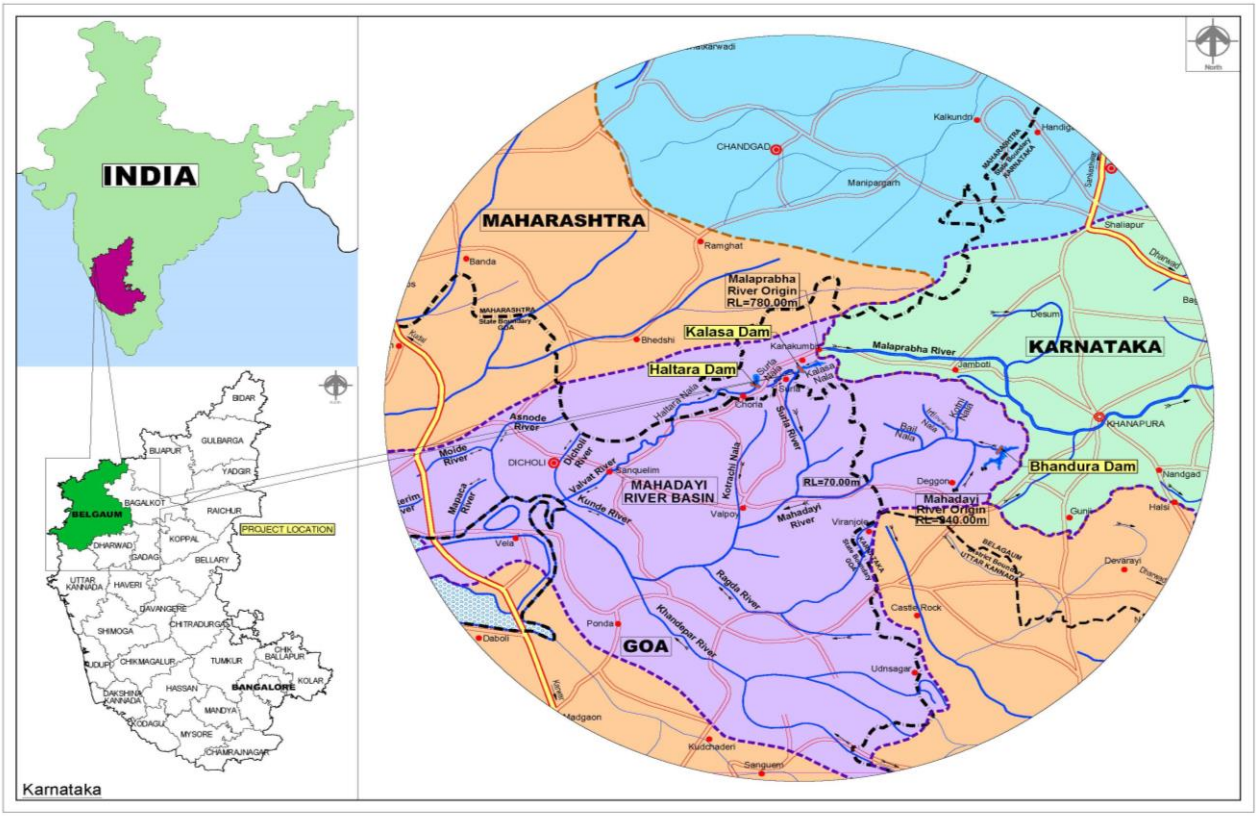
KARNATAKA NEERAVARI NIGAM LIMITED

(A Government of Karnataka Undertaking)

BHANDURA NALA DIVERSION SCHEME (LIFT SCHEME)



MODIFIED PRE FEASIBILITY REPORT

VOLUME-I- Report

Estimated Cost- Rs. 577.20 Crores

(at 2020-21 price level)

Consultant:	**Client:**
E I Technologies Private Limited [ISO 9001:2015 Certified]	**Karnataka Neeravari Nigam Limited** (A Government of Karnataka Undertaking)
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Bhandura Nala Diversion Scheme

SECTION - 1

CHECK LIST

(As per CWC Guidelines 2017)

No.	Particulars	
I.	**GENERAL DATA**	
1)	Name of the project	Bandura Nala Diversion Project
2)	Location	Nerse village
a)	State(s)	Karnataka
b)	District(s)	Belgaum
c)	Taluka (s) / Tehsil (s)	Khanapur
d)	Longitude/Latitude	15°40'52.54"N 74°11'22.98"E } Bandura Divesrion Dam
e)	Survey of India Topographical Map reference No.	48 I/2 & 48 I/6
f)	Earthquake Zone number	Zone III
g)	Complete address for correspondence along with pin code /E-mail	Executive Engineer, KNNL Kalasa Project Division Khanapur-591302 eekpdkhanapur@gmail.com
3)	Category of the project	Drinking water supply
a)	Irrigation/Multipurpose	Drinking water supply to Hubli and Dharwad towns, Kundgol Town and en route villages
b)	Storage/diversion	Diversion
II.	**PLANNING**	
4)	Has the Master plan for overall development of the River basin been prepared and stages of basin development discussed?	Not Applicable
5)	Have the alternative proposals (including set of smaller developments vis-a-vis a single large development) been studied and their merits and demerits discussed?	Alternative proposals have been discussed in the report.

No.	Particulars	
6)	Does the scheme fit in the overall development of the River basin and has its priority in the overall development of the basin been discussed?	Not Applicable
7)	Have the other Departments concerned with the development been informed?	All the concerned departments has been informed.
8)	Is the present scheme proposed to be executed in stages? If so, are various stages of execution and development discussed in the report?	The present scheme is proposed to be executed as a single project comprising of construction of diversion Dam across Bandura Nala for diverting the required quantum of water through water conducting system.
9)	Are the effects of the scheme on the riparian rights & existing Upstream and downstream projects etc. discussed?	There are no projects envisaged either u/s of the present scheme or on the d/s within the state of Karnataka.The present scheme envisages providing drinking water supply to Hubli – Dharwad twin cities along with Kundgol Town and en route villages. The scheme proposes to divert 2.18 TMC of water from Bhandura Project, as providing drinking water takes precedence over supply for irrigation and other uses. As such, effects on the upstream & downstream projects do not arise.
10)	Has the provision for municipal and industrial water supply been made?	The present proposal is to divert the Water to Malaprabha River for augmenting the storage of Malaprabha reservoir, this augmentation will in turn cater the drinking water supply needs of Hubli-Dharwad twin cities along with Kundgol Town and en route villages.

No.	Particulars	
III.	**INTERSTATE AND INTERNATIONAL ASPECTS**	
11)	Are there any International/Interstate issues involved? If so have these issues been identified and present status of agreement or tribunal decision indicated specially in respect of	
a)	Sharing of water	Discussed
b)	Sharing of cost	Not Applicable
c)	Sharing of benefits (irrigation, flood control. Power etc.)	Not Applicable
d)	Acceptance of the submergence by the upstream state(s)	Not Applicable
e)	Acceptance by the upstream state(s) of compensation of land coming under submergence	Not Applicable
f)	Settlement of oustees	Not Applicable
g)	Any other	Not Applicable
NOTE:-If there is no agreement, state the present position against each of the above item		
IV.	**SURVEYS**	
12)	Have the detailed topographical surveys been carried out for the following items and maps prepared as per prescribed scales	
a)	River surveys	Carried out
b)	Reservoir surveys	Carried out
c)	Head work surveys (dam(s), dyke(s), barrage(s).Dam(s) etc. and auxiliary components)	Carried out
d)	Plant and Colonies sites	Not Carried out
e)	Canal(s),branch canal(s) and water distribution system	Carried out
f)	Major canal structures	Carried out
g)	Power house, switch-yard, surge shafts, tailrace	Not Applicable
h)	Tunnel(s), adit(s),penstocks etc.	Not Applicable
i)	Surveys (detailed and sample) of areas of the command for OFD and Drainage work	Not Applicable

No.	Particulars	
j)	Soil surveys	Carried out
k)	Surveys for soil conservation	Not Applicable
l)	Any other surveys i.e. archeological right of way. Communication etc.	Not Applicable
	GEOLOGICAL INVESTIGATIONS	
13)	Have the geological surveys for the following items been carried out and report on geology of the following appended?	
a)	Region as a whole	Carried out
b)	Reservoir	Carried out
c)	Head work and energy dissipation area	Carried out
d)	Power house and appurtenances	Not Applicable
e)	Intakes and regulators	Carried out
f)	Major canal structures	Carried out
g)	Tunnel(s),Pen stock(s),hill(s)etc.	Not Applicable
h)	Communication routes	Carried out
i)	Any other	Not Applicable
	SEISMIC INVESTIGATIONS	
14)	Has the seismicity of the region been studied and co-efficient of vertical horizontal acceleration for the various structures discussed?	Effect of seismicity of the region is discussed in the Design Report. For details refer Voulume-II
15)	Has the approval of the Standing Committee for recommending design of seismic coefficients for River Valley Project been obtained?	Will be Obtained during DPR Stage.
16)	Is there possibility of liquefaction of foundations? If so whether liquefaction studies been carried out?	No
	FOUNDATION INVESTIGATIONS	
17)	Have the detailed foundation investigations (including in-situ tests and laboratory tests) for the following structures been carried out and detailed report(s) appended?	
a)	Earth and rock fill dam(s)	Not Applicable

No.	Particulars	
b)	Masonry/concrete dam(s)	Not Applicable
c)	Barrage(s) / Dam(s) / head regulators) etc.	Carried out
d)	Canal(s) & Canal Structures	Carried out
e)	Power house (t),tunnel (s), transformer caverns), desilting chamber(s), surge tank(s) / shaft(s), intake(s)	Not Applicable
f)	Pump House(s)	Carried out
g)	Any other	Nil
18)	Are there any Special features affecting the designs?	No
	CONSTRUCTION MATERIAL SURVEYS	
19)	Have the surveys and laboratory tests for the· following Construction materials been carried out and report(s) appended?	
a)	Soils for impervious, semi-pervious and pervious zones of earth and rock-fill dam(s)	Not Applicable
b)	Sand	Detailed Investigations about the availability and quality of the material have been carried out
c)	Rock and coarse aggregates	Detailed Investigations about the availability and quality of the material have been carried out
d)	Bricks and tiles	Not Applicable
e)	Pozzolona	Will be done during execution.
f)	Cement and lime stone	Will be done for cement.
g)	Steel	Will be done for steel.
h)	Any other	As necessary
20)	Have the sources for each of the above material been identified and need etc. indicated?	Sources identified and details collected
21)	Have the proposals for procurement of scarce materials been indicated?	Not Applicable

No.	Particulars	
V.	**HYDROLOGY**	
22)	(a) Have the hydrological and meteorological investigations been carried out and status of following data discussed in report?	Yes
	i. Rainfall	Yes
	ii. Temperature	Yes
	iii. Sunshine	Yes
	iv. Gauge & Discharge	Yes
	v. Sediment	Carried out
	vi. Water quality	Will be done while preparing detailed estimates.
	vii. Evaporation	Will be done while preparing detailed estimates.
	(b) Has the above data been collected & appended?	Provided in the Report.
23)	Is the Hydrology dealt with in detail in a separate volume? Have its brief details been included in this Report?	Yes
24)	Have an index map and bar chart showing locations of various hydro-metric, climatic and rainfall stations existing / ongoing / planned water resources projects and the data availability at those stations been attached?	Attached
25)	Have required detail note about project-specific-hydro-meteorological data observatories been attached.	Attached
26)	Have required detail in case of Himalayan Rivers, if project being planned in upper reaches the satellite imageries of project catchment especially one during snow melt period (March-May) and one during monsoon (June-September) period been attached?	Not Applicable
27)	Are detail notes about quality, Consistency? Processing and gap filling of the data included.	Attached

No.	Particulars	
28)	Have hydrological studies been carried out for the following:	
a)	To establish the availability of water for the benefits envisaged?	Yes
b)	To determine design flood for the various structures (spillway, Dam, barrage etc.)	Yes
c)	Sediments storage	Carried out
d)	Design flood for diversion during construction	Will be carried out during construction stage
e)	Tail water rating curve	Not Applicable
f)	Evaporation rates from reservoirs/concerned area	Yes
g)	Command area rainfall	Not Applicable
29)	Has the Ground Water Potential (existing use and additional availability) been indicated?	Not considered.
30)	Have the studies regarding reservoir sedimentation been carried out and revised elevation-area capacity curves been used in the simulation studies (Working Table)?	Detailed sedimentation studies will be done while preparing detailed estimates.
31)	Have the ecological requirements of water such as low flow augmentation and water quality control etc. and water requirement for domestic, industrial use and power generation (thermal, Hydel, nuclear) been considered and included in the Project Report and incorporated in the simulation studies?	No.
32)	Have the details of the simulation studies. (Working Tables) and conclusions arrived, from the various alternatives explaining the factors and assumptions been included and discussed?	Yes
33)	Has the number of failures for different aspects been indicated?	No
34)	Have the likely desirable and, undesirable changes in the hydrologic regime due to-.the project been	No changes

No.	Particulars	
	brought out in the report?	
35)	Is the criteria adopted for selection of the construction diversion flood discussed?	Will be done while preparing detailed estimates.
36)	Has the basis for determining the storage capacity been discussed?	Yes
37)	Have integrated working tables (for more than one reservoir in the system) been prepared?	Yes
38)	Has carry over storage been provided? If so. Whether studies for most economic carry over storage been done?	Not Applicable
39)	Have the flood routing studies been carried out?	Yes. Ungated spillway is proposed.
40)	Have the back water studies been carried out?	Not Applicable
VI.	**IRRIGATION AND COMMAND AREA DEVELOPMENT**	
41)	Have the conveyance and field irrigation efficiencies for paddy and upland crops during kharif, rabi etc. been indicated, discussed and justified?	Not Applicable
42)	Have the 10-daily/monthly crop water requirements at the canal head been worked out?	Not Applicable
43)	Are there any proposals for introducing Warabandi and if so have these proposals been discussed in the report and sample calculations for a typical distributary / minor / sub- minor furnished?	Not Applicable
44)	Has the present position of irrigation in the command through existing canals, tanks, and lift schemes, wells etc. been brought out in the report?	Not Applicable
45)	Are the particulars of all irrigation projects (including minors schemes) existing / proposed in the command been indicated?	Not Applicable
46)	Are there any potential areas, where ground water is available? If so, has the quantity & quality of the	Not Applicable

No.	Particulars	
	ground water been indicated?	
47)	Has the quantum of available ground water been assessed and plan for its conjunctive use with surface water been prepared and incorporated in the report?	Not Applicable
48)	Have the semi-detailed soil surveys been carried out for the entire command? If not the extent of area surveyed may be indicated.	Not Applicable
49)	Have soil and land Irrigability classifications brought out in the report?	Not Applicable
50)	Is the method used for determining the crop water requirements discussed?	Not Applicable
51)	Has the pre-project cropping pattern and the proposed cropping pattern along with justification been furnished?	Not Applicable
52)	Has the proposed cropping pattern been certified by Centre/State Agricultural: Authorities giving the statement of having considered the soil characteristics and land Irrigability characteristics of the command area in-deciding the percentage of the command area falling under respective crops as suggested in DPR.	Not Applicable
53)	Whether drinking water needs of the population projected for the 25-30 years after construction of the project on enroute and that in the command of the project considered.	Yes
54)	Whether the proposed G.W utilization is certified by CGWB and a statement furnished.	Not Applicable

No.	Particulars	
55)	Are the areas and percentages of the CCA that will be irrigated during kharif, rabi, two seasonal, summer and perennial been indicated?	Not Applicable
56)	Is justification furnished for irrigating perennials and summer crops from the reservoir?	Not Applicable
57)	Have the monthly reservoir operation studies been carried out at least for 20 years and summary on annual basis attached?	Not Applicable
58)	Have the number of blocks selected for detailed surveys for On Farm Development (OFD) works including drainage and total area covered by such blocks been indicated?	Not Applicable
59)	Have the existing locations of the Trial cum Demonstration Farm, input centers (seeds, fertilizer and insecticides) in .the command been indicated and proposal to strengthen the same discussed?	Not Applicable
60)	Have the arrangements for financing the OFD works and proposals, if any, for strengthening, the same been discussed?	Not Applicable
61)	Have the agencies responsible for execution of OFD Works been identified and simultaneous planning of execution of OFD works along with engineering works discussed?	Not Applicable
62)	Has-the year wise phasing of irrigation development as a result of the project been discussed?	Not Applicable
63)	Is the existing communication system telephone. Wireless and roads within command are a sufficient to meet the requirement after full development to irrigation? If not, have the new proposals been planned and discussed?	Not Applicable

No.	Particulars	
64)	Is the adequacy of the marketing centers in the Command Area and new proposals to meet the requirements after full development of irrigation been discussed?	Not Applicable
65)	Is there any stabilization of existing irrigation proposed?	Not Applicable
VII.	**PLANNING FOR OTHER INTENDED BENIFITS**	
66)	Have the various flood control components of the multipurpose project been indicated?	Not Applicable
67)	Have the damage areas in pre-project & post project situations been identified and flood intensities worked out at each of the damage center(s) which gets affected?	Not Applicable
68)	Have the following flood aspects been discussed?	
a)	Flood cushion in the reservoir.	Not Applicable
b)	Maximum moderated flood outflows over the spillway etc. and its frequency	Not Applicable
c)	Existing and proposed safe carrying capacities of the channel below the dam after construction of flood embankment, channel improvement, River diversion etc.	Not Applicable
d)	Synchronized moderated peak floods due to releaser(s) from the dam upstream and un-intercepted catchment up to the damage centers.	Not Applicable
e)	Average annual expenditure incurred on flood relief works.	Not Applicable
f)	Area and population affected/likely to be affected before/after the project.	Not Applicable
g)	Estimated saving in annual loss of life, property, cattle, crops etc. (evaluated in terms of money) due to flood control.	Not Applicable

No.	Particulars	
69)	Have the following drainage aspects of command area been discussed?	
a)	Existing Surface and sub-surface drainage network and problems of the drainage congestion, water logging, alkalinity/salinity if any.	Not Applicable
b)	Studies on sub soil water table (pre-monsoon, post monsoon etc.).	Not Applicable
c)	Maximum intensity of 1, 2 and 3 day rainfall.	Not Applicable
d)	Deficiencies in farm drains.	Not Applicable
e)	Deficiencies in existing natural drains	Not Applicable
f)	Proposal for improvement of drainage water logging /alkalinity/salinity of the area along with justification thereof.	Not Applicable
g)	Identification of the area in Command which will get benefited due to execution of drainage net-work and benefits thereof in terms of relief from crop damage, increased yields etc.	Not Applicable
	POWER	
70)	Have the following points been discussed	
a)	Availability of the power generating capacity in the state as well as in the region from different sources.	Total Peak Power Generating Station Installed capacity:30943.39 MW
b)	Total energy available and peaking capacity of the system, in the state as well as in the region from different sources.	
c)	Integrated operation of the system and present status of utilization in the state as well as in the region.	Total State utilization Demand: 11715 MW
d)	Surpluses and shortfalls in the system in the state as well as in the region.	Not Applicable

No.	Particulars	
e)	Future plans of power development from different sources in the State/region.	Not Applicable
f)	Fitment of the scheme in planning of power development of the state /region.	
g)	Energy generated from the project Firm power, seasonal power and total power.	Not Applicable
h)	Proposal for transmission lines connecting to the existing system / grid.	Not Applicable
i)	Project. Cost. Per kwh installed and per kwh generated at bus bar as compared to the different hydro-electric: thermal generation and gas projects and different sources.in the State as well as.in the region to justify the power component of the project.	Not Applicable
j)	Whether the proposed addition to the transmission system has been shown-on a geographical map Whether options considered for the proposed addition have been discussed with statement of justification for the selected option after carrying out supporting studies covering load flow studies , short circuit studies (three phase and single phase) and stability studies.	Not Applicable
k)	* Whether sufficient surplus of Peak power is available for pumping of water from lower to upper reservoir.	Yes
l)	*Actual off peak energy requirement of proposed, scheme	Total Power Requirement for Scheme is 12.5MVA
m	*Cost of peak-and off peak energy	Not Applicable
	for pumped storage schemes only	
	ESTIMATE	

No.	Particulars	
71)	Is the separate volume of estimate attached as appendix?	Yes
72)	Is the year to which the rates adopted in the estimate relate to indicated?	The estimates were prepared based on Common SoR of 2020 – 21
73)	Have the analysis of rates for various major items of the work for the major components of the project been furnished and with basis of analysis described?	Rate analysis sheet is appended with the cost estimates
74)	Are the provision for the following items made on the basis of sample survey and sub estimates	
a)	Distributaries ,minor and sub-minors	Not Applicable
b)	Watercourses	Not Applicable
c)	Drainage	Not Applicable
d)	CAD works	Not Applicable
VIII.	**ECOLOGICAL ASPECTS**	
75)	(a) Is the area likely to have any of the following environmental and ecological problems due to the altered surface water pattern? If yes, whether preventive measures have been discussed?	
	Excessive sedimentation of the reservoir and the upper reaches of the River and its tributaries tailing into reservoir	Not anticipated
	i. Water logging, salinity/alkalinity	Not Applicable
	ii. Quality of surface and ground water	No
	iii. Ground water recharge	No
	iv. Health hazards-water borne diseases, industrial pollution etc.	Not Applicable
	v. Submergence of important minerals deposits	Not Applicable
	vi. Submergence of monuments/archeological sites	Not Applicable
	vii. Fish culture and aquatic life	Not Applicable
	viii. Plant life (flora)	Not Applicable
	ix. Wild Life	Not Applicable

No.	Particulars	
	x. Migratory birds	Not Applicable
	xi. National parks and sanctuaries	Not Applicable
	xii. Seismicity due to filling of reservoir	Not Applicable
	xiii. Likely changes in the regime of the River	Not Applicable
	xiv. Any other	Not Applicable
	(b) Have the environmental and forest clearances from MOE&F been obtained? If not what is status thereof?	The proposal regarding applicability of EIA & Forest clearance is already submitted to MoEF&CC

BHANDURA NALA DIVERSION SCHEME

SALIENT FEATURES

SALIENT FEATURES

KALASA NALA DIVERSION SCHEME

No	Particulars	Details
I	**General**	
	Name of the Project	Bhandura Nala Diversion Scheme
	Name of the river to which diversion is proposed	Malaprabha River
	Name of the Nalas proposed to be diverted	Bhandura Nala, Singar Nala & Pat Nala
	Total quantity of water proposed to be diverted per year	2.18 TMC
	Purpose	To augment the storage of Malaprabha Reservoir
	Location	
	Latitude	15º 36' 30" N
	Longitude	74º 24' 15" E
	Village	Near Nerse
	Taluka	Khanapur
	District	Belgaum
	State	Karnataka
	Vicinity	15 Km from Khanapur
II	**Hydrology**	
	Catchment area	34.90 Sqkm
	Average Rainfall	3764 mm
	Design discharge	542.93 Cumec (19173 Cusecs)
III	**Lift Scheme**	
	Source	**Bhandura Nala**
	Off take point	**Bhandura Nala**
	Diversion Dam	
	Type of Diversion Dam	Ogee Diversion Dam
	FRL/Crest level	637.00m
	MWL	638.68 m
	Length of spillway (including piers)	121.80m
	Thickness of intermediate pier	0.60 m
	Thickness of sluice pier	3.00 m

No	Particulars	Details
	Length of NOF	13.50 m left flank 7.00 m on Right flank
	Design discharge	542.93 Cumecs
	Top of Road level	641.30 m
	Max. height of Diversion Dam (foundation to crest level)	10.60 m
	Number of overflow Vents	12
	Clear Width of Vents	9.4 m
	Top width of Walk way	2.70m
	Nos. of sluice	1 no
	Invert level of sluice	RL 627.90 m
	Size of sluice	1.00 m(W) x 1.00m (D)
	Hoisting arrangement of sluice gate	Electrically operated screw rod hoist
	Energy dissipating arrangement	Ski jump bucket type
	Inverted level of bucket	RL 727.40m
	Lip angle	40 degree
	Type of Diversion Dam	Ogee Diversion Dam
	Intake system	Intake Forebay
	Lift System	Jackwell cum pump house
IV	**Pumps**	
	Description	**Main**
	Type of Pump	Vertical Turbine Pumps
	Efficiency of Pump	86%
	Intake Level	630.500 m
	Peak Level	685.000 m
	Delivery Level	644.000 m
	Static Head	54.50 m
	Losses (Friction + pump internal+ other)	13.50 m
	Total Pump Head	68.00 m
	Peak Discharge	10.6 cumecs
	Number of Pumps	4 working + 1 standby
	Capacity of each Pump	3200.00 HP (2387.2 KW)
	Total Installed Capacity	16000.00 HP(11936.0 KW)
	Total Power Requirement	12.00 MVA

No	Particulars	Details
	Electrical Sub-station	110 KV / 6.6 KV outdoor type with 2 No's of 12.0 MVA Power transformer (1 Working + 1 Standby)
V	**Rising main**	
	Description	
	Length of the Rising Main (m)	12470
	Peak Discharge (Cumecs)	10.6
	Number of Rows (No)	1
	Discharge for each Row (Cumecs)	10.6
	Velocity considered (m/s)	2.00
	Diameter of Pipe (mm)	2600.0
	Thickness of Pipe (mm)	16.1
	Coating Internal (Epoxy Lining in mm)	0.406
	External tar tape coating (in mm)	4
	Grade	E-250
COST OF THE PROJECT		
The total cost of the project is **Rs 577.20 Crores.** The estimate is based on the Common Schedule of Rates 2020-2021.		

