMNL-1 (29%)	102.13	179.94	182	2.06	102.28	70.23
	NMNL-1 (28%)	98.61	179.94	181.98	2.04	100.57	69.77
	NMNL-1 (27%)	95.09	179.94	181.95	2.01	98.77	69.28
	NMNL-1 (26%)	91.56	179.94	181.92	1.98	96.89	68.76
	NMNL-1 (25%)	88.04	179.94	181.89	1.95	94.92	68.21
	NMNL-1 (24%)	84.52	179.94	181.86	1.92	92.87	67.63
	NMNL-1 (23%)	81	179.94	181.84	1.9	90.97	67.1
	NMNL-1 (22%)	77.48	179.94	181.81	1.87	89.05	66.55
	NMNL-1 (21%)	73.96	179.94	181.78	1.84	87.12	65.99
	NMNL-1 (20%)	70.43	179.94	181.75	1.81	85.17	65.43
	NMNL-1 (19%)	66.91	179.94	181.72	1.78	83.17	64.83
	NMNL-1 (18%)	63.39	179.94	181.69	1.75	81.09	64.21
	NMNL-1 (17%)	59.87	179.94	181.65	1.71	78.94	63.56
	NMNL-1 (16%)	56.35	179.94	181.62	1.68	76.75	62.89
	NMNL-1 (15%)	52.83	179.94	181.58	1.64	74.41	62.17
	NMNL-2 (100%)	369	179.94	183.22	3.28	224.64	174.17
	NMNL-2 (30%)	110.7	179.94	182.06	2.12	106.12	71.27
	NMNL-2 (29%)	107.01	179.94	182.03	2.09	104.49	70.83
	NMNL-2 (28%)	103.32	179.94	182.01	2.07	102.83	70.38
	NMNL-2 (27%)	99.63	179.94	181.98	2.04	101.08	69.91
	NMNL-2 (26%)	95.94	179.94	181.96	2.02	99.2	69.39
	NMNL-2 (25%)	92.25	179.94	181.93	1.99	97.26	68.86
	NMNL-2 (24%)	88.56	179.94	181.9	1.96	95.21	68.29
	NMNL-2 (23%)	84.87	179.94	181.87	1.93	93.05	67.68
	NMNL-2 (22%)	81.18	179.94	181.84	1.9	91.07	67.12
	NMNL-2 (21%)	77.49	179.94	181.81	1.87	89.05	66.55
	NMNL-2 (20%)	73.8	179.94	181.78	1.84	87.04	65.97
	NMNL-2 (19%)	70.11	179.94	181.75	1.81	84.99	65.37
	NMNL-2 (18%)	66.42	179.94	181.71	1.77	82.89	64.75
	NMNL-2 (17%)	62.73	179.94	181.68	1.74	80.69	64.09
	NMNL-2 (16%)	59.04	179.94	181.64	1.7	78.43	63.4
	NMNL-2 (15%)	55.35	179.94	181.61	1.67	76.1	62.69
	L (100%)	128.5	179.94	182.16	2.22	113.9	73.32
	L (30%)	38.55	179.94	181.39	1.45	63.24	58.65
	L (29%)	37.27	179.94	181.38	1.44	62.21	58.39
	L (28%)	35.98	179.94	181.36	1.42	61.18	58.13
	L (27%)	34.7	179.94	181.34	1.4	60.13	57.87

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (26%)	33.41	179.94	181.32	1.38	59.02	57.59
	L (25%)	32.13	179.94	181.3	1.36	57.78	57.28
	L (24%)	30.84	179.94	181.28	1.34	56.5	56.95
	L (23%)	29.56	179.94	181.26	1.32	55.27	56.63
	L (22%)	28.27	179.94	181.23	1.29	53.98	56.3
	L (21%)	26.99	179.94	181.21	1.27	52.61	55.94
	L (20%)	25.7	179.94	181.19	1.25	51.27	55.59
	L (19%)	24.42	179.94	181.16	1.22	49.93	55.24
	L (18%)	23.13	179.94	181.14	1.2	48.54	54.87
	L (17%)	21.85	179.94	181.11	1.17	47.09	54.49
	L (16%)	20.56	179.94	181.08	1.14	45.63	54.09
	L (15%)	19.28	179.94	181.05	1.11	44.07	53.67
200 m d/s of Barrage axis	M (100%)	910	179.8	185	5.2	635.86	218.47
	M (30%)	273	179.8	182.74	2.94	182.96	173.42
	M (29%)	263.9	179.8	182.7	2.9	175.09	172.62
	M (28%)	254.8	179.8	182.65	2.85	167.04	171.8
	M (27%)	245.7	179.8	182.61	2.81	159.26	170.98
	M (26%)	236.6	179.8	182.56	2.76	150.94	170.08
	M (25%)	227.5	179.8	182.51	2.71	142.85	163.06
	M (24%)	218.4	179.8	182.46	2.66	135.32	157.54
	M (23%)	209.3	179.8	182.41	2.61	127.94	151.97
	M (22%)	200.2	179.8	182.37	2.57	121.18	146.67
	M (21%)	191.1	179.8	182.32	2.52	113.89	140.71
	M (20%)	182	179.8	182.27	2.47	107.31	132.91
	M (19%)	172.9	179.8	182.22	2.42	101.26	121.75
	M (18%)	163.8	179.8	182.17	2.37	95.17	109.2
	M (17%)	154.7	179.8	182.12	2.32	89.5	96.33
	M (16%)	145.6	179.8	182.06	2.26	84.2	87.83
	M (15%)	136.5	179.8	182	2.2	79.13	82.57
	NMNL-1 (100%)	352.17	179.8	183.11	3.31	248.43	180.54
	NMNL-1 (30%)	105.65	179.8	181.79	1.99	63.58	70.86
	NMNL-1 (29%)	102.13	179.8	181.77	1.97	61.89	69.53
	NMNL-1 (28%)	98.61	179.8	181.75	1.95	60.2	68.18
	NMNL-1 (27%)	95.09	179.8	181.72	1.92	58.56	66.81
	NMNL-1 (26%)	91.56	179.8	181.7	1.9	56.92	65.1
	NMNL-1 (25%)	88.04	179.8	181.67	1.87	55.31	63.36
	NMNL-1 (24%)	84.52	179.8	181.65	1.85	53.69	61.56
	NMNL-1 (23%)	81	179.8	181.62	1.82	52.07	59.72
	NMNL-1 (22%)	77.48	179.8	181.59	1.79	50.53	57.91
	NMNL-1 (21%)	73.96	179.8	181.57	1.77	48.99	56.04
	NMNL-1 (20%)	70.43	179.8	181.54	1.74	47.45	54.11
	NMNL-1 (19%)	66.91	179.8	181.51	1.71	45.93	52.13
	NMNL-1 (18%)	63.39	179.8	181.48	1.68	44.43	50.11

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (17%)	59.87	179.8	181.45	1.65	42.93	48.69
	NMNL-1 (16%)	56.35	179.8	181.42	1.62	41.45	47.82
	NMNL-1 (15%)	52.83	179.8	181.39	1.59	39.88	46.88
	NMNL-2 (100%)	369	179.8	183.19	3.39	261.66	182.09
	NMNL-2 (30%)	110.7	179.8	181.83	2.03	65.97	72.7
	NMNL-2 (29%)	107.01	179.8	181.8	2	64.23	71.37
	NMNL-2 (28%)	103.32	179.8	181.78	1.98	62.46	69.99
	NMNL-2 (27%)	99.63	179.8	181.75	1.95	60.69	68.57
	NMNL-2 (26%)	95.94	179.8	181.73	1.93	58.92	67.12
	NMNL-2 (25%)	92.25	179.8	181.7	1.9	57.24	65.44
	NMNL-2 (24%)	88.56	179.8	181.68	1.88	55.55	63.62
	NMNL-2 (23%)	84.87	179.8	181.65	1.85	53.85	61.74
	NMNL-2 (22%)	81.18	179.8	181.62	1.82	52.15	59.81
	NMNL-2 (21%)	77.49	179.8	181.59	1.79	50.54	57.92
	NMNL-2 (20%)	73.8	179.8	181.56	1.76	48.92	55.95
	NMNL-2 (19%)	70.11	179.8	181.53	1.73	47.31	53.93
	NMNL-2 (18%)	66.42	179.8	181.5	1.7	45.72	51.85
	NMNL-2 (17%)	62.73	179.8	181.47	1.67	44.15	49.72
	NMNL-2 (16%)	59.04	179.8	181.44	1.64	42.58	48.49
	NMNL-2 (15%)	55.35	179.8	181.41	1.61	41.01	47.55
	L (100%)	128.5	179.8	181.95	2.15	74.99	79.27
	L (30%)	38.55	179.8	181.23	1.43	33.03	42.81
	L (29%)	37.27	179.8	181.22	1.42	32.38	42.4
	L (28%)	35.98	179.8	181.2	1.4	31.7	41.96
	L (27%)	34.7	179.8	181.18	1.38	31.01	41.52
	L (26%)	33.41	179.8	181.17	1.37	30.25	41.04
	L (25%)	32.13	179.8	181.15	1.35	29.4	40.48
	L (24%)	30.84	179.8	181.12	1.32	28.5	39.88
	L (23%)	29.56	179.8	181.1	1.3	27.67	39.31
	L (22%)	28.27	179.8	181.08	1.28	26.81	38.73
	L (21%)	26.99	179.8	181.06	1.26	25.89	38.09
	L (20%)	25.7	179.8	181.03	1.23	24.98	37.44
	L (19%)	24.42	179.8	181.01	1.21	24.07	36.79
	L (18%)	23.13	179.8	180.98	1.18	23.12	36.12
	L (17%)	21.85	179.8	180.95	1.15	22.09	35.4
	L (16%)	20.56	179.8	180.92	1.12	21.08	34.68
	L (15%)	19.28	179.8	180.89	1.09	20.04	33.92
250 m d/s of Barrage axis	M (100%)	910	179.66	184.99	5.33	757.29	214.68
	M (30%)	273	179.66	182.7	3.04	284.37	191.3
	M (29%)	263.9	179.66	182.65	2.99	275.07	190.73
	M (28%)	254.8	179.66	182.6	2.94	265.42	190.14
	M (27%)	245.7	179.66	182.55	2.89	255.89	189.55
	M (26%)	236.6	179.66	182.5	2.84	245.68	185.4

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (25%)	227.5	179.66	182.44	2.78	235.77	181.29
	M (24%)	218.4	179.66	182.39	2.73	226.04	178.66
	M (23%)	209.3	179.66	182.33	2.67	215.88	175.88
	M (22%)	200.2	179.66	182.28	2.62	206.12	173.17
	M (21%)	191.1	179.66	182.22	2.56	195.69	170.39
	M (20%)	182	179.66	182.16	2.5	185.55	169.16
	M (19%)	172.9	179.66	182.1	2.44	175.62	167.95
	M (18%)	163.8	179.66	182.04	2.38	165.37	166.67
	M (17%)	154.7	179.66	181.98	2.32	155.22	165.39
	M (16%)	145.6	179.66	181.91	2.25	144.85	164.08
	M (15%)	136.5	179.66	181.85	2.19	134.56	162.76
	NMNL-1 (100%)	352.17	179.66	183.09	3.43	359.89	201.1
	NMNL-1 (30%)	105.65	179.66	181.63	1.97	100.51	141.3
	NMNL-1 (29%)	102.13	179.66	181.61	1.95	96.98	135.83
	NMNL-1 (28%)	98.61	179.66	181.58	1.92	93.57	130.38
	NMNL-1 (27%)	95.09	179.66	181.56	1.9	90.35	124.89
	NMNL-1 (26%)	91.56	179.66	181.53	1.87	87.18	119.27
	NMNL-1 (25%)	88.04	179.66	181.5	1.84	84.17	113.73
	NMNL-1 (24%)	84.52	179.66	181.48	1.82	81.17	107.98
	NMNL-1 (23%)	81	179.66	181.45	1.79	78.31	102.44
	NMNL-1 (22%)	77.48	179.66	181.42	1.76	75.61	100.7
	NMNL-1 (21%)	73.96	179.66	181.4	1.74	72.88	98.92
	NMNL-1 (20%)	70.43	179.66	181.37	1.71	70.17	97.11
	NMNL-1 (19%)	66.91	179.66	181.34	1.68	67.49	95.28
	NMNL-1 (18%)	63.39	179.66	181.31	1.65	64.81	93.43
	NMNL-1 (17%)	59.87	179.66	181.28	1.62	62.05	91.48
	NMNL-1 (16%)	56.35	179.66	181.25	1.59	59.28	89.48
	NMNL-1 (15%)	52.83	179.66	181.22	1.56	56.46	87.4
	NMNL-2 (100%)	369	179.66	183.16	3.5	374.9	202.36
	NMNL-2 (30%)	110.7	179.66	181.67	2.01	105.78	149.2
	NMNL-2 (29%)	107.01	179.66	181.64	1.98	101.9	143.45
	NMNL-2 (28%)	103.32	179.66	181.62	1.96	98.17	137.7
	NMNL-2 (27%)	99.63	179.66	181.59	1.93	94.56	131.97
	NMNL-2 (26%)	95.94	179.66	181.56	1.9	91.1	126.21
	NMNL-2 (25%)	92.25	179.66	181.54	1.88	87.8	120.37
	NMNL-2 (24%)	88.56	179.66	181.51	1.85	84.61	114.55
	NMNL-2 (23%)	84.87	179.66	181.48	1.82	81.46	108.55
	NMNL-2 (22%)	81.18	179.66	181.45	1.79	78.45	102.53
	NMNL-2 (21%)	77.49	179.66	181.42	1.76	75.62	100.71
	NMNL-2 (20%)	73.8	179.66	181.39	1.73	72.75	98.83
	NMNL-2 (19%)	70.11	179.66	181.37	1.71	69.92	96.94
	NMNL-2 (18%)	66.42	179.66	181.34	1.68	67.11	95.02
	NMNL-2 (17%)	62.73	179.66	181.31	1.65	64.32	93.08
	NMNL-2 (16%)	59.04	179.66	181.28	1.62	61.39	91.01

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (15%)	55.35	179.66	181.24	1.58	58.48	88.89
	L (100%)	128.5	179.66	181.79	2.13	125.68	161.61
	L (30%)	38.55	179.66	181.08	1.42	44.49	78.07
	L (29%)	37.27	179.66	181.06	1.4	43.33	77.11
	L (28%)	35.98	179.66	181.05	1.39	42.17	76.14
	L (27%)	34.7	179.66	181.03	1.37	40.99	75.08
	L (26%)	33.41	179.66	181.01	1.35	39.69	73.25
	L (25%)	32.13	179.66	180.99	1.33	38.08	70.94
	L (24%)	30.84	179.66	180.97	1.31	36.55	68.68
	L (23%)	29.56	179.66	180.95	1.29	35.05	66.38
	L (22%)	28.27	179.66	180.92	1.26	33.56	64
	L (21%)	26.99	179.66	180.9	1.24	31.99	58.67
	L (20%)	25.7	179.66	180.87	1.21	30.55	55.71
	L (19%)	24.42	179.66	180.85	1.19	29.14	54.08
	L (18%)	23.13	179.66	180.82	1.16	27.69	52.37
	L (17%)	21.85	179.66	180.79	1.13	26.21	50.54
	L (16%)	20.56	179.66	180.76	1.1	24.65	48.55
	L (15%)	19.28	179.66	180.73	1.07	23.08	46.47
300 m d/s of Barrage axis	M (100%)	910	179.53	184.98	5.45	797.74	192.61
	M (30%)	273	179.53	182.69	3.16	375.55	176.16
	M (29%)	263.9	179.53	182.64	3.11	366.94	175.76
	M (28%)	254.8	179.53	182.59	3.06	357.98	175.34
	M (27%)	245.7	179.53	182.54	3.01	349.13	174.93
	M (26%)	236.6	179.53	182.48	2.95	339.56	174.48
	M (25%)	227.5	179.53	182.43	2.9	330.04	174.03
	M (24%)	218.4	179.53	182.37	2.84	320.53	173.58
	M (23%)	209.3	179.53	182.32	2.79	310.48	173.1
	M (22%)	200.2	179.53	182.26	2.73	300.72	172.64
	M (21%)	191.1	179.53	182.2	2.67	290.09	172.13
	M (20%)	182	179.53	182.14	2.61	279.65	171.58
	M (19%)	172.9	179.53	182.08	2.55	269.4	171.05
	M (18%)	163.8	179.53	182.02	2.49	258.72	170.49
	M (17%)	154.7	179.53	181.95	2.42	248.05	169.93
	M (16%)	145.6	179.53	181.89	2.36	237.11	169.35
	M (15%)	136.5	179.53	181.82	2.29	226.09	168.77
	NMNL-1 (100%)	352.17	179.53	183.08	3.55	444.39	179.28
	NMNL-1 (30%)	105.65	179.53	181.6	2.07	188.24	166.22
	NMNL-1 (29%)	102.13	179.53	181.57	2.04	183.78	165.54
	NMNL-1 (28%)	98.61	179.53	181.54	2.01	179.31	164.85
	NMNL-1 (27%)	95.09	179.53	181.52	1.99	174.83	164.16
	NMNL-1 (26%)	91.56	179.53	181.49	1.96	170.27	163.45
	NMNL-1 (25%)	88.04	179.53	181.46	1.93	165.74	162.74
	NMNL-1 (24%)	84.52	179.53	181.43	1.9	161.13	162.02

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (23%)	81	179.53	181.4	1.87	156.48	161.28
	NMNL-1 (22%)	77.48	179.53	181.37	1.84	151.83	160.55
	NMNL-1 (21%)	73.96	179.53	181.34	1.81	147.05	159.79
	NMNL-1 (20%)	70.43	179.53	181.31	1.78	142.21	159.01
	NMNL-1 (19%)	66.91	179.53	181.28	1.75	137.3	158.22
	NMNL-1 (18%)	63.39	179.53	181.25	1.72	132.36	157.42
	NMNL-1 (17%)	59.87	179.53	181.22	1.69	127.25	156.52
	NMNL-1 (16%)	56.35	179.53	181.19	1.66	122.09	155.52
	NMNL-1 (15%)	52.83	179.53	181.15	1.62	116.95	144.92
	NMNL-2 (100%)	369	179.53	183.15	3.62	457.77	179.87
	NMNL-2 (30%)	110.7	179.53	181.64	2.11	194.56	167.08
	NMNL-2 (29%)	107.01	179.53	181.61	2.08	189.94	166.49
	NMNL-2 (28%)	103.32	179.53	181.58	2.05	185.31	165.78
	NMNL-2 (27%)	99.63	179.53	181.55	2.02	180.62	165.05
	NMNL-2 (26%)	95.94	179.53	181.52	1.99	175.93	164.33
	NMNL-2 (25%)	92.25	179.53	181.49	1.96	171.18	163.59
	NMNL-2 (24%)	88.56	179.53	181.46	1.93	166.4	162.84
	NMNL-2 (23%)	84.87	179.53	181.44	1.91	161.59	162.09
	NMNL-2 (22%)	81.18	179.53	181.41	1.88	156.72	161.32
	NMNL-2 (21%)	77.49	179.53	181.37	1.84	151.85	160.55
	NMNL-2 (20%)	73.8	179.53	181.34	1.81	146.83	159.75
	NMNL-2 (19%)	70.11	179.53	181.31	1.78	141.76	158.94
	NMNL-2 (18%)	66.42	179.53	181.28	1.75	136.61	158.11
	NMNL-2 (17%)	62.73	179.53	181.25	1.72	131.44	157.27
	NMNL-2 (16%)	59.04	179.53	181.21	1.68	126.03	156.28
	NMNL-2 (15%)	55.35	179.53	181.18	1.65	120.6	153.28
	L (100%)	128.5	179.53	181.77	2.24	216.51	168.26
	L (30%)	38.55	179.53	180.99	1.46	94.96	129.61
	L (29%)	37.27	179.53	180.98	1.45	92.91	128.38
	L (28%)	35.98	179.53	180.96	1.43	90.83	127.11
	L (27%)	34.7	179.53	180.94	1.41	88.7	125.8
	L (26%)	33.41	179.53	180.92	1.39	86.22	124.26
	L (25%)	32.13	179.53	180.9	1.37	83.52	122.56
	L (24%)	30.84	179.53	180.88	1.35	80.73	120.78
	L (23%)	29.56	179.53	180.86	1.33	78.08	119.06
	L (22%)	28.27	179.53	180.83	1.3	75.38	117.28
	L (21%)	26.99	179.53	180.81	1.28	72.64	115.45
	L (20%)	25.7	179.53	180.78	1.25	69.82	113.53
	L (19%)	24.42	179.53	180.76	1.23	66.9	111.51
	L (18%)	23.13	179.53	180.73	1.2	63.88	109.38
	L (17%)	21.85	179.53	180.7	1.17	60.8	106.04
	L (16%)	20.56	179.53	180.67	1.14	57.61	102.3
	L (15%)	19.28	179.53	180.64	1.11	54.31	98.26

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
350 m d/s of Barrage axis	M (100%)	910	179.4	184.95	5.55	743.2	187.73
	M (30%)	273	179.4	182.67	3.27	341.05	164.26
	M (29%)	263.9	179.4	182.62	3.22	333.02	163.73
	M (28%)	254.8	179.4	182.57	3.17	324.67	163.23
	M (27%)	245.7	179.4	182.52	3.12	316.41	162.73
	M (26%)	236.6	179.4	182.46	3.06	307.49	162.19
	M (25%)	227.5	179.4	182.41	3.01	298.62	161.66
	M (24%)	218.4	179.4	182.35	2.95	289.76	161.12
	M (23%)	209.3	179.4	182.29	2.89	280.38	160.54
	M (22%)	200.2	179.4	182.24	2.84	271.3	159.99
	M (21%)	191.1	179.4	182.17	2.77	261.38	159.38
	M (20%)	182	179.4	182.11	2.71	251.66	158.78
	M (19%)	172.9	179.4	182.05	2.65	242.13	158.19
	M (18%)	163.8	179.4	181.99	2.59	232.19	157.57
	M (17%)	154.7	179.4	181.93	2.53	222.26	156.95
	M (16%)	145.6	179.4	181.86	2.46	212.07	156.31
	M (15%)	136.5	179.4	181.8	2.4	201.82	155.63
	NMNL-1 (100%)	352.17	179.4	183.05	3.65	405.47	168.5
	NMNL-1 (30%)	105.65	179.4	181.57	2.17	166.68	153.18
	NMNL-1 (29%)	102.13	179.4	181.54	2.14	162.55	152.75
	NMNL-1 (28%)	98.61	179.4	181.51	2.11	158.4	151.88
	NMNL-1 (27%)	95.09	179.4	181.49	2.09	154.25	151
	NMNL-1 (26%)	91.56	179.4	181.46	2.06	150.05	150.1
	NMNL-1 (25%)	88.04	179.4	181.43	2.03	145.86	149.2
	NMNL-1 (24%)	84.52	179.4	181.4	2	141.63	148.29
	NMNL-1 (23%)	81	179.4	181.37	1.97	137.35	147.36
	NMNL-1 (22%)	77.48	179.4	181.34	1.94	133.09	146.43
	NMNL-1 (21%)	73.96	179.4	181.31	1.91	128.71	145.47
	NMNL-1 (20%)	70.43	179.4	181.28	1.88	124.29	144.49
	NMNL-1 (19%)	66.91	179.4	181.25	1.85	119.8	143.49
	NMNL-1 (18%)	63.39	179.4	181.22	1.82	115.3	142.48
	NMNL-1 (17%)	59.87	179.4	181.19	1.79	110.65	141.42
	NMNL-1 (16%)	56.35	179.4	181.15	1.75	105.96	140.35
	NMNL-1 (15%)	52.83	179.4	181.12	1.72	101.17	138.68
	NMNL-2 (100%)	369	179.4	183.13	3.73	418.04	169.27
	NMNL-2 (30%)	110.7	179.4	181.61	2.21	172.55	153.59
	NMNL-2 (29%)	107.01	179.4	181.58	2.18	168.27	153.29
	NMNL-2 (28%)	103.32	179.4	181.55	2.15	163.97	152.99
	NMNL-2 (27%)	99.63	179.4	181.52	2.12	159.62	152.13
	NMNL-2 (26%)	95.94	179.4	181.49	2.09	155.27	151.21
	NMNL-2 (25%)	92.25	179.4	181.46	2.06	150.88	150.28
	NMNL-2 (24%)	88.56	179.4	181.43	2.03	146.48	149.34
	NMNL-2 (23%)	84.87	179.4	181.4	2	142.05	148.38
	NMNL-2 (22%)	81.18	179.4	181.37	1.97	137.57	147.41

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (21%)	77.49	179.4	181.34	1.94	133.11	146.44
	NMNL-2 (20%)	73.8	179.4	181.31	1.91	128.51	145.42
	NMNL-2 (19%)	70.11	179.4	181.28	1.88	123.88	144.4
	NMNL-2 (18%)	66.42	179.4	181.25	1.85	119.17	143.35
	NMNL-2 (17%)	62.73	179.4	181.21	1.81	114.48	142.29
	NMNL-2 (16%)	59.04	179.4	181.18	1.78	109.54	141.17
	NMNL-2 (15%)	55.35	179.4	181.14	1.74	104.61	140.04
	L (100%)	128.5	179.4	181.74	2.34	192.93	155.01
	L (30%)	38.55	179.4	180.96	1.56	80.94	117.72
	L (29%)	37.27	179.4	180.95	1.55	79.12	115.92
	L (28%)	35.98	179.4	180.93	1.53	77.28	114.08
	L (27%)	34.7	179.4	180.91	1.51	75.4	112.15
	L (26%)	33.41	179.4	180.89	1.49	73.2	109.86
	L (25%)	32.13	179.4	180.87	1.47	70.81	107.41
	L (24%)	30.84	179.4	180.85	1.45	68.35	104.86
	L (23%)	29.56	179.4	180.83	1.43	66.06	102.43
	L (22%)	28.27	179.4	180.8	1.4	63.74	99.89
	L (21%)	26.99	179.4	180.78	1.38	61.42	97.28
	L (20%)	25.7	179.4	180.76	1.36	59.05	94.55
	L (19%)	24.42	179.4	180.73	1.33	56.62	91.87
	L (18%)	23.13	179.4	180.7	1.3	54.13	89.25
	L (17%)	21.85	179.4	180.67	1.27	51.59	86.49
	L (16%)	20.56	179.4	180.64	1.24	48.96	83.54
	L (15%)	19.28	179.4	180.61	1.21	46.2	80.35
400 m d/s of Barrage axis	M (100%)	910	179.26	184.93	5.67	752.08	182.07
	M (30%)	273	179.26	182.65	3.39	351.53	164.59
	M (29%)	263.9	179.26	182.6	3.34	343.47	163.78
	M (28%)	254.8	179.26	182.55	3.29	335.09	162.94
	M (27%)	245.7	179.26	182.5	3.24	326.83	162.1
	M (26%)	236.6	179.26	182.44	3.18	317.91	161.17
	M (25%)	227.5	179.26	182.39	3.13	309.05	160.24
	M (24%)	218.4	179.26	182.33	3.07	300.25	159.31
	M (23%)	209.3	179.26	182.27	3.01	290.93	158.32
	M (22%)	200.2	179.26	182.22	2.96	281.95	157.36
	M (21%)	191.1	179.26	182.15	2.89	272.14	156.31
	M (20%)	182	179.26	182.09	2.83	262.55	155.27
	M (19%)	172.9	179.26	182.03	2.77	253.19	154.25
	M (18%)	163.8	179.26	181.97	2.71	243.44	153.18
	M (17%)	154.7	179.26	181.9	2.64	233.74	152.11
	M (16%)	145.6	179.26	181.84	2.58	223.8	151.01
	M (15%)	136.5	179.26	181.77	2.51	213.84	149.85
	NMNL-1 (100%)	352.17	179.26	183.04	3.78	416.53	170.05
	NMNL-1 (30%)	105.65	179.26	181.54	2.28	180.01	144.62

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (29%)	102.13	179.26	181.52	2.26	176.13	141.13
	NMNL-1 (28%)	98.61	179.26	181.49	2.23	172.34	137.79
	NMNL-1 (27%)	95.09	179.26	181.46	2.2	168.58	136.97
	NMNL-1 (26%)	91.56	179.26	181.43	2.17	164.76	136.13
	NMNL-1 (25%)	88.04	179.26	181.41	2.15	160.98	135.3
	NMNL-1 (24%)	84.52	179.26	181.38	2.12	157.15	134.45
	NMNL-1 (23%)	81	179.26	181.35	2.09	153.28	133.59
	NMNL-1 (22%)	77.48	179.26	181.32	2.06	149.44	132.72
	NMNL-1 (21%)	73.96	179.26	181.29	2.03	145.51	131.84
	NMNL-1 (20%)	70.43	179.26	181.26	2	141.52	130.93
	NMNL-1 (19%)	66.91	179.26	181.23	1.97	137.47	130
	NMNL-1 (18%)	63.39	179.26	181.2	1.94	133.42	129.07
	NMNL-1 (17%)	59.87	179.26	181.17	1.91	129.23	128.09
	NMNL-1 (16%)	56.35	179.26	181.13	1.87	125	127.1
	NMNL-1 (15%)	52.83	179.26	181.1	1.84	120.68	126.08
	NMNL-2 (100%)	369	179.26	183.11	3.85	429.23	170.9
	NMNL-2 (30%)	110.7	179.26	181.58	2.32	185.61	146.45
	NMNL-2 (29%)	107.01	179.26	181.55	2.29	181.51	145.67
	NMNL-2 (28%)	103.32	179.26	181.53	2.27	177.45	142.32
	NMNL-2 (27%)	99.63	179.26	181.5	2.24	173.45	138.66
	NMNL-2 (26%)	95.94	179.26	181.47	2.21	169.5	137.17
	NMNL-2 (25%)	92.25	179.26	181.44	2.18	165.52	136.3
	NMNL-2 (24%)	88.56	179.26	181.41	2.15	161.54	135.42
	NMNL-2 (23%)	84.87	179.26	181.38	2.12	157.53	134.53
	NMNL-2 (22%)	81.18	179.26	181.35	2.09	153.49	133.63
	NMNL-2 (21%)	77.49	179.26	181.32	2.06	149.45	132.73
	NMNL-2 (20%)	73.8	179.26	181.29	2.03	145.33	131.79
	NMNL-2 (19%)	70.11	179.26	181.26	2	141.14	130.84
	NMNL-2 (18%)	66.42	179.26	181.22	1.96	136.91	129.87
	NMNL-2 (17%)	62.73	179.26	181.19	1.93	132.68	128.89
	NMNL-2 (16%)	59.04	179.26	181.16	1.9	128.22	127.86
	NMNL-2 (15%)	55.35	179.26	181.12	1.86	123.78	126.81
	L (100%)	128.5	179.26	181.72	2.46	205.24	148.82
	L (30%)	38.55	179.26	180.94	1.68	101.6	118.07
	L (29%)	37.27	179.26	180.93	1.67	99.82	116.57
	L (28%)	35.98	179.26	180.91	1.65	98.03	113.54
	L (27%)	34.7	179.26	180.9	1.64	96.22	110.4
	L (26%)	33.41	179.26	180.88	1.62	94.11	106.61
	L (25%)	32.13	179.26	180.85	1.59	91.86	102.39
	L (24%)	30.84	179.26	180.83	1.57	89.57	97.89
	L (23%)	29.56	179.26	180.81	1.55	87.52	93.67
	L (22%)	28.27	179.26	180.79	1.53	85.45	92.29
	L (21%)	26.99	179.26	180.76	1.5	83.34	91.06
	L (20%)	25.7	179.26	180.74	1.48	81.17	89.77

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (19%)	24.42	179.26	180.72	1.46	78.89	88.4
	L (18%)	23.13	179.26	180.69	1.43	76.52	86.96
	L (17%)	21.85	179.26	180.66	1.4	74.07	85.43
	L (16%)	20.56	179.26	180.63	1.37	71.49	83.8
	L (15%)	19.28	179.26	180.6	1.34	68.74	82.02
450 m d/s of Barrage axis	M (100%)	910	179.13	184.9	5.77	702.76	173.29
	M (30%)	273	179.13	182.63	3.5	342.34	144.64
	M (29%)	263.9	179.13	182.58	3.45	335.29	144.05
	M (28%)	254.8	179.13	182.53	3.4	327.94	143.44
	M (27%)	245.7	179.13	182.48	3.35	320.69	142.83
	M (26%)	236.6	179.13	182.42	3.29	312.85	142.12
	M (25%)	227.5	179.13	182.37	3.24	305.05	141.39
	M (24%)	218.4	179.13	182.31	3.18	297.31	140.66
	M (23%)	209.3	179.13	182.26	3.13	289.1	139.88
	M (22%)	200.2	179.13	182.2	3.07	281.18	139.13
	M (21%)	191.1	179.13	182.14	3.01	272.5	138.29
	M (20%)	182	179.13	182.07	2.94	264.03	137.45
	M (19%)	172.9	179.13	182.01	2.88	255.77	136.59
	M (18%)	163.8	179.13	181.95	2.82	247.15	135.69
	M (17%)	154.7	179.13	181.89	2.76	238.58	134.79
	M (16%)	145.6	179.13	181.82	2.69	229.79	133.86
	M (15%)	136.5	179.13	181.76	2.63	220.98	132.92
	NMNL-1 (100%)	352.17	179.13	183.02	3.89	399.05	149.44
	NMNL-1 (30%)	105.65	179.13	181.53	2.4	191.08	129.01
	NMNL-1 (29%)	102.13	179.13	181.5	2.37	187.62	128.38
	NMNL-1 (28%)	98.61	179.13	181.47	2.34	184.17	127.74
	NMNL-1 (27%)	95.09	179.13	181.45	2.32	180.71	127.09
	NMNL-1 (26%)	91.56	179.13	181.42	2.29	177.2	126.43
	NMNL-1 (25%)	88.04	179.13	181.39	2.26	173.73	125.77
	NMNL-1 (24%)	84.52	179.13	181.36	2.23	170.21	125.1
	NMNL-1 (23%)	81	179.13	181.34	2.21	166.64	124.41
	NMNL-1 (22%)	77.48	179.13	181.31	2.18	163.1	123.73
	NMNL-1 (21%)	73.96	179.13	181.28	2.15	159.5	123.03
	NMNL-1 (20%)	70.43	179.13	181.25	2.12	155.82	122.17
	NMNL-1 (19%)	66.91	179.13	181.22	2.09	152.1	121.06
	NMNL-1 (18%)	63.39	179.13	181.19	2.06	148.38	119.93
	NMNL-1 (17%)	59.87	179.13	181.15	2.02	144.55	118.77
	NMNL-1 (16%)	56.35	179.13	181.12	1.99	140.68	117.58
	NMNL-1 (15%)	52.83	179.13	181.09	1.96	136.75	116.35
	NMNL-2 (100%)	369	179.13	183.09	3.96	410.15	150.39
	NMNL-2 (30%)	110.7	179.13	181.57	2.44	196.02	129.89
	NMNL-2 (29%)	107.01	179.13	181.54	2.41	192.41	129.25
	NMNL-2 (28%)	103.32	179.13	181.51	2.38	188.8	128.6

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (27%)	99.63	179.13	181.48	2.35	185.18	127.93
	NMNL-2 (26%)	95.94	179.13	181.45	2.32	181.55	127.25
	NMNL-2 (25%)	92.25	179.13	181.43	2.3	177.89	126.56
	NMNL-2 (24%)	88.56	179.13	181.4	2.27	174.24	125.86
	NMNL-2 (23%)	84.87	179.13	181.37	2.24	170.56	125.16
	NMNL-2 (22%)	81.18	179.13	181.34	2.21	166.83	124.45
	NMNL-2 (21%)	77.49	179.13	181.31	2.18	163.12	123.73
	NMNL-2 (20%)	73.8	179.13	181.28	2.15	159.33	123
	NMNL-2 (19%)	70.11	179.13	181.24	2.11	155.47	122.07
	NMNL-2 (18%)	66.42	179.13	181.21	2.08	151.58	120.9
	NMNL-2 (17%)	62.73	179.13	181.18	2.05	147.7	119.73
	NMNL-2 (16%)	59.04	179.13	181.15	2.02	143.63	118.48
	NMNL-2 (15%)	55.35	179.13	181.11	1.98	139.58	117.23
	L (100%)	128.5	179.13	181.7	2.57	213.37	132.1
	L (30%)	38.55	179.13	180.94	1.81	120.1	95.9
	L (29%)	37.27	179.13	180.92	1.79	118.68	95.43
	L (28%)	35.98	179.13	180.9	1.77	117.23	94.95
	L (27%)	34.7	179.13	180.89	1.76	115.74	94.45
	L (26%)	33.41	179.13	180.87	1.74	113.95	93.86
	L (25%)	32.13	179.13	180.85	1.72	111.95	93.18
	L (24%)	30.84	179.13	180.83	1.7	109.85	92.47
	L (23%)	29.56	179.13	180.8	1.67	107.89	91.8
	L (22%)	28.27	179.13	180.78	1.65	105.87	91.11
	L (21%)	26.99	179.13	180.76	1.63	103.8	90.39
	L (20%)	25.7	179.13	180.74	1.61	101.65	89.64
	L (19%)	24.42	179.13	180.71	1.58	99.38	88.84
	L (18%)	23.13	179.13	180.68	1.55	97.01	88.03
	L (17%)	21.85	179.13	180.66	1.53	94.52	87.2
	L (16%)	20.56	179.13	180.63	1.5	91.9	86.32
	L (15%)	19.28	179.13	180.59	1.46	89.06	85.35
500 m d/s of Barrage axis	M (100%)	910	178.99	184.82	5.83	555.07	131.15
	M (30%)	273	178.99	182.59	3.6	282.09	113.39
	M (29%)	263.9	178.99	182.54	3.55	276.63	112.93
	M (28%)	254.8	178.99	182.49	3.5	270.92	112.44
	M (27%)	245.7	178.99	182.44	3.45	265.31	111.96
	M (26%)	236.6	178.99	182.39	3.4	259.22	111.44
	M (25%)	227.5	178.99	182.33	3.34	253.16	110.92
	M (24%)	218.4	178.99	182.28	3.29	247.15	110.4
	M (23%)	209.3	178.99	182.22	3.23	240.74	109.84
	M (22%)	200.2	178.99	182.16	3.17	234.59	109.3
	M (21%)	191.1	178.99	182.1	3.11	227.82	108.7
	M (20%)	182	178.99	182.04	3.05	221.22	108.12
	M (19%)	172.9	178.99	181.98	2.99	214.78	107.54

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (18%)	163.8	178.99	181.92	2.93	208.06	106.94
	M (17%)	154.7	178.99	181.86	2.87	201.37	106.34
	M (16%)	145.6	178.99	181.79	2.8	194.52	105.65
	M (15%)	136.5	178.99	181.73	2.74	187.64	104.93
	NMNL-1 (100%)	352.17	178.99	182.97	3.98	325.9	116.65
	NMNL-1 (30%)	105.65	178.99	181.5	2.51	164.5	100.6
	NMNL-1 (29%)	102.13	178.99	181.48	2.49	161.86	99.8
	NMNL-1 (28%)	98.61	178.99	181.45	2.46	159.25	99
	NMNL-1 (27%)	95.09	178.99	181.42	2.43	156.7	93.67
	NMNL-1 (26%)	91.56	178.99	181.4	2.41	154.26	87.69
	NMNL-1 (25%)	88.04	178.99	181.37	2.38	151.94	86.56
	NMNL-1 (24%)	84.52	178.99	181.34	2.35	149.59	86.19
	NMNL-1 (23%)	81	178.99	181.31	2.32	147.22	85.83
	NMNL-1 (22%)	77.48	178.99	181.29	2.3	144.86	85.46
	NMNL-1 (21%)	73.96	178.99	181.26	2.27	142.43	85.08
	NMNL-1 (20%)	70.43	178.99	181.23	2.24	139.98	84.69
	NMNL-1 (19%)	66.91	178.99	181.2	2.21	137.48	84.29
	NMNL-1 (18%)	63.39	178.99	181.17	2.18	134.97	83.89
	NMNL-1 (17%)	59.87	178.99	181.14	2.15	132.37	83.48
	NMNL-1 (16%)	56.35	178.99	181.11	2.12	129.73	83.05
	NMNL-1 (15%)	52.83	178.99	181.07	2.08	127.02	82.62
	NMNL-2 (100%)	369	178.99	183.04	4.05	334.43	117.24
	NMNL-2 (30%)	110.7	178.99	181.54	2.55	168.28	101.74
	NMNL-2 (29%)	107.01	178.99	181.51	2.52	165.52	100.91
	NMNL-2 (28%)	103.32	178.99	181.48	2.49	162.77	100.07
	NMNL-2 (27%)	99.63	178.99	181.46	2.47	160.02	99.23
	NMNL-2 (26%)	95.94	178.99	181.43	2.44	157.31	95.1
	NMNL-2 (25%)	92.25	178.99	181.4	2.41	154.73	88.87
	NMNL-2 (24%)	88.56	178.99	181.37	2.38	152.28	86.61
	NMNL-2 (23%)	84.87	178.99	181.34	2.35	149.82	86.23
	NMNL-2 (22%)	81.18	178.99	181.32	2.33	147.35	85.85
	NMNL-2 (21%)	77.49	178.99	181.29	2.3	144.86	85.46
	NMNL-2 (20%)	73.8	178.99	181.26	2.27	142.32	85.06
	NMNL-2 (19%)	70.11	178.99	181.23	2.24	139.75	84.65
	NMNL-2 (18%)	66.42	178.99	181.2	2.21	137.13	84.24
	NMNL-2 (17%)	62.73	178.99	181.16	2.17	134.5	83.82
	NMNL-2 (16%)	59.04	178.99	181.13	2.14	131.75	83.38
	NMNL-2 (15%)	55.35	178.99	181.1	2.11	128.97	82.93
	L (100%)	128.5	178.99	181.67	2.68	181.73	104.31
	L (30%)	38.55	178.99	180.93	1.94	114.88	80.53
	L (29%)	37.27	178.99	180.91	1.92	113.71	80.32
	L (28%)	35.98	178.99	180.9	1.91	112.52	80.11
	L (27%)	34.7	178.99	180.88	1.89	111.28	79.89
	L (26%)	33.41	178.99	180.86	1.87	109.78	79.62

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (25%)	32.13	178.99	180.84	1.85	108.11	79.32
	L (24%)	30.84	178.99	180.82	1.83	106.33	79
	L (23%)	29.56	178.99	180.8	1.81	104.68	78.7
	L (22%)	28.27	178.99	180.78	1.79	102.96	78.38
	L (21%)	26.99	178.99	180.75	1.76	101.2	78.08
	L (20%)	25.7	178.99	180.73	1.74	99.35	77.81
	L (19%)	24.42	178.99	180.7	1.71	97.39	77.53
	L (18%)	23.13	178.99	180.68	1.69	95.34	77.22
	L (17%)	21.85	178.99	180.65	1.66	93.17	76.9
	L (16%)	20.56	178.99	180.62	1.63	90.86	76.56
	L (15%)	19.28	178.99	180.59	1.6	88.36	76.19
550 m d/s of Barrage axis	M (100%)	910	178.86	184.6	5.74	382.99	115.11
	M (30%)	273	178.86	182.4	3.54	149.16	82.46
	M (29%)	263.9	178.86	182.35	3.49	145.31	81.52
	M (28%)	254.8	178.86	182.3	3.44	141.25	80.52
	M (27%)	245.7	178.86	182.25	3.39	137.33	79.55
	M (26%)	236.6	178.86	182.2	3.34	133.23	78.64
	M (25%)	227.5	178.86	182.15	3.29	129.08	78.14
	M (24%)	218.4	178.86	182.09	3.23	124.94	77.63
	M (23%)	209.3	178.86	182.04	3.18	120.44	77.08
	M (22%)	200.2	178.86	181.98	3.12	116.2	76.56
	M (21%)	191.1	178.86	181.92	3.06	111.61	75.98
	M (20%)	182	178.86	181.86	3	107.02	75.41
	M (19%)	172.9	178.86	181.8	2.94	102.62	74.85
	M (18%)	163.8	178.86	181.74	2.88	98	74.26
	M (17%)	154.7	178.86	181.68	2.82	93.56	73.69
	M (16%)	145.6	178.86	181.61	2.75	88.87	73.08
	M (15%)	136.5	178.86	181.55	2.69	84.22	72.48
	NMNL-1 (100%)	352.17	178.86	182.78	3.92	184.98	101.06
	NMNL-1 (30%)	105.65	178.86	181.34	2.48	69.07	70.46
	NMNL-1 (29%)	102.13	178.86	181.31	2.45	67.34	70.22
	NMNL-1 (28%)	98.61	178.86	181.29	2.43	65.66	69.99
	NMNL-1 (27%)	95.09	178.86	181.27	2.41	63.98	69.76
	NMNL-1 (26%)	91.56	178.86	181.24	2.38	62.27	69.53
	NMNL-1 (25%)	88.04	178.86	181.22	2.36	60.58	69.3
	NMNL-1 (24%)	84.52	178.86	181.19	2.33	58.87	69.06
	NMNL-1 (23%)	81	178.86	181.17	2.31	57.17	68.82
	NMNL-1 (22%)	77.48	178.86	181.14	2.28	55.47	68.59
	NMNL-1 (21%)	73.96	178.86	181.12	2.26	53.73	68.34
	NMNL-1 (20%)	70.43	178.86	181.09	2.23	51.97	68.09
	NMNL-1 (19%)	66.91	178.86	181.07	2.21	50.19	67.84
	NMNL-1 (18%)	63.39	178.86	181.04	2.18	48.4	67.59
	NMNL-1 (17%)	59.87	178.86	181.01	2.15	46.54	67.32

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (16%)	56.35	178.86	180.98	2.12	44.64	67.05
	NMNL-1 (15%)	52.83	178.86	180.95	2.09	42.69	66.78
	NMNL-2 (100%)	369	178.86	182.85	3.99	192.37	101.7
	NMNL-2 (30%)	110.7	178.86	181.37	2.51	71.54	70.79
	NMNL-2 (29%)	107.01	178.86	181.35	2.49	69.74	70.55
	NMNL-2 (28%)	103.32	178.86	181.32	2.46	67.93	70.3
	NMNL-2 (27%)	99.63	178.86	181.3	2.44	66.14	70.06
	NMNL-2 (26%)	95.94	178.86	181.27	2.41	64.39	69.82
	NMNL-2 (25%)	92.25	178.86	181.25	2.39	62.61	69.57
	NMNL-2 (24%)	88.56	178.86	181.22	2.36	60.83	69.33
	NMNL-2 (23%)	84.87	178.86	181.2	2.34	59.04	69.08
	NMNL-2 (22%)	81.18	178.86	181.17	2.31	57.26	68.83
	NMNL-2 (21%)	77.49	178.86	181.14	2.28	55.48	68.59
	NMNL-2 (20%)	73.8	178.86	181.12	2.26	53.65	68.33
	NMNL-2 (19%)	70.11	178.86	181.09	2.23	51.81	68.07
	NMNL-2 (18%)	66.42	178.86	181.06	2.2	49.94	67.81
	NMNL-2 (17%)	62.73	178.86	181.03	2.17	48.08	67.55
	NMNL-2 (16%)	59.04	178.86	181.01	2.15	46.09	67.26
	NMNL-2 (15%)	55.35	178.86	180.98	2.12	44.1	66.98
	L (100%)	128.5	178.86	181.5	2.64	80.32	71.96
	L (30%)	38.55	178.86	180.82	1.96	33.71	65.47
	L (29%)	37.27	178.86	180.81	1.95	32.82	65.34
	L (28%)	35.98	178.86	180.79	1.93	31.94	65.21
	L (27%)	34.7	178.86	180.78	1.92	30.98	65.07
	L (26%)	33.41	178.86	180.76	1.9	29.68	63.85
	L (25%)	32.13	178.86	180.73	1.87	28.22	60.99
	L (24%)	30.84	178.86	180.71	1.85	26.71	57.87
	L (23%)	29.56	178.86	180.69	1.83	25.43	55.13
	L (22%)	28.27	178.86	180.66	1.8	24.18	52.28
	L (21%)	26.99	178.86	180.64	1.78	22.96	49.35
	L (20%)	25.7	178.86	180.61	1.75	21.75	46.27
	L (19%)	24.42	178.86	180.59	1.73	20.55	42.84
	L (18%)	23.13	178.86	180.56	1.7	19.37	39.82
	L (17%)	21.85	178.86	180.53	1.67	18.21	36.63
	L (16%)	20.56	178.86	180.49	1.63	17.07	33.57
	L (15%)	19.28	178.86	180.46	1.6	15.9	30.17
600 m d/s of Barrage axis	M (100%)	910	178.71	184.55	5.84	414.24	120.98
	M (30%)	273	178.71	182.28	3.57	157.79	101.05
	M (29%)	263.9	178.71	182.23	3.52	152.79	100.03
	M (28%)	254.8	178.71	182.18	3.47	147.72	98.99
	M (27%)	245.7	178.71	182.12	3.41	142.66	97.94
	M (26%)	236.6	178.71	182.07	3.36	137.51	96.87
	M (25%)	227.5	178.71	182.02	3.31	132.33	94.82

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (24%)	218.4	178.71	181.96	3.25	127.16	92.44
	M (23%)	209.3	178.71	181.9	3.19	122.29	78.03
	M (22%)	200.2	178.71	181.85	3.14	117.9	75.75
	M (21%)	191.1	178.71	181.78	3.07	113.03	75
	M (20%)	182	178.71	181.72	3.01	108.16	74.24
	M (19%)	172.9	178.71	181.65	2.94	103.47	73.5
	M (18%)	163.8	178.71	181.58	2.87	98.43	72.7
	M (17%)	154.7	178.71	181.52	2.81	93.63	71.93
	M (16%)	145.6	178.71	181.44	2.73	88.38	71.09
	M (15%)	136.5	178.71	181.37	2.66	83.13	70.23
	NMNL-1 (100%)	352.17	178.71	182.67	3.96	199.55	108.67
	NMNL-1 (30%)	105.65	178.71	181.12	2.41	65.81	67.3
	NMNL-1 (29%)	102.13	178.71	181.09	2.38	63.76	66.94
	NMNL-1 (28%)	98.61	178.71	181.06	2.35	61.81	66.6
	NMNL-1 (27%)	95.09	178.71	181.03	2.32	59.88	66.26
	NMNL-1 (26%)	91.56	178.71	181	2.29	57.93	65.07
	NMNL-1 (25%)	88.04	178.71	180.97	2.26	56	63.77
	NMNL-1 (24%)	84.52	178.71	180.94	2.23	54.11	62.46
	NMNL-1 (23%)	81	178.71	180.91	2.2	52.3	61.18
	NMNL-1 (22%)	77.48	178.71	180.88	2.17	50.56	59.93
	NMNL-1 (21%)	73.96	178.71	180.85	2.14	48.86	58.69
	NMNL-1 (20%)	70.43	178.71	180.82	2.11	47.14	57.4
	NMNL-1 (19%)	66.91	178.71	180.79	2.08	45.48	56.13
	NMNL-1 (18%)	63.39	178.71	180.76	2.05	43.89	54.88
	NMNL-1 (17%)	59.87	178.71	180.74	2.03	42.35	53.69
	NMNL-1 (16%)	56.35	178.71	180.71	2	40.81	52.57
	NMNL-1 (15%)	52.83	178.71	180.68	1.97	39.23	51.39
	NMNL-2 (100%)	369	178.71	182.75	4.04	207.98	109.12
	NMNL-2 (30%)	110.7	178.71	181.16	2.45	68.69	67.8
	NMNL-2 (29%)	107.01	178.71	181.13	2.42	66.59	67.43
	NMNL-2 (28%)	103.32	178.71	181.1	2.39	64.46	67.06
	NMNL-2 (27%)	99.63	178.71	181.07	2.36	62.38	66.7
	NMNL-2 (26%)	95.94	178.71	181.04	2.33	60.35	66.34
	NMNL-2 (25%)	92.25	178.71	181	2.29	58.31	65.32
	NMNL-2 (24%)	88.56	178.71	180.97	2.26	56.29	63.96
	NMNL-2 (23%)	84.87	178.71	180.94	2.23	54.29	62.59
	NMNL-2 (22%)	81.18	178.71	180.91	2.2	52.39	61.25
	NMNL-2 (21%)	77.49	178.71	180.88	2.17	50.56	59.94
	NMNL-2 (20%)	73.8	178.71	180.85	2.14	48.78	58.63
	NMNL-2 (19%)	70.11	178.71	180.82	2.11	46.98	57.28
	NMNL-2 (18%)	66.42	178.71	180.79	2.08	45.26	55.95
	NMNL-2 (17%)	62.73	178.71	180.76	2.05	43.6	54.65
	NMNL-2 (16%)	59.04	178.71	180.73	2.02	41.99	53.43
	NMNL-2 (15%)	55.35	178.71	180.7	1.99	40.37	52.24

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (100%)	128.5	178.71	181.31	2.6	78.79	69.51
	L (30%)	38.55	178.71	180.52	1.81	31.68	45.36
	L (29%)	37.27	178.71	180.5	1.79	30.95	44.73
	L (28%)	35.98	178.71	180.49	1.78	30.22	44.09
	L (27%)	34.7	178.71	180.47	1.76	29.48	43.44
	L (26%)	33.41	178.71	180.45	1.74	28.73	42.77
	L (25%)	32.13	178.71	180.44	1.73	27.98	42.08
	L (24%)	30.84	178.71	180.42	1.71	27.2	41.36
	L (23%)	29.56	178.71	180.4	1.69	26.42	40.62
	L (22%)	28.27	178.71	180.38	1.67	25.64	39.88
	L (21%)	26.99	178.71	180.36	1.65	24.85	39.1
	L (20%)	25.7	178.71	180.34	1.63	24.05	38.3
	L (19%)	24.42	178.71	180.32	1.61	23.23	37.47
	L (18%)	23.13	178.71	180.29	1.58	22.39	36.6
	L (17%)	21.85	178.71	180.27	1.56	21.55	35.71
	L (16%)	20.56	178.71	180.25	1.54	20.68	34.77
	L (15%)	19.28	178.71	180.22	1.51	19.8	33.78
650 m d/s of Barrage axis	M (100%)	910	178.59	184.53	5.94	483.42	135.19
	M (30%)	273	178.59	182.2	3.61	191.96	112.87
	M (29%)	263.9	178.59	182.15	3.56	186.01	112.24
	M (28%)	254.8	178.59	182.1	3.51	179.9	111.59
	M (27%)	245.7	178.59	182.04	3.45	173.74	110.97
	M (26%)	236.6	178.59	181.98	3.39	167.46	110.43
	M (25%)	227.5	178.59	181.93	3.34	161.04	109.88
	M (24%)	218.4	178.59	181.87	3.28	154.5	108.96
	M (23%)	209.3	178.59	181.8	3.21	147.82	107.09
	M (22%)	200.2	178.59	181.74	3.15	141.11	105.18
	M (21%)	191.1	178.59	181.68	3.09	134.31	103.15
	M (20%)	182	178.59	181.61	3.02	127.44	100.97
	M (19%)	172.9	178.59	181.54	2.95	120.54	98.72
	M (18%)	163.8	178.59	181.47	2.88	113.62	96.41
	M (17%)	154.7	178.59	181.39	2.8	106.64	94.01
	M (16%)	145.6	178.59	181.32	2.73	99.64	90.58
	M (15%)	136.5	178.59	181.24	2.65	93.13	71.9
	NMNL-1 (100%)	352.17	178.59	182.62	4.03	240	117.81
	NMNL-1 (30%)	105.65	178.59	180.95	2.36	72.77	67.67
	NMNL-1 (29%)	102.13	178.59	180.91	2.32	70.21	67.12
	NMNL-1 (28%)	98.61	178.59	180.87	2.28	67.76	66.59
	NMNL-1 (27%)	95.09	178.59	180.84	2.25	65.33	66.06
	NMNL-1 (26%)	91.56	178.59	180.8	2.21	62.86	65.52
	NMNL-1 (25%)	88.04	178.59	180.76	2.17	60.31	64.96
	NMNL-1 (24%)	84.52	178.59	180.72	2.13	57.7	64.37
	NMNL-1 (23%)	81	178.59	180.68	2.09	55.13	63.8