Executive Engineer
KNNL, Kalasa Project Division
Khanapur

Chapter 1
Introduction

1.1 Aim of the Project

The present project is one of the several alternatives thought of to augment / supply of drinking water to Hubli – Dharwad twin cities, Kundgol town and en route villages.

This is due to the fact that Malaprabha River in itself is not drained enough by its catchment. The proposal considers diverting water from a tributary of River Mahadayi called as Bhandura nala which is close by after giving due consideration to:

- Water quality
- Availability of required quantum of water
- Pumping head
- Length of transmission line
- Capital cost
- Requirement of power
- Electricity charges
- Annual O & M cost

Lastly an approximate water tariff which can be charged during the projected year of 2051

This project is one of the two projects proposed to be undertaken for diverting about 3.90 TMC of water to meet the drinking water needs of the above areas, Under Bhandura project, it is envisaged to divert 2.18 TMC of water after the following works are completed

Construction of Diversion Dam across Halatri Nala

Construction of Jackwell cum pump house along with rising main for diverting water from Bhandura diversion dam to Malaprabha river - Inter connecting canal.

As against the claim of Government of Karnataka for the diversion of 4.00 TMC from the Bhandura nala, diversion scheme, and the tribunal has allotted 2.18 TMC in its award dated 14/08/2018 which has been published in the extraordinary Gazette of India by the Ministry of Water Resources, Government of India on 27/02/2020.

The Government of Karnataka has already filed an SLP seeking increased allocation as per its original claim before the Hon'ble. Supreme Court of India.

As per the tribunal award the diversion shall be regulated by the Mahadayi Monitoring committee which will be constituted by Govt. of India. This shall ensure the diversion of waters as per the allocation by the Tribunal.

1.2 The River and the Proposed Scheme

1.2.1 Malaprabha River

Malaprabha River originates at an elevation of 793.0 m in the Khanapur taluk of Belgaum district and flows towards east to join River Krishna at an elevation about 488.0 m after traversing a distance of 306 Km. It is one of the principal tributary of River Krishna.

Government of Karanataka has constructed a storage dam across Malaprabha River at Naviluthirtha in Soundatti taluk of Belgaum district, to cater to the needs of irrigation in the identified command. The construction of Dam was completed in the year 1972 and water is being supplied for irrigation and Drinking water.

It is observed that since 1972, the reservoir is not getting contemplated 75% dependable yield. This has resulted in the Malaprabha reservoir not getting the required quantum of water thereby becoming a deficit reservoir. On account of this, the Hubli-Dharwad cities and most of the towns and villages on the banks of Malaprabha River are facing acute shortage of water, for drinking and for this purpose the Karnataka Govt. earlier planned to augment the Malaprabha reservoir by proposing Bhandura Nala Diversion Scheme to divert 4.00 TMC of water. Now as per the allocation of 2.18 TMC made by the tribunal for ***BHANDURA NALA DIVERSION SCHEME***, the west flowing Bhandura nala water in Khanapur Taluk is to be diverted to the Malaprabha Reservoir to agument the storage for drinking water needs.

1.2.2 Mahadayi River

River Mahadayi (Mandovi) is a West flowing interstate river in Western Ghats. The river takes its origin in Karnataka, flows for about 35 Kms in Karnataka State and enters Goa and joins the Arabian Sea.

The total catchment area of the river Mahadayi is 2032 Sq.Kms, out of which 375 Sq.Kms is in Karnataka, 77 Sq.Kms is in Maharastra and 1554.84 Sq.Kms is in Goa.

The yield of the river, as per the study report of Central Water Commission (CWC), New Delhi is about 199.6 TMC at 75% Dependability and 220 TMC at 50% Dependability, out of which the yield in Karnataka portion of catchments is estimated to be around 44.15 TMC.Now the yield worked out by the tribunal for enter Mahadayi Basin is **188.62 TMC** at 75% depandibility. The State wise allocations made by the tribunal are Goa - 24.00TMC, Karnataka-13.42TMC & Maharashtra - 1.30TMC.

However now the Hon'ble Mahadayi Disputes Tribunal has made an independent study to assess the yield of the Bhandura Nala. The comparitive statement of Yeild details at 75% dependibilty and allocation for the proposed scheme are as follows.(vide MWDT award Volume-VII Pg.1441-1443)

Table 1.1: Comparitive statement of Yeild details at 75% dependibilty and allocation for the proposed scheme

Sl. No	Name of Project	Yield as per the tribunal	Allocation made by the tribunal
1.	Proposed Bhandura dam site with catchment area of 32.25 sq.km.	**2.77 TMC**	**2.18 TMC**

The project is envisaged to supply water for drinking purposes of Hubli – Dharwad and Kundagol town including enroute villages. Hubli – Dharwad, the twin cities are considered as the major developing areas in the State of Karnataka. Its strategic location with good connectivity by rail and roads are along with it being an important commercial centre in the Northern Karanataka make them ideal for growth. Their growth in the past few years reflects the potential to become one of the most important cities in the State and also the country.

1.2.3 Bhandura Nala Diversion Scheme (Earlier Proposed Scheme)

Consequent to the award by the MWDT, GoK swung into action and directed KNNL to take up preparation of Pre-Feasibility report in accordance with the allocations made by the MWDT. GoK vide their office letter No WRD 18 MPZ 2020 (Bhandura) dated 22/05/2020 submitted to Central Water Commission, New Delhi seeking “IN-PRINCIPLE CLEARANCE” for diverting 2.18 TMC of water from Bhandura Nala diversion Scheme. The details of observations/compliances for PFR of Bhandura Nala Diversion Scheme till date shown in below table

Details of observations/compliances for PFR of Bhandura Nala Diversion Scheme:

Table 1.2: Details of observations/compliances for PFR of Bhandura Nala Diversion Scheme

No.	Authority	Letter No.	Date	Remarks
1.	CWC-ISM	File No. T-89015/1/2020-ISM-1 DTE Part(1)	21/08/2021	Observation
2.	CWC-Hydrology	U.O.7/Kar 81/2020-Hyd(s)/206	07/09/2020	Observation
3.	CE-Malaprabha	e-PAMS-ISM-Hydrology	26/11/2020	Compliance

No.	Authority	Letter No.	Date	Remarks
4.	CWC-ISM	File No T-89015/1/2020-ISM-1 DTE	08/12/2020	Observation
5.	CE-Malaprabha	e-PAMS-ISM	14/09/2021	Compliance
6.	CWC-Hydrology	U.O.7/Kar 80/2020-Hyd(s)/79	16/12/2020	Observation
7.	CWC-CMDD(NWS)	File No T-84/4/21-CMDD(NWS)DTE	18/06/2021	Observation
8.	CE-Malaprabha	e-PAMS-CMDD(NWS)	14/09/2021	Compliance
9.	CE-Malaprabha	e-PAMS-CMDD-NWS	12/05/2022	Revised Compliance
10.	CWC-Hydrology	U.O.7/Kar 80/2020-Hyd(s)/179	23/09/2021	Observation

Major findings of the Directors of Central Water Commission for the earlier proposed Bhandura nala diversion scheme are:

- Height of the dam,
- Over sizing of the inter connecting canals,
- Hydrology.

For the above observations, suitable compliance reports have been submitted justifying the technical feasibility of the project components.

Further, The Government of Karnataka has conceptualized an alternate proposal of ***lift scheme instead of gravity since the diversion is meant for meeting the drinking water needs,*** there by addressing all the concerns of CWC. The alternate proposal has thus minimized the storage by reducing the height of the dam, submergence in forest area, re-assessment and working on the section on the conveyance system based on the revised hydrology (as per CWC direction).

The proposed lift scheme will now address the,

- Concerns of the downstream riparian states regarding diversion of additional water over and above the allocation by having regulating arrangements at the lift point as well as at delivery point.
- Minimizing the time required for execution of the project from 5 years to 6 months.
- Minimizing the extent of forest submergence by about 85%
- Avoiding major infrastructure for diverting water in terms of open canal, diversion dam etc by having piped conveyance system.

1.3 Modified proposal under Bhandura nala Diversion Scheme (Lift Scheme)

Consequent to the reduction in allocation of water, a diversion Dam of 10.6 m high (from the bed level of nala) is proposed across Bhandura Nala bed level.

The extent of storage is now restricted to 10 - hours, thereby minimizing the forest submergence. The total extent of submergence is 13.26 ha at Bhandura. The forest land required for the conveyance system under Bhandura will be will be 3.01 Ha.

1.3.1 Conveyance System

A jack well cum pump house is proposed at the fore shore of the diversion Dam and water will be lifted and conveyed through a raising main of MS pipe of 2.60 m diameter and will delivered directly to Malaprabha river.

1.3.2 Extent of Forest Diversion

- The total submergence under Bhandura diversion will be 13.26 Ha (32.75 Acres).
- The extent of forest land required for the conveyance system will be 3.01 Ha (7.43 Acres)
- The total forest land diversion under Bhandura scheme will be 16.27 Ha (40.18 Acres).

1.3.3 Cost of the scheme

The estimated cost of the **Alternate proposal (lift scheme) across Bhandura Nala** as per the Common schedule of rates - 2021-22 is **Rs.577.20 Crores (including GST @ 18%).**

1.4 Location of the project

The project is located in Belgaum district of Karnataka.

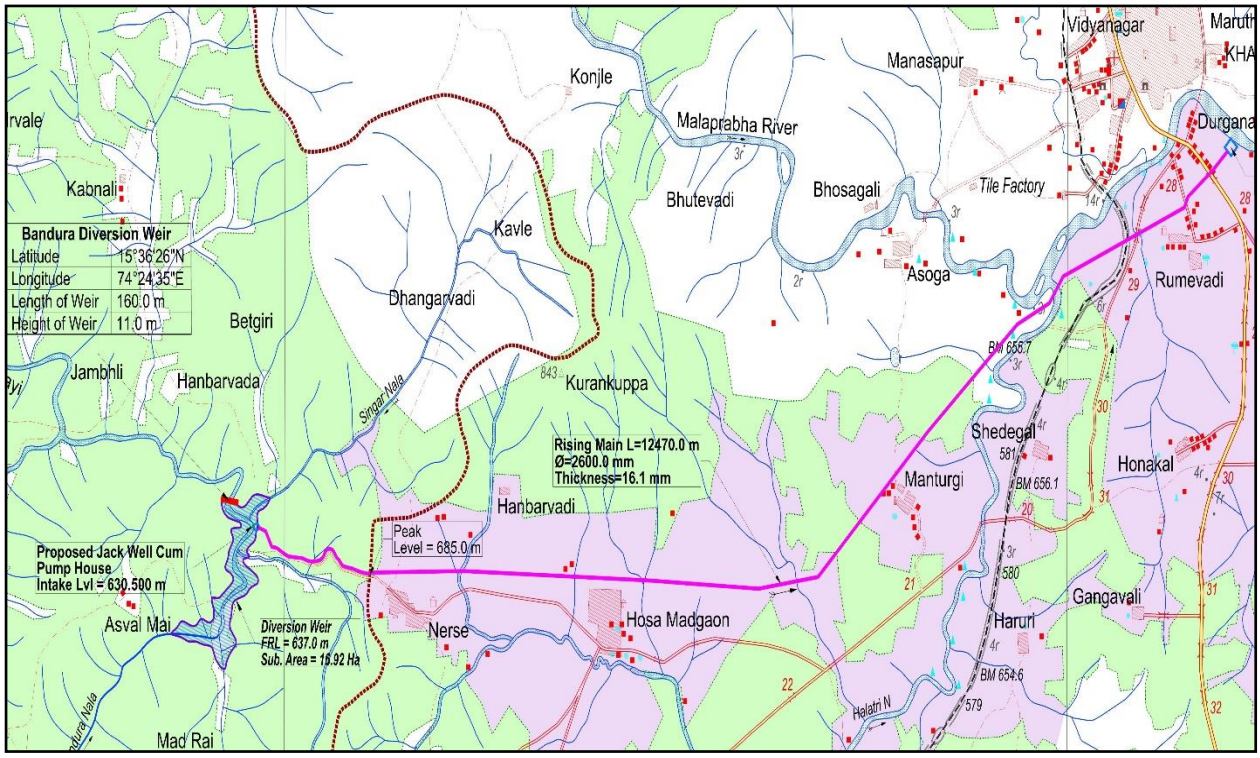

Figure 1.1 Location Map

1.4.1 Description of the Work

The Bhandura Nala diversion scheme consists of Diversion Dam, Jackwell cum pumphouse and Conveyance system.

1.4.2 Districts Benefitted

The project is specific to drinking water purpose and the districts benefitted on account of the said project will be Hubli Dharwad cities, Kundgol town and enroute villages.

1.5 Access by Air/Rail/Road/Sea/Port and other Communication Facilities

By Air

The nearest airport is Belgaum at around 65 Km

By Road

The projects are accessed by an all weather road from Belgaum at a distance of about 65 Km through SH-33 & NH4A.

By Rail

The nearest rail station is Khanapur and it is at a distance of 21 Km

By Port

The nearest port is Karwar at a distance of 163 Km and Goa at a distance of 141 Km

1.6 General Climatic Condition of the Project Area

Three distinct seasons prevailing in the basin:

(i) Summer season - March to May

(ii) Monsoon season - June to November

(iii) Winter season - December to February.

The basin receives substantial rainfall during monsoon period from June to November.

- The normal rainfall varies from 3000 mm to 6000 mm.
- The maximum, minimum and average rainfall of the basin is 5697 mm, 1834 mm and 3468 mm respectively.
- The annual average maximum and minimum temperature is 31.3º C and 21.4º C
- The average monthly maximum and minimum relative humidity is 88% and 60% respectively.
- The winds are fairly strong during the monsoon period whci is westerly through out the day.
- The average monthly maximum and minimum wind speed is around 23.1 Km/hr and 9.5 Km/hr.
- The average monthly sunshine varies from 92.48% to 31.55%.
- It is seen that the sky is generally clear or lightly clouded except during south-west monsoon season.

1.7 Topography, Physiography and Geology of the Project Area

1.7.1 Topography

The Bhanduranala Diversion Project lie in the hilly terrain of the Western Ghats. The area is highly undulating with hills covered by thick evergreen forests.

1.7.2 Physiography

The project as a whole lies in the Northern Karnataka Plateau covering the districts of Belgaum, Baglakot, Dharwad and Gadag.This region largely covers the parts of Malaprabha sub basin in Krishna

basin lying in Karnataka.. In the west, it is enclosed by the ranges of Western Ghats with an elevation ranging from 700 m to more than 1000 m with its northern part being an interrupted but clearly identifiable high plateau.

In the east, the valleys of the Malaprabha followed by that of Krishna and its tributaries open out to form undulating plains. The general elevation of the region varies between 500 m to 700 m.

1.8 Implementation of the project

The Project will be taken up by the Karnataka Neeravari Nigam Limited and will be executed by the Chief Engineer, KNNL, Malaprabha Project Zone, Dharwad

1.9 Fitment of the scheme in overall development of the River basin

This project has been envisaged exclusively as a drinking water supply scheme and as such, overall development of the River basin is not a criteria considered.

1.10 Intimation to the other development authorities regarding this scheme

The scope of the project is intimated to other development authorities.

1.11 Public announcements and public hearings

The project is an important scheme involving exclusive drinking water supply to the Hubli – Dharwad twin cities, Kundgol town along with en-route villages, the project would be taken up by giving wide publicity by way of public announcements and conducting public hearings

1.12 Interlinking of the scheme with the neighbouring schemes

After diverting water from Bhandura to Malaprabha River as envisaged, arrangements would be made to supply the required quantum of water to the twn cities of Hubli – Dharwad, Kundgol Town along with en route villages. The total quantum of water proposed to be diverted from Bhandura Nala Dam is 2.18 TMC as per the award of the Hon'ble Mahadayi Water Disputes Tribunal.

1.13 Interstate / International aspect(s)

Discussed in Chapter 3

1.14 Public cooperation and participation

The details of the project have been widely publicized and the people in the areas concerned have been made aware of the project. The Government on its part has taken views of the elected representatives and the technical experts on the scheme before giving approval to it. Even after giving administrative approval, the Department has carried out enough alternative studies to address all the issues concerned

such as land acquisition, forest etc. Further deliberations on the scheme has lead to finalizing the most economical, viable and implementable alternative.

1.15 Provision for domestic and industrial power supply

No provision has been made in the project for domestic and industrial power supply.

1.16 Availability of land

Bandura Nala diversion scheme (lift scheme)

The total area required for construction of Diversion Dam, JW and Conveyance system including submergence is about 59.41 Ha. The classification of land is as below:

Table 1.3: Details for classification of land

Sl. No.	Type of Land	Area
1.	Forest Land	16.27 Ha
2.	Revenue land	43.15 Ha
	Total	**59.41 Ha**

1.17 Statutory clearance

All the statutory clearance will be obtained.

Chapter 2
General Planning

2.1 Choice of the Project

2.1.1 Earlier Proposal – Alternate -1

The Mahadayi Project is a combined project for both irrigation and Electricity generation, providing 9 TMC of water for diversion to Malaprabha river (4 TMC from Mahadayi and 5 TMC from neighboring nalas Kalasa, Haltar and Potli) was approved by the government vide order No. PWD: 132: PPC: 88: Dated 5-11-1988. As per which the Karnataka Power Corporation has to take action to prepare the project report for diversion of 4 TMC of water in consultation with the Irrigation Department and send this proposal for Central Electricity Authority for clearance.

However in the meeting held on 19-04-1991 in the chambers of the Commissioner and secretary to government, Department of energy, Bangalore it was decided that the project reports for Irrigation and Power components of Mahadayi project are to be prepared separately.

The Karnataka Irrigation Department is entrusted with the execution of Irrigation components of the above project. The diversion scheme contemplates construction of dams, tunnels and open cuts. The total catchment of Mahadayi River is 2032.00 Sq.Kms. out of which the Karnataka catchment is 375.00 Sq.Kms.

The Kotni Dam was proposed on Mahadayi River by Karnataka Power Corporation Ltd., for generation of Electricity and to divert 4 TMC of water to Malaprabha River. This proposal could not get a clearance on account of objection of Government of Goa on the Environmental Grounds.

It is felt that in the near future, the implementation of this proposal may not materialize. Hence a series of three small Dams on tributaries on Mahadayi River have been examined to be tapped to augment the Malaprabha River.

Hence, Bhandura nala, Singar nala and Nerse nala, tributaries of Mahadayi River in its initial reach have been considered for proposed diversion near Nerse village of Khanapur taluk, District: Belgaum.

Based on topographical study, three small dams have been proposed on Bhandura nala, Singar nala and Nerse nala. Water from Bhandura nala reservoir and Singar nala reservoir was proposed to be diverted through an open channel. Then from Nerse nala reservoir, water is to be diverted to Haltar nala which joins Malaprabha River.

Mean while, the Hon'ble Minister for Major and Medium Irrigation, Government of Karnataka, visited the above sites on 18-12-1999 and instructed to study the feasibility of diverting water from three Nalas viz,.

Bhandura Nala, Pat nala and Singar Nala to Malaprabha River and also instructed to study the feasibility of diverting water by constructing single dam across Bhandura Nala at down stream of confluence point of Singar nala to Bhandura Nala.

Accordingly, studies have been conducted for both the proposals and it was worked out that by constructing three dams across Bhandura Nala, Nerse Nala (Pat Nala), and Singar Nala, 2.81 TMC of water can be diverted to Malaprabha River. Whereas, by constructing single Dam across Bhandura Nala down stream of confluence point of Singar Nala and Pat Nala to Bhandura Nala 4.00 TMC of water can be diverted to Malaprabha River.

The above proposals have been also examined by the Expert Committee headed by Shri.V.H.Patil, (Administrator, Rtd.) appointed by the Government of Karnataka. The Committee visited the sites on 06-01-2000 and they have opined that by constructing Single Dam across Bhandura Nala to divert 4 TMC of water is feasible than constructing three small dams to divert 2.81 TMC of water. As per the directions of Expert Committee, the Pre-Feasibility Report has been prepared adopting MLBC Circle Naviluteertha CSR for 1999-2000 to divert 4 TMC of water to Malaprabha River.

However, the Mahadayi Water Disputes Tribunal on 14.08.2018 has awarded a total of 3.90 TMC of water for diversion from Mahadayi Basin to Malaprabha River for drinking water purpose, comprising of 2.18 TMC from Bhandura Nala and 1.72 TMC from Kalasa Nala. Considering the above, PFR is prepared restricting the quantum of water to 2.18 TMC.

2.1.2 Earlier proposal – Alternate - 2 (PFR of 2020)

2.1.2.1 Water requirement

The earlier proposals were modified as the drinking water became priority due to scarcity of drinking water of Hubli-Dharwad Towns, Kundgol town and Enroute villages. Drinking water requirement has been arrived at as 7.56 TMC considering the projected population up to the year 2044. Out of 7.56 TMC, 3.56 TMC is contributed by Kalasa Nala diversion scheme.Now as per the allocation made by MWDT the contribution from Bhandura Nala Diversion will be 2.18 TMC out of 3.90 TMC.

2.1.2.2 Cost of the project

The proposal envisages implementation of

- Construction of Bhandura Nala Dams and Conveyence syestem required quantum of water to divert Malaprabha River.

The cost of the Project is worked out based on detailed designs and drawings.The cost of the project works out to **791.50 Crores (As per 2018-19 SoR)**

2.1.3 Conceptualization of Lift Scheme (Modified Proposal)

Major findings of the Directors of Central Water Commission for the earlier proposed Bhandura diversion scheme were:

- Height of the dam,
- Over sizing of the inter connecting canals,
- Hydrology.

For the above observations, suitable compliance reports have been submitted justifying the technical feasibility of the project components.

Further, The Government of Karnataka has conceptualized an alternate proposal of ***lift scheme instead of gravity since the diversion is meant for meeting the drinking water needs,*** there by addressing all the concerns of CWC. The alternate proposal has thus minimized the storage by reducing the height of the dam, submergence in forest area, re-assessment and working on the section on the conveyance system based on the revised hydrology (as per CWC direction).

The proposed lift scheme will now address the,

- Concerns of the downstream riparian states regarding diversion of additional water over and above the allocation by having regulating arrangements at the lift point as well as at delivery point.
- Minimizing the time required for execution of the project from 5 years to 6 months.
- Minimizing the extent of forest submergence by about 93%
- Avoiding major infrastructure for diverting water in terms of open canal, diversion dam etc by having piped conveyance system.

2.2 Modified proposal under Bhandura nala Diversion Scheme (Lift Scheme)

Consequent to the reduction in allocation of water, a diversion Dam of 10.6 m high (from the bed level of nala) is proposed across Bhandura Nala bed level.

The extent of storage is now restricted to 10 - hours, thereby minimizing the forest submergence. The total extent of submergence is 13.26 ha at Bhandura. The forest land required for the conveyance system under Bhandura will be will be 3.01 Ha.

2.2.1 Conveyance System

A jack well cum pump house is proposed at the fore shore of the diversion Dam and water will be lifted and conveyed through a raising main of MS pipe of 2.60 m diameter and will delivered directly to Malaprabha river.

2.2.2 Extent of Forest Diversion

- The total submergence under Bhandura diversion will be 13.26 Ha (32.75 Acres).
- The extent of forest land required for the conveyance system will be 3.01 Ha (7.43 Acres)
- The total forest land diversion under Bhandura scheme will be 16.27 Ha (40.18 Acres).

Chapter 3
Interstate / International Aspects

River Mahadayi (Mandovi) is a West flowing Interstate River. The River takes its origin in Karnataka, runs for about 35 Km in Karnataka State and enters Goa and joins the Arabian Sea along with several tributaries. The total catchments of the River Mahadayi is 2032 Sq.kms out of which 375 Sq.kms is in Karnataka, 77 Sq.Kms is in Maharashtra and 1580 Sq.Kms is in Goa.

The yield of the River, as per the study report of Central Water Commission (CWC), New Delhi is about 199.6 TMC, at 75% Dependibility and 220 TMC at 50% Dependability. The yield in Karnataka catchment is 44.15 TMC at 75% dependability and 52.60 TMC at 50% dependability. Presently, except for a negligible quantity, the entire flow of about 199.6 TMC is draining in to the Arabian Sea.

Kalasa Nala and Bhandura Nala are the main tributaries of Mahadayi River .Karnataka planned to divert a small quantity 7.56 TMC of its Mahadayi basin contribution to Malaprabha Reservoir, 3.56 T.M.C from Kalasa nala and 4.00 T.M.C from Bhandura Nala, so as to meet the drinking water requirements of Hubli-Dharwar cities, and surrounding towns and villages.

The State of Goa has expressed objections regarding Kalasa and Bhandura Nala diversion scheme before the Hon'ble Supreme Court. Further, as per the request of Government of Goa the Hon'ble Supreme court had issued the directions to the Central Government for constitution of "MAHADAYI WATER DISPUTE TRIBUNAL" and as per the direction of Supreme Court the Ministry of Water Resources, Government of India constituted the Mahadayi Water Disputes Triunal on 16.11.2010.Further, the Hon'ble Mahadayi Disputes Tribunal after detailed hearings pronounced its final Award on 14.08.2018.

Table 3.1: Details of the award viz State wise and project wise allocation

No.	Name of Project	Claim Before MWDT (TMC)	Allocation by MWDT (TMC)	Difference (TMC)
I.	**Consumptive Use**			
1.	Diversion of Kalasa Nala to Malaprabha river for Drinking water supply of Hubli-Dharwad cities surrounding towns and enroute villages	3.56	1.72	1.84
2.	Diversion of Bandura Nala to Malaprabha river for Drinking water supply of Hubli-Dharwad cities surrounding towns and enroute villages	4.00	2.18	1.82

No.	Name of Project	Claim Before MWDT (TMC)	Allocation by MWDT (TMC)	Difference (TMC)
	Drinking Water Total	**7.56**	**3.90**	**3.66**
3.	Within the basin use	1.50	1.50	---
4.	Diversion to Kali dam for augmentation for power generation	5.527	--	5.527
5.	Diversion of surplus water at 75% dependability from Kotni dam (MHEP) to Malaprabha river to meet irrigation, drinking water filling , irrigation tanks in DPAP talukas of Ramdurga, Bailhongal and Soudantti for meeting requirement of suffering atchakat of Malaprabha command	7.00	---	7.00
	Total (I)	**21.587**	**5.40**	**16.187**
II.	Non Consumptive Use			
1.	Mahadayi Hydro Electric Project (MHEP) (Including evaporation loses of 0.4 TMC)	14.971	8.02	6.951
	Total (II)	14.971	8.02	6.951
	Total (I+II)	**36.558**	**13.42**	**23.138**

No.	Project	Allocation Proposed by the State	Allocation as per Hon'ble MWDT
1.	Bhandura Nala Diversion scheme for drinking water supply	**4.00 TMC**	**2.18 TMC**

The tribunal vide its award under volume XII, "clause VIII, A, ii, d" has directed the State of Karnataka to get the Detailed Project Report approved for technical appraisal from concerned central agencies and obtain all mandatory clearences as required by law.

Considering the above, Detailed Project Reports for the above scheme are prepared as per the directions and allocation of the Mahadayi Water Disputes Tribunal vide its pronounced award dated: 14.08.2018.

Considering the above, The Pre – Feasibilty Report for the above scheme was prepared as per the directions and allocation of the Mahadayi Water Disputes Tribunal and submitted to CWC on 22/05/2020. Further the interstate aspects were scrutinized by ISM – I directorate and the following comments were communicated to the state of Karnataka

1. Project Authority has mentioned that Hydrology Directorate has examined the related matters and has given their comments regarding Catchment Area and Yield etc. However, it is reiterated that the views of Hydrology Directorate on specific issue regarding the viability of diversion of 1.72 TMC of water through almost completed works are yet to be furnished. The same may be furnished.
2. Giving reference to the Award of Krishna Water Dispute Tribunal, this Directorate has conveyed that prior consent/No Objection from the co-basin states of Krishna River for the proposal would be required. However, in reply to this, the Project Authority has mentioned that the issue can be amicably resolved in due course. As, already mentioned in the comments that prior consent/No objection of co-basin States of Krishna River would be required. Therefore, the PFR of the proposed project may be shared with co-basin stated of Krishna River and their consent/ No Objection/ views on the project proposal may be submitted.

In reply to the above the state of Karntaka had submitted the following complinaces.

1. The construction of Inter Connecting Canal to divert 3.56 TMC of water from Kalasa nala to Malaprabha river has been commenced in the year 2006 and is nearing completion with a design discharge capacity of 60 cumecs.However, the MWDT award pronounced on 14.08.2018 and Gazetted by Government of India on 27.02.2020 has allowed to divert 1.72 TMC from Kalasa Nala diversion scheme to Malaprabha River.

The Hydrology Directorate during discussion has expressed that the issue of viability of diversion of 1.72 TMC of water through almost completed works of Kalasa does not fall under the preview of Hydrology Directorate as they are concerned with yield and design flood aspects. Further, this aspect is being looked upon by Design Directorate of CWC and this issue does not involve any inert-state aspect.

However, the diversion of 1.72 TMC of water through the already completed work will be regulated through a controlling arrangement provided in the intake channel at Ch.690m and the same will be owned and operated by the outcome of the pending SLP's in the Hon'ble Supreme Court.

2. The observation of Central Water Commission that Karnataka must obtain the prior consent or no objection of Krishna basin States for diversion of 1.72 TMC of Mahadayi water into Krishna Basin in Malaprabha under Kalasa Project is wholly misconceived and it is plainly contrary to the mandate in the published decisions of both Mahadayi Water Disputes Tribunal (MWDT) dated 27.02.2020 and Krishna Water Disputes Tribunal – 1 (KWDT-1) Dated 31.05.1976 under the provisions of the ISRWD Act of 1956.

With regard to published decision of MWDT dated 27.02.2020, its submitted that requirement of prior consent of Krishna basin is nowhere mentioned. No clause mandates such prior consent. Hence, if a condition of prior consent is imposed, it amounts to defeating the very mandate of published decision of MWDT dated 27.02.2020. Therefore, the Directorate or even the Central Govt has no powers to impose such condition.

The published decision of KWDT-1 also doesn't prohibit importing or transfer of water into Krishna basin by any States. There is no mention in any clause of the published decision that the consent of co-basin State must be obtained before importing or transferring of any water into Krishna basin from neighboring basins.

Clause XIV (B) of KWDT-1 decision also doesn't direct for obtaining the prior consent. The said clause XIV (B) states that "In event of the augmentation of the waters of the river Krishna by the diversion of the waters of any other river, no State shall be debarred from claiming before any authority or tribunal even before the 31st May, 2000 that it is entitled to a greater share in the waters of the river Krishna on account of such augmentation nor shall any State be debarred from disputing such claim".

What clause XIV (B) states is that – "In the event of augmentation" (transfer or import of water) into Krishna basin, co-basin State is not "debarred from claiming before any authority or tribunal", greater share in Krishna water. Therefore, what co basin State has been granted is only a right to claim greater share in Krishna water on account of such augmentation into Krishna basin. If States of Andhra Pradesh and Telangana were to register such claims before any authority or tribunal, Karnataka reserves its right to oppose their claim. Clause XIV (B) has also clarified that the augmenting State (Karnataka), is not "debarred from disputing such claim". However, Andhra Pradesh or Telangana have no right to stop or restrain Karnataka from augmenting (transferring or importing water) of 1.72 TMC of water from Mahadayi into Krishna basin in Malaprabha river as permitted under the published decision of MWDT dated 27.02.2020.

As far as Maharashtra is concerned, which is the other Krishna Basin State, it was a party before Mahadayi Water Disputes Tribunal and has got its share of water. Hence, it cannot stake further claim.

Even otherwise, the general law is clear that no consent of co-basin State is necessary. If State X is required to take consent of another basin State Y, then it amounts to granting veto power to State Y, which unconstitutional. The aggrieved State raise water dispute, but cannot ask for consent. The Constitution bench of Supreme Court (State of Karnataka VS State of AP and AP VS State of Karnataka: 2000(9) SCC 572 @ 627 and 640) in Almatti matter held no consent is necessary. Andhra Pradesh as plaintiff in OS 2 of 1997 had raised specific issue in this regard as Issue No 4. However, it was answered

against the Plaintiff Andhra Pradesh (Karnataka was plaintiff in OS 1 of 1997 and Andhra Pradesh was plaintiff in OS 2 of 1997).

Hence, it's clarified that, Karnataka is under no obligation to obtain any prior consent from Krishna basin States of Andhra Pradesh, Telangana or Maharashtra. The clearance of the PFR of Kalasa Nala Diversion Scheme is accordingly requested.

In response to the above compliance the ISM – I director at further communicated his comments to the state of Karnataka which is as below.

It is correct that as per MWDT Award, the State of Karnataka has been permitted to divert 1.72 TMC of Mahadayi water at proposed Kalasa Dam and therefore, there is no question on the issue. Karnataka has right to utilize 1.72 TMC of Mahadayi water by diverting it to proposed Kalasa Dam. This Directorate never stated that Govt. of Karnataka has to take prior consent of co-basin states in view of any clause/ provision of MWDT Award. However, since the water is proposed to be diverted to the Malaprabha reservoir in Malaprabha River, a tributary of Krishna River, KWDT-I Award comes into force.

This Directorate never stated that KWDT-I prohibit importing or transfer of water into Krishna Basin as mentioned in the reply/compliances submitted by the Project Authority. The only issue is that since the water of river Krishna is being augmented by diverting waters of Mahadayi river into Malprabha river, a tributary of Krishna River, as per clause-XIV of KWDT Award, prior consent of co-basin states of Krishna Basin has been sought from the Project Authority.

It has been mentioned in the Compliances that Maharashtra is the other Krishna Basin State, it was a party before Mahadayi Water Dispute Tribunal and has got its share of water. Hence, it cannot stake further claim. This statement is not correct. Mahadayi and Krishna are two different River basins and if Maharashtra got its share in Mahadayi then it does not debar Maharashtra to claim its share in Krishna Basin due to increase in water.

It has also been mentioned in the Compliances that the Constitution bench of Supreme Court [State of Karnataka VS State of AP and State of AP VS State of Karnataka 2000(9) SCC 572 @ 627 and 640] in Almatti matter held that no consent is necessary. This is altogether a different issue and not relevant to the present matter.

Here it is made clear that as soon as any water from any River is augmented into Krishna River, it forms a part of the water of Krishna River. In this case, only the competent Authority or Tribunal can decide further allocation of such waters based on the claims of co-basin States, if they raise it. Therefore, at present, if any clearance is given to proposed Kalasa Nala Diversion Scheme without getting the views of co-basin States of Krishna, there is a great chance that co-basin States may move to Hon'ble Court just as happened in the case of Mekedatu Project.

In view of above, it is again reiterated that the Project Authority may be asked to share the Revised PFR of Kalasa Nala Diversion Scheme with co-basin States of Krishna River, obtain their views and submit the same to this Directorate for taking further action in the matter. A decision on acceptance of the PFR of Kalasa Nala Diversion Scheme may be taken after obtaining the views from the co basin states in the time limit.

In reply to the above the state of Karntaka had submitted the following complinaces.

As per the communication by Government of Karnataka to Chairman, Central Water Commission vide letter dated: 18.04.2022 the following is resubmitted

"It is hereby informed that, Clause XIV (B) does not stipulate any State to obtain no objection from the co-basin states of Krishna Basin. However, the Clause provides that, the co-basin states are not debarred from claiming their share out of the augmented water. If any co-basin State claim their share before competent authority, the Karnataka State will deal the issue at that point of time appropriately. However, the State of Andhra Pradesh and Telangana have been kept informed about the projects viz.., Kalasa & Bhanduri Nala projects. Copy of the letter are enclosed.

In view of the above facts, it is requested to accord the clearances to the PFR's of Kalasa Nala & Bhanduri Nala projects at the earliest"

Chapter 4
Survey & Investigation

4.1 Introduction

This chapter details the Survey, Alignment of Head Works consisting of Intake fore bay, Jack Well cum Pump House, Rising Main and Delivery Chamber.

It involves establishment of Ground Control points, Temporary Bench Marks with respect to GTS BM and preparation of maps, Geotechnical Investigations and analysis etc.

4.2 Data Collection

The Topo Sheets in which project area lies have been collected from Survey of India. Details of Topo Sheets are as below.

Table 4.1: Details of Topo Sheets

No.	Topo Sheet No.	Scale
1.	48 I	1:2,50,000
2.	48 I-06 (D43C06) & 48 I-06 (D43C10)	1:50,000

4.3 Index Map of the Scheme

All topo sheets collected are combined to form command area map. Head works consisting Intake canal, location of jack well cum pump house, alignment of Rising Main is prepared on 1:50,000 scale topo maps. The alignments planned have been transferred to ground and detailed surveys carried out.

4.4 Alternative Studies for Alignment of Raising Main

4.5 Identification of Bench Mark

Based on the joint inspection along with the client officials, it was decided to carry out survey from the reference benchmark GTSBM situated on top of the slab near the Railway line at CH-582+020 from Hubli to Belagavi. The GTSBM location lies at 15° 37' 06.05" N, 74° 29' 52.71" E, Easting: 446186.202 m, Northing: 1726783.491 m and EL: 655.740 m is considered for the project. The images of the Reference Benchmark GTSBM and the reference control points established with reference to GTSBM is furnished in Figure 6.2.p




Figure 4.1 Reference GTS Benchmark

4.6 Establishment of Ground Control Points

Based on the GTS bench mark Ground control points are established at every 500 m interval along the proposed pipeline alignment are established using DGPS instrument and is shown below **Table 4.2.**

Table 4.2: Criteria for establishment of Ground Control Points

No.	Description	Standard
1.	Site Selection	• Protected areas like premises of permanent government offices / permanent structures or sheet rocks. • Open and clear to sky – Above 15^{o}angle • Avoid locations which interferes GPS signals
2.	Duration of observation	1 hours
3.	Accuracy	1:10,000
4.	Densification	3.5 km - 4 km apart
5.	Horizontal datum	WGS 84
6.	Instrument to be used	DGPS
7.	Vertical datum	Spirit height/ GTS RL
8.	Permissible error	12 √K. where K is length of levelling line in Km.

The details of DGPS control points established are enclosed to this report.

Table 4.3: Ground Control Points of Bhandura nala Diversion Sceheme.

No.	Point	Easting	Northing	RL	Description
1	GTSBM	446186.202	1726783.491	655.740	GTSBM:- Marked with Engraved on Railway bridge at CH-582+020 . From Hubli to Belgaum
2	GPS1	446312.599	1726949.050	657.621	GPS1 :- Marked With Yellow Paint on Top of Railway bridge . at CH-582+300
3	GPS2	442079.660	1723309.722	658.263	GPS2:- Marked With Yellow Paint on Top of Boulder stone. 15Mt South East of Khanapur to Hemmadaga ASP Road.
4	GPS2A	442123.163	1723336.125	660.119	GPS2A:- Marked With Yellow Paint on Top of Boulder Stone 120Mtrs East of Sheet House Near ASP Road Leading from Khanapur to Hemmadaga
5	GPS3	441079.667	1724461.644	666.044	GPS3:- Marked With Yellow Paint on Top of side wall of Drain 30Mtrs South of Masid in Ashok Nagar Village
6	GPS3A	441078.843	1724520.870	667.088	GPS3A:- Marked With Yellow Paint on Top of Cement concrete road. In Ashok Nagar village.

No.	Point	Easting	Northing	RL	Description
7	GPS3B	440979.159	1724459.000	665.845	GPS3B:- Marked With Yellow Paint on Top of Small Boulder Stone. 150Mtrs South West of Ashok Nagar village.
8	GPS4	439136.870	1724511.181	681.855	GPS4:-Marked With Yellow Paint on Top of stone. Near primeri school Nersa village.
9	GPS4A	439144.749	1724544.457	680.338	GPS4A:- Marked With Yellow Paint on Top of stone. Entrance primeri school Gate in Nerasa village.
10	GPS5	437775.864	1724977.973	654.425	GPS5:- Marked With Yellow Paint on Top of Survey stone.
11	GPS5A	437670.066	1724937.775	648.981	GPS5A:- Marked With Yellow Paint on Top of basement 30 Mt South East of Pump House.
12	GPS-6	436891.529	1725132.830	638.617	GPS6:- Marked With Yellow Paint on Top of Stone .10Mt South East of Cart track.
13	GPS-6A	436894.374	1725093.878	634.469	GPS6A:- Marked With Yellow Paint on Top of Stone .30Mt South East of Cart track.

4.7 Fixing Alignment on Ground and Detailed Survey

The planned alignment is fixed on the ground and all the care has been taken for the following:-

- The alignment shall be straight as for as possible.
- Alignment crosses Roads such as MDR, SH, NH perpendicularly.
- Alignment crosses nalas and vallies perpendicularly.
- Avoid steep gradients which creates high water pressure.
- Numbers of appurtenances (gate valve, check valve, drain, air release valve, pressure break valve) are minimized.
- Minimum cushion ensured at road crossings
- Alignment through rocky strata is avoided as far as possible.

The detailed strip survey along the alignment is carried out by taking center levels at every 20 m interval and cross levels for a width of 30 m (15 m on either side) with levels at every 5 m interval. At crossing locations such as Road crossings, nala crossing, railway crossing's structure locations block levels along with cross sections and L-sections are collected for design of structures.

4.8 Detailed Topographical Survey

The proposed alignment has been physically transferred to the ground and all the care has been taken for most economical alignment. Before the commencement of alignment survey, control points have been established along the proposed alignment at about 500 m distance c/c using total station.

The traverse point established using the total station and the auto level have been ensured that they are common so as to facilitate for having data and elevation at the same point/ location.

The entire surveyed data which has been captured using the total station has been down loaded and a strip map has been generated for the entire corridor in an Auto CAD DX format. Detailed strip plan is prepared and enclosed along with longitudinal section.

The topographic survey plan so prepared has been taken as the base on which the cadastral map of the concerned villages have been super imposed in order to assess the name of the villages through which the alignment has been planned including the survey nos.

Longitudinal section of alignment from take-off point to terminal point is drawn as per the standard scale. The below table shown the list of TBM list of Bhandura nala Diversion Sceheme.

Table 4.4: Bhandura nala Diversion Sceheme TBM list

No	Point	Easting	Northing	RL
1	TBM1	438505.067	1724933.643	682.211
2	TBM1A	438480.485	1725002.770	681.723
3	TBM5	436821.070	1725143.351	631.306
4	TBM5A	436791.456	1725156.057	632.812
5	TBM6	437027.615	1725337.209	640.026
6	TBM6A	437017.375	1725292.689	641.026

No	Point	Easting	Northing	RL
7	TBM7	436843.979	1725527.793	637.294
8	TBM7A	436831.637	1725486.353	635.715
9	TBM8	436736.953	1725575.630	629.966
10	TBM8A	436754.608	1725602.451	630.034
11	TBM9	437092.231	1725736.784	657.213
12	TBM9A	437104.618	1725730.249	657.106

4.9 Geotechnical Investigation

Geo technical investigation is an important aspect in any project. This is required not only to decide about the type of foundation of the structures, but also to ensure the availability and adequacy of materials from borrow areas required for the project. An adequate Geo-tech investigation minimizes the cost and time over run-in projects.