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (22%)	77.48	178.59	180.64	2.05	52.51	63.2
	NMNL-1 (21%)	73.96	178.59	180.6	2.01	49.85	62.59
	NMNL-1 (20%)	70.43	178.59	180.55	1.96	47.15	61.97
	NMNL-1 (19%)	66.91	178.59	180.51	1.92	44.42	61.33
	NMNL-1 (18%)	63.39	178.59	180.46	1.87	41.69	60.69
	NMNL-1 (17%)	59.87	178.59	180.42	1.83	38.95	60.04
	NMNL-1 (16%)	56.35	178.59	180.37	1.78	36.15	58.73
	NMNL-1 (15%)	52.83	178.59	180.32	1.73	33.41	55.67
	NMNL-2 (100%)	369	178.59	182.7	4.11	249.49	118.77
	NMNL-2 (30%)	110.7	178.59	181	2.41	76.29	68.42
	NMNL-2 (29%)	107.01	178.59	180.96	2.37	73.73	67.88
	NMNL-2 (28%)	103.32	178.59	180.92	2.33	71.09	67.31
	NMNL-2 (27%)	99.63	178.59	180.88	2.29	68.47	66.74
	NMNL-2 (26%)	95.94	178.59	180.84	2.25	65.93	66.19
	NMNL-2 (25%)	92.25	178.59	180.81	2.22	63.35	65.63
	NMNL-2 (24%)	88.56	178.59	180.77	2.18	60.69	65.04
	NMNL-2 (23%)	84.87	178.59	180.72	2.13	57.95	64.43
	NMNL-2 (22%)	81.18	178.59	180.68	2.09	55.26	63.83
	NMNL-2 (21%)	77.49	178.59	180.64	2.05	52.51	63.2
	NMNL-2 (20%)	73.8	178.59	180.59	2	49.73	62.57
	NMNL-2 (19%)	70.11	178.59	180.55	1.96	46.89	61.91
	NMNL-2 (18%)	66.42	178.59	180.5	1.91	44.05	61.24
	NMNL-2 (17%)	62.73	178.59	180.45	1.86	41.18	60.56
	NMNL-2 (16%)	59.04	178.59	180.41	1.82	38.3	59.88
	NMNL-2 (15%)	55.35	178.59	180.36	1.77	35.33	57.84
	L (100%)	128.5	178.59	181.17	2.58	88.18	70.9
	L (30%)	38.55	178.59	180.13	1.54	23.84	45.43
	L (29%)	37.27	178.59	180.11	1.52	23.02	44.59
	L (28%)	35.98	178.59	180.09	1.5	22.19	43.72
	L (27%)	34.7	178.59	180.08	1.49	21.4	42.88
	L (26%)	33.41	178.59	180.06	1.47	20.63	42.04
	L (25%)	32.13	178.59	180.04	1.45	19.92	41.25
	L (24%)	30.84	178.59	180.02	1.43	19.23	40.47
	L (23%)	29.56	178.59	180.01	1.42	18.57	39.74
	L (22%)	28.27	178.59	179.99	1.4	17.92	39
	L (21%)	26.99	178.59	179.98	1.39	17.29	38.27
	L (20%)	25.7	178.59	179.96	1.37	16.66	37.46
	L (19%)	24.42	178.59	179.94	1.35	16.02	36.58
	L (18%)	23.13	178.59	179.92	1.33	15.36	35.65
	L (17%)	21.85	178.59	179.9	1.31	14.72	34.73
	L (16%)	20.56	178.59	179.89	1.3	14.08	33.78
	L (15%)	19.28	178.59	179.87	1.28	13.46	32.84
700 m	M (100%)	910	178.45	184.54	6.09	612.28	146.47

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
d/s of Barrage axis	M (30%)	273	178.45	182.2	3.75	296.84	124.23
	M (29%)	263.9	178.45	182.15	3.7	290.23	123.77
	M (28%)	254.8	178.45	182.09	3.64	283.42	123.4
	M (27%)	245.7	178.45	182.04	3.59	276.53	123.05
	M (26%)	236.6	178.45	181.98	3.53	269.48	122.69
	M (25%)	227.5	178.45	181.92	3.47	262.25	122.32
	M (24%)	218.4	178.45	181.86	3.41	254.86	121.94
	M (23%)	209.3	178.45	181.8	3.35	247.23	121.55
	M (22%)	200.2	178.45	181.73	3.28	239.42	121.15
	M (21%)	191.1	178.45	181.67	3.22	231.37	120.73
	M (20%)	182	178.45	181.6	3.15	223.12	120.3
	M (19%)	172.9	178.45	181.53	3.08	214.64	119.86
	M (18%)	163.8	178.45	181.46	3.01	205.94	119.4
	M (17%)	154.7	178.45	181.38	2.93	196.99	118.93
	M (16%)	145.6	178.45	181.3	2.85	187.78	118.44
	M (15%)	136.5	178.45	181.22	2.77	178.28	117.94
	NMNL-1 (100%)	352.17	178.45	182.62	4.17	349.68	127.89
	NMNL-1 (30%)	105.65	178.45	180.92	2.47	143.34	116.06
	NMNL-1 (29%)	102.13	178.45	180.89	2.44	139.01	115.83
	NMNL-1 (28%)	98.61	178.45	180.85	2.4	134.58	115.59
	NMNL-1 (27%)	95.09	178.45	180.81	2.36	130.18	114.62
	NMNL-1 (26%)	91.56	178.45	180.77	2.32	125.79	112.31
	NMNL-1 (25%)	88.04	178.45	180.73	2.28	121.34	109.86
	NMNL-1 (24%)	84.52	178.45	180.69	2.24	116.89	106.7
	NMNL-1 (23%)	81	178.45	180.65	2.2	112.49	103.48
	NMNL-1 (22%)	77.48	178.45	180.61	2.16	108.12	100.19
	NMNL-1 (21%)	73.96	178.45	180.56	2.11	103.79	96.8
	NMNL-1 (20%)	70.43	178.45	180.52	2.07	99.49	93.33
	NMNL-1 (19%)	66.91	178.45	180.47	2.02	95.23	89.8
	NMNL-1 (18%)	63.39	178.45	180.42	1.97	91.01	86.15
	NMNL-1 (17%)	59.87	178.45	180.37	1.92	86.85	82.18
	NMNL-1 (16%)	56.35	178.45	180.32	1.87	82.87	71.07
	NMNL-1 (15%)	52.83	178.45	180.27	1.82	79.31	66.82
	NMNL-2 (100%)	369	178.45	182.7	4.25	360.01	128.6
	NMNL-2 (30%)	110.7	178.45	180.98	2.53	149.44	116.39
	NMNL-2 (29%)	107.01	178.45	180.94	2.49	144.97	116.15
	NMNL-2 (28%)	103.32	178.45	180.9	2.45	140.48	115.91
	NMNL-2 (27%)	99.63	178.45	180.86	2.41	135.86	115.66
	NMNL-2 (26%)	95.94	178.45	180.82	2.37	131.25	115.18
	NMNL-2 (25%)	92.25	178.45	180.78	2.33	126.66	112.77
	NMNL-2 (24%)	88.56	178.45	180.74	2.29	121.99	110.28
	NMNL-2 (23%)	84.87	178.45	180.69	2.24	117.33	107.02
	NMNL-2 (22%)	81.18	178.45	180.65	2.2	112.72	103.65
	NMNL-2 (21%)	77.49	178.45	180.61	2.16	108.14	100.2

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (20%)	73.8	178.45	180.56	2.11	103.6	96.65
	NMNL-2 (19%)	70.11	178.45	180.51	2.06	99.1	93.02
	NMNL-2 (18%)	66.42	178.45	180.46	2.01	94.65	89.3
	NMNL-2 (17%)	62.73	178.45	180.41	1.96	90.22	85.45
	NMNL-2 (16%)	59.04	178.45	180.36	1.91	85.88	80.04
	NMNL-2 (15%)	55.35	178.45	180.31	1.86	81.85	67.55
	L (100%)	128.5	178.45	181.15	2.7	169.69	117.48
	L (30%)	38.55	178.45	180.03	1.58	63.73	62.15
	L (29%)	37.27	178.45	180	1.55	62.21	61.68
	L (28%)	35.98	178.45	179.98	1.53	60.65	61.19
	L (27%)	34.7	178.45	179.95	1.5	59.1	60.71
	L (26%)	33.41	178.45	179.93	1.48	57.52	60.21
	L (25%)	32.13	178.45	179.9	1.45	55.92	59.7
	L (24%)	30.84	178.45	179.87	1.42	54.27	59.17
	L (23%)	29.56	178.45	179.84	1.39	52.62	58.64
	L (22%)	28.27	178.45	179.81	1.36	50.9	58.07
	L (21%)	26.99	178.45	179.78	1.33	49.17	57.5
	L (20%)	25.7	178.45	179.75	1.3	47.4	56.91
	L (19%)	24.42	178.45	179.72	1.27	45.61	56.32
	L (18%)	23.13	178.45	179.69	1.24	43.75	55.71
	L (17%)	21.85	178.45	179.65	1.2	41.86	55.07
	L (16%)	20.56	178.45	179.62	1.17	39.85	54.39
	L (15%)	19.28	178.45	179.58	1.13	37.87	53.71
750 m d/s of Barrage axis	M (100%)	910	178.32	184.52	6.2	616.97	137.09
	M (30%)	273	178.32	182.19	3.87	321.53	117.46
	M (29%)	263.9	178.32	182.14	3.82	315.29	117.02
	M (28%)	254.8	178.32	182.08	3.76	308.86	116.57
	M (27%)	245.7	178.32	182.02	3.7	302.37	116.11
	M (26%)	236.6	178.32	181.97	3.65	295.72	115.64
	M (25%)	227.5	178.32	181.91	3.59	288.92	115.16
	M (24%)	218.4	178.32	181.85	3.53	281.97	114.66
	M (23%)	209.3	178.32	181.79	3.47	274.8	114.15
	M (22%)	200.2	178.32	181.72	3.4	267.47	113.62
	M (21%)	191.1	178.32	181.65	3.33	259.93	113.07
	M (20%)	182	178.32	181.59	3.27	252.2	112.51
	M (19%)	172.9	178.32	181.52	3.2	244.27	111.92
	M (18%)	163.8	178.32	181.44	3.12	236.14	111.32
	M (17%)	154.7	178.32	181.37	3.05	227.79	110.7
	M (16%)	145.6	178.32	181.29	2.97	219.21	110.06
	M (15%)	136.5	178.32	181.21	2.89	210.38	109.4
	NMNL-1 (100%)	352.17	178.32	182.61	4.29	371.37	120.89
	NMNL-1 (30%)	105.65	178.32	180.91	2.59	177.96	106.92
	NMNL-1 (29%)	102.13	178.32	180.87	2.55	173.95	106.61

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (28%)	98.61	178.32	180.83	2.51	169.86	106.29
	NMNL-1 (27%)	95.09	178.32	180.8	2.48	165.79	105.97
	NMNL-1 (26%)	91.56	178.32	180.76	2.44	161.68	105.64
	NMNL-1 (25%)	88.04	178.32	180.72	2.4	157.43	105.31
	NMNL-1 (24%)	84.52	178.32	180.67	2.35	153.08	104.96
	NMNL-1 (23%)	81	178.32	180.63	2.31	148.66	104.61
	NMNL-1 (22%)	77.48	178.32	180.59	2.27	144.15	104.25
	NMNL-1 (21%)	73.96	178.32	180.54	2.22	139.55	103.89
	NMNL-1 (20%)	70.43	178.32	180.5	2.18	134.84	103.51
	NMNL-1 (19%)	66.91	178.32	180.45	2.13	130.03	103.12
	NMNL-1 (18%)	63.39	178.32	180.4	2.08	125.09	102.72
	NMNL-1 (17%)	59.87	178.32	180.36	2.04	120.04	102.31
	NMNL-1 (16%)	56.35	178.32	180.3	1.98	114.85	101.89
	NMNL-1 (15%)	52.83	178.32	180.25	1.93	109.55	99.15
	NMNL-2 (100%)	369	178.32	182.69	4.37	381.11	121.55
	NMNL-2 (30%)	110.7	178.32	180.96	2.64	183.61	107.36
	NMNL-2 (29%)	107.01	178.32	180.92	2.6	179.47	107.04
	NMNL-2 (28%)	103.32	178.32	180.88	2.56	175.32	106.71
	NMNL-2 (27%)	99.63	178.32	180.84	2.52	171.05	106.38
	NMNL-2 (26%)	95.94	178.32	180.8	2.48	166.78	106.04
	NMNL-2 (25%)	92.25	178.32	180.76	2.44	162.49	105.71
	NMNL-2 (24%)	88.56	178.32	180.72	2.4	158.06	105.36
	NMNL-2 (23%)	84.87	178.32	180.68	2.36	153.52	105
	NMNL-2 (22%)	81.18	178.32	180.63	2.31	148.89	104.63
	NMNL-2 (21%)	77.49	178.32	180.59	2.27	144.17	104.25
	NMNL-2 (20%)	73.8	178.32	180.54	2.22	139.35	103.87
	NMNL-2 (19%)	70.11	178.32	180.5	2.18	134.42	103.47
	NMNL-2 (18%)	66.42	178.32	180.45	2.13	129.35	103.07
	NMNL-2 (17%)	62.73	178.32	180.4	2.08	124.15	102.64
	NMNL-2 (16%)	59.04	178.32	180.34	2.02	118.83	102.21
	NMNL-2 (15%)	55.35	178.32	180.29	1.97	113.35	101.36
	L (100%)	128.5	178.32	181.14	2.82	202.4	108.79
	L (30%)	38.55	178.32	180.01	1.69	87.44	83.86
	L (29%)	37.27	178.32	179.99	1.67	85.41	82.25
	L (28%)	35.98	178.32	179.96	1.64	83.35	80.59
	L (27%)	34.7	178.32	179.94	1.62	81.32	79.42
	L (26%)	33.41	178.32	179.91	1.59	79.25	78.36
	L (25%)	32.13	178.32	179.88	1.56	77.18	77.27
	L (24%)	30.84	178.32	179.86	1.54	75.06	76.15
	L (23%)	29.56	178.32	179.83	1.51	72.93	75
	L (22%)	28.27	178.32	179.8	1.48	70.74	73.08
	L (21%)	26.99	178.32	179.77	1.45	68.58	70.73
	L (20%)	25.7	178.32	179.74	1.42	66.42	68.91
	L (19%)	24.42	178.32	179.71	1.39	64.25	68.02

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (18%)	23.13	178.32	179.67	1.35	62.01	67.09
	L (17%)	21.85	178.32	179.64	1.32	59.72	66.13
	L (16%)	20.56	178.32	179.6	1.28	57.29	65.09
	L (15%)	19.28	178.32	179.56	1.24	54.91	64.06
800 m d/s of Barrage axis	M (100%)	910	178.18	184.48	6.3	579.36	129.19
	M (30%)	273	178.18	182.17	3.99	303.37	109.26
	M (29%)	263.9	178.18	182.11	3.93	297.6	108.79
	M (28%)	254.8	178.18	182.06	3.88	291.66	108.3
	M (27%)	245.7	178.18	182	3.82	285.65	107.8
	M (26%)	236.6	178.18	181.95	3.77	279.52	107.29
	M (25%)	227.5	178.18	181.89	3.71	273.24	106.77
	M (24%)	218.4	178.18	181.83	3.65	266.82	106.23
	M (23%)	209.3	178.18	181.77	3.59	260.22	105.67
	M (22%)	200.2	178.18	181.7	3.52	253.46	105.1
	M (21%)	191.1	178.18	181.64	3.46	246.51	104.51
	M (20%)	182	178.18	181.57	3.39	239.39	103.9
	M (19%)	172.9	178.18	181.5	3.32	232.09	103.27
	M (18%)	163.8	178.18	181.42	3.24	224.63	102.62
	M (17%)	154.7	178.18	181.35	3.17	216.95	101.95
	M (16%)	145.6	178.18	181.27	3.09	209.07	101.26
	M (15%)	136.5	178.18	181.19	3.01	200.98	100.54
	NMNL-1 (100%)	352.17	178.18	182.58	4.4	349.54	112.97
	NMNL-1 (30%)	105.65	178.18	180.89	2.71	171.54	95.43
	NMNL-1 (29%)	102.13	178.18	180.85	2.67	167.98	94.64
	NMNL-1 (28%)	98.61	178.18	180.82	2.64	164.36	93.83
	NMNL-1 (27%)	95.09	178.18	180.78	2.6	160.79	93.03
	NMNL-1 (26%)	91.56	178.18	180.74	2.56	157.22	91.3
	NMNL-1 (25%)	88.04	178.18	180.7	2.52	153.59	89.36
	NMNL-1 (24%)	84.52	178.18	180.66	2.48	149.95	87.38
	NMNL-1 (23%)	81	178.18	180.62	2.44	146.31	86.36
	NMNL-1 (22%)	77.48	178.18	180.57	2.39	142.62	85.37
	NMNL-1 (21%)	73.96	178.18	180.53	2.35	138.9	84.36
	NMNL-1 (20%)	70.43	178.18	180.48	2.3	135.11	83.31
	NMNL-1 (19%)	66.91	178.18	180.44	2.26	131.29	82.24
	NMNL-1 (18%)	63.39	178.18	180.39	2.21	127.39	81.14
	NMNL-1 (17%)	59.87	178.18	180.34	2.16	123.46	80.14
	NMNL-1 (16%)	56.35	178.18	180.29	2.11	119.45	79.18
	NMNL-1 (15%)	52.83	178.18	180.24	2.06	115.36	78.18
	NMNL-2 (100%)	369	178.18	182.66	4.48	358.58	113.67
	NMNL-2 (30%)	110.7	178.18	180.94	2.76	176.6	96.54
	NMNL-2 (29%)	107.01	178.18	180.91	2.73	172.89	95.73
	NMNL-2 (28%)	103.32	178.18	180.87	2.69	169.19	94.91
	NMNL-2 (27%)	99.63	178.18	180.83	2.65	165.41	94.07

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (26%)	95.94	178.18	180.79	2.61	161.65	93.22
	NMNL-2 (25%)	92.25	178.18	180.75	2.57	157.92	91.67
	NMNL-2 (24%)	88.56	178.18	180.71	2.53	154.13	89.65
	NMNL-2 (23%)	84.87	178.18	180.66	2.48	150.32	87.58
	NMNL-2 (22%)	81.18	178.18	180.62	2.44	146.5	86.41
	NMNL-2 (21%)	77.49	178.18	180.57	2.39	142.64	85.37
	NMNL-2 (20%)	73.8	178.18	180.53	2.35	138.73	84.31
	NMNL-2 (19%)	70.11	178.18	180.48	2.3	134.77	83.22
	NMNL-2 (18%)	66.42	178.18	180.43	2.25	130.75	82.09
	NMNL-2 (17%)	62.73	178.18	180.38	2.2	126.66	80.93
	NMNL-2 (16%)	59.04	178.18	180.33	2.15	122.52	79.92
	NMNL-2 (15%)	55.35	178.18	180.28	2.1	118.3	78.9
	L (100%)	128.5	178.18	181.12	2.94	193.66	99.89
	L (30%)	38.55	178.18	180	1.82	97.33	73.52
	L (29%)	37.27	178.18	179.98	1.8	95.55	73.15
	L (28%)	35.98	178.18	179.95	1.77	93.72	72.76
	L (27%)	34.7	178.18	179.93	1.75	91.89	72.38
	L (26%)	33.41	178.18	179.9	1.72	90.01	71.98
	L (25%)	32.13	178.18	179.87	1.69	88.11	71.57
	L (24%)	30.84	178.18	179.85	1.67	86.15	71.15
	L (23%)	29.56	178.18	179.82	1.64	84.17	70.72
	L (22%)	28.27	178.18	179.79	1.61	82.1	70.27
	L (21%)	26.99	178.18	179.76	1.58	80.01	69.81
	L (20%)	25.7	178.18	179.73	1.55	77.86	69.34
	L (19%)	24.42	178.18	179.7	1.52	75.68	68.85
	L (18%)	23.13	178.18	179.66	1.48	73.4	68.34
	L (17%)	21.85	178.18	179.63	1.45	71.07	67.82
	L (16%)	20.56	178.18	179.59	1.41	68.58	67.25
	L (15%)	19.28	178.18	179.56	1.38	66.11	66.68
850 m d/s of Barrage axis	M (100%)	910	178.04	184.35	6.31	454.82	124.05
	M (30%)	273	178.04	182.08	4.04	205.5	95.54
	M (29%)	263.9	178.04	182.03	3.99	200.51	94.94
	M (28%)	254.8	178.04	181.98	3.94	195.38	94.34
	M (27%)	245.7	178.04	181.92	3.88	190.2	93.78
	M (26%)	236.6	178.04	181.87	3.83	184.9	93.19
	M (25%)	227.5	178.04	181.81	3.77	179.49	92.59
	M (24%)	218.4	178.04	181.75	3.71	173.97	91.98
	M (23%)	209.3	178.04	181.69	3.65	168.27	91.34
	M (22%)	200.2	178.04	181.62	3.58	162.45	90.68
	M (21%)	191.1	178.04	181.56	3.52	156.46	90
	M (20%)	182	178.04	181.49	3.45	150.33	89.29
	M (19%)	172.9	178.04	181.42	3.38	144.05	88.57
	M (18%)	163.8	178.04	181.34	3.3	137.62	87.82

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (17%)	154.7	178.04	181.27	3.23	131.02	87.03
	M (16%)	145.6	178.04	181.19	3.15	124.26	85.96
	M (15%)	136.5	178.04	181.11	3.07	117.34	84.84
	NMNL-1 (100%)	352.17	178.04	182.49	4.45	245.66	100.42
	NMNL-1 (30%)	105.65	178.04	180.8	2.76	92.12	80.64
	NMNL-1 (29%)	102.13	178.04	180.77	2.73	89.05	78.6
	NMNL-1 (28%)	98.61	178.04	180.73	2.69	86.03	75.74
	NMNL-1 (27%)	95.09	178.04	180.69	2.65	83.1	74.43
	NMNL-1 (26%)	91.56	178.04	180.65	2.61	80.16	73.35
	NMNL-1 (25%)	88.04	178.04	180.61	2.57	77.23	71.43
	NMNL-1 (24%)	84.52	178.04	180.57	2.53	74.32	69.48
	NMNL-1 (23%)	81	178.04	180.52	2.48	71.44	67.5
	NMNL-1 (22%)	77.48	178.04	180.48	2.44	68.58	65.53
	NMNL-1 (21%)	73.96	178.04	180.44	2.4	65.74	63.82
	NMNL-1 (20%)	70.43	178.04	180.39	2.35	62.9	62.06
	NMNL-1 (19%)	66.91	178.04	180.35	2.31	60.07	60.26
	NMNL-1 (18%)	63.39	178.04	180.3	2.26	57.26	58.42
	NMNL-1 (17%)	59.87	178.04	180.25	2.21	54.47	56.53
	NMNL-1 (16%)	56.35	178.04	180.2	2.16	51.71	54.6
	NMNL-1 (15%)	52.83	178.04	180.15	2.11	48.96	52.6
	NMNL-2 (100%)	369	178.04	182.57	4.53	253.57	101.36
	NMNL-2 (30%)	110.7	178.04	180.86	2.82	96.51	81.39
	NMNL-2 (29%)	107.01	178.04	180.82	2.78	93.29	80.84
	NMNL-2 (28%)	103.32	178.04	180.78	2.74	90.09	79.55
	NMNL-2 (27%)	99.63	178.04	180.74	2.7	86.9	76.57
	NMNL-2 (26%)	95.94	178.04	180.7	2.66	83.81	74.66
	NMNL-2 (25%)	92.25	178.04	180.66	2.62	80.74	73.63
	NMNL-2 (24%)	88.56	178.04	180.61	2.57	77.66	71.72
	NMNL-2 (23%)	84.87	178.04	180.57	2.53	74.61	69.68
	NMNL-2 (22%)	81.18	178.04	180.53	2.49	71.59	67.6
	NMNL-2 (21%)	77.49	178.04	180.48	2.44	68.59	65.53
	NMNL-2 (20%)	73.8	178.04	180.43	2.39	65.61	63.74
	NMNL-2 (19%)	70.11	178.04	180.39	2.35	62.64	61.9
	NMNL-2 (18%)	66.42	178.04	180.34	2.3	59.68	60.01
	NMNL-2 (17%)	62.73	178.04	180.29	2.25	56.73	58.07
	NMNL-2 (16%)	59.04	178.04	180.24	2.2	53.82	56.08
	NMNL-2 (15%)	55.35	178.04	180.19	2.15	50.93	54.04
	L (100%)	128.5	178.04	181.03	2.99	111.11	83.82
	L (30%)	38.55	178.04	179.91	1.87	37.71	43.49
	L (29%)	37.27	178.04	179.89	1.85	36.69	42.56
	L (28%)	35.98	178.04	179.87	1.83	35.65	41.61
	L (27%)	34.7	178.04	179.84	1.8	34.64	40.64
	L (26%)	33.41	178.04	179.82	1.78	33.62	39.65
	L (25%)	32.13	178.04	179.79	1.75	32.6	38.64

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (24%)	30.84	178.04	179.76	1.72	31.58	37.59
	L (23%)	29.56	178.04	179.74	1.7	30.56	36.53
	L (22%)	28.27	178.04	179.71	1.67	29.54	35.27
	L (21%)	26.99	178.04	179.68	1.64	28.53	33.97
	L (20%)	25.7	178.04	179.65	1.61	27.52	33.24
	L (19%)	24.42	178.04	179.62	1.58	26.51	32.53
	L (18%)	23.13	178.04	179.58	1.54	25.47	31.79
	L (17%)	21.85	178.04	179.55	1.51	24.42	31.03
	L (16%)	20.56	178.04	179.51	1.47	23.31	30.19
	L (15%)	19.28	178.04	179.48	1.44	22.25	29.38
900 m d/s of Barrage axis	M (100%)	910	177.92	183.08	5.16	185.18	75.63
	M (30%)	273	177.92	181.11	3.19	68.13	41.91
	M (29%)	263.9	177.92	181.06	3.14	66.15	41.05
	M (28%)	254.8	177.92	181.02	3.1	64.3	40.22
	M (27%)	245.7	177.92	180.97	3.05	62.28	39.3
	M (26%)	236.6	177.92	180.91	2.99	60.24	38.35
	M (25%)	227.5	177.92	180.86	2.94	58.18	37.37
	M (24%)	218.4	177.92	180.8	2.88	56.1	36.35
	M (23%)	209.3	177.92	180.75	2.83	54.01	35.3
	M (22%)	200.2	177.92	180.68	2.76	51.82	34.16
	M (21%)	191.1	177.92	180.62	2.7	49.79	33.47
	M (20%)	182	177.92	180.56	2.64	47.86	32.88
	M (19%)	172.9	177.92	180.51	2.59	46.02	32.32
	M (18%)	163.8	177.92	180.45	2.53	44.15	31.73
	M (17%)	154.7	177.92	180.39	2.47	42.34	31.15
	M (16%)	145.6	177.92	180.33	2.41	40.38	30.52
	M (15%)	136.5	177.92	180.26	2.34	38.4	29.86
	NMNL-1 (100%)	352.17	177.92	181.48	3.56	84.77	48.57
	NMNL-1 (30%)	105.65	177.92	180.05	2.13	32.18	27.69
	NMNL-1 (29%)	102.13	177.92	180.03	2.11	31.59	27.47
	NMNL-1 (28%)	98.61	177.92	180	2.08	30.98	27.25
	NMNL-1 (27%)	95.09	177.92	179.98	2.06	30.36	27.02
	NMNL-1 (26%)	91.56	177.92	179.96	2.04	29.74	26.79
	NMNL-1 (25%)	88.04	177.92	179.93	2.01	29.1	26.55
	NMNL-1 (24%)	84.52	177.92	179.91	1.99	28.46	26.3
	NMNL-1 (23%)	81	177.92	179.88	1.96	27.8	26.05
	NMNL-1 (22%)	77.48	177.92	179.86	1.94	27.12	25.79
	NMNL-1 (21%)	73.96	177.92	179.83	1.91	26.43	25.53
	NMNL-1 (20%)	70.43	177.92	179.8	1.88	25.73	25.27
	NMNL-1 (19%)	66.91	177.92	179.77	1.85	25.01	25.01
	NMNL-1 (18%)	63.39	177.92	179.74	1.82	24.26	24.74
	NMNL-1 (17%)	59.87	177.92	179.71	1.79	23.51	24.45
	NMNL-1 (16%)	56.35	177.92	179.68	1.76	22.73	24.16

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (15%)	52.83	177.92	179.65	1.73	21.91	23.75
	NMNL-2 (100%)	369	177.92	181.55	3.63	88.18	49.83
	NMNL-2 (30%)	110.7	177.92	180.08	2.16	33.09	28.01
	NMNL-2 (29%)	107.01	177.92	180.05	2.13	32.41	27.77
	NMNL-2 (28%)	103.32	177.92	180.03	2.11	31.79	27.54
	NMNL-2 (27%)	99.63	177.92	180.01	2.09	31.16	27.31
	NMNL-2 (26%)	95.94	177.92	179.99	2.07	30.51	27.07
	NMNL-2 (25%)	92.25	177.92	179.96	2.04	29.86	26.83
	NMNL-2 (24%)	88.56	177.92	179.94	2.02	29.2	26.58
	NMNL-2 (23%)	84.87	177.92	179.91	1.99	28.52	26.33
	NMNL-2 (22%)	81.18	177.92	179.88	1.96	27.83	26.06
	NMNL-2 (21%)	77.49	177.92	179.86	1.94	27.12	25.79
	NMNL-2 (20%)	73.8	177.92	179.83	1.91	26.4	25.52
	NMNL-2 (19%)	70.11	177.92	179.8	1.88	25.66	25.25
	NMNL-2 (18%)	66.42	177.92	179.77	1.85	24.9	24.97
	NMNL-2 (17%)	62.73	177.92	179.74	1.82	24.12	24.69
	NMNL-2 (16%)	59.04	177.92	179.71	1.79	23.32	24.39
	NMNL-2 (15%)	55.35	177.92	179.67	1.75	22.5	24.05
	L (100%)	128.5	177.92	180.2	2.28	36.64	29.26
	L (30%)	38.55	177.92	179.49	1.57	18.36	21.85
	L (29%)	37.27	177.92	179.48	1.56	18.01	21.65
	L (28%)	35.98	177.92	179.46	1.54	17.64	21.45
	L (27%)	34.7	177.92	179.44	1.52	17.28	21.24
	L (26%)	33.41	177.92	179.42	1.5	16.91	21.02
	L (25%)	32.13	177.92	179.41	1.49	16.52	20.8
	L (24%)	30.84	177.92	179.39	1.47	16.13	20.57
	L (23%)	29.56	177.92	179.37	1.45	15.74	20.33
	L (22%)	28.27	177.92	179.35	1.43	15.33	20.08
	L (21%)	26.99	177.92	179.33	1.41	14.91	19.83
	L (20%)	25.7	177.92	179.3	1.38	14.48	19.56
	L (19%)	24.42	177.92	179.28	1.36	14.05	19.29
	L (18%)	23.13	177.92	179.26	1.34	13.6	19.01
	L (17%)	21.85	177.92	179.23	1.31	13.14	18.7
	L (16%)	20.56	177.92	179.21	1.29	12.65	18.38
	L (15%)	19.28	177.92	179.18	1.26	12.16	18.05
950 m d/s of Barrage axis	M (100%)	910	177.77	182.36	4.59	290.65	106.84
	M (30%)	273	177.77	180.7	2.93	134.78	80.75
	M (29%)	263.9	177.77	180.66	2.89	131.85	80.15
	M (28%)	254.8	177.77	180.63	2.86	128.88	79.53
	M (27%)	245.7	177.77	180.59	2.82	125.89	78.91
	M (26%)	236.6	177.77	180.55	2.78	122.86	78.27
	M (25%)	227.5	177.77	180.51	2.74	119.79	77.62
	M (24%)	218.4	177.77	180.47	2.7	116.73	76.96

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (23%)	209.3	177.77	180.43	2.66	113.59	76.28
	M (22%)	200.2	177.77	180.39	2.62	110.45	75.63
	M (21%)	191.1	177.77	180.35	2.58	107.24	74.99
	M (20%)	182	177.77	180.3	2.53	103.96	74.33
	M (19%)	172.9	177.77	180.26	2.49	100.64	73.65
	M (18%)	163.8	177.77	180.21	2.44	97.27	72.96
	M (17%)	154.7	177.77	180.16	2.39	93.78	72.23
	M (16%)	145.6	177.77	180.12	2.35	90.28	71.5
	M (15%)	136.5	177.77	180.07	2.3	86.7	70.57
	NMNL-1 (100%)	352.17	177.77	181	3.23	159.23	85.62
	NMNL-1 (30%)	105.65	177.77	179.88	2.11	74	66.55
	NMNL-1 (29%)	102.13	177.77	179.86	2.09	72.5	66.01
	NMNL-1 (28%)	98.61	177.77	179.83	2.06	70.97	65.46
	NMNL-1 (27%)	95.09	177.77	179.81	2.04	69.44	64.91
	NMNL-1 (26%)	91.56	177.77	179.79	2.02	67.88	64.34
	NMNL-1 (25%)	88.04	177.77	179.76	1.99	66.34	63.77
	NMNL-1 (24%)	84.52	177.77	179.74	1.97	64.76	63.18
	NMNL-1 (23%)	81	177.77	179.71	1.94	63.16	62.58
	NMNL-1 (22%)	77.48	177.77	179.69	1.92	61.54	61.96
	NMNL-1 (21%)	73.96	177.77	179.66	1.89	59.9	60.99
	NMNL-1 (20%)	70.43	177.77	179.63	1.86	58.24	60
	NMNL-1 (19%)	66.91	177.77	179.6	1.83	56.58	58.99
	NMNL-1 (18%)	63.39	177.77	179.58	1.81	54.9	57.94
	NMNL-1 (17%)	59.87	177.77	179.55	1.78	53.19	56.86
	NMNL-1 (16%)	56.35	177.77	179.52	1.75	51.47	55.75
	NMNL-1 (15%)	52.83	177.77	179.48	1.71	49.71	54.82
	NMNL-2 (100%)	369	177.77	181.05	3.28	164.16	86.56
	NMNL-2 (30%)	110.7	177.77	179.91	2.14	76.14	67.3
	NMNL-2 (29%)	107.01	177.77	179.89	2.12	74.58	66.75
	NMNL-2 (28%)	103.32	177.77	179.87	2.1	73.01	66.19
	NMNL-2 (27%)	99.63	177.77	179.84	2.07	71.42	65.62
	NMNL-2 (26%)	95.94	177.77	179.82	2.05	69.81	65.04
	NMNL-2 (25%)	92.25	177.77	179.79	2.02	68.19	64.45
	NMNL-2 (24%)	88.56	177.77	179.77	2	66.57	63.85
	NMNL-2 (23%)	84.87	177.77	179.74	1.97	64.91	63.24
	NMNL-2 (22%)	81.18	177.77	179.71	1.94	63.24	62.61
	NMNL-2 (21%)	77.49	177.77	179.69	1.92	61.54	61.96
	NMNL-2 (20%)	73.8	177.77	179.66	1.89	59.82	60.95
	NMNL-2 (19%)	70.11	177.77	179.63	1.86	58.09	59.91
	NMNL-2 (18%)	66.42	177.77	179.6	1.83	56.34	58.84
	NMNL-2 (17%)	62.73	177.77	179.57	1.8	54.58	57.74
	NMNL-2 (16%)	59.04	177.77	179.54	1.77	52.79	56.61
	NMNL-2 (15%)	55.35	177.77	179.51	1.74	50.97	55.49
	L (100%)	128.5	177.77	180.02	2.25	83.49	69.7

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (30%)	38.55	177.77	179.34	1.57	42.24	50.7
	L (29%)	37.27	177.77	179.33	1.56	41.53	50.28
	L (28%)	35.98	177.77	179.31	1.54	40.74	49.82
	L (27%)	34.7	177.77	179.3	1.53	39.95	49.35
	L (26%)	33.41	177.77	179.28	1.51	39.14	48.87
	L (25%)	32.13	177.77	179.26	1.49	38.32	48.37
	L (24%)	30.84	177.77	179.25	1.48	37.48	47.86
	L (23%)	29.56	177.77	179.23	1.46	36.63	47.33
	L (22%)	28.27	177.77	179.21	1.44	35.75	46.78
	L (21%)	26.99	177.77	179.19	1.42	34.85	46.21
	L (20%)	25.7	177.77	179.17	1.4	33.93	45.62
	L (19%)	24.42	177.77	179.15	1.38	32.99	45.01
	L (18%)	23.13	177.77	179.13	1.36	32	44.36
	L (17%)	21.85	177.77	179.1	1.33	30.97	43.68
	L (16%)	20.56	177.77	179.08	1.31	29.89	42.94
	L (15%)	19.28	177.77	179.05	1.28	28.79	42.18
1000 m d/s of Barrage axis	M (100%)	910	177.64	182.34	4.7	414.25	232.24
	M (30%)	273	177.64	180.58	2.94	153.26	95.17
	M (29%)	263.9	177.64	180.54	2.9	149.72	94.45
	M (28%)	254.8	177.64	180.5	2.86	146.14	93.73
	M (27%)	245.7	177.64	180.46	2.82	142.52	92.98
	M (26%)	236.6	177.64	180.42	2.78	138.87	92.22
	M (25%)	227.5	177.64	180.38	2.74	135.17	91.45
	M (24%)	218.4	177.64	180.34	2.7	131.44	90.66
	M (23%)	209.3	177.64	180.3	2.66	127.66	89.86
	M (22%)	200.2	177.64	180.26	2.62	123.9	89.05
	M (21%)	191.1	177.64	180.21	2.57	120.03	88.21
	M (20%)	182	177.64	180.17	2.53	116.11	87.35
	M (19%)	172.9	177.64	180.12	2.48	112.14	86.47
	M (18%)	163.8	177.64	180.08	2.44	108.1	85.57
	M (17%)	154.7	177.64	180.03	2.39	103.95	84.63
	M (16%)	145.6	177.64	179.98	2.34	99.8	83.68
	M (15%)	136.5	177.64	179.93	2.29	95.58	82.71
	NMNL-1 (100%)	352.17	177.64	180.88	3.24	182.86	100.95
	NMNL-1 (30%)	105.65	177.64	179.74	2.1	80.52	79.13
	NMNL-1 (29%)	102.13	177.64	179.72	2.08	78.72	78.69
	NMNL-1 (28%)	98.61	177.64	179.7	2.06	76.9	78.25
	NMNL-1 (27%)	95.09	177.64	179.67	2.03	75.06	77.79
	NMNL-1 (26%)	91.56	177.64	179.65	2.01	73.19	77.33
	NMNL-1 (25%)	88.04	177.64	179.62	1.98	71.35	76.88
	NMNL-1 (24%)	84.52	177.64	179.6	1.96	69.46	76.4
	NMNL-1 (23%)	81	177.64	179.57	1.93	67.53	75.92
	NMNL-1 (22%)	77.48	177.64	179.55	1.91	65.58	75.42

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (21%)	73.96	177.64	179.52	1.88	63.61	74.92
	NMNL-1 (20%)	70.43	177.64	179.49	1.85	61.6	74.41
	NMNL-1 (19%)	66.91	177.64	179.47	1.83	59.56	73.88
	NMNL-1 (18%)	63.39	177.64	179.44	1.8	57.49	73.34
	NMNL-1 (17%)	59.87	177.64	179.41	1.77	55.38	72.79
	NMNL-1 (16%)	56.35	177.64	179.38	1.74	53.23	72.22
	NMNL-1 (15%)	52.83	177.64	179.35	1.71	51.04	71.64
	NMNL-2 (100%)	369	177.64	180.94	3.3	188.82	102.1
	NMNL-2 (30%)	110.7	177.64	179.77	2.13	83.07	79.75
	NMNL-2 (29%)	107.01	177.64	179.75	2.11	81.21	79.3
	NMNL-2 (28%)	103.32	177.64	179.73	2.09	79.33	78.84
	NMNL-2 (27%)	99.63	177.64	179.7	2.06	77.43	78.38
	NMNL-2 (26%)	95.94	177.64	179.68	2.04	75.5	77.9
	NMNL-2 (25%)	92.25	177.64	179.65	2.01	73.55	77.42
	NMNL-2 (24%)	88.56	177.64	179.63	1.99	71.63	76.94
	NMNL-2 (23%)	84.87	177.64	179.6	1.96	69.65	76.45
	NMNL-2 (22%)	81.18	177.64	179.58	1.94	67.63	75.94
	NMNL-2 (21%)	77.49	177.64	179.55	1.91	65.59	75.43
	NMNL-2 (20%)	73.8	177.64	179.52	1.88	63.52	74.9
	NMNL-2 (19%)	70.11	177.64	179.49	1.85	61.41	74.36
	NMNL-2 (18%)	66.42	177.64	179.46	1.82	59.27	73.81
	NMNL-2 (17%)	62.73	177.64	179.43	1.79	57.1	73.24
	NMNL-2 (16%)	59.04	177.64	179.4	1.76	54.88	72.66
	NMNL-2 (15%)	55.35	177.64	179.37	1.73	52.62	72.06
	L (100%)	128.5	177.64	179.88	2.24	91.8	81.83
	L (30%)	38.55	177.64	179.22	1.58	41.64	69.08
	L (29%)	37.27	177.64	179.2	1.56	40.73	68.76
	L (28%)	35.98	177.64	179.19	1.55	39.66	67.82
	L (27%)	34.7	177.64	179.17	1.53	38.59	66.86
	L (26%)	33.41	177.64	179.16	1.52	37.5	65.87
	L (25%)	32.13	177.64	179.14	1.5	36.4	64.86
	L (24%)	30.84	177.64	179.12	1.48	35.27	63.8
	L (23%)	29.56	177.64	179.1	1.46	34.16	62.74
	L (22%)	28.27	177.64	179.09	1.45	33.03	61.65
	L (21%)	26.99	177.64	179.07	1.43	31.89	60.53
	L (20%)	25.7	177.64	179.05	1.41	30.73	59.36
	L (19%)	24.42	177.64	179.03	1.39	29.56	58.16
	L (18%)	23.13	177.64	179.01	1.37	28.36	56.9
	L (17%)	21.85	177.64	178.99	1.35	27.16	55.62
	L (16%)	20.56	177.64	178.96	1.32	25.94	54.3
	L (15%)	19.28	177.64	178.94	1.3	24.73	53.06

Note:

M - Monsoon Season

NMNL1 - Non Monsoon Non Lean Season (October & November)

L - Lean Season
NMNL2 - Non Monsoon Non Lean Season (April & May)

Table-13.13: Depth of flow for release in the year 2014 for Teesta Low Dam -III HEP

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
At Barrage axis	M (100%)	1007.5	180.34	185.32	4.98	380.35	123.37
	M (30%)	302.25	180.34	183.19	2.85	161.45	80.59
	M (29%)	292.18	180.34	183.15	2.81	158.07	79.97
	M (28%)	282.1	180.34	183.11	2.77	154.61	79.33
	M (27%)	272.03	180.34	183.06	2.72	151.14	78.69
	M (26%)	261.95	180.34	183.02	2.68	147.72	78.05
	M (25%)	251.88	180.34	182.97	2.63	144.3	77.41
	M (24%)	241.8	180.34	182.93	2.59	140.92	76.77
	M (23%)	231.73	180.34	182.89	2.55	137.48	76.11
	M (22%)	221.65	180.34	182.84	2.5	133.96	75.43
	M (21%)	211.58	180.34	182.79	2.45	130.5	74.75
	M (20%)	201.5	180.34	182.75	2.41	127.09	74.08
	M (19%)	191.43	180.34	182.7	2.36	123.52	73.37
	M (18%)	181.35	180.34	182.65	2.31	119.98	72.66
	M (17%)	171.28	180.34	182.6	2.26	116.32	71.92
	M (16%)	161.2	180.34	182.54	2.2	112.38	71.11
	M (15%)	151.13	180.34	182.49	2.15	108.21	70.22
	NMNL-1 (100%)	272.33	180.34	183.06	2.72	151.24	78.71
	NMNL-1 (30%)	81.7	180.34	182	1.66	76.15	62.99
	NMNL-1 (29%)	78.98	180.34	181.98	1.64	74.69	62.64
	NMNL-1 (28%)	76.25	180.34	181.96	1.62	73.18	62.28
	NMNL-1 (27%)	73.53	180.34	181.93	1.59	71.69	61.92
	NMNL-1 (26%)	70.81	180.34	181.91	1.57	70.17	61.55
	NMNL-1 (25%)	68.08	180.34	181.88	1.54	68.61	61.17
	NMNL-1 (24%)	65.36	180.34	181.86	1.52	67.02	60.78
	NMNL-1 (23%)	62.64	180.34	181.83	1.49	65.39	60.37
	NMNL-1 (22%)	59.91	180.34	181.8	1.46	63.72	59.96
	NMNL-1 (21%)	57.19	180.34	181.77	1.43	62.03	59.52
	NMNL-1 (20%)	54.47	180.34	181.74	1.4	60.27	59.07
	NMNL-1 (19%)	51.74	180.34	181.71	1.37	58.44	58.6
	NMNL-1 (18%)	49.02	180.34	181.68	1.34	56.61	58.11
	NMNL-1 (17%)	46.3	180.34	181.65	1.31	54.67	57.6
	NMNL-1 (16%)	43.57	180.34	181.61	1.27	52.44	57.01
	NMNL-1 (15%)	40.85	180.34	181.57	1.23	50.26	56.42
	NMNL-2 (100%)	281.33	180.34	183.1	2.76	154.35	79.29
	NMNL-2 (30%)	84.4	180.34	182.03	1.69	77.6	63.34
	NMNL-2 (29%)	81.59	180.34	182	1.66	76.1	62.98
	NMNL-2 (28%)	78.77	180.34	181.98	1.64	74.57	62.61
	NMNL-2 (27%)	75.96	180.34	181.95	1.61	73.02	62.24
	NMNL-2 (26%)	73.15	180.34	181.93	1.59	71.48	61.87
	NMNL-2 (25%)	70.33	180.34	181.9	1.56	69.89	61.48

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (24%)	67.52	180.34	181.88	1.54	68.29	61.09
	NMNL-2 (23%)	64.71	180.34	181.85	1.51	66.63	60.68
	NMNL-2 (22%)	61.89	180.34	181.82	1.48	64.93	60.26
	NMNL-2 (21%)	59.08	180.34	181.79	1.45	63.21	59.83
	NMNL-2 (20%)	56.27	180.34	181.76	1.42	61.45	59.38
	NMNL-2 (19%)	53.45	180.34	181.73	1.39	59.59	58.89
	NMNL-2 (18%)	50.64	180.34	181.7	1.36	57.71	58.4
	NMNL-2 (17%)	47.83	180.34	181.67	1.33	55.79	57.9
	NMNL-2 (16%)	45.01	180.34	181.63	1.29	53.66	57.33
	NMNL-2 (15%)	42.2	180.34	181.59	1.25	51.31	56.7
	L (100%)	139.5	180.34	182.42	2.08	103.38	69.18
	L (30%)	41.85	180.34	181.58	1.24	51.03	56.63
	L (29%)	40.46	180.34	181.57	1.23	49.96	56.34
	L (28%)	39.06	180.34	181.55	1.21	48.9	56.05
	L (27%)	37.67	180.34	181.53	1.19	47.8	55.75
	L (26%)	36.27	180.34	181.51	1.17	46.7	55.44
	L (25%)	34.88	180.34	181.49	1.15	45.59	55.14
	L (24%)	33.48	180.34	181.47	1.13	44.44	54.82
	L (23%)	32.09	180.34	181.44	1.1	43.21	54.47
	L (22%)	30.69	180.34	181.42	1.08	41.94	54.12
	L (21%)	29.3	180.34	181.4	1.06	40.7	53.76
	L (20%)	27.9	180.34	181.37	1.03	39.38	53.39
	L (19%)	26.51	180.34	181.35	1.01	38.07	53.01
	L (18%)	25.11	180.34	181.32	0.98	36.73	52.62
	L (17%)	23.72	180.34	181.3	0.96	35.38	52.23
	L (16%)	22.32	180.34	181.27	0.93	34	51.82
	L (15%)	20.93	180.34	181.24	0.9	32.59	51.4
50 m d/s of Barrage axis	M (100%)	1007.5	180.21	185.31	5.1	446.96	132.24
	M (30%)	302.25	180.21	183.13	2.92	192.45	98.84
	M (29%)	292.18	180.21	183.09	2.88	188.24	98.25
	M (28%)	282.1	180.21	183.05	2.84	183.91	97.64
	M (27%)	272.03	180.21	183	2.79	179.56	97.03
	M (26%)	261.95	180.21	182.96	2.75	175.3	96.42
	M (25%)	251.88	180.21	182.91	2.7	171.02	95.8
	M (24%)	241.8	180.21	182.87	2.66	166.8	95.19
	M (23%)	231.73	180.21	182.82	2.61	162.51	94.57
	M (22%)	221.65	180.21	182.78	2.57	158.09	93.92
	M (21%)	211.58	180.21	182.73	2.52	153.77	93.28
	M (20%)	201.5	180.21	182.68	2.47	149.53	92.66
	M (19%)	191.43	180.21	182.64	2.43	145.08	91.99
	M (18%)	181.35	180.21	182.59	2.38	140.66	91.32
	M (17%)	171.28	180.21	182.54	2.33	136.1	90.63
	M (16%)	161.2	180.21	182.48	2.27	131.12	89.87

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (15%)	151.13	180.21	182.42	2.21	125.82	89.05
	NMNL-1 (100%)	272.33	180.21	183	2.79	179.69	97.04
	NMNL-1 (30%)	81.7	180.21	181.94	1.73	85.48	78.53
	NMNL-1 (29%)	78.98	180.21	181.92	1.71	83.67	77.95
	NMNL-1 (28%)	76.25	180.21	181.9	1.69	81.81	77.34
	NMNL-1 (27%)	73.53	180.21	181.87	1.66	79.98	76.74
	NMNL-1 (26%)	70.81	180.21	181.85	1.64	78.12	76.12
	NMNL-1 (25%)	68.08	180.21	181.82	1.61	76.22	75.49
	NMNL-1 (24%)	65.36	180.21	181.8	1.59	74.29	74.84
	NMNL-1 (23%)	62.64	180.21	181.77	1.56	72.3	74.16
	NMNL-1 (22%)	59.91	180.21	181.74	1.53	70.27	73.46
	NMNL-1 (21%)	57.19	180.21	181.72	1.51	68.21	72.75
	NMNL-1 (20%)	54.47	180.21	181.69	1.48	66.08	72
	NMNL-1 (19%)	51.74	180.21	181.66	1.45	63.87	71.22
	NMNL-1 (18%)	49.02	180.21	181.63	1.42	61.66	70.43
	NMNL-1 (17%)	46.3	180.21	181.59	1.38	59.32	69.58
	NMNL-1 (16%)	43.57	180.21	181.55	1.34	56.56	68.57
	NMNL-1 (15%)	40.85	180.21	181.51	1.3	53.9	67.58
	NMNL-2 (100%)	281.33	180.21	183.04	2.83	183.58	97.6
	NMNL-2 (30%)	84.4	180.21	181.97	1.76	87.26	79.11
	NMNL-2 (29%)	81.59	180.21	181.94	1.73	85.4	78.51
	NMNL-2 (28%)	78.77	180.21	181.92	1.71	83.52	77.9
	NMNL-2 (27%)	75.96	180.21	181.9	1.69	81.61	77.28
	NMNL-2 (26%)	73.15	180.21	181.87	1.66	79.72	76.65
	NMNL-2 (25%)	70.33	180.21	181.85	1.64	77.78	76.01
	NMNL-2 (24%)	67.52	180.21	181.82	1.61	75.82	75.35
	NMNL-2 (23%)	64.71	180.21	181.79	1.58	73.81	74.67
	NMNL-2 (22%)	61.89	180.21	181.76	1.55	71.74	73.97
	NMNL-2 (21%)	59.08	180.21	181.74	1.53	69.65	73.25
	NMNL-2 (20%)	56.27	180.21	181.71	1.5	67.52	72.51
	NMNL-2 (19%)	53.45	180.21	181.68	1.47	65.26	71.71
	NMNL-2 (18%)	50.64	180.21	181.64	1.43	62.99	70.91
	NMNL-2 (17%)	47.83	180.21	181.61	1.4	60.67	70.07
	NMNL-2 (16%)	45.01	180.21	181.57	1.36	58.07	69.13
	NMNL-2 (15%)	42.2	180.21	181.53	1.32	55.17	68.05
	L (100%)	139.5	180.21	182.35	2.14	119.71	88.1
	L (30%)	41.85	180.21	181.53	1.32	54.82	67.92
	L (29%)	40.46	180.21	181.51	1.3	53.54	67.44
	L (28%)	39.06	180.21	181.49	1.28	52.26	66.96
	L (27%)	37.67	180.21	181.47	1.26	50.94	66.46
	L (26%)	36.27	180.21	181.45	1.24	49.63	65.96
	L (25%)	34.88	180.21	181.43	1.22	48.31	65.45
	L (24%)	33.48	180.21	181.41	1.2	46.94	64.92
	L (23%)	32.09	180.21	181.38	1.17	45.45	64.33

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (22%)	30.69	180.21	181.36	1.15	43.92	63.7
	L (21%)	29.3	180.21	181.34	1.13	42.43	63.08
	L (20%)	27.9	180.21	181.31	1.1	40.84	62.41
	L (19%)	26.51	180.21	181.29	1.08	39.26	61.74
	L (18%)	25.11	180.21	181.26	1.05	37.67	61.06
	L (17%)	23.72	180.21	181.23	1.02	36.05	60.36
	L (16%)	22.32	180.21	181.21	1	34.41	59.63
	L (15%)	20.93	180.21	181.18	0.97	32.74	58.89
100 m d/s of Barrage axis	M (100%)	1007.5	180.07	185.34	5.27	669.35	239.72
	M (30%)	302.25	180.07	183.08	3.01	217.19	108.66
	M (29%)	292.18	180.07	183.03	2.96	212.54	107.95
	M (28%)	282.1	180.07	182.99	2.92	207.76	107.21
	M (27%)	272.03	180.07	182.95	2.88	202.98	106.46
	M (26%)	261.95	180.07	182.9	2.83	198.3	105.73
	M (25%)	251.88	180.07	182.86	2.79	193.61	104.99
	M (24%)	241.8	180.07	182.81	2.74	189.01	104.26
	M (23%)	231.73	180.07	182.77	2.7	184.32	103.51
	M (22%)	221.65	180.07	182.72	2.65	179.51	102.73
	M (21%)	211.58	180.07	182.68	2.61	174.84	101.97
	M (20%)	201.5	180.07	182.63	2.56	170.27	101.23
	M (19%)	191.43	180.07	182.58	2.51	165.46	100.44
	M (18%)	181.35	180.07	182.53	2.46	160.71	99.65
	M (17%)	171.28	180.07	182.49	2.42	155.81	98.83
	M (16%)	161.2	180.07	182.43	2.36	150.42	97.92
	M (15%)	151.13	180.07	182.37	2.3	144.67	96.93
	NMNL-1 (100%)	272.33	180.07	182.95	2.88	203.12	106.49
	NMNL-1 (30%)	81.7	180.07	181.9	1.83	100.48	89.02
	NMNL-1 (29%)	78.98	180.07	181.87	1.8	98.43	88.64
	NMNL-1 (28%)	76.25	180.07	181.85	1.78	96.32	88.24
	NMNL-1 (27%)	73.53	180.07	181.83	1.76	94.24	87.85
	NMNL-1 (26%)	70.81	180.07	181.8	1.73	92.13	87.45
	NMNL-1 (25%)	68.08	180.07	181.78	1.71	89.96	87.03
	NMNL-1 (24%)	65.36	180.07	181.75	1.68	87.74	86.55
	NMNL-1 (23%)	62.64	180.07	181.72	1.65	85.45	85.96
	NMNL-1 (22%)	59.91	180.07	181.7	1.63	83.11	85.37
	NMNL-1 (21%)	57.19	180.07	181.67	1.6	80.73	84.75
	NMNL-1 (20%)	54.47	180.07	181.64	1.57	78.29	84.12
	NMNL-1 (19%)	51.74	180.07	181.61	1.54	75.7	83.44
	NMNL-1 (18%)	49.02	180.07	181.58	1.51	73.09	82.75
	NMNL-1 (17%)	46.3	180.07	181.54	1.47	70.31	82.01
	NMNL-1 (16%)	43.57	180.07	181.5	1.43	66.98	80.85
	NMNL-1 (15%)	40.85	180.07	181.46	1.39	63.81	79.11
	NMNL-2 (100%)	281.33	180.07	182.99	2.92	207.4	107.15