A detailed investigation for site is essential before a design can be finalized. The object of Geo technical and related site investigation is to provide the engineer or architect with as much information as possible about the existing conditions,

The methods of Geo technical investigation enable vertical sections of the strata to be drawn and samples to be tested, on the site or in a laboratory for determining shear strength parameters, bearing capacity of the soil, permeability, water table, type classification, and other geophysical information in the field. This information, together with the normal topographical survey, provides the engineer with complete details of the site and enables him to prepare economical designs for the foundations.

4.10 Trial Pits

Geo technical Investigation shall be carried out by open trial pits or by exploratory borings depending up on the type of structure. In this project, open pits are proposed along the main & distributary pipe line.

- Trial pits are excavated at every 100 m interval along the approved alignment of rising main of size 1.5 m x 1.5 m and depth up to Canal Bed Level/ Pipe Invert level or refusal level (Hard rock) whichever is earlier.

- Two trial pits are taken on either side of the road crossing wherever structures like nala crossing, Road crossings, canal crossings etc.
- The size of the trial pit is 1.5m x 1.5m and depth minimum up to bed level or up to founding level as per the design requirements.

4.11 Bore Holes

Geo technical investigation shall be carried out in accordance with IS 1892 – 1997 Code of Practice Subsurface Investigation for foundation.

- Three Nos of bore holes are taken at Jack well location.
- The minimum diameter of boreholes is 150 mm.
- Disturbed representative samples are to be collected from boreholes at every meter depth to classify the sub soil.

4.12 Classification of soil and core logging

The soil sub strata classification and core logging is done by a senior Geologist for deciding soil classification and the type of foundation required for the structure.

4.13 Site photos showing Survey and Investigation photos

Figure 4.2 Bandura Diversion Dam Location

Figure 4.3 Alignment Survey Photos

Figure 4.4 Alignment Survey Photos

Figure 4.5 Site inspection Photos

Figure 4.6 Site inspection Photos

Figure 4.7 Site inspection Photos

Chapter 5
Hydrology

5.1 Hydrologic inputs to the project planning

5.1.1. Mahadayi River

River Mahadayi (Mandovi) is a West flowing interstate river in Western Ghats. The river takes its origin in Karnataka, flows for about 35 Kms in Karnataka State and enters Goa and joins the Arabian Sea.

The total catchment area of the River Mahadayi is 2032 Sq.Kms, out of which 375 Sq.Kms is in Karnataka, 77 Sq.Kms is in Maharastra and 1580.00 Sq.Kms is in Goa.

However now the Hon'ble Mahadayi Disputes Tribunal has made an independent study to assess the yield of the Bhandura Nala. The comparitive statement of Yeild details at 75% dependibilty and allocation for the proposed scheme are as follows. (vide MWDT award Volume-VII Pg.1441-1443)

Table 5.1: comparitive statement of Yeild details at 75% dependibilty and allocation for the proposed scheme

Sl. No	Name of Project	Yield as per the tribunal	Allocation made by the tribunal
1.	Proposed Bhandura dam site with catchment area of 32.25 sq.km.	**2.77 TMC**	**2.18 TMC**

The annual yield was estimated in the Report prepared in the year 2010 by considering the catchment area of Bhandura Nala is 32.25 Sq.km. The annual yield was computed by using various formulae then available for computing the runoff from rainfall for the basin. The formulae adopted were as follows:

a) Rainfall runoff correlation developed by KPCL for Mahadayi basin.
b) Rainfall runoff correlation developed by NWDA for Mahadayi basin.
c) Rainfall runoff correlation developed by Inglis formulae for ghat section.

In the present report the method used for computing the yield is by applying the proportionate rainfall-catchment area to the gauged yield at Ganjim Gauging Station.

Further in accordance with the stipulation of MWDT Award the State of Karnataka had submitted Pre-feasibility Report for Bhandura Nala Diversion scheme for drinking water supply to CWC, New Delhi on 22.05.2020.

In the Pre-feasibility Report of Bhandura Nala Diversion scheme the yield were worked out based on Ct-Pt method after incorporating the revised catchment area as directed by the Hydrology Directorate of CWC the details of catchment area and yield is as tabulated below.

Table 5.2: Hydrology Directorate of CWC the details of catchment area and yield

Sl No	Project	Catchment Area, Sqkm	Yield @ 75% dependability, TMC
1.	Kalasa	26.60	3.969
2.	Bhandura	34.90	3.699

On examination of Pre-feasibility Reports submitted by the State, as regards the Hydrology of the Projects, the Director, Hydrology (South), Central Water Commission, New Delhi vide letter dated: 16.12.2020 has approved the project yield by adopting Co-efficient of Rainfall-Runoff method (Ct-Pt). The yield series approved by CWC for Kalasa and Bhandura project is as follows:

Table 5.3: The yield series approved by CWC for Kalasa and Bhandura project

Sl No	Project	Catchment Area, Sqkm	Yield @ 75% dependability, TMC
1.	Kalasa	26.60	3.747
2.	Bhandura	34.90	3.699

Duly complying the aforesaid comment / observation, the State of Karnataka based on the CWC approved yield series re-submitted the modified PFR of Bhandura Nala diversion scheme to CWC for approval on 18.08.2021

After scrutiny of the submitted modified PFR of Bhandura Nala Diversion Scheme the Director, Hydrology (south), CWC, New Delhi mentioning that the earlier approved yield series are withdrawn as it had some calculation error, but further the director in context of rectifying the calculation error has reassessed the yield for the projects by discarding the actual available IMD rain gauge stations data by IMD gridded data and accordingly reducing the CWC river gauging data by 30% arbitrarily on the pretext of attaining homogeneity between IMD gridded data and CWC river gauging data. Director, Hydrology has quoated as ***"Checked the water availability computation and of rainfall gauge details with reference to at a particular rain gauge station with its corresponding Thiessen weightage.The Directorate had***

considered IMD gridded rainfall data and calculated their Thiessen weightage for Ganjim catchment."

- The Director, Hydrology (south), CWC, New Delhi re-assessed the yield for the Bhandura Nala Diversion scheme and communicated revised Yeild series vide letter no: U.O.7/Kar 81/2020-Hyd(s)/179 Dated 23/09/2021 as under

Table 5.4: The re-assessed yield series for Kalasa and Bhandura project

Scheme	Catchment Area (Sq Km.)	As approved Earlier by Director, Hydrology (South), on 16/12/2020	Present approval communicated by Director, Hydrology (South), on 23/09/2021	Reduction in TMC
		Yield @ 75% Dependability (TMC)	Yield @ 75% Dependability (TMC)	
Bhandura Nala Diversion	34.90	3.699	2.818	0.881

Duly enclosing the re-assessed water availability series along with the dependable flow computation the Director, Hydrology (South), CWC, New Delhi has informed the State Government that the same may be utilized for the planning purpose of the projects.

In this regards the state of Karnataka vide its communications dated 23/03/2022 and 18/04/2022 has submitted its objections and stand that ***the procedure adopted by CWC by arbitrarily reducing yield of gauge data by 30% is not acceptable to Karnataka. The Government of Karnataka has already forwarded a detailed objection with the findings of the studies conducted with respect to the revised yield of CWC requesting to re-examine and rectify the yield calculations to restore the earlier yield assessment. <u>This may be looked into separately.</u>***

<u>However, the revised yield worked out by CWC is sufficient to take up the projects as per the allocations of MWDT ie.., 2.18 TMC for Bhandura Nala project.</u> Therefore, it was requested to clear the PFR of Bhandura Nala Project without prejudices to the contentions and outcome of studies forwarded in the letter dated: 23.03.2022 and also the contentions made in the Special Leave Petitions and Reference Petitions field before Hon'ble Supreme Court and Mahadayi Tribunal respectively.

As submitted in the above para the yield series approved by CWC vide letter no U.O.7/Kar 81/2020-Hyd(s)/179 Dated 23/09/2021 for catchment area of 34.90 sq.km has been adopted.

5.2 Runoff

Flow in Bhandura stream has been gauged by float method. Some estimates of annual yield have been made using empirical or regression formulae. However, since the main river Mahadayi is being gauged by CWC at Ganjim since 1979, a better approach is to derive the flows in the concerned catchment from the Ganjim flows in proportion with respect to catchment area and rainfall. The catchment area of Mahadayi at the Ganjim gauging station is 880 Sq km.

5.3 Rainfall

The Hydrology South Directorate (vide letter no U.O.7/Kar 81/2020-Hyd(s)/179 Dated 23/09/2021 the extract of the report is as below

"…. has also considered IMD gridded rainfall data and calculated their Thiesson weightage for Ganjim catchment as given in Table 5.5

Table 5.5: IMD Grid coordinates and weights

S.No.	IMD Grid Coordinates		Thiessen Weightage
	Latitude (Degrees)	Longitude (Degrees)	
1	15.50 N	74.00 E	0.0925
2	15.50 N	74.25 E	0.6446
3	15.50 N	74.50 E	0.0612
4	15.75 N	74.00 E	0.0029
5	15.75 N	74.25 E	0.1986

From the gridded rainfall data, the average catchment representative rainfall (June-November) at from the gridded rainfall data, the average catchment representative rainfall (June-November) at Ganjim G&D site is of the order of 3650 mm. For Bhandura site, the average catchment representative rainfall (June-November) is about 3860 mm from IMD Gridded rainfall of 15.5 N. 74.25 E. Further, the observed average yield (June-November) at Ganjim G&D site is about 3420 MCM or 3886.6 mm. So, this gives a runoff coefficient of 1.06, which is more than 1. For the catchment representative rainfall scenario, the runoff coefficient at Ganjim G&D site should be of the order of 0.75. Therefore, the observed flow at Ganjim G&D site (June-November) need to be reduced by 30 % to make it consistent for a runoff coefficient of the order of 0.75.

Also, as per Volume-11 of Hon'ble MWDT Award, environmental flow requirement at proposed Bhandura dam site is 0.59 TMC. This directorate has also carried out water availability computation for catchment area of 34.9 sq.km. The estimated average yield (June-November) for Bhandura Nala Diversion Scheme (for catchment area of 34.9 sq.km) is 3.424 TMC (96.96 MCM). The 75% and 90%dependable yields are 2.818 TMC (79.79 MCM) and 2.49 TMC (70.54 MCM) respectively. The water availability series along with the dependable flow computation is enclosed in Annex-I of this letter. The same may be utilized for the planning purpose of the project".

5.4 Design Flood Studies

Frequency Analysis by Gumbel Method

As a simple method, frequencies (or probabilities), P(X ≥ x), of the observed flood peaks could be calculated. The Gumbel method of frequency analysis is based on extreme value distribution and uses frequency factors developed for theoretical distribution.

Ganjim gauged site observed flood peaks values are utilised to determine the 100 year return period flood was estimated for Ganjim Catchment by flood frequency approach. Similarly, for Bhandura catchment 100 year return period flood was estimated by using flood frequency approach is 542.93 cumecs.

5.5 Diversion Flood

The computation of diversion flood will be submitted to CWC during DPR stage of the project after finalization of construction schedule.

5.6 Reservoir Sedimentation Studies

The catchment area of Bhandura Nala Diversion dam is 34.90 sq.km only and the reservoir is very small with a gross storage capacity of 14.25 Mcft. Hence, for such a small reservoir effective sediment management practice will be adopted.

5.7 Working Tables

The daily working tables for Bhandura Nala reservoirs are prepared consdiring 10-hr of retension period, hence minimising the forest submergence and providing buffer for optimam pumping discharge. Gross storage capacity of Bhandura Nala dam is 14.25 Mcft. The daily working tables are prepared from June to November for the years 1979-80 to 2018 using the Daily flows shown in Table 5.11. The diversion from the dam is set equal to the sum but subject to a maximum of 2.18 TMC per monsoon season. Balance water flows over the overflow section of the dam as surplus. The closing storage is then computed by subtracting

the diversion, evaporation, and surplus from the sum of the opening storage and inflow. It will be the opening storage for the next period. The Daily working table Annual abstracts are shown in Table 5.11 It is seen from these Tables that the 75% dependable inflow at ***Bhandura Nala is 2.818 TMC out of which it is possible to divert 2.18 TMC.***

5.8 Conclusions

1. The yield series approved by CWC vide letter no U.O.7/Kar 81/2020-Hyd(s)/179 Dated 23/09/2021 for Bhandura catchment area of 34.90 sq.km has been adopted. However, the revised yield worked out by CWC is sufficient to take up the projects as per the allocations of MWDT ie.., 2.18 TMC for Bhandura Nala project. Therefore, it was requested to clear the PFR of Bhandura Nala Project without prejudices to the contentions and outcome of studies forwarded in the letter dated: 23.03.2022 and also the contentions made in the Special Leave Petitions and Reference Petitions field before Hon'ble Supreme Court and Mahadayi Tribunal respectively.
2. Working tables for the Bhandura Nala Diversion dam with lift scheme is developed on Dailly basis using the flows derived as stated above.
3. The quantity of water that can be diverted annually during monsoon season from the proposed Bhandura Nala Diversion scheme will be 2.18 TMC at 75% Dependability.

Table 5.6: Monthly Virgin Flows in Mahadayi River at Ganjim G&D Site (Jun-Nov)

OBSERVED MONSOON FLOW AT GANJIM STATION IN MCUM							
Year	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Total (Jun-Nov)**
1979-80	139.15	881.67	1343.97	256.36	144.31	66.35	2831.81
1980-81	581.99	1744.97	1583.5	309.29	112.62	40.46	4372.83
1981-82	343.82	1441.29	1504.67	375.92	138.34	49.7	3853.74
1982-83	261.55	1713.25	1846.13	215.85	92.82	45.74	4175.34
1983-84	526.61	1164.94	1367.04	538.32	177.03	66.42	3840.36
1984-85	384.92	1713.77	779.69	330.03	216.91	56.95	3482.27
1985-86	464.7	867.48	1168.38	200.73	271.18	59.26	3031.73
1986-87	353.02	796.15	1073.33	142.4	87.06	65.98	2517.94
1987-88	156.74	779.31	721.14	245.39	217.94	68.58	2189.1
1988-89	106.31	1751.95	1294.41	671.29	202.05	55.27	4081.28
1989-90	432.64	1068.06	744.13	266.23	163.22	50.93	2725.21
1990-91	390.9	1582.48	1261.93	569.64	95.54	66.4	3966.89
1991-92	259.66	1567.19	1090.83	199.91	102.22	44.85	3264.66
1992-93	171.74	1203.34	1280.19	426.19	135.88	52.8	3270.14
1993-94	141.18	1397.68	1069.62	295.53	247.1	81.70	3232.81
1994-95	438.23	2058.9	1246.48	644.42	159.48	102.44	4649.95
1995-96	53.98	1259.26	739.59	542.25	208.78	64.80	2868.66
1996-97	238.66	1022.31	612.99	195.12	353.28	65.68	2488.04
1997-98	346.28	1270.3	1684.97	217.03	82.99	27.68	3629.25
1998-99	160.5	854.24	838.11	500.51	348.02	113.12	2814.5
1999-00	499.49	2200.35	592.55	332.14	213.35	45.64	3883.52
2000-01	503.03	1238.11	884.1	331.89	139.29	50.45	3146.87
2001-02	154.77	961.81	934.91	181.56	129	38.16	2400.21
2002-03	207.09	573.45	1143.24	248.32	118.99	32.85	2323.94
2003-04	276.1	1055.28	766.27	297.35	118.86	34.26	2548.12
2004-05	323.73	648.89	1338.93	201.86	95.04	29.81	2638.26
2005-06	224.09	1408.46	1073.13	834.32	161.44	60.01	3761.45
2006-07	329.01	1639.46	1505.29	558.78	317.24	0.00	4349.78
2007-08	455.04	1306.08	1456.55	926.86	335.13	196.37	4676.03
2008-09	415.77	794.62	1749.44	697.58	195.83	76.87	3930.11
2009-10	37.49	1583.25	523.09	501.86	335.8	2.56	2984.05
2010-11	14.69	1280.38	1147.17	789.1	333.8	203.63	3768.77
20011-12	740.53	1557.59	1475.15	1143.81	219.04	70.42	5206.54
2012-13	120.32	1040.4	1359.98	746.51	200.51	0.00	3467.72
2013-14	385.25	2245.54	1205.87	402.23	330.26	71.02	4640.17
2014-15	206.31	1348.06	1305.34	741.89	150	43.63	3795.23
2015-16	485.84	762.5	761.11	350.84	194.98	36.69	2591.96
2016-17	121.52	1057.84	1081.92	445.1	142.27	28.25	2876.9
2017-18	444.52	1354.81	568.42	509.9	235.19	0.00	3112.84
						Avg	3420.23
						Avg yield	**3886.63**

Table 5.7: IMD Gridded Rainfall For Bhandura Nala Diversion

Catchment Details				Bhandura Nala Diversion Scheme			
Catchment Area in Sq.Km				34.90			
Bhandura rainfall (mm)						IMD Grid 15.5, 74.25	
Year	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	sum
1979-80	537.19	726.13	1326.03	355.37	77.15	160.52	3182.39
1980-81	1032.08	1329.97	1097.22	194.05	11.95	54.63	3719.90
1981-82	758.97	1589.91	1606.07	432.68	70.45	26.16	4484.24
1982-83	559.27	1701.40	1615.31	165.52	56.50	10.05	4108.04
1983-84	1008.60	1234.70	1016.81	455.36	104.28	7.69	3827.45
1984-85	849.52	1516.82	740.48	225.60	144.89	0.00	3477.30
1985-86	806.71	832.06	888.73	138.18	269.87	0.00	2935.55
1986-87	1042.27	1003.22	1118.38	85.44	22.32	5.80	3277.41
1987-88	593.29	1089.98	772.50	234.05	177.53	29.94	2897.29
1988-89	661.60	2096.68	1086.96	643.43	70.76	0.00	4559.42
1989-90	1211.14	1316.66	816.64	225.20	31.78	15.40	3616.82
1990-91	1093.61	1775.20	1407.75	446.16	192.43	33.43	4948.58
1991-92	978.65	1986.69	1216.49	81.40	45.26	6.47	4314.96
1992-93	699.25	1452.16	1444.63	404.97	165.04	19.47	4185.52
1993-94	770.68	1822.04	1146.65	301.42	127.10	34.97	4202.87
1994-95	1442.05	2524.72	1440.15	591.65	202.11	0.00	6200.67
1995-96	344.44	1504.92	775.05	466.95	224.59	12.55	3328.50
1996-97	783.77	1439.38	705.44	331.58	414.73	0.00	3674.89
1997-98	1166.96	1686.71	2019.92	169.07	54.06	22.34	5119.07
1998-99	728.08	1163.62	716.26	333.90	187.54	46.48	3175.87
1999-00	937.44	2314.76	678.44	340.24	188.32	0.44	4459.64
2000-01	722.67	1513.90	965.29	329.81	100.23	1.34	3633.24
2001-02	717.13	1251.33	1112.94	156.11	48.83	8.00	3294.34
2002-03	820.39	815.67	1228.92	181.24	136.61	0.00	3182.83
2003-04	1303.08	1388.04	938.92	420.19	122.12	4.64	4176.98
2004-05	1129.64	1476.00	1961.43	187.68	59.30	8.55	4822.60
2005-06	950.29	1508.89	628.13	729.16	212.82	0.51	4029.80
2006-07	831.40	2212.71	1610.56	399.58	188.69	10.53	5253.48
2007-08	824.46	1600.52	1652.18	849.78	30.05	12.06	4969.06
2008-09	908.87	978.96	1542.57	538.30	32.53	28.89	4030.13
2009-10	428.64	2176.19	702.72	598.25	210.63	49.43	4165.86
2010-11	478.46	1009.20	653.30	602.02	177.06	148.78	3068.81
20011-12	1405.48	1363.71	1060.26	659.33	179.30	36.06	4704.13
2012-13	942.03	1160.37	1022.32	397.85	142.25	24.91	3689.73
2013-14	967.25	2182.47	604.56	192.40	104.63	3.67	4054.98
2014-15	332.57	1573.19	1141.36	527.29	221.37	37.17	3832.95
2015-16	626.99	374.19	374.46	94.87	153.71	24.26	1648.49
2016-17	420.86	726.83	618.12	200.44	48.11	12.87	2027.23
2017-18	617.52	842.59	303.77	288.00	139.26	3.10	2194.24

Table 5.8: IMD Gridded Weighted Rainfall For Ganjim Catchment Area

Ganjim rainfall (mm)							
Year	**JUNE**	**JULY**	**AUGUST**	**SEPTEMBER**	**OCTOBER**	**NOVEMBER**	**sum**
1979-80	572.23	747.78	1216.78	332.05	84.26	163.20	3116.29
1980-81	989.90	1287.15	1074.83	203.32	31.90	59.57	3646.67
1981-82	756.43	1569.39	1525.93	442.53	73.59	28.89	4396.76
1982-83	598.36	1668.84	1685.73	168.70	62.88	17.07	4201.58
1983-84	1031.81	1230.61	1088.11	461.33	104.36	8.55	3924.77
1984-85	865.55	1525.34	754.45	242.56	171.70	0.04	3559.63
1985-86	875.91	853.79	913.27	146.57	272.04	0.72	3062.30
1986-87	1020.06	947.35	1063.66	103.10	31.40	26.56	3192.14
1987-88	554.43	1041.36	683.87	225.17	186.18	27.41	2718.41
1988-89	617.15	1953.18	1073.14	648.69	71.78	0.00	4363.95
1989-90	1193.47	1318.19	815.52	255.07	39.79	16.24	3638.27
1990-91	994.92	1580.53	1293.27	405.00	187.86	36.96	4498.54
1991-92	896.05	1781.34	1112.04	113.95	62.69	5.71	3971.78
1992-93	717.45	1318.40	1319.80	368.20	161.20	30.57	3915.62
1993-94	753.56	1685.76	1057.44	298.05	158.80	37.37	3990.99
1994-95	1345.85	2367.11	1330.18	531.13	200.99	0.04	5775.31
1995-96	335.16	1413.62	707.89	414.71	198.72	12.41	3082.51
1996-97	755.25	1319.26	658.23	304.98	369.29	1.55	3408.56
1997-98	1060.39	1628.89	1890.29	139.88	57.55	41.92	4818.91
1998-99	711.12	1142.30	711.03	301.98	196.12	53.55	3116.10
1999-00	902.70	2089.71	588.82	295.06	221.38	2.62	4100.29
2000-01	747.73	1217.31	884.84	294.19	93.88	2.48	3240.43
2001-02	671.86	1137.27	973.89	149.71	62.64	12.72	3008.09
2002-03	788.11	734.52	1110.59	162.56	160.33	0.00	2956.12
2003-04	1222.33	1296.31	908.77	357.64	117.33	5.32	3907.69
2004-05	1040.87	1260.04	1706.13	182.32	53.33	7.30	4250.00
2005-06	826.49	1513.89	627.28	735.39	209.77	0.47	3913.28
2006-07	820.26	1987.30	1441.01	373.92	165.40	16.32	4804.21
2007-08	774.16	1336.77	1451.40	725.31	64.70	19.26	4371.60
2008-09	901.35	851.58	1389.45	517.89	31.77	22.74	3714.78
2009-10	394.98	1998.04	591.78	518.83	207.34	67.55	3778.52
2010-11	466.32	958.45	619.07	525.00	185.29	139.35	2893.49
20011-12	1231.75	1194.48	950.59	601.85	181.26	28.81	4188.74
2012-13	845.56	1047.28	915.67	366.02	129.01	23.42	3326.95
2013-14	842.04	1822.99	557.73	217.68	107.91	4.59	3552.94
2014-15	297.02	1390.11	947.52	435.32	210.69	37.33	3317.97
2015-16	593.97	374.11	347.39	94.83	156.61	22.86	1589.76
2016-17	408.61	730.29	606.50	202.93	50.76	12.77	2011.86
2017-18	583.64	817.75	295.40	292.68	137.08	2.83	2129.36

Table 5.9: Catchment Water Availability For Bhandura Nala Diversion

Catchment area of Bhandura Nala Diversion Scheme is 34.90 sq.km									
Water Availabilty series for Bhandura Nala Divesion Scheme								MCM	
Pt	Ct	Year	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	Sum
1.021	0.040	1979-80	3.945	24.995	38.102	7.268	4.091	1.881	80.282
1.020	0.040	1980-81	16.500	49.470	44.892	8.768	3.193	1.147	123.970
1.020	0.040	1981-82	9.747	40.861	42.658	10.657	3.922	1.409	109.254
0.978	0.040	1982-83	7.415	48.571	52.338	6.119	2.631	1.297	118.372
0.975	0.040	1983-84	14.929	33.026	38.756	15.261	5.019	1.883	108.875
0.977	0.040	1984-85	10.913	48.586	22.104	9.356	6.149	1.615	98.723
0.959	0.040	1985-86	13.174	24.593	33.124	5.691	7.688	1.680	85.950
1.027	0.040	1986-87	10.008	22.571	30.429	4.037	2.468	1.871	71.384
1.066	0.040	1987-88	4.444	22.094	20.444	6.957	6.179	1.944	62.061
1.045	0.040	1988-89	3.014	49.668	36.697	19.031	5.728	1.567	115.705
0.994	0.040	1989-90	12.265	30.280	21.096	7.548	4.627	1.444	77.260
1.100	0.040	1990-91	11.082	44.864	35.776	16.149	2.709	1.882	112.462
1.086	0.040	1991-92	7.361	44.430	30.925	5.667	2.898	1.272	92.554
1.069	0.040	1992-93	4.869	34.115	36.294	12.083	3.852	1.497	92.709
1.053	0.040	1993-94	4.002	39.624	30.324	8.378	7.005	2.316	91.651
1.074	0.040	1994-95	12.424	58.370	35.338	18.269	4.521	2.904	131.827
1.080	0.040	1995-96	1.530	35.700	20.968	15.373	5.919	1.837	81.327
1.078	0.040	1996-97	6.766	28.983	17.378	5.532	10.016	1.862	70.536
1.062	0.040	1997-98	9.817	36.013	47.769	6.153	2.353	0.785	102.890
1.019	0.040	1998-99	4.550	24.218	23.761	14.190	9.866	3.207	79.792
1.088	0.040	1999-00	14.161	62.380	16.799	9.416	6.049	1.294	110.098
1.121	0.040	2000-01	14.261	35.101	25.064	9.409	3.949	1.430	89.214
1.095	0.040	2001-02	4.388	27.267	26.505	5.147	3.657	1.082	68.046
1.077	0.040	2002-03	5.871	16.257	32.411	7.040	3.373	0.931	65.884
1.069	0.040	2003-04	7.827	29.917	21.724	8.430	3.370	0.971	72.240
1.135	0.040	2004-05	9.178	18.396	37.959	5.723	2.694	0.845	74.795
1.030	0.040	2005-06	6.353	39.930	30.423	23.653	4.577	1.701	106.638
1.094	0.040	2006-07	9.327	46.479	42.675	15.842	8.994	0.000	123.317
1.137	0.040	2007-08	12.900	37.028	41.293	26.277	9.501	5.567	132.566
1.085	0.040	2008-09	11.787	22.528	49.597	19.777	5.552	2.179	111.419
1.103	0.040	2009-10	1.063	44.885	14.830	14.228	9.520	0.073	84.598
1.061	0.040	2010-11	0.416	36.299	32.522	22.371	9.463	5.773	106.845
1.123	0.040	20011-12	20.994	44.158	41.821	32.427	6.210	1.996	147.606
1.109	0.040	2012-13	3.411	29.496	38.556	21.164	5.684	0.000	98.310
1.141	0.040	2013-14	10.922	63.661	34.187	11.403	9.363	2.013	131.550
1.155	0.040	2014-15	5.849	38.218	37.007	21.033	4.253	1.237	107.595
1.037	0.040	2015-16	13.774	21.617	21.578	9.946	5.528	1.040	73.483
1.008	0.040	2016-17	3.445	29.990	30.673	12.619	4.033	0.801	81.561
1.030	0.040	2017-18	12.602	38.409	16.115	14.456	6.668	0.000	88.250

Table 5.10: Combined Catchment Water Availability For Bhandura Nala Diversion

Water Availabilty series for Bhandura Nala Divesion Scheme								TMC		
Year	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	Total	Total-des-order	Rank	%Dep
1979-80	0.139	0.883	1.346	0.257	0.144	0.066	2.835	5.213	1.000	2.500
1980-81	0.583	1.747	1.585	0.310	0.113	0.041	4.378	4.682	2.000	5.000
1981-82	0.344	1.443	1.506	0.376	0.139	0.050	3.858	4.655	3.000	7.500
1982-83	0.262	1.715	1.848	0.216	0.093	0.046	4.180	4.646	4.000	10.000
1983-84	0.527	1.166	1.369	0.539	0.177	0.066	3.845	4.378	5.000	12.500
1984-85	0.385	1.716	0.781	0.330	0.217	0.057	3.486	4.355	6.000	15.000
1985-86	0.465	0.869	1.170	0.201	0.271	0.059	3.035	4.180	7.000	17.500
1986-87	0.353	0.797	1.075	0.143	0.087	0.066	2.521	4.086	8.000	20.000
1987-88	0.157	0.780	0.722	0.246	0.218	0.069	2.192	3.972	9.000	22.500
1988-89	0.106	1.754	1.296	0.672	0.202	0.055	4.086	3.935	10.000	25.000
1989-90	0.433	1.069	0.745	0.267	0.163	0.051	2.728	3.888	11.000	27.500
1990-91	0.391	1.584	1.263	0.570	0.096	0.066	3.972	3.858	12.000	30.000
1991-92	0.260	1.569	1.092	0.200	0.102	0.045	3.269	3.845	13.000	32.500
1992-93	0.172	1.205	1.282	0.427	0.136	0.053	3.274	3.800	14.000	35.000
1993-94	0.141	1.399	1.071	0.296	0.247	0.082	3.237	3.773	15.000	37.500
1994-95	0.439	2.061	1.248	0.645	0.160	0.103	4.655	3.766	16.000	40.000
1995-96	0.054	1.261	0.740	0.543	0.209	0.065	2.872	3.634	17.000	42.500
1996-97	0.239	1.024	0.614	0.195	0.354	0.066	2.491	3.486	18.000	45.000
1997-98	0.347	1.272	1.687	0.217	0.083	0.028	3.634	3.472	19.000	47.500
1998-99	0.161	0.855	0.839	0.501	0.348	0.113	2.818	3.274	20.000	50.000
1999-00	0.500	2.203	0.593	0.333	0.214	0.046	3.888	3.269	21.000	52.500
2000-01	0.504	1.240	0.885	0.332	0.139	0.051	3.151	3.237	22.000	55.000
2001-02	0.155	0.963	0.936	0.182	0.129	0.038	2.403	3.151	23.000	57.500
2002-03	0.207	0.574	1.145	0.249	0.119	0.033	2.327	3.117	24.000	60.000
2003-04	0.276	1.057	0.767	0.298	0.119	0.034	2.551	3.035	25.000	62.500
2004-05	0.324	0.650	1.341	0.202	0.095	0.030	2.641	2.988	26.000	65.000
2005-06	0.224	1.410	1.074	0.835	0.162	0.060	3.766	2.880	27.000	67.500
2006-07	0.329	1.641	1.507	0.559	0.318	0.000	4.355	2.872	28.000	70.000
2007-08	0.456	1.308	1.458	0.928	0.336	0.197	4.682	2.835	29.000	72.500
2008-09	0.416	0.796	1.752	0.698	0.196	0.077	3.935	2.818	30.000	75.000
2009-10	0.038	1.585	0.524	0.502	0.336	0.003	2.988	2.728	31.000	77.500
2010-11	0.015	1.282	1.149	0.790	0.334	0.204	3.773	2.641	32.000	80.000
20011-12	0.741	1.559	1.477	1.145	0.219	0.071	5.213	2.595	33.000	82.500
2012-13	0.120	1.042	1.362	0.747	0.201	0.000	3.472	2.551	34.000	85.000
2013-14	0.386	2.248	1.207	0.403	0.331	0.071	4.646	2.521	35.000	87.500
2014-15	0.207	1.350	1.307	0.743	0.150	0.044	3.800	2.491	36.000	90.000
2015-16	0.486	0.763	0.762	0.351	0.195	0.037	2.595	2.403	37.000	92.500
2016-17	0.122	1.059	1.083	0.446	0.142	0.028	2.880	2.327	38.000	95.000
2017-18	0.445	1.356	0.569	0.511	0.235	0.000	3.117	2.192	39.000	97.500
						Avg	3.424	TMC		

Table 5.11: Water availability for Bhandura Nala and correspong Diversion Details (Unit: in Mcft)

Available Yield in Mcft									Available Diversion in Mcft						
Year	Jun	Jul	Aug	Sep	Oct	Nov	Monsoon Available		Jun	Jul	Aug	Sep	Oct	Nov	Monsoon Available
1979	139	883	1345	257	144	66	2835		153	678	660	256	144	66	**1958**
1980	586	1747	1585	310	113	40	4380		381	838	919	58	0	0	**2196**
1981	344	1443	1506	376	138	50	3857		306	863	820	207	0	0	**2196**
1982	262	1715	1848	216	93	46	4179		259	605	902	216	93	46	**2121**
1983	432	1166	1368	539	177	66	3749		191	826	796	373	0	0	**2186**
1984	385	1715	780	330	217	57	3486		342	843	751	251	0	0	**2187**
1985	506	910	1170	201	271	59	3117		371	787	702	201	138	0	**2199**
1986	353	797	1058	143	87	66	2504		307	626	587	143	87	66	**1815**
1987	157	819	722	246	218	69	2230		169	667	664	246	218	69	**2033**
1988	106	1822	1296	672	202	55	4154		118	736	778	500	54	0	**2186**
1989	433	1069	745	266	163	51	2728		412	640	737	266	126	0	**2181**
1990	391	1584	1263	570	96	66	3971		338	884	841	119	0	0	**2181**
1991	260	1569	1092	200	102	45	3268		252	768	875	200	87	0	**2182**
1992	172	1205	1281	427	136	53	3273		170	605	815	408	136	46	**2181**
1993	141	1399	1071	296	247	82	3236		155	758	713	296	247	12	**2181**
1994	439	2061	1248	645	160	103	4654		333	919	823	119	0	0	**2194**
1995	54	1260	740	543	209	65	2871		68	733	560	407	205	65	**2039**
1996	239	1023	614	195	354	66	2490		252	606	625	195	298	66	**2042**
1997	347	1272	1687	217	83	28	3633		195	766	894	217	83	25	**2180**
1998	161	855	839	501	348	113	2817		142	701	748	509	81	0	**2181**
1999	580	2158	593	332	214	46	3923		445	749	574	332	91	0	**2191**
2000	504	1239	885	332	139	50	3150		393	721	599	313	139	16	**2181**
2001	155	963	936	182	129	38	2403		168	754	795	182	129	38	**2067**
2002	208	574	1115	249	119	33	2297		219	561	742	249	119	33	**1923**
2003	276	1053	767	298	119	34	2548		276	862	714	298	34	0	**2184**
2004	324	649	1338	202	95	30	2638		329	604	787	202	95	30	**2047**
2005	224	1410	1075	835	167	63	3773		172	679	741	589	0	0	**2181**
2006	330	1641	1507	559	318	0	4355		256	909	823	197	0	0	**2184**
2007	455	1307	1458	928	335	197	4681		220	839	809	321	0	0	**2189**
2008	416	808	1751	698	196	77	3947		368	650	714	463	0	0	**2196**
2009	38	1585	524	502	336	3	2987		43	889	530	470	251	0	**2183**
2010	15	1282	1148	790	334	204	3772		20	655	796	680	30	0	**2182**
2011	741	1559	1477	1145	219	70	5212		579	915	712	0	0	0	**2206**
2012	120	1041	1361	747	201	0	3471		125	804	807	457	0	0	**2193**
2013	386	2248	1207	403	331	71	4645		372	919	815	75	0	0	**2181**
2014	207	1349	1307	743	150	44	3799		218	618	762	590	0	0	**2187**
2015	486	763	761	351	195	96	2654		488	684	674	338	0	0	**2185**
2016	122	1059	1083	446	142	28	2880		129	919	919	222	0	0	**2189**
2017	445	1356	569	510	235	0	3116		342	826	565	456	0	0	**2189**
50%	**324**	**1272**	**1148**	**376**	**177**	**55**	**3273**		252	754	751	256	54	0	2182
75%	**157**	**970**	**787**	**250**	**130**	**38**	**2819**		**169**	**656**	**678**	**200**	**0**	**0**	**2180**

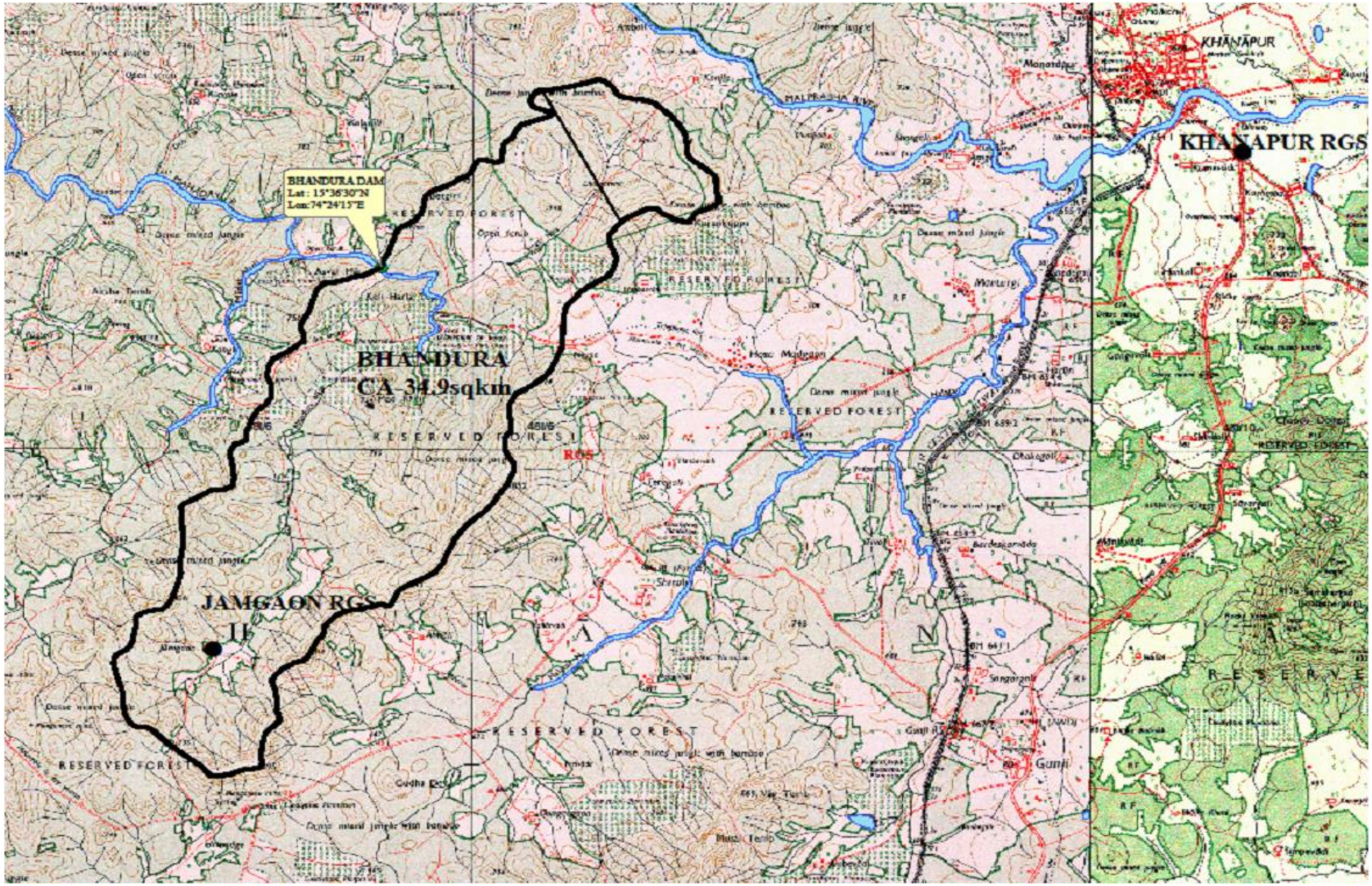

Figure 5.1: Bhandura Catchment (Blue-filled): Jamagaon Rain Gauge Station is in the Southwest Part

Chapter 6
Irrigation Planning

The present scheme is an exclusive drinking water supply project and as such, no irrigation aspect has been envisaged and irrigation Planning is not a part of the scheme

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Chapter 7
Planning & Other Intended Benefits

7.1 Drinking Water Requirements

The present population of Hubli – Dharwad is about 10 Lakhs covering an area of 202.28 Sq Km.The population forecast for Hubli – Dharwad is based on Geometrical Increase Method on the basis of the following factors.

- This twin city is fast growing and has vast scope for expansion
- It is a major hub as far as industrial, commercial and education is concerned
- It is ideally located at almost midway between Pune and Bangalore and is well connected by Road and Rail
- An Airport is located in Hubli
- Availability of vast stretches of land
- Availability of technical, skilled and unskilled man power

Details of Population forecast:

- Present population of Hubli – Dharwad is 10 lakhs
- Projected population in the year 2051 is 33.41 lakhs
- Projected floating population for the year 2051 is 2.97 lakhs
- Projected population of Kundgol town for the year 2051 is 0.36 lakhs
- Projected population of enroute villages for the year 2051 is 1.94 lakhs
- Provision is also made for drinking water needs of live stock in the area.

7.2 Natural Resources

Since this project is exclusively for drinking water, the details of Master Plan for overall development of water Resources do not arise. (However Master plan for utilization of Mahadayi water is prepared considering the thrust area of drinking water and in basin developments.)

7.3 Land use and Socio Economic aspects

The main purpose of taking up this project is to supply drinking water to the Hubli – Dharwad twin cities, Kundgol town including en route villages which are facing acute shortage of the potable water.

7.4 History

The Hubli – Dharwad twin cities were earlier depending on open wells as is the case with other areas. The piped water supply scheme was first implemented in the year 1912.

7.4.1 Dependency on existing water schemes

There are two important schemes which supplied water to the twin cities

- Water supply from Unkal and Kelageri schemes
- Neersagar reservoir

Out of the two, water supply from Unkal and Kelageri is stopped long ago due to it being unable to meet the growing demand.

Neersagar reservoir is the one which is supplying water to the twin cities. However, due to vagaries of monsoon, the reservoir is unable to supply water even once in 8 to 10 days over last few years. Thus, Neersagar reservoir cannot be considered as a dependable source of supply.

Hence, it has become all the more important that a dependable source need to be identified and actions initiated to mitigate the drinking wter supply problem being faced by the twin cities of Hubli – Dharwad.

The twin cities of Hubli – Dharwad are facing lot of hardships due to shortage of supply of drinking water. These towns located strategically and with their easy accessibility have become industrial, educational and commercial hub.

They have witnessed tremendous growth in the recent past with population growing at a very fast rate. It has thus become imperative to have a dependable source for supply of drinking water to the area. As a part of the project, it is necessary to consider the drinking water needs of the Towns and villages en route also.

With this in view, several attempts have been made to study alternate sources

At present, water supply is from Neersagar reservoir which was constructed during the year 1955. However, does not have the capacity to supply water to meet the required demand. Furthermore, there are instances when reservoir got dried up or was left with meager quantity of water which had resulted in

supply to the Hubli – Dharwad once in 8 – 10 days. This has made the present source to be considered not dependable.

Thus, getting the water from Malaprabha source was seen as feasible considering all the factors indicated above.The Malaprabha source is proposed to be augmented by diversion.

For the present project, Power requirement, Eletricity charges including O & M costs are not to be considered.

As a result, the present proposal has been prepared by identifying the source, construction of dams of suitable capacity, conveying / diverting the required quantum of water to Malaprabha River and further supplying it to Hubli _ Dharwad towns as well as village en route.

7.5 Water requirement

7.5.1 Identification of beneficiary

The present project aims at providing drinking water supply to Hubli – Dharwad and Kundgol town along with Enroute villages.

The twin cities of Hubli-Dharwad boasts of a High Court Bench, three Universities, two medical colleges, eight engineering colleges, an IIT, a very busy Airport and is known to be an educational hub. Under the "Smart City" Challenge of the Government of India, the Hubli-Dharwad twin cities are selected and it has been proposed to be covered under the smart city scheme and works are being undertaken by the Hubli-Dharwad Smart City Limited.

For details refer **Annexure-4**

7.5.2 Process of arriving at the total quantum of water

In order to arrive at the total quantum of water required for drinking water purpose, a scientific method has been adopted involving the following

1 Design period for storage by Dams as per CPHEEO Manual
2 Present population as per 2011 census.
3 Projecting the population upto 2051.
4 Adopting the requirement of water for towns, rural areas and livestock as per the CPHEEO manual.
5 Calculation of quantum of water as per the above.

As per CPHEEO Manual Clause 2.2.8.1 Table 2.1, a Per capita supply rate of 135 LPCD has been considered for Hubli – Dharwad and Kundgol towns. For en route villages, a Per capita rate of 70 LPCD is

considered along with 35 LPCD for livestock for cattles / buffaloes and 25 LPCD for sheep / poultry and Goat.

The water demand for the project is detailed hereunder.