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (30%)	84.4	180.07	181.92	1.85	102.49	89.4
	NMNL-2 (29%)	81.59	180.07	181.9	1.83	100.39	89.01
	NMNL-2 (28%)	78.77	180.07	181.87	1.8	98.26	88.61
	NMNL-2 (27%)	75.96	180.07	181.85	1.78	96.09	88.2
	NMNL-2 (26%)	73.15	180.07	181.82	1.75	93.95	87.79
	NMNL-2 (25%)	70.33	180.07	181.8	1.73	91.74	87.37
	NMNL-2 (24%)	67.52	180.07	181.77	1.7	89.51	86.95
	NMNL-2 (23%)	64.71	180.07	181.75	1.68	87.2	86.41
	NMNL-2 (22%)	61.89	180.07	181.72	1.65	84.8	85.8
	NMNL-2 (21%)	59.08	180.07	181.69	1.62	82.39	85.18
	NMNL-2 (20%)	56.27	180.07	181.66	1.59	79.93	84.54
	NMNL-2 (19%)	53.45	180.07	181.63	1.56	77.32	83.87
	NMNL-2 (18%)	50.64	180.07	181.6	1.53	74.65	83.16
	NMNL-2 (17%)	47.83	180.07	181.56	1.49	71.92	82.44
	NMNL-2 (16%)	45.01	180.07	181.53	1.46	68.81	81.61
	NMNL-2 (15%)	42.2	180.07	181.48	1.41	65.31	79.94
	L (100%)	139.5	180.07	182.3	2.23	138.07	95.79
	L (30%)	41.85	180.07	181.48	1.41	64.9	79.71
	L (29%)	40.46	180.07	181.46	1.39	63.4	78.88
	L (28%)	39.06	180.07	181.44	1.37	61.91	78.05
	L (27%)	37.67	180.07	181.42	1.35	60.38	77.19
	L (26%)	36.27	180.07	181.4	1.33	58.86	76.33
	L (25%)	34.88	180.07	181.38	1.31	57.34	75.94
	L (24%)	33.48	180.07	181.36	1.29	55.73	75.62
	L (23%)	32.09	180.07	181.34	1.27	53.95	75.15
	L (22%)	30.69	180.07	181.31	1.24	52.13	74.1
	L (21%)	29.3	180.07	181.29	1.22	50.37	73.07
	L (20%)	27.9	180.07	181.26	1.19	48.49	71.95
	L (19%)	26.51	180.07	181.24	1.17	46.64	70.84
	L (18%)	25.11	180.07	181.21	1.14	44.81	69.72
	L (17%)	23.72	180.07	181.18	1.11	42.95	68.56
	L (16%)	22.32	180.07	181.15	1.08	41.04	67.35
	L (15%)	20.93	180.07	181.13	1.06	39.12	66.12
150 m d/s of Barrage axis	M (100%)	1007.5	179.94	185.3	5.36	674.95	240.17
	M (30%)	302.25	179.94	182.95	3.01	182.18	128.93
	M (29%)	292.18	179.94	182.91	2.97	177	117.12
	M (28%)	282.1	179.94	182.87	2.93	172.21	105.09
	M (27%)	272.03	179.94	182.82	2.88	167.81	99.03
	M (26%)	261.95	179.94	182.78	2.84	163.67	95.52
	M (25%)	251.88	179.94	182.74	2.8	159.67	91.99
	M (24%)	241.8	179.94	182.7	2.76	155.89	88.52
	M (23%)	231.73	179.94	182.65	2.71	152.17	85.19
	M (22%)	221.65	179.94	182.61	2.67	148.59	82.16

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (21%)	211.58	179.94	182.57	2.63	145.16	80.95
	M (20%)	201.5	179.94	182.53	2.59	141.87	80.19
	M (19%)	191.43	179.94	182.48	2.54	138.4	79.37
	M (18%)	181.35	179.94	182.44	2.5	134.98	78.56
	M (17%)	171.28	179.94	182.4	2.46	131.47	77.72
	M (16%)	161.2	179.94	182.34	2.4	127.57	76.78
	M (15%)	151.13	179.94	182.29	2.35	123.35	75.73
	NMNL-1 (100%)	272.33	179.94	182.82	2.88	167.94	99.13
	NMNL-1 (30%)	81.7	179.94	181.84	1.9	91.35	67.2
	NMNL-1 (29%)	78.98	179.94	181.82	1.88	89.88	66.79
	NMNL-1 (28%)	76.25	179.94	181.8	1.86	88.37	66.35
	NMNL-1 (27%)	73.53	179.94	181.77	1.83	86.89	65.93
	NMNL-1 (26%)	70.81	179.94	181.75	1.81	85.38	65.49
	NMNL-1 (25%)	68.08	179.94	181.73	1.79	83.84	65.03
	NMNL-1 (24%)	65.36	179.94	181.7	1.76	82.27	64.56
	NMNL-1 (23%)	62.64	179.94	181.68	1.74	80.63	64.07
	NMNL-1 (22%)	59.91	179.94	181.65	1.71	78.97	63.57
	NMNL-1 (21%)	57.19	179.94	181.63	1.69	77.27	63.05
	NMNL-1 (20%)	54.47	179.94	181.6	1.66	75.52	62.51
	NMNL-1 (19%)	51.74	179.94	181.57	1.63	73.67	61.94
	NMNL-1 (18%)	49.02	179.94	181.54	1.6	71.81	61.35
	NMNL-1 (17%)	46.3	179.94	181.51	1.57	69.8	60.72
	NMNL-1 (16%)	43.57	179.94	181.46	1.52	67.36	59.93
	NMNL-1 (15%)	40.85	179.94	181.43	1.49	65.04	59.18
	NMNL-2 (100%)	281.33	179.94	182.86	2.92	171.88	104.24
	NMNL-2 (30%)	84.4	179.94	181.86	1.92	92.8	67.61
	NMNL-2 (29%)	81.59	179.94	181.84	1.9	91.29	67.19
	NMNL-2 (28%)	78.77	179.94	181.82	1.88	89.76	66.75
	NMNL-2 (27%)	75.96	179.94	181.79	1.85	88.21	66.31
	NMNL-2 (26%)	73.15	179.94	181.77	1.83	86.68	65.87
	NMNL-2 (25%)	70.33	179.94	181.75	1.81	85.11	65.41
	NMNL-2 (24%)	67.52	179.94	181.72	1.78	83.52	64.94
	NMNL-2 (23%)	64.71	179.94	181.7	1.76	81.88	64.45
	NMNL-2 (22%)	61.89	179.94	181.67	1.73	80.17	63.93
	NMNL-2 (21%)	59.08	179.94	181.64	1.7	78.45	63.41
	NMNL-2 (20%)	56.27	179.94	181.62	1.68	76.7	62.87
	NMNL-2 (19%)	53.45	179.94	181.59	1.65	74.83	62.3
	NMNL-2 (18%)	50.64	179.94	181.56	1.62	72.92	61.7
	NMNL-2 (17%)	47.83	179.94	181.52	1.58	70.96	61.09
	NMNL-2 (16%)	45.01	179.94	181.49	1.55	68.71	60.37
	NMNL-2 (15%)	42.2	179.94	181.44	1.5	66.13	59.54
	L (100%)	139.5	179.94	182.23	2.29	118.54	74.51
	L (30%)	41.85	179.94	181.44	1.5	65.82	59.44
	L (29%)	40.46	179.94	181.42	1.48	64.74	59.08

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (28%)	39.06	179.94	181.4	1.46	63.65	58.75
	L (27%)	37.67	179.94	181.38	1.44	62.53	58.47
	L (26%)	36.27	179.94	181.36	1.42	61.41	58.19
	L (25%)	34.88	179.94	181.34	1.4	60.28	57.91
	L (24%)	33.48	179.94	181.32	1.38	59.08	57.61
	L (23%)	32.09	179.94	181.3	1.36	57.74	57.27
	L (22%)	30.69	179.94	181.28	1.34	56.36	56.91
	L (21%)	29.3	179.94	181.25	1.31	55.01	56.57
	L (20%)	27.9	179.94	181.23	1.29	53.56	56.19
	L (19%)	26.51	179.94	181.2	1.26	52.1	55.81
	L (18%)	25.11	179.94	181.17	1.23	50.66	55.43
	L (17%)	23.72	179.94	181.15	1.21	49.17	55.04
	L (16%)	22.32	179.94	181.12	1.18	47.63	54.63
	L (15%)	20.93	179.94	181.09	1.15	46.05	54.21
200 m d/s of Barrage axis	M (100%)	1007.5	179.8	185.25	5.45	692.01	219.7
	M (30%)	302.25	179.8	182.89	3.09	208.26	175.95
	M (29%)	292.18	179.8	182.84	3.04	199.79	175.11
	M (28%)	282.1	179.8	182.79	2.99	191.06	174.23
	M (27%)	272.03	179.8	182.74	2.94	182.13	173.33
	M (26%)	261.95	179.8	182.69	2.89	173.4	172.45
	M (25%)	251.88	179.8	182.64	2.84	164.5	171.54
	M (24%)	241.8	179.8	182.59	2.79	155.7	170.59
	M (23%)	231.73	179.8	182.53	2.73	146.59	167.25
	M (22%)	221.65	179.8	182.48	2.68	137.95	159.5
	M (21%)	211.58	179.8	182.43	2.63	129.7	153.31
	M (20%)	201.5	179.8	182.38	2.58	122.12	147.42
	M (19%)	191.43	179.8	182.32	2.52	114.15	140.93
	M (18%)	181.35	179.8	182.27	2.47	106.86	132.12
	M (17%)	171.28	179.8	182.21	2.41	100.23	119.71
	M (16%)	161.2	179.8	182.15	2.35	93.48	105.53
	M (15%)	151.13	179.8	182.09	2.29	87.26	90.9
	NMNL-1 (100%)	272.33	179.8	182.74	2.94	182.39	173.36
	NMNL-1 (30%)	81.7	179.8	181.62	1.82	52.39	60.09
	NMNL-1 (29%)	78.98	179.8	181.6	1.8	51.18	58.68
	NMNL-1 (28%)	76.25	179.8	181.58	1.78	49.99	57.26
	NMNL-1 (27%)	73.53	179.8	181.56	1.76	48.8	55.81
	NMNL-1 (26%)	70.81	179.8	181.54	1.74	47.62	54.32
	NMNL-1 (25%)	68.08	179.8	181.52	1.72	46.43	52.79
	NMNL-1 (24%)	65.36	179.8	181.5	1.7	45.27	51.25
	NMNL-1 (23%)	62.64	179.8	181.47	1.67	44.12	49.67
	NMNL-1 (22%)	59.91	179.8	181.45	1.65	42.95	48.7
	NMNL-1 (21%)	57.19	179.8	181.43	1.63	41.79	48.02
	NMNL-1 (20%)	54.47	179.8	181.4	1.6	40.62	47.32

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (19%)	51.74	179.8	181.37	1.57	39.39	46.59
	NMNL-1 (18%)	49.02	179.8	181.35	1.55	38.14	45.87
	NMNL-1 (17%)	46.3	179.8	181.32	1.52	36.83	45.11
	NMNL-1 (16%)	43.57	179.8	181.29	1.49	35.49	44.31
	NMNL-1 (15%)	40.85	179.8	181.26	1.46	34.18	43.52
	NMNL-2 (100%)	281.33	179.8	182.79	2.99	190.42	174.17
	NMNL-2 (30%)	84.4	179.8	181.64	1.84	53.64	61.5
	NMNL-2 (29%)	81.59	179.8	181.62	1.82	52.34	60.03
	NMNL-2 (28%)	78.77	179.8	181.6	1.8	51.09	58.57
	NMNL-2 (27%)	75.96	179.8	181.58	1.78	49.86	57.1
	NMNL-2 (26%)	73.15	179.8	181.56	1.76	48.64	55.6
	NMNL-2 (25%)	70.33	179.8	181.54	1.74	47.41	54.05
	NMNL-2 (24%)	67.52	179.8	181.51	1.71	46.19	52.48
	NMNL-2 (23%)	64.71	179.8	181.49	1.69	44.99	50.87
	NMNL-2 (22%)	61.89	179.8	181.47	1.67	43.79	49.22
	NMNL-2 (21%)	59.08	179.8	181.44	1.64	42.6	48.5
	NMNL-2 (20%)	56.27	179.8	181.42	1.62	41.41	47.8
	NMNL-2 (19%)	53.45	179.8	181.39	1.59	40.16	47.05
	NMNL-2 (18%)	50.64	179.8	181.36	1.56	38.89	46.3
	NMNL-2 (17%)	47.83	179.8	181.34	1.54	37.57	45.54
	NMNL-2 (16%)	45.01	179.8	181.3	1.5	36.19	44.73
	NMNL-2 (15%)	42.2	179.8	181.27	1.47	34.84	43.92
	L (100%)	139.5	179.8	182.02	2.22	80.74	84.27
	L (30%)	41.85	179.8	181.27	1.47	34.68	43.82
	L (29%)	40.46	179.8	181.25	1.45	33.99	43.4
	L (28%)	39.06	179.8	181.24	1.44	33.3	42.98
	L (27%)	37.67	179.8	181.22	1.42	32.58	42.53
	L (26%)	36.27	179.8	181.2	1.4	31.85	42.06
	L (25%)	34.88	179.8	181.19	1.39	31.11	41.59
	L (24%)	33.48	179.8	181.17	1.37	30.3	41.06
	L (23%)	32.09	179.8	181.14	1.34	29.38	40.46
	L (22%)	30.69	179.8	181.12	1.32	28.4	39.81
	L (21%)	29.3	179.8	181.1	1.3	27.5	39.2
	L (20%)	27.9	179.8	181.07	1.27	26.56	38.55
	L (19%)	26.51	179.8	181.05	1.25	25.54	37.84
	L (18%)	25.11	179.8	181.02	1.22	24.56	37.15
	L (17%)	23.72	179.8	180.99	1.19	23.55	36.42
	L (16%)	22.32	179.8	180.96	1.16	22.48	35.67
	L (15%)	20.93	179.8	180.93	1.13	21.37	34.89
250 m d/s of Barrage axis	M (100%)	1007.5	179.66	185.25	5.59	812.61	215.87
	M (30%)	302.25	179.66	182.86	3.2	313.79	193.09
	M (29%)	292.18	179.66	182.8	3.14	304.05	192.5
	M (28%)	282.1	179.66	182.75	3.09	293.88	191.88

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (27%)	272.03	179.66	182.7	3.04	283.39	191.24
	M (26%)	261.95	179.66	182.64	2.98	273.07	190.61
	M (25%)	251.88	179.66	182.59	2.93	262.35	189.95
	M (24%)	241.8	179.66	182.53	2.87	251.52	188.27
	M (23%)	231.73	179.66	182.47	2.81	240.39	182.75
	M (22%)	221.65	179.66	182.41	2.75	229.49	179.6
	M (21%)	211.58	179.66	182.35	2.69	218.33	176.56
	M (20%)	201.5	179.66	182.28	2.62	207.51	173.56
	M (19%)	191.43	179.66	182.22	2.56	196.05	170.43
	M (18%)	181.35	179.66	182.15	2.49	184.84	169.07
	M (17%)	171.28	179.66	182.09	2.43	173.83	167.73
	M (16%)	161.2	179.66	182.02	2.36	162.49	166.31
	M (15%)	151.13	179.66	181.95	2.29	150.99	164.86
	NMNL-1 (100%)	272.33	179.66	182.7	3.04	283.7	191.26
	NMNL-1 (30%)	81.7	179.66	181.46	1.8	78.87	103.31
	NMNL-1 (29%)	78.98	179.66	181.43	1.77	76.75	101.44
	NMNL-1 (28%)	76.25	179.66	181.41	1.75	74.65	100.08
	NMNL-1 (27%)	73.53	179.66	181.39	1.73	72.55	98.69
	NMNL-1 (26%)	70.81	179.66	181.37	1.71	70.47	97.31
	NMNL-1 (25%)	68.08	179.66	181.35	1.69	68.37	95.89
	NMNL-1 (24%)	65.36	179.66	181.33	1.67	66.31	94.47
	NMNL-1 (23%)	62.64	179.66	181.31	1.65	64.25	93.03
	NMNL-1 (22%)	59.91	179.66	181.28	1.62	62.08	91.5
	NMNL-1 (21%)	57.19	179.66	181.26	1.6	59.94	89.96
	NMNL-1 (20%)	54.47	179.66	181.23	1.57	57.78	88.37
	NMNL-1 (19%)	51.74	179.66	181.21	1.55	55.57	86.73
	NMNL-1 (18%)	49.02	179.66	181.18	1.52	53.37	85.05
	NMNL-1 (17%)	46.3	179.66	181.16	1.5	51.15	83.36
	NMNL-1 (16%)	43.57	179.66	181.13	1.47	48.83	81.56
	NMNL-1 (15%)	40.85	179.66	181.1	1.44	46.53	79.73
	NMNL-2 (100%)	281.33	179.66	182.75	3.09	293.13	191.83
	NMNL-2 (30%)	84.4	179.66	181.48	1.82	81.08	107.79
	NMNL-2 (29%)	81.59	179.66	181.45	1.79	78.78	103.12
	NMNL-2 (28%)	78.77	179.66	181.43	1.77	76.59	101.34
	NMNL-2 (27%)	75.96	179.66	181.41	1.75	74.43	99.93
	NMNL-2 (26%)	73.15	179.66	181.39	1.73	72.25	98.5
	NMNL-2 (25%)	70.33	179.66	181.37	1.71	70.09	97.06
	NMNL-2 (24%)	67.52	179.66	181.35	1.69	67.95	95.6
	NMNL-2 (23%)	64.71	179.66	181.32	1.66	65.81	94.13
	NMNL-2 (22%)	61.89	179.66	181.3	1.64	63.65	92.62
	NMNL-2 (21%)	59.08	179.66	181.28	1.62	61.42	91.03
	NMNL-2 (20%)	56.27	179.66	181.25	1.59	59.22	89.43
	NMNL-2 (19%)	53.45	179.66	181.23	1.57	56.96	87.77
	NMNL-2 (18%)	50.64	179.66	181.2	1.54	54.69	86.06

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (17%)	47.83	179.66	181.17	1.51	52.42	84.33
	NMNL-2 (16%)	45.01	179.66	181.14	1.48	50.08	82.53
	NMNL-2 (15%)	42.2	179.66	181.12	1.46	47.7	80.66
	L (100%)	139.5	179.66	181.87	2.21	137.88	163.18
	L (30%)	41.85	179.66	181.11	1.45	47.4	80.42
	L (29%)	40.46	179.66	181.1	1.44	46.2	79.46
	L (28%)	39.06	179.66	181.08	1.42	45	78.49
	L (27%)	37.67	179.66	181.06	1.4	43.69	77.4
	L (26%)	36.27	179.66	181.05	1.39	42.44	76.36
	L (25%)	34.88	179.66	181.03	1.37	41.17	75.29
	L (24%)	33.48	179.66	181.01	1.35	39.76	73.36
	L (23%)	32.09	179.66	180.99	1.33	38.03	70.87
	L (22%)	30.69	179.66	180.96	1.3	36.37	68.4
	L (21%)	29.3	179.66	180.94	1.28	34.75	65.91
	L (20%)	27.9	179.66	180.92	1.26	33.11	62.94
	L (19%)	26.51	179.66	180.89	1.23	31.43	56.71
	L (18%)	25.11	179.66	180.86	1.2	29.9	54.97
	L (17%)	23.72	179.66	180.83	1.17	28.34	53.15
	L (16%)	22.32	179.66	180.8	1.14	26.77	51.24
	L (15%)	20.93	179.66	180.77	1.11	25.11	49.14
300 m d/s of Barrage axis	M (100%)	1007.5	179.53	185.23	5.7	847.34	194.46
	M (30%)	302.25	179.53	182.84	3.31	402.71	177.42
	M (29%)	292.18	179.53	182.79	3.26	393.74	177
	M (28%)	282.1	179.53	182.74	3.21	384.35	176.57
	M (27%)	272.03	179.53	182.68	3.15	374.65	176.12
	M (26%)	261.95	179.53	182.63	3.1	365.08	175.67
	M (25%)	251.88	179.53	182.57	3.04	355.14	175.21
	M (24%)	241.8	179.53	182.52	2.99	345.06	174.73
	M (23%)	231.73	179.53	182.46	2.93	334.5	174.24
	M (22%)	221.65	179.53	182.39	2.86	323.92	173.74
	M (21%)	211.58	179.53	182.33	2.8	312.9	173.22
	M (20%)	201.5	179.53	182.27	2.74	302.12	172.71
	M (19%)	191.43	179.53	182.2	2.67	290.46	172.15
	M (18%)	181.35	179.53	182.13	2.6	278.91	171.55
	M (17%)	171.28	179.53	182.07	2.54	267.54	170.95
	M (16%)	161.2	179.53	182	2.47	255.71	170.33
	M (15%)	151.13	179.53	181.93	2.4	243.61	169.69
	NMNL-1 (100%)	272.33	179.53	182.69	3.16	374.93	176.13
	NMNL-1 (30%)	81.7	179.53	181.41	1.88	157.41	161.43
	NMNL-1 (29%)	78.98	179.53	181.39	1.86	153.81	160.86
	NMNL-1 (28%)	76.25	179.53	181.36	1.83	150.17	160.28
	NMNL-1 (27%)	73.53	179.53	181.34	1.81	146.46	159.69
	NMNL-1 (26%)	70.81	179.53	181.32	1.79	142.75	159.1

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (25%)	68.08	179.53	181.29	1.76	138.92	158.48
	NMNL-1 (24%)	65.36	179.53	181.27	1.74	135.13	157.87
	NMNL-1 (23%)	62.64	179.53	181.25	1.72	131.32	157.25
	NMNL-1 (22%)	59.91	179.53	181.22	1.69	127.31	156.53
	NMNL-1 (21%)	57.19	179.53	181.19	1.66	123.33	155.76
	NMNL-1 (20%)	54.47	179.53	181.17	1.64	119.31	148.91
	NMNL-1 (19%)	51.74	179.53	181.14	1.61	115.36	143.29
	NMNL-1 (18%)	49.02	179.53	181.11	1.58	111.4	140.68
	NMNL-1 (17%)	46.3	179.53	181.08	1.55	107.26	137.89
	NMNL-1 (16%)	43.57	179.53	181.05	1.52	102.99	134.95
	NMNL-1 (15%)	40.85	179.53	181.02	1.49	98.65	131.91
	NMNL-2 (100%)	281.33	179.53	182.74	3.21	383.66	176.54
	NMNL-2 (30%)	84.4	179.53	181.43	1.9	160.97	161.99
	NMNL-2 (29%)	81.59	179.53	181.41	1.88	157.26	161.41
	NMNL-2 (28%)	78.77	179.53	181.39	1.86	153.53	160.82
	NMNL-2 (27%)	75.96	179.53	181.36	1.83	149.77	160.22
	NMNL-2 (26%)	73.15	179.53	181.34	1.81	145.94	159.61
	NMNL-2 (25%)	70.33	179.53	181.31	1.78	142.06	158.99
	NMNL-2 (24%)	67.52	179.53	181.29	1.76	138.15	158.36
	NMNL-2 (23%)	64.71	179.53	181.26	1.73	134.22	157.72
	NMNL-2 (22%)	61.89	179.53	181.24	1.71	130.22	157.07
	NMNL-2 (21%)	59.08	179.53	181.21	1.68	126.08	156.29
	NMNL-2 (20%)	56.27	179.53	181.19	1.66	121.98	155.49
	NMNL-2 (19%)	53.45	179.53	181.16	1.63	117.84	146.16
	NMNL-2 (18%)	50.64	179.53	181.13	1.6	113.78	142.25
	NMNL-2 (17%)	47.83	179.53	181.1	1.57	109.67	139.52
	NMNL-2 (16%)	45.01	179.53	181.07	1.54	105.25	136.51
	NMNL-2 (15%)	42.2	179.53	181.04	1.51	100.83	133.45
	L (100%)	139.5	179.53	181.84	2.31	229.65	168.95
	L (30%)	41.85	179.53	181.03	1.5	100.27	133.06
	L (29%)	40.46	179.53	181.02	1.49	98.03	131.46
	L (28%)	39.06	179.53	181	1.47	95.78	130.1
	L (27%)	37.67	179.53	180.98	1.45	93.55	128.76
	L (26%)	36.27	179.53	180.96	1.43	91.31	127.4
	L (25%)	34.88	179.53	180.95	1.42	89.02	126
	L (24%)	33.48	179.53	180.92	1.39	86.36	124.35
	L (23%)	32.09	179.53	180.9	1.37	83.44	122.51
	L (22%)	30.69	179.53	180.88	1.35	80.4	120.57
	L (21%)	29.3	179.53	180.85	1.32	77.54	118.71
	L (20%)	27.9	179.53	180.83	1.3	74.59	116.75
	L (19%)	26.51	179.53	180.8	1.27	71.6	114.74
	L (18%)	25.11	179.53	180.77	1.24	68.49	112.62
	L (17%)	23.72	179.53	180.74	1.21	65.25	110.35
	L (16%)	22.32	179.53	180.71	1.18	61.94	107.35

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (15%)	20.93	179.53	180.68	1.15	58.53	103.39
350 m d/s of Barrage axis	M (100%)	1007.5	179.4	185.2	5.8	791.44	190.07
	M (30%)	302.25	179.4	182.82	3.42	366.44	165.98
	M (29%)	292.18	179.4	182.77	3.37	358.06	165.41
	M (28%)	282.1	179.4	182.72	3.32	349.28	164.82
	M (27%)	272.03	179.4	182.66	3.26	340.22	164.21
	M (26%)	261.95	179.4	182.61	3.21	331.29	163.63
	M (25%)	251.88	179.4	182.55	3.15	322.01	163.07
	M (24%)	241.8	179.4	182.49	3.09	312.62	162.5
	M (23%)	231.73	179.4	182.43	3.03	302.78	161.91
	M (22%)	221.65	179.4	182.37	2.97	292.91	161.31
	M (21%)	211.58	179.4	182.31	2.91	282.63	160.68
	M (20%)	201.5	179.4	182.24	2.84	272.61	160.07
	M (19%)	191.43	179.4	182.18	2.78	261.73	159.4
	M (18%)	181.35	179.4	182.11	2.71	250.98	158.74
	M (17%)	171.28	179.4	182.04	2.64	240.4	158.08
	M (16%)	161.2	179.4	181.97	2.57	229.38	157.39
	M (15%)	151.13	179.4	181.9	2.5	218.11	156.69
	NMNL-1 (100%)	272.33	179.4	182.66	3.26	340.48	164.22
	NMNL-1 (30%)	81.7	179.4	181.38	1.98	138.21	147.55
	NMNL-1 (29%)	78.98	179.4	181.36	1.96	134.9	146.83
	NMNL-1 (28%)	76.25	179.4	181.33	1.93	131.57	146.1
	NMNL-1 (27%)	73.53	179.4	181.31	1.91	128.17	145.35
	NMNL-1 (26%)	70.81	179.4	181.29	1.89	124.77	144.6
	NMNL-1 (25%)	68.08	179.4	181.26	1.86	121.28	143.82
	NMNL-1 (24%)	65.36	179.4	181.24	1.84	117.83	143.05
	NMNL-1 (23%)	62.64	179.4	181.21	1.81	114.36	142.26
	NMNL-1 (22%)	59.91	179.4	181.19	1.79	110.71	141.44
	NMNL-1 (21%)	57.19	179.4	181.16	1.76	107.09	140.61
	NMNL-1 (20%)	54.47	179.4	181.14	1.74	103.41	139.72
	NMNL-1 (19%)	51.74	179.4	181.11	1.71	99.62	137.96
	NMNL-1 (18%)	49.02	179.4	181.08	1.68	95.86	133.52
	NMNL-1 (17%)	46.3	179.4	181.05	1.65	92.07	128.77
	NMNL-1 (16%)	43.57	179.4	181.02	1.62	88.19	124.63
	NMNL-1 (15%)	40.85	179.4	180.99	1.59	84.26	120.94
	NMNL-2 (100%)	281.33	179.4	182.71	3.31	348.64	164.78
	NMNL-2 (30%)	84.4	179.4	181.4	2	141.48	148.26
	NMNL-2 (29%)	81.59	179.4	181.38	1.98	138.07	147.52
	NMNL-2 (28%)	78.77	179.4	181.35	1.95	134.65	146.77
	NMNL-2 (27%)	75.96	179.4	181.33	1.93	131.2	146.02
	NMNL-2 (26%)	73.15	179.4	181.31	1.91	127.7	145.24
	NMNL-2 (25%)	70.33	179.4	181.28	1.88	124.15	144.46
	NMNL-2 (24%)	67.52	179.4	181.26	1.86	120.57	143.66

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (23%)	64.71	179.4	181.23	1.83	117	142.86
	NMNL-2 (22%)	61.89	179.4	181.21	1.81	113.36	142.04
	NMNL-2 (21%)	59.08	179.4	181.18	1.78	109.59	141.18
	NMNL-2 (20%)	56.27	179.4	181.15	1.75	105.85	140.33
	NMNL-2 (19%)	53.45	179.4	181.13	1.73	102.02	139.07
	NMNL-2 (18%)	50.64	179.4	181.1	1.7	98.1	136.25
	NMNL-2 (17%)	47.83	179.4	181.07	1.67	94.25	131.52
	NMNL-2 (16%)	45.01	179.4	181.04	1.64	90.25	126.5
	NMNL-2 (15%)	42.2	179.4	181.01	1.61	86.24	122.81
	L (100%)	139.5	179.4	181.82	2.42	205.12	155.86
	L (30%)	41.85	179.4	181	1.6	85.73	122.33
	L (29%)	40.46	179.4	180.99	1.59	83.7	120.4
	L (28%)	39.06	179.4	180.97	1.57	81.68	118.44
	L (27%)	37.67	179.4	180.95	1.55	79.69	116.49
	L (26%)	36.27	179.4	180.93	1.53	77.7	114.5
	L (25%)	34.88	179.4	180.92	1.52	75.69	112.45
	L (24%)	33.48	179.4	180.9	1.5	73.33	109.99
	L (23%)	32.09	179.4	180.87	1.47	70.74	107.33
	L (22%)	30.69	179.4	180.85	1.45	68.06	104.56
	L (21%)	29.3	179.4	180.82	1.42	65.6	101.93
	L (20%)	27.9	179.4	180.8	1.4	63.07	99.15
	L (19%)	26.51	179.4	180.77	1.37	60.53	96.27
	L (18%)	25.11	179.4	180.74	1.34	57.95	93.25
	L (17%)	23.72	179.4	180.71	1.31	55.25	90.44
	L (16%)	22.32	179.4	180.68	1.28	52.53	87.53
	L (15%)	20.93	179.4	180.65	1.25	49.72	84.41
400 m d/s of Barrage axis	M (100%)	1007.5	179.26	185.19	5.93	798.72	183.33
	M (30%)	302.25	179.26	182.8	3.54	377.11	167.13
	M (29%)	292.18	179.26	182.75	3.49	368.66	166.3
	M (28%)	282.1	179.26	182.7	3.44	359.81	165.42
	M (27%)	272.03	179.26	182.64	3.38	350.69	164.51
	M (26%)	261.95	179.26	182.59	3.33	341.73	163.61
	M (25%)	251.88	179.26	182.53	3.27	332.43	162.67
	M (24%)	241.8	179.26	182.47	3.21	323.03	161.7
	M (23%)	231.73	179.26	182.41	3.15	313.2	160.68
	M (22%)	221.65	179.26	182.35	3.09	303.38	159.64
	M (21%)	211.58	179.26	182.29	3.03	293.17	158.56
	M (20%)	201.5	179.26	182.22	2.96	283.24	157.5
	M (19%)	191.43	179.26	182.16	2.9	272.48	156.35
	M (18%)	181.35	179.26	182.09	2.83	261.88	155.2
	M (17%)	171.28	179.26	182.02	2.76	251.49	154.07
	M (16%)	161.2	179.26	181.95	2.69	240.7	152.88
	M (15%)	151.13	179.26	181.88	2.62	229.69	151.66

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (100%)	272.33	179.26	182.64	3.38	350.95	164.53
	NMNL-1 (30%)	81.7	179.26	181.35	2.09	154.06	133.76
	NMNL-1 (29%)	78.98	179.26	181.33	2.07	151.07	133.09
	NMNL-1 (28%)	76.25	179.26	181.31	2.05	148.07	132.41
	NMNL-1 (27%)	73.53	179.26	181.29	2.03	145.02	131.72
	NMNL-1 (26%)	70.81	179.26	181.26	2	141.96	131.03
	NMNL-1 (25%)	68.08	179.26	181.24	1.98	138.8	130.31
	NMNL-1 (24%)	65.36	179.26	181.22	1.96	135.7	129.59
	NMNL-1 (23%)	62.64	179.26	181.19	1.93	132.57	128.87
	NMNL-1 (22%)	59.91	179.26	181.17	1.91	129.28	128.1
	NMNL-1 (21%)	57.19	179.26	181.14	1.88	126.02	127.34
	NMNL-1 (20%)	54.47	179.26	181.11	1.85	122.7	126.56
	NMNL-1 (19%)	51.74	179.26	181.09	1.83	119.31	125.76
	NMNL-1 (18%)	49.02	179.26	181.06	1.8	115.87	124.8
	NMNL-1 (17%)	46.3	179.26	181.03	1.77	112.34	123.72
	NMNL-1 (16%)	43.57	179.26	181	1.74	108.63	121.85
	NMNL-1 (15%)	40.85	179.26	180.97	1.71	104.83	119.82
	NMNL-2 (100%)	281.33	179.26	182.69	3.43	359.17	165.35
	NMNL-2 (30%)	84.4	179.26	181.38	2.12	157.01	134.42
	NMNL-2 (29%)	81.59	179.26	181.35	2.09	153.93	133.73
	NMNL-2 (28%)	78.77	179.26	181.33	2.07	150.84	133.04
	NMNL-2 (27%)	75.96	179.26	181.31	2.05	147.74	132.34
	NMNL-2 (26%)	73.15	179.26	181.28	2.02	144.6	131.63
	NMNL-2 (25%)	70.33	179.26	181.26	2	141.4	130.9
	NMNL-2 (24%)	67.52	179.26	181.23	1.97	138.17	130.16
	NMNL-2 (23%)	64.71	179.26	181.21	1.95	134.95	129.42
	NMNL-2 (22%)	61.89	179.26	181.18	1.92	131.67	128.66
	NMNL-2 (21%)	59.08	179.26	181.16	1.9	128.27	127.87
	NMNL-2 (20%)	56.27	179.26	181.13	1.87	124.91	127.08
	NMNL-2 (19%)	53.45	179.26	181.1	1.84	121.45	126.26
	NMNL-2 (18%)	50.64	179.26	181.08	1.82	117.93	125.43
	NMNL-2 (17%)	47.83	179.26	181.05	1.79	114.38	124.35
	NMNL-2 (16%)	45.01	179.26	181.02	1.76	110.59	122.88
	NMNL-2 (15%)	42.2	179.26	180.99	1.73	106.74	120.85
	L (100%)	139.5	179.26	181.79	2.53	217.04	150.23
	L (30%)	41.85	179.26	180.98	1.72	106.26	120.59
	L (29%)	40.46	179.26	180.96	1.7	104.28	119.52
	L (28%)	39.06	179.26	180.95	1.69	102.32	118.46
	L (27%)	37.67	179.26	180.93	1.67	100.37	117.39
	L (26%)	36.27	179.26	180.92	1.66	98.43	114.24
	L (25%)	34.88	179.26	180.9	1.64	96.5	110.89
	L (24%)	33.48	179.26	180.88	1.62	94.23	106.83
	L (23%)	32.09	179.26	180.85	1.59	91.79	102.26
	L (22%)	30.69	179.26	180.83	1.57	89.3	97.36

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (21%)	29.3	179.26	180.81	1.55	87.11	93.26
	L (20%)	27.9	179.26	180.78	1.52	84.85	91.94
	L (19%)	26.51	179.26	180.76	1.5	82.54	90.59
	L (18%)	25.11	179.26	180.73	1.47	80.13	89.15
	L (17%)	23.72	179.26	180.7	1.44	77.61	87.62
	L (16%)	22.32	179.26	180.67	1.41	74.98	86
	L (15%)	20.93	179.26	180.64	1.38	72.25	84.28
450 m d/s of Barrage axis	M (100%)	1007.5	179.13	185.15	6.02	747.05	176.45
	M (30%)	302.25	179.13	182.78	3.65	364.68	146.48
	M (29%)	292.18	179.13	182.73	3.6	357.31	145.87
	M (28%)	282.1	179.13	182.68	3.55	349.59	145.24
	M (27%)	272.03	179.13	182.62	3.49	341.6	144.58
	M (26%)	261.95	179.13	182.57	3.44	333.76	143.92
	M (25%)	251.88	179.13	182.51	3.38	325.6	143.24
	M (24%)	241.8	179.13	182.46	3.33	317.35	142.54
	M (23%)	231.73	179.13	182.39	3.26	308.71	141.73
	M (22%)	221.65	179.13	182.33	3.2	300.07	140.92
	M (21%)	211.58	179.13	182.27	3.14	291.06	140.07
	M (20%)	201.5	179.13	182.21	3.08	282.32	139.23
	M (19%)	191.43	179.13	182.14	3.01	272.8	138.32
	M (18%)	181.35	179.13	182.07	2.94	263.44	137.39
	M (17%)	171.28	179.13	182	2.87	254.27	136.43
	M (16%)	161.2	179.13	181.93	2.8	244.73	135.44
	M (15%)	151.13	179.13	181.86	2.73	234.99	134.41
	NMNL-1 (100%)	272.33	179.13	182.63	3.5	341.83	144.6
	NMNL-1 (30%)	81.7	179.13	181.34	2.21	167.36	124.55
	NMNL-1 (29%)	78.98	179.13	181.32	2.19	164.61	124.02
	NMNL-1 (28%)	76.25	179.13	181.3	2.17	161.85	123.49
	NMNL-1 (27%)	73.53	179.13	181.27	2.14	159.05	122.94
	NMNL-1 (26%)	70.81	179.13	181.25	2.12	156.22	122.29
	NMNL-1 (25%)	68.08	179.13	181.23	2.1	153.32	121.42
	NMNL-1 (24%)	65.36	179.13	181.2	2.07	150.47	120.57
	NMNL-1 (23%)	62.64	179.13	181.18	2.05	147.6	119.7
	NMNL-1 (22%)	59.91	179.13	181.15	2.02	144.59	118.78
	NMNL-1 (21%)	57.19	179.13	181.13	2	141.62	117.86
	NMNL-1 (20%)	54.47	179.13	181.1	1.97	138.6	116.93
	NMNL-1 (19%)	51.74	179.13	181.08	1.95	135.51	115.96
	NMNL-1 (18%)	49.02	179.13	181.05	1.92	132.39	114.98
	NMNL-1 (17%)	46.3	179.13	181.02	1.89	129.18	113.96
	NMNL-1 (16%)	43.57	179.13	180.99	1.86	125.88	108.39
	NMNL-1 (15%)	40.85	179.13	180.96	1.83	122.68	99.01
	NMNL-2 (100%)	281.33	179.13	182.68	3.55	349.03	145.19
	NMNL-2 (30%)	84.4	179.13	181.36	2.23	170.08	125.07

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (29%)	81.59	179.13	181.34	2.21	167.24	124.53
	NMNL-2 (28%)	78.77	179.13	181.32	2.19	164.39	123.98
	NMNL-2 (27%)	75.96	179.13	181.29	2.16	161.55	123.43
	NMNL-2 (26%)	73.15	179.13	181.27	2.14	158.66	122.86
	NMNL-2 (25%)	70.33	179.13	181.25	2.12	155.71	122.14
	NMNL-2 (24%)	67.52	179.13	181.22	2.09	152.74	121.25
	NMNL-2 (23%)	64.71	179.13	181.2	2.07	149.78	120.36
	NMNL-2 (22%)	61.89	179.13	181.17	2.04	146.79	119.45
	NMNL-2 (21%)	59.08	179.13	181.15	2.02	143.67	118.5
	NMNL-2 (20%)	56.27	179.13	181.12	1.99	140.6	117.55
	NMNL-2 (19%)	53.45	179.13	181.09	1.96	137.45	116.57
	NMNL-2 (18%)	50.64	179.13	181.07	1.94	134.26	115.57
	NMNL-2 (17%)	47.83	179.13	181.04	1.91	131.04	114.55
	NMNL-2 (16%)	45.01	179.13	181.01	1.88	127.61	111.36
	NMNL-2 (15%)	42.2	179.13	180.98	1.85	124.26	104.14
	L (100%)	139.5	179.13	181.78	2.65	223.81	133.22
	L (30%)	41.85	179.13	180.97	1.84	123.85	102.83
	L (29%)	40.46	179.13	180.96	1.83	122.23	97.52
	L (28%)	39.06	179.13	180.94	1.81	120.67	96.08
	L (27%)	37.67	179.13	180.92	1.79	119.12	95.57
	L (26%)	36.27	179.13	180.91	1.78	117.56	95.06
	L (25%)	34.88	179.13	180.89	1.76	115.97	94.53
	L (24%)	33.48	179.13	180.87	1.74	114.05	93.89
	L (23%)	32.09	179.13	180.85	1.72	111.89	93.16
	L (22%)	30.69	179.13	180.82	1.69	109.6	92.39
	L (21%)	29.3	179.13	180.8	1.67	107.5	91.67
	L (20%)	27.9	179.13	180.78	1.65	105.28	90.91
	L (19%)	26.51	179.13	180.75	1.62	103.01	90.12
	L (18%)	25.11	179.13	180.72	1.59	100.62	89.28
	L (17%)	23.72	179.13	180.7	1.57	98.1	88.4
	L (16%)	22.32	179.13	180.67	1.54	95.45	87.52
	L (15%)	20.93	179.13	180.63	1.5	92.67	86.58
500 m d/s of Barrage axis	M (100%)	1007.5	178.99	185.07	6.08	587.66	133
	M (30%)	302.25	178.99	182.74	3.75	299.42	114.72
	M (29%)	292.18	178.99	182.69	3.7	293.72	114.3
	M (28%)	282.1	178.99	182.64	3.65	287.73	113.85
	M (27%)	272.03	178.99	182.59	3.6	281.52	113.35
	M (26%)	261.95	178.99	182.53	3.54	275.45	112.83
	M (25%)	251.88	178.99	182.48	3.49	269.12	112.29
	M (24%)	241.8	178.99	182.42	3.43	262.72	111.74
	M (23%)	231.73	178.99	182.36	3.37	256	111.16
	M (22%)	221.65	178.99	182.3	3.31	249.28	110.58
	M (21%)	211.58	178.99	182.23	3.24	242.28	109.97

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (20%)	201.5	178.99	182.17	3.18	235.48	109.38
	M (19%)	191.43	178.99	182.1	3.11	228.05	108.72
	M (18%)	181.35	178.99	182.04	3.05	220.76	108.08
	M (17%)	171.28	178.99	181.97	2.98	213.61	107.44
	M (16%)	161.2	178.99	181.9	2.91	206.17	106.77
	M (15%)	151.13	178.99	181.83	2.84	198.56	106.07
	NMNL-1 (100%)	272.33	178.99	182.59	3.6	281.7	113.36
	NMNL-1 (30%)	81.7	178.99	181.32	2.33	147.7	85.9
	NMNL-1 (29%)	78.98	178.99	181.3	2.31	145.86	85.61
	NMNL-1 (28%)	76.25	178.99	181.28	2.29	144.01	85.32
	NMNL-1 (27%)	73.53	178.99	181.25	2.26	142.13	85.03
	NMNL-1 (26%)	70.81	178.99	181.23	2.24	140.25	84.73
	NMNL-1 (25%)	68.08	178.99	181.21	2.22	138.31	84.42
	NMNL-1 (24%)	65.36	178.99	181.19	2.2	136.38	84.12
	NMNL-1 (23%)	62.64	178.99	181.16	2.17	134.44	83.81
	NMNL-1 (22%)	59.91	178.99	181.14	2.15	132.4	83.48
	NMNL-1 (21%)	57.19	178.99	181.11	2.12	130.37	83.16
	NMNL-1 (20%)	54.47	178.99	181.09	2.1	128.29	82.82
	NMNL-1 (19%)	51.74	178.99	181.06	2.07	126.16	82.48
	NMNL-1 (18%)	49.02	178.99	181.04	2.05	124.01	82.13
	NMNL-1 (17%)	46.3	178.99	181.01	2.02	121.77	81.75
	NMNL-1 (16%)	43.57	178.99	180.98	1.99	119.42	81.34
	NMNL-1 (15%)	40.85	178.99	180.95	1.96	116.98	80.91
	NMNL-2 (100%)	281.33	178.99	182.64	3.65	287.29	113.81
	NMNL-2 (30%)	84.4	178.99	181.34	2.35	149.51	86.18
	NMNL-2 (29%)	81.59	178.99	181.32	2.33	147.62	85.89
	NMNL-2 (28%)	78.77	178.99	181.3	2.31	145.72	85.59
	NMNL-2 (27%)	75.96	178.99	181.27	2.28	143.81	85.29
	NMNL-2 (26%)	73.15	178.99	181.25	2.26	141.87	84.99
	NMNL-2 (25%)	70.33	178.99	181.23	2.24	139.91	84.68
	NMNL-2 (24%)	67.52	178.99	181.2	2.21	137.91	84.36
	NMNL-2 (23%)	64.71	178.99	181.18	2.19	135.91	84.04
	NMNL-2 (22%)	61.89	178.99	181.16	2.17	133.88	83.72
	NMNL-2 (21%)	59.08	178.99	181.13	2.14	131.77	83.38
	NMNL-2 (20%)	56.27	178.99	181.11	2.12	129.67	83.04
	NMNL-2 (19%)	53.45	178.99	181.08	2.09	127.51	82.69
	NMNL-2 (18%)	50.64	178.99	181.05	2.06	125.3	82.34
	NMNL-2 (17%)	47.83	178.99	181.03	2.04	123.07	81.97
	NMNL-2 (16%)	45.01	178.99	181	2.01	120.67	81.56
	NMNL-2 (15%)	42.2	178.99	180.97	1.98	118.21	81.12
	L (100%)	139.5	178.99	181.75	2.76	189.85	105.16
	L (30%)	41.85	178.99	180.96	1.97	117.9	81.07
	L (29%)	40.46	178.99	180.95	1.96	116.63	80.84
	L (28%)	39.06	178.99	180.93	1.94	115.35	80.62

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (27%)	37.67	178.99	180.92	1.93	114.07	80.39
	L (26%)	36.27	178.99	180.9	1.91	112.79	80.16
	L (25%)	34.88	178.99	180.88	1.89	111.48	79.93
	L (24%)	33.48	178.99	180.86	1.87	109.87	79.64
	L (23%)	32.09	178.99	180.84	1.85	108.06	79.31
	L (22%)	30.69	178.99	180.82	1.83	106.12	78.96
	L (21%)	29.3	178.99	180.79	1.8	104.34	78.64
	L (20%)	27.9	178.99	180.77	1.78	102.46	78.29
	L (19%)	26.51	178.99	180.74	1.75	100.52	77.98
	L (18%)	25.11	178.99	180.72	1.73	98.47	77.68
	L (17%)	23.72	178.99	180.69	1.7	96.29	77.36
	L (16%)	22.32	178.99	180.66	1.67	93.98	77.02
	L (15%)	20.93	178.99	180.63	1.64	91.54	76.66
550 m d/s of Barrage axis	M (100%)	1007.5	178.86	184.84	5.98	410.92	116.56
	M (30%)	302.25	178.86	182.55	3.69	162.33	96.12
	M (29%)	292.18	178.86	182.5	3.64	157.61	91.22
	M (28%)	282.1	178.86	182.45	3.59	153.25	83.44
	M (27%)	272.03	178.86	182.39	3.53	148.76	82.36
	M (26%)	261.95	178.86	182.34	3.48	144.47	81.32
	M (25%)	251.88	178.86	182.28	3.42	139.98	80.21
	M (24%)	241.8	178.86	182.23	3.37	135.51	79.09
	M (23%)	231.73	178.86	182.17	3.31	131.07	78.38
	M (22%)	221.65	178.86	182.11	3.25	126.4	77.81
	M (21%)	211.58	178.86	182.05	3.19	121.5	77.21
	M (20%)	201.5	178.86	181.99	3.13	116.81	76.63
	M (19%)	191.43	178.86	181.92	3.06	111.77	76
	M (18%)	181.35	178.86	181.86	3	106.71	75.37
	M (17%)	171.28	178.86	181.79	2.93	101.84	74.75
	M (16%)	161.2	178.86	181.72	2.86	96.73	74.1
	M (15%)	151.13	178.86	181.65	2.79	91.59	73.44
	NMNL-1 (100%)	272.33	178.86	182.39	3.53	148.88	82.39
	NMNL-1 (30%)	81.7	178.86	181.17	2.31	57.51	68.87
	NMNL-1 (29%)	78.98	178.86	181.15	2.29	56.19	68.69
	NMNL-1 (28%)	76.25	178.86	181.13	2.27	54.86	68.5
	NMNL-1 (27%)	73.53	178.86	181.11	2.25	53.51	68.31
	NMNL-1 (26%)	70.81	178.86	181.1	2.24	52.17	68.12
	NMNL-1 (25%)	68.08	178.86	181.07	2.21	50.79	67.93
	NMNL-1 (24%)	65.36	178.86	181.05	2.19	49.41	67.73
	NMNL-1 (23%)	62.64	178.86	181.03	2.17	48.04	67.54
	NMNL-1 (22%)	59.91	178.86	181.01	2.15	46.56	67.33
	NMNL-1 (21%)	57.19	178.86	180.99	2.13	45.11	67.12
	NMNL-1 (20%)	54.47	178.86	180.97	2.11	43.61	66.91
	NMNL-1 (19%)	51.74	178.86	180.95	2.09	42.07	66.69

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (18%)	49.02	178.86	180.92	2.06	40.53	66.46
	NMNL-1 (17%)	46.3	178.86	180.9	2.04	38.9	66.23
	NMNL-1 (16%)	43.57	178.86	180.87	2.01	37.14	65.97
	NMNL-1 (15%)	40.85	178.86	180.84	1.98	35.3	65.7
	NMNL-2 (100%)	281.33	178.86	182.44	3.58	152.94	83.37
	NMNL-2 (30%)	84.4	178.86	181.19	2.33	58.81	69.05
	NMNL-2 (29%)	81.59	178.86	181.17	2.31	57.45	68.86
	NMNL-2 (28%)	78.77	178.86	181.15	2.29	56.09	68.67
	NMNL-2 (27%)	75.96	178.86	181.13	2.27	54.72	68.48
	NMNL-2 (26%)	73.15	178.86	181.11	2.25	53.32	68.28
	NMNL-2 (25%)	70.33	178.86	181.09	2.23	51.92	68.09
	NMNL-2 (24%)	67.52	178.86	181.07	2.21	50.5	67.89
	NMNL-2 (23%)	64.71	178.86	181.05	2.19	49.08	67.69
	NMNL-2 (22%)	61.89	178.86	181.03	2.17	47.64	67.48
	NMNL-2 (21%)	59.08	178.86	181.01	2.15	46.11	67.26
	NMNL-2 (20%)	56.27	178.86	180.98	2.12	44.6	67.05
	NMNL-2 (19%)	53.45	178.86	180.96	2.1	43.04	66.83
	NMNL-2 (18%)	50.64	178.86	180.94	2.08	41.45	66.6
	NMNL-2 (17%)	47.83	178.86	180.91	2.05	39.86	66.37
	NMNL-2 (16%)	45.01	178.86	180.88	2.02	38.07	66.11
	NMNL-2 (15%)	42.2	178.86	180.86	2	36.23	65.84
	L (100%)	139.5	178.86	181.57	2.71	85.69	72.67
	L (30%)	41.85	178.86	180.85	1.99	36	65.81
	L (29%)	40.46	178.86	180.84	1.98	35.03	65.66
	L (28%)	39.06	178.86	180.82	1.96	34.06	65.52
	L (27%)	37.67	178.86	180.81	1.95	33.1	65.38
	L (26%)	36.27	178.86	180.79	1.93	32.14	65.24
	L (25%)	34.88	178.86	180.78	1.92	31.14	65.09
	L (24%)	33.48	178.86	180.76	1.9	29.76	63.99
	L (23%)	32.09	178.86	180.73	1.87	28.17	60.89
	L (22%)	30.69	178.86	180.7	1.84	26.53	57.5
	L (21%)	29.3	178.86	180.68	1.82	25.19	54.58
	L (20%)	27.9	178.86	180.66	1.8	23.83	51.46
	L (19%)	26.51	178.86	180.63	1.77	22.51	48.22
	L (18%)	25.11	178.86	180.6	1.74	21.2	44.79
	L (17%)	23.72	178.86	180.57	1.71	19.91	41.21
	L (16%)	22.32	178.86	180.54	1.68	18.63	37.83
	L (15%)	20.93	178.86	180.5	1.64	17.39	34.47
600 m d/s of Barrage axis	M (100%)	1007.5	178.71	184.79	6.08	443.98	122.72
	M (30%)	302.25	178.71	182.43	3.72	173.62	104.19
	M (29%)	292.18	178.71	182.38	3.67	168.21	103.13
	M (28%)	282.1	178.71	182.32	3.61	162.77	102.04
	M (27%)	272.03	178.71	182.27	3.56	157.26	100.94

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (26%)	261.95	178.71	182.22	3.51	151.74	99.82
	M (25%)	251.88	178.71	182.16	3.45	146.09	98.66
	M (24%)	241.8	178.71	182.1	3.39	140.46	97.49
	M (23%)	231.73	178.71	182.04	3.33	134.74	95.92
	M (22%)	221.65	178.71	181.98	3.27	129.01	93.3
	M (21%)	211.58	178.71	181.92	3.21	123.41	78.82
	M (20%)	201.5	178.71	181.85	3.14	118.53	75.84
	M (19%)	191.43	178.71	181.78	3.07	113.2	75.02
	M (18%)	181.35	178.71	181.71	3	107.83	74.19
	M (17%)	171.28	178.71	181.64	2.93	102.64	73.37
	M (16%)	161.2	178.71	181.56	2.85	97.06	72.48
	M (15%)	151.13	178.71	181.49	2.78	91.37	71.57
	NMNL-1 (100%)	272.33	178.71	182.27	3.56	157.43	100.97
	NMNL-1 (30%)	81.7	178.71	180.92	2.21	52.66	61.44
	NMNL-1 (29%)	78.98	178.71	180.89	2.18	51.29	60.46
	NMNL-1 (28%)	76.25	178.71	180.87	2.16	49.96	59.5
	NMNL-1 (27%)	73.53	178.71	180.85	2.14	48.65	58.53
	NMNL-1 (26%)	70.81	178.71	180.83	2.12	47.32	57.53
	NMNL-1 (25%)	68.08	178.71	180.8	2.09	46.02	56.55
	NMNL-1 (24%)	65.36	178.71	180.78	2.07	44.78	55.58
	NMNL-1 (23%)	62.64	178.71	180.76	2.05	43.56	54.62
	NMNL-1 (22%)	59.91	178.71	180.74	2.03	42.36	53.7
	NMNL-1 (21%)	57.19	178.71	180.71	2	41.19	52.85
	NMNL-1 (20%)	54.47	178.71	180.69	1.98	39.98	51.96
	NMNL-1 (19%)	51.74	178.71	180.67	1.96	38.71	51
	NMNL-1 (18%)	49.02	178.71	180.64	1.93	37.46	50.04
	NMNL-1 (17%)	46.3	178.71	180.61	1.9	36.11	48.99
	NMNL-1 (16%)	43.57	178.71	180.59	1.88	34.72	47.88
	NMNL-1 (15%)	40.85	178.71	180.55	1.84	33.15	46.59
	NMNL-2 (100%)	281.33	178.71	182.32	3.61	162.34	101.96
	NMNL-2 (30%)	84.4	178.71	180.94	2.23	54.05	62.42
	NMNL-2 (29%)	81.59	178.71	180.91	2.2	52.6	61.4
	NMNL-2 (28%)	78.77	178.71	180.89	2.18	51.18	60.39
	NMNL-2 (27%)	75.96	178.71	180.87	2.16	49.82	59.4
	NMNL-2 (26%)	73.15	178.71	180.84	2.13	48.46	58.39
	NMNL-2 (25%)	70.33	178.71	180.82	2.11	47.09	57.36
	NMNL-2 (24%)	67.52	178.71	180.8	2.09	45.76	56.35
	NMNL-2 (23%)	64.71	178.71	180.78	2.07	44.48	55.35
	NMNL-2 (22%)	61.89	178.71	180.75	2.04	43.23	54.35
	NMNL-2 (21%)	59.08	178.71	180.73	2.02	42	53.44
	NMNL-2 (20%)	56.27	178.71	180.71	2	40.77	52.54
	NMNL-2 (19%)	53.45	178.71	180.68	1.97	39.51	51.61
	NMNL-2 (18%)	50.64	178.71	180.66	1.95	38.2	50.61
	NMNL-2 (17%)	47.83	178.71	180.63	1.92	36.89	49.6

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (16%)	45.01	178.71	180.6	1.89	35.45	48.46
	NMNL-2 (15%)	42.2	178.71	180.57	1.86	34	47.3
	L (100%)	139.5	178.71	181.39	2.68	84.75	70.49
	L (30%)	41.85	178.71	180.57	1.86	33.8	47.13
	L (29%)	40.46	178.71	180.55	1.84	32.9	46.39
	L (28%)	39.06	178.71	180.53	1.82	32	45.63
	L (27%)	37.67	178.71	180.51	1.8	31.17	44.92
	L (26%)	36.27	178.71	180.49	1.78	30.38	44.24
	L (25%)	34.88	178.71	180.47	1.76	29.59	43.54
	L (24%)	33.48	178.71	180.45	1.74	28.77	42.81
	L (23%)	32.09	178.71	180.44	1.73	27.95	42.06
	L (22%)	30.69	178.71	180.41	1.7	27.11	41.28
	L (21%)	29.3	178.71	180.39	1.68	26.26	40.47
	L (20%)	27.9	178.71	180.37	1.66	25.42	39.66
	L (19%)	26.51	178.71	180.35	1.64	24.56	38.81
	L (18%)	25.11	178.71	180.33	1.62	23.68	37.92
	L (17%)	23.72	178.71	180.3	1.59	22.78	37
	L (16%)	22.32	178.71	180.28	1.57	21.86	36.04
	L (15%)	20.93	178.71	180.25	1.54	20.93	35.04
650 m d/s of Barrage axis	M (100%)	1007.5	178.59	184.77	6.18	517.03	137
	M (30%)	302.25	178.59	182.37	3.78	210.46	114.8
	M (29%)	292.18	178.59	182.31	3.72	204.19	114.15
	M (28%)	282.1	178.59	182.26	3.67	197.82	113.48
	M (27%)	272.03	178.59	182.2	3.61	191.34	112.8
	M (26%)	261.95	178.59	182.14	3.55	184.72	112.1
	M (25%)	251.88	178.59	182.08	3.49	177.94	111.38
	M (24%)	241.8	178.59	182.02	3.43	171.07	110.74
	M (23%)	231.73	178.59	181.95	3.36	164.04	110.14
	M (22%)	221.65	178.59	181.89	3.3	156.85	109.52
	M (21%)	211.58	178.59	181.82	3.23	149.5	107.56
	M (20%)	201.5	178.59	181.75	3.16	142.04	105.45
	M (19%)	191.43	178.59	181.68	3.09	134.56	103.23
	M (18%)	181.35	178.59	181.6	3.01	126.95	100.81
	M (17%)	171.28	178.59	181.53	2.94	119.31	98.31
	M (16%)	161.2	178.59	181.45	2.86	111.61	95.72
	M (15%)	151.13	178.59	181.37	2.78	103.9	93.06
	NMNL-1 (100%)	272.33	178.59	182.2	3.61	191.53	112.82
	NMNL-1 (30%)	81.7	178.59	180.69	2.1	55.64	63.91
	NMNL-1 (29%)	78.98	178.59	180.66	2.07	53.63	63.46
	NMNL-1 (28%)	76.25	178.59	180.62	2.03	51.58	62.99
	NMNL-1 (27%)	73.53	178.59	180.59	2	49.52	62.52
	NMNL-1 (26%)	70.81	178.59	180.56	1.97	47.44	62.04
	NMNL-1 (25%)	68.08	178.59	180.52	1.93	45.33	61.54

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (24%)	65.36	178.59	180.49	1.9	43.25	61.06
	NMNL-1 (23%)	62.64	178.59	180.45	1.86	41.11	60.55
	NMNL-1 (22%)	59.91	178.59	180.42	1.83	38.98	60.04
	NMNL-1 (21%)	57.19	178.59	180.38	1.79	36.84	59.48
	NMNL-1 (20%)	54.47	178.59	180.34	1.75	34.67	57.1
	NMNL-1 (19%)	51.74	178.59	180.31	1.72	32.59	54.71
	NMNL-1 (18%)	49.02	178.59	180.27	1.68	30.58	52.31
	NMNL-1 (17%)	46.3	178.59	180.23	1.64	28.66	50.1
	NMNL-1 (16%)	43.57	178.59	180.2	1.61	26.88	48.43
	NMNL-1 (15%)	40.85	178.59	180.16	1.57	25.18	46.78
	NMNL-2 (100%)	281.33	178.59	182.25	3.66	197.33	113.43
	NMNL-2 (30%)	84.4	178.59	180.72	2.13	57.61	64.35
	NMNL-2 (29%)	81.59	178.59	180.69	2.1	55.56	63.89
	NMNL-2 (28%)	78.77	178.59	180.65	2.06	53.47	63.42
	NMNL-2 (27%)	75.96	178.59	180.62	2.03	51.37	62.94
	NMNL-2 (26%)	73.15	178.59	180.59	2	49.23	62.45
	NMNL-2 (25%)	70.33	178.59	180.55	1.96	47.07	61.95
	NMNL-2 (24%)	67.52	178.59	180.52	1.93	44.9	61.44
	NMNL-2 (23%)	64.71	178.59	180.48	1.89	42.73	60.93
	NMNL-2 (22%)	61.89	178.59	180.44	1.85	40.52	60.41
	NMNL-2 (21%)	59.08	178.59	180.41	1.82	38.33	59.89
	NMNL-2 (20%)	56.27	178.59	180.37	1.78	36.07	58.65
	NMNL-2 (19%)	53.45	178.59	180.33	1.74	33.89	56.21
	NMNL-2 (18%)	50.64	178.59	180.29	1.7	31.78	53.76
	NMNL-2 (17%)	47.83	178.59	180.25	1.66	29.71	51.23
	NMNL-2 (16%)	45.01	178.59	180.22	1.63	27.79	49.29
	NMNL-2 (15%)	42.2	178.59	180.18	1.59	26	47.59
	L (100%)	139.5	178.59	181.26	2.67	94.96	72.27
	L (30%)	41.85	178.59	180.17	1.58	25.79	47.38
	L (29%)	40.46	178.59	180.16	1.57	24.97	46.57
	L (28%)	39.06	178.59	180.14	1.55	24.17	45.76
	L (27%)	37.67	178.59	180.12	1.53	23.27	44.85
	L (26%)	36.27	178.59	180.1	1.51	22.38	43.92
	L (25%)	34.88	178.59	180.08	1.49	21.51	43
	L (24%)	33.48	178.59	180.06	1.47	20.67	42.08
	L (23%)	32.09	178.59	180.04	1.45	19.9	41.23
	L (22%)	30.69	178.59	180.02	1.43	19.15	40.38
	L (21%)	29.3	178.59	180	1.41	18.44	39.59
	L (20%)	27.9	178.59	179.99	1.4	17.74	38.78
	L (19%)	26.51	178.59	179.97	1.38	17.06	37.99
	L (18%)	25.11	178.59	179.95	1.36	16.38	37.07
	L (17%)	23.72	178.59	179.93	1.34	15.66	36.08
	L (16%)	22.32	178.59	179.91	1.32	14.95	35.07
	L (15%)	20.93	178.59	179.89	1.3	14.26	34.06

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
700 m d/s of Barrage axis	M (100%)	1007.5	178.45	184.79	6.34	649.05	149.09
	M (30%)	302.25	178.45	182.37	3.92	317.29	125.66
	M (29%)	292.18	178.45	182.31	3.86	310.38	125.18
	M (28%)	282.1	178.45	182.25	3.8	303.33	124.69
	M (27%)	272.03	178.45	182.2	3.75	296.14	124.18
	M (26%)	261.95	178.45	182.14	3.69	288.79	123.67
	M (25%)	251.88	178.45	182.08	3.63	281.22	123.29
	M (24%)	241.8	178.45	182.01	3.56	273.53	122.9
	M (23%)	231.73	178.45	181.95	3.5	265.63	122.49
	M (22%)	221.65	178.45	181.88	3.43	257.52	122.08
	M (21%)	211.58	178.45	181.81	3.36	249.16	121.65
	M (20%)	201.5	178.45	181.74	3.29	240.51	121.2
	M (19%)	191.43	178.45	181.67	3.22	231.67	120.74
	M (18%)	181.35	178.45	181.59	3.14	222.52	120.27
	M (17%)	171.28	178.45	181.52	3.07	213.1	119.77
	M (16%)	161.2	178.45	181.43	2.98	203.38	119.26
	M (15%)	151.13	178.45	181.35	2.9	193.4	118.74
	NMNL-1 (100%)	272.33	178.45	182.2	3.75	296.36	124.2
	NMNL-1 (30%)	81.7	178.45	180.66	2.21	113.36	104.12
	NMNL-1 (29%)	78.98	178.45	180.62	2.17	109.98	101.6
	NMNL-1 (28%)	76.25	178.45	180.59	2.14	106.6	99.01
	NMNL-1 (27%)	73.53	178.45	180.56	2.11	103.27	96.39
	NMNL-1 (26%)	70.81	178.45	180.52	2.07	99.95	93.71
	NMNL-1 (25%)	68.08	178.45	180.49	2.04	96.65	90.99
	NMNL-1 (24%)	65.36	178.45	180.45	2	93.37	88.21
	NMNL-1 (23%)	62.64	178.45	180.41	1.96	90.12	85.36
	NMNL-1 (22%)	59.91	178.45	180.37	1.92	86.89	82.28
	NMNL-1 (21%)	57.19	178.45	180.33	1.88	83.79	75.21
	NMNL-1 (20%)	54.47	178.45	180.29	1.84	80.97	67.3
	NMNL-1 (19%)	51.74	178.45	180.25	1.8	78.2	66.5
	NMNL-1 (18%)	49.02	178.45	180.21	1.76	75.37	65.67
	NMNL-1 (17%)	46.3	178.45	180.16	1.71	72.45	64.8
	NMNL-1 (16%)	43.57	178.45	180.12	1.67	69.48	63.91
	NMNL-1 (15%)	40.85	178.45	180.07	1.62	66.4	62.96
	NMNL-2 (100%)	281.33	178.45	182.25	3.8	302.79	124.65
	NMNL-2 (30%)	84.4	178.45	180.69	2.24	116.74	106.59
	NMNL-2 (29%)	81.59	178.45	180.66	2.21	113.22	104.02
	NMNL-2 (28%)	78.77	178.45	180.62	2.17	109.72	101.4
	NMNL-2 (27%)	75.96	178.45	180.59	2.14	106.24	98.74
	NMNL-2 (26%)	73.15	178.45	180.55	2.1	102.8	96.01
	NMNL-2 (25%)	70.33	178.45	180.52	2.07	99.37	93.23
	NMNL-2 (24%)	67.52	178.45	180.48	2.03	95.98	90.43
	NMNL-2 (23%)	64.71	178.45	180.44	1.99	92.59	87.53

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (22%)	61.89	178.45	180.4	1.95	89.23	84.56
	NMNL-2 (21%)	59.08	178.45	180.36	1.91	85.92	80.14
	NMNL-2 (20%)	56.27	178.45	180.32	1.87	82.78	69.9
	NMNL-2 (19%)	53.45	178.45	180.28	1.83	79.94	67
	NMNL-2 (18%)	50.64	178.45	180.24	1.79	77.09	66.17
	NMNL-2 (17%)	47.83	178.45	180.19	1.74	74.08	65.29
	NMNL-2 (16%)	45.01	178.45	180.14	1.69	71.06	64.38
	NMNL-2 (15%)	42.2	178.45	180.09	1.64	67.93	63.43
	L (100%)	139.5	178.45	181.25	2.8	181.45	118.11
	L (30%)	41.85	178.45	180.09	1.64	67.53	63.31
	L (29%)	40.46	178.45	180.06	1.61	65.95	62.82
	L (28%)	39.06	178.45	180.04	1.59	64.32	62.33
	L (27%)	37.67	178.45	180.01	1.56	62.69	61.83
	L (26%)	36.27	178.45	179.98	1.53	61.01	61.31
	L (25%)	34.88	178.45	179.96	1.51	59.32	60.78
	L (24%)	33.48	178.45	179.93	1.48	57.61	60.24
	L (23%)	32.09	178.45	179.9	1.45	55.86	59.68
	L (22%)	30.69	178.45	179.87	1.42	54.08	59.11
	L (21%)	29.3	178.45	179.84	1.39	52.28	58.52
	L (20%)	27.9	178.45	179.81	1.36	50.41	57.91
	L (19%)	26.51	178.45	179.77	1.32	48.52	57.28
	L (18%)	25.11	178.45	179.74	1.29	46.58	56.64
	L (17%)	23.72	178.45	179.7	1.25	44.61	55.99
	L (16%)	22.32	178.45	179.67	1.22	42.57	55.31
	L (15%)	20.93	178.45	179.63	1.18	40.43	54.59
750 m d/s of Barrage axis	M (100%)	1007.5	178.32	184.77	6.45	651.42	141.09
	M (30%)	302.25	178.32	182.35	4.03	340.83	118.8
	M (29%)	292.18	178.32	182.3	3.98	334.3	118.35
	M (28%)	282.1	178.32	182.24	3.92	327.66	117.89
	M (27%)	272.03	178.32	182.18	3.86	320.88	117.41
	M (26%)	261.95	178.32	182.12	3.8	313.93	116.93
	M (25%)	251.88	178.32	182.06	3.74	306.79	116.42
	M (24%)	241.8	178.32	182	3.68	299.54	115.91
	M (23%)	231.73	178.32	181.94	3.62	292.11	115.38
	M (22%)	221.65	178.32	181.87	3.55	284.47	114.84
	M (21%)	211.58	178.32	181.8	3.48	276.62	114.28
	M (20%)	201.5	178.32	181.73	3.41	268.5	113.69
	M (19%)	191.43	178.32	181.66	3.34	260.21	113.09
	M (18%)	181.35	178.32	181.58	3.26	251.64	112.46
	M (17%)	171.28	178.32	181.5	3.18	242.83	111.82
	M (16%)	161.2	178.32	181.42	3.1	233.75	111.14
	M (15%)	151.13	178.32	181.34	3.02	224.45	110.45
	NMNL-1 (100%)	272.33	178.32	182.19	3.87	321.08	117.43

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (30%)	81.7	178.32	180.64	2.32	149.55	104.68
	NMNL-1 (29%)	78.98	178.32	180.61	2.29	146.09	104.41
	NMNL-1 (28%)	76.25	178.32	180.57	2.25	142.55	104.13
	NMNL-1 (27%)	73.53	178.32	180.54	2.22	138.99	103.84
	NMNL-1 (26%)	70.81	178.32	180.5	2.18	135.36	103.55
	NMNL-1 (25%)	68.08	178.32	180.47	2.15	131.65	103.25
	NMNL-1 (24%)	65.36	178.32	180.43	2.11	127.88	102.95
	NMNL-1 (23%)	62.64	178.32	180.39	2.07	124.02	102.63
	NMNL-1 (22%)	59.91	178.32	180.36	2.04	120.09	102.31
	NMNL-1 (21%)	57.19	178.32	180.32	2	116.1	101.99
	NMNL-1 (20%)	54.47	178.32	180.28	1.96	112.03	100.6
	NMNL-1 (19%)	51.74	178.32	180.24	1.92	107.91	98.18
	NMNL-1 (18%)	49.02	178.32	180.19	1.87	103.8	95.78
	NMNL-1 (17%)	46.3	178.32	180.15	1.83	99.62	93.49
	NMNL-1 (16%)	43.57	178.32	180.1	1.78	95.37	91.1
	NMNL-1 (15%)	40.85	178.32	180.05	1.73	91.07	87
	NMNL-2 (100%)	281.33	178.32	182.24	3.92	327.14	117.85
	NMNL-2 (30%)	84.4	178.32	180.67	2.35	152.93	104.95
	NMNL-2 (29%)	81.59	178.32	180.64	2.32	149.4	104.67
	NMNL-2 (28%)	78.77	178.32	180.61	2.29	145.81	104.39
	NMNL-2 (27%)	75.96	178.32	180.57	2.25	142.18	104.1
	NMNL-2 (26%)	73.15	178.32	180.53	2.21	138.48	103.8
	NMNL-2 (25%)	70.33	178.32	180.5	2.18	134.71	103.5
	NMNL-2 (24%)	67.52	178.32	180.46	2.14	130.88	103.19
	NMNL-2 (23%)	64.71	178.32	180.42	2.1	126.96	102.87
	NMNL-2 (22%)	61.89	178.32	180.38	2.06	122.95	102.55
	NMNL-2 (21%)	59.08	178.32	180.34	2.02	118.88	102.22
	NMNL-2 (20%)	56.27	178.32	180.3	1.98	114.73	101.88
	NMNL-2 (19%)	53.45	178.32	180.26	1.94	110.49	99.7
	NMNL-2 (18%)	50.64	178.32	180.22	1.9	106.28	97.2
	NMNL-2 (17%)	47.83	178.32	180.17	1.85	101.98	94.79
	NMNL-2 (16%)	45.01	178.32	180.13	1.81	97.62	92.38
	NMNL-2 (15%)	42.2	178.32	180.08	1.76	93.19	89.12
	L (100%)	139.5	178.32	181.24	2.92	213.32	109.62
	L (30%)	41.85	178.32	180.07	1.75	92.64	88.57
	L (29%)	40.46	178.32	180.05	1.73	90.45	86.37
	L (28%)	39.06	178.32	180.02	1.7	88.24	84.48
	L (27%)	37.67	178.32	180	1.68	86.05	82.76
	L (26%)	36.27	178.32	179.97	1.65	83.82	80.97
	L (25%)	34.88	178.32	179.94	1.62	81.61	79.57
	L (24%)	33.48	178.32	179.91	1.59	79.37	78.42
	L (23%)	32.09	178.32	179.88	1.56	77.11	77.24
	L (22%)	30.69	178.32	179.85	1.53	74.81	76.01
	L (21%)	29.3	178.32	179.82	1.5	72.49	74.76

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (20%)	27.9	178.32	179.79	1.47	70.12	72.41
	L (19%)	26.51	178.32	179.76	1.44	67.78	69.83
	L (18%)	25.11	178.32	179.72	1.4	65.43	68.51
	L (17%)	23.72	178.32	179.69	1.37	63.04	67.52
	L (16%)	22.32	178.32	179.65	1.33	60.57	66.49
	L (15%)	20.93	178.32	179.61	1.29	57.99	65.39
800 m d/s of Barrage axis	M (100%)	1007.5	178.18	184.72	6.54	611.24	131.12
	M (30%)	302.25	178.18	182.33	4.15	321.23	110.71
	M (29%)	292.18	178.18	182.28	4.1	315.19	110.23
	M (28%)	282.1	178.18	182.22	4.04	309.04	109.73
	M (27%)	272.03	178.18	182.16	3.98	302.76	109.21
	M (26%)	261.95	178.18	182.1	3.92	296.34	108.69
	M (25%)	251.88	178.18	182.04	3.86	289.74	108.14
	M (24%)	241.8	178.18	181.98	3.8	283.04	107.59
	M (23%)	231.73	178.18	181.92	3.74	276.18	107.02
	M (22%)	221.65	178.18	181.85	3.67	269.14	106.43
	M (21%)	211.58	178.18	181.78	3.6	261.89	105.82
	M (20%)	201.5	178.18	181.71	3.53	254.4	105.18
	M (19%)	191.43	178.18	181.64	3.46	246.77	104.53
	M (18%)	181.35	178.18	181.56	3.38	238.88	103.85
	M (17%)	171.28	178.18	181.48	3.3	230.77	103.15
	M (16%)	161.2	178.18	181.4	3.22	222.43	102.43
	M (15%)	151.13	178.18	181.32	3.14	213.89	101.68
	NMNL-1 (100%)	272.33	178.18	182.16	3.98	302.95	109.23
	NMNL-1 (30%)	81.7	178.18	180.62	2.44	147.03	86.56
	NMNL-1 (29%)	78.98	178.18	180.59	2.41	144.2	85.8
	NMNL-1 (28%)	76.25	178.18	180.56	2.38	141.32	85.02
	NMNL-1 (27%)	73.53	178.18	180.52	2.34	138.44	84.23
	NMNL-1 (26%)	70.81	178.18	180.49	2.31	135.52	83.43
	NMNL-1 (25%)	68.08	178.18	180.45	2.27	132.57	82.6
	NMNL-1 (24%)	65.36	178.18	180.42	2.24	129.58	81.76
	NMNL-1 (23%)	62.64	178.18	180.38	2.2	126.56	80.9
	NMNL-1 (22%)	59.91	178.18	180.34	2.16	123.5	80.15
	NMNL-1 (21%)	57.19	178.18	180.3	2.12	120.42	79.41
	NMNL-1 (20%)	54.47	178.18	180.26	2.08	117.28	78.65
	NMNL-1 (19%)	51.74	178.18	180.22	2.04	114.07	77.86
	NMNL-1 (18%)	49.02	178.18	180.18	2	110.83	77.03
	NMNL-1 (17%)	46.3	178.18	180.14	1.96	107.48	76.17
	NMNL-1 (16%)	43.57	178.18	180.09	1.91	104.02	75.27
	NMNL-1 (15%)	40.85	178.18	180.04	1.86	100.45	74.32
	NMNL-2 (100%)	281.33	178.18	182.21	4.03	308.56	109.69
	NMNL-2 (30%)	84.4	178.18	180.66	2.48	149.83	87.31
	NMNL-2 (29%)	81.59	178.18	180.62	2.44	146.92	86.53

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (28%)	78.77	178.18	180.59	2.41	143.98	85.74
	NMNL-2 (27%)	75.96	178.18	180.55	2.37	141.02	84.94
	NMNL-2 (26%)	73.15	178.18	180.52	2.34	138.03	84.12
	NMNL-2 (25%)	70.33	178.18	180.48	2.3	135.01	83.28
	NMNL-2 (24%)	67.52	178.18	180.45	2.27	131.96	82.43
	NMNL-2 (23%)	64.71	178.18	180.41	2.23	128.86	81.56
	NMNL-2 (22%)	61.89	178.18	180.37	2.19	125.72	80.68
	NMNL-2 (21%)	59.08	178.18	180.33	2.15	122.57	79.93
	NMNL-2 (20%)	56.27	178.18	180.29	2.11	119.36	79.16
	NMNL-2 (19%)	53.45	178.18	180.25	2.07	116.09	78.36
	NMNL-2 (18%)	50.64	178.18	180.21	2.03	112.79	77.53
	NMNL-2 (17%)	47.83	178.18	180.16	1.98	109.38	76.66
	NMNL-2 (16%)	45.01	178.18	180.12	1.94	105.86	75.75
	NMNL-2 (15%)	42.2	178.18	180.07	1.89	102.23	74.8
	L (100%)	139.5	178.18	181.22	3.04	203.67	100.78
	L (30%)	41.85	178.18	180.06	1.88	101.77	74.67
	L (29%)	40.46	178.18	180.04	1.86	99.92	74.19
	L (28%)	39.06	178.18	180.01	1.83	98.03	73.68
	L (27%)	37.67	178.18	179.98	1.8	96.11	73.27
	L (26%)	36.27	178.18	179.96	1.78	94.14	72.85
	L (25%)	34.88	178.18	179.93	1.75	92.15	72.43
	L (24%)	33.48	178.18	179.9	1.72	90.12	72
	L (23%)	32.09	178.18	179.87	1.69	88.05	71.56
	L (22%)	30.69	178.18	179.84	1.66	85.92	71.1
	L (21%)	29.3	178.18	179.81	1.63	83.76	70.63
	L (20%)	27.9	178.18	179.78	1.6	81.51	70.14
	L (19%)	26.51	178.18	179.75	1.57	79.22	69.64
	L (18%)	25.11	178.18	179.71	1.53	76.86	69.11
	L (17%)	23.72	178.18	179.68	1.5	74.45	68.58
	L (16%)	22.32	178.18	179.64	1.46	71.94	68.01
	L (15%)	20.93	178.18	179.6	1.42	69.3	67.41
850 m d/s of Barrage axis	M (100%)	1007.5	178.04	184.59	6.55	484.74	125.63
	M (30%)	302.25	178.04	182.24	4.2	220.98	97.42
	M (29%)	292.18	178.04	182.19	4.15	215.74	96.77
	M (28%)	282.1	178.04	182.14	4.1	210.4	96.12
	M (27%)	272.03	178.04	182.08	4.04	204.97	95.48
	M (26%)	261.95	178.04	182.02	3.98	199.42	94.81
	M (25%)	251.88	178.04	181.96	3.92	193.72	94.16
	M (24%)	241.8	178.04	181.9	3.86	187.94	93.53
	M (23%)	231.73	178.04	181.83	3.79	182.02	92.87
	M (22%)	221.65	178.04	181.77	3.73	175.96	92.2
	M (21%)	211.58	178.04	181.7	3.66	169.71	91.5
	M (20%)	201.5	178.04	181.63	3.59	163.25	90.77

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (19%)	191.43	178.04	181.56	3.52	156.68	90.02
	M (18%)	181.35	178.04	181.48	3.44	149.88	89.24
	M (17%)	171.28	178.04	181.4	3.36	142.91	88.43
	M (16%)	161.2	178.04	181.32	3.28	135.72	87.59
	M (15%)	151.13	178.04	181.24	3.2	128.39	86.61
	NMNL-1 (100%)	272.33	178.04	182.08	4.04	205.14	95.5
	NMNL-1 (30%)	81.7	178.04	180.53	2.49	72.01	67.89
	NMNL-1 (29%)	78.98	178.04	180.5	2.46	69.8	66.33
	NMNL-1 (28%)	76.25	178.04	180.47	2.43	67.58	64.93
	NMNL-1 (27%)	73.53	178.04	180.43	2.39	65.39	63.61
	NMNL-1 (26%)	70.81	178.04	180.4	2.36	63.2	62.25
	NMNL-1 (25%)	68.08	178.04	180.36	2.32	61.01	60.87
	NMNL-1 (24%)	65.36	178.04	180.32	2.28	58.84	59.46
	NMNL-1 (23%)	62.64	178.04	180.29	2.25	56.66	58.02
	NMNL-1 (22%)	59.91	178.04	180.25	2.21	54.5	56.55
	NMNL-1 (21%)	57.19	178.04	180.21	2.17	52.37	55.07
	NMNL-1 (20%)	54.47	178.04	180.17	2.13	50.24	53.54
	NMNL-1 (19%)	51.74	178.04	180.13	2.09	48.1	51.97
	NMNL-1 (18%)	49.02	178.04	180.09	2.05	46	50.37
	NMNL-1 (17%)	46.3	178.04	180.05	2.01	43.87	48.69
	NMNL-1 (16%)	43.57	178.04	180	1.96	41.72	46.94
	NMNL-1 (15%)	40.85	178.04	179.96	1.92	39.55	45.11
	NMNL-2 (100%)	281.33	178.04	182.13	4.09	209.99	96.07
	NMNL-2 (30%)	84.4	178.04	180.56	2.52	74.22	69.42
	NMNL-2 (29%)	81.59	178.04	180.53	2.49	71.92	67.83
	NMNL-2 (28%)	78.77	178.04	180.5	2.46	69.62	66.21
	NMNL-2 (27%)	75.96	178.04	180.46	2.42	67.35	64.79
	NMNL-2 (26%)	73.15	178.04	180.43	2.39	65.09	63.42
	NMNL-2 (25%)	70.33	178.04	180.39	2.35	62.82	62.01
	NMNL-2 (24%)	67.52	178.04	180.35	2.31	60.56	60.58
	NMNL-2 (23%)	64.71	178.04	180.32	2.28	58.32	59.12
	NMNL-2 (22%)	61.89	178.04	180.28	2.24	56.06	57.62
	NMNL-2 (21%)	59.08	178.04	180.24	2.2	53.85	56.1
	NMNL-2 (20%)	56.27	178.04	180.2	2.16	51.65	54.55
	NMNL-2 (19%)	53.45	178.04	180.16	2.12	49.44	52.96
	NMNL-2 (18%)	50.64	178.04	180.12	2.08	47.27	51.34
	NMNL-2 (17%)	47.83	178.04	180.07	2.03	45.07	49.64
	NMNL-2 (16%)	45.01	178.04	180.03	1.99	42.86	47.87
	NMNL-2 (15%)	42.2	178.04	179.98	1.94	40.62	46.02
	L (100%)	139.5	178.04	181.14	3.1	119.64	85.21
	L (30%)	41.85	178.04	179.97	1.93	40.34	45.78
	L (29%)	40.46	178.04	179.95	1.91	39.24	44.84
	L (28%)	39.06	178.04	179.92	1.88	38.12	43.85
	L (27%)	37.67	178.04	179.9	1.86	37.01	42.85

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (26%)	36.27	178.04	179.87	1.83	35.89	41.82
	L (25%)	34.88	178.04	179.84	1.8	34.78	40.78
	L (24%)	33.48	178.04	179.82	1.78	33.67	39.71
	L (23%)	32.09	178.04	179.79	1.75	32.57	38.61
	L (22%)	30.69	178.04	179.76	1.72	31.46	37.47
	L (21%)	29.3	178.04	179.73	1.69	30.36	36.28
	L (20%)	27.9	178.04	179.7	1.66	29.25	34.9
	L (19%)	26.51	178.04	179.67	1.63	28.16	33.68
	L (18%)	25.11	178.04	179.63	1.59	27.06	32.92
	L (17%)	23.72	178.04	179.6	1.56	25.95	32.13
	L (16%)	22.32	178.04	179.56	1.52	24.81	31.31
	L (15%)	20.93	178.04	179.53	1.49	23.63	30.44
900 m d/s of Barrage axis	M (100%)	1007.5	177.92	183.28	5.36	200.84	78.69
	M (30%)	302.25	177.92	181.26	3.34	74.4	44.54
	M (29%)	292.18	177.92	181.21	3.29	72.26	43.66
	M (28%)	282.1	177.92	181.16	3.24	70.1	42.75
	M (27%)	272.03	177.92	181.11	3.19	67.92	41.82
	M (26%)	261.95	177.92	181.05	3.13	65.73	40.86
	M (25%)	251.88	177.92	181	3.08	63.66	39.93
	M (24%)	241.8	177.92	180.95	3.03	61.41	38.9
	M (23%)	231.73	177.92	180.89	2.97	59.14	37.83
	M (22%)	221.65	177.92	180.82	2.9	56.84	36.72
	M (21%)	211.58	177.92	180.76	2.84	54.53	35.56
	M (20%)	201.5	177.92	180.7	2.78	52.25	34.38
	M (19%)	191.43	177.92	180.62	2.7	49.86	33.49
	M (18%)	181.35	177.92	180.56	2.64	47.73	32.84
	M (17%)	171.28	177.92	180.5	2.58	45.69	32.22
	M (16%)	161.2	177.92	180.44	2.52	43.72	31.6
	M (15%)	151.13	177.92	180.37	2.45	41.58	30.91
	NMNL-1 (100%)	272.33	177.92	181.11	3.19	67.99	41.85
	NMNL-1 (30%)	81.7	177.92	179.89	1.97	27.93	26.1
	NMNL-1 (29%)	78.98	177.92	179.87	1.95	27.41	25.9
	NMNL-1 (28%)	76.25	177.92	179.85	1.93	26.88	25.69
	NMNL-1 (27%)	73.53	177.92	179.83	1.91	26.35	25.5
	NMNL-1 (26%)	70.81	177.92	179.81	1.89	25.8	25.3
	NMNL-1 (25%)	68.08	177.92	179.78	1.86	25.25	25.1
	NMNL-1 (24%)	65.36	177.92	179.76	1.84	24.68	24.89
	NMNL-1 (23%)	62.64	177.92	179.74	1.82	24.1	24.68
	NMNL-1 (22%)	59.91	177.92	179.71	1.79	23.51	24.46
	NMNL-1 (21%)	57.19	177.92	179.69	1.77	22.91	24.23
	NMNL-1 (20%)	54.47	177.92	179.66	1.74	22.29	23.95
	NMNL-1 (19%)	51.74	177.92	179.64	1.72	21.66	23.62
	NMNL-1 (18%)	49.02	177.92	179.61	1.69	21	23.28

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (17%)	46.3	177.92	179.58	1.66	20.34	22.93
	NMNL-1 (16%)	43.57	177.92	179.55	1.63	19.65	22.56
	NMNL-1 (15%)	40.85	177.92	179.52	1.6	18.97	22.19
	NMNL-2 (100%)	281.33	177.92	181.15	3.23	69.93	42.69
	NMNL-2 (30%)	84.4	177.92	179.91	1.99	28.43	26.29
	NMNL-2 (29%)	81.59	177.92	179.89	1.97	27.91	26.09
	NMNL-2 (28%)	78.77	177.92	179.87	1.95	27.37	25.88
	NMNL-2 (27%)	75.96	177.92	179.85	1.93	26.83	25.67
	NMNL-2 (26%)	73.15	177.92	179.82	1.9	26.27	25.47
	NMNL-2 (25%)	70.33	177.92	179.8	1.88	25.71	25.27
	NMNL-2 (24%)	67.52	177.92	179.78	1.86	25.13	25.06
	NMNL-2 (23%)	64.71	177.92	179.76	1.84	24.54	24.84
	NMNL-2 (22%)	61.89	177.92	179.73	1.81	23.94	24.62
	NMNL-2 (21%)	59.08	177.92	179.71	1.79	23.33	24.39
	NMNL-2 (20%)	56.27	177.92	179.68	1.76	22.71	24.15
	NMNL-2 (19%)	53.45	177.92	179.65	1.73	22.06	23.83
	NMNL-2 (18%)	50.64	177.92	179.63	1.71	21.39	23.48
	NMNL-2 (17%)	47.83	177.92	179.6	1.68	20.71	23.13
	NMNL-2 (16%)	45.01	177.92	179.57	1.65	20.02	22.76
	NMNL-2 (15%)	42.2	177.92	179.53	1.61	19.3	22.37
	L (100%)	139.5	177.92	180.28	2.36	39.06	30.08
	L (30%)	41.85	177.92	179.53	1.61	19.21	22.32
	L (29%)	40.46	177.92	179.51	1.59	18.87	22.13
	L (28%)	39.06	177.92	179.5	1.58	18.5	21.93
	L (27%)	37.67	177.92	179.48	1.56	18.12	21.72
	L (26%)	36.27	177.92	179.46	1.54	17.73	21.49
	L (25%)	34.88	177.92	179.44	1.52	17.33	21.27
	L (24%)	33.48	177.92	179.42	1.5	16.93	21.03
	L (23%)	32.09	177.92	179.4	1.48	16.51	20.79
	L (22%)	30.69	177.92	179.38	1.46	16.08	20.54
	L (21%)	29.3	177.92	179.36	1.44	15.66	20.28
	L (20%)	27.9	177.92	179.34	1.42	15.21	20.01
	L (19%)	26.51	177.92	179.32	1.4	14.75	19.73
	L (18%)	25.11	177.92	179.29	1.37	14.28	19.44
	L (17%)	23.72	177.92	179.27	1.35	13.8	19.14
	L (16%)	22.32	177.92	179.24	1.32	13.31	18.82
	L (15%)	20.93	177.92	179.22	1.3	12.79	18.48
950 m d/s of Barrage axis	M (100%)	1007.5	177.77	182.49	4.72	304.92	108.53
	M (30%)	302.25	177.77	180.81	3.04	144.02	82.62
	M (29%)	292.18	177.77	180.78	3.01	140.87	81.99
	M (28%)	282.1	177.77	180.74	2.97	137.68	81.34
	M (27%)	272.03	177.77	180.7	2.93	134.46	80.69
	M (26%)	261.95	177.77	180.66	2.89	131.21	80.02

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (25%)	251.88	177.77	180.62	2.85	127.93	79.33
	M (24%)	241.8	177.77	180.57	2.8	124.59	78.63
	M (23%)	231.73	177.77	180.53	2.76	121.22	77.92
	M (22%)	221.65	177.77	180.49	2.72	117.83	77.2
	M (21%)	211.58	177.77	180.44	2.67	114.39	76.45
	M (20%)	201.5	177.77	180.4	2.63	110.91	75.72
	M (19%)	191.43	177.77	180.35	2.58	107.36	75.01
	M (18%)	181.35	177.77	180.3	2.53	103.73	74.28
	M (17%)	171.28	177.77	180.25	2.48	100.06	73.53
	M (16%)	161.2	177.77	180.2	2.43	96.29	72.76
	M (15%)	151.13	177.77	180.15	2.38	92.41	71.95
	NMNL-1 (100%)	272.33	177.77	180.7	2.93	134.56	80.71
	NMNL-1 (30%)	81.7	177.77	179.72	1.95	63.48	62.7
	NMNL-1 (29%)	78.98	177.77	179.7	1.93	62.23	62.23
	NMNL-1 (28%)	76.25	177.77	179.68	1.91	60.97	61.62
	NMNL-1 (27%)	73.53	177.77	179.66	1.89	59.7	60.87
	NMNL-1 (26%)	70.81	177.77	179.64	1.87	58.42	60.11
	NMNL-1 (25%)	68.08	177.77	179.61	1.84	57.14	59.33
	NMNL-1 (24%)	65.36	177.77	179.59	1.82	55.84	58.53
	NMNL-1 (23%)	62.64	177.77	179.57	1.8	54.53	57.71
	NMNL-1 (22%)	59.91	177.77	179.55	1.78	53.21	56.88
	NMNL-1 (21%)	57.19	177.77	179.52	1.75	51.88	56.02
	NMNL-1 (20%)	54.47	177.77	179.5	1.73	50.53	55.26
	NMNL-1 (19%)	51.74	177.77	179.47	1.7	49.16	54.53
	NMNL-1 (18%)	49.02	177.77	179.45	1.68	47.78	53.79
	NMNL-1 (17%)	46.3	177.77	179.42	1.65	46.38	53.03
	NMNL-1 (16%)	43.57	177.77	179.4	1.63	44.96	52.24
	NMNL-1 (15%)	40.85	177.77	179.37	1.6	43.51	51.42
	NMNL-2 (100%)	281.33	177.77	180.73	2.96	137.44	81.29
	NMNL-2 (30%)	84.4	177.77	179.74	1.97	64.7	63.16
	NMNL-2 (29%)	81.59	177.77	179.72	1.95	63.43	62.68
	NMNL-2 (28%)	78.77	177.77	179.7	1.93	62.13	62.19
	NMNL-2 (27%)	75.96	177.77	179.68	1.91	60.83	61.55
	NMNL-2 (26%)	73.15	177.77	179.65	1.88	59.52	60.77
	NMNL-2 (25%)	70.33	177.77	179.63	1.86	58.2	59.97
	NMNL-2 (24%)	67.52	177.77	179.61	1.84	56.87	59.16
	NMNL-2 (23%)	64.71	177.77	179.59	1.82	55.53	58.33
	NMNL-2 (22%)	61.89	177.77	179.56	1.79	54.17	57.48
	NMNL-2 (21%)	59.08	177.77	179.54	1.77	52.81	56.62
	NMNL-2 (20%)	56.27	177.77	179.51	1.74	51.42	55.73
	NMNL-2 (19%)	53.45	177.77	179.49	1.72	50.02	54.99
	NMNL-2 (18%)	50.64	177.77	179.46	1.69	48.6	54.24
	NMNL-2 (17%)	47.83	177.77	179.44	1.67	47.17	53.46
	NMNL-2 (16%)	45.01	177.77	179.41	1.64	45.71	52.66

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (15%)	42.2	177.77	179.38	1.61	44.23	51.83
	L (100%)	139.5	177.77	180.08	2.31	87.89	70.89
	L (30%)	41.85	177.77	179.38	1.61	44.04	51.73
	L (29%)	40.46	177.77	179.36	1.59	43.29	51.3
	L (28%)	39.06	177.77	179.35	1.58	42.53	50.86
	L (27%)	37.67	177.77	179.33	1.56	41.75	50.41
	L (26%)	36.27	177.77	179.32	1.55	40.92	49.93
	L (25%)	34.88	177.77	179.3	1.53	40.06	49.42
	L (24%)	33.48	177.77	179.28	1.51	39.19	48.9
	L (23%)	32.09	177.77	179.26	1.49	38.3	48.36
	L (22%)	30.69	177.77	179.24	1.47	37.38	47.8
	L (21%)	29.3	177.77	179.22	1.45	36.46	47.22
	L (20%)	27.9	177.77	179.2	1.43	35.49	46.62
	L (19%)	26.51	177.77	179.18	1.41	34.51	45.99
	L (18%)	25.11	177.77	179.16	1.39	33.5	45.34
	L (17%)	23.72	177.77	179.14	1.37	32.46	44.66
	L (16%)	22.32	177.77	179.11	1.34	31.36	43.93
	L (15%)	20.93	177.77	179.09	1.32	30.21	43.15
1000 m d/s of Barrage axis	M (100%)	1007.5	177.64	182.49	4.85	451.41	244.66
	M (30%)	302.25	177.64	180.69	3.05	164.44	97.4
	M (29%)	292.18	177.64	180.65	3.01	160.63	96.64
	M (28%)	282.1	177.64	180.61	2.97	156.77	95.88
	M (27%)	272.03	177.64	180.57	2.93	152.88	95.09
	M (26%)	261.95	177.64	180.53	2.89	148.95	94.3
	M (25%)	251.88	177.64	180.49	2.85	144.98	93.49
	M (24%)	241.8	177.64	180.45	2.81	140.96	92.66
	M (23%)	231.73	177.64	180.4	2.76	136.9	91.81
	M (22%)	221.65	177.64	180.36	2.72	132.78	90.95
	M (21%)	211.58	177.64	180.31	2.67	128.61	90.06
	M (20%)	201.5	177.64	180.26	2.62	124.45	89.17
	M (19%)	191.43	177.64	180.22	2.58	120.17	88.24
	M (18%)	181.35	177.64	180.17	2.53	115.83	87.29
	M (17%)	171.28	177.64	180.12	2.48	111.43	86.31
	M (16%)	161.2	177.64	180.06	2.42	106.94	85.31
	M (15%)	151.13	177.64	180.01	2.37	102.33	84.26
	NMNL-1 (100%)	272.33	177.64	180.57	2.93	153	95.12
	NMNL-1 (30%)	81.7	177.64	179.58	1.94	67.92	76.01
	NMNL-1 (29%)	78.98	177.64	179.56	1.92	66.42	75.64
	NMNL-1 (28%)	76.25	177.64	179.54	1.9	64.9	75.25
	NMNL-1 (27%)	73.53	177.64	179.52	1.88	63.36	74.86
	NMNL-1 (26%)	70.81	177.64	179.5	1.86	61.81	74.46
	NMNL-1 (25%)	68.08	177.64	179.48	1.84	60.24	74.06
	NMNL-1 (24%)	65.36	177.64	179.46	1.82	58.65	73.64

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (23%)	62.64	177.64	179.43	1.79	57.04	73.22
	NMNL-1 (22%)	59.91	177.64	179.41	1.77	55.4	72.8
	NMNL-1 (21%)	57.19	177.64	179.39	1.75	53.75	72.36
	NMNL-1 (20%)	54.47	177.64	179.36	1.72	52.07	71.91
	NMNL-1 (19%)	51.74	177.64	179.34	1.7	50.35	71.45
	NMNL-1 (18%)	49.02	177.64	179.32	1.68	48.62	70.99
	NMNL-1 (17%)	46.3	177.64	179.29	1.65	46.85	70.51
	NMNL-1 (16%)	43.57	177.64	179.27	1.63	45.07	70.02
	NMNL-1 (15%)	40.85	177.64	179.24	1.6	43.23	69.52
	NMNL-2 (100%)	281.33	177.64	180.61	2.97	156.48	95.82
	NMNL-2 (30%)	84.4	177.64	179.6	1.96	69.39	76.38
	NMNL-2 (29%)	81.59	177.64	179.58	1.94	67.86	76
	NMNL-2 (28%)	78.77	177.64	179.56	1.92	66.3	75.61
	NMNL-2 (27%)	75.96	177.64	179.54	1.9	64.73	75.21
	NMNL-2 (26%)	73.15	177.64	179.52	1.88	63.15	74.8
	NMNL-2 (25%)	70.33	177.64	179.49	1.85	61.54	74.39
	NMNL-2 (24%)	67.52	177.64	179.47	1.83	59.91	73.97
	NMNL-2 (23%)	64.71	177.64	179.45	1.81	58.27	73.54
	NMNL-2 (22%)	61.89	177.64	179.43	1.79	56.59	73.11
	NMNL-2 (21%)	59.08	177.64	179.4	1.76	54.9	72.66
	NMNL-2 (20%)	56.27	177.64	179.38	1.74	53.18	72.21
	NMNL-2 (19%)	53.45	177.64	179.36	1.72	51.43	71.74
	NMNL-2 (18%)	50.64	177.64	179.33	1.69	49.65	71.27
	NMNL-2 (17%)	47.83	177.64	179.31	1.67	47.85	70.78
	NMNL-2 (16%)	45.01	177.64	179.28	1.64	46	70.28
	NMNL-2 (15%)	42.2	177.64	179.25	1.61	44.15	69.77
	L (100%)	139.5	177.64	179.94	2.3	96.99	83.04
	L (30%)	41.85	177.64	179.25	1.61	43.91	69.71
	L (29%)	40.46	177.64	179.24	1.6	42.96	69.45
	L (28%)	39.06	177.64	179.22	1.58	42	69.18
	L (27%)	37.67	177.64	179.21	1.57	41.02	68.91
	L (26%)	36.27	177.64	179.19	1.55	39.9	68.03
	L (25%)	34.88	177.64	179.17	1.53	38.74	66.99
	L (24%)	33.48	177.64	179.16	1.52	37.55	65.92
	L (23%)	32.09	177.64	179.14	1.5	36.37	64.83
	L (22%)	30.69	177.64	179.12	1.48	35.14	63.68
	L (21%)	29.3	177.64	179.1	1.46	33.93	62.53
	L (20%)	27.9	177.64	179.08	1.44	32.71	61.33
	L (19%)	26.51	177.64	179.06	1.42	31.46	60.1
	L (18%)	25.11	177.64	179.04	1.4	30.19	58.81
	L (17%)	23.72	177.64	179.02	1.38	28.91	57.48
	L (16%)	22.32	177.64	178.99	1.35	27.6	56.09
	L (15%)	20.93	177.64	178.97	1.33	26.28	54.66

Note:

M - Monsoon Season
NMNL1 - Non Monsoon Non Lean Season (October & November)
L - Lean Season
NMNL2 - Non Monsoon Non Lean Season (April & May)

Table-13.14: Depth of flow for release in the year 2015 for Teesta Low Dam -III HEP

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
At Barrage axis	M (100%)	1003.92	180.34	185.31	4.97	379.29	123.26
	M (30%)	301.18	180.34	183.19	2.85	161.1	80.52
	M (29%)	291.14	180.34	183.14	2.8	157.7	79.9
	M (28%)	281.1	180.34	183.1	2.76	154.27	79.27
	M (27%)	271.06	180.34	183.06	2.72	150.81	78.63
	M (26%)	261.02	180.34	183.01	2.67	147.41	77.99
	M (25%)	250.98	180.34	182.97	2.63	144.01	77.35
	M (24%)	240.94	180.34	182.93	2.59	140.63	76.71
	M (23%)	230.9	180.34	182.88	2.54	137.18	76.05
	M (22%)	220.86	180.34	182.84	2.5	133.69	75.37
	M (21%)	210.82	180.34	182.79	2.45	130.24	74.7
	M (20%)	200.78	180.34	182.74	2.4	126.85	74.03
	M (19%)	190.74	180.34	182.7	2.36	123.28	73.32
	M (18%)	180.71	180.34	182.65	2.31	119.75	72.61
	M (17%)	170.67	180.34	182.6	2.26	116.09	71.87
	M (16%)	160.63	180.34	182.54	2.2	112.15	71.06
	M (15%)	150.59	180.34	182.48	2.14	107.99	70.17
	NMNL-1 (100%)	306	180.34	183.21	2.87	162.69	80.81
	NMNL-1 (30%)	91.8	180.34	182.09	1.75	81.66	64.29
	NMNL-1 (29%)	88.74	180.34	182.07	1.73	80.01	63.91
	NMNL-1 (28%)	85.68	180.34	182.04	1.7	78.3	63.5
	NMNL-1 (27%)	82.62	180.34	182.01	1.67	76.65	63.11
	NMNL-1 (26%)	79.56	180.34	181.99	1.65	75	62.72
	NMNL-1 (25%)	76.5	180.34	181.96	1.62	73.32	62.31
	NMNL-1 (24%)	73.44	180.34	181.93	1.59	71.64	61.91
	NMNL-1 (23%)	70.38	180.34	181.9	1.56	69.92	61.49
	NMNL-1 (22%)	67.32	180.34	181.88	1.54	68.17	61.06
	NMNL-1 (21%)	64.26	180.34	181.85	1.51	66.36	60.61
	NMNL-1 (20%)	61.2	180.34	181.82	1.48	64.51	60.15
	NMNL-1 (19%)	58.14	180.34	181.78	1.44	62.62	59.68
	NMNL-1 (18%)	55.08	180.34	181.75	1.41	60.67	59.17
	NMNL-1 (17%)	52.02	180.34	181.72	1.38	58.63	58.64
	NMNL-1 (16%)	48.96	180.34	181.68	1.34	56.57	58.1
	NMNL-1 (15%)	45.9	180.34	181.64	1.3	54.36	57.52
	NMNL-2 (100%)	331.83	180.34	183.31	2.97	171.16	82.33
	NMNL-2 (30%)	99.55	180.34	182.15	1.81	85.63	65.21
	NMNL-2 (29%)	96.23	180.34	182.13	1.79	83.96	64.83
	NMNL-2 (28%)	92.91	180.34	182.1	1.76	82.24	64.43
	NMNL-2 (27%)	89.6	180.34	182.07	1.73	80.48	64.02

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (26%)	86.28	180.34	182.04	1.7	78.64	63.58
	NMNL-2 (25%)	82.96	180.34	182.02	1.68	76.83	63.15
	NMNL-2 (24%)	79.64	180.34	181.99	1.65	75.05	62.73
	NMNL-2 (23%)	76.32	180.34	181.96	1.62	73.22	62.29
	NMNL-2 (22%)	73	180.34	181.93	1.59	71.39	61.85
	NMNL-2 (21%)	69.69	180.34	181.9	1.56	69.53	61.39
	NMNL-2 (20%)	66.37	180.34	181.87	1.53	67.62	60.92
	NMNL-2 (19%)	63.05	180.34	181.83	1.49	65.64	60.43
	NMNL-2 (18%)	59.73	180.34	181.8	1.46	63.61	59.93
	NMNL-2 (17%)	56.41	180.34	181.77	1.43	61.54	59.4
	NMNL-2 (16%)	53.09	180.34	181.73	1.39	59.34	58.83
	NMNL-2 (15%)	49.78	180.34	181.69	1.35	57.12	58.25
	L (100%)	133.58	180.34	182.38	2.04	100.9	68.64
	L (30%)	40.08	180.34	181.56	1.22	49.68	56.26
	L (29%)	38.74	180.34	181.54	1.2	48.64	55.98
	L (28%)	37.4	180.34	181.52	1.18	47.58	55.69
	L (27%)	36.07	180.34	181.5	1.16	46.54	55.4
	L (26%)	34.73	180.34	181.48	1.14	45.47	55.1
	L (25%)	33.4	180.34	181.47	1.13	44.37	54.8
	L (24%)	32.06	180.34	181.44	1.1	43.18	54.47
	L (23%)	30.72	180.34	181.42	1.08	41.97	54.12
	L (22%)	29.39	180.34	181.4	1.06	40.78	53.79
	L (21%)	28.05	180.34	181.38	1.04	39.52	53.43
	L (20%)	26.72	180.34	181.35	1.01	38.26	53.07
	L (19%)	25.38	180.34	181.33	0.99	36.99	52.7
	L (18%)	24.05	180.34	181.3	0.96	35.71	52.32
	L (17%)	22.71	180.34	181.28	0.94	34.39	51.94
	L (16%)	21.37	180.34	181.25	0.91	33.04	51.54
	L (15%)	20.04	180.34	181.23	0.89	31.67	51.13
50 m d/s of Barrage axis	M (100%)	1003.92	180.21	185.3	5.09	445.81	132.17
	M (30%)	301.18	180.21	183.13	2.92	192.01	98.78
	M (29%)	291.14	180.21	183.08	2.87	187.77	98.19
	M (28%)	281.1	180.21	183.04	2.83	183.49	97.58
	M (27%)	271.06	180.21	183	2.79	179.15	96.97
	M (26%)	261.02	180.21	182.95	2.74	174.91	96.36
	M (25%)	250.98	180.21	182.91	2.7	170.65	95.75
	M (24%)	240.94	180.21	182.86	2.65	166.43	95.14
	M (23%)	230.9	180.21	182.82	2.61	162.13	94.51
	M (22%)	220.86	180.21	182.77	2.56	157.75	93.87
	M (21%)	210.82	180.21	182.73	2.52	153.45	93.24
	M (20%)	200.78	180.21	182.68	2.47	149.23	92.61
	M (19%)	190.74	180.21	182.63	2.42	144.77	91.94
	M (18%)	180.71	180.21	182.58	2.37	140.38	91.28

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (17%)	170.67	180.21	182.53	2.32	135.81	90.59
	M (16%)	160.63	180.21	182.48	2.27	130.84	89.83
	M (15%)	150.59	180.21	182.42	2.21	125.54	89.01
	NMNL-1 (100%)	306	180.21	183.15	2.94	194	99.06
	NMNL-1 (30%)	91.8	180.21	182.03	1.82	92.37	80.73
	NMNL-1 (29%)	88.74	180.21	182.01	1.8	90.29	80.07
	NMNL-1 (28%)	85.68	180.21	181.98	1.77	88.14	79.39
	NMNL-1 (27%)	82.62	180.21	181.95	1.74	86.09	78.73
	NMNL-1 (26%)	79.56	180.21	181.93	1.72	84.05	78.07
	NMNL-1 (25%)	76.5	180.21	181.9	1.69	81.98	77.4
	NMNL-1 (24%)	73.44	180.21	181.87	1.66	79.92	76.72
	NMNL-1 (23%)	70.38	180.21	181.85	1.64	77.82	76.02
	NMNL-1 (22%)	67.32	180.21	181.82	1.61	75.69	75.31
	NMNL-1 (21%)	64.26	180.21	181.79	1.58	73.48	74.56
	NMNL-1 (20%)	61.2	180.21	181.76	1.55	71.23	73.79
	NMNL-1 (19%)	58.14	180.21	181.73	1.52	68.93	73
	NMNL-1 (18%)	55.08	180.21	181.69	1.48	66.57	72.18
	NMNL-1 (17%)	52.02	180.21	181.66	1.45	64.09	71.3
	NMNL-1 (16%)	48.96	180.21	181.62	1.41	61.61	70.41
	NMNL-1 (15%)	45.9	180.21	181.59	1.38	58.94	69.44
	NMNL-2 (100%)	331.83	180.21	183.25	3.04	204.52	100.5
	NMNL-2 (30%)	99.55	180.21	182.09	1.88	97.34	82.27
	NMNL-2 (29%)	96.23	180.21	182.07	1.86	95.25	81.63
	NMNL-2 (28%)	92.91	180.21	182.04	1.83	93.09	80.96
	NMNL-2 (27%)	89.6	180.21	182.01	1.8	90.88	80.26
	NMNL-2 (26%)	86.28	180.21	181.98	1.77	88.57	79.52
	NMNL-2 (25%)	82.96	180.21	181.96	1.75	86.32	78.81
	NMNL-2 (24%)	79.64	180.21	181.93	1.72	84.11	78.09
	NMNL-2 (23%)	76.32	180.21	181.9	1.69	81.85	77.36
	NMNL-2 (22%)	73	180.21	181.87	1.66	79.62	76.62
	NMNL-2 (21%)	69.69	180.21	181.84	1.63	77.34	75.86
	NMNL-2 (20%)	66.37	180.21	181.81	1.6	75.01	75.08
	NMNL-2 (19%)	63.05	180.21	181.78	1.57	72.6	74.26
	NMNL-2 (18%)	59.73	180.21	181.74	1.53	70.14	73.42
	NMNL-2 (17%)	56.41	180.21	181.71	1.5	67.63	72.55
	NMNL-2 (16%)	53.09	180.21	181.67	1.46	64.96	71.61
	NMNL-2 (15%)	49.78	180.21	181.63	1.42	62.28	70.65
	L (100%)	133.58	180.21	182.32	2.11	116.56	87.6
	L (30%)	40.08	180.21	181.5	1.29	53.19	67.31
	L (29%)	38.74	180.21	181.48	1.27	51.96	66.85
	L (28%)	37.4	180.21	181.46	1.25	50.68	66.36
	L (27%)	36.07	180.21	181.45	1.24	49.44	65.88
	L (26%)	34.73	180.21	181.43	1.22	48.16	65.39
	L (25%)	33.4	180.21	181.41	1.2	46.86	64.89