The total water demnd for Hubli – Dharwad twin cities, Kundgol Town, en route villages etc works out to 7.56 Tmc and 8.69 TMC respectively for the yers 2044 and 2051. Abstarct of water demnd is tabled below.

7.5.3 Projected water requirement

Table 7.1: Abstarct of water demand is table

No	Description	Water demand as on 2051 (TMC)
1	Domestic water demand of Hubli – Dharwad twin city	7.70
2	Domestic water demand of en route villages	0.22
3	Domestic water demand of Kundgol town	0.08
4	Domestic water demand of live stock	0.69
	Total demand in the year 2051	**8.69**

7.5.4 Allocation of water

Drinking water requirement

Drinking water requirement has been arrived at as 8.69 TMC considering the projected population up to 2051.

However, the projected Water Demand up to 2044 will be 7.56 TMC which has been considered as the basis for taking up the present project, but diversion of 3.90 TMC as per Hon'ble Mahadayi Water Disputes Tribunal award shall be adheared.

Chapter 8
Environment, Ecology and Forest Aspects of the project

8.1 Bhandura Nala Project

The total forest area required is 16.27 Ha out of which forest area going to be submerged is 13.26 Ha. Area required for conveyance system and other allied works is 3.01 Ha. Land has been identified in Belgaum District for Afforestation.

Environmental Clearance: The Karnataka State Pollution Control Board has cleared the Project from Water and Air Pollution Act vide letter No.CFB/DEO/AEO-3/2000-01/108 Dtd: 29-06-2000. A Proposal for Diversion of Forest Land has been submitted to MOEF, Delhi for clearance. Now as per thr directions of tribunal submission of fresh proposals for obtaining clearences are under process.

8.2 Environmental Sensitivity

Bhimgad Wildlife Sanctuary is in the core zone of Western Ghats comprising of semi evergreen and evergreen dense forests with steep slopes.

Bhimgad Wild Life Sanctuary is a rich reservoir of medicinal plants. One such area in semi evergreen forests of Amagoan has been identified for Medicinal Plants conservation area (MPCA) during 2010-11. Out of the recorded species, about 82% of the plants are found to be of medicinal value. Around 47% of the recorded plant species are trees, followed by shrubs (28%) and herbs (18%). The area is also home to several endemic plant species such as *Ancistrocladus heyneanus, Diospyros paniculata, Euonymus indicus, Myristica Arborea,* etc., several among the recorded medicinal plants such as *Aristolochia tagala, Diospyros montana, Emblica officinalis, Garcinia indica, Nothapodytes nimmoniana* etc., are with high medicinal and economic value.

It is habitat for endangered and endemic Wroughton's free tailed bats and Theobald's tomb bats. Barapede caves are known to be the only roosting and breeding place for Wroughton's free tailed bats. The forests with beautiful mosaic of woodlands and grass lands are the habitat for Tigers, Leopards, Indian Gaur (Bisons), Sloth Bear, Sambar, Barking deer, Chital, Wild dogs, King Cobra and a variety of other mammals and reptiles.

Bhimgad Wildlife Sanctuary has a very good population of avifauna which includes Great Indian hornbills and variety of Drongos, Wagtails, wood peckers, Kingfishers, Eagles, egrets, Sunbirds, owls and doves.

Grey Jungle fowl, Jungle myna, crow pheasants, paradise fly catcher, Malabar drongo etc., are also commonly seen in the region.

Figure 8.1 Bhimgad Wildlife Sanctuary

Google view of the proposed project components, Eco-sensitive Zone and boundary of Bhimgad Wildlife Sanctuary and Madei Wildlife Sanctuary is given in figure 12.

Figure 8.2 Pandanus tectorius

Figure 8.3 Bombax ceiba

Figure 8.4 Acacia auriculiformis

Figure 8.5 Memecylon edule

Figure 8.6 Symplocos racemosa

Figure 8.7 Mangifera indica

Figure 8.8 Common Crow

Figure 8.9 Bonnet macaque

Flora and Fauna at Project Site

Chapter 9
Design of Lift scheme

9.1 General

The capacity of **2.18 TMC** of water is proposed to be lifted from Bhandura nala.

9.2 Design Details of the Scheme

The design details are as follows Diversion Dam, Intake forebay, Jack well cum pump house, Pumping Machinery, Electrical substation and Rising Main are as under:

9.2.1 Bhandura Lift Scheme – Main Route (Alignment cross country)

The scheme comprises of following components:

- Construction of Diversion Dam.
- Construction of Intake forebay and Jack well cum pump house to accommodate **5 No's of Vertical Turbine Pumps (4 Working + 1 Standby)** for Lifting the water.
- Supply, Installation, testing and commissioning of **Pumping Machinery** and pump house electrical works.
- Construction of **110/6.6 KV** Electrical sub station with 2 No's (1 working + 1 standby) **12.0 MVA** capacity Transformer including construction of Terminal Bay and Erection of 110 KV SC line using DC towers (13.120 Km) & UG cable of single core 630 sqmm (1.345 Km) from nearest KPTCL substation (Khanapur) for power supply to pumping station.
- Supply, jointing, laying, testing and commissioning of **MS Rising Main** for conveying water
- Construction of **Delivery Chamber** at the end of the Rising Main.
- Operation and Maintenance of the scheme for 5 years.

9.2.2 Bhandura Lift Scheme – Alternate Route (Alignment parallel to road)

The scheme comprises of following components:

- Construction of Diversion Dam.
- Construction of Intake forebay and Jack well cum pump house to accommodate **5 No's of Vertical Turbine Pumps (4 Working + 1 Standby)** for Lifting the water from Bhima River.
- Supply, Installation, testing and commissioning of **Pumping Machinery** and pump house electrical works.

- Construction of **110/6.6 KV** Electrical sub station with 2 No's (1 working + 1 standby) **12.5 MVA** capacity Transformer including construction of Terminal Bay and Erection of 110 KV SC line using DC towers (13.120 Km) & UG cable of single core 630 sqmm (1.345 Km) from nearest KPTCL substation (Khanapur) for power supply to pumping station.
- Supply, jointing, laying, testing and commissioning of **MS Rising Main** for conveying water
- Construction of **Delivery Chamber** at the end of the Rising Main.
- Operation and Maintenance of the scheme for 5 years.

9.3 Diversion Dam

It is proposed to construct a diversion Dam for impounding of water and assuring minimum 10 hours storage for pumping of water. The details of the proposed diversion Dam are as under:

Table 9.1. Design details of Diversion Dam

No.	Particulars	Bhandura Lift
1	Type of Dam	Ogee Dam
2	FRL/Crest level	637.00m
3	MWL	638.68 m
4	Length of spillway (including piers)	121.80m
5	Thickness of intermediate pier	0.60 m
6	Thickness of sluice pier	3.00 m
7	Length of NOF	13.50 m left flank 7.00 m on Right flank
8	Design discharge	542.93 Cumecs
9	Top of Road level	641.30 m
10	Max. height of Dam (foundation to crest level)	10.60 m
11	Number of overflow Vents	12
12	Clear Width of Vents	9.4 m
13	Top width of Walk way	2.70m
14	Nos. of sluice	1 no
15	Invert level of sluice	RL 627.90 m
16	Size of sluice	1.00 m(W) x 1.00m (D)
17	Hoisting arrangement of sluice gate	Electrically operated screw rod hoist
18	Energy dissipating arrangement	Ski jump bucket type
19	Inverted level of bucket	RL 727.40m

No.	Particulars	Bhandura Lift
20	Lip angle	40 degree

9.4 Jack well cum Pump House

Intake Forebay is proposed to draw the water from the Nala to the jack well cum pump house.

Rectangular RCC framed structure is proposed at end of intake trough for accommodating Vertical Turbine pumps for Lifting water from Nala. Provision of accommodating HT board panels, starters, EOT crane are made in the jack well. Details of the Jack well cum pump house are as under:

Table 9.2: Details of Jack well cum pump house

No.	Particulars	Bhandura Lift
1.	Bed Width of Forebay	30.0 m
2.	Length of Forebay	50.0 m
3.	Type of structure	RCC framed structure
4.	Minimum water level / Intake level	630.500 m
5.	High Flood Level	637.000 m
6.	Sump bottom level	625.000 m
7.	Delivery floor level/ Pump floor level	639.000 m
8.	Control room floor level	642.500 m
9.	Corbel level	648.000 m
10.	Roof level	651.000 m
11.	Overall size of the pump house	24.3 m x 42.4 m

Based on the minimum water level available in the sump and the specific speed requirements, the Sump bottom level is decided, to ensure cavitation free and satisfactory operation of the pumps.

The motor floor and service bay level are kept at approach level for ease of approach of heavy trucks carrying the large equipment to the Pump house. The panel room floor level is maintained same as that of the mortar floor level. A cable cellar is proposed below the Panel room, for routing various cables as required for various electrical equipment.

Based on the size of the equipment and clearance required for erection and dismantling of the pump house equipment, such as pump, pump shafts, motors, valves etc. the crane girder level is decided. The level of fitting the monorail for gates and trash racks shall be decided during detailed engineering, considering the clearances required for lowering, lifting and shifting of Gates and Trash racks.

It is proposed to provide all-round embankment for Jack well for accommodating service bay, electrical substation, surge protection equipment's etc.

9.4.1 Fixing the dimensions of Jack well Cum Pump House

General rule the size of the suction pipe should be 1 to 2 sizes larger than the nominal suction size of the Pump. Alternatively the suction pipe should be of such size that the velocity shall be about 2m/s. Where bell mouth is used, the inlet of the bell mouth should be of such size that the Velocity at the bell mouth shall be about 1.5m/s.

A dummy wall (baffle wall) may be provided to avoid dead spots by keeping rear clearance, the dimension 'B' to about 0.75D from the centre line of the pump.

Avoid dead spots at the suction bell mouth by maintaining the bottom clearance, dimension 'C' between D/4 to D/2, preferably D/3 in the GAD D/4 is considered.

Avoid mutual interference between two adjoining pumps by maintaining minimum sufficiency clearance, the 'S' is equal to 2D to 2.5 D. it is also advisable to provide diving walls between the pumps. In GAD 4D is considered.

The floor underneath the pump suction should be flat up to ≥3 D.

Distance from the pump inlet bell centerline to the intake structure entrance shall be ≥5 D.

Pump inlet bay entrance width shall be =2 D. in the GAD > 5D is considered.

Provide tapered walls between the approach channel and sump. By this velocity should reduce gradually to about 0.3m/s near the pump. This also helps to avoid sudden change in the direction of the flow (Max =15 Deg. and preferred =10 Deg.) in the GAD 11 Deg. is considered.

To avoid sudden drop between the approach channel and the sump. A slop of Max =15 Deg. is recommended (preferred =10 Deg.) in the GAD 4 Deg. Is considered.

9.4.2 Fixing of dimensions of Pumping Station

Pumping station Layout to be prepared with sufficient space for the purpose of safe maintenance and operation. Pumps, piping and equipment must be protected from the weather as dictated by local climatic conditions by suitable coating/painting etc. The impact of noise on the surrounding area and the need for security fencing will be considered for all stations. Structures will be fire-resistive construction.

1. A minimum clear distance of 1 mtr. To be provided between each pump set (between pump to pump or motor to motor whichever is more).

2. F/F distance of min. 300 mm to be provided between each valve (or as per flange fixing bolt dimension for ease of fixing and dismantling).
3. Walkway of min. 1 mtr. Width to be provided on the pump floor with suitable handrails all around wherever necessary.
4. Service/loading & unloading Bay shall be provided with sufficient space (min. 2 times the dimension of the pump or motor whichever is more.
5. Crossover of min. 1 mtr. Width shall be provided between each pump delivery pipes and wherever required for the ease of maintenance.
6. Height of pump floor shall be kept according to the maximum height of the pump assembly of motor to avoid fouling/ease of maintenance.
7. Vendor instructions shall be followed while installing of mechanical equipment (for pump set foundation design, Headroom clearance for EOT Crane, Trash rack etc.). And vendor data for loading and spacing shall be considered while designing of design of jack well.
8. Pump floor shall be provided with sufficient lighting and ventilation.
9. Inspection Manhole of in. 1m x 1m shall be provided for maintenance and monitoring purpose.
10. Ladder/ satire case shall be provided wherever necessary for ease of maintenance with suitable coating/painting.
11. All pipes and valves shall be supported by proper support.
12. Thrust blocks shall be provided for as per structural design for elbows, tees etc.
13. Pump set foundation, thrust block, pipe support etc. shall be as per structural drawings and cable routing, earthling etc. electrical drawing.
14. All possible dimensions shall be shown in the mechanical GAD.

9.5 Pumps and Motors

Vertical Turbine Pumps for lifting are recommended for this project. These pumps provide trouble free service for long time. It is recommended to have minimum 1 stand-by for the ease of maintenance.

Table 9.3: Details of Pumping Machinery

No.	Particulars	Bhandura Lift	
		Main	**Alternate**
1	Type of Pump	Vertical Turbine Pumps	Vertical Turbine Pumps
2	Efficiency of Pump	86%	86%
3	Intake Level	630.500 m	729.500 m
4	Peak Level	685.000 m	780.000 m
5	Delivery Level	644.000 m	644.000 m
6	Static Head	54.50 m	50.50 m
7	Losses (Friction + pump internal + other)	13.50 m	15.50 m
8	Total Pump Head	68.00 m	70.00 m
9	Required Discharge	10.6 cumecs	10.6 cumecs
10	Number of Pumps	4 working + 1 Standby	4 working + 1 Standby
11	Discharge for each Pump	2.650 cumecs, 9541 m^3/ hr	2.650 cumecs, 9541 m^3/ hr
12	Capacity of each Pump	3200.00 HP (2387.2 KW)	3350.00 HP (2499.1 KW)
13	Total Installed Capacity	16000.00 HP (11936.0 KW)	16750.00 HP (12495.5 KW)
14	Total Power Requirement	12.0 MVA	12.5 MVA
15	Electrical Sub-station	110 KV / 6.6 KV outdoor type with 2 No's of 12.0 MVA Power transformer (1 Working + 1 Standby)	110 KV / 6.6 KV outdoor type with 2 No's of 12.5 MVA Power transformer (1 Working + 1 Standby)
16	Delivery pipe	1200 mm diameter 12.0 mm thick MS pipes	1200 mm diameter 12.0 mm thick MS pipes
17	Manifold system	3400 mm diameter 28.0 mm thick MS pipe	3400 mm diameter 28.0 mm thick MS pipe

9.6 Power Requirement and Electrical Substation

9.6.1 Bhandura Lift Scheme - Main Route (Alignment in cross country)

The total power requirement for diverting water from Bhandura Nala is **12 MVA.** The power requirement is calculated taking into account of no. of working pumps and auxiliary power supply. The voltage level at which power is required is 6.6 KV and required transformer capacity is to receive 110 KV for power stepping down to 6.6 KV for feeding HT motors.

It is proposed to provide 1 Nos. of 110 KV sub-station with transformer capacity of 12 MVA power for Lifting water from Bhandura Nala catering the above loads with OLTC & RTCC panels. Provision of 2 No's of transformers (1 working + 1 standby) is made.

9.6.2 Bhandura Lift Scheme - Alternate Route (Alignment parallel to road)

The total power requirement for diverting water from Bhandura Nala is **12.5 MVA.** The power requirement is calculated taking into account of no. of working pumps and auxiliary power supply. The voltage level at which power is required is 6.6 KV and required transformer capacity is to receive 110 KV for Kalasa power stepping down to 6.6 KV for feeding HT motors.

It is proposed to provide 1 Nos. of 110 KV sub-station with transformer capacity of 12.5 MVA power for Lifting water from Bhandura Nala catering the above loads with OLTC & RTCC panels. Provision of 2 No's of transformers (1 working + 1 standby) is made.

The details are as under:-

Table 9.4: Details of Power Requirement and Electrical Substation

No.	Particulars	Bhandura Lift	
		Main	Alternate
1	Power Requirement	12.00 MVA	12.50 MVA
2	Transformer Rating & Voltage	2 Nos x 12.0 MVA 110 KV / 6.6 KV	2 Nos x 12.5 MVA 110 KV / 6.6 KV
3	Number	1 Working+1 Stand by	1 Working+1 Stand by

9.7 Power Supply to Proposed Pumping System

9.7.1 Bhandura Lift Scheme

It is proposed to construct 110 KV Terminal bay at existing KPTCL Substation and to draw the power from the existing nearest substation through 33 KV transmission line. Provision for construction of 110 KV Terminal Bay at the nearest KPTCL Substation is also made in the estimate.

The power supply required for the scheme Bhandura LIS of 12.00 MVA for main route and 12.50 MVA for alternate route is considered from the existing Khanapur KPTCL substation.

The length of power line by adopting under ground cable works out to be 14.465 Km Approx from KPTCL substation to the proposed lifting point.

Table 9.5: Details of Power Supply

No.	Particulars	Details
1	Terminal Bay & Transmission line	110 KV
2	Existing KPTCL Substation	Khanapur
3	Length of powerline by providing underground cable	1.345 Km
4	Length of powerline by providing overhead SC line using DC tower	13.12 Km
5	Total Length of powerline	14.465 Km

9.8 Rising Main

9.8.1 Selection of Pipe Material and design velocity

It is proposed to use Mild Steel (MS) as a material of rising main pipe.It is proposed to construct a Rising main to cater the required discharge from Jack well cum Pump house to feed tanks under the scheme.

Designing of M.S. Rising Main is based on following considerations:

i. Velocity of flow shall be as far as possible, limited to 2.0 m/sec.

ii. Wall Thickness:

   a. D/t ratio not exceeding 150.

   b. Safe check for hoop stress.

   c. The thickness shall not be less than as specified in IS 1916

   d. Check for design pressure 150% of pump head.

   e. Check for 150% of Working Pressure.

It is proposed to consider External coating as Pipe coating of fibres, coal tar and solvent based rubber modified bituminous primer of density 0.92 gms/cu cm and viscosity of 1000-2000 cps @ 150 gms/sqm followed by seven layers (4 mm thick) of polythene polymerized bitumen and polyester of total 7 layers pipe coat 4 mm should conform to requirement of IS-10221 and AWWA C-203 for prefabricated tapes to speed up the work.

MS pipes with inner lining and outer tar tape coating is considered for the design of Rising Main. The details of the Rising Main areas under.

Table 9.6: Details of Rising Main

No.	Particulars	Bhandura Lift	
		Main	Alternate
1	Length of the Rising Main (m)	12470.0	14580.0
2	Peak Discharge (Cumecs)	10.6	10.6
3	Number of Rows (No)	1	1
4	Discharge for each Row (Cumecs)	10.6	10.6
5	Velocity considered (m/s)	2.00	2.00
6	Actual Velocity (m/s)	2.00	2.00
7	Diameter of Pipe (ID) (mm)	2600.0	2600.0
8	Pipe Type	MS	MS
9	Grade of Steel	E 250	E 250
10	Thickness of Pipe (mm)	16.1	16.1
11	Internal Epoxy Coating (mm)	0.406	0.406
12	External tar tape coating (in mm)	4	4

Following provisions are made in the estimate of pipeline:

- Earthwork Excavation for pipeline trenches.
- Supplying, Laying, jointing Testing & commissioning of M.S Pipes.
- Provision for Air valves and scour valves.
- Construction of Thrust Blocks & Anchor Blocks.
- Construction of Valve chambers.
- Construction of Hard passage for nala crossing
- Construction of Cart Track & Asphalt Road Crossings
- Construction of Railway crossings
- Construciton of National Highway crossing
- Refilling of trenches.
- Provision of Boundary pillars, Kilo meter stones as per specifications.

9.9 Delivery Chamber

RCC delivery chamber is proposed at the end of raising main for leading the water directly to Malaprabha River by providing an outlet pipe. It is proposed to provide a Delivery chamber with RCC wall on all sides with outlet pipe on downstream side leading to Malaprabha River.

The details of the proposed Delivery chamber are as indicated below **Table 9.7.**

Table 9.7 Details of Delivery chamber

No.	Particulars	Details
1	Peak Level	685.000 m
2	Delivery level	644.000 m
3	Top of Delivery chamber	648.200 m
4	Bed level of Delivery chamber	644.200 m

9.10 Design Philosophy and Design Standards

9.10.1 Piped Planning

The planning and layout of Piped system is not controlled by topography of the area. The layout of main line is generally fixed on the consideration of economy.

The stage for general planning and layout of Piped system arises after the general feasibility of the project has been established.

A gravity closed conduit preferably circular pipe consisting of pipes, fittings and other devices properly designed and installed to supply water under pressure from the source of the water to the consumption points are more efficient.

9.10.2 Data Required for Piped Planning

The following data is required for planning and layout of a Pipe system:

- Index map showing detailed planning
- Survey data along the proposed alignment

Adequate investigation should be carried out to collect the data given by digging trial pits and bore holes, where necessary, to ascertain the nature of soil encountered along different alternative alignments.

9.10.3 Route selection of Pipe Network

Length of pipelines in the network is minimal, as much as possible.

- High water pressure is avoided.
- Numbers of appurtenances (gate valve, check valve, drain, air release valve, pressure break valve) are minimized.
- Very low or high velocities are avoided because low velocities cause sedimentation in pipes and high velocities cause corrosion of pipe.
- This results into most economical system.
- If horizontal pipe sections are used, release of air and drain the dirt will not be possible. So, in case of horizontal ground surface, artificial slopes are given to pipes to be laid.

9.10.4 Guidelines for Cost Effective Design of Pipelines

The cost of transmission and distribution system constitutes a major portion of the project cost. It is desirable to adopt the following guidelines:

1. The design velocity should not be less than 0.6 m/s in order to avoid deposition and consequent loss of carrying capacity
2. In design of pipe, the design velocity should not be less than 0.6 m/s to avoid low velocity conditions which may encourage deposition and / or corrosion resulting in deterioration in quality. However, where inevitable due to minimum pipe diameter criteria or other hydraulic constraints, lower velocities may be adopted with adequate provision of scouring.
3. In all hydraulic calculation, the actual internal diameter of the pipe shall be adopted after accounting for the thickness of lining, if any, instead of the nominal diameter or outside diameter (OD).
4. In providing for head loss due to fitting, specials and other appurtenance, actual head loss calculation based on consideration included in sub-section 6.2.9 should be done instead of making an arbitrary provision.

9.10.5 Water Losses and Efficiencies

To account for losses of water incurred during conveyance and efficiency factor should be included while calculating the water requirements.

Conveyance losses in canals consist of two components i) Evaporation losses and ii) Seepage losses. The evaporation losses depend on the climatic zone and temperature variation whereas the seepage losses depend on the type of sub-soil, Ground water levels and type of lining and wetted area of the canal. With most effective lining and most efficient canal section the adopted efficiency for canals are 0.80.

As the piped networks are a closed system, there will be neither evaporation losses nor absorption/seepage losses except some leakages at fittings. Therefore, Design conveyance efficiency should not be lower than 0.95.