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (24%)	32.06	180.21	181.38	1.17	45.42	64.32
	L (23%)	30.72	180.21	181.36	1.15	43.95	63.71
	L (22%)	29.39	180.21	181.34	1.13	42.53	63.12
	L (21%)	28.05	180.21	181.31	1.1	41.01	62.49
	L (20%)	26.72	180.21	181.29	1.08	39.5	61.84
	L (19%)	25.38	180.21	181.27	1.06	37.98	61.19
	L (18%)	24.05	180.21	181.24	1.03	36.44	60.53
	L (17%)	22.71	180.21	181.21	1	34.87	59.84
	L (16%)	21.37	180.21	181.19	0.98	33.27	59.13
	L (15%)	20.04	180.21	181.16	0.95	31.65	58.4
100 m d/s of Barrage axis	M (100%)	1003.92	180.07	185.33	5.26	667.16	239.56
	M (30%)	301.18	180.07	183.07	3	216.71	108.59
	M (29%)	291.14	180.07	183.03	2.96	212.02	107.87
	M (28%)	281.1	180.07	182.99	2.92	207.3	107.14
	M (27%)	271.06	180.07	182.94	2.87	202.52	106.39
	M (26%)	261.02	180.07	182.9	2.83	197.87	105.66
	M (25%)	250.98	180.07	182.85	2.78	193.2	104.92
	M (24%)	240.94	180.07	182.81	2.74	188.6	104.19
	M (23%)	230.9	180.07	182.76	2.69	183.91	103.44
	M (22%)	220.86	180.07	182.72	2.65	179.15	102.67
	M (21%)	210.82	180.07	182.67	2.6	174.49	101.92
	M (20%)	200.78	180.07	182.63	2.56	169.95	101.17
	M (19%)	190.74	180.07	182.58	2.51	165.13	100.38
	M (18%)	180.71	180.07	182.53	2.46	160.41	99.6
	M (17%)	170.67	180.07	182.48	2.41	155.5	98.77
	M (16%)	160.63	180.07	182.43	2.36	150.12	97.87
	M (15%)	150.59	180.07	182.37	2.3	144.37	96.88
	NMNL-1 (100%)	306	180.07	183.09	3.02	218.9	108.93
	NMNL-1 (30%)	91.8	180.07	181.98	1.91	108.27	90.47
	NMNL-1 (29%)	88.74	180.07	181.96	1.89	105.93	90.04
	NMNL-1 (28%)	85.68	180.07	181.93	1.86	103.49	89.58
	NMNL-1 (27%)	82.62	180.07	181.9	1.83	101.17	89.15
	NMNL-1 (26%)	79.56	180.07	181.88	1.81	98.87	88.72
	NMNL-1 (25%)	76.5	180.07	181.85	1.78	96.51	88.28
	NMNL-1 (24%)	73.44	180.07	181.83	1.76	94.17	87.84
	NMNL-1 (23%)	70.38	180.07	181.8	1.73	91.78	87.38
	NMNL-1 (22%)	67.32	180.07	181.77	1.7	89.35	86.92
	NMNL-1 (21%)	64.26	180.07	181.74	1.67	86.82	86.31
	NMNL-1 (20%)	61.2	180.07	181.71	1.64	84.22	85.65
	NMNL-1 (19%)	58.14	180.07	181.68	1.61	81.56	84.97
	NMNL-1 (18%)	55.08	180.07	181.65	1.58	78.85	84.26
	NMNL-1 (17%)	52.02	180.07	181.61	1.54	75.96	83.51
	NMNL-1 (16%)	48.96	180.07	181.58	1.51	73.04	82.74

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (15%)	45.9	180.07	181.54	1.47	69.85	81.89
	NMNL-2 (100%)	331.83	180.07	183.2	3.13	230.55	110.99
	NMNL-2 (30%)	99.55	180.07	182.04	1.97	113.81	91.48
	NMNL-2 (29%)	96.23	180.07	182.02	1.95	111.49	91.06
	NMNL-2 (28%)	92.91	180.07	181.99	1.92	109.09	90.62
	NMNL-2 (27%)	89.6	180.07	181.96	1.89	106.6	90.16
	NMNL-2 (26%)	86.28	180.07	181.94	1.87	103.97	89.67
	NMNL-2 (25%)	82.96	180.07	181.91	1.84	101.42	89.2
	NMNL-2 (24%)	79.64	180.07	181.88	1.81	98.93	88.73
	NMNL-2 (23%)	76.32	180.07	181.85	1.78	96.37	88.25
	NMNL-2 (22%)	73	180.07	181.82	1.75	93.83	87.77
	NMNL-2 (21%)	69.69	180.07	181.79	1.72	91.24	87.28
	NMNL-2 (20%)	66.37	180.07	181.76	1.69	88.58	86.76
	NMNL-2 (19%)	63.05	180.07	181.73	1.66	85.8	86.05
	NMNL-2 (18%)	59.73	180.07	181.7	1.63	82.95	85.33
	NMNL-2 (17%)	56.41	180.07	181.66	1.59	80.05	84.58
	NMNL-2 (16%)	53.09	180.07	181.63	1.56	76.98	83.78
	NMNL-2 (15%)	49.78	180.07	181.59	1.52	73.82	82.95
	L (100%)	133.58	180.07	182.27	2.2	134.68	95.2
	L (30%)	40.08	180.07	181.45	1.38	62.99	78.66
	L (29%)	38.74	180.07	181.44	1.37	61.56	77.86
	L (28%)	37.4	180.07	181.42	1.35	60.08	77.02
	L (27%)	36.07	180.07	181.4	1.33	58.64	76.2
	L (26%)	34.73	180.07	181.38	1.31	57.16	75.9
	L (25%)	33.4	180.07	181.36	1.29	55.64	75.6
	L (24%)	32.06	180.07	181.34	1.27	53.92	75.13
	L (23%)	30.72	180.07	181.31	1.24	52.17	74.12
	L (22%)	29.39	180.07	181.29	1.22	50.48	73.13
	L (21%)	28.05	180.07	181.26	1.19	48.7	72.08
	L (20%)	26.72	180.07	181.24	1.17	46.92	71.01
	L (19%)	25.38	180.07	181.21	1.14	45.16	69.94
	L (18%)	24.05	180.07	181.19	1.12	43.4	68.84
	L (17%)	22.71	180.07	181.16	1.09	41.58	67.7
	L (16%)	21.37	180.07	181.13	1.06	39.72	66.51
	L (15%)	20.04	180.07	181.11	1.04	37.86	65.29
150 m d/s of Barrage axis	M (100%)	1003.92	179.94	185.29	5.35	672.73	240.01
	M (30%)	301.18	179.94	182.95	3.01	181.62	127.72
	M (29%)	291.14	179.94	182.9	2.96	176.47	115.85
	M (28%)	281.1	179.94	182.86	2.92	171.77	103.98
	M (27%)	271.06	179.94	182.82	2.88	167.4	98.68
	M (26%)	261.02	179.94	182.78	2.84	163.3	95.2
	M (25%)	250.98	179.94	182.73	2.79	159.33	91.68
	M (24%)	240.94	179.94	182.69	2.75	155.56	88.21

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (23%)	230.9	179.94	182.65	2.71	151.87	84.94
	M (22%)	220.86	179.94	182.61	2.67	148.32	81.93
	M (21%)	210.82	179.94	182.56	2.62	144.91	80.89
	M (20%)	200.78	179.94	182.52	2.58	141.64	80.14
	M (19%)	190.74	179.94	182.48	2.54	138.15	79.32
	M (18%)	180.71	179.94	182.44	2.5	134.76	78.51
	M (17%)	170.67	179.94	182.39	2.45	131.24	77.67
	M (16%)	160.63	179.94	182.34	2.4	127.35	76.72
	M (15%)	150.59	179.94	182.29	2.35	123.13	75.67
	NMNL-1 (100%)	306	179.94	182.97	3.03	184.21	133.22
	NMNL-1 (30%)	91.8	179.94	181.93	1.99	97.02	68.79
	NMNL-1 (29%)	88.74	179.94	181.9	1.96	95.31	68.32
	NMNL-1 (28%)	85.68	179.94	181.87	1.93	93.53	67.82
	NMNL-1 (27%)	82.62	179.94	181.85	1.91	91.85	67.35
	NMNL-1 (26%)	79.56	179.94	181.82	1.88	90.19	66.88
	NMNL-1 (25%)	76.5	179.94	181.8	1.86	88.5	66.39
	NMNL-1 (24%)	73.44	179.94	181.77	1.83	86.84	65.91
	NMNL-1 (23%)	70.38	179.94	181.75	1.81	85.14	65.42
	NMNL-1 (22%)	67.32	179.94	181.72	1.78	83.4	64.9
	NMNL-1 (21%)	64.26	179.94	181.69	1.75	81.6	64.36
	NMNL-1 (20%)	61.2	179.94	181.66	1.72	79.75	63.81
	NMNL-1 (19%)	58.14	179.94	181.64	1.7	77.86	63.23
	NMNL-1 (18%)	55.08	179.94	181.6	1.66	75.93	62.64
	NMNL-1 (17%)	52.02	179.94	181.57	1.63	73.85	61.99
	NMNL-1 (16%)	48.96	179.94	181.54	1.6	71.77	61.34
	NMNL-1 (15%)	45.9	179.94	181.5	1.56	69.47	60.61
	NMNL-2 (100%)	331.83	179.94	183.07	3.13	199.69	155.77
	NMNL-2 (30%)	99.55	179.94	181.98	2.04	101.04	69.9
	NMNL-2 (29%)	96.23	179.94	181.96	2.02	99.36	69.44
	NMNL-2 (28%)	92.91	179.94	181.93	1.99	97.61	68.96
	NMNL-2 (27%)	89.6	179.94	181.91	1.97	95.8	68.45
	NMNL-2 (26%)	86.28	179.94	181.88	1.94	93.88	67.92
	NMNL-2 (25%)	82.96	179.94	181.85	1.91	92.03	67.4
	NMNL-2 (24%)	79.64	179.94	181.83	1.89	90.24	66.89
	NMNL-2 (23%)	76.32	179.94	181.8	1.86	88.41	66.36
	NMNL-2 (22%)	73	179.94	181.77	1.83	86.6	65.84
	NMNL-2 (21%)	69.69	179.94	181.74	1.8	84.75	65.3
	NMNL-2 (20%)	66.37	179.94	181.71	1.77	82.86	64.74
	NMNL-2 (19%)	63.05	179.94	181.68	1.74	80.88	64.15
	NMNL-2 (18%)	59.73	179.94	181.65	1.71	78.86	63.53
	NMNL-2 (17%)	56.41	179.94	181.62	1.68	76.79	62.9
	NMNL-2 (16%)	53.09	179.94	181.58	1.64	74.59	62.22
	NMNL-2 (15%)	49.78	179.94	181.55	1.61	72.33	61.52
	L (100%)	133.58	179.94	182.19	2.25	116.08	73.88

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (30%)	40.08	179.94	181.42	1.48	64.44	58.99
	L (29%)	38.74	179.94	181.4	1.46	63.4	58.69
	L (28%)	37.4	179.94	181.38	1.44	62.31	58.42
	L (27%)	36.07	179.94	181.36	1.42	61.25	58.15
	L (26%)	34.73	179.94	181.34	1.4	60.15	57.88
	L (25%)	33.4	179.94	181.32	1.38	59.01	57.59
	L (24%)	32.06	179.94	181.3	1.36	57.71	57.26
	L (23%)	30.72	179.94	181.28	1.34	56.38	56.92
	L (22%)	29.39	179.94	181.25	1.31	55.1	56.59
	L (21%)	28.05	179.94	181.23	1.29	53.72	56.23
	L (20%)	26.72	179.94	181.2	1.26	52.32	55.87
	L (19%)	25.38	179.94	181.18	1.24	50.94	55.51
	L (18%)	24.05	179.94	181.15	1.21	49.53	55.14
	L (17%)	22.71	179.94	181.13	1.19	48.07	54.75
	L (16%)	21.37	179.94	181.1	1.16	46.55	54.34
	L (15%)	20.04	179.94	181.07	1.13	45	53.92
200 m d/s of Barrage axis	M (100%)	1003.92	179.8	185.24	5.44	689.98	219.66
	M (30%)	301.18	179.8	182.88	3.08	207.39	175.87
	M (29%)	291.14	179.8	182.84	3.04	198.88	175.02
	M (28%)	281.1	179.8	182.79	2.99	190.22	174.15
	M (27%)	271.06	179.8	182.73	2.93	181.28	173.25
	M (26%)	261.02	179.8	182.68	2.88	172.6	172.36
	M (25%)	250.98	179.8	182.63	2.83	163.73	171.46
	M (24%)	240.94	179.8	182.58	2.78	154.9	170.51
	M (23%)	230.9	179.8	182.53	2.73	145.86	166.38
	M (22%)	220.86	179.8	182.47	2.67	137.29	159.01
	M (21%)	210.82	179.8	182.42	2.62	129.12	152.87
	M (20%)	200.78	179.8	182.37	2.57	121.62	147.02
	M (19%)	190.74	179.8	182.32	2.52	113.59	140.46
	M (18%)	180.71	179.8	182.26	2.46	106.42	131.33
	M (17%)	170.67	179.8	182.21	2.41	99.82	118.88
	M (16%)	160.63	179.8	182.15	2.35	93.13	104.75
	M (15%)	150.59	179.8	182.09	2.29	86.95	90.57
	NMNL-1 (100%)	306	179.8	182.91	3.11	211.34	176.26
	NMNL-1 (30%)	91.8	179.8	181.7	1.9	57.03	65.21
	NMNL-1 (29%)	88.74	179.8	181.68	1.88	55.64	63.71
	NMNL-1 (28%)	85.68	179.8	181.65	1.85	54.22	62.16
	NMNL-1 (27%)	82.62	179.8	181.63	1.83	52.82	60.57
	NMNL-1 (26%)	79.56	179.8	181.61	1.81	51.44	58.98
	NMNL-1 (25%)	76.5	179.8	181.59	1.79	50.1	57.39
	NMNL-1 (24%)	73.44	179.8	181.56	1.76	48.76	55.76
	NMNL-1 (23%)	70.38	179.8	181.54	1.74	47.43	54.08
	NMNL-1 (22%)	67.32	179.8	181.51	1.71	46.1	52.36

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (21%)	64.26	179.8	181.49	1.69	44.8	50.61
	NMNL-1 (20%)	61.2	179.8	181.46	1.66	43.5	49.02
	NMNL-1 (19%)	58.14	179.8	181.43	1.63	42.2	48.26
	NMNL-1 (18%)	55.08	179.8	181.41	1.61	40.89	47.48
	NMNL-1 (17%)	52.02	179.8	181.38	1.58	39.52	46.66
	NMNL-1 (16%)	48.96	179.8	181.35	1.55	38.11	45.85
	NMNL-1 (15%)	45.9	179.8	181.31	1.51	36.63	44.99
	NMNL-2 (100%)	331.83	179.8	183.02	3.22	232.31	178.64
	NMNL-2 (30%)	99.55	179.8	181.75	1.95	60.66	68.55
	NMNL-2 (29%)	96.23	179.8	181.73	1.93	59.08	67.24
	NMNL-2 (28%)	92.91	179.8	181.71	1.91	57.54	65.76
	NMNL-2 (27%)	89.6	179.8	181.68	1.88	56.03	64.14
	NMNL-2 (26%)	86.28	179.8	181.66	1.86	54.5	62.47
	NMNL-2 (25%)	82.96	179.8	181.63	1.83	52.97	60.75
	NMNL-2 (24%)	79.64	179.8	181.61	1.81	51.47	59.02
	NMNL-2 (23%)	76.32	179.8	181.58	1.78	50.02	57.3
	NMNL-2 (22%)	73	179.8	181.56	1.76	48.57	55.52
	NMNL-2 (21%)	69.69	179.8	181.53	1.73	47.13	53.69
	NMNL-2 (20%)	66.37	179.8	181.5	1.7	45.7	51.83
	NMNL-2 (19%)	63.05	179.8	181.48	1.68	44.29	49.91
	NMNL-2 (18%)	59.73	179.8	181.45	1.65	42.87	48.66
	NMNL-2 (17%)	56.41	179.8	181.42	1.62	41.47	47.83
	NMNL-2 (16%)	53.09	179.8	181.39	1.59	40	46.95
	NMNL-2 (15%)	49.78	179.8	181.36	1.56	38.49	46.07
	L (100%)	133.58	179.8	181.98	2.18	77.63	81.1
	L (30%)	40.08	179.8	181.25	1.45	33.8	43.29
	L (29%)	38.74	179.8	181.24	1.44	33.14	42.88
	L (28%)	37.4	179.8	181.22	1.42	32.44	42.44
	L (27%)	36.07	179.8	181.2	1.4	31.74	42
	L (26%)	34.73	179.8	181.18	1.38	31.02	41.53
	L (25%)	33.4	179.8	181.17	1.37	30.25	41.03
	L (24%)	32.06	179.8	181.14	1.34	29.36	40.45
	L (23%)	30.72	179.8	181.12	1.32	28.42	39.82
	L (22%)	29.39	179.8	181.1	1.3	27.56	39.24
	L (21%)	28.05	179.8	181.08	1.28	26.66	38.63
	L (20%)	26.72	179.8	181.05	1.25	25.69	37.95
	L (19%)	25.38	179.8	181.03	1.23	24.75	37.28
	L (18%)	24.05	179.8	181	1.2	23.8	36.59
	L (17%)	22.71	179.8	180.97	1.17	22.79	35.89
	L (16%)	21.37	179.8	180.94	1.14	21.72	35.14
	L (15%)	20.04	179.8	180.91	1.11	20.65	34.37
250 m d/s of	M (100%)	1003.92	179.66	185.24	5.58	810.62	215.83
	M (30%)	301.18	179.66	182.85	3.19	312.78	193.03

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
Barrage axis	M (29%)	291.14	179.66	182.8	3.14	303	192.44
	M (28%)	281.1	179.66	182.75	3.09	292.9	191.82
	M (27%)	271.06	179.66	182.69	3.03	282.39	191.18
	M (26%)	261.02	179.66	182.64	2.98	272.11	190.55
	M (25%)	250.98	179.66	182.58	2.92	261.41	189.89
	M (24%)	240.94	179.66	182.52	2.86	250.55	187.8
	M (23%)	230.9	179.66	182.46	2.8	239.5	182.31
	M (22%)	220.86	179.66	182.4	2.74	228.64	179.37
	M (21%)	210.82	179.66	182.34	2.68	217.53	176.34
	M (20%)	200.78	179.66	182.28	2.62	206.77	173.35
	M (19%)	190.74	179.66	182.21	2.55	195.3	170.34
	M (18%)	180.71	179.66	182.15	2.49	184.13	168.99
	M (17%)	170.67	179.66	182.08	2.42	173.15	167.64
	M (16%)	160.63	179.66	182.02	2.36	161.86	166.23
	M (15%)	150.59	179.66	181.95	2.29	150.39	164.78
	NMNL-1 (100%)	306	179.66	182.87	3.21	317.3	193.31
	NMNL-1 (30%)	91.8	179.66	181.53	1.87	87.39	119.64
	NMNL-1 (29%)	88.74	179.66	181.51	1.85	84.76	114.83
	NMNL-1 (28%)	85.68	179.66	181.49	1.83	82.15	109.89
	NMNL-1 (27%)	82.62	179.66	181.46	1.8	79.61	104.83
	NMNL-1 (26%)	79.56	179.66	181.44	1.78	77.2	101.73
	NMNL-1 (25%)	76.5	179.66	181.42	1.76	74.85	100.21
	NMNL-1 (24%)	73.44	179.66	181.39	1.73	72.47	98.65
	NMNL-1 (23%)	70.38	179.66	181.37	1.71	70.13	97.08
	NMNL-1 (22%)	67.32	179.66	181.34	1.68	67.8	95.5
	NMNL-1 (21%)	64.26	179.66	181.32	1.66	65.47	93.89
	NMNL-1 (20%)	61.2	179.66	181.29	1.63	63.11	92.23
	NMNL-1 (19%)	58.14	179.66	181.27	1.61	60.68	90.5
	NMNL-1 (18%)	55.08	179.66	181.24	1.58	58.27	88.74
	NMNL-1 (17%)	52.02	179.66	181.21	1.55	55.8	86.9
	NMNL-1 (16%)	48.96	179.66	181.18	1.52	53.32	85.01
	NMNL-1 (15%)	45.9	179.66	181.15	1.49	50.82	83.1
	NMNL-2 (100%)	331.83	179.66	183	3.34	341.36	199.53
	NMNL-2 (30%)	99.55	179.66	181.59	1.93	94.48	131.84
	NMNL-2 (29%)	96.23	179.66	181.56	1.9	91.35	126.65
	NMNL-2 (28%)	92.91	179.66	181.54	1.88	88.38	121.39
	NMNL-2 (27%)	89.6	179.66	181.52	1.86	85.5	116.2
	NMNL-2 (26%)	86.28	179.66	181.49	1.83	82.65	110.86
	NMNL-2 (25%)	82.96	179.66	181.47	1.81	79.89	105.4
	NMNL-2 (24%)	79.64	179.66	181.44	1.78	77.26	101.77
	NMNL-2 (23%)	76.32	179.66	181.41	1.75	74.71	100.12
	NMNL-2 (22%)	73	179.66	181.39	1.73	72.14	98.43
	NMNL-2 (21%)	69.69	179.66	181.36	1.7	69.6	96.72
	NMNL-2 (20%)	66.37	179.66	181.34	1.68	67.08	95

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (19%)	63.05	179.66	181.31	1.65	64.55	93.25
	NMNL-2 (18%)	59.73	179.66	181.28	1.62	61.93	91.39
	NMNL-2 (17%)	56.41	179.66	181.25	1.59	59.33	89.51
	NMNL-2 (16%)	53.09	179.66	181.22	1.56	56.66	87.55
	NMNL-2 (15%)	49.78	179.66	181.19	1.53	53.98	85.52
	L (100%)	133.58	179.66	181.83	2.17	131.33	162.34
	L (30%)	40.08	179.66	181.09	1.43	45.87	79.19
	L (29%)	38.74	179.66	181.08	1.42	44.73	78.27
	L (28%)	37.4	179.66	181.06	1.4	43.45	77.2
	L (27%)	36.07	179.66	181.05	1.39	42.25	76.21
	L (26%)	34.73	179.66	181.03	1.37	41.02	75.12
	L (25%)	33.4	179.66	181.01	1.35	39.68	73.24
	L (24%)	32.06	179.66	180.99	1.33	38	70.82
	L (23%)	30.72	179.66	180.97	1.31	36.4	68.45
	L (22%)	29.39	179.66	180.94	1.28	34.86	66.08
	L (21%)	28.05	179.66	180.92	1.26	33.3	63.58
	L (20%)	26.72	179.66	180.89	1.23	31.67	57.38
	L (19%)	25.38	179.66	180.87	1.21	30.2	55.31
	L (18%)	24.05	179.66	180.84	1.18	28.72	53.59
	L (17%)	22.71	179.66	180.81	1.15	27.22	51.79
	L (16%)	21.37	179.66	180.78	1.12	25.64	49.83
	L (15%)	20.04	179.66	180.75	1.09	24	47.7
300 m d/s of Barrage axis	M (100%)	1003.92	179.53	185.22	5.69	845.55	194.4
	M (30%)	301.18	179.53	182.84	3.31	401.78	177.38
	M (29%)	291.14	179.53	182.79	3.26	392.77	176.96
	M (28%)	281.1	179.53	182.73	3.2	383.44	176.53
	M (27%)	271.06	179.53	182.68	3.15	373.72	176.07
	M (26%)	261.02	179.53	182.62	3.09	364.19	175.63
	M (25%)	250.98	179.53	182.57	3.04	354.26	175.17
	M (24%)	240.94	179.53	182.51	2.98	344.15	174.69
	M (23%)	230.9	179.53	182.45	2.92	333.65	174.2
	M (22%)	220.86	179.53	182.39	2.86	323.08	173.7
	M (21%)	210.82	179.53	182.33	2.8	312.1	173.18
	M (20%)	200.78	179.53	182.26	2.73	301.37	172.67
	M (19%)	190.74	179.53	182.2	2.67	289.69	172.11
	M (18%)	180.71	179.53	182.13	2.6	278.19	171.51
	M (17%)	170.67	179.53	182.06	2.53	266.86	170.92
	M (16%)	160.63	179.53	181.99	2.46	255.04	170.3
	M (15%)	150.59	179.53	181.92	2.39	242.98	169.66
	NMNL-1 (100%)	306	179.53	182.86	3.33	405.95	177.57
	NMNL-1 (30%)	91.8	179.53	181.49	1.96	170.59	163.5
	NMNL-1 (29%)	88.74	179.53	181.47	1.94	166.63	162.88
	NMNL-1 (28%)	85.68	179.53	181.44	1.91	162.66	162.26

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (27%)	82.62	179.53	181.42	1.89	158.63	161.62
	NMNL-1 (26%)	79.56	179.53	181.39	1.86	154.58	160.98
	NMNL-1 (25%)	76.5	179.53	181.37	1.84	150.51	160.34
	NMNL-1 (24%)	73.44	179.53	181.34	1.81	146.33	159.67
	NMNL-1 (23%)	70.38	179.53	181.31	1.78	142.14	159
	NMNL-1 (22%)	67.32	179.53	181.29	1.76	137.87	158.31
	NMNL-1 (21%)	64.26	179.53	181.26	1.73	133.58	157.62
	NMNL-1 (20%)	61.2	179.53	181.23	1.7	129.23	156.9
	NMNL-1 (19%)	58.14	179.53	181.2	1.67	124.71	156.02
	NMNL-1 (18%)	55.08	179.53	181.17	1.64	120.2	151.96
	NMNL-1 (17%)	52.02	179.53	181.14	1.61	115.76	143.55
	NMNL-1 (16%)	48.96	179.53	181.11	1.58	111.31	140.62
	NMNL-1 (15%)	45.9	179.53	181.08	1.55	106.64	137.47
	NMNL-2 (100%)	331.83	179.53	182.98	3.45	427.81	178.56
	NMNL-2 (30%)	99.55	179.53	181.55	2.02	180.52	165.04
	NMNL-2 (29%)	96.23	179.53	181.53	2	176.28	164.38
	NMNL-2 (28%)	92.91	179.53	181.5	1.97	172.02	163.72
	NMNL-2 (27%)	89.6	179.53	181.47	1.94	167.76	163.06
	NMNL-2 (26%)	86.28	179.53	181.45	1.92	163.44	162.38
	NMNL-2 (25%)	82.96	179.53	181.42	1.89	159.08	161.69
	NMNL-2 (24%)	79.64	179.53	181.39	1.86	154.68	161
	NMNL-2 (23%)	76.32	179.53	181.37	1.84	150.26	160.3
	NMNL-2 (22%)	73	179.53	181.34	1.81	145.75	159.58
	NMNL-2 (21%)	69.69	179.53	181.31	1.78	141.18	158.84
	NMNL-2 (20%)	66.37	179.53	181.28	1.75	136.55	158.1
	NMNL-2 (19%)	63.05	179.53	181.25	1.72	131.88	157.34
	NMNL-2 (18%)	59.73	179.53	181.22	1.69	127.03	156.47
	NMNL-2 (17%)	56.41	179.53	181.19	1.66	122.18	155.53
	NMNL-2 (16%)	53.09	179.53	181.15	1.62	117.31	145.43
	NMNL-2 (15%)	49.78	179.53	181.12	1.59	112.51	141.41
	L (100%)	133.58	179.53	181.8	2.27	222.62	168.58
	L (30%)	40.08	179.53	181.01	1.48	97.4	131.06
	L (29%)	38.74	179.53	180.99	1.46	95.27	129.79
	L (28%)	37.4	179.53	180.98	1.45	93.12	128.5
	L (27%)	36.07	179.53	180.96	1.43	90.98	127.2
	L (26%)	34.73	179.53	180.94	1.41	88.75	125.83
	L (25%)	33.4	179.53	180.92	1.39	86.2	124.25
	L (24%)	32.06	179.53	180.9	1.37	83.38	122.47
	L (23%)	30.72	179.53	180.88	1.35	80.46	120.61
	L (22%)	29.39	179.53	180.85	1.32	77.73	118.83
	L (21%)	28.05	179.53	180.83	1.3	74.9	116.96
	L (20%)	26.72	179.53	180.8	1.27	72.06	115.05
	L (19%)	25.38	179.53	180.78	1.25	69.11	113.04
	L (18%)	24.05	179.53	180.75	1.22	66.03	110.9

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (17%)	22.71	179.53	180.72	1.19	62.88	108.41
	L (16%)	21.37	179.53	180.69	1.16	59.62	104.68
	L (15%)	20.04	179.53	180.66	1.13	56.31	100.73
350 m d/s of Barrage axis	M (100%)	1003.92	179.4	185.19	5.79	789.7	189.99
	M (30%)	301.18	179.4	182.81	3.41	365.58	165.92
	M (29%)	291.14	179.4	182.76	3.36	357.15	165.35
	M (28%)	281.1	179.4	182.71	3.31	348.43	164.76
	M (27%)	271.06	179.4	182.66	3.26	339.35	164.15
	M (26%)	261.02	179.4	182.6	3.2	330.47	163.58
	M (25%)	250.98	179.4	182.54	3.14	321.2	163.02
	M (24%)	240.94	179.4	182.49	3.09	311.77	162.45
	M (23%)	230.9	179.4	182.43	3.03	301.98	161.86
	M (22%)	220.86	179.4	182.37	2.97	292.14	161.26
	M (21%)	210.82	179.4	182.3	2.9	281.89	160.64
	M (20%)	200.78	179.4	182.24	2.84	271.91	160.03
	M (19%)	190.74	179.4	182.17	2.77	261.01	159.35
	M (18%)	180.71	179.4	182.1	2.7	250.3	158.69
	M (17%)	170.67	179.4	182.04	2.64	239.76	158.04
	M (16%)	160.63	179.4	181.97	2.57	228.76	157.36
	M (15%)	150.59	179.4	181.9	2.5	217.53	156.65
	NMNL-1 (100%)	306	179.4	182.84	3.44	369.47	166.18
	NMNL-1 (30%)	91.8	179.4	181.46	2.06	150.34	150.16
	NMNL-1 (29%)	88.74	179.4	181.44	2.04	146.69	149.38
	NMNL-1 (28%)	85.68	179.4	181.41	2.01	143.03	148.59
	NMNL-1 (27%)	82.62	179.4	181.39	1.99	139.33	147.79
	NMNL-1 (26%)	79.56	179.4	181.36	1.96	135.61	146.98
	NMNL-1 (25%)	76.5	179.4	181.34	1.94	131.88	146.17
	NMNL-1 (24%)	73.44	179.4	181.31	1.91	128.06	145.32
	NMNL-1 (23%)	70.38	179.4	181.28	1.88	124.22	144.47
	NMNL-1 (22%)	67.32	179.4	181.26	1.86	120.32	143.6
	NMNL-1 (21%)	64.26	179.4	181.23	1.83	116.42	142.73
	NMNL-1 (20%)	61.2	179.4	181.2	1.8	112.46	141.83
	NMNL-1 (19%)	58.14	179.4	181.17	1.77	108.34	140.9
	NMNL-1 (18%)	55.08	179.4	181.14	1.74	104.24	139.96
	NMNL-1 (17%)	52.02	179.4	181.11	1.71	100.02	138.14
	NMNL-1 (16%)	48.96	179.4	181.08	1.68	95.78	133.42
	NMNL-1 (15%)	45.9	179.4	181.05	1.65	91.51	128.05
	NMNL-2 (100%)	331.83	179.4	182.96	3.56	389.93	167.54
	NMNL-2 (30%)	99.55	179.4	181.52	2.12	159.53	152.11
	NMNL-2 (29%)	96.23	179.4	181.49	2.09	155.6	151.28
	NMNL-2 (28%)	92.91	179.4	181.47	2.07	151.66	150.44
	NMNL-2 (27%)	89.6	179.4	181.44	2.04	147.73	149.6
	NMNL-2 (26%)	86.28	179.4	181.42	2.02	143.75	148.75

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (25%)	82.96	179.4	181.39	1.99	139.74	147.88
	NMNL-2 (24%)	79.64	179.4	181.36	1.96	135.71	147
	NMNL-2 (23%)	76.32	179.4	181.33	1.93	131.65	146.12
	NMNL-2 (22%)	73	179.4	181.31	1.91	127.51	145.2
	NMNL-2 (21%)	69.69	179.4	181.28	1.88	123.34	144.28
	NMNL-2 (20%)	66.37	179.4	181.25	1.85	119.12	143.33
	NMNL-2 (19%)	63.05	179.4	181.22	1.82	114.87	142.38
	NMNL-2 (18%)	59.73	179.4	181.19	1.79	110.45	141.38
	NMNL-2 (17%)	56.41	179.4	181.16	1.76	106.04	140.37
	NMNL-2 (16%)	53.09	179.4	181.12	1.72	101.52	138.84
	NMNL-2 (15%)	49.78	179.4	181.09	1.69	96.9	134.79
	L (100%)	133.58	179.4	181.77	2.37	198.6	155.41
	L (30%)	40.08	179.4	180.98	1.58	83.13	119.85
	L (29%)	38.74	179.4	180.96	1.56	81.22	118
	L (28%)	37.4	179.4	180.95	1.55	79.31	116.11
	L (27%)	36.07	179.4	180.93	1.53	77.42	114.21
	L (26%)	34.73	179.4	180.91	1.51	75.45	112.2
	L (25%)	33.4	179.4	180.89	1.49	73.18	109.84
	L (24%)	32.06	179.4	180.87	1.47	70.68	107.28
	L (23%)	30.72	179.4	180.85	1.45	68.11	104.61
	L (22%)	29.39	179.4	180.82	1.42	65.76	102.11
	L (21%)	28.05	179.4	180.8	1.4	63.33	99.44
	L (20%)	26.72	179.4	180.78	1.38	60.92	96.72
	L (19%)	25.38	179.4	180.75	1.35	58.45	93.84
	L (18%)	24.05	179.4	180.72	1.32	55.89	91.12
	L (17%)	22.71	179.4	180.69	1.29	53.3	88.36
	L (16%)	21.37	179.4	180.66	1.26	50.62	85.42
	L (15%)	20.04	179.4	180.63	1.23	47.88	82.3
400 m d/s of Barrage axis	M (100%)	1003.92	179.26	185.18	5.92	797.04	183.29
	M (30%)	301.18	179.26	182.8	3.54	376.23	167.05
	M (29%)	291.14	179.26	182.75	3.49	367.73	166.21
	M (28%)	281.1	179.26	182.69	3.43	358.96	165.33
	M (27%)	271.06	179.26	182.64	3.38	349.82	164.42
	M (26%)	261.02	179.26	182.58	3.32	340.9	163.52
	M (25%)	250.98	179.26	182.53	3.27	331.62	162.58
	M (24%)	240.94	179.26	182.47	3.21	322.19	161.61
	M (23%)	230.9	179.26	182.41	3.15	312.41	160.59
	M (22%)	220.86	179.26	182.35	3.09	302.61	159.56
	M (21%)	210.82	179.26	182.28	3.02	292.44	158.48
	M (20%)	200.78	179.26	182.22	2.96	282.56	157.43
	M (19%)	190.74	179.26	182.15	2.89	271.77	156.27
	M (18%)	180.71	179.26	182.08	2.82	261.22	155.13
	M (17%)	170.67	179.26	182.02	2.76	250.87	154

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (16%)	160.63	179.26	181.95	2.69	240.09	152.81
	M (15%)	150.59	179.26	181.87	2.61	229.12	151.6
	NMNL-1 (100%)	306	179.26	182.82	3.56	380.17	167.43
	NMNL-1 (30%)	91.8	179.26	181.44	2.18	165.03	136.19
	NMNL-1 (29%)	88.74	179.26	181.41	2.15	161.73	135.47
	NMNL-1 (28%)	85.68	179.26	181.39	2.13	158.41	134.73
	NMNL-1 (27%)	82.62	179.26	181.36	2.1	155.07	133.99
	NMNL-1 (26%)	79.56	179.26	181.34	2.08	151.71	133.23
	NMNL-1 (25%)	76.5	179.26	181.31	2.05	148.35	132.48
	NMNL-1 (24%)	73.44	179.26	181.29	2.03	144.92	131.7
	NMNL-1 (23%)	70.38	179.26	181.26	2	141.45	130.91
	NMNL-1 (22%)	67.32	179.26	181.23	1.97	137.94	130.11
	NMNL-1 (21%)	64.26	179.26	181.21	1.95	134.43	129.3
	NMNL-1 (20%)	61.2	179.26	181.18	1.92	130.86	128.47
	NMNL-1 (19%)	58.14	179.26	181.15	1.89	127.14	127.6
	NMNL-1 (18%)	55.08	179.26	181.12	1.86	123.45	126.74
	NMNL-1 (17%)	52.02	179.26	181.09	1.83	119.67	125.84
	NMNL-1 (16%)	48.96	179.26	181.06	1.8	115.79	124.78
	NMNL-1 (15%)	45.9	179.26	181.03	1.77	111.8	123.52
	NMNL-2 (100%)	331.83	179.26	182.94	3.68	400.83	168.99
	NMNL-2 (30%)	99.55	179.26	181.5	2.24	173.36	138.58
	NMNL-2 (29%)	96.23	179.26	181.47	2.21	169.8	137.24
	NMNL-2 (28%)	92.91	179.26	181.44	2.18	166.23	136.46
	NMNL-2 (27%)	89.6	179.26	181.42	2.16	162.66	135.67
	NMNL-2 (26%)	86.28	179.26	181.39	2.13	159.06	134.88
	NMNL-2 (25%)	82.96	179.26	181.37	2.11	155.44	134.07
	NMNL-2 (24%)	79.64	179.26	181.34	2.08	151.8	133.25
	NMNL-2 (23%)	76.32	179.26	181.31	2.05	148.14	132.43
	NMNL-2 (22%)	73	179.26	181.28	2.02	144.43	131.59
	NMNL-2 (21%)	69.69	179.26	181.25	1.99	140.66	130.73
	NMNL-2 (20%)	66.37	179.26	181.22	1.96	136.86	129.86
	NMNL-2 (19%)	63.05	179.26	181.19	1.93	133.03	128.98
	NMNL-2 (18%)	59.73	179.26	181.16	1.9	129.05	128.05
	NMNL-2 (17%)	56.41	179.26	181.13	1.87	125.07	127.12
	NMNL-2 (16%)	53.09	179.26	181.1	1.84	121	126.16
	NMNL-2 (15%)	49.78	179.26	181.07	1.81	116.83	125.09
	L (100%)	133.58	179.26	181.75	2.49	210.72	149.48
	L (30%)	40.08	179.26	180.96	1.7	103.73	119.22
	L (29%)	38.74	179.26	180.94	1.68	101.87	118.22
	L (28%)	37.4	179.26	180.93	1.67	100	116.87
	L (27%)	36.07	179.26	180.91	1.65	98.15	113.76
	L (26%)	34.73	179.26	180.9	1.64	96.26	110.48
	L (25%)	33.4	179.26	180.88	1.62	94.09	106.58
	L (24%)	32.06	179.26	180.85	1.59	91.74	102.17

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (23%)	30.72	179.26	180.83	1.57	89.35	97.46
	L (22%)	29.39	179.26	180.81	1.55	87.25	93.34
	L (21%)	28.05	179.26	180.78	1.52	85.09	92.08
	L (20%)	26.72	179.26	180.76	1.5	82.89	90.79
	L (19%)	25.38	179.26	180.73	1.47	80.61	89.44
	L (18%)	24.05	179.26	180.71	1.45	78.22	88
	L (17%)	22.71	179.26	180.68	1.42	75.73	86.47
	L (16%)	21.37	179.26	180.65	1.39	73.13	84.84
	L (15%)	20.04	179.26	180.62	1.36	70.42	83.11
450 m d/s of Barrage axis	M (100%)	1003.92	179.13	185.14	6.01	745.45	176.34
	M (30%)	301.18	179.13	182.78	3.65	363.92	146.42
	M (29%)	291.14	179.13	182.73	3.6	356.51	145.81
	M (28%)	281.1	179.13	182.67	3.54	348.84	145.18
	M (27%)	271.06	179.13	182.62	3.49	340.84	144.51
	M (26%)	261.02	179.13	182.57	3.44	333.04	143.86
	M (25%)	250.98	179.13	182.51	3.38	324.89	143.18
	M (24%)	240.94	179.13	182.45	3.32	316.61	142.47
	M (23%)	230.9	179.13	182.39	3.26	308.01	141.66
	M (22%)	220.86	179.13	182.33	3.2	299.39	140.85
	M (21%)	210.82	179.13	182.26	3.13	290.42	140
	M (20%)	200.78	179.13	182.2	3.07	281.71	139.18
	M (19%)	190.74	179.13	182.13	3	272.18	138.26
	M (18%)	180.71	179.13	182.07	2.94	262.85	137.33
	M (17%)	170.67	179.13	182	2.87	253.72	136.38
	M (16%)	160.63	179.13	181.93	2.8	244.19	135.38
	M (15%)	150.59	179.13	181.86	2.73	234.48	134.36
	NMNL-1 (100%)	306	179.13	182.8	3.67	367.35	146.72
	NMNL-1 (30%)	91.8	179.13	181.42	2.29	177.44	126.47
	NMNL-1 (29%)	88.74	179.13	181.4	2.27	174.42	125.9
	NMNL-1 (28%)	85.68	179.13	181.37	2.24	171.37	125.32
	NMNL-1 (27%)	82.62	179.13	181.35	2.22	168.29	124.73
	NMNL-1 (26%)	79.56	179.13	181.32	2.19	165.2	124.13
	NMNL-1 (25%)	76.5	179.13	181.3	2.17	162.1	123.53
	NMNL-1 (24%)	73.44	179.13	181.27	2.14	158.95	122.92
	NMNL-1 (23%)	70.38	179.13	181.25	2.12	155.76	122.15
	NMNL-1 (22%)	67.32	179.13	181.22	2.09	152.53	121.19
	NMNL-1 (21%)	64.26	179.13	181.19	2.06	149.3	120.21
	NMNL-1 (20%)	61.2	179.13	181.17	2.04	146.04	119.22
	NMNL-1 (19%)	58.14	179.13	181.14	2.01	142.64	118.18
	NMNL-1 (18%)	55.08	179.13	181.11	1.98	139.28	117.14
	NMNL-1 (17%)	52.02	179.13	181.08	1.95	135.83	116.07
	NMNL-1 (16%)	48.96	179.13	181.05	1.92	132.32	114.96
	NMNL-1 (15%)	45.9	179.13	181.02	1.89	128.69	113.18

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (100%)	331.83	179.13	182.92	3.79	385.35	148.27
	NMNL-2 (30%)	99.55	179.13	181.48	2.35	185.11	127.91
	NMNL-2 (29%)	96.23	179.13	181.46	2.33	181.83	127.3
	NMNL-2 (28%)	92.91	179.13	181.43	2.3	178.54	126.68
	NMNL-2 (27%)	89.6	179.13	181.4	2.27	175.27	126.06
	NMNL-2 (26%)	86.28	179.13	181.38	2.25	171.97	125.43
	NMNL-2 (25%)	82.96	179.13	181.35	2.22	168.63	124.79
	NMNL-2 (24%)	79.64	179.13	181.32	2.19	165.28	124.15
	NMNL-2 (23%)	76.32	179.13	181.3	2.17	161.92	123.5
	NMNL-2 (22%)	73	179.13	181.27	2.14	158.5	122.83
	NMNL-2 (21%)	69.69	179.13	181.24	2.11	155.03	121.93
	NMNL-2 (20%)	66.37	179.13	181.21	2.08	151.54	120.89
	NMNL-2 (19%)	63.05	179.13	181.18	2.05	148.02	119.83
	NMNL-2 (18%)	59.73	179.13	181.15	2.02	144.38	118.71
	NMNL-2 (17%)	56.41	179.13	181.12	1.99	140.75	117.6
	NMNL-2 (16%)	53.09	179.13	181.09	1.96	137.04	116.44
	NMNL-2 (15%)	49.78	179.13	181.06	1.93	133.26	115.26
	L (100%)	133.58	179.13	181.74	2.61	218.22	132.62
	L (30%)	40.08	179.13	180.95	1.82	121.79	96.45
	L (29%)	38.74	179.13	180.94	1.81	120.32	95.96
	L (28%)	37.4	179.13	180.92	1.79	118.82	95.47
	L (27%)	36.07	179.13	180.91	1.78	117.33	94.98
	L (26%)	34.73	179.13	180.89	1.76	115.78	94.47
	L (25%)	33.4	179.13	180.87	1.74	113.93	93.85
	L (24%)	32.06	179.13	180.85	1.72	111.84	93.15
	L (23%)	30.72	179.13	180.82	1.69	109.64	92.4
	L (22%)	29.39	179.13	180.8	1.67	107.63	91.72
	L (21%)	28.05	179.13	180.78	1.65	105.52	90.99
	L (20%)	26.72	179.13	180.76	1.63	103.36	90.24
	L (19%)	25.38	179.13	180.73	1.6	101.09	89.45
	L (18%)	24.05	179.13	180.7	1.57	98.71	88.6
	L (17%)	22.71	179.13	180.67	1.54	96.21	87.77
	L (16%)	21.37	179.13	180.64	1.51	93.57	86.88
	L (15%)	20.04	179.13	180.61	1.48	90.79	85.94
500 m d/s of Barrage axis	M (100%)	1003.92	178.99	185.06	6.07	586.49	132.93
	M (30%)	301.18	178.99	182.74	3.75	298.83	114.68
	M (29%)	291.14	178.99	182.69	3.7	293.09	114.25
	M (28%)	281.1	178.99	182.63	3.64	287.15	113.8
	M (27%)	271.06	178.99	182.58	3.59	280.94	113.3
	M (26%)	261.02	178.99	182.53	3.54	274.89	112.78
	M (25%)	250.98	178.99	182.47	3.48	268.56	112.24
	M (24%)	240.94	178.99	182.41	3.42	262.14	111.69
	M (23%)	230.9	178.99	182.35	3.36	255.45	111.12

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (22%)	220.86	178.99	182.29	3.3	248.76	110.54
	M (21%)	210.82	178.99	182.23	3.24	241.78	109.93
	M (20%)	200.78	178.99	182.17	3.18	235.01	109.33
	M (19%)	190.74	178.99	182.1	3.11	227.57	108.68
	M (18%)	180.71	178.99	182.03	3.04	220.3	108.04
	M (17%)	170.67	178.99	181.97	2.98	213.18	107.4
	M (16%)	160.63	178.99	181.9	2.91	205.75	106.73
	M (15%)	150.59	178.99	181.83	2.84	198.17	106.03
	NMNL-1 (100%)	306	178.99	182.76	3.77	301.48	114.87
	NMNL-1 (30%)	91.8	178.99	181.4	2.41	154.43	88.1
	NMNL-1 (29%)	88.74	178.99	181.37	2.38	152.4	86.63
	NMNL-1 (28%)	85.68	178.99	181.35	2.36	150.36	86.32
	NMNL-1 (27%)	82.62	178.99	181.33	2.34	148.31	86
	NMNL-1 (26%)	79.56	178.99	181.3	2.31	146.26	85.68
	NMNL-1 (25%)	76.5	178.99	181.28	2.29	144.18	85.35
	NMNL-1 (24%)	73.44	178.99	181.25	2.26	142.07	85.02
	NMNL-1 (23%)	70.38	178.99	181.23	2.24	139.94	84.68
	NMNL-1 (22%)	67.32	178.99	181.2	2.21	137.77	84.34
	NMNL-1 (21%)	64.26	178.99	181.18	2.19	135.59	83.99
	NMNL-1 (20%)	61.2	178.99	181.15	2.16	133.37	83.64
	NMNL-1 (19%)	58.14	178.99	181.12	2.13	131.07	83.27
	NMNL-1 (18%)	55.08	178.99	181.1	2.11	128.76	82.9
	NMNL-1 (17%)	52.02	178.99	181.07	2.08	126.39	82.51
	NMNL-1 (16%)	48.96	178.99	181.04	2.05	123.97	82.12
	NMNL-1 (15%)	45.9	178.99	181.01	2.02	121.44	81.69
	NMNL-2 (100%)	331.83	178.99	182.88	3.89	315.36	115.9
	NMNL-2 (30%)	99.55	178.99	181.46	2.47	159.96	99.22
	NMNL-2 (29%)	96.23	178.99	181.43	2.44	157.51	95.58
	NMNL-2 (28%)	92.91	178.99	181.41	2.42	155.18	89.98
	NMNL-2 (27%)	89.6	178.99	181.38	2.39	152.98	86.72
	NMNL-2 (26%)	86.28	178.99	181.36	2.37	150.76	86.38
	NMNL-2 (25%)	82.96	178.99	181.33	2.34	148.54	86.03
	NMNL-2 (24%)	79.64	178.99	181.3	2.31	146.31	85.68
	NMNL-2 (23%)	76.32	178.99	181.28	2.29	144.06	85.33
	NMNL-2 (22%)	73	178.99	181.25	2.26	141.76	84.97
	NMNL-2 (21%)	69.69	178.99	181.22	2.23	139.46	84.61
	NMNL-2 (20%)	66.37	178.99	181.2	2.21	137.1	84.23
	NMNL-2 (19%)	63.05	178.99	181.17	2.18	134.72	83.85
	NMNL-2 (18%)	59.73	178.99	181.14	2.15	132.26	83.46
	NMNL-2 (17%)	56.41	178.99	181.11	2.12	129.78	83.06
	NMNL-2 (16%)	53.09	178.99	181.08	2.09	127.22	82.65
	NMNL-2 (15%)	49.78	178.99	181.05	2.06	124.62	82.22
	L (100%)	133.58	178.99	181.71	2.72	185.51	104.71
	L (30%)	40.08	178.99	180.94	1.95	116.27	80.78

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (29%)	38.74	178.99	180.93	1.94	115.06	80.56
	L (28%)	37.4	178.99	180.91	1.92	113.83	80.35
	L (27%)	36.07	178.99	180.9	1.91	112.6	80.13
	L (26%)	34.73	178.99	180.88	1.89	111.31	79.9
	L (25%)	33.4	178.99	180.86	1.87	109.77	79.62
	L (24%)	32.06	178.99	180.84	1.85	108.02	79.3
	L (23%)	30.72	178.99	180.82	1.83	106.16	78.97
	L (22%)	29.39	178.99	180.79	1.8	104.46	78.66
	L (21%)	28.05	178.99	180.77	1.78	102.66	78.33
	L (20%)	26.72	178.99	180.75	1.76	100.82	78.02
	L (19%)	25.38	178.99	180.72	1.73	98.87	77.74
	L (18%)	24.05	178.99	180.7	1.71	96.81	77.44
	L (17%)	22.71	178.99	180.67	1.68	94.64	77.12
	L (16%)	21.37	178.99	180.64	1.65	92.33	76.78
	L (15%)	20.04	178.99	180.61	1.62	89.89	76.42
550 m d/s of Barrage axis	M (100%)	1003.92	178.86	184.83	5.97	409.92	116.51
	M (30%)	301.18	178.86	182.54	3.68	161.83	96.02
	M (29%)	291.14	178.86	182.49	3.63	157.13	89.77
	M (28%)	281.1	178.86	182.44	3.58	152.84	83.34
	M (27%)	271.06	178.86	182.39	3.53	148.34	82.26
	M (26%)	261.02	178.86	182.34	3.48	144.08	81.22
	M (25%)	250.98	178.86	182.28	3.42	139.6	80.11
	M (24%)	240.94	178.86	182.22	3.36	135.12	78.99
	M (23%)	230.9	178.86	182.17	3.31	130.69	78.33
	M (22%)	220.86	178.86	182.11	3.25	126.04	77.77
	M (21%)	210.82	178.86	182.04	3.18	121.15	77.17
	M (20%)	200.78	178.86	181.98	3.12	116.5	76.59
	M (19%)	190.74	178.86	181.92	3.06	111.44	75.96
	M (18%)	180.71	178.86	181.85	2.99	106.4	75.33
	M (17%)	170.67	178.86	181.79	2.93	101.55	74.71
	M (16%)	160.63	178.86	181.72	2.86	96.45	74.06
	M (15%)	150.59	178.86	181.65	2.79	91.33	73.4
	NMNL-1 (100%)	306	178.86	182.57	3.71	164.07	96.48
	NMNL-1 (30%)	91.8	178.86	181.24	2.38	62.39	69.54
	NMNL-1 (29%)	88.74	178.86	181.22	2.36	60.92	69.34
	NMNL-1 (28%)	85.68	178.86	181.2	2.34	59.44	69.14
	NMNL-1 (27%)	82.62	178.86	181.18	2.32	57.95	68.93
	NMNL-1 (26%)	79.56	178.86	181.16	2.3	56.47	68.72
	NMNL-1 (25%)	76.5	178.86	181.14	2.28	54.99	68.52
	NMNL-1 (24%)	73.44	178.86	181.11	2.25	53.47	68.3
	NMNL-1 (23%)	70.38	178.86	181.09	2.23	51.95	68.09
	NMNL-1 (22%)	67.32	178.86	181.07	2.21	50.4	67.87
	NMNL-1 (21%)	64.26	178.86	181.05	2.19	48.85	67.65

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (20%)	61.2	178.86	181.02	2.16	47.27	67.43
	NMNL-1 (19%)	58.14	178.86	181	2.14	45.6	67.19
	NMNL-1 (18%)	55.08	178.86	180.97	2.11	43.95	66.95
	NMNL-1 (17%)	52.02	178.86	180.95	2.09	42.24	66.71
	NMNL-1 (16%)	48.96	178.86	180.92	2.06	40.49	66.46
	NMNL-1 (15%)	45.9	178.86	180.89	2.03	38.64	66.19
	NMNL-2 (100%)	331.83	178.86	182.69	3.83	175.88	99.09
	NMNL-2 (30%)	99.55	178.86	181.3	2.44	66.11	70.05
	NMNL-2 (29%)	96.23	178.86	181.27	2.41	64.52	69.84
	NMNL-2 (28%)	92.91	178.86	181.25	2.39	62.93	69.62
	NMNL-2 (27%)	89.6	178.86	181.23	2.37	61.34	69.4
	NMNL-2 (26%)	86.28	178.86	181.21	2.35	59.73	69.18
	NMNL-2 (25%)	82.96	178.86	181.18	2.32	58.12	68.95
	NMNL-2 (24%)	79.64	178.86	181.16	2.3	56.51	68.73
	NMNL-2 (23%)	76.32	178.86	181.13	2.27	54.9	68.51
	NMNL-2 (22%)	73	178.86	181.11	2.25	53.25	68.27
	NMNL-2 (21%)	69.69	178.86	181.09	2.23	51.6	68.04
	NMNL-2 (20%)	66.37	178.86	181.06	2.2	49.92	67.81
	NMNL-2 (19%)	63.05	178.86	181.04	2.18	48.23	67.57
	NMNL-2 (18%)	59.73	178.86	181.01	2.15	46.46	67.31
	NMNL-2 (17%)	56.41	178.86	180.98	2.12	44.68	67.06
	NMNL-2 (16%)	53.09	178.86	180.96	2.1	42.84	66.8
	NMNL-2 (15%)	49.78	178.86	180.93	2.07	40.96	66.53
	L (100%)	133.58	178.86	181.53	2.67	82.8	72.29
	L (30%)	40.08	178.86	180.83	1.97	34.75	65.62
	L (29%)	38.74	178.86	180.82	1.96	33.84	65.49
	L (28%)	37.4	178.86	180.81	1.95	32.91	65.36
	L (27%)	36.07	178.86	180.79	1.93	31.99	65.22
	L (26%)	34.73	178.86	180.78	1.92	31	65.07
	L (25%)	33.4	178.86	180.76	1.9	29.67	63.82
	L (24%)	32.06	178.86	180.73	1.87	28.14	60.83
	L (23%)	30.72	178.86	180.71	1.85	26.56	57.57
	L (22%)	29.39	178.86	180.68	1.82	25.27	54.77
	L (21%)	28.05	178.86	180.66	1.8	23.97	51.79
	L (20%)	26.72	178.86	180.63	1.77	22.7	48.72
	L (19%)	25.38	178.86	180.61	1.75	21.46	45.47
	L (18%)	24.05	178.86	180.58	1.72	20.21	41.98
	L (17%)	22.71	178.86	180.55	1.69	18.99	38.8
	L (16%)	21.37	178.86	180.52	1.66	17.79	35.52
	L (15%)	20.04	178.86	180.48	1.62	16.61	32.27
600 m d/s of Barrage	M (100%)	1003.92	178.71	184.78	6.07	442.91	122.66
	M (30%)	301.18	178.71	182.42	3.71	173.04	104.08
	M (29%)	291.14	178.71	182.37	3.66	167.66	103.02