9.11 Design Standards

9.11.1 Permissible Velocity

9.11.1.1 Maximum Velocity

The higher the velocity, the greater the risk of damage through surges and water hammer. This risk particularly applies to pipes subject to uncontrolled starting and stopping. Using larger pipe results in a smaller water velocity for a given flow rate, but smaller pipe is often preferred for cost reasons. It is suggested to carry out water hammer analysis under such situations where higher velocities are provided. When the water is silt rich, design velocity of Piped Irrigation Network should not lower be than non-silting velocity. Non silting velocity should be determined by experiments. The maximum velocity may be limited to 3.0 m/s.

9.11.1.2 Minimum Velocity

Designers must specify pipe diameters and flow rates that allow for a minimum operational water velocity, especially for irrigation systems that utilize emitters with small apertures such as drip and micro sprinklers. This will ensure that any sediment or solids are flushed through the lines. Minimum velocity should not be below 0.6 m/s.

9.11.2 Permissible Head

Minimum driving head at Receiving Chamber should be 0.5 m.

9.11.3 Determination of Pipe Diameter

The diameter of the pipe can be preliminarily determined based on the design discharge and permissible velocity in a particular section.

9.11.4 Overburden for buried pipes

A minimum overburden of 1.2 m shall be provided for Main and Branch lines and 0.6m for distributaries and minors to avoid land acquisition problem.

When the over burden depth is more than 3.0 m concrete encasement is proposed to take care of the deflection of the pipe material.

9.11.5 Concrete Encasement

Concrete encasement is proposed for the proposed pipe when the pipe is failing in the buckling.

9.11.6 Land Acquisition

Pipeline layout should be parallel with ditch, trench and road, and avoid fill section segments and areas with possible landslide or flood. The land acquisition should be minimum to nil when laid parallel to existing communications lines.

9.11.7 Service Road

Service road is provide all along the alignment for inspection, repairs and maintenance of valves other components of the gravity pipes.

9.11.8 Cross Drainage Works

There are only two possibilities for crossing the streams or nalas. They are as follows:

a) If the Nalas is very wide compared to its bank heights, pipe can be crossed by siphoning of pipe under Nalas bed.

b) In case of deep gorges and nala with higher discharge, pipe can be carried over bank piers to cross the Nalas. At minor Nalas the pipe may be taken at the same grade with supports at the banks.

Enough Anchor Blocks and Anchorages shall be provided wherever necessary.

9.11.9 Air Vent

Air vents are provided to release the entrapped air from the system. The dia. of riser pipe should be minimum of 10% of the diameter of buried pipe and should extend a minimum of 60 cm above HGL. Provide at all points of change of direction of flow. Provide at every 500-1000 m on the straight line. For field irrigation pipes the spacing may be reduced to 150 m based on the requirement.

9.11.10 Vacuum Relief Valves

Vacuum Relief valves shall be provided at all summits.

9.11.11 Drain Valves

Drain Valves shall be provided at the lowest points near Nala.

9.11.12 Scour Valves

If the velocity in the pipes is less than 0.6 m/s, scour valves shall be provided as per the site conditions at deep Nala locations.

9.11.13 Friction losses

9.11.13.1 Major losses

There is a number of formulas available for use in calculating the velocity of flow. However, Hazen-Williams formula for pressure conduits and for free flow conduits has been popularly used.

9.11.13.2 Hazen William's Formula:

$$h_f = \frac{[10.65 \times L \times (Q/C)^{1.852}]}{C^{1.852} D^{4.87}}$$

Where h=friction head loss in m

Q=Flow in pipe (m^3/sec)

V = Velocity of flow (m/sec)

C = Pipe roughness coefficient

D = Internal Diameter of pipe (m)

L = Length of pipeline (m)

9.11.13.3 Minor Losses

For design and estimation purpose, total minor losses may be taken as 10% of the major loss.

9.11.14 Stress calculation

Various stress calculations are performed to check the strength of the proposed pipe material which can with stand the pressure available in the pipe network. The detailed calculations are as under:

9.11.14.1 Hoop Stress checking

If Working Pressure is Used

The Nominal thickness of steel pipe is calculated as given below, Plus the permitted manufacturing tolerance for reduction in thickness.

$$t = \frac{p D}{2 a f e + p}$$

t = Thickness of the Pipe in mm

p = internal pressure Kgf/ cm^2 = Kgf/cm^2

D = OD of the pipe in mm = mm

a = design factor (0.6 if p is the working pressure and 0.9 if p is the test pressure inclusive of surge pressure). =

f = Minimum yield stress of the steel Kgf/ cm^2 = Kgf/cm^2

e = Weld efficiency of the joint (0.9 for shop welding and 0.8 for field welding). =

t = Thickness of the Pipe in mm

p = internal pressure Kgf/ cm^2

D = OD of the pipe in mm

a = design factor (0.6 if p is the working pressure and 0.9 if p is the test pressure inclusive of surge pressure).

f = Minimum yield stress of the steel Kgf/ cm^2

e = Weld efficiency of the joint (0.9 for shop welding and 0.8 for field welding).

If hydraulic test Pressure is used

$$t = \frac{P\,D}{2\,a\,f\,e + P}$$

P = Hydraulic test pressure

t = Thickness of the Pipe proposed in mm

D = OD of the pipe in mm

a = design factor (0.6 if p is the working pressure and 0.9 if p is the test pressure inclusive of surge pressure).

f = Minimum yield stress of the steel Kgf/ cm^2

e = Weld efficiency of the joint (0.9 for shop welding and 0.8 for field welding).

9.11.14.2 Check for Deflection

The deflection is given by Spangler's Theory (AWWA Manual M11)

a. $\Delta x = D_1 \left\{ \frac{KW\,r^3}{EI + 0.06\,E'\,r^3} \right\}$

Δx = Deflection Cm

W = Load per unit length of pipe due to soil overburden Kgf/cm^2

k= Bedding Constant

r = Pipe radius cm

E = Modulus of elasticity of steel Kgf/ cm^2

t= Thickness of Pipe

I = Transverse Moment of Inertia per unit length of pipe wall Cm^3

E' = Modulus of soil reaction Kgf/ cm^2

b. $W = \frac{\gamma_s D H}{100}$

D = Mean diameter of pipe, m

H= Height of backfill above pipe top, m

γs = Specific weight of backfill material Kgf/ cm^2

The division by 100 is to convert the load per Mtr length to load per cm length.

Deflection should be less than 3% of the Mean diameter

9.11.14.3 Check for Buckling

The allowable buckling pressure is given by (AWWA Manual M11)

$$q_a = \left[\frac{1}{FS}\right]\left\{\frac{32 R_w B' E' EI}{D^3}\right\}^{0.5}$$

q_a = Allowable buckling pressure Kgf/ cm^2

FS = design factor (2 as per 4th edition of AWWA manual M11)

R_w = water buoyancy factor given by 1-.33 (H_w / H)

H_w = height of water surface above top of pipe cm

H = Height of backfill above top of pipe cm

E' =Modulus of soil reaction Kgf/ cm^2

E = Modulus of elasticity of steel Kgf/ cm^2

t= Thickness of Pipe

I = Transverse Moment of Inertia per unit length of pipe wall Cm^3

D = Diameter

Calculations are done for 1 Mtr overburden of soil with no waterlogging in the trench, that is H_w =0 as Hw is 0, R_w = 1. The value of B' is calculated based on H value in Ft, as follows.

$$B' = \frac{1}{1+ 4 e^{(-0.065 H)}}$$

B' = empirical constant given by

H is in ft

e is mathematical constant

The requirement of safety from buckling is verified by the following Equation

$\gamma_w H_w + R_w W/D + P_v \leq q_a$

γ_w = Specific Wt of water Kgf/ cm^3

W = Load per cm length due to soil overburden Kgf/ cm^2

Pv = Internal vacuum Pressure Kgf/ cm^2

Where W is calculated using

$$W = \frac{\gamma_s D H}{100}$$

γ_s= Specific weight of backfill material Kgf/ cm^2

D= dia in Mtr

H= Height of backfill Mtr

9.11.14.4 Check for Collapse Pressure

$$P_c = \frac{2E}{(1 - v^2)} \frac{t}{D}$$

P_c= Critical collapse pressure Kgf/ cm^2

E= Young's Modulus of steel Kgf/ cm^2

v = Poisson Ratio.

t= Thickness of wall in mm

D is diameter in mm

For steel pipe in FPS units the formula reduces to….

$$P_c = 66 \times 10^{\wedge} 6 \left\{ \frac{t}{D} \right\}^3$$

Pc =is in PSI

9.11.15 Planning Criteria

In order to facilitate crossing of pipeline across rivers/ nalas /deep valleys, the pipes will be taken over a permanent concrete structure which is known as pipe Bridge.

9.11.15.1 Design Criteria

The structural design aspects of the aqueduct are as follows:

The pipe Aqueduct is designed for the following loads:

- Dead load of the structure

- Super imposed dead loads involve pipe and its appurtenance
- Water load
- Live load on service road

The structure is checked for stability against following forces:

1. Differential thermal expansion between concrete and pipe material
2. Wind force
3. Temperature variation
4. Water current of the stream
5. Seismic loads if applicable
6. Eccentricity force due to Dead Load and Live Load

The following assumptions are made for the design of a pipe aqueduct.

1. Precast technology for superstructure will be adopted with minimum grade of concrete as M-35
2. Single lane service road required for maintenance will be a part of the bridge
3. In absence of any specific data the horizontal force along the pipe towards friction/ water hammer will be considered as 8 % of the dead load of pipe and water.

Following drawings are to be prepared;

1. Index map
2. General schematic drawing
3. GAD indicating plan, L/S, C/S, approaches, protective works, type of foundation, sub structure, super structure and arrangement of pipes and saddles
4. RC details of foundation, substructure and super structure
5. Anchoring of saddle to the super structure
6. Safety features like parapet, drainage spouts, Expansion joints, etc.
7. Connection of approach to the structure by appropriate bank connection.

9.11.16 Anchor Block and Thrust Block

A conventional anchor block is a reinforced concrete block which is cast around a straight piece of pipe, and which is designed to restrain the pipe against longitudinal movement. The longitudinal thrust from the pipe is transferred into the anchor block via a puddle flange clamped onto the pipe or via a thrust collar welded to the pipe. The anchor block is cast into slots cut into the trench wall so as to transfer the thrust into undisturbed native soil. Anchor blocks will normally be used at in-line valves or tapers, where it is not possible to use the much simpler “thrust block”. The anchor blocks are also constructed around pipes to resist buoyancy, when the pipes are laid underwater.

A thrust block is a simple unreinforced block of concrete cast against, rather than around, the pipe special. A conventional thrust block at a horizontal bend or tee would be a concrete block designed to transfer the thrust from the pipe into the undisturbed native soil in the trench wall. A conventional thrust block at a vertical bend (downward thrust) would be similar to that for a horizontal bend, but would bear on the trench floor rather than the wall. A conventional thrust block at a vertical bend (upward thrust) is simply a block of concrete attached to the pipe with sufficient weight to counterbalance the thrust.

9.11.17 Geotechnical Design Principles

An anchor or thrust block must be designed to transfer the thrust from the pipe ONLY into the undisturbed native soil in the trench wall. On no account should the pipe embedment be relied upon to resist any of the thrust. There are three main reasons for this:

(1) It is generally impossible to compact embedment material (or any other material) sufficiently densely against an anchor or thrust block to eliminate any bedding-in movement.

(2) It is possible that the trench fill material will not have been placed when the pressure test is carried out. If so, the pipe embedment material would have no surcharge load on it and therefore could not resist any horizontal force.

(3) The natural material is likely to have a much higher stiffness modulus than the embedment material, and will therefore attract most of the thrust anyway. It is to be understood that in most pipe networks it is likely that the thrust on a valve etc. could come from either direction. Therefore it is necessary to specify that BOTH faces of an anchor block must be poured against undisturbed native soil.

9.11.18 Constraints on Anchor and Thrust Block Location

It should be kept in mind that, the proposed location of an anchor or thrust block might have other pipe or service trenches or other excavations close to it. If these trenches or excavations, whether open or backfilled, are within the zone of ground stressed by the bearing area of the anchor or thrust block, then

they may compromise the effectiveness of the proposed block to resist the thrust without exceeding the allowable movement. In such circumstances, it may be necessary to relocate the pipe special so that the anchor or thrust block is located well away from any cross trenches or other excavated areas or disturbed ground.

9.11.19 Design of Anchors & Thrust blocks

The design pressure for anchor and thrust blocks will generally be the test pressure. For water supply trunk mains, sewer rising mains, irrigation water supply mains, etc. the test pressure will be the specified rated pressure by the manufacturer of the pipes. The test pressure will generally be the rated pressure of the pipe.

9.11.20 Thrust Blocks at Bends

Thrust blocks at horizontal and vertical bends on buried pipelines with unrestrained flexible joints are designed to resist the total resultant hydraulic thrust. It is assumed that the block transmits all of the thrust into the adjacent native soil or rock only (i.e. not into the pipe embedment material or any compacted fill). The thrust block should not protrude beyond the space allocation for the pipeline when located in a road reserve Delivery Chamber

The size of the delivery chambers is also a determining factor of the time of retention of water. It is to be determined based on the required retention time of water. Retention time of water is determined by the required head and velocity of the canal or pipeline. The delivery chamber is generally square or rectangular in plan with inlet pipe and outlet pipe arrangements. The arrangements of the gate for the canal shall be located in a separate regulator structure outside the delivery chamber. The principle of designing the delivery chamber is similar to that of any water retaining structure and the code of practice of IS 456 and IS 3370 are applicable. The structural designs can be developed after the dimensions of the D/C are determined.

9.11.21 Design Criteria

The criteria adopted for the design of storage reservoirs and tanks in reinforced concrete is that the stresses in the concrete and steel is limited to those prescribed in IS codes for un cracked condition. However unlike overhead tanks, the foundation here will be a raft type and forms the base for the delivery chamber. The foundation will be provided with double mat foundation to take care of the reversal of bending in tank full and tank empty condition. The time of retention determines the size of the delivery chamber.

As design will be carried out on established theories, no assumption will be made in the designs.

9.11.22 Hard Passage

Hard Passage is generally provided in wetland region areas for carrying the pipe line. The concept of Hard Passage is that it should provide firm supports to the pipe line on weak soil or wet land. The supports will be generally above the water line during monsoon and will be firm enough so that they don't get scoured during monsoon

Chapter 10
Cost Estimate

10.1 Guidelines

The estimates are based on IS 4877 – 1968 entitled "Guidelines for preparation of estimates for River valley projects", Part 1- namely "Guidelines for preparation of detailed Project Reports of Irrigation and Multipurpose Projects".

10.2 Account heads

The total cost of Bhandura Nala Project under I – works is detailed hereunder.

Detailed sub heads under I – Works

A. PRELIMINARY

A provision of **Rs. 916.24 lakhs** is made for consultancy charges for detailed survey and investigation and other preliminary works for Construction of Bhandura Dams and Inter Connecting Canal f Geological & Geophysical, Hydrology, Sedimentation analysis, River gauging, Investigation for foundations, models

Survey, investigation, preparation of Design, Drawings, Estimates, Draft tender papers for Bhandura Nala Diversion Scheme (Lift Scheme)etc.,

B. LAND

A provision of **Rs. 3551.81 lakhs** is made in the estimate towards Land acquision for construction of Diversion Dam , Lift conveyance system including compensation for houses and trees including crop compensation etc.,

C. WORKS

A provision of **Rs 38636.75 lakhs** is made in the estimate towards construction of Bhandura Diversion Dam Jackwell cum pump houses, Electricle sub stations, rising mains, Delivery chambers etc., etc.,

D. REGULATOR AND MEASURING DEVICE

No provision is made in the estimate

E. FALLS

No provision is made in the estimate.

F. CDWORKS

A provision of **Rs 400.00 lakhs** is made in the estimate towards construction of CD work for existing roads.

G. BRIDGES

No provision is made in the estimate.

H. ESCAPES

No provision is made in the estimate.

I. NAVIGATION WORKS

No provision is made in the estimate.

J. POWER PLANT CIVIL WORKS

No provision is made in the estimate.

K. BUILDINGS

A provision of **Rs 1370.00 lakhs** is made in the estimate towards construction of Temporary and permanent Office buildings.

L. EARTHWORK

No provision is made in the estimate.

M. PLANTATION

A provision of **Rs 143.50 lakhs** is made in the estimate for planting trees on foreshore of reservoir & colony etc.

O. MISCELLANEOUS

A provision of **Rs. 57.80 lakhs** is made for electrification, telephone lines, and Maintenance & Services & Other items.

P. MAINTENANCE

A provision of **Rs 865.16 lakhs** is made for maintenance of Dam & appurtenant works, roads, machinery, colony etc.

Q. SPECIAL TOOLS AND PLANTS

A provision of **Rs. 35 lakhs** is made in the estimate towards procurement of inspection vehicles for officers of WRD.

R. COMMUNICATIONS

A provision of **Rs 976.00 lakhs** is made in the estimate for construction of diversion roads. (**Interconnecting Roads)**

X. ENVIRONMENT AND ECOLOGY

A provision of **Rs 1043.21. lakhs** is made in the estimate for compensatory afforestation, Public health measures and catchment area treatment.

Y.LOSSES ON STOCK

A provision of **Rs. 103.46 lakhs** is made in the estimate at 0.25% of the cost of I – works less A, B,M,P,Q and X as per CWC guidelines.

I. ESTABLISHMENT CHARGES

A provision of **Rs. 2227.36 lakhs** is made in the estimate @ 5% of the cost of I – Works less B- Lands.

II. TOOLS AND PLANTS

SMALL T&P 1% OF I - WORKS

A provision of **Rs. 480.99 lakhs** is made in the estimate

III. SUSPENSE

No provision is made in the estimate.

IV. Provision of cost control cell @ 1% of I-Works

No provision made in the estimate

V. RECEIPTS AND RECOVERIES ON CAPITAsL

Resale value of temporary buildings @ 15% cost of buildings. Rs (-) 205.50 lakhs

Total Direct Charges: 87371.46 Lakhs

VI. INDIRECT CHARGES

a) Abutment of land revenue @ 5% of land cost Rs 177.59 lakhs

b) Audit & Account charges @ 1% of I-Works Rs 480.99 lakhs

c) Add GST for work portion Rs 6457.28 lakhs

Total In Direct Charges: 7115.86 Lakhs

Total Direct and Indirect Charges: 57717.62 Lakhs

GRAND TOTAL = 57720.00 LAKHS, SAY = 577.20 CRORES

The cost estimates are based on Common Schedule of Rates for Engineering Departments 2021-2022.The recommended SR Volumes for 2021-2022

Table 10.1 SR Volumes for 2021-2022

Volume.	SR's of Organizations Concerned Under
1	COMMON SR for Earthwork & Concrete Works
2	PWD (C&B) - Buildings
3	PWD (C&B), NH & PRED - Roads & Bridges
4	WRD, MI & KPCL
5	BWSSB , KUWSDB & RWS
6	KPTCL, ESCOMS, PWD ELECTRICAL
7	PORTS & IWTD
8	FOREST, WATERSHED, HORTICULTURE

For items where market rates are considered, such rates are obtained from various vendors to arrive at a reasonably correct cost. While framing the estimate, the steel rate as per the WRD, MI & KPCL Vol-4 for 2021-22 taken and steel difference cost is worked out for present quarter steel rate of Rs 86.00 /Kg issued by Superintending Engineer, PWD, Bangalore Circle, Bangalore.

The total cost of the project works out to Rs 577.20 Crores.

10.3 Preparation of estimates

10.3.1 Capital cost

The capital cost of the project is **Rs. 577.20 Crores** which includes all cost associated with investigations, design, construction and maintenance during construction period of the project.

10.3.2 Analysis of rates for various items

The analysis of rates for various items of works is done considering the cost of materials, carriage, Handling, storing including labour and costing machines.

10.3.3 Quantitative assessment of material requirement

This has been done considering the unit cost of materials prevalent in the region which includes fright, unloading, cartage, storage, inspection and testing.

10.3.4 Guidelines on use rates of machinery, hire charges etc

The rates considered are as per schedule of rates of the department which includes the rates for machinery, higher charges etc.

10.3.5 Contingencies and work charged establishment

Provision for contingencies and work charged establishment is about 3% to 5%.

10.3.6 Communication facilities

The project lies in Western Ghats with completely hilly terrain and is approachable by an all weather road from Khanapur and Belgaum.

Chapter 11
Conclusion

As per the revised allocation, the extent of water planned to be diverted from **Bhandura is 2.18 TMC**. A diversion Dam is 10.60 m high (from the bed level of nala) is proposed across Bandura nala. The extent of storage is restricted to 10 - hours, thereby minimizing the forest submergence.

A jack well cum pump house is proposed at the fore shore of the diversion Dam and water will be lifted and conveyed through a raising main of MS pipe of 2.60 m dia and will delivered directly to Malaprabha river.

- The total submergence under Bhandura diversion will be 13.26 Ha (32.75 Acres).
- The extent of forest land required for the conveyance system will be 3.01 Ha (7.43 Acres)
- The total forest land diversion under Bhandura scheme will be 16.27 Ha (40.18 Acres).

The modified proposal is prepared by Karnataka to comply the CWC observations and to follow the directions given under Clause IX A (ii) (a)&(b) of MWDT award.

In addition, the modified proposal brings down the requirement of forest land.The extent of forest land requirement is reduced by about 80%, hence the revised proposal is Forest and Environment-friendly.Reduce the cost of the projects and addresses the apprehensions of CWC pertaining to excess diversion of water, over and above the allocation, in the canal gravity system as proposed in the earlier proposal.

The total cost of the project works out to Rs 577.20 Crores.