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
axis	M (28%)	281.1	178.71	182.32	3.61	162.21	101.93
	M (27%)	271.06	178.71	182.27	3.56	156.72	100.83
	M (26%)	261.02	178.71	182.21	3.5	151.22	99.71
	M (25%)	250.98	178.71	182.15	3.44	145.59	98.55
	M (24%)	240.94	178.71	182.1	3.39	139.97	97.38
	M (23%)	230.9	178.71	182.04	3.33	134.26	95.7
	M (22%)	220.86	178.71	181.98	3.27	128.56	93.09
	M (21%)	210.82	178.71	181.91	3.2	123.04	78.56
	M (20%)	200.78	178.71	181.85	3.14	118.2	75.79
	M (19%)	190.74	178.71	181.78	3.07	112.85	74.97
	M (18%)	180.71	178.71	181.71	3	107.49	74.13
	M (17%)	170.67	178.71	181.64	2.93	102.32	73.32
	M (16%)	160.63	178.71	181.56	2.85	96.76	72.43
	M (15%)	150.59	178.71	181.48	2.77	91.09	71.52
	NMNL-1 (100%)	306	178.71	182.45	3.74	175.61	104.58
	NMNL-1 (30%)	91.8	178.71	181	2.29	58.06	65.16
	NMNL-1 (29%)	88.74	178.71	180.97	2.26	56.38	64.02
	NMNL-1 (28%)	85.68	178.71	180.95	2.24	54.73	62.89
	NMNL-1 (27%)	82.62	178.71	180.92	2.21	53.13	61.77
	NMNL-1 (26%)	79.56	178.71	180.9	2.19	51.57	60.67
	NMNL-1 (25%)	76.5	178.71	180.87	2.16	50.08	59.59
	NMNL-1 (24%)	73.44	178.71	180.85	2.14	48.6	58.5
	NMNL-1 (23%)	70.38	178.71	180.82	2.11	47.11	57.38
	NMNL-1 (22%)	67.32	178.71	180.8	2.09	45.67	56.27
	NMNL-1 (21%)	64.26	178.71	180.77	2.06	44.28	55.19
	NMNL-1 (20%)	61.2	178.71	180.75	2.04	42.92	54.11
	NMNL-1 (19%)	58.14	178.71	180.72	2.01	41.6	53.15
	NMNL-1 (18%)	55.08	178.71	180.7	1.99	40.25	52.16
	NMNL-1 (17%)	52.02	178.71	180.67	1.96	38.86	51.11
	NMNL-1 (16%)	48.96	178.71	180.64	1.93	37.43	50.02
	NMNL-1 (15%)	45.9	178.71	180.61	1.9	35.9	48.82
	NMNL-2 (100%)	331.83	178.71	182.58	3.87	189.11	107.18
	NMNL-2 (30%)	99.55	178.71	181.06	2.35	62.33	66.69
	NMNL-2 (29%)	96.23	178.71	181.04	2.33	60.5	66.37
	NMNL-2 (28%)	92.91	178.71	181.01	2.3	58.67	65.56
	NMNL-2 (27%)	89.6	178.71	180.98	2.27	56.85	64.34
	NMNL-2 (26%)	86.28	178.71	180.95	2.24	55.05	63.12
	NMNL-2 (25%)	82.96	178.71	180.93	2.22	53.3	61.9
	NMNL-2 (24%)	79.64	178.71	180.9	2.19	51.61	60.7
	NMNL-2 (23%)	76.32	178.71	180.87	2.16	49.99	59.52
	NMNL-2 (22%)	73	178.71	180.84	2.13	48.38	58.34
	NMNL-2 (21%)	69.69	178.71	180.82	2.11	46.78	57.13
	NMNL-2 (20%)	66.37	178.71	180.79	2.08	45.23	55.93
	NMNL-2 (19%)	63.05	178.71	180.76	2.05	43.74	54.76

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (18%)	59.73	178.71	180.73	2.02	42.29	53.64
	NMNL-2 (17%)	56.41	178.71	180.71	2	40.83	52.58
	NMNL-2 (16%)	53.09	178.71	180.68	1.97	39.35	51.48
	NMNL-2 (15%)	49.78	178.71	180.65	1.94	37.81	50.32
	L (100%)	133.58	178.71	181.35	2.64	81.56	69.97
	L (30%)	40.08	178.71	180.54	1.83	32.62	46.15
	L (29%)	38.74	178.71	180.52	1.81	31.81	45.46
	L (28%)	37.4	178.71	180.51	1.8	31.02	44.79
	L (27%)	36.07	178.71	180.49	1.78	30.27	44.14
	L (26%)	34.73	178.71	180.47	1.76	29.5	43.46
	L (25%)	33.4	178.71	180.45	1.74	28.73	42.77
	L (24%)	32.06	178.71	180.43	1.72	27.94	42.04
	L (23%)	30.72	178.71	180.42	1.71	27.13	41.29
	L (22%)	29.39	178.71	180.4	1.69	26.32	40.53
	L (21%)	28.05	178.71	180.38	1.67	25.51	39.75
	L (20%)	26.72	178.71	180.35	1.64	24.69	38.94
	L (19%)	25.38	178.71	180.33	1.62	23.85	38.1
	L (18%)	24.05	178.71	180.31	1.6	22.99	37.21
	L (17%)	22.71	178.71	180.29	1.58	22.12	36.31
	L (16%)	21.37	178.71	180.26	1.55	21.23	35.36
	L (15%)	20.04	178.71	180.24	1.53	20.33	34.38
650 m d/s of Barrage axis	M (100%)	1003.92	178.59	184.77	6.18	515.82	136.93
	M (30%)	301.18	178.59	182.36	3.77	209.8	114.73
	M (29%)	291.14	178.59	182.31	3.72	203.55	114.08
	M (28%)	281.1	178.59	182.25	3.66	197.17	113.41
	M (27%)	271.06	178.59	182.19	3.6	190.69	112.73
	M (26%)	261.02	178.59	182.13	3.54	184.1	112.04
	M (25%)	250.98	178.59	182.07	3.48	177.33	111.32
	M (24%)	240.94	178.59	182.01	3.42	170.47	110.69
	M (23%)	230.9	178.59	181.95	3.36	163.45	110.09
	M (22%)	220.86	178.59	181.88	3.29	156.28	109.45
	M (21%)	210.82	178.59	181.81	3.22	148.95	107.41
	M (20%)	200.78	178.59	181.74	3.15	141.53	105.3
	M (19%)	190.74	178.59	181.67	3.08	134.04	103.07
	M (18%)	180.71	178.59	181.6	3.01	126.47	100.65
	M (17%)	170.67	178.59	181.52	2.93	118.84	98.16
	M (16%)	160.63	178.59	181.44	2.85	111.17	95.57
	M (15%)	150.59	178.59	181.36	2.77	103.48	92.91
	NMNL-1 (100%)	306	178.59	182.39	3.8	212.77	115.03
	NMNL-1 (30%)	91.8	178.59	180.8	2.21	63.03	65.56
	NMNL-1 (29%)	88.74	178.59	180.77	2.18	60.82	65.07
	NMNL-1 (28%)	85.68	178.59	180.73	2.14	58.56	64.57
	NMNL-1 (27%)	82.62	178.59	180.7	2.11	56.32	64.06

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (26%)	79.56	178.59	180.66	2.07	54.06	63.55
	NMNL-1 (25%)	76.5	178.59	180.63	2.04	51.77	63.03
	NMNL-1 (24%)	73.44	178.59	180.59	2	49.45	62.5
	NMNL-1 (23%)	70.38	178.59	180.55	1.96	47.11	61.96
	NMNL-1 (22%)	67.32	178.59	180.51	1.92	44.74	61.41
	NMNL-1 (21%)	64.26	178.59	180.47	1.88	42.38	60.85
	NMNL-1 (20%)	61.2	178.59	180.43	1.84	39.99	60.28
	NMNL-1 (19%)	58.14	178.59	180.39	1.8	37.59	59.71
	NMNL-1 (18%)	55.08	178.59	180.35	1.76	35.12	57.6
	NMNL-1 (17%)	52.02	178.59	180.31	1.72	32.81	54.97
	NMNL-1 (16%)	48.96	178.59	180.27	1.68	30.54	52.25
	NMNL-1 (15%)	45.9	178.59	180.23	1.64	28.39	49.85
	NMNL-2 (100%)	331.83	178.59	182.52	3.93	228.23	116.62
	NMNL-2 (30%)	99.55	178.59	180.88	2.29	68.42	66.73
	NMNL-2 (29%)	96.23	178.59	180.85	2.26	66.13	66.23
	NMNL-2 (28%)	92.91	178.59	180.81	2.22	63.8	65.73
	NMNL-2 (27%)	89.6	178.59	180.78	2.19	61.44	65.21
	NMNL-2 (26%)	86.28	178.59	180.74	2.15	59.02	64.67
	NMNL-2 (25%)	82.96	178.59	180.7	2.11	56.56	64.12
	NMNL-2 (24%)	79.64	178.59	180.66	2.07	54.12	63.57
	NMNL-2 (23%)	76.32	178.59	180.62	2.03	51.63	63
	NMNL-2 (22%)	73	178.59	180.58	1.99	49.12	62.42
	NMNL-2 (21%)	69.69	178.59	180.54	1.95	46.56	61.83
	NMNL-2 (20%)	66.37	178.59	180.5	1.91	44.01	61.23
	NMNL-2 (19%)	63.05	178.59	180.46	1.87	41.43	60.62
	NMNL-2 (18%)	59.73	178.59	180.42	1.83	38.84	60.01
	NMNL-2 (17%)	56.41	178.59	180.37	1.78	36.2	58.79
	NMNL-2 (16%)	53.09	178.59	180.33	1.74	33.61	55.9
	NMNL-2 (15%)	49.78	178.59	180.28	1.69	31.15	53
	L (100%)	133.58	178.59	181.21	2.62	91.34	71.54
	L (30%)	40.08	178.59	180.15	1.56	24.75	46.35
	L (29%)	38.74	178.59	180.13	1.54	23.96	45.55
	L (28%)	37.4	178.59	180.12	1.53	23.1	44.67
	L (27%)	36.07	178.59	180.1	1.51	22.25	43.78
	L (26%)	34.73	178.59	180.08	1.49	21.42	42.9
	L (25%)	33.4	178.59	180.06	1.47	20.62	42.03
	L (24%)	32.06	178.59	180.04	1.45	19.89	41.21
	L (23%)	30.72	178.59	180.02	1.43	19.17	40.4
	L (22%)	29.39	178.59	180.01	1.42	18.49	39.64
	L (21%)	28.05	178.59	179.99	1.4	17.81	38.87
	L (20%)	26.72	178.59	179.97	1.38	17.16	38.11
	L (19%)	25.38	178.59	179.95	1.36	16.51	37.26
	L (18%)	24.05	178.59	179.94	1.35	15.83	36.32
	L (17%)	22.71	178.59	179.92	1.33	15.15	35.35

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (16%)	21.37	178.59	179.9	1.31	14.48	34.38
	L (15%)	20.04	178.59	179.88	1.29	13.83	33.4
700 m d/s of Barrage axis	M (100%)	1003.92	178.45	184.78	6.33	647.73	149
	M (30%)	301.18	178.45	182.36	3.91	316.56	125.61
	M (29%)	291.14	178.45	182.31	3.86	309.66	125.13
	M (28%)	281.1	178.45	182.25	3.8	302.62	124.64
	M (27%)	271.06	178.45	182.19	3.74	295.44	124.13
	M (26%)	261.02	178.45	182.13	3.68	288.1	123.64
	M (25%)	250.98	178.45	182.07	3.62	280.54	123.26
	M (24%)	240.94	178.45	182.01	3.56	272.85	122.86
	M (23%)	230.9	178.45	181.94	3.49	264.97	122.46
	M (22%)	220.86	178.45	181.88	3.43	256.88	122.05
	M (21%)	210.82	178.45	181.81	3.36	248.52	121.62
	M (20%)	200.78	178.45	181.74	3.29	239.92	121.17
	M (19%)	190.74	178.45	181.67	3.22	231.05	120.71
	M (18%)	180.71	178.45	181.59	3.14	221.93	120.24
	M (17%)	170.67	178.45	181.51	3.06	212.52	119.74
	M (16%)	160.63	178.45	181.43	2.98	202.82	119.24
	M (15%)	150.59	178.45	181.35	2.9	192.86	118.71
	NMNL-1 (100%)	306	178.45	182.39	3.94	319.83	125.84
	NMNL-1 (30%)	91.8	178.45	180.77	2.32	126.09	112.47
	NMNL-1 (29%)	88.74	178.45	180.74	2.29	122.22	110.4
	NMNL-1 (28%)	85.68	178.45	180.7	2.25	118.35	107.75
	NMNL-1 (27%)	82.62	178.45	180.67	2.22	114.51	104.97
	NMNL-1 (26%)	79.56	178.45	180.63	2.18	110.7	102.14
	NMNL-1 (25%)	76.5	178.45	180.59	2.14	106.91	99.26
	NMNL-1 (24%)	73.44	178.45	180.56	2.11	103.15	96.3
	NMNL-1 (23%)	70.38	178.45	180.52	2.07	99.43	93.28
	NMNL-1 (22%)	67.32	178.45	180.48	2.03	95.73	90.22
	NMNL-1 (21%)	64.26	178.45	180.43	1.98	92.05	87.07
	NMNL-1 (20%)	61.2	178.45	180.39	1.94	88.41	83.83
	NMNL-1 (19%)	58.14	178.45	180.35	1.9	84.85	77.7
	NMNL-1 (18%)	55.08	178.45	180.3	1.85	81.58	67.48
	NMNL-1 (17%)	52.02	178.45	180.26	1.81	78.5	66.59
	NMNL-1 (16%)	48.96	178.45	180.21	1.76	75.3	65.65
	NMNL-1 (15%)	45.9	178.45	180.16	1.71	72.03	64.67
	NMNL-2 (100%)	331.83	178.45	182.52	4.07	336.81	127.01
	NMNL-2 (30%)	99.55	178.45	180.86	2.41	135.77	115.65
	NMNL-2 (29%)	96.23	178.45	180.82	2.37	131.61	115.36
	NMNL-2 (28%)	92.91	178.45	180.79	2.34	127.46	113.19
	NMNL-2 (27%)	89.6	178.45	180.75	2.3	123.31	110.99
	NMNL-2 (26%)	86.28	178.45	180.71	2.26	119.11	108.29
	NMNL-2 (25%)	82.96	178.45	180.67	2.22	114.94	105.28

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (24%)	79.64	178.45	180.63	2.18	110.8	102.22
	NMNL-2 (23%)	76.32	178.45	180.59	2.14	106.69	99.08
	NMNL-2 (22%)	73	178.45	180.55	2.1	102.62	95.86
	NMNL-2 (21%)	69.69	178.45	180.51	2.06	98.59	92.6
	NMNL-2 (20%)	66.37	178.45	180.46	2.01	94.59	89.25
	NMNL-2 (19%)	63.05	178.45	180.42	1.97	90.6	85.79
	NMNL-2 (18%)	59.73	178.45	180.37	1.92	86.68	81.82
	NMNL-2 (17%)	56.41	178.45	180.32	1.87	82.93	71.91
	NMNL-2 (16%)	53.09	178.45	180.27	1.82	79.57	66.9
	NMNL-2 (15%)	49.78	178.45	180.22	1.77	76.19	65.91
	L (100%)	133.58	178.45	181.2	2.75	175.18	117.77
	L (30%)	40.08	178.45	180.06	1.61	65.51	62.69
	L (29%)	38.74	178.45	180.03	1.58	63.95	62.21
	L (28%)	37.4	178.45	180.01	1.56	62.37	61.73
	L (27%)	36.07	178.45	179.98	1.53	60.76	61.23
	L (26%)	34.73	178.45	179.95	1.5	59.14	60.72
	L (25%)	33.4	178.45	179.93	1.48	57.51	60.21
	L (24%)	32.06	178.45	179.9	1.45	55.83	59.67
	L (23%)	30.72	178.45	179.87	1.42	54.12	59.12
	L (22%)	29.39	178.45	179.84	1.39	52.39	58.56
	L (21%)	28.05	178.45	179.81	1.36	50.61	57.98
	L (20%)	26.72	178.45	179.78	1.33	48.8	57.38
	L (19%)	25.38	178.45	179.74	1.29	46.96	56.76
	L (18%)	24.05	178.45	179.71	1.26	45.08	56.15
	L (17%)	22.71	178.45	179.68	1.23	43.14	55.5
	L (16%)	21.37	178.45	179.64	1.19	41.12	54.82
	L (15%)	20.04	178.45	179.6	1.15	39.05	54.12
750 m d/s of Barrage axis	M (100%)	1003.92	178.32	184.76	6.44	650.17	140.94
	M (30%)	301.18	178.32	182.35	4.03	340.14	118.75
	M (29%)	291.14	178.32	182.29	3.97	333.63	118.3
	M (28%)	281.1	178.32	182.24	3.92	326.99	117.84
	M (27%)	271.06	178.32	182.18	3.86	320.21	117.37
	M (26%)	261.02	178.32	182.12	3.8	313.28	116.88
	M (25%)	250.98	178.32	182.06	3.74	306.15	116.38
	M (24%)	240.94	178.32	182	3.68	298.9	115.87
	M (23%)	230.9	178.32	181.93	3.61	291.48	115.34
	M (22%)	220.86	178.32	181.86	3.54	283.87	114.8
	M (21%)	210.82	178.32	181.8	3.48	276.02	114.23
	M (20%)	200.78	178.32	181.73	3.41	267.95	113.65
	M (19%)	190.74	178.32	181.65	3.33	259.63	113.05
	M (18%)	180.71	178.32	181.58	3.26	251.09	112.42
	M (17%)	170.67	178.32	181.5	3.18	242.29	111.78
	M (16%)	160.63	178.32	181.42	3.1	233.23	111.11

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (15%)	150.59	178.32	181.33	3.01	223.95	110.41
	NMNL-1 (100%)	306	178.32	182.37	4.05	343.22	118.96
	NMNL-1 (30%)	91.8	178.32	180.76	2.44	161.96	105.67
	NMNL-1 (29%)	88.74	178.32	180.72	2.4	158.28	105.38
	NMNL-1 (28%)	85.68	178.32	180.69	2.37	154.52	105.08
	NMNL-1 (27%)	82.62	178.32	180.65	2.33	150.71	104.78
	NMNL-1 (26%)	79.56	178.32	180.61	2.29	146.83	104.47
	NMNL-1 (25%)	76.5	178.32	180.58	2.26	142.88	104.15
	NMNL-1 (24%)	73.44	178.32	180.54	2.22	138.87	103.83
	NMNL-1 (23%)	70.38	178.32	180.5	2.18	134.77	103.5
	NMNL-1 (22%)	67.32	178.32	180.46	2.14	130.6	103.17
	NMNL-1 (21%)	64.26	178.32	180.42	2.1	126.33	102.82
	NMNL-1 (20%)	61.2	178.32	180.37	2.05	121.96	102.47
	NMNL-1 (19%)	58.14	178.32	180.33	2.01	117.51	102.1
	NMNL-1 (18%)	55.08	178.32	180.29	1.97	112.94	101.13
	NMNL-1 (17%)	52.02	178.32	180.24	1.92	108.36	98.45
	NMNL-1 (16%)	48.96	178.32	180.19	1.87	103.71	95.73
	NMNL-1 (15%)	45.9	178.32	180.14	1.82	99.01	93.15
	NMNL-2 (100%)	331.83	178.32	182.51	4.19	359.24	120.06
	NMNL-2 (30%)	99.55	178.32	180.84	2.52	170.95	106.37
	NMNL-2 (29%)	96.23	178.32	180.81	2.49	167.11	106.07
	NMNL-2 (28%)	92.91	178.32	180.77	2.45	163.25	105.77
	NMNL-2 (27%)	89.6	178.32	180.73	2.41	159.32	105.46
	NMNL-2 (26%)	86.28	178.32	180.7	2.38	155.26	105.14
	NMNL-2 (25%)	82.96	178.32	180.66	2.34	151.14	104.81
	NMNL-2 (24%)	79.64	178.32	180.62	2.3	146.93	104.47
	NMNL-2 (23%)	76.32	178.32	180.57	2.25	142.64	104.13
	NMNL-2 (22%)	73	178.32	180.53	2.21	138.28	103.78
	NMNL-2 (21%)	69.69	178.32	180.49	2.17	133.85	103.43
	NMNL-2 (20%)	66.37	178.32	180.45	2.13	129.28	103.06
	NMNL-2 (19%)	63.05	178.32	180.4	2.08	124.6	102.68
	NMNL-2 (18%)	59.73	178.32	180.35	2.03	119.83	102.29
	NMNL-2 (17%)	56.41	178.32	180.31	1.99	114.94	101.89
	NMNL-2 (16%)	53.09	178.32	180.26	1.94	109.94	99.38
	NMNL-2 (15%)	49.78	178.32	180.21	1.89	104.97	96.41
	L (100%)	133.58	178.32	181.18	2.86	207.49	109.18
	L (30%)	40.08	178.32	180.04	1.72	89.85	85.76
	L (29%)	38.74	178.32	180.02	1.7	87.73	84.09
	L (28%)	37.4	178.32	179.99	1.67	85.62	82.42
	L (27%)	36.07	178.32	179.96	1.64	83.49	80.71
	L (26%)	34.73	178.32	179.94	1.62	81.36	79.45
	L (25%)	33.4	178.32	179.91	1.59	79.23	78.35
	L (24%)	32.06	178.32	179.88	1.56	77.06	77.21
	L (23%)	30.72	178.32	179.85	1.53	74.86	76.04

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (22%)	29.39	178.32	179.82	1.5	72.65	74.84
	L (21%)	28.05	178.32	179.79	1.47	70.38	72.69
	L (20%)	26.72	178.32	179.76	1.44	68.13	70.22
	L (19%)	25.38	178.32	179.73	1.41	65.89	68.69
	L (18%)	24.05	178.32	179.7	1.38	63.62	67.76
	L (17%)	22.71	178.32	179.66	1.34	61.27	66.78
	L (16%)	21.37	178.32	179.63	1.31	58.83	65.75
	L (15%)	20.04	178.32	179.59	1.27	56.33	64.68
800 m d/s of Barrage axis	M (100%)	1003.92	178.18	184.71	6.53	610.1	131.06
	M (30%)	301.18	178.18	182.32	4.14	320.59	110.66
	M (29%)	291.14	178.18	182.27	4.09	314.57	110.18
	M (28%)	281.1	178.18	182.21	4.03	308.41	109.67
	M (27%)	271.06	178.18	182.16	3.98	302.15	109.16
	M (26%)	261.02	178.18	182.1	3.92	295.74	108.64
	M (25%)	250.98	178.18	182.04	3.86	289.15	108.09
	M (24%)	240.94	178.18	181.97	3.79	282.45	107.54
	M (23%)	230.9	178.18	181.91	3.73	275.6	106.97
	M (22%)	220.86	178.18	181.84	3.66	268.58	106.38
	M (21%)	210.82	178.18	181.78	3.6	261.33	105.77
	M (20%)	200.78	178.18	181.71	3.53	253.9	105.14
	M (19%)	190.74	178.18	181.63	3.45	246.23	104.49
	M (18%)	180.71	178.18	181.56	3.38	238.37	103.81
	M (17%)	170.67	178.18	181.48	3.3	230.28	103.11
	M (16%)	160.63	178.18	181.4	3.22	221.95	102.39
	M (15%)	150.59	178.18	181.31	3.13	213.42	101.64
	NMNL-1 (100%)	306	178.18	182.35	4.17	323.45	110.89
	NMNL-1 (30%)	91.8	178.18	180.74	2.56	157.46	91.43
	NMNL-1 (29%)	88.74	178.18	180.71	2.53	154.31	89.75
	NMNL-1 (28%)	85.68	178.18	180.67	2.49	151.15	88.04
	NMNL-1 (27%)	82.62	178.18	180.64	2.46	147.99	86.81
	NMNL-1 (26%)	79.56	178.18	180.6	2.42	144.81	85.96
	NMNL-1 (25%)	76.5	178.18	180.56	2.38	141.59	85.09
	NMNL-1 (24%)	73.44	178.18	180.52	2.34	138.34	84.2
	NMNL-1 (23%)	70.38	178.18	180.48	2.3	135.06	83.3
	NMNL-1 (22%)	67.32	178.18	180.44	2.26	131.74	82.37
	NMNL-1 (21%)	64.26	178.18	180.4	2.22	128.37	81.42
	NMNL-1 (20%)	61.2	178.18	180.36	2.18	124.95	80.5
	NMNL-1 (19%)	58.14	178.18	180.32	2.14	121.5	79.67
	NMNL-1 (18%)	55.08	178.18	180.27	2.09	117.98	78.82
	NMNL-1 (17%)	52.02	178.18	180.23	2.05	114.43	77.95
	NMNL-1 (16%)	48.96	178.18	180.18	2	110.76	77.02
	NMNL-1 (15%)	45.9	178.18	180.13	1.95	106.99	76.04
	NMNL-2 (100%)	331.83	178.18	182.48	4.3	338.29	112.08

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (30%)	99.55	178.18	180.83	2.65	165.33	94.05
	NMNL-2 (29%)	96.23	178.18	180.79	2.61	161.95	93.29
	NMNL-2 (28%)	92.91	178.18	180.75	2.57	158.57	92.01
	NMNL-2 (27%)	89.6	178.18	180.72	2.54	155.2	90.23
	NMNL-2 (26%)	86.28	178.18	180.68	2.5	151.77	88.38
	NMNL-2 (25%)	82.96	178.18	180.64	2.46	148.35	86.91
	NMNL-2 (24%)	79.64	178.18	180.6	2.42	144.89	85.98
	NMNL-2 (23%)	76.32	178.18	180.56	2.38	141.4	85.04
	NMNL-2 (22%)	73	178.18	180.52	2.34	137.87	84.07
	NMNL-2 (21%)	69.69	178.18	180.47	2.29	134.32	83.09
	NMNL-2 (20%)	66.37	178.18	180.43	2.25	130.7	82.08
	NMNL-2 (19%)	63.05	178.18	180.39	2.21	127.02	81.04
	NMNL-2 (18%)	59.73	178.18	180.34	2.16	123.3	80.1
	NMNL-2 (17%)	56.41	178.18	180.29	2.11	119.52	79.2
	NMNL-2 (16%)	53.09	178.18	180.24	2.06	115.66	78.26
	NMNL-2 (15%)	49.78	178.18	180.19	2.01	111.75	77.27
	L (100%)	133.58	178.18	181.16	2.98	198.33	100.3
	L (30%)	40.08	178.18	180.03	1.85	99.41	74.05
	L (29%)	38.74	178.18	180	1.82	97.59	73.57
	L (28%)	37.4	178.18	179.98	1.8	95.74	73.19
	L (27%)	36.07	178.18	179.95	1.77	93.85	72.79
	L (26%)	34.73	178.18	179.93	1.75	91.93	72.38
	L (25%)	33.4	178.18	179.9	1.72	90	71.97
	L (24%)	32.06	178.18	179.87	1.69	88.01	71.55
	L (23%)	30.72	178.18	179.84	1.66	85.97	71.11
	L (22%)	29.39	178.18	179.81	1.63	83.9	70.66
	L (21%)	28.05	178.18	179.78	1.6	81.75	70.19
	L (20%)	26.72	178.18	179.75	1.57	79.56	69.71
	L (19%)	25.38	178.18	179.72	1.54	77.32	69.22
	L (18%)	24.05	178.18	179.69	1.51	75.03	68.71
	L (17%)	22.71	178.18	179.65	1.47	72.65	68.17
	L (16%)	21.37	178.18	179.62	1.44	70.16	67.61
	L (15%)	20.04	178.18	179.58	1.4	67.59	67.02
850 m d/s of Barrage axis	M (100%)	1003.92	178.04	184.58	6.54	483.66	125.57
	M (30%)	301.18	178.04	182.24	4.2	220.42	97.35
	M (29%)	291.14	178.04	182.18	4.14	215.2	96.71
	M (28%)	281.1	178.04	182.13	4.09	209.86	96.06
	M (27%)	271.06	178.04	182.07	4.03	204.44	95.41
	M (26%)	261.02	178.04	182.01	3.97	198.91	94.75
	M (25%)	250.98	178.04	181.95	3.91	193.21	94.11
	M (24%)	240.94	178.04	181.89	3.85	187.44	93.47
	M (23%)	230.9	178.04	181.83	3.79	181.53	92.82
	M (22%)	220.86	178.04	181.76	3.72	175.48	92.15

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (21%)	210.82	178.04	181.7	3.66	169.23	91.45
	M (20%)	200.78	178.04	181.63	3.59	162.82	90.72
	M (19%)	190.74	178.04	181.55	3.51	156.22	89.97
	M (18%)	180.71	178.04	181.48	3.44	149.45	89.19
	M (17%)	170.67	178.04	181.4	3.36	142.48	88.38
	M (16%)	160.63	178.04	181.32	3.28	135.32	87.55
	M (15%)	150.59	178.04	181.23	3.19	127.99	86.55
	NMNL-1 (100%)	306	178.04	182.26	4.22	222.9	97.66
	NMNL-1 (30%)	91.8	178.04	180.65	2.61	80.36	73.48
	NMNL-1 (29%)	88.74	178.04	180.61	2.57	77.81	71.82
	NMNL-1 (28%)	85.68	178.04	180.58	2.54	75.28	70.13
	NMNL-1 (27%)	82.62	178.04	180.54	2.5	72.76	68.42
	NMNL-1 (26%)	79.56	178.04	180.51	2.47	70.27	66.67
	NMNL-1 (25%)	76.5	178.04	180.47	2.43	67.79	65.05
	NMNL-1 (24%)	73.44	178.04	180.43	2.39	65.32	63.56
	NMNL-1 (23%)	70.38	178.04	180.39	2.35	62.86	62.03
	NMNL-1 (22%)	67.32	178.04	180.35	2.31	60.4	60.48
	NMNL-1 (21%)	64.26	178.04	180.31	2.27	57.96	58.88
	NMNL-1 (20%)	61.2	178.04	180.27	2.23	55.52	57.25
	NMNL-1 (19%)	58.14	178.04	180.23	2.19	53.11	55.59
	NMNL-1 (18%)	55.08	178.04	180.18	2.14	50.72	53.89
	NMNL-1 (17%)	52.02	178.04	180.14	2.1	48.35	52.15
	NMNL-1 (16%)	48.96	178.04	180.09	2.05	45.95	50.33
	NMNL-1 (15%)	45.9	178.04	180.04	2	43.56	48.44
	NMNL-2 (100%)	331.83	178.04	182.4	4.36	235.83	99.23
	NMNL-2 (30%)	99.55	178.04	180.74	2.7	86.83	76.51
	NMNL-2 (29%)	96.23	178.04	180.7	2.66	84.05	74.75
	NMNL-2 (28%)	92.91	178.04	180.66	2.62	81.29	73.82
	NMNL-2 (27%)	89.6	178.04	180.62	2.58	78.52	72.29
	NMNL-2 (26%)	86.28	178.04	180.59	2.55	75.77	70.46
	NMNL-2 (25%)	82.96	178.04	180.55	2.51	73.04	68.61
	NMNL-2 (24%)	79.64	178.04	180.51	2.47	70.33	66.71
	NMNL-2 (23%)	76.32	178.04	180.47	2.43	67.64	64.97
	NMNL-2 (22%)	73	178.04	180.42	2.38	64.96	63.34
	NMNL-2 (21%)	69.69	178.04	180.38	2.34	62.3	61.69
	NMNL-2 (20%)	66.37	178.04	180.34	2.3	59.64	59.99
	NMNL-2 (19%)	63.05	178.04	180.29	2.25	56.99	58.24
	NMNL-2 (18%)	59.73	178.04	180.25	2.21	54.36	56.46
	NMNL-2 (17%)	56.41	178.04	180.2	2.16	51.76	54.63
	NMNL-2 (16%)	53.09	178.04	180.15	2.11	49.16	52.75
	NMNL-2 (15%)	49.78	178.04	180.1	2.06	46.6	50.83
	L (100%)	133.58	178.04	181.08	3.04	115.09	84.47
	L (30%)	40.08	178.04	179.94	1.9	38.94	44.57
	L (29%)	38.74	178.04	179.92	1.88	37.86	43.62

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (28%)	37.4	178.04	179.89	1.85	36.79	42.66
	L (27%)	36.07	178.04	179.87	1.83	35.73	41.67
	L (26%)	34.73	178.04	179.84	1.8	34.66	40.66
	L (25%)	33.4	178.04	179.82	1.78	33.61	39.64
	L (24%)	32.06	178.04	179.79	1.75	32.54	38.58
	L (23%)	30.72	178.04	179.76	1.72	31.48	37.5
	L (22%)	29.39	178.04	179.73	1.69	30.43	36.37
	L (21%)	28.05	178.04	179.7	1.66	29.37	35.05
	L (20%)	26.72	178.04	179.67	1.63	28.32	33.79
	L (19%)	25.38	178.04	179.64	1.6	27.27	33.07
	L (18%)	24.05	178.04	179.61	1.57	26.21	32.32
	L (17%)	22.71	178.04	179.57	1.53	25.13	31.54
	L (16%)	21.37	178.04	179.54	1.5	24.01	30.72
	L (15%)	20.04	178.04	179.5	1.46	22.88	29.87
900 m d/s of Barrage axis	M (100%)	1003.92	177.92	183.28	5.36	200.27	78.58
	M (30%)	301.18	177.92	181.25	3.33	74.17	44.45
	M (29%)	291.14	177.92	181.2	3.28	72.03	43.57
	M (28%)	281.1	177.92	181.15	3.23	69.88	42.66
	M (27%)	271.06	177.92	181.1	3.18	67.71	41.73
	M (26%)	261.02	177.92	181.05	3.13	65.52	40.77
	M (25%)	250.98	177.92	181	3.08	63.46	39.84
	M (24%)	240.94	177.92	180.94	3.02	61.22	38.81
	M (23%)	230.9	177.92	180.88	2.96	58.96	37.74
	M (22%)	220.86	177.92	180.82	2.9	56.66	36.63
	M (21%)	210.82	177.92	180.76	2.84	54.36	35.47
	M (20%)	200.78	177.92	180.69	2.77	51.96	34.23
	M (19%)	190.74	177.92	180.62	2.7	49.71	33.44
	M (18%)	180.71	177.92	180.56	2.64	47.6	32.8
	M (17%)	170.67	177.92	180.49	2.57	45.57	32.18
	M (16%)	160.63	177.92	180.43	2.51	43.6	31.56
	M (15%)	150.59	177.92	180.36	2.44	41.46	30.87
	NMNL-1 (100%)	306	177.92	181.27	3.35	75.19	44.86
	NMNL-1 (30%)	91.8	177.92	179.96	2.04	29.78	26.8
	NMNL-1 (29%)	88.74	177.92	179.94	2.02	29.23	26.59
	NMNL-1 (28%)	85.68	177.92	179.92	2	28.67	26.38
	NMNL-1 (27%)	82.62	177.92	179.9	1.98	28.1	26.16
	NMNL-1 (26%)	79.56	177.92	179.87	1.95	27.52	25.94
	NMNL-1 (25%)	76.5	177.92	179.85	1.93	26.93	25.71
	NMNL-1 (24%)	73.44	177.92	179.83	1.91	26.33	25.49
	NMNL-1 (23%)	70.38	177.92	179.8	1.88	25.72	25.27
	NMNL-1 (22%)	67.32	177.92	179.78	1.86	25.09	25.04
	NMNL-1 (21%)	64.26	177.92	179.75	1.83	24.45	24.81
	NMNL-1 (20%)	61.2	177.92	179.73	1.81	23.8	24.56

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (19%)	58.14	177.92	179.7	1.78	23.13	24.31
	NMNL-1 (18%)	55.08	177.92	179.67	1.75	22.44	24.02
	NMNL-1 (17%)	52.02	177.92	179.64	1.72	21.72	23.66
	NMNL-1 (16%)	48.96	177.92	179.61	1.69	20.99	23.27
	NMNL-1 (15%)	45.9	177.92	179.58	1.66	20.24	22.88
	NMNL-2 (100%)	331.83	177.92	181.39	3.47	80.59	46.99
	NMNL-2 (30%)	99.55	177.92	180.01	2.09	31.14	27.31
	NMNL-2 (29%)	96.23	177.92	179.99	2.07	30.56	27.09
	NMNL-2 (28%)	92.91	177.92	179.97	2.05	29.98	26.88
	NMNL-2 (27%)	89.6	177.92	179.94	2.02	29.39	26.65
	NMNL-2 (26%)	86.28	177.92	179.92	2	28.78	26.42
	NMNL-2 (25%)	82.96	177.92	179.9	1.98	28.16	26.19
	NMNL-2 (24%)	79.64	177.92	179.87	1.95	27.54	25.95
	NMNL-2 (23%)	76.32	177.92	179.85	1.93	26.9	25.7
	NMNL-2 (22%)	73	177.92	179.82	1.9	26.24	25.46
	NMNL-2 (21%)	69.69	177.92	179.8	1.88	25.58	25.22
	NMNL-2 (20%)	66.37	177.92	179.77	1.85	24.89	24.97
	NMNL-2 (19%)	63.05	177.92	179.74	1.82	24.19	24.71
	NMNL-2 (18%)	59.73	177.92	179.71	1.79	23.47	24.44
	NMNL-2 (17%)	56.41	177.92	179.68	1.76	22.74	24.17
	NMNL-2 (16%)	53.09	177.92	179.65	1.73	21.97	23.78
	NMNL-2 (15%)	49.78	177.92	179.62	1.7	21.19	23.38
	L (100%)	133.58	177.92	180.24	2.32	37.76	29.64
	L (30%)	40.08	177.92	179.51	1.59	18.77	22.08
	L (29%)	38.74	177.92	179.49	1.57	18.41	21.88
	L (28%)	37.4	177.92	179.48	1.56	18.05	21.68
	L (27%)	36.07	177.92	179.46	1.54	17.67	21.46
	L (26%)	34.73	177.92	179.44	1.52	17.28	21.24
	L (25%)	33.4	177.92	179.42	1.5	16.9	21.02
	L (24%)	32.06	177.92	179.4	1.48	16.5	20.79
	L (23%)	30.72	177.92	179.38	1.46	16.09	20.54
	L (22%)	29.39	177.92	179.36	1.44	15.69	20.3
	L (21%)	28.05	177.92	179.34	1.42	15.26	20.04
	L (20%)	26.72	177.92	179.32	1.4	14.82	19.77
	L (19%)	25.38	177.92	179.3	1.38	14.38	19.5
	L (18%)	24.05	177.92	179.28	1.36	13.92	19.21
	L (17%)	22.71	177.92	179.25	1.33	13.45	18.91
	L (16%)	21.37	177.92	179.22	1.3	12.96	18.59
	L (15%)	20.04	177.92	179.2	1.28	12.45	18.25
950 m d/s of Barrage axis	M (100%)	1003.92	177.77	182.48	4.71	304.4	108.47
	M (30%)	301.18	177.77	180.81	3.04	143.69	82.56
	M (29%)	291.14	177.77	180.77	3	140.54	81.92
	M (28%)	281.1	177.77	180.73	2.96	137.36	81.28

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (27%)	271.06	177.77	180.69	2.92	134.15	80.62
	M (26%)	261.02	177.77	180.65	2.88	130.91	79.95
	M (25%)	250.98	177.77	180.61	2.84	127.63	79.27
	M (24%)	240.94	177.77	180.57	2.8	124.31	78.57
	M (23%)	230.9	177.77	180.53	2.76	120.94	77.86
	M (22%)	220.86	177.77	180.48	2.71	117.56	77.14
	M (21%)	210.82	177.77	180.44	2.67	114.12	76.4
	M (20%)	200.78	177.77	180.39	2.62	110.66	75.67
	M (19%)	190.74	177.77	180.35	2.58	107.12	74.96
	M (18%)	180.71	177.77	180.3	2.53	103.49	74.23
	M (17%)	170.67	177.77	180.25	2.48	99.83	73.49
	M (16%)	160.63	177.77	180.2	2.43	96.07	72.71
	M (15%)	150.59	177.77	180.14	2.37	92.21	71.91
	NMNL-1 (100%)	306	177.77	180.83	3.06	145.19	82.86
	NMNL-1 (30%)	91.8	177.77	179.79	2.02	68.01	64.38
	NMNL-1 (29%)	88.74	177.77	179.77	2	66.65	63.88
	NMNL-1 (28%)	85.68	177.77	179.75	1.98	65.28	63.37
	NMNL-1 (27%)	82.62	177.77	179.72	1.95	63.9	62.86
	NMNL-1 (26%)	79.56	177.77	179.7	1.93	62.5	62.33
	NMNL-1 (25%)	76.5	177.77	179.68	1.91	61.08	61.69
	NMNL-1 (24%)	73.44	177.77	179.66	1.89	59.65	60.85
	NMNL-1 (23%)	70.38	177.77	179.63	1.86	58.22	59.99
	NMNL-1 (22%)	67.32	177.77	179.61	1.84	56.77	59.1
	NMNL-1 (21%)	64.26	177.77	179.58	1.81	55.31	58.2
	NMNL-1 (20%)	61.2	177.77	179.56	1.79	53.84	57.27
	NMNL-1 (19%)	58.14	177.77	179.53	1.76	52.35	56.32
	NMNL-1 (18%)	55.08	177.77	179.5	1.73	50.84	55.42
	NMNL-1 (17%)	52.02	177.77	179.48	1.71	49.3	54.61
	NMNL-1 (16%)	48.96	177.77	179.45	1.68	47.75	53.78
	NMNL-1 (15%)	45.9	177.77	179.42	1.65	46.17	52.92
	NMNL-2 (100%)	331.83	177.77	180.92	3.15	153.11	84.43
	NMNL-2 (30%)	99.55	177.77	179.84	2.07	71.38	65.61
	NMNL-2 (29%)	96.23	177.77	179.82	2.05	69.94	65.09
	NMNL-2 (28%)	92.91	177.77	179.8	2.03	68.48	64.56
	NMNL-2 (27%)	89.6	177.77	179.77	2	67.03	64.03
	NMNL-2 (26%)	86.28	177.77	179.75	1.98	65.55	63.48
	NMNL-2 (25%)	82.96	177.77	179.73	1.96	64.05	62.91
	NMNL-2 (24%)	79.64	177.77	179.7	1.93	62.53	62.34
	NMNL-2 (23%)	76.32	177.77	179.68	1.91	61	61.64
	NMNL-2 (22%)	73	177.77	179.65	1.88	59.45	60.72
	NMNL-2 (21%)	69.69	177.77	179.63	1.86	57.89	59.79
	NMNL-2 (20%)	66.37	177.77	179.6	1.83	56.32	58.83
	NMNL-2 (19%)	63.05	177.77	179.57	1.8	54.73	57.84
	NMNL-2 (18%)	59.73	177.77	179.54	1.77	53.12	56.82

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (17%)	56.41	177.77	179.52	1.75	51.49	55.77
	NMNL-2 (16%)	53.09	177.77	179.49	1.72	49.84	54.89
	NMNL-2 (15%)	49.78	177.77	179.46	1.69	48.16	54
	L (100%)	133.58	177.77	180.05	2.28	85.51	70.25
	L (30%)	40.08	177.77	179.36	1.59	43.09	51.18
	L (29%)	38.74	177.77	179.34	1.57	42.35	50.76
	L (28%)	37.4	177.77	179.33	1.56	41.61	50.33
	L (27%)	36.07	177.77	179.31	1.54	40.8	49.85
	L (26%)	34.73	177.77	179.3	1.53	39.97	49.36
	L (25%)	33.4	177.77	179.28	1.51	39.14	48.87
	L (24%)	32.06	177.77	179.26	1.49	38.28	48.35
	L (23%)	30.72	177.77	179.24	1.47	37.4	47.81
	L (22%)	29.39	177.77	179.23	1.46	36.52	47.26
	L (21%)	28.05	177.77	179.21	1.44	35.59	46.68
	L (20%)	26.72	177.77	179.19	1.42	34.66	46.09
	L (19%)	25.38	177.77	179.16	1.39	33.69	45.47
	L (18%)	24.05	177.77	179.14	1.37	32.71	44.83
	L (17%)	22.71	177.77	179.12	1.35	31.67	44.14
	L (16%)	21.37	177.77	179.09	1.32	30.57	43.41
	L (15%)	20.04	177.77	179.07	1.3	29.45	42.64
1000 m d/s of Barrage axis	M (100%)	1003.92	177.64	182.49	4.85	450	244.1
	M (30%)	301.18	177.64	180.69	3.05	164.04	97.32
	M (29%)	291.14	177.64	180.65	3.01	160.23	96.56
	M (28%)	281.1	177.64	180.61	2.97	156.39	95.8
	M (27%)	271.06	177.64	180.57	2.93	152.51	95.02
	M (26%)	261.02	177.64	180.53	2.89	148.59	94.23
	M (25%)	250.98	177.64	180.48	2.84	144.63	93.42
	M (24%)	240.94	177.64	180.44	2.8	140.62	92.59
	M (23%)	230.9	177.64	180.4	2.76	136.56	91.74
	M (22%)	220.86	177.64	180.35	2.71	132.45	90.88
	M (21%)	210.82	177.64	180.31	2.67	128.3	89.99
	M (20%)	200.78	177.64	180.26	2.62	124.15	89.1
	M (19%)	190.74	177.64	180.21	2.57	119.88	88.18
	M (18%)	180.71	177.64	180.16	2.52	115.55	87.23
	M (17%)	170.67	177.64	180.11	2.47	111.16	86.25
	M (16%)	160.63	177.64	180.06	2.42	106.69	85.25
	M (15%)	150.59	177.64	180.01	2.37	102.08	84.21
	NMNL-1 (100%)	306	177.64	180.71	3.07	165.85	97.67
	NMNL-1 (30%)	91.8	177.64	179.65	2.01	73.36	77.37
	NMNL-1 (29%)	88.74	177.64	179.63	1.99	71.73	76.97
	NMNL-1 (28%)	85.68	177.64	179.61	1.97	70.08	76.56
	NMNL-1 (27%)	82.62	177.64	179.59	1.95	68.42	76.14
	NMNL-1 (26%)	79.56	177.64	179.56	1.92	66.74	75.72

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-1 (25%)	76.5	177.64	179.54	1.9	65.04	75.29
	NMNL-1 (24%)	73.44	177.64	179.52	1.88	63.31	74.85
	NMNL-1 (23%)	70.38	177.64	179.49	1.85	61.57	74.4
	NMNL-1 (22%)	67.32	177.64	179.47	1.83	59.8	73.94
	NMNL-1 (21%)	64.26	177.64	179.45	1.81	58	73.48
	NMNL-1 (20%)	61.2	177.64	179.42	1.78	56.18	73
	NMNL-1 (19%)	58.14	177.64	179.4	1.76	54.33	72.51
	NMNL-1 (18%)	55.08	177.64	179.37	1.73	52.45	72.01
	NMNL-1 (17%)	52.02	177.64	179.34	1.7	50.53	71.5
	NMNL-1 (16%)	48.96	177.64	179.32	1.68	48.58	70.98
	NMNL-1 (15%)	45.9	177.64	179.29	1.65	46.58	70.44
	NMNL-2 (100%)	331.83	177.64	180.8	3.16	175.45	99.54
	NMNL-2 (30%)	99.55	177.64	179.7	2.06	77.38	78.37
	NMNL-2 (29%)	96.23	177.64	179.68	2.04	75.65	77.94
	NMNL-2 (28%)	92.91	177.64	179.66	2.02	73.9	77.51
	NMNL-2 (27%)	89.6	177.64	179.63	1.99	72.19	77.08
	NMNL-2 (26%)	86.28	177.64	179.61	1.97	70.41	76.64
	NMNL-2 (25%)	82.96	177.64	179.59	1.95	68.61	76.19
	NMNL-2 (24%)	79.64	177.64	179.56	1.92	66.78	75.73
	NMNL-2 (23%)	76.32	177.64	179.54	1.9	64.94	75.26
	NMNL-2 (22%)	73	177.64	179.51	1.87	63.06	74.78
	NMNL-2 (21%)	69.69	177.64	179.49	1.85	61.17	74.3
	NMNL-2 (20%)	66.37	177.64	179.46	1.82	59.24	73.8
	NMNL-2 (19%)	63.05	177.64	179.44	1.8	57.29	73.29
	NMNL-2 (18%)	59.73	177.64	179.41	1.77	55.29	72.77
	NMNL-2 (17%)	56.41	177.64	179.38	1.74	53.27	72.23
	NMNL-2 (16%)	53.09	177.64	179.35	1.71	51.2	71.68
	NMNL-2 (15%)	49.78	177.64	179.32	1.68	49.1	71.12
	L (100%)	133.58	177.64	179.91	2.27	94.16	82.38
	L (30%)	40.08	177.64	179.23	1.59	42.7	69.38
	L (29%)	38.74	177.64	179.22	1.58	41.78	69.12
	L (28%)	37.4	177.64	179.21	1.57	40.84	68.85
	L (27%)	36.07	177.64	179.19	1.55	39.73	67.88
	L (26%)	34.73	177.64	179.17	1.53	38.61	66.88
	L (25%)	33.4	177.64	179.16	1.52	37.49	65.86
	L (24%)	32.06	177.64	179.14	1.5	36.34	64.8
	L (23%)	30.72	177.64	179.12	1.48	35.17	63.7
	L (22%)	29.39	177.64	179.1	1.46	34.01	62.6
	L (21%)	28.05	177.64	179.08	1.44	32.84	61.46
	L (20%)	26.72	177.64	179.06	1.42	31.65	60.29
	L (19%)	25.38	177.64	179.04	1.4	30.44	59.06
	L (18%)	24.05	177.64	179.02	1.38	29.22	57.8
	L (17%)	22.71	177.64	179	1.36	27.97	56.49
	L (16%)	21.37	177.64	178.98	1.34	26.7	55.12

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (15%)	20.04	177.64	178.95	1.31	25.45	53.8

Note:

M - Monsoon Season
NMNL1 - Non Monsoon Non Lean Season (October & November)
L - Lean Season
NMNL2 - Non Monsoon Non Lean Season (April & May)

Table-13.15: Depth of flow for release in the year 2016 for Teesta Low Dam -III HEP

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
At Barrage axis	M (100%)	1069.08	180.34	185.46	5.12	398.27	125.16
	M (30%)	320.73	180.34	183.27	2.93	167.55	81.69
	M (29%)	310.03	180.34	183.22	2.88	164.03	81.05
	M (28%)	299.34	180.34	183.18	2.84	160.49	80.41
	M (27%)	288.65	180.34	183.13	2.79	156.83	79.74
	M (26%)	277.96	180.34	183.09	2.75	153.21	79.07
	M (25%)	267.27	180.34	183.04	2.7	149.53	78.39
	M (24%)	256.58	180.34	183	2.66	145.89	77.71
	M (23%)	245.89	180.34	182.95	2.61	142.32	77.03
	M (22%)	235.2	180.34	182.9	2.56	138.66	76.33
	M (21%)	224.51	180.34	182.85	2.51	134.95	75.62
	M (20%)	213.82	180.34	182.8	2.46	131.26	74.9
	M (19%)	203.13	180.34	182.75	2.41	127.64	74.19
	M (18%)	192.44	180.34	182.7	2.36	123.89	73.45
	M (17%)	181.74	180.34	182.65	2.31	120.11	72.69
	M (16%)	171.05	180.34	182.6	2.26	116.24	71.9
	M (15%)	160.36	180.34	182.54	2.2	112.04	71.04
	NMNL-2 (100%)	298.83	180.34	183.18	2.84	160.32	80.38
	NMNL-2 (30%)	89.65	180.34	182.07	1.73	80.51	64.02
	NMNL-2 (29%)	86.66	180.34	182.05	1.71	78.83	63.63
	NMNL-2 (28%)	83.67	180.34	182.02	1.68	77.21	63.24
	NMNL-2 (27%)	80.69	180.34	182	1.66	75.61	62.86
	NMNL-2 (26%)	77.7	180.34	181.97	1.63	73.98	62.47
	NMNL-2 (25%)	74.71	180.34	181.94	1.6	72.34	62.08
	NMNL-2 (24%)	71.72	180.34	181.92	1.58	70.68	61.67
	NMNL-2 (23%)	68.73	180.34	181.89	1.55	68.98	61.26
	NMNL-2 (22%)	65.74	180.34	181.86	1.52	67.25	60.83
	NMNL-2 (21%)	62.76	180.34	181.83	1.49	65.46	60.39
	NMNL-2 (20%)	59.77	180.34	181.8	1.46	63.63	59.93
	NMNL-2 (19%)	56.78	180.34	181.77	1.43	61.77	59.46
	NMNL-2 (18%)	53.79	180.34	181.74	1.4	59.81	58.95
	NMNL-2 (17%)	50.8	180.34	181.7	1.36	57.81	58.43

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (16%)	47.81	180.34	181.67	1.33	55.77	57.9
	NMNL-2 (15%)	44.83	180.34	181.63	1.29	53.51	57.29
	L (100%)	124.11	180.34	182.32	1.98	96.78	67.73
	L (30%)	37.23	180.34	181.52	1.18	47.45	55.65
	L (29%)	35.99	180.34	181.5	1.16	46.47	55.38
	L (28%)	34.75	180.34	181.49	1.15	45.49	55.11
	L (27%)	33.51	180.34	181.47	1.13	44.46	54.82
	L (26%)	32.27	180.34	181.45	1.11	43.37	54.52
	L (25%)	31.03	180.34	181.43	1.09	42.25	54.2
	L (24%)	29.79	180.34	181.41	1.07	41.14	53.89
	L (23%)	28.55	180.34	181.38	1.04	40.01	53.57
	L (22%)	27.3	180.34	181.36	1.02	38.82	53.22
	L (21%)	26.06	180.34	181.34	1	37.64	52.88
	L (20%)	24.82	180.34	181.32	0.98	36.45	52.54
	L (19%)	23.58	180.34	181.29	0.95	35.24	52.19
	L (18%)	22.34	180.34	181.27	0.93	34.01	51.83
	L (17%)	21.1	180.34	181.25	0.91	32.77	51.46
	L (16%)	19.86	180.34	181.22	0.88	31.48	51.07
	L (15%)	18.62	180.34	181.2	0.86	30.14	50.67
At 50 m d/s of Barrage axis	M (100%)	1069.08	180.21	185.45	5.24	466.46	133.35
	M (30%)	320.73	180.21	183.21	3	200.03	99.9
	M (29%)	310.03	180.21	183.16	2.95	195.66	99.29
	M (28%)	299.34	180.21	183.12	2.91	191.26	98.68
	M (27%)	288.65	180.21	183.07	2.86	186.68	98.03
	M (26%)	277.96	180.21	183.03	2.82	182.15	97.39
	M (25%)	267.27	180.21	182.98	2.77	177.55	96.74
	M (24%)	256.58	180.21	182.93	2.72	173	96.09
	M (23%)	245.89	180.21	182.89	2.68	168.55	95.45
	M (22%)	235.2	180.21	182.84	2.63	163.98	94.78
	M (21%)	224.51	180.21	182.79	2.58	159.33	94.1
	M (20%)	213.82	180.21	182.74	2.53	154.72	93.42
	M (19%)	203.13	180.21	182.69	2.48	150.22	92.76
	M (18%)	192.44	180.21	182.64	2.43	145.54	92.06
	M (17%)	181.74	180.21	182.59	2.38	140.83	91.35
	M (16%)	171.05	180.21	182.54	2.33	136	90.62
	M (15%)	160.36	180.21	182.48	2.27	130.69	89.8
	NMNL-2 (100%)	298.83	180.21	183.12	2.91	191.05	98.65
	NMNL-2 (30%)	89.65	180.21	182.01	1.8	90.91	80.27
	NMNL-2 (29%)	86.66	180.21	181.99	1.78	88.8	79.6
	NMNL-2 (28%)	83.67	180.21	181.96	1.75	86.78	78.95
	NMNL-2 (27%)	80.69	180.21	181.94	1.73	84.81	78.32
	NMNL-2 (26%)	77.7	180.21	181.91	1.7	82.79	77.66
	NMNL-2 (25%)	74.71	180.21	181.88	1.67	80.77	77

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (24%)	71.72	180.21	181.86	1.65	78.75	76.33
	NMNL-2 (23%)	68.73	180.21	181.83	1.62	76.67	75.64
	NMNL-2 (22%)	65.74	180.21	181.8	1.59	74.56	74.93
	NMNL-2 (21%)	62.76	180.21	181.77	1.56	72.38	74.19
	NMNL-2 (20%)	59.77	180.21	181.74	1.53	70.16	73.43
	NMNL-2 (19%)	56.78	180.21	181.71	1.5	67.9	72.64
	NMNL-2 (18%)	53.79	180.21	181.68	1.47	65.53	71.81
	NMNL-2 (17%)	50.8	180.21	181.65	1.44	63.11	70.95
	NMNL-2 (16%)	47.81	180.21	181.61	1.4	60.66	70.07
	NMNL-2 (15%)	44.83	180.21	181.57	1.36	57.89	69.06
	L (100%)	124.11	180.21	182.26	2.05	111.33	86.48
	L (30%)	37.23	180.21	181.46	1.25	50.52	66.3
	L (29%)	35.99	180.21	181.44	1.23	49.36	65.86
	L (28%)	34.75	180.21	181.43	1.22	48.19	65.4
	L (27%)	33.51	180.21	181.41	1.2	46.97	64.93
	L (26%)	32.27	180.21	181.39	1.18	45.64	64.41
	L (25%)	31.03	180.21	181.37	1.16	44.29	63.85
	L (24%)	29.79	180.21	181.35	1.14	42.96	63.3
	L (23%)	28.55	180.21	181.32	1.11	41.6	62.73
	L (22%)	27.3	180.21	181.3	1.09	40.16	62.13
	L (21%)	26.06	180.21	181.28	1.07	38.75	61.52
	L (20%)	24.82	180.21	181.25	1.04	37.34	60.92
	L (19%)	23.58	180.21	181.23	1.02	35.89	60.29
	L (18%)	22.34	180.21	181.21	1	34.43	59.64
	L (17%)	21.1	180.21	181.18	0.97	32.95	58.99
	L (16%)	19.86	180.21	181.16	0.95	31.42	58.3
	L (15%)	18.62	180.21	181.13	0.92	29.81	57.57
At 100 m d/s of Barrage axis	M (100%)	1069.08	180.07	185.49	5.42	706.53	242.47
	M (30%)	320.73	180.07	183.15	3.08	225.57	110.11
	M (29%)	310.03	180.07	183.11	3.04	220.74	109.24
	M (28%)	299.34	180.07	183.07	3	215.88	108.46
	M (27%)	288.65	180.07	183.02	2.95	210.82	107.68
	M (26%)	277.96	180.07	182.97	2.9	205.83	106.91
	M (25%)	267.27	180.07	182.92	2.85	200.76	106.12
	M (24%)	256.58	180.07	182.88	2.81	195.78	105.33
	M (23%)	245.89	180.07	182.83	2.76	190.92	104.56
	M (22%)	235.2	180.07	182.78	2.71	185.93	103.76
	M (21%)	224.51	180.07	182.73	2.66	180.86	102.95
	M (20%)	213.82	180.07	182.69	2.62	175.86	102.14
	M (19%)	203.13	180.07	182.64	2.57	171	101.35
	M (18%)	192.44	180.07	182.59	2.52	165.96	100.52
	M (17%)	181.74	180.07	182.54	2.47	160.9	99.68
	M (16%)	171.05	180.07	182.48	2.41	155.7	98.81

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (15%)	160.36	180.07	182.43	2.36	149.96	97.84
	NMNL-2 (100%)	298.83	180.07	183.06	2.99	215.64	108.43
	NMNL-2 (30%)	89.65	180.07	181.97	1.9	106.63	90.17
	NMNL-2 (29%)	86.66	180.07	181.94	1.87	104.23	89.72
	NMNL-2 (28%)	83.67	180.07	181.91	1.84	101.95	89.3
	NMNL-2 (27%)	80.69	180.07	181.89	1.82	99.72	88.88
	NMNL-2 (26%)	77.7	180.07	181.86	1.79	97.44	88.45
	NMNL-2 (25%)	74.71	180.07	181.84	1.77	95.14	88.02
	NMNL-2 (24%)	71.72	180.07	181.81	1.74	92.84	87.58
	NMNL-2 (23%)	68.73	180.07	181.78	1.71	90.48	87.13
	NMNL-2 (22%)	65.74	180.07	181.76	1.69	88.06	86.63
	NMNL-2 (21%)	62.76	180.07	181.73	1.66	85.55	85.99
	NMNL-2 (20%)	59.77	180.07	181.7	1.63	82.99	85.33
	NMNL-2 (19%)	56.78	180.07	181.67	1.6	80.37	84.66
	NMNL-2 (18%)	53.79	180.07	181.63	1.56	77.65	83.95
	NMNL-2 (17%)	50.8	180.07	181.6	1.53	74.8	83.2
	NMNL-2 (16%)	47.81	180.07	181.56	1.49	71.9	82.44
	NMNL-2 (15%)	44.83	180.07	181.52	1.45	68.59	81.55
	L (100%)	124.11	180.07	182.21	2.14	129.04	94.21
	L (30%)	37.23	180.07	181.41	1.34	59.9	76.92
	L (29%)	35.99	180.07	181.4	1.33	58.55	76.17
	L (28%)	34.75	180.07	181.38	1.31	57.19	75.91
	L (27%)	33.51	180.07	181.36	1.29	55.76	75.63
	L (26%)	32.27	180.07	181.34	1.27	54.18	75.28
	L (25%)	31.03	180.07	181.32	1.25	52.56	74.35
	L (24%)	29.79	180.07	181.3	1.23	50.99	73.43
	L (23%)	28.55	180.07	181.27	1.2	49.4	72.49
	L (22%)	27.3	180.07	181.25	1.18	47.7	71.48
	L (21%)	26.06	180.07	181.23	1.16	46.05	70.48
	L (20%)	24.82	180.07	181.2	1.13	44.42	69.48
	L (19%)	23.58	180.07	181.18	1.11	42.76	68.44
	L (18%)	22.34	180.07	181.15	1.08	41.07	67.37
	L (17%)	21.1	180.07	181.13	1.06	39.35	66.27
	L (16%)	19.86	180.07	181.1	1.03	37.59	65.12
	L (15%)	18.62	180.07	181.07	1	35.72	63.87
At 150 m d/s of Barrage axis	M (100%)	1069.08	179.94	185.46	5.52	712.63	242.93
	M (30%)	320.73	179.94	183.03	3.09	192.76	149.44
	M (29%)	310.03	179.94	182.98	3.04	186.46	137.85
	M (28%)	299.34	179.94	182.94	3	180.68	125.65
	M (27%)	288.65	179.94	182.89	2.95	175.22	112.76
	M (26%)	277.96	179.94	182.85	2.91	170.41	101.15
	M (25%)	267.27	179.94	182.8	2.86	165.83	97.37

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (24%)	256.58	179.94	182.76	2.82	161.5	93.62
	M (23%)	245.89	179.94	182.71	2.77	157.45	89.96
	M (22%)	235.2	179.94	182.67	2.73	153.43	86.24
	M (21%)	224.51	179.94	182.62	2.68	149.57	83
	M (20%)	213.82	179.94	182.58	2.64	145.91	81.12
	M (19%)	203.13	179.94	182.53	2.59	142.39	80.31
	M (18%)	192.44	179.94	182.49	2.55	138.76	79.46
	M (17%)	181.74	179.94	182.44	2.5	135.11	78.6
	M (16%)	171.05	179.94	182.39	2.45	131.38	77.7
	M (15%)	160.36	179.94	182.34	2.4	127.23	76.7
	NMNL-2 (100%)	298.83	179.94	182.94	3	180.41	125.06
	NMNL-2 (30%)	89.65	179.94	181.91	1.97	95.83	68.46
	NMNL-2 (29%)	86.66	179.94	181.88	1.94	94.06	67.97
	NMNL-2 (28%)	83.67	179.94	181.86	1.92	92.41	67.5
	NMNL-2 (27%)	80.69	179.94	181.83	1.89	90.81	67.05
	NMNL-2 (26%)	77.7	179.94	181.81	1.87	89.17	66.58
	NMNL-2 (25%)	74.71	179.94	181.78	1.84	87.53	66.11
	NMNL-2 (24%)	71.72	179.94	181.76	1.82	85.89	65.64
	NMNL-2 (23%)	68.73	179.94	181.73	1.79	84.21	65.14
	NMNL-2 (22%)	65.74	179.94	181.71	1.77	82.49	64.63
	NMNL-2 (21%)	62.76	179.94	181.68	1.74	80.71	64.09
	NMNL-2 (20%)	59.77	179.94	181.65	1.71	78.88	63.54
	NMNL-2 (19%)	56.78	179.94	181.62	1.68	77.01	62.97
	NMNL-2 (18%)	53.79	179.94	181.59	1.65	75.07	62.37
	NMNL-2 (17%)	50.8	179.94	181.56	1.62	73.03	61.74
	NMNL-2 (16%)	47.81	179.94	181.52	1.58	70.95	61.08
	NMNL-2 (15%)	44.83	179.94	181.48	1.54	68.55	60.32
	L (100%)	124.11	179.94	182.14	2.2	111.98	72.82
	L (30%)	37.23	179.94	181.38	1.44	62.18	58.38
	L (29%)	35.99	179.94	181.36	1.42	61.18	58.13
	L (28%)	34.75	179.94	181.34	1.4	60.17	57.88
	L (27%)	33.51	179.94	181.32	1.38	59.11	57.61
	L (26%)	32.27	179.94	181.3	1.36	57.91	57.31
	L (25%)	31.03	179.94	181.28	1.34	56.68	57
	L (24%)	29.79	179.94	181.26	1.32	55.49	56.69
	L (23%)	28.55	179.94	181.24	1.3	54.27	56.37
	L (22%)	27.3	179.94	181.22	1.28	52.94	56.03
	L (21%)	26.06	179.94	181.19	1.25	51.64	55.69
	L (20%)	24.82	179.94	181.17	1.23	50.35	55.35
	L (19%)	23.58	179.94	181.14	1.2	49.02	55
	L (18%)	22.34	179.94	181.12	1.18	47.65	54.64
	L (17%)	21.1	179.94	181.09	1.15	46.24	54.26
	L (16%)	19.86	179.94	181.07	1.13	44.78	53.86
	L (15%)	18.62	179.94	181.04	1.1	43.2	53.44

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
At 200 m d/s of Barrage axis	M (100%)	1069.08	179.8	185.41	5.61	726.11	220.44
	M (30%)	320.73	179.8	182.97	3.17	223.37	177.57
	M (29%)	310.03	179.8	182.93	3.13	214.63	176.59
	M (28%)	299.34	179.8	182.88	3.08	205.89	175.72
	M (27%)	288.65	179.8	182.82	3.02	196.66	174.8
	M (26%)	277.96	179.8	182.77	2.97	187.5	173.87
	M (25%)	267.27	179.8	182.72	2.92	178	172.91
	M (24%)	256.58	179.8	182.66	2.86	168.61	171.96
	M (23%)	245.89	179.8	182.61	2.81	159.42	171
	M (22%)	235.2	179.8	182.55	2.75	149.66	169.94
	M (21%)	224.51	179.8	182.49	2.69	140.31	161.22
	M (20%)	213.82	179.8	182.44	2.64	131.46	154.64
	M (19%)	203.13	179.8	182.38	2.58	123.3	148.36
	M (18%)	192.44	179.8	182.33	2.53	115.01	141.64
	M (17%)	181.74	179.8	182.27	2.47	107.13	132.59
	M (16%)	171.05	179.8	182.21	2.41	100.09	119.42
	M (15%)	160.36	179.8	182.15	2.35	92.96	104.38
	NMNL-2 (100%)	298.83	179.8	182.87	3.07	205.47	175.68
	NMNL-2 (30%)	89.65	179.8	181.68	1.88	56.05	64.16
	NMNL-2 (29%)	86.66	179.8	181.66	1.86	54.67	62.66
	NMNL-2 (28%)	83.67	179.8	181.64	1.84	53.3	61.12
	NMNL-2 (27%)	80.69	179.8	181.62	1.82	51.94	59.56
	NMNL-2 (26%)	77.7	179.8	181.59	1.79	50.63	58.03
	NMNL-2 (25%)	74.71	179.8	181.57	1.77	49.32	56.44
	NMNL-2 (24%)	71.72	179.8	181.55	1.75	48.01	54.82
	NMNL-2 (23%)	68.73	179.8	181.52	1.72	46.71	53.16
	NMNL-2 (22%)	65.74	179.8	181.5	1.7	45.43	51.47
	NMNL-2 (21%)	62.76	179.8	181.47	1.67	44.17	49.74
	NMNL-2 (20%)	59.77	179.8	181.45	1.65	42.89	48.67
	NMNL-2 (19%)	56.78	179.8	181.42	1.62	41.62	47.92
	NMNL-2 (18%)	53.79	179.8	181.39	1.59	40.32	47.14
	NMNL-2 (17%)	50.8	179.8	181.37	1.57	38.96	46.35
	NMNL-2 (16%)	47.81	179.8	181.34	1.54	37.57	45.54
	NMNL-2 (15%)	44.83	179.8	181.3	1.5	36.1	44.68
	L (100%)	124.11	179.8	181.92	2.12	72.66	77.63
	L (30%)	37.23	179.8	181.22	1.42	32.36	42.38
	L (29%)	35.99	179.8	181.2	1.4	31.7	41.97
	L (28%)	34.75	179.8	181.19	1.39	31.04	41.54
	L (27%)	33.51	179.8	181.17	1.37	30.31	41.07
	L (26%)	32.27	179.8	181.15	1.35	29.49	40.54
	L (25%)	31.03	179.8	181.13	1.33	28.62	39.96
	L (24%)	29.79	179.8	181.11	1.31	27.82	39.42
	L (23%)	28.55	179.8	181.08	1.28	27	38.86

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (22%)	27.3	179.8	181.06	1.26	26.12	38.25
	L (21%)	26.06	179.8	181.04	1.24	25.23	37.62
	L (20%)	24.82	179.8	181.02	1.22	24.36	37
	L (19%)	23.58	179.8	180.99	1.19	23.45	36.35
	L (18%)	22.34	179.8	180.96	1.16	22.5	35.68
	L (17%)	21.1	179.8	180.94	1.14	21.51	34.99
	L (16%)	19.86	179.8	180.91	1.11	20.51	34.27
	L (15%)	18.62	179.8	180.88	1.08	19.5	33.51
At 250 m d/s of Barrage axis	M (100%)	1069.08	179.66	185.4	5.74	846.17	216.5
	M (30%)	320.73	179.66	182.94	3.28	330.99	196.95
	M (29%)	310.03	179.66	182.89	3.23	321.04	193.53
	M (28%)	299.34	179.66	182.84	3.18	311.07	192.93
	M (27%)	288.65	179.66	182.79	3.13	300.42	192.28
	M (26%)	277.96	179.66	182.73	3.07	289.71	191.63
	M (25%)	267.27	179.66	182.67	3.01	278.54	190.94
	M (24%)	256.58	179.66	182.61	2.95	267.31	190.25
	M (23%)	245.89	179.66	182.55	2.89	256.09	189.56
	M (22%)	235.2	179.66	182.49	2.83	244.11	184.62
	M (21%)	224.51	179.66	182.43	2.77	232.54	180.42
	M (20%)	213.82	179.66	182.36	2.7	220.73	177.22
	M (19%)	203.13	179.66	182.29	2.63	209.25	174.04
	M (18%)	192.44	179.66	182.22	2.56	197.15	170.64
	M (17%)	181.74	179.66	182.15	2.49	185.26	169.12
	M (16%)	171.05	179.66	182.09	2.43	173.58	167.7
	M (15%)	160.36	179.66	182.01	2.35	161.56	166.19
	NMNL-2 (100%)	298.83	179.66	182.84	3.18	310.59	192.9
	NMNL-2 (30%)	89.65	179.66	181.52	1.86	85.54	116.27
	NMNL-2 (29%)	86.66	179.66	181.49	1.83	82.97	111.47
	NMNL-2 (28%)	83.67	179.66	181.47	1.81	80.47	106.57
	NMNL-2 (27%)	80.69	179.66	181.45	1.79	78.07	102.29
	NMNL-2 (26%)	77.7	179.66	181.43	1.77	75.78	100.81
	NMNL-2 (25%)	74.71	179.66	181.4	1.74	73.45	99.29
	NMNL-2 (24%)	71.72	179.66	181.38	1.72	71.16	97.77
	NMNL-2 (23%)	68.73	179.66	181.35	1.69	68.86	96.22
	NMNL-2 (22%)	65.74	179.66	181.33	1.67	66.6	94.67
	NMNL-2 (21%)	62.76	179.66	181.31	1.65	64.34	93.1
	NMNL-2 (20%)	59.77	179.66	181.28	1.62	61.96	91.42
	NMNL-2 (19%)	56.78	179.66	181.26	1.6	59.62	89.72
	NMNL-2 (18%)	53.79	179.66	181.23	1.57	57.23	87.97
	NMNL-2 (17%)	50.8	179.66	181.2	1.54	54.82	86.16
	NMNL-2 (16%)	47.81	179.66	181.17	1.51	52.41	84.32
	NMNL-2 (15%)	44.83	179.66	181.14	1.48	49.93	82.42
	L (100%)	124.11	179.66	181.76	2.1	120.73	160.97

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (30%)	37.23	179.66	181.06	1.4	43.29	77.08
	L (29%)	35.99	179.66	181.05	1.39	42.18	76.15
	L (28%)	34.75	179.66	181.03	1.37	41.04	75.14
	L (27%)	33.51	179.66	181.01	1.35	39.79	73.4
	L (26%)	32.27	179.66	180.99	1.33	38.25	71.19
	L (25%)	31.03	179.66	180.97	1.31	36.78	69.02
	L (24%)	29.79	179.66	180.95	1.29	35.32	66.8
	L (23%)	28.55	179.66	180.93	1.27	33.88	64.52
	L (22%)	27.3	179.66	180.9	1.24	32.37	60.15
	L (21%)	26.06	179.66	180.88	1.22	30.94	56.15
	L (20%)	24.82	179.66	180.85	1.19	29.58	54.6
	L (19%)	23.58	179.66	180.83	1.17	28.19	52.97
	L (18%)	22.34	179.66	180.8	1.14	26.79	51.27
	L (17%)	21.1	179.66	180.77	1.11	25.31	49.41
	L (16%)	19.86	179.66	180.74	1.08	23.77	47.4
	L (15%)	18.62	179.66	180.71	1.05	22.26	45.34
At 300 m d/s of Barrage axis	M (100%)	1069.08	179.53	185.39	5.86	877.54	195.58
	M (30%)	320.73	179.53	182.93	3.4	418.5	178.15
	M (29%)	310.03	179.53	182.88	3.35	409.39	177.73
	M (28%)	299.34	179.53	182.83	3.3	400.21	177.3
	M (27%)	288.65	179.53	182.77	3.24	390.39	176.85
	M (26%)	277.96	179.53	182.72	3.19	380.49	176.39
	M (25%)	267.27	179.53	182.66	3.13	370.16	175.91
	M (24%)	256.58	179.53	182.6	3.07	359.74	175.42
	M (23%)	245.89	179.53	182.54	3.01	349.31	174.93
	M (22%)	235.2	179.53	182.48	2.95	338.07	174.41
	M (21%)	224.51	179.53	182.41	2.88	326.9	173.88
	M (20%)	213.82	179.53	182.34	2.81	315.28	173.33
	M (19%)	203.13	179.53	182.28	2.75	303.87	172.79
	M (18%)	192.44	179.53	182.21	2.68	291.58	172.21
	M (17%)	181.74	179.53	182.14	2.61	279.35	171.57
	M (16%)	171.05	179.53	182.07	2.54	267.28	170.94
	M (15%)	160.36	179.53	181.99	2.46	254.73	170.28
	NMNL-2 (100%)	298.83	179.53	182.83	3.3	399.77	177.28
	NMNL-2 (30%)	89.65	179.53	181.47	1.94	167.82	163.07
	NMNL-2 (29%)	86.66	179.53	181.45	1.92	163.93	162.46
	NMNL-2 (28%)	83.67	179.53	181.43	1.9	160.01	161.84
	NMNL-2 (27%)	80.69	179.53	181.4	1.87	156.07	161.22
	NMNL-2 (26%)	77.7	179.53	181.38	1.85	152.13	160.6
	NMNL-2 (25%)	74.71	179.53	181.35	1.82	148.07	159.95
	NMNL-2 (24%)	71.72	179.53	181.33	1.8	144	159.3
	NMNL-2 (23%)	68.73	179.53	181.3	1.77	139.84	158.63
	NMNL-2 (22%)	65.74	179.53	181.27	1.74	135.67	157.96

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (21%)	62.76	179.53	181.25	1.72	131.49	157.28
	NMNL-2 (20%)	59.77	179.53	181.22	1.69	127.09	156.48
	NMNL-2 (19%)	56.78	179.53	181.19	1.66	122.73	155.64
	NMNL-2 (18%)	53.79	179.53	181.16	1.63	118.33	146.85
	NMNL-2 (17%)	50.8	179.53	181.13	1.6	114.01	142.4
	NMNL-2 (16%)	47.81	179.53	181.1	1.57	109.64	139.5
	NMNL-2 (15%)	44.83	179.53	181.07	1.54	104.95	136.31
	L (100%)	124.11	179.53	181.73	2.2	211.15	167.97
	L (30%)	37.23	179.53	180.98	1.45	92.84	128.33
	L (29%)	35.99	179.53	180.96	1.43	90.85	127.12
	L (28%)	34.75	179.53	180.94	1.41	88.78	125.85
	L (27%)	33.51	179.53	180.92	1.39	86.42	124.38
	L (26%)	32.27	179.53	180.9	1.37	83.83	122.76
	L (25%)	31.03	179.53	180.88	1.35	81.15	121.05
	L (24%)	29.79	179.53	180.86	1.33	78.55	119.37
	L (23%)	28.55	179.53	180.84	1.31	75.95	117.66
	L (22%)	27.3	179.53	180.82	1.29	73.31	115.9
	L (21%)	26.06	179.53	180.79	1.26	70.61	114.07
	L (20%)	24.82	179.53	180.77	1.24	67.82	112.15
	L (19%)	23.58	179.53	180.74	1.21	64.94	110.13
	L (18%)	22.34	179.53	180.71	1.18	61.99	107.41
	L (17%)	21.1	179.53	180.69	1.16	58.96	103.9
	L (16%)	19.86	179.53	180.65	1.12	55.81	100.12
	L (15%)	18.62	179.53	180.62	1.09	52.48	95.91
At 350 m d/s of Barrage axis	M (100%)	1069.08	179.4	185.36	5.96	820.89	191.49
	M (30%)	320.73	179.4	182.91	3.51	381.21	166.97
	M (29%)	310.03	179.4	182.86	3.46	372.68	166.4
	M (28%)	299.34	179.4	182.81	3.41	364.11	165.82
	M (27%)	288.65	179.4	182.75	3.35	354.92	165.2
	M (26%)	277.96	179.4	182.69	3.29	345.68	164.58
	M (25%)	267.27	179.4	182.64	3.24	336.03	163.92
	M (24%)	256.58	179.4	182.58	3.18	326.31	163.33
	M (23%)	245.89	179.4	182.52	3.12	316.59	162.74
	M (22%)	235.2	179.4	182.45	3.05	306.09	162.11
	M (21%)	224.51	179.4	182.39	2.99	295.69	161.48
	M (20%)	213.82	179.4	182.32	2.92	284.85	160.82
	M (19%)	203.13	179.4	182.25	2.85	274.23	160.17
	M (18%)	192.44	179.4	182.18	2.78	262.77	159.46
	M (17%)	181.74	179.4	182.11	2.71	251.38	158.76
	M (16%)	171.05	179.4	182.04	2.64	240.16	158.06
	M (15%)	160.36	179.4	181.97	2.57	228.47	157.34
	NMNL-2 (100%)	298.83	179.4	182.8	3.4	363.7	165.79
	NMNL-2 (30%)	89.65	179.4	181.44	2.04	147.78	149.62

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (29%)	86.66	179.4	181.42	2.02	144.2	148.85
	NMNL-2 (28%)	83.67	179.4	181.39	1.99	140.59	148.07
	NMNL-2 (27%)	80.69	179.4	181.37	1.97	136.98	147.28
	NMNL-2 (26%)	77.7	179.4	181.35	1.95	133.36	146.49
	NMNL-2 (25%)	74.71	179.4	181.32	1.92	129.64	145.67
	NMNL-2 (24%)	71.72	179.4	181.29	1.89	125.93	144.85
	NMNL-2 (23%)	68.73	179.4	181.27	1.87	122.11	144
	NMNL-2 (22%)	65.74	179.4	181.24	1.84	118.32	143.15
	NMNL-2 (21%)	62.76	179.4	181.22	1.82	114.51	142.3
	NMNL-2 (20%)	59.77	179.4	181.19	1.79	110.51	141.39
	NMNL-2 (19%)	56.78	179.4	181.16	1.76	106.54	140.49
	NMNL-2 (18%)	53.79	179.4	181.13	1.73	102.49	139.29
	NMNL-2 (17%)	50.8	179.4	181.1	1.7	98.32	136.52
	NMNL-2 (16%)	47.81	179.4	181.07	1.67	94.23	131.49
	NMNL-2 (15%)	44.83	179.4	181.04	1.64	89.98	126.26
	L (100%)	124.11	179.4	181.71	2.31	187.95	154.67
	L (30%)	37.23	179.4	180.95	1.55	79.06	115.86
	L (29%)	35.99	179.4	180.93	1.53	77.3	114.09
	L (28%)	34.75	179.4	180.91	1.51	75.48	112.23
	L (27%)	33.51	179.4	180.9	1.5	73.38	110.05
	L (26%)	32.27	179.4	180.87	1.47	71.09	107.69
	L (25%)	31.03	179.4	180.85	1.45	68.72	105.25
	L (24%)	29.79	179.4	180.83	1.43	66.47	102.87
	L (23%)	28.55	179.4	180.81	1.41	64.23	100.43
	L (22%)	27.3	179.4	180.79	1.39	61.98	97.92
	L (21%)	26.06	179.4	180.76	1.36	59.71	95.32
	L (20%)	24.82	179.4	180.74	1.34	57.39	92.66
	L (19%)	23.58	179.4	180.71	1.31	55	90.17
	L (18%)	22.34	179.4	180.68	1.28	52.57	87.57
	L (17%)	21.1	179.4	180.66	1.26	50.08	84.81
	L (16%)	19.86	179.4	180.62	1.22	47.45	81.81
	L (15%)	18.62	179.4	180.59	1.19	44.66	78.51
At 400 m d/s of Barrage axis	M (100%)	1069.08	179.26	185.34	6.08	827.05	184
	M (30%)	320.73	179.26	182.89	3.63	392.02	168.39
	M (29%)	310.03	179.26	182.84	3.58	383.4	167.75
	M (28%)	299.34	179.26	182.79	3.53	374.76	166.9
	M (27%)	288.65	179.26	182.73	3.47	365.49	165.98
	M (26%)	277.96	179.26	182.68	3.42	356.19	165.06
	M (25%)	267.27	179.26	182.62	3.36	346.48	164.08
	M (24%)	256.58	179.26	182.56	3.3	336.73	163.1
	M (23%)	245.89	179.26	182.5	3.24	327.01	162.12
	M (22%)	235.2	179.26	182.43	3.17	316.51	161.02
	M (21%)	224.51	179.26	182.37	3.11	306.14	159.93

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (20%)	213.82	179.26	182.3	3.04	295.37	158.79
	M (19%)	203.13	179.26	182.23	2.97	284.85	157.67
	M (18%)	192.44	179.26	182.16	2.9	273.51	156.46
	M (17%)	181.74	179.26	182.09	2.83	262.28	155.24
	M (16%)	171.05	179.26	182.02	2.76	251.26	154.04
	M (15%)	160.36	179.26	181.94	2.68	239.8	152.78
	NMNL-2 (100%)	298.83	179.26	182.79	3.53	374.34	166.86
	NMNL-2 (30%)	89.65	179.26	181.42	2.16	162.72	135.68
	NMNL-2 (29%)	86.66	179.26	181.4	2.14	159.47	134.97
	NMNL-2 (28%)	83.67	179.26	181.37	2.11	156.21	134.24
	NMNL-2 (27%)	80.69	179.26	181.35	2.09	152.94	133.51
	NMNL-2 (26%)	77.7	179.26	181.32	2.06	149.68	132.78
	NMNL-2 (25%)	74.71	179.26	181.3	2.04	146.35	132.03
	NMNL-2 (24%)	71.72	179.26	181.27	2.01	143	131.26
	NMNL-2 (23%)	68.73	179.26	181.25	1.99	139.55	130.48
	NMNL-2 (22%)	65.74	179.26	181.22	1.96	136.13	129.69
	NMNL-2 (21%)	62.76	179.26	181.19	1.93	132.71	128.9
	NMNL-2 (20%)	59.77	179.26	181.16	1.9	129.1	128.06
	NMNL-2 (19%)	56.78	179.26	181.14	1.88	125.53	127.22
	NMNL-2 (18%)	53.79	179.26	181.11	1.85	121.88	126.36
	NMNL-2 (17%)	50.8	179.26	181.08	1.82	118.13	125.48
	NMNL-2 (16%)	47.81	179.26	181.05	1.79	114.35	124.34
	NMNL-2 (15%)	44.83	179.26	181.01	1.75	110.34	122.75
	L (100%)	124.11	179.26	181.68	2.42	200.42	148.24
	L (30%)	37.23	179.26	180.93	1.67	99.75	116.46
	L (29%)	35.99	179.26	180.91	1.65	98.04	113.56
	L (28%)	34.75	179.26	180.9	1.64	96.29	110.53
	L (27%)	33.51	179.26	180.88	1.62	94.28	106.92
	L (26%)	32.27	179.26	180.86	1.6	92.12	102.89
	L (25%)	31.03	179.26	180.84	1.58	89.91	98.58
	L (24%)	29.79	179.26	180.81	1.55	87.87	94.42
	L (23%)	28.55	179.26	180.79	1.53	85.89	92.55
	L (22%)	27.3	179.26	180.77	1.51	83.86	91.36
	L (21%)	26.06	179.26	180.75	1.49	81.78	90.13
	L (20%)	24.82	179.26	180.72	1.46	79.61	88.84
	L (19%)	23.58	179.26	180.7	1.44	77.36	87.47
	L (18%)	22.34	179.26	180.67	1.41	75.02	86.03
	L (17%)	21.1	179.26	180.64	1.38	72.6	84.5
	L (16%)	19.86	179.26	180.61	1.35	69.99	82.84
	L (15%)	18.62	179.26	180.58	1.32	67.19	81
At 450 m d/s of Barrage	M (100%)	1069.08	179.13	185.3	6.17	774.21	178.36
	M (30%)	320.73	179.13	182.87	3.74	377.67	147.61
	M (29%)	310.03	179.13	182.82	3.69	370.17	146.96

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
axis	M (28%)	299.34	179.13	182.77	3.64	362.64	146.31
	M (27%)	288.65	179.13	182.71	3.58	354.55	145.65
	M (26%)	277.96	179.13	182.66	3.53	346.42	144.98
	M (25%)	267.27	179.13	182.6	3.47	337.92	144.27
	M (24%)	256.58	179.13	182.54	3.41	329.38	143.56
	M (23%)	245.89	179.13	182.48	3.35	320.84	142.84
	M (22%)	235.2	179.13	182.42	3.29	311.62	142
	M (21%)	224.51	179.13	182.35	3.22	302.49	141.15
	M (20%)	213.82	179.13	182.28	3.15	293	140.25
	M (19%)	203.13	179.13	182.22	3.09	283.73	139.37
	M (18%)	192.44	179.13	182.14	3.01	273.72	138.41
	M (17%)	181.74	179.13	182.07	2.94	263.79	137.42
	M (16%)	171.05	179.13	182	2.87	254.06	136.41
	M (15%)	160.36	179.13	181.93	2.8	243.93	135.35
	NMNL-2 (100%)	298.83	179.13	182.77	3.64	362.27	146.28
	NMNL-2 (30%)	89.65	179.13	181.4	2.27	175.33	126.07
	NMNL-2 (29%)	86.66	179.13	181.38	2.25	172.35	125.5
	NMNL-2 (28%)	83.67	179.13	181.36	2.23	169.35	124.93
	NMNL-2 (27%)	80.69	179.13	181.33	2.2	166.33	124.35
	NMNL-2 (26%)	77.7	179.13	181.31	2.18	163.32	123.77
	NMNL-2 (25%)	74.71	179.13	181.28	2.15	160.27	123.18
	NMNL-2 (24%)	71.72	179.13	181.26	2.13	157.18	122.57
	NMNL-2 (23%)	68.73	179.13	181.23	2.1	154.01	121.63
	NMNL-2 (22%)	65.74	179.13	181.21	2.08	150.87	120.69
	NMNL-2 (21%)	62.76	179.13	181.18	2.05	147.73	119.74
	NMNL-2 (20%)	59.77	179.13	181.15	2.02	144.43	118.73
	NMNL-2 (19%)	56.78	179.13	181.13	2	141.17	117.73
	NMNL-2 (18%)	53.79	179.13	181.1	1.97	137.84	116.69
	NMNL-2 (17%)	50.8	179.13	181.07	1.94	134.44	115.63
	NMNL-2 (16%)	47.81	179.13	181.04	1.91	131.01	114.55
	NMNL-2 (15%)	44.83	179.13	181.01	1.88	127.39	110.98
	L (100%)	124.11	179.13	181.67	2.54	209.12	131.64
	L (30%)	37.23	179.13	180.92	1.79	118.63	95.41
	L (29%)	35.99	179.13	180.91	1.78	117.24	94.95
	L (28%)	34.75	179.13	180.89	1.76	115.8	94.47
	L (27%)	33.51	179.13	180.87	1.74	114.09	93.91
	L (26%)	32.27	179.13	180.85	1.72	112.18	93.26
	L (25%)	31.03	179.13	180.83	1.7	110.17	92.58
	L (24%)	29.79	179.13	180.81	1.68	108.24	91.92
	L (23%)	28.55	179.13	180.79	1.66	106.3	91.26
	L (22%)	27.3	179.13	180.77	1.64	104.31	90.57
	L (21%)	26.06	179.13	180.74	1.61	102.25	89.85
	L (20%)	24.82	179.13	180.72	1.59	100.1	89.1
	L (19%)	23.58	179.13	180.69	1.56	97.85	88.31

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (18%)	22.34	179.13	180.67	1.54	95.49	87.53
	L (17%)	21.1	179.13	180.64	1.51	93.02	86.7
	L (16%)	19.86	179.13	180.61	1.48	90.35	85.79
	L (15%)	18.62	179.13	180.57	1.44	87.44	84.79
At 500 m d/s of Barrage axis	M (100%)	1069.08	178.99	185.21	6.22	607.58	134.12
	M (30%)	320.73	178.99	182.83	3.84	309.44	115.46
	M (29%)	310.03	178.99	182.78	3.79	303.65	115.04
	M (28%)	299.34	178.99	182.73	3.74	297.84	114.6
	M (27%)	288.65	178.99	182.67	3.68	291.57	114.13
	M (26%)	277.96	178.99	182.62	3.63	285.27	113.66
	M (25%)	267.27	178.99	182.56	3.57	278.68	113.1
	M (24%)	256.58	178.99	182.5	3.51	272.04	112.54
	M (23%)	245.89	178.99	182.44	3.45	265.43	111.97
	M (22%)	235.2	178.99	182.38	3.39	258.26	111.36
	M (21%)	224.51	178.99	182.31	3.32	251.17	110.74
	M (20%)	213.82	178.99	182.25	3.26	243.78	110.1
	M (19%)	203.13	178.99	182.18	3.19	236.58	109.47
	M (18%)	192.44	178.99	182.11	3.12	228.77	108.79
	M (17%)	181.74	178.99	182.04	3.05	221.03	108.1
	M (16%)	171.05	178.99	181.97	2.98	213.46	107.43
	M (15%)	160.36	178.99	181.89	2.9	205.55	106.72
	NMNL-2 (100%)	298.83	178.99	182.73	3.74	297.56	114.58
	NMNL-2 (30%)	89.65	178.99	181.38	2.39	153.01	86.73
	NMNL-2 (29%)	86.66	178.99	181.36	2.37	151.02	86.42
	NMNL-2 (28%)	83.67	178.99	181.34	2.35	149.02	86.11
	NMNL-2 (27%)	80.69	178.99	181.31	2.32	147.02	85.79
	NMNL-2 (26%)	77.7	178.99	181.29	2.3	145	85.48
	NMNL-2 (25%)	74.71	178.99	181.26	2.27	142.95	85.16
	NMNL-2 (24%)	71.72	178.99	181.24	2.25	140.88	84.83
	NMNL-2 (23%)	68.73	178.99	181.21	2.22	138.77	84.5
	NMNL-2 (22%)	65.74	178.99	181.19	2.2	136.65	84.16
	NMNL-2 (21%)	62.76	178.99	181.16	2.17	134.52	83.82
	NMNL-2 (20%)	59.77	178.99	181.14	2.15	132.29	83.47
	NMNL-2 (19%)	56.78	178.99	181.11	2.12	130.06	83.11
	NMNL-2 (18%)	53.79	178.99	181.08	2.09	127.77	82.74
	NMNL-2 (17%)	50.8	178.99	181.05	2.06	125.43	82.36
	NMNL-2 (16%)	47.81	178.99	181.03	2.04	123.06	81.97
	NMNL-2 (15%)	44.83	178.99	180.99	2	120.51	81.53
	L (100%)	124.11	178.99	181.64	2.65	178.43	103.96
	L (30%)	37.23	178.99	180.91	1.92	113.67	80.32
	L (29%)	35.99	178.99	180.9	1.91	112.53	80.11
	L (28%)	34.75	178.99	180.88	1.89	111.33	79.9
	L (27%)	33.51	178.99	180.86	1.87	109.91	79.64

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (26%)	32.27	178.99	180.84	1.85	108.3	79.35
	L (25%)	31.03	178.99	180.82	1.83	106.6	79.05
	L (24%)	29.79	178.99	180.8	1.81	104.97	78.75
	L (23%)	28.55	178.99	180.78	1.79	103.33	78.45
	L (22%)	27.3	178.99	180.76	1.77	101.63	78.14
	L (21%)	26.06	178.99	180.74	1.75	99.87	77.89
	L (20%)	24.82	178.99	180.71	1.72	98.01	77.62
	L (19%)	23.58	178.99	180.69	1.7	96.07	77.33
	L (18%)	22.34	178.99	180.66	1.67	94.01	77.03
	L (17%)	21.1	178.99	180.63	1.64	91.85	76.71
	L (16%)	19.86	178.99	180.6	1.61	89.5	76.36
	L (15%)	18.62	178.99	180.57	1.58	86.92	75.98
At 550 m d/s of Barrage axis	M (100%)	1069.08	178.86	184.99	6.13	427.92	117.42
	M (30%)	320.73	178.86	182.63	3.77	170.81	97.96
	M (29%)	310.03	178.86	182.58	3.72	165.9	96.85
	M (28%)	299.34	178.86	182.53	3.67	161.01	95.85
	M (27%)	288.65	178.86	182.48	3.62	156	86.11
	M (26%)	277.96	178.86	182.43	3.57	151.49	83.02
	M (25%)	267.27	178.86	182.37	3.51	146.75	81.87
	M (24%)	256.58	178.86	182.31	3.45	142.04	80.72
	M (23%)	245.89	178.86	182.25	3.39	137.41	79.57
	M (22%)	235.2	178.86	182.19	3.33	132.61	78.57
	M (21%)	224.51	178.86	182.13	3.27	127.71	77.97
	M (20%)	213.82	178.86	182.06	3.2	122.54	77.34
	M (19%)	203.13	178.86	182	3.14	117.57	76.73
	M (18%)	192.44	178.86	181.93	3.07	112.25	76.06
	M (17%)	181.74	178.86	181.86	3	106.9	75.39
	M (16%)	171.05	178.86	181.79	2.93	101.73	74.74
	M (15%)	160.36	178.86	181.72	2.86	96.32	74.05
	NMNL-2 (100%)	298.83	178.86	182.53	3.67	160.77	95.8
	NMNL-2 (30%)	89.65	178.86	181.23	2.37	61.37	69.4
	NMNL-2 (29%)	86.66	178.86	181.21	2.35	59.91	69.2
	NMNL-2 (28%)	83.67	178.86	181.19	2.33	58.46	69
	NMNL-2 (27%)	80.69	178.86	181.17	2.31	57.02	68.8
	NMNL-2 (26%)	77.7	178.86	181.14	2.28	55.58	68.6
	NMNL-2 (25%)	74.71	178.86	181.12	2.26	54.1	68.39
	NMNL-2 (24%)	71.72	178.86	181.1	2.24	52.62	68.19
	NMNL-2 (23%)	68.73	178.86	181.08	2.22	51.12	67.97
	NMNL-2 (22%)	65.74	178.86	181.06	2.2	49.6	67.76
	NMNL-2 (21%)	62.76	178.86	181.04	2.18	48.1	67.55
	NMNL-2 (20%)	59.77	178.86	181.01	2.15	46.48	67.32
	NMNL-2 (19%)	56.78	178.86	180.99	2.13	44.88	67.09
	NMNL-2 (18%)	53.79	178.86	180.96	2.1	43.24	66.85

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (17%)	50.8	178.86	180.94	2.08	41.54	66.61
	NMNL-2 (16%)	47.81	178.86	180.91	2.05	39.85	66.37
	NMNL-2 (15%)	44.83	178.86	180.88	2.02	37.95	66.09
	L (100%)	124.11	178.86	181.47	2.61	78.19	71.68
	L (30%)	37.23	178.86	180.8	1.94	32.8	65.34
	L (29%)	35.99	178.86	180.79	1.93	31.94	65.21
	L (28%)	34.75	178.86	180.78	1.92	31.02	65.08
	L (27%)	33.51	178.86	180.76	1.9	29.79	64.06
	L (26%)	32.27	178.86	180.74	1.88	28.38	61.31
	L (25%)	31.03	178.86	180.71	1.85	26.93	58.35
	L (24%)	29.79	178.86	180.69	1.83	25.66	55.61
	L (23%)	28.55	178.86	180.67	1.81	24.44	52.89
	L (22%)	27.3	178.86	180.64	1.78	23.26	50.08
	L (21%)	26.06	178.86	180.62	1.76	22.09	47.15
	L (20%)	24.82	178.86	180.59	1.73	20.93	43.97
	L (19%)	23.58	178.86	180.57	1.71	19.78	40.89
	L (18%)	22.34	178.86	180.54	1.68	18.65	37.88
	L (17%)	21.1	178.86	180.51	1.65	17.55	34.89
	L (16%)	19.86	178.86	180.47	1.61	16.42	31.72
	L (15%)	18.62	178.86	180.44	1.58	15.27	28.12
At 600 m d/s of Barrage axis	M (100%)	1069.08	178.71	184.94	6.23	462.08	123.76
	M (30%)	320.73	178.71	182.52	3.81	183.34	106.08
	M (29%)	310.03	178.71	182.47	3.76	177.7	104.99
	M (28%)	299.34	178.71	182.42	3.71	172.06	103.89
	M (27%)	288.65	178.71	182.36	3.65	166.31	102.75
	M (26%)	277.96	178.71	182.3	3.59	160.5	101.59
	M (25%)	267.27	178.71	182.24	3.53	154.64	100.41
	M (24%)	256.58	178.71	182.19	3.48	148.75	99.2
	M (23%)	245.89	178.71	182.12	3.41	142.77	97.97
	M (22%)	235.2	178.71	182.06	3.35	136.72	96.7
	M (21%)	224.51	178.71	182	3.29	130.63	94.05
	M (20%)	213.82	178.71	181.93	3.22	124.52	79.6
	M (19%)	203.13	178.71	181.86	3.15	119.31	75.96
	M (18%)	192.44	178.71	181.79	3.08	113.7	75.1
	M (17%)	181.74	178.71	181.71	3	108.02	74.22
	M (16%)	171.05	178.71	181.64	2.93	102.52	73.35
	M (15%)	160.36	178.71	181.56	2.85	96.62	72.41
	NMNL-2 (100%)	298.83	178.71	182.41	3.7	171.79	103.83
	NMNL-2 (30%)	89.65	178.71	180.98	2.27	56.88	64.36
	NMNL-2 (29%)	86.66	178.71	180.96	2.25	55.26	63.26
	NMNL-2 (28%)	83.67	178.71	180.93	2.22	53.67	62.15
	NMNL-2 (27%)	80.69	178.71	180.91	2.2	52.14	61.07
	NMNL-2 (26%)	77.7	178.71	180.88	2.17	50.67	60.01

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (25%)	74.71	178.71	180.86	2.15	49.22	58.96
	NMNL-2 (24%)	71.72	178.71	180.83	2.12	47.76	57.87
	NMNL-2 (23%)	68.73	178.71	180.81	2.1	46.33	56.78
	NMNL-2 (22%)	65.74	178.71	180.78	2.07	44.95	55.71
	NMNL-2 (21%)	62.76	178.71	180.76	2.05	43.61	54.66
	NMNL-2 (20%)	59.77	178.71	180.74	2.03	42.3	53.66
	NMNL-2 (19%)	56.78	178.71	180.71	2	41.01	52.72
	NMNL-2 (18%)	53.79	178.71	180.69	1.98	39.67	51.72
	NMNL-2 (17%)	50.8	178.71	180.66	1.95	38.28	50.67
	NMNL-2 (16%)	47.81	178.71	180.63	1.92	36.88	49.6
	NMNL-2 (15%)	44.83	178.71	180.6	1.89	35.35	48.39
	L (100%)	124.11	178.71	181.27	2.56	76.39	69.11
	L (30%)	37.23	178.71	180.5	1.79	30.92	44.71
	L (29%)	35.99	178.71	180.49	1.78	30.22	44.1
	L (28%)	34.75	178.71	180.47	1.76	29.51	43.47
	L (27%)	33.51	178.71	180.46	1.75	28.79	42.83
	L (26%)	32.27	178.71	180.44	1.73	28.06	42.16
	L (25%)	31.03	178.71	180.42	1.71	27.32	41.47
	L (24%)	29.79	178.71	180.4	1.69	26.56	40.75
	L (23%)	28.55	178.71	180.38	1.67	25.81	40.04
	L (22%)	27.3	178.71	180.36	1.65	25.04	39.29
	L (21%)	26.06	178.71	180.34	1.63	24.27	38.53
	L (20%)	24.82	178.71	180.32	1.61	23.49	37.74
	L (19%)	23.58	178.71	180.3	1.59	22.69	36.91
	L (18%)	22.34	178.71	180.28	1.57	21.87	36.05
	L (17%)	21.1	178.71	180.26	1.55	21.05	35.17
	L (16%)	19.86	178.71	180.23	1.52	20.2	34.24
	L (15%)	18.62	178.71	180.21	1.5	19.32	33.25
At 650 m d/s of Barrage axis	M (100%)	1069.08	178.59	184.92	6.33	537.47	138.08
	M (30%)	320.73	178.59	182.46	3.87	221.67	115.95
	M (29%)	310.03	178.59	182.41	3.82	215.22	115.29
	M (28%)	299.34	178.59	182.35	3.76	208.67	114.61
	M (27%)	288.65	178.59	182.29	3.7	201.97	113.91
	M (26%)	277.96	178.59	182.23	3.64	195.16	113.2
	M (25%)	267.27	178.59	182.17	3.58	188.22	112.47
	M (24%)	256.58	178.59	182.11	3.52	181.14	111.72
	M (23%)	245.89	178.59	182.04	3.45	173.87	110.98
	M (22%)	235.2	178.59	181.97	3.38	166.48	110.35
	M (21%)	224.51	178.59	181.91	3.32	158.91	109.7
	M (20%)	213.82	178.59	181.84	3.25	151.15	108.03
	M (19%)	203.13	178.59	181.76	3.17	143.25	105.79
	M (18%)	192.44	178.59	181.69	3.1	135.32	103.47
	M (17%)	181.74	178.59	181.61	3.02	127.26	100.91

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (16%)	171.05	178.59	181.52	2.93	119.14	98.25
	M (15%)	160.36	178.59	181.44	2.85	110.96	95.5
	NMNL-2 (100%)	298.83	178.59	182.35	3.76	208.35	114.58
	NMNL-2 (30%)	89.65	178.59	180.78	2.19	61.49	65.22
	NMNL-2 (29%)	86.66	178.59	180.74	2.15	59.3	64.73
	NMNL-2 (28%)	83.67	178.59	180.71	2.12	57.08	64.24
	NMNL-2 (27%)	80.69	178.59	180.68	2.09	54.9	63.74
	NMNL-2 (26%)	77.7	178.59	180.64	2.05	52.67	63.24
	NMNL-2 (25%)	74.71	178.59	180.6	2.01	50.42	62.72
	NMNL-2 (24%)	71.72	178.59	180.57	1.98	48.14	62.2
	NMNL-2 (23%)	68.73	178.59	180.53	1.94	45.83	61.66
	NMNL-2 (22%)	65.74	178.59	180.49	1.9	43.55	61.13
	NMNL-2 (21%)	62.76	178.59	180.45	1.86	41.2	60.57
	NMNL-2 (20%)	59.77	178.59	180.42	1.83	38.87	60.02
	NMNL-2 (19%)	56.78	178.59	180.38	1.79	36.5	59.12
	NMNL-2 (18%)	53.79	178.59	180.34	1.75	34.15	56.51
	NMNL-2 (17%)	50.8	178.59	180.3	1.71	31.9	53.9
	NMNL-2 (16%)	47.81	178.59	180.25	1.66	29.7	51.22
	NMNL-2 (15%)	44.83	178.59	180.21	1.62	27.67	49.18
	L (100%)	124.11	178.59	181.13	2.54	85.43	70.33
	L (30%)	37.23	178.59	180.11	1.52	22.99	44.56
	L (29%)	35.99	178.59	180.09	1.5	22.2	43.73
	L (28%)	34.75	178.59	180.08	1.49	21.43	42.91
	L (27%)	33.51	178.59	180.06	1.47	20.69	42.1
	L (26%)	32.27	178.59	180.04	1.45	20	41.34
	L (25%)	31.03	178.59	180.03	1.44	19.33	40.58
	L (24%)	29.79	178.59	180.01	1.42	18.69	39.87
	L (23%)	28.55	178.59	179.99	1.4	18.06	39.16
	L (22%)	27.3	178.59	179.98	1.39	17.44	38.44
	L (21%)	26.06	178.59	179.96	1.37	16.84	37.71
	L (20%)	24.82	178.59	179.95	1.36	16.23	36.87
	L (19%)	23.58	178.59	179.93	1.34	15.59	35.98
	L (18%)	22.34	178.59	179.91	1.32	14.96	35.08
	L (17%)	21.1	178.59	179.89	1.3	14.35	34.18
	L (16%)	19.86	178.59	179.88	1.29	13.74	33.26
	L (15%)	18.62	178.59	179.86	1.27	13.12	32.3
At 700 m d/s of Barrage axis	M (100%)	1069.08	178.45	184.94	6.49	671.51	150.67
	M (30%)	320.73	178.45	182.46	4.01	329.61	126.51
	M (29%)	310.03	178.45	182.41	3.96	322.53	126.02
	M (28%)	299.34	178.45	182.35	3.9	315.31	125.52
	M (27%)	288.65	178.45	182.29	3.84	307.92	125.01
	M (26%)	277.96	178.45	182.23	3.78	300.39	124.48
	M (25%)	267.27	178.45	182.17	3.72	292.68	123.94

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (24%)	256.58	178.45	182.11	3.66	284.8	123.47
	M (23%)	245.89	178.45	182.04	3.59	276.67	123.06
	M (22%)	235.2	178.45	181.97	3.52	268.37	122.63
	M (21%)	224.51	178.45	181.9	3.45	259.85	122.2
	M (20%)	213.82	178.45	181.83	3.38	251.04	121.75
	M (19%)	203.13	178.45	181.76	3.31	241.93	121.27
	M (18%)	192.44	178.45	181.68	3.23	232.57	120.79
	M (17%)	181.74	178.45	181.6	3.15	222.88	120.29
	M (16%)	171.05	178.45	181.51	3.06	212.88	119.76
	M (15%)	160.36	178.45	181.43	2.98	202.56	119.22
	NMNL-2 (100%)	298.83	178.45	182.35	3.9	314.96	125.5
	NMNL-2 (30%)	89.65	178.45	180.75	2.3	123.38	111.02
	NMNL-2 (29%)	86.66	178.45	180.72	2.27	119.59	108.63
	NMNL-2 (28%)	83.67	178.45	180.68	2.23	115.82	105.92
	NMNL-2 (27%)	80.69	178.45	180.65	2.2	112.1	103.19
	NMNL-2 (26%)	77.7	178.45	180.61	2.16	108.4	100.4
	NMNL-2 (25%)	74.71	178.45	180.57	2.12	104.71	97.53
	NMNL-2 (24%)	71.72	178.45	180.53	2.08	101.06	94.6
	NMNL-2 (23%)	68.73	178.45	180.49	2.04	97.43	91.64
	NMNL-2 (22%)	65.74	178.45	180.45	2	93.83	88.6
	NMNL-2 (21%)	62.76	178.45	180.41	1.96	90.26	85.48
	NMNL-2 (20%)	59.77	178.45	180.37	1.92	86.73	81.93
	NMNL-2 (19%)	56.78	178.45	180.33	1.88	83.34	74.13
	NMNL-2 (18%)	53.79	178.45	180.28	1.83	80.28	67.1
	NMNL-2 (17%)	50.8	178.45	180.24	1.79	77.25	66.22
	NMNL-2 (16%)	47.81	178.45	180.19	1.74	74.06	65.28
	NMNL-2 (15%)	44.83	178.45	180.14	1.69	70.87	64.32
	L (100%)	124.11	178.45	181.11	2.66	164.89	117.22
	L (30%)	37.23	178.45	180	1.55	62.16	61.66
	L (29%)	35.99	178.45	179.98	1.53	60.66	61.2
	L (28%)	34.75	178.45	179.95	1.5	59.17	60.73
	L (27%)	33.51	178.45	179.93	1.48	57.65	60.25
	L (26%)	32.27	178.45	179.9	1.45	56.1	59.76
	L (25%)	31.03	178.45	179.88	1.43	54.52	59.25
	L (24%)	29.79	178.45	179.85	1.4	52.92	58.73
	L (23%)	28.55	178.45	179.82	1.37	51.28	58.2
	L (22%)	27.3	178.45	179.79	1.34	49.59	57.64
	L (21%)	26.06	178.45	179.76	1.31	47.9	57.08
	L (20%)	24.82	178.45	179.73	1.28	46.17	56.5
	L (19%)	23.58	178.45	179.7	1.25	44.41	55.92
	L (18%)	22.34	178.45	179.67	1.22	42.6	55.32
	L (17%)	21.1	178.45	179.63	1.18	40.71	54.68
	L (16%)	19.86	178.45	179.6	1.15	38.78	54.02
	L (15%)	18.62	178.45	179.56	1.11	36.81	53.34

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
At 750 m d/s of Barrage axis	M (100%)	1069.08	178.32	184.92	6.6	672.64	143.56
	M (30%)	320.73	178.32	182.45	4.13	352.45	119.6
	M (29%)	310.03	178.32	182.39	4.07	345.76	119.14
	M (28%)	299.34	178.32	182.34	4.02	338.96	118.67
	M (27%)	288.65	178.32	182.28	3.96	331.99	118.19
	M (26%)	277.96	178.32	182.22	3.9	324.89	117.69
	M (25%)	267.27	178.32	182.16	3.84	317.61	117.18
	M (24%)	256.58	178.32	182.09	3.77	310.17	116.66
	M (23%)	245.89	178.32	182.03	3.71	302.5	116.12
	M (22%)	235.2	178.32	181.96	3.64	294.69	115.57
	M (21%)	224.51	178.32	181.89	3.57	286.66	115
	M (20%)	213.82	178.32	181.82	3.5	278.39	114.4
	M (19%)	203.13	178.32	181.74	3.42	269.83	113.79
	M (18%)	192.44	178.32	181.66	3.34	261.06	113.15
	M (17%)	181.74	178.32	181.58	3.26	251.98	112.49
	M (16%)	171.05	178.32	181.5	3.18	242.63	111.8
	M (15%)	160.36	178.32	181.41	3.09	232.98	111.09
	NMNL-2 (100%)	298.83	178.32	182.33	4.01	338.63	118.65
	NMNL-2 (30%)	89.65	178.32	180.73	2.41	159.39	105.46
	NMNL-2 (29%)	86.66	178.32	180.7	2.38	155.74	105.17
	NMNL-2 (28%)	83.67	178.32	180.66	2.34	152.02	104.88
	NMNL-2 (27%)	80.69	178.32	180.63	2.31	148.27	104.58
	NMNL-2 (26%)	77.7	178.32	180.59	2.27	144.44	104.28
	NMNL-2 (25%)	74.71	178.32	180.55	2.23	140.54	103.96
	NMNL-2 (24%)	71.72	178.32	180.52	2.2	136.58	103.65
	NMNL-2 (23%)	68.73	178.32	180.48	2.16	132.54	103.32
	NMNL-2 (22%)	65.74	178.32	180.44	2.12	128.41	102.99
	NMNL-2 (21%)	62.76	178.32	180.4	2.08	124.19	102.65
	NMNL-2 (20%)	59.77	178.32	180.35	2.03	119.89	102.3
	NMNL-2 (19%)	56.78	178.32	180.31	1.99	115.49	101.94
	NMNL-2 (18%)	53.79	178.32	180.27	1.95	111	100
	NMNL-2 (17%)	50.8	178.32	180.22	1.9	106.52	97.34
	NMNL-2 (16%)	47.81	178.32	180.17	1.85	101.95	94.77
	NMNL-2 (15%)	44.83	178.32	180.12	1.8	97.34	92.22
	L (100%)	124.11	178.32	181.09	2.77	197.93	108.45
	L (30%)	37.23	178.32	179.99	1.67	85.35	82.2
	L (29%)	35.99	178.32	179.96	1.64	83.37	80.61
	L (28%)	34.75	178.32	179.94	1.62	81.4	79.46
	L (27%)	33.51	178.32	179.91	1.59	79.42	78.44
	L (26%)	32.27	178.32	179.89	1.57	77.41	77.39
	L (25%)	31.03	178.32	179.86	1.54	75.37	76.31
	L (24%)	29.79	178.32	179.83	1.51	73.31	75.21
	L (23%)	28.55	178.32	179.81	1.49	71.22	73.59