Executive Engineer
KNNL, Kalasa Project Division
Khanapur

Superintending Engineer
KNNL, MLBCC Circle
Naviluteetha

Chief Engineer
KNNL, Malaprabha Project Zone
Dharwad

Managing Director
Karnataka Neeravri Nigam
Bengaluru

KARNATAKA NEERAVARI NIGAM LIMITED

BHANDURA NALA DIVERSION SCHEME

ANNEXURE-1
HEADWISE ABSTRACT AS PER CWC

KARNATAKA NEERAVARI NIGAM LIMITED

BHANDURA NALA DIVERSION SCHEME

GENERAL ABSTRACT OF BHANDURA NALA DIVERSION SCHEME

Sl No.	Particulars	PFR Amount Rupees in Lakhs	Remarks
1	A- Preliminary	916.24	
2	B- Land	3551.81	
3	C- Works	38636.75	
4	D- Regulators	NIL	
5	E- Falls(for canals only)	NIL	
6	F- Cross Drainage works(for canals only)	400.00	
7	G- Bridges (for canals only)	NIL	
8	H- Escapes	NIL	
9	I- Navigation works	NIL	
10	J- Power plants civil works	NIL	
11	K- Buildings	1370.00	
12	L-for canals only	NIL	
	a) Earth work	NIL	
	b) Lining	NIL	
	c) Service roads	NIL	
13	M-Plantation	143.50	
14	N- Tank and Reservoir	NIL	
15	O- Miscellaneous	57.80	
16	P- Maintanance	865.16	
17	Q- Special T and P	35.00	
18	R- Communication	976.00	
19	S- Power plant and Electrical system	NIL	
20	T- Water supply works(LS)	NIL	
21	U- Distributaries,Minors & sub minors	NIL	
22	V- Water courses and Field channels	NIL	
23	W- Drainage	NIL	
24	X- Environment and ecology	1043.21	
25	Y- Loss on stock & Unforeseen		
	0.25% of I works less (A+B+M+O+Q+X+P)	103.46	
	Total cost of I works	**48098.92**	
II	Establishment (5% of cost of I works less B - Land)	2227.36	
III	Tools & Plants (1% of I works including B)	480.99	
IV	**Suspense**	NIL	

Sl No.	Particulars	DPR Amount Rupees in Lakhs	Remarks
V	**Receipts and recoveries on capital account**		
	a) Recoveries on account of K-building 15 % salvage value of building cost.	-205.50	
	b) Recoveries towards resale transfer of special T & P @ 75 % of machinery & 20% of cost of vehicle	NIL	
	Total Direct charges	**50601.77**	
	INDIRECT CHARGES		
	a) Capitalised value of abatement of land revenue(5% of B-Lands)	177.59	
	b)Audit and Account charges (1% of cost of I works)	480.99	
	Add GST for work Portion	6457.28	
	Total Indirect charges	**7115.86**	
	TOTAL DIRECT AND INDIRECT CHARGES	**57717.62**	**Lakhs**
	Rounding off	**2.376**	**Lakhs**
	Total cost of the project	**57720.00 Lakhs**	
		577.20 Crores	

Executive Engineer
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Khanapur

Superintending Engineer
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Naviluteetha

Chief Engineer
KNNL, Malaprabha Project Zone
Dharwad

KARNATAKA NEERAVARI NIGAM LIMITED

BHANDURA NALA DIVERSION SCHEME

A -PRELIMINARIES

Sl No.	Description	Amount (Rs in Lakhs)	Remarks
PREPARATION OF DETAILED PROJECT REPORT			
1	Expenditure incurred on previous investigation.		
a)	Consultancy services for investigation ,survey,Detalied Engineering,Detailed Hydrology,Yield Calculation,preparation of DPR/Estimates, DTPs, Land Acquisition proposals and forest proposals etc.,including obtaining Clearence from KNNL/ Government for Haltara Dam & ICC,Bhandura Dam & ICC (Balance Work).	41.44	
2	Consultancy services for survey, investigation, preparation of Design, Drawings,Estimates, Draft tender papers for Bhandura Nala Diversion Scheme (Lift Scheme)	250.00	
3	Detailed surveys for final location.	21.90	
4	Contour survey for F.R.L and M.W.L and fixing demarcation stones	17.40	
5	Geological survey & Geophysical survey by electrical resistivity method in tunnel.	26.16	
6	Hydrological and meteorological surveys including establishment of rain-gauge and river gauges & other charges.	7.20	
7	Investigations for foundation/bore drilling along the dams/channels.		
a)	Drilling of additional trial Bores on Diversion Dam on Bhandur Reservoir to Malaprabha River. (As per Tender)	27.90	
8	Investigations for availability of materials & openings of new stone quarries.	7.20	
9	Preliminary soil testing & establishment of material testing laboratory.	7.20	
	TOTAL =	**406.40**	
PREPARATION OF DETAILED DESIGNS, CONSTRUCTION DRAWING, TENDER DOCUMENTS			
10	Model Experiments	7.20	
11	Preparation & Printing of Project reports.	3.00	
12	Vehicles for inspecting officers for site Investigation (2 Nos.)	17.40	
13	Camp equipment	11.70	
14	Charges for preliminary design work including consultant's fee or advice.	14.40	
15	Writing of completion report & History of Project.	1.50	
16	Construction of access roads to dam site, Approach roads & Exit points to facilitate investigation.	43.80	

Sl No.	Description	Amount (Rs in Lakhs)	Remarks
17	Rental charges for private building in initial stages.	41.94	
18	Environmental & Ecological studies.	317.00	
19	Consultancy charges for Geo-physical survey & investigations, preparation of Design Drawings & Estimates etc.	51.90	
	Total =	**509.84**	
	Grand Total =	**916.24**	
	=	**9.16 Crores**	

Rupees Nine Crores Sixteen Lakhs Only

COST OF A-PRELIMINARIES = Rs. 916.24 LAKHS

Executive Engineer
KNNL, Kalasa Project Division
Khanapur

KARNATAKA NEERAVARI NIGAM LIMITED
BHANDURA NALA DIVERSION SCHEME
B-LAND ACQUISITION

No.	Details of land	Unit	Bandura	Remarks
1	**Diversion Dam**			
a.	Total area required for seating of diversion Dam submergence	**Ha**	**16.92**	
b.	The extent of forset land required for seating of diversion Dam submergence	**Ha**	13.26	
c.	The extent of revenue land required for submergence	**Ha**	3.66	
2	**Jack well cum pump house, Rising main, Delivery chamber and eletrical sub station**			
a.	Total area required for Jack well cum pump house, Rising main , Delivery chamber and eletrical sub station	Ha	**13.47**	
b.	The extent of forset land required for Jack well cum pump house, Rising main and eletrical sub station	Ha	2.85	
c.	The extent of revenue land required for Jack well cum pump house, Rising main and eletrical sub station	Ha	10.62	
3	**Power line**			
a.	Total length of power line	m	14465	
b.	Length of power line under forest area	m	1345	
c.	Length of power line under revenue area	m	13120	
d	Land width required for 110 kV transmission line (clearance B/w conductor & tree is 2.8 m & 0.45m b/w phase) for tower reach = (L) x 22m(W) **Revenue land**	Ha	28.86	1.OHT Length for Bandura=13120 m
e	Land width for UG cable -1.20m(W) X m(L) in **Forest land**	Ha	0.16	1.UG cable Length for Bandura =1345 m
3	**Total forest land required =**	Ha	**16.27**	
4	**Total revenue land required =**	Ha	**43.14**	
5	**Total land required for Kalasa and Haltara =**	Ha	**59.42**	

Sl No.	Particulars	Unit	Quantity (Ha)	Rate (Rs. In Lakhs)	Cost (Rs in Lakhs)
1	Acquisition of land for Diversion Dam, Rising main Alignment, Jack well cum Pump house and submergence etc.,				
	i) Revenue Land	Ha	43.14	40.00	1725.76
	ii) Alternative revenue land for afforestation	Ha	16.27	11.64	189.40
2	Crop conpensation	Ha	0.6	30.00	18.00
3	Solatium charges for compulsory acquisition for 30% of the cost of revenue land				574.55
4	Establishment charges at 6.25%of revenue land cost				107.86
5	Interest rate between award and actual payment @ 12% on cost of revenue land per anum, for 1 year				459.64
6	Litigation charges at 4.00% of revenue land cost				76.61
7	Relocation of communications like roads, telegraphic etc (lum sum considered)				300.00
8	Joint measurement charges and rounding				100.00
				Total=	**3551.81**

COST OF B-LANDS FOR DAM AND ALLIED WORKS Rs.3552 LAKHS

GRAND TOTAL = 3551.81 = 3551.81 Lakhs
= 35.52 Crores

Rupees Seven Crore and Five Thousand Only

COST OF B-LANDS : Rs.3552 LAKHS

Executive Engineer
KNNL, Kalasa Project Division
Khanapur

KARNATAKA NEERAVARI NIGAM LIMITED
BHANDURA NALA DIVERSION SCHEME
C-WORKS
ABSTRACT

Sl No.	Description	Amount (Rs in Lakhs)	Remarks
I.Diversion Dam			
1	Construction of Diversion Dam across Bhandur Nala near Nerse Village of Khanapur Taluk.	1291.01	
II.Construction of Lift Scheme			
A	**Electromechanical works**		
1	Pumping Machinery and Pump house electrical works 5 No's (4 working + 1 Standby) Vertical Turbine pumps of capacity 3300 HP. Static head = 54.50 m, Pump Head = 70.0 m Discharge per pump = 2.65 m3/s, 9540 m3/hr).	3645.14	
2	Construction of 110/6.6 KV Electrical sub station with 2 No's (1working+1standby) 12.5 MVA capacity Transformer including construction of Terminal Bay and Erection of 110 KV SC line using DC towers (13.5 km) & UG cable of single core 630 sqmm (1.5 Km) from nearest KPTCL substation (Khanapur). Erection of terminal bay at MK hubli KPTCL substation & stringing of second circuit on existing DC towers for a lenght of 24 km from MK Hubli KPTCL substation to Khanapur KPTCL substation. Total lenght of power line to be drawn = 15.0 km Length of power line in revenue land = 13.12 km Length of power line in forest land = 1.345 km Length of power line adopted for UG cable = 1.5 km Length of power line adopted for Overhead tower = 13.5 km Cost per km considered for overhead tower = 75 Lakhs Cost per km considered for 1 core 630 sqmm UG cable = 400 Lakhs	2715.49	
	Total Part A =	**6360.63**	
B	**Civil Works**		
1	Construction of Intake forebay & Jack well cum pump house for housing 4 working + 1 stand by Vertical Turbine pumps.	1308.39	

Sl No.	Description	Amount (Rs in Lakhs)	Remarks
2	Construction of Rising main: 1 row of 2600 mm of inner diameter of 16.1 mm thickness of MS E-250 grade Pipe for a length of 14.58 Km. Pipe coating of fibres, coal tar and solvent based rubber modified bituminous primer	29089.29	
2	Contruction of Delivery chamber at the end of Rising Main.	11.43	
	Total Part B =	**30409.11**	
C	**Maintenance**		
1	Operation and Maintenance of the Scheme for 5 years.	276.00	
	Total Part C =	**276.00**	
D	**Statutory Deposits**		
1	KPTCL Deposits, Electrical Inspection charges.	300.00	
2	Add 3% contingency for work portion.	1150.10	
	Total Part A+B+C+D+E	**38636.75**	
		386.37 Crores	

Rupees Three Hundred OneCrores and Twenty Lakhs Only

COST OF C-WORKS Rs.38636.75 LAKHS

Executive Engineer
KNNL, Kalasa Project Division
Khanapur

KARNATAKA NEERAVARI NIGAM LIMITED

BANDURA NALA DIVERSION SCHEME

Diversion of Bandura Nala by Providing Lift Scheme

GENERAL ABSTRACT - ALTERNATE - 1

No.	Description of Work	Estimated Cost in Lakhs (At 2021-22 price level)	Remarks
1	Pumping Machinery and Pump house electrical works 5 No's (4 working + 1 Standby) Vertical Turbine pumps of capacity 3300 HP. Static head = 54.50 m, Pump Head = 70.0 m Discharge per pump = 2.65 m3/s, 9540 m3/hr).	3645.14	
2	Construction of 110/6.6 KV Electrical sub station with 2 No's (1working+1standby) 12.5 MVA capacity Transformer including construction of Terminal Bay and Erection of 110 KV SC line using DC towers (13.5 km) & UG cable of single core 630 sqmm (1.5 Km) from nearest KPTCL substation (Khanapur). Erection of terminal bay at MK hubli KPTCL substation & stringing of second circuit on existing DC towers for a lenght of 24 km from MK Hubli KPTCL substation to Khanapur KPTCL substation. Total length of power line to be drawn = 14.465 km Length of power line in revenue land = 13.12 km Length of power line in forest land = 1.345 km Length of power line adopted for UG cable = 1.5 km Length of power line adopted for Overhead tower = 13.5 km Cost per km considered for overhead tower = 75 Lakhs Cost per km considered for 1 core 630 sqmm UG cable = 400 Lakhs	2715.49	
3	Construction of Diversion Dam across Bandura Nala.	1291.01	
4	Construction of Intake forebay & Jack well cum pump house for housing 4 working + 1 stand by Vertical Turbine pumps.	1308.39	
5	Construction of Rising main: 1 row of 2600 mm of inner diameter of 16.1 mm thickness of MS E-250 grade Pipe for a length of 14.58 Km.	28065.20	
6	Pipe coating of fibres, coal tar and solvent based rubber modified bituminous primer	1024.09	
	Total cost of Rising Main (5+6) =	29089.29	
7	Contruction of Delivery chamber at the end of Rising Main.	11.43	
8	Operation and Maintenance of the Scheme for 5 years.	276.00	
	Total for work portion=	**38336.75**	

No.	Description of Work	Estimated Cost in Lakhs (At 2021-22 price level)	Remarks
9	KPTCL Deposits, Electrical Inspection charges.	300.00	
10	Add 3% contingency for work portion.	1150.10	
	Total Estimated Cost =	**39786.85 Lakhs**	
	Other Miscellaneous Rounding off =	**3.15 Lakhs**	
	Grand Total without GST =	**39790.00 Lakhs**	
	Total GST =	**4833.60 Lakhs**	
	Grand Total with GST =	**44623.60 Lakhs**	
	Grand Total =	**446.24 Crores**	

Consultant,
E I Technologies Private Limited,
Bengaluru.

Executive Engineer,
KNNL, Kalasa Project Division,
Khanapur.

Superintending Engineer,
KNNL, MLBCC Circle,
Naviluteertha.

The Chief Engineer,
KNNL, Malaprabha Project Zone,
Dharwad.

KARNATAKA NEERAVARI NIGAM LIMITED
BHANDURA NALA DIVERSION SCHEME
D-REGULATORS
ABSTRACT

Sl No.	Description	Amount (Rs in Lakhs)	Remarks
	COST OF D-WORKS NILL		

Executive Engineer
KNNL, Kalasa Project Division
Khanapur

KARNATAKA NEERAVARI NIGAM LIMITED

BHANDURA NALA DIVERSION SCHEME

E-FALLS

ABSTRACT

Sl.No.	Item of Work	Amount (Rs. in Lakhs)	Remarks

COST OF E-WORKS NILL

Executive Engineer
KNNL, Kalasa Project Division
Khanapur

KARNATAKA NEERAVARI NIGAM LIMITED
BHANDURA NALA DIVERSION SCHEME
F-CROSS DRAINAGE WORKS
ABSTRACT

Sl No.	Description	Amount (Rs. in Lakhs)	Remarks
1	Across Singarnala along approach road to Right bank of Diversion Dam	400.00	
	TOTAL	**400.00**	
	Say =	**4.00 Crores**	

Rupees Two Crores and Fourty Lakhs Only

COST OF C-WORKS Rs.400.00 LAKHS

Executive Engineer
KNNL, Kalasa Project Division
Khanapur

KARNATAKA NEERAVARI NIGAM LIMITED
BHANDURA NALA DIVERSION SCHEME
G-BRIDGES
ABSTRACT

COST OF G-WORKS NILL

Executive Engineer
KNNL, Kalasa Project Division
Khanapur

KARNATAKA NEERAVARI NIGAM LIMITED
BHANDURA NALA DIVERSION SCHEME
GENERAL ABSTRACT
K-BUILDINGS

Sl No.	Particulars	Nos	Plinth area Sqmt	Rate per Sqmt Rs. Lakhs	Cost (Rs in Lakhs)	Remarks
I. Non - Residential Buildings						
1	SCADA remote control operation Building	1	50.0	2.00	100.00	
				Total for Non-Residential buildings	**100.00**	
Residential Buildings						
2	Inspection bunglow	2	50.0	2.00	200.00	
3	Residential quarters- C Type	9	15.0	2.00	270.00	
4	Residential quarters- D Type	12	12.5	2.00	300.00	
				Total for Residential buildings	**770.00**	
			Miscellaneous works			
14	Land levelling				300.00	Lum sum considered
15	Fencing around the colony				200.00	
				Grand Total	**1370.00**	
					13.70 Crores	

Rupees Thirteen Crores and Sevety Lakhs only

COST OF K- BUILDINGS : Rs.1370 LAKHS

Executive Engineer
KNNL, Kalasa Project Division
Khanapur

KARNATAKA NEERAVARI NIGAM LIMITED
BHANDURA NALA DIVERSION SCHEME
L-EARTHWORK AND LINING

Sl No.	Description	Amount (Rs. in Lakhs)	Remarks
	COST OF L-WORKS NILL		

Executive Engineer
KNNL, Kalasa Project Division
Khanapur

KARNATAKA NEERAVARI NIGAM LIMITED
BHANDURA NALA DIVERSION SCHEME

M - PLANTATION

Sl No.	Particulars	Unit	Quantity	Rate(Rs. In Lakhs)	Cost (Rs in Lakhs)
1	Plantation along the perifery of the submergence area	Km	5.50	0.50	2.75
2	Plantation along the approach road and at colonies.	Ha	5.00	25.00	125.00
3	Providing afforestation and planting trees for diverted forest land.	Ha	7	2.25	15.75
				Total=	**143.50**
				Say =	**1.44 Crores**

Rupees One Crore Fourty Four Lakhs Only

COST OF M-PLANTATION : Rs.144 LAKHS

Executive Engineer
KNNL, Kalasa Project Division
Khanapur

KARNATAKA NEERAVARI NIGAM LIMITED
BHANDURA NALA DIVERSION SCHEME

O - MISCELLANEOUS

Sl No.	Items	Unit	Quantity	Rate (Rs)	Amount (Rs)
1	Capital cost				
2	Telegraphs and Telephone Equipments	No	30.00	3000.00	90,000 / -
3	Maintenance and service	Job	1.00	50000.00	50,000 / -
4	Wireless/mobile phones at all sites one near Bhandura Diversion Dam ,one @ intake structure division office and one each at division & sub division	No	4.00	10000.00	40,000 / -
5	Electrification	Job	1.00	500000.00	5,00,000 / -
6	Water supply	Job	1.00	100000.00	1,00,000 / -
7	Sewage disposal	Job	1.00	100000.00	1,00,000 / -
8	Fire fighting equipments	Job	1.00	200000.00	2,00,000 / -
9	Maintenance and service	Job	1.00	100000.00	1,00,000 / -
13	Security	Year	3.00	200000.00	6,00,000 / -
	Other items				
1	Visit of dignitaries.	LS			5,00,000 / -
2	Records	LS			2,00,000 / -
3	Compensation to work men	LS			3,00,000 / -
4	Boundary marking	LS			5,00,000 / -
5	Models	LS			10,00,000 / -
6	Publicity	LS			5,00,000 / -
7	Providing flood warning system	LS			5,00,000 / -
8	Retrenchment	LS			5,00,000 / -
		Total =		**Rs.**	**57,80,000 / -**
				Say	**57,80,000 / -**
				=	**57.80 Lakhs**

Rupees Fifty Seven Lakhs Eighty Thousand Only

COST OF O- MISCELLANEOUS DAM WORKS Rs. 57.80 Lakhs

Executive Engineer
KNNL, Kalasa Project Division
Khanapur

KARNATAKA NEERAVARI NIGAM LIMITED
BHANDURA NALA DIVERSION SCHEME
P – MAINTENANCE

Sl.No.	Item of work	Quantity	Rate	Amount (Rs. in Lakhs)
1	Maintenance & repairs for the Dam and appurtenant works during construction.	2 years	10.00 / Yr	20.00
2	Maintenance of approach roads/Quarry/colony roads etc, for 5 years	16 Kms.	9.60	768.00
3	Maintenance to building including water supply & sanitary service.i.e. at 1% for temporary building (2.232 Lakhs/year.)	5 years	2.232	11.16
4	Maintenance of machinery during execution & idle period.	5 years	9.60	48.00
5	Running expenses of telephones.	5 years	3.60	18.00
			TOTAL Rs.	**865.16**
			Say =	**8.65 Crores**

Rupees Eight Crores and Sixty Five Lakhs Only

COST OF P – MAINTENANCE Rs. 865.16 Lakhs

Executive Engineer
KNNL, Kalasa Project Division
Khanapur

KARNATAKA NEERAVARI NIGAM LIMITED

BHANDURA NALA DIVERSION SCHEME

Q- SPECIAL TOOLS AND PLANTS

Sl No.	Description	Amount Rs. (In Lakhs)	Remarks
1	Vehicle required for KNNL officials	35.00	
	Total=	**35.00 Lakhs**	

Rupees Thirty Five Lakhs only

COST OF Q- SPECIAL TOOLS AND PLANTS Rs. 35.00 Lakhs

Executive Engineer
KNNL, Kalasa Project Division
Khanapur

KARNATAKA NEERAVARI NIGAM LIMITED
BHANDURA NALA DIVERSION SCHEME

R - COMMUNICATION

No.	Road Name	Length, Km	Lane Configuration	Cost/Kmin Rs. Crore as per MoRTH Guidelines	Adopted Rate per Km (70% of Rates)	Total Amount, Rs. Crores
1	Approach Road 1					
a	Approach road from Nerse village to Bhandura Diversion Dam	5.6	Intermediate Line	2.49	1.74	9.76
	Total Length = 5.60 km					**9.76**
					Say =	**9.76**
					Grand Total =	**976 Lakhs**

Rupees Nine Crores and Sevety Six Lakhs Only

COST OF R-COMMUNICATION FOR DIVERSION Dam WORKS : Rs.976.00 LAKHS

Executive Engineer
KNNL, Kalasa Project Division
Khanapur

CAUVERY NEERAVARI NIGAM LIMITED
BHANDURA NALA DIVERSION SCHEME
X - Environment and Ecology

Sl.No	Description	Amount (Rs Lakhs)
A. Construction Phase		
1	Environmental safeguard measures to control air, noise and water pollution	9.50
2	Restoration of construction site /Green belt development	33.00
3	Public health delivery system	6.00
4	Sanitation and Solid waste management plan	4.00
5	Environmental monitoring programme	50.60
	Total, A	**103.10**
B. Operation Phase		
6	Catchment area treatment plan	600.00
7	Local area development plan	47.00
8	Restoration of construction site /Green belt development	33.00
9	Fisheries conservation and management plan	25.00
10	Environmental monitoring programme	50.60
11	Reservoir RIM Treatment	12.00
12	Energy conservation measures	3.00
13	Compensatory Afforestation* (16.27Ha x Rs. 1.12 Lakhs)	18.27
14	Net Present Value+	
i	for Tropical semi evergreen forests- Western Ghats for Moderately dense forest type) classified under reserved forest = 16.27 Ha x 4,68,590/-	76.24
15	Wildlife Management Plan	75.00
	Total, B	**940.11**
	Grand Total (A+B)	**1043.21**
	Grand Total	**1043.21**
		10.43 Crores

Rupees Ten Crores and Fourty Three Lakhs Only

COST OF X - ENVIRONMENT AND ECOLOGY Rs. 1043.2 Lakhs

*- Compensatory afforestation considered for 16.27 Ha at Rs. 1,12,000/- per Ha

+ - for Tropical semi evergreen forests- Western Ghats for Moderately dense forest type) classified under reserved forest for 16.27 at Rs. 4,68,590/-

Executive Engineer
KNNL, Kalasa Project Division
Khanapur