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (22%)	27.3	178.32	179.78	1.46	69.11	71.3
	L (21%)	26.06	178.32	179.75	1.43	67.03	69.16
	L (20%)	24.82	178.32	179.72	1.4	64.94	68.3
	L (19%)	23.58	178.32	179.68	1.36	62.8	67.42
	L (18%)	22.34	178.32	179.65	1.33	60.61	66.5
	L (17%)	21.1	178.32	179.62	1.3	58.33	65.54
	L (16%)	19.86	178.32	179.58	1.26	56	64.53
	L (15%)	18.62	178.32	179.54	1.22	53.63	63.5
At 800 m d/s of Barrage axis	M (100%)	1069.08	178.18	184.87	6.69	630.65	132.29
	M (30%)	320.73	178.18	182.43	4.25	332	111.58
	M (29%)	310.03	178.18	182.37	4.19	325.8	111.08
	M (28%)	299.34	178.18	182.31	4.13	319.5	110.57
	M (27%)	288.65	178.18	182.26	4.08	313.05	110.05
	M (26%)	277.96	178.18	182.2	4.02	306.47	109.52
	M (25%)	267.27	178.18	182.13	3.95	299.74	108.97
	M (24%)	256.58	178.18	182.07	3.89	292.86	108.4
	M (23%)	245.89	178.18	182.01	3.83	285.78	107.81
	M (22%)	235.2	178.18	181.94	3.76	278.56	107.21
	M (21%)	224.51	178.18	181.87	3.69	271.15	106.6
	M (20%)	213.82	178.18	181.8	3.62	263.52	105.95
	M (19%)	203.13	178.18	181.72	3.54	255.63	105.29
	M (18%)	192.44	178.18	181.65	3.47	247.55	104.6
	M (17%)	181.74	178.18	181.57	3.39	239.19	103.88
	M (16%)	171.05	178.18	181.48	3.3	230.59	103.14
	M (15%)	160.36	178.18	181.4	3.22	221.73	102.37
	NMNL-2 (100%)	298.83	178.18	182.31	4.13	319.19	110.55
	NMNL-2 (30%)	89.65	178.18	180.72	2.54	155.26	90.26
	NMNL-2 (29%)	86.66	178.18	180.68	2.5	152.17	88.59
	NMNL-2 (28%)	83.67	178.18	180.65	2.47	149.07	87.1
	NMNL-2 (27%)	80.69	178.18	180.61	2.43	145.98	86.27
	NMNL-2 (26%)	77.7	178.18	180.58	2.4	142.85	85.43
	NMNL-2 (25%)	74.71	178.18	180.54	2.36	139.69	84.57
	NMNL-2 (24%)	71.72	178.18	180.5	2.32	136.5	83.7
	NMNL-2 (23%)	68.73	178.18	180.46	2.28	133.27	82.8
	NMNL-2 (22%)	65.74	178.18	180.42	2.24	130	81.88
	NMNL-2 (21%)	62.76	178.18	180.38	2.2	126.69	80.94
	NMNL-2 (20%)	59.77	178.18	180.34	2.16	123.35	80.11
	NMNL-2 (19%)	56.78	178.18	180.3	2.12	119.95	79.3
	NMNL-2 (18%)	53.79	178.18	180.25	2.07	116.48	78.46
	NMNL-2 (17%)	50.8	178.18	180.21	2.03	112.98	77.58
	NMNL-2 (16%)	47.81	178.18	180.16	1.98	109.35	76.65
	NMNL-2 (15%)	44.83	178.18	180.11	1.93	105.64	75.69
	L (100%)	124.11	178.18	181.08	2.9	189.57	99.33

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (30%)	37.23	178.18	179.98	1.8	95.5	73.14
	L (29%)	35.99	178.18	179.95	1.77	93.74	72.77
	L (28%)	34.75	178.18	179.93	1.75	91.96	72.39
	L (27%)	33.51	178.18	179.9	1.72	90.16	72.01
	L (26%)	32.27	178.18	179.88	1.7	88.32	71.62
	L (25%)	31.03	178.18	179.85	1.67	86.44	71.21
	L (24%)	29.79	178.18	179.82	1.64	84.53	70.8
	L (23%)	28.55	178.18	179.8	1.62	82.56	70.37
	L (22%)	27.3	178.18	179.77	1.59	80.52	69.92
	L (21%)	26.06	178.18	179.74	1.56	78.47	69.47
	L (20%)	24.82	178.18	179.71	1.53	76.37	69
	L (19%)	23.58	178.18	179.68	1.5	74.21	68.52
	L (18%)	22.34	178.18	179.64	1.46	71.98	68.02
	L (17%)	21.1	178.18	179.61	1.43	69.64	67.49
	L (16%)	19.86	178.18	179.57	1.39	67.24	66.94
	L (15%)	18.62	178.18	179.54	1.36	64.79	66.38
At 850 m d/s of Barrage axis	M (100%)	1069.08	178.04	184.74	6.7	502.9	126.58
	M (30%)	320.73	178.04	182.34	4.3	230.34	98.57
	M (29%)	310.03	178.04	182.29	4.25	224.95	97.91
	M (28%)	299.34	178.04	182.23	4.19	219.47	97.24
	M (27%)	288.65	178.04	182.17	4.13	213.88	96.54
	M (26%)	277.96	178.04	182.11	4.07	208.18	95.86
	M (25%)	267.27	178.04	182.05	4.01	202.36	95.17
	M (24%)	256.58	178.04	181.99	3.95	196.42	94.46
	M (23%)	245.89	178.04	181.92	3.88	190.3	93.79
	M (22%)	235.2	178.04	181.86	3.82	184.08	93.1
	M (21%)	224.51	178.04	181.79	3.75	177.69	92.39
	M (20%)	213.82	178.04	181.72	3.68	171.12	91.66
	M (19%)	203.13	178.04	181.64	3.6	164.31	90.89
	M (18%)	192.44	178.04	181.56	3.52	157.35	90.1
	M (17%)	181.74	178.04	181.48	3.44	150.15	89.27
	M (16%)	171.05	178.04	181.4	3.36	142.75	88.42
	M (15%)	160.36	178.04	181.31	3.27	135.12	87.52
	NMNL-2 (100%)	298.83	178.04	182.23	4.19	219.21	97.2
	NMNL-2 (30%)	89.65	178.04	180.63	2.59	78.56	72.31
	NMNL-2 (29%)	86.66	178.04	180.59	2.55	76.09	70.68
	NMNL-2 (28%)	83.67	178.04	180.56	2.52	73.62	69.01
	NMNL-2 (27%)	80.69	178.04	180.52	2.48	71.19	67.32
	NMNL-2 (26%)	77.7	178.04	180.48	2.44	68.76	65.63
	NMNL-2 (25%)	74.71	178.04	180.45	2.41	66.34	64.18
	NMNL-2 (24%)	71.72	178.04	180.41	2.37	63.93	62.71
	NMNL-2 (23%)	68.73	178.04	180.37	2.33	61.53	61.2
	NMNL-2 (22%)	65.74	178.04	180.33	2.29	59.14	59.66

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (21%)	62.76	178.04	180.29	2.25	56.76	58.08
	NMNL-2 (20%)	59.77	178.04	180.25	2.21	54.39	56.48
	NMNL-2 (19%)	56.78	178.04	180.21	2.17	52.05	54.84
	NMNL-2 (18%)	53.79	178.04	180.16	2.12	49.71	53.15
	NMNL-2 (17%)	50.8	178.04	180.12	2.08	47.4	51.43
	NMNL-2 (16%)	47.81	178.04	180.07	2.03	45.05	49.63
	NMNL-2 (15%)	44.83	178.04	180.02	1.98	42.72	47.76
	L (100%)	124.11	178.04	180.99	2.95	107.63	83.25
	L (30%)	37.23	178.04	179.89	1.85	36.66	42.53
	L (29%)	35.99	178.04	179.87	1.83	35.66	41.61
	L (28%)	34.75	178.04	179.84	1.8	34.68	40.68
	L (27%)	33.51	178.04	179.82	1.78	33.69	39.73
	L (26%)	32.27	178.04	179.79	1.75	32.71	38.75
	L (25%)	31.03	178.04	179.77	1.73	31.73	37.75
	L (24%)	29.79	178.04	179.74	1.7	30.75	36.72
	L (23%)	28.55	178.04	179.71	1.67	29.76	35.54
	L (22%)	27.3	178.04	179.68	1.64	28.78	34.29
	L (21%)	26.06	178.04	179.66	1.62	27.81	33.44
	L (20%)	24.82	178.04	179.63	1.59	26.83	32.76
	L (19%)	23.58	178.04	179.6	1.56	25.83	32.05
	L (18%)	22.34	178.04	179.56	1.52	24.82	31.32
	L (17%)	21.1	178.04	179.53	1.49	23.78	30.55
	L (16%)	19.86	178.04	179.5	1.46	22.73	29.75
	L (15%)	18.62	178.04	179.46	1.42	21.69	28.96
At 900 m d/s of Barrage axis	M (100%)	1069.08	177.92	183.41	5.49	210.46	80.51
	M (30%)	320.73	177.92	181.34	3.42	78.28	46.09
	M (29%)	310.03	177.92	181.29	3.37	76.04	45.2
	M (28%)	299.34	177.92	181.24	3.32	73.78	44.29
	M (27%)	288.65	177.92	181.19	3.27	71.5	43.35
	M (26%)	277.96	177.92	181.14	3.22	69.21	42.38
	M (25%)	267.27	177.92	181.08	3.16	66.89	41.37
	M (24%)	256.58	177.92	181.02	3.1	64.55	40.33
	M (23%)	245.89	177.92	180.97	3.05	62.33	39.33
	M (22%)	235.2	177.92	180.91	2.99	59.93	38.21
	M (21%)	224.51	177.92	180.84	2.92	57.5	37.04
	M (20%)	213.82	177.92	180.77	2.85	55.05	35.82
	M (19%)	203.13	177.92	180.71	2.79	52.61	34.57
	M (18%)	192.44	177.92	180.63	2.71	50.09	33.56
	M (17%)	181.74	177.92	180.56	2.64	47.81	32.87
	M (16%)	171.05	177.92	180.5	2.58	45.65	32.2
	M (15%)	160.36	177.92	180.43	2.51	43.55	31.54
	NMNL-2 (100%)	298.83	177.92	181.24	3.32	73.67	44.25
	NMNL-2 (30%)	89.65	177.92	179.94	2.02	29.4	26.66

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (29%)	86.66	177.92	179.92	2	28.85	26.45
	NMNL-2 (28%)	83.67	177.92	179.9	1.98	28.3	26.24
	NMNL-2 (27%)	80.69	177.92	179.88	1.96	27.74	26.02
	NMNL-2 (26%)	77.7	177.92	179.86	1.94	27.16	25.8
	NMNL-2 (25%)	74.71	177.92	179.84	1.92	26.58	25.58
	NMNL-2 (24%)	71.72	177.92	179.81	1.89	25.99	25.37
	NMNL-2 (23%)	68.73	177.92	179.79	1.87	25.38	25.15
	NMNL-2 (22%)	65.74	177.92	179.76	1.84	24.76	24.92
	NMNL-2 (21%)	62.76	177.92	179.74	1.82	24.13	24.69
	NMNL-2 (20%)	59.77	177.92	179.71	1.79	23.48	24.45
	NMNL-2 (19%)	56.78	177.92	179.69	1.77	22.82	24.2
	NMNL-2 (18%)	53.79	177.92	179.66	1.74	22.14	23.87
	NMNL-2 (17%)	50.8	177.92	179.63	1.71	21.43	23.5
	NMNL-2 (16%)	47.81	177.92	179.6	1.68	20.71	23.13
	NMNL-2 (15%)	44.83	177.92	179.56	1.64	19.97	22.73
	L (100%)	124.11	177.92	180.17	2.25	35.66	28.92
	L (30%)	37.23	177.92	179.48	1.56	18	21.65
	L (29%)	35.99	177.92	179.46	1.54	17.65	21.45
	L (28%)	34.75	177.92	179.44	1.52	17.29	21.24
	L (27%)	33.51	177.92	179.43	1.51	16.94	21.04
	L (26%)	32.27	177.92	179.41	1.49	16.57	20.82
	L (25%)	31.03	177.92	179.39	1.47	16.19	20.6
	L (24%)	29.79	177.92	179.37	1.45	15.81	20.38
	L (23%)	28.55	177.92	179.35	1.43	15.42	20.14
	L (22%)	27.3	177.92	179.33	1.41	15.01	19.89
	L (21%)	26.06	177.92	179.31	1.39	14.6	19.64
	L (20%)	24.82	177.92	179.29	1.37	14.19	19.38
	L (19%)	23.58	177.92	179.27	1.35	13.76	19.1
	L (18%)	22.34	177.92	179.24	1.32	13.32	18.82
	L (17%)	21.1	177.92	179.22	1.3	12.86	18.52
	L (16%)	19.86	177.92	179.19	1.27	12.39	18.21
	L (15%)	18.62	177.92	179.16	1.24	11.86	17.85
At 950 m d/s of Barrage axis	M (100%)	1069.08	177.77	182.57	4.8	314	109.6
	M (30%)	320.73	177.77	180.88	3.11	149.73	83.76
	M (29%)	310.03	177.77	180.84	3.07	146.44	83.11
	M (28%)	299.34	177.77	180.8	3.03	143.11	82.44
	M (27%)	288.65	177.77	180.76	2.99	139.75	81.77
	M (26%)	277.96	177.77	180.72	2.95	136.36	81.08
	M (25%)	267.27	177.77	180.68	2.91	132.93	80.37
	M (24%)	256.58	177.77	180.64	2.87	129.47	79.65
	M (23%)	245.89	177.77	180.59	2.82	125.95	78.92
	M (22%)	235.2	177.77	180.55	2.78	122.39	78.17
	M (21%)	224.51	177.77	180.5	2.73	118.8	77.4

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (20%)	213.82	177.77	180.45	2.68	115.16	76.62
	M (19%)	203.13	177.77	180.4	2.63	111.48	75.84
	M (18%)	192.44	177.77	180.35	2.58	107.72	75.09
	M (17%)	181.74	177.77	180.3	2.53	103.87	74.31
	M (16%)	171.05	177.77	180.25	2.48	99.97	73.52
	M (15%)	160.36	177.77	180.19	2.42	95.97	72.69
	NMNL-2 (100%)	298.83	177.77	180.8	3.03	142.95	82.41
	NMNL-2 (30%)	89.65	177.77	179.77	2	67.05	64.03
	NMNL-2 (29%)	86.66	177.77	179.75	1.98	65.72	63.54
	NMNL-2 (28%)	83.67	177.77	179.73	1.96	64.37	63.03
	NMNL-2 (27%)	80.69	177.77	179.71	1.94	63.02	62.52
	NMNL-2 (26%)	77.7	177.77	179.69	1.92	61.64	62
	NMNL-2 (25%)	74.71	177.77	179.67	1.9	60.25	61.2
	NMNL-2 (24%)	71.72	177.77	179.64	1.87	58.85	60.36
	NMNL-2 (23%)	68.73	177.77	179.62	1.85	57.44	59.51
	NMNL-2 (22%)	65.74	177.77	179.6	1.83	56.02	58.64
	NMNL-2 (21%)	62.76	177.77	179.57	1.8	54.59	57.75
	NMNL-2 (20%)	59.77	177.77	179.55	1.78	53.14	56.83
	NMNL-2 (19%)	56.78	177.77	179.52	1.75	51.68	55.89
	NMNL-2 (18%)	53.79	177.77	179.49	1.72	50.19	55.08
	NMNL-2 (17%)	50.8	177.77	179.46	1.69	48.69	54.28
	NMNL-2 (16%)	47.81	177.77	179.44	1.67	47.16	53.46
	NMNL-2 (15%)	44.83	177.77	179.41	1.64	45.61	52.61
	L (100%)	124.11	177.77	179.99	2.22	81.71	69.22
	L (30%)	37.23	177.77	179.33	1.56	41.51	50.27
	L (29%)	35.99	177.77	179.31	1.54	40.75	49.82
	L (28%)	34.75	177.77	179.3	1.53	39.98	49.37
	L (27%)	33.51	177.77	179.28	1.51	39.21	48.91
	L (26%)	32.27	177.77	179.27	1.5	38.41	48.43
	L (25%)	31.03	177.77	179.25	1.48	37.61	47.94
	L (24%)	29.79	177.77	179.23	1.46	36.78	47.43
	L (23%)	28.55	177.77	179.21	1.44	35.94	46.9
	L (22%)	27.3	177.77	179.19	1.42	35.07	46.35
	L (21%)	26.06	177.77	179.18	1.41	34.19	45.79
	L (20%)	24.82	177.77	179.16	1.39	33.28	45.2
	L (19%)	23.58	177.77	179.13	1.36	32.35	44.59
	L (18%)	22.34	177.77	179.11	1.34	31.37	43.94
	L (17%)	21.1	177.77	179.09	1.32	30.35	43.25
	L (16%)	19.86	177.77	179.06	1.29	29.29	42.53
	L (15%)	18.62	177.77	179.03	1.26	28.04	41.65
At 1000 m d/s of Barrage	M (100%)	1069.08	177.64	182.59	4.95	476.54	254.46
	M (30%)	320.73	177.64	180.76	3.12	171.35	98.74
	M (29%)	310.03	177.64	180.72	3.08	167.36	97.97

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
axis	M (28%)	299.34	177.64	180.68	3.04	163.34	97.18
	M (27%)	288.65	177.64	180.64	3	159.28	96.38
	M (26%)	277.96	177.64	180.6	2.96	155.18	95.56
	M (25%)	267.27	177.64	180.55	2.91	151.03	94.72
	M (24%)	256.58	177.64	180.51	2.87	146.84	93.87
	M (23%)	245.89	177.64	180.46	2.82	142.6	93
	M (22%)	235.2	177.64	180.42	2.78	138.3	92.11
	M (21%)	224.51	177.64	180.37	2.73	133.95	91.19
	M (20%)	213.82	177.64	180.32	2.68	129.54	90.26
	M (19%)	203.13	177.64	180.27	2.63	125.13	89.31
	M (18%)	192.44	177.64	180.22	2.58	120.61	88.33
	M (17%)	181.74	177.64	180.17	2.53	116	87.33
	M (16%)	171.05	177.64	180.11	2.47	111.32	86.29
	M (15%)	160.36	177.64	180.06	2.42	106.56	85.22
	NMNL-2 (100%)	298.83	177.64	180.68	3.04	163.15	97.14
	NMNL-2 (30%)	89.65	177.64	179.64	2	72.22	77.09
	NMNL-2 (29%)	86.66	177.64	179.61	1.97	70.61	76.69
	NMNL-2 (28%)	83.67	177.64	179.59	1.95	68.99	76.29
	NMNL-2 (27%)	80.69	177.64	179.57	1.93	67.36	75.87
	NMNL-2 (26%)	77.7	177.64	179.55	1.91	65.71	75.46
	NMNL-2 (25%)	74.71	177.64	179.53	1.89	64.03	75.03
	NMNL-2 (24%)	71.72	177.64	179.5	1.86	62.33	74.6
	NMNL-2 (23%)	68.73	177.64	179.48	1.84	60.62	74.15
	NMNL-2 (22%)	65.74	177.64	179.46	1.82	58.87	73.7
	NMNL-2 (21%)	62.76	177.64	179.43	1.79	57.11	73.24
	NMNL-2 (20%)	59.77	177.64	179.41	1.77	55.32	72.77
	NMNL-2 (19%)	56.78	177.64	179.38	1.74	53.5	72.29
	NMNL-2 (18%)	53.79	177.64	179.36	1.72	51.64	71.8
	NMNL-2 (17%)	50.8	177.64	179.33	1.69	49.76	71.29
	NMNL-2 (16%)	47.81	177.64	179.31	1.67	47.83	70.78
	NMNL-2 (15%)	44.83	177.64	179.28	1.64	45.88	70.25
	L (100%)	124.11	177.64	179.86	2.22	89.68	81.33
	L (30%)	37.23	177.64	179.2	1.56	40.7	68.73
	L (29%)	35.99	177.64	179.19	1.55	39.67	67.82
	L (28%)	34.75	177.64	179.17	1.53	38.63	66.9
	L (27%)	33.51	177.64	179.16	1.52	37.58	65.94
	L (26%)	32.27	177.64	179.14	1.5	36.52	64.97
	L (25%)	31.03	177.64	179.12	1.48	35.45	63.97
	L (24%)	29.79	177.64	179.11	1.47	34.36	62.93
	L (23%)	28.55	177.64	179.09	1.45	33.28	61.89
	L (22%)	27.3	177.64	179.07	1.43	32.17	60.8
	L (21%)	26.06	177.64	179.05	1.41	31.06	59.69
	L (20%)	24.82	177.64	179.03	1.39	29.93	58.54
	L (19%)	23.58	177.64	179.01	1.37	28.78	57.35

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	L (18%)	22.34	177.64	178.99	1.35	27.62	56.12
	L (17%)	21.1	177.64	178.97	1.33	26.45	54.84
	L (16%)	19.86	177.64	178.95	1.31	25.27	53.62
	L (15%)	18.62	177.64	178.93	1.29	24.01	51.97

Note:
M - Monsoon Season
L - Lean Season
NMNL2 - Non Monsoon Non Lean Season (April & May)

Table-13.16: Depth of flow for release in the year 2016 for Teesta Low Dam -IV HEP

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
At Dam Axis	M (100%)	1259.92	150.09	156.76	6.67	413.19	112.99
	M (30%)	377.98	150.09	154.49	4.4	199.32	75.13
	M (29%)	365.38	150.09	154.43	4.34	195.39	74.26
	M (28%)	352.78	150.09	154.38	4.29	191.37	73.35
	M (27%)	340.18	150.09	154.33	4.24	187.38	72.44
	M (26%)	327.58	150.09	154.27	4.18	183.36	71.51
	M (25%)	314.98	150.09	154.21	4.12	179.21	70.53
	M (24%)	302.38	150.09	154.15	4.06	175.04	69.54
	M (23%)	289.78	150.09	154.09	4	170.83	68.53
	M (22%)	277.18	150.09	154.03	3.94	166.6	67.49
	M (21%)	264.58	150.09	153.96	3.87	162.32	66.43
	M (20%)	251.98	150.09	153.9	3.81	157.94	65.32
	M (19%)	239.38	150.09	153.83	3.74	153.47	64.17
	M (18%)	226.79	150.09	153.76	3.67	149	63
	M (17%)	214.19	150.09	153.69	3.6	144.47	61.79
	M (16%)	201.59	150.09	153.61	3.52	139.8	60.52
	M (15%)	188.99	150.09	153.53	3.44	135.09	59.21
	NMNL-2 (100%)	341	150.09	154.33	4.24	187.64	72.5
	NMNL-2 (30%)	102.3	150.09	152.87	2.78	99.11	50.3
	NMNL-2 (29%)	98.89	150.09	152.84	2.75	97.5	49.93
	NMNL-2 (28%)	95.48	150.09	152.8	2.71	95.84	49.54
	NMNL-2 (27%)	92.07	150.09	152.77	2.68	94.2	49.16
	NMNL-2 (26%)	88.66	150.09	152.74	2.65	92.53	48.76
	NMNL-2 (25%)	85.25	150.09	152.7	2.61	90.83	48.35
	NMNL-2 (24%)	81.84	150.09	152.67	2.58	89.1	47.94
	NMNL-2 (23%)	78.43	150.09	152.63	2.54	87.33	47.5
	NMNL-2 (22%)	75.02	150.09	152.59	2.5	85.53	47.06
	NMNL-2 (21%)	71.61	150.09	152.55	2.46	83.7	46.61
	NMNL-2 (20%)	68.2	150.09	152.51	2.42	81.85	46.14
	NMNL-2 (19%)	64.79	150.09	152.47	2.38	79.96	45.66

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	NMNL-2 (18%)	61.38	150.09	152.43	2.34	78.02	45.17
	NMNL-2 (17%)	57.97	150.09	152.38	2.29	76.03	44.65
	NMNL-2 (16%)	54.56	150.09	152.34	2.25	73.99	44.12
	NMNL-2 (15%)	51.15	150.09	152.29	2.2	71.93	43.57
					0		
At 300 m d/s of Dam Axis	M (100%)	1259.92	150.36	154.25	3.89	251.02	88.74
	M (30%)	377.98	150.36	152.67	2.31	118.61	78.8
	M (29%)	365.38	150.36	152.64	2.28	116.13	78.6
	M (28%)	352.78	150.36	152.61	2.25	113.62	78.4
	M (27%)	340.18	150.36	152.57	2.21	111.07	78.19
	M (26%)	327.58	150.36	152.54	2.18	108.48	77.99
	M (25%)	314.98	150.36	152.51	2.15	105.84	77.77
	M (24%)	302.38	150.36	152.47	2.11	103.16	77.56
	M (23%)	289.78	150.36	152.44	2.08	100.42	77.33
	M (22%)	277.18	150.36	152.4	2.04	97.61	77.1
	M (21%)	264.58	150.36	152.36	2	94.78	76.87
	M (20%)	251.98	150.36	152.32	1.96	91.82	76.63
	M (19%)	239.38	150.36	152.28	1.92	88.8	76.38
	M (18%)	226.79	150.36	152.24	1.88	85.65	76.12
	M (17%)	214.19	150.36	152.2	1.84	82.24	75.84
	M (16%)	201.59	150.36	152.15	1.79	78.7	75.35
	M (15%)	188.99	150.36	152.1	1.74	74.98	73.92
	NMNL-2 (100%)	341	150.36	152.57	2.21	111.24	78.21
	NMNL-2 (30%)	102.3	150.36	151.64	1.28	44.45	54.55
	NMNL-2 (29%)	98.89	150.36	151.62	1.26	43.58	54.24
	NMNL-2 (28%)	95.48	150.36	151.6	1.24	42.52	53.86
	NMNL-2 (27%)	92.07	150.36	151.58	1.22	41.54	53.52
	NMNL-2 (26%)	88.66	150.36	151.56	1.2	40.37	53.1
	NMNL-2 (25%)	85.25	150.36	151.54	1.18	39.32	52.72
	NMNL-2 (24%)	81.84	150.36	151.52	1.16	38.26	52.33
	NMNL-2 (23%)	78.43	150.36	151.5	1.14	37.18	51.94
	NMNL-2 (22%)	75.02	150.36	151.48	1.12	36.09	51.54
	NMNL-2 (21%)	71.61	150.36	151.46	1.1	34.98	51.12
	NMNL-2 (20%)	68.2	150.36	151.44	1.08	33.86	50.7
	NMNL-2 (19%)	64.79	150.36	151.41	1.05	32.72	50.27
	NMNL-2 (18%)	61.38	150.36	151.39	1.03	31.57	49.83
	NMNL-2 (17%)	57.97	150.36	151.37	1.01	30.39	49.38
	NMNL-2 (16%)	54.56	150.36	151.34	0.98	29.19	48.91
	NMNL-2 (15%)	51.15	150.36	151.32	0.96	27.97	48.44
At 600 m d/s of Dam Axis	M (100%)	1259.92	143.64	151.16	7.52	263.94	70.77
	M (30%)	377.98	143.64	148.25	4.61	114.72	41.59
	M (29%)	365.38	143.64	148.19	4.55	112.2	41.23
	M (28%)	352.78	143.64	148.13	4.49	109.65	40.86

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (27%)	340.18	143.64	148.06	4.42	107.09	40.48
	M (26%)	327.58	143.64	148	4.36	104.48	40.09
	M (25%)	314.98	143.64	147.93	4.29	101.84	39.69
	M (24%)	302.38	143.64	147.87	4.23	99.18	39.29
	M (23%)	289.78	143.64	147.8	4.16	96.46	38.87
	M (22%)	277.18	143.64	147.72	4.08	93.71	38.45
	M (21%)	264.58	143.64	147.65	4.01	90.92	38.01
	M (20%)	251.98	143.64	147.58	3.94	88.08	37.56
	M (19%)	239.38	143.64	147.5	3.86	85.2	37.1
	M (18%)	226.79	143.64	147.42	3.78	82.25	36.62
	M (17%)	214.19	143.64	147.34	3.7	79.24	36.13
	M (16%)	201.59	143.64	147.25	3.61	76.16	35.61
	M (15%)	188.99	143.64	147.16	3.52	72.98	35.07
	NMNL-2 (100%)	341	143.64	148.07	4.43	107.26	40.5
	NMNL-2 (30%)	102.3	143.64	146.36	2.72	47.22	28.29
	NMNL-2 (29%)	98.89	143.64	146.32	2.68	46.07	27.88
	NMNL-2 (28%)	95.48	143.64	146.27	2.63	44.91	27.46
	NMNL-2 (27%)	92.07	143.64	146.23	2.59	43.74	27.02
	NMNL-2 (26%)	88.66	143.64	146.19	2.55	42.57	26.58
	NMNL-2 (25%)	85.25	143.64	146.14	2.5	41.38	26.13
	NMNL-2 (24%)	81.84	143.64	146.1	2.46	40.18	25.66
	NMNL-2 (23%)	78.43	143.64	146.05	2.41	38.98	25.18
	NMNL-2 (22%)	75.02	143.64	146	2.36	37.76	24.69
	NMNL-2 (21%)	71.61	143.64	145.95	2.31	36.54	24.19
	NMNL-2 (20%)	68.2	143.64	145.9	2.26	35.31	23.67
	NMNL-2 (19%)	64.79	143.64	145.85	2.21	34.08	23.14
	NMNL-2 (18%)	61.38	143.64	145.79	2.15	32.85	22.6
	NMNL-2 (17%)	57.97	143.64	145.74	2.1	31.63	22.06
	NMNL-2 (16%)	54.56	143.64	145.68	2.04	30.4	21.71
	NMNL-2 (15%)	51.15	143.64	145.62	1.98	29.15	21.34
At 900 m d/s of Dam Axis	M (100%)	1259.92	142.71	149.87	7.16	321.53	74.86
	M (30%)	377.98	142.71	146.59	3.88	122.56	48.71
	M (29%)	365.38	142.71	146.53	3.82	119.49	48.21
	M (28%)	352.78	142.71	146.46	3.75	116.35	47.7
	M (27%)	340.18	142.71	146.4	3.69	113.19	47.18
	M (26%)	327.58	142.71	146.33	3.62	110	46.64
	M (25%)	314.98	142.71	146.26	3.55	106.8	46.1
	M (24%)	302.38	142.71	146.19	3.48	103.56	45.55
	M (23%)	289.78	142.71	146.12	3.41	100.31	44.98
	M (22%)	277.18	142.71	146.04	3.33	97.01	44.41
	M (21%)	264.58	142.71	145.97	3.26	93.69	43.82
	M (20%)	251.98	142.71	145.89	3.18	90.31	43.21
	M (19%)	239.38	142.71	145.81	3.1	86.86	42.58

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (18%)	226.79	142.71	145.73	3.02	83.32	41.72
	M (17%)	214.19	142.71	145.64	2.93	79.79	40.84
	M (16%)	201.59	142.71	145.55	2.84	76.22	39.94
	M (15%)	188.99	142.71	145.46	2.75	72.62	39
	NMNL-2 (100%)	341	142.71	146.4	3.69	113.4	47.21
	NMNL-2 (30%)	102.3	142.71	144.7	1.99	46.01	31.25
	NMNL-2 (29%)	98.89	142.71	144.67	1.96	44.89	31.03
	NMNL-2 (28%)	95.48	142.71	144.63	1.92	43.77	30.8
	NMNL-2 (27%)	92.07	142.71	144.6	1.89	42.65	30.58
	NMNL-2 (26%)	88.66	142.71	144.56	1.85	41.55	30.35
	NMNL-2 (25%)	85.25	142.71	144.52	1.81	40.42	30.12
	NMNL-2 (24%)	81.84	142.71	144.48	1.77	39.28	29.89
	NMNL-2 (23%)	78.43	142.71	144.44	1.73	38.13	29.65
	NMNL-2 (22%)	75.02	142.71	144.41	1.7	36.97	29.41
	NMNL-2 (21%)	71.61	142.71	144.37	1.66	35.78	29.16
	NMNL-2 (20%)	68.2	142.71	144.32	1.61	34.59	28.91
	NMNL-2 (19%)	64.79	142.71	144.28	1.57	33.37	28.64
	NMNL-2 (18%)	61.38	142.71	144.24	1.53	32.13	28.38
	NMNL-2 (17%)	57.97	142.71	144.19	1.48	30.88	28.1
	NMNL-2 (16%)	54.56	142.71	144.15	1.44	29.6	27.82
	NMNL-2 (15%)	51.15	142.71	144.1	1.39	28.31	27.53
At 1200 m d/s of Dam Axis	M (100%)	1259.92	140.42	147.34	6.92	221.07	49.64
	M (30%)	377.98	140.42	144.39	3.97	93.69	36.14
	M (29%)	365.38	140.42	144.33	3.91	91.47	35.83
	M (28%)	352.78	140.42	144.27	3.85	89.23	35.52
	M (27%)	340.18	140.42	144.2	3.78	86.96	35.2
	M (26%)	327.58	140.42	144.14	3.72	84.73	34.89
	M (25%)	314.98	140.42	144.07	3.65	82.42	34.55
	M (24%)	302.38	140.42	144	3.58	80.09	34.22
	M (23%)	289.78	140.42	143.93	3.51	77.73	33.87
	M (22%)	277.18	140.42	143.86	3.44	75.35	33.52
	M (21%)	264.58	140.42	143.79	3.37	72.93	33.16
	M (20%)	251.98	140.42	143.72	3.3	70.49	32.79

Location	Profile	Q Total	Deepest Bed Level	Water Surface Elevation	Depth of Flow	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m)	(m2)	(m)
	M (19%)	239.38	140.42	143.64	3.22	68.01	32.41
	M (18%)	226.79	140.42	143.56	3.14	65.5	32.02
	M (17%)	214.19	140.42	143.48	3.06	62.95	31.62
	M (16%)	201.59	140.42	143.4	2.98	60.29	31.15
	M (15%)	188.99	140.42	143.31	2.89	57.47	30.45
	NMNL-2 (100%)	341	140.42	144.21	3.79	87.11	35.22
	NMNL-2 (30%)	102.3	140.42	142.55	2.13	36.48	24.68
	NMNL-2 (29%)	98.89	140.42	142.51	2.09	35.58	24.4
	NMNL-2 (28%)	95.48	140.42	142.47	2.05	34.67	24.12
	NMNL-2 (27%)	92.07	140.42	142.43	2.01	33.76	23.83
	NMNL-2 (26%)	88.66	140.42	142.39	1.97	32.83	23.53
	NMNL-2 (25%)	85.25	140.42	142.35	1.93	31.89	23.23
	NMNL-2 (24%)	81.84	140.42	142.31	1.89	30.95	22.92
	NMNL-2 (23%)	78.43	140.42	142.27	1.85	29.99	22.6
	NMNL-2 (22%)	75.02	140.42	142.23	1.81	29.03	22.27
	NMNL-2 (21%)	71.61	140.42	142.18	1.76	28.05	21.94
	NMNL-2 (20%)	68.2	140.42	142.14	1.72	27.07	21.6
	NMNL-2 (19%)	64.79	140.42	142.09	1.67	26.07	21.24
	NMNL-2 (18%)	61.38	140.42	142.04	1.62	25.05	20.88
	NMNL-2 (17%)	57.97	140.42	142	1.58	24.04	20.53
	NMNL-2 (16%)	54.56	140.42	141.94	1.52	23.02	20.19
	NMNL-2 (15%)	51.15	140.42	141.89	1.47	22	19.85

Note:

M – Monsoon Season

NMNL2 – Non Monsoon Non Lean Season (April & May)

13.5 FREE STRETCH IN CASCADE DEVELOPMENT

The details of free stretch between various projects with and without Teesta Low Dam V HEP &Rammam Intermediate HEP is given in Table-13.17 and 13.18 respectively.

Table-13.17: Details of length of free flow of river with Teesta Low Dam V HEP

S. No.	Projects	Length of free flow of river (km)
A.	**River Teesta**	
1.	TWL of Teesta VI HEP & FRL Teesta Intermediate HEP	1.40
2.	TWL of Teesta intermediate HEP and FRL of Teesta Low Dam III HEP	6.00
3.	TWL of Low Dam III HEP and FRL of Teesta IV Low Dam HEP	4.47
4.	TWL of Teesta IV Low Dam HEP and FRL of Teesta V Low Dam HEP	1.10
5.	TWL of Teesta Low Dam V HEP and FRL of Teesta Barrage	15.0
B.	**River Great Rangit**	
6.	TWL of Jorthang Loop HEP & FRL of Teesta Low dam (I&II) HEP	1.124
7.	TWL of TLDP (I & II) HEP & Confluence of Bari Rangit&Teesta River	3.0
C.	**River Rammam**	
8.	TWL of Rammam-I HEP & FRL of Rammam Intermediate HEP	1.0
8.	TWL of Rammam Intermediate HEP and Trench Weir of Rammam-II HEP	1.0
10.	TWL of Rammam-II HEP & FRL of Rammam-III HEP	1.60
11.	TWL of Rammam-III to confluence with Great Rangit River	6.70

Table-13.18: Details of length of free flow of river without Teesta Low Dam V HEP

S. No.	Projects	Length of free flow of river (km)
A.	**River Teesta**	
1.	TWL of Teesta VI HEP & FRL Teesta Intermediate HEP	1.40
2.	TWL of Teesta intermediate HEP and FRL of Teesta Low Dam III HEP	6.00
3.	TWL of Low Dam III HEP and FRL of Teesta IV Low Dam HEP	4.47
4.	TWL of Teesta IV Low Dam HEP and FRL of Teesta Barrage	20.77
B.	**River Great Rangit**	
5.	TWL of Jorthang Loop HEP & FRL of Teesta low Dam – I&II HEP	1.124
6.	TWL of Teesta low Dam – I&II HEP & Confluence of Bari Rangit&Teesta River	3.0
C.	**River Rammam**	
7.	TWL of Rammam-I HEP & FRL of Rammam Intermediate HEP	1.0
8.	TWL of Rammam Intermediate HEP and Trench Weir of Rammam-II HEP	1.0
9.	TWL of Rammam-II HEP & FRL of Rammam-III HEP	1.60
10.	TWL of Rammam-III to confluence with Great Rangit River	6.70

The current norms of Ministry of Environment Forest and Climate Change is that at least 1 km free river stretch should be available between TWL of upstream and FRL of downstream hydroelectric projects.

In the present study, a total of 7 (seven) hydroelectric projects are proposed in the study area. 5 (five) hydroelectric projects are located on main Teesta river and 2 (two) hydroelectric projects are located on river Rangit.

With the construction of 5 (five) hydroelectric projects, free flowing river stretch on river Teesta within the Study Area has been or will be affected for a stretch of about 51.55 km. Thus, the projects in its present configuration would convert the free flowing river into a series of river stretch with reduced or no flow downstream of dam site upto tail race disposal site followed by reservoir of the next project in the cascade development. In the stretch of about 51.55 km, free river stretch will be available for a distance of about 27.97 km in four stretches. The details are given in Figure-11.1.

With the construction of 2 (two) hydroelectric projects, free flowing river stretch on river Rangit within the Study Area has been or will be affected for a stretch of about 25 km. Thus, the projects in its present configuration would convert the free flowing river into a In the stretch of about 25 km, free river stretch will be available for a distance of about 8.6 km. The details are given in Figure-11.2.

It is worthwhile to mention here that on Rammam River total 4 HEPs are proposed out of which Rammam-II &Rammam-III HEPs are operational and under construction and two HEPs namely Rammam-I and Rammam intermediate are at DPR stage. As mentioned , free flowing river stretch on river Rammam within the Study Area has been or will be affected for a stretch of about 31.6km. Thus, the projects in its present configuration would convert the free flowing river into a In the stretch of about 31.6 km, free river stretch will be available for a distance of about 10.3 km. The details are given in Figure-11.3.

Normally, under such circumstances, adverse impacts on water quality as well, increase the residence time in the reservoir. As a result, there could be adverse impacts on water quality. In the study area, the pollution loading is virtually negligible, on account of low population density, low cropping intensity with minimal use of agro-chemicals and absence of industrialization in the area. Thus, the pollution loading is low, and as a result no major impacts on reservoir water quality are anticipated.

13.6 COMMISSIONING OF BASE LOAD POWER STATION

The following projects are already constructed or under construction:

- Jorethang Loop HEP (under operation)
- Teesta Stage-VI HEP (under construction)
- Teesta Low Dam III HEP (under operation)

- Teesta Low Dam IV HEP (under operation)
- Rammam-II HEP(under operation)
- Rammam-III HEP(under construction)

The Teesta Low Dam V HEP requires further assessment based on the fact that its submergence is coming within Mahananda wildlife Sanctuary. Based on the recommended Environmental Flow forTeesta Intermediate HEP and Teesta Low Dam, (I & II) HEP, it suggested that for optimal utilization of Environmental Flows, possibility of base load stations of appropriate capacity be studied. This will ensure optimal utilization of Environmental Flows. The capacity of base load stations can be estimated as a part of DPR preparation of individual hydroelectric projects.

13.7 MANAGEMENT PLAN FOR SUSTENANCE OF FISH SPECIES

Based on the field studies, the following migratory fish species are observed in the study area:

- *Schizothoraxrichardsonii*
- *Labeopangusia*
- *Acrossocheilushexagondepsis*
- *Tor putitora*
- *Tor tor*

The species *Schizothoraxrichardsonii* and *Acrossocheilushexagonolepis* migrate from lower elevation to higher elevation in summer months and return to lower elevation in winter months. These species were observed at various sampling locations of all the six hydroelectric projects.

The fish species such as *Tor Putitora*, *Tor tor* and *Labeopangusia* migrate to lower elevations in summer months and undertake the return journey in winter months.

As mentioned earlier, following four projects are already commissioned or under construction:

- Jorethang Loop HEP (under operation)
- Teesta Stage-VI HEP (under construction)
- Teesta Low Dam III HEP (under operation)
- Teesta Low Dam IV HEP (under operation)

The following projects are under planning stage:

- Teesta Low Dam (I&II) HEP
- Teesta Intermediate HEP
- Teesta Low Dam V HEP requires further study.

It is proposed to construct separate hatcheries for snow trout and mahaseerwithinthe study area. These hatcheries can be developed by the Department of Fisheries, Government of West Bengal, for the six projects coming under study (excluding Teesta Low Dam V HEP).The stocking program shall comprise of the following:

- Acclimatization stocking (a new fish species is introduced in a water course)
- Supplementary stocking (a species already living in a water body)
- Transfer stocking (transportation of mature fish from one water body to another)
- Repetitive stocking (species which do not propagate in natural conditions).

A fish hatchery is the centre of ova production. It helps in propagating the ova of required species and stocking of fish fingerlingsto different water bodies. A hatchery can play an important role in the conservation of threatened species and sustenance fishery.

It is proposed to stock the reservoirs of all the six projects with fingerlings of *Schizothoraxrichardsonii, Acrossocheilushexagonolepis, Tor tor*and *Tor putitora*. The rate of stocking shall be 50 per ha.

The cost for fisheries development shall be shared amongst all the various hydro-electric projects proposed to be developed in the study area.

A Steering Committee of the project would be constituted for the monitoring of the project as listed in Table-13.19.

Table-13.19:Steering Committee constituted for the monitoring of fisheries development

S. No.	Officer	Position
1	Secretary (Fisheries) to the Government of West Bengal	Chairman
2	Representative of District Collector, Darjeeling	Member
3	Representative of Department of Power, state government of West Bengal	Member
4	Nominated representative of local public	Member
5	Nominated representative of proponents of various hydroelectric projects	Member
6	Assistant Director of Fisheries, state government of West Bengal	Member Secretary

The main task of the Committee shall be:

- Review of the progress and adequacy of various measures being implemented for sustenance of riverine fisheries.
- Consideration of the need for any mid-course change in the project component.

13.8 CONSERVATION OF THREATENED FLORA

The flora of N. Bengal is under great pressure due to biotic factors like various developmental projects viz., many hydro power projects, road construction, heavy deforestation and encroachment for agricultural fields, tourist bunglows, etc. As result many plant species have become rare and threatened. Nayar and Sastry (1987, 1988 & 1990) have discussed the rare and endangered plant species of lower and higher groups (flowering plants) in Red Data Book of Indian Plants from Sikkim Himalaya (includes Adjacent Darjeeling Himalaya and Bhutan) and Eastern Himalaya. Some of the rare and threatened taxa of the Lower Teesta valley and Rangit valley of Kalimpong division are *Begonia rubella, Calamusinermis, Cissusspectabilis, Livistonajenkinsiana* and *Ophiorrhizalurida*(Refer Table 13.20).

Table-13.20: Rare and endangered plants of the Lower Teesta Basin (as per Nayar&Sastry)

Name of species	Status	Distribution
Thelypteridaceae		
Christella clarkia	VU	Darjeeling
Ranunculaceae		
Aconitum ferox	VU	Darjeeling
Aceraceae		
*Acer hooker*var. *Major*	EN	Darjeeling
A. osmastonii	EN	Darjeeling
Begoniaceae		
Begonia rubella	Rare	Darjeeling
Begonia satrapis	Rare	Darjeeling
Vitaceae		
Cissusspectabilis	Rare	Siliguri
Apiaceae		
Pimpinellatongloensis	EN	Darjeeling
Rubiaceae		
Hedyotisscabra	Rare	Darjeeling
Ophiorrhizalurida	Rare	Darjeeling
Campnulaceae		
Codonopsisaffinis	Rare	Darjeeling
Ericaceae		
Rhododendronedgeworthii	Rare	Darjeeling
Orchidaceae		
Bulleyiayunnanensis	Rare	Darjeeling
Cymbidiumeburnum		
Diplomerishirsute	VU	Darjeeling
Cocalvulaceae		
Tricarpelemagiganteum	*Rare*	
Arecaceae		
Calamusinermis	EN	Kurseong
Phoenix rupícola	Rare	Teestavalley

EN =Endangered ; VU= Vulnerable

It is thus recommended that a detailed study be conducted as a part of the CEIA study for Teesta Low Dam I & II and Teesta Intermediate hydroelectric projects in the basin. If these species are observed, then an appropriate conservation plan needs to be prepared.

13.9 CONSERVATION OF ECONOMICALLY IMPORTANT PLANT SPECIES

It is recommended that the economically important plant species be grown as a part of Compensatory Afforestation Programme, which is to be implemented as a part of Environmental Management Plan for Teesta Low Dam I & II and Teesta Intermediate hydroelectric projectsthat are yet to be developed in the study area.

13.10 AFFORESTATION

The total forest to be acquired for various project appurtenances needs to be ascertained as a part of the project related studies. The Indian Forest Conservation Act (1980) stipulates:

- If non-forest land is not available, compensatory afforestation are to be established on degraded forest lands, which must be twice the forest area affected or lost, and
- If non- forest land is available, compensatory forest are to be raised over an area equivalent to the forest area affected or lost.

Compensatory afforestation, NPV and cost of trees need to be included as a part of the Environmental Management Plan to be prepare as a part of the CEIA study of individual hydroelectric projects (Teesta Low Dam I & II and Teesta Intermediate hydroelectric projects) in the study area.

13.11MEASURES TO PREVENT DEGRADATION DUE TO INCREASED LABOUR POPULATION

Keeping in view the sudden influx of labour population in the 'wildlife rich areas, during construction phase of Teesta Low Dam (I & II) and Teesta Intermediate hydroelectric projects the following actions are suggested for the conservation of flora and fauna in the region.

- The project authorities would ensure that strict vigil is kept especially during the breeding season of animals i.e. from October- December and when young ones are born/nesting season, i.e. from March-June. Activities like blasting or heavy machine operations producing noise levels more than 80-100 dB(A) will be restricted during this period. Heavy penalties would be imposed for violation of this conduct by contractors/labourers, etc. during this period. These aspects shall be included in the Tender Document for the Contractor involved in construction works.
- Information dissemination emphasizing the need of conservation and legal consequences on violation of Forest and Wildlife (Protection) Acts will be prioritised and publicised.

- Awareness would also be imparted to the labourers engaged in construction activities for exerting great restraint especially during critical months of breeding and nesting of animals and birds.
- The signboards/Notice boards highlighting penalties for violation of rules, will be put nearby habitation areas of labourers.
- Strict monitoring of laborers and associated workers for any activity related to endangering the life or habitat of wild animals and birds.
- Strict restrictions will be imposed on the workers at project sites to ensure that they do not harvest any produce from the natural forests and cause any danger or harm to the animals and birds in wild.
- Minimum levels of noise during construction activities will be maintained and no activity will be carried out at night since where the project site is in the close vicinity of natural animal/bird habitats.
- Fuel wood to the laborers will be provided from plantations meant for the purpose and/or the provision has been made for the supply of the free subsidized kerosene/LPG from the depots being set up for this purpose to avoid forest degradation and animal habitats.
- Interference of human population would be kept to the minimum and it would be ensured that the contractors do not set up laborer colonies in the vicinity of forests and wilderness areas.

13.12 ANTI-POACHING MEASURES

During construction phase for Teesta Low Dam I & II and Teesta Intermediate hydroelectric projects in and around the main construction areas where construction workers congregate, some disturbance to the wildlife population may occur. Therefore, marginal impacts may be on wildlife due to various construction activities. In view of this it is recommended that 2adequate check posts be developed in the major construction area and in vicinity labour camps for each project to prevent anti-poaching activities in the area. Each check post shall have 4 guards to ensure that poaching does not take place in the area. The guards will be supervised by a range officer. It is also recommended that the staff manning these check posts have adequate communication equipment and other facilities. Apart from inter-linking of check posts, communication link needs to be extended to Divisional Forest Office and the local police station also.

CHAPTER 14
RECOMMENDATIONS

CHAPTER-14
RECOMMENDATIONS

14.1 RECOMMENDATIONS

The recommendations for the Teesta basin study are following:

- Construction of the hydroelectric projects would lead to conversion of free flowing river into a series of reservoirs with dams/diversion structure of various hydroelectric projects.
- As present, free flow stretch will be available for a stretch of 27.97 km out of a total stretch of 51.55 km on main Teesta river.
- The Teesta Low Dam V HEP has been accorded TOR Clearance by EAC of River Valley Project of Ministry of Environment and Forests in 2013 vide their letter no. No-J-12011/39/2012-IA-I dated 23.08.2013.
- The validity of TOR is for 5 years, and the project proponent will have to get fresh TOR Clearance.
- It is recommended while appraising Teesta Low Dam V HEP for TOR Clearance, that the NBWL Clearance, which was a condition in the TOR Clearance in the year 2013, should still continue. In addition, additional studies to assess the impacts on Mahananda Wildlife Sanctuary should also be considered, while appraising the project for TOR Clearance. Impacts on Elephant migratory route is one such study. Likewise, special study on impacts on flora and fauna of the sanctuary during construction phase can also be recommended.
- Four hydroelectric projects are operational/ under construction for which provision of Environmental Flows has not been made. Only spills in monsoon months are expected on those days, when discharge is higher than rated discharge. The four hydroelectric projects operational/ under construction are as follows:
    - Teesta Stage-VI HEP(500 MW)
    - Teesta Low Dam –III HEP(132 MW)
    - Teesta Low Dam –IV HEP(160MW)
    - Jorethang Loop HEP(96 MW)

- Free stretch for about 4.124 km is available in HEP’s located on river Great Rangit.

- It is recommended that in addition to spills in monsoon season for Teesta Low Dam-IV HEP an Environmental Flow of 1.25 cumec be released by project proponent, which should be maintained in all the non-monsoon months.
- In absence of sufficient data on river cross-section for Teesta Stage-VI and Teesta Low Dam-III HEP which are located upstream of Teesta-IV Low Dam HEP, a discharge of 1.25 cumec be released in non-monsoon months as Environmental Flows, in addition to the spills in monsoon season.
- As mentioned earlier, that Rammam-II & Rammam-III is under operation and construction stage respectively. However, for Rammam-I and Rammam Intermediate HEP Environmental Flows have been recommended as per the following Norms:

Monsoon Season	: 30% of average Discharge of monsoon season for 90% dependable year
Non-Monsoon non Lean season	: 25% of average Discharge of Non-Monsoon non Lean season for 90% dependable year
Lean Season	: 20% of average Discharge of lean season for 90% dependable year

- It is recommended to change the layout of Rammam Intermediate HEP to ensure that free stretch is available between TWL of Rammam-I HEP and FRL of Rammam Intermediate HEP.
- The recommended Environmental Flows for HEPs for which cross sections are available are given in Table-14.1.

Table-14.1: Recommended Environmental Flows of Discharge for 90% dependable year for various Hydro-electric Projects

Month	**Teesta Low Dam (I&II) HEP**	**Teesta Intermediate HEP**
Monsoon Season	20% *(61.64 m^3/s)*	20% *(147.56 m^3/s)*
Lean season	15% *(3.78m^3/s)*	15% *(69.12m^3/s)*
Non-Monsoon non lean season (April-May)	20% *(22.52 m^3/s)*	20% *(64.34 m^3/s)*
Non-Monsoon non lean season (October-November)	23% *(12.96m^3/s)*	23% *(34.13m^3/s)*

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ANNEXURES

Government of West Bengal,
Department of Power & NES,
Bidyut Unnayan Bhaban, 5th Floor,
3/C, LA Block, Sector-III, Bidhannagar,
Kolkata-700 098

No. 69 – PO/O/C-III/4M-13/2017 **Dated : Kolkata, the 18th April, 2019**

From: Dr. A. N. Biswas, IAS
Commissioner to the
Government of West Bengal

To: The Director,
IA – I Division
Ministry of Environment, Forest & Climate Change
Govt. of India
Indira Paryavaran Bhawan
Bayu Wing, 3rd Floor, Jorbagh Road
Aliganj, New Delhi – 100 003

Sub: Finalisation of Teesta Basin Study Report by MoEF & CC, Govt. of India - Concurrence for the Hydro-electric projects (*operation, under construction & proposed*) to be considered for the River Basin Study (RBS) in West Bengal regarding.

Ref.: (i) MoM of the 22nd Meeting of the EAC for River Valley and Hydroelectric Projects held on 27.02.2019

(ii) Office Memorandum No. J-11013/1/2013-IA-I dated 28.05.2013 for Streamlining of process of EC and FC cases by the EAC & FAC respectively for Hydropower and River Valley Projects.

Dear Sir,

Please refer to the above subject. This is for your kind information that the Power & NES Department, Govt. of West Bengal has gone through the resolutions of the 22nd Meeting of the EAC for River Valley and Hydroelectric Projects of the MoEF & CC, Govt. of India held on 27.02.2019.

Accordingly, I am directed to inform that the Department on behalf of the State Government, conveys its concurrence on the recommendations of the Draft Teesta Basin Study Report regarding the Hydro-electric projects (*operation, under construction & proposed*) to be considered in the said RBS Report in West Bengal for final acceptance.

Yours faithfully,

18/4/19

Commissioner

No. 69 – PO/O/C-III/4M-13/2017 **Dated : Kolkata, the 18th April, 2019**

Copy for kind information to:

The CMD, WBSEDCL, 7th floor, Vidyut Bhavan, Kolkata – 700 091

Commissioner

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