EXECUTIVE SUMMARY

1. GENERAL

Kanhar Barrage Project, Garhwa, Water Resources Department, Govt. of Jharkhand approved by Advisory Committee of Ministry of Water Resources, River Development & Ganga Rejuvenation on Irrigation, Flood Control and Multipurpose Projects.

Estimated Cost	:	Rs. 190884.46 Lakhs (PL 2016-17)
CCA	:	53,283 ha
Annual Irrigation	:	53,283 ha (only Khariff Irrigation) from the project No Rabi
Intensity of Irrigation	:	100 %
B.C. Ratio	:	1.07

2. INTRODUCTION

Kanhar barrage project envisages construction of a barrage on river Kanhar near village Khuri (Lat $83^0$32'05"E and Long $23^0$57'8"N) under Chinia Block of Garhwa district in Jharkhand, around 12 kms downstream of earlier proposed dam site at Baradih. River Kanhar is one of the major right bank tributary of river Sone. Bansagar agreement was signed in 1973 followed by Kanhar water sharing agreement in 1982. Among water sharing states in which Bihar (now Jharkhand) state was allowed to utilize 0.43 MAF for its use at Baradih. The then Government of Bihar had prepared a detailed project report in 1984 for Kanhar Reservoir Project which primarily was a reservoir project with a earthen dam at Baradih followed by main trunk canal negotiating a 100.0 m fall at Lawadoni and thereafter two canals emanating from the lower forebay at Lawadoni. The reservoir project was conceived to irrigate about 67,000 Ha of Land in Garhwa & Palamu district of the then Bihar with provision for pumped hydro power generation of 302.00 MW by utilizing the 100.0m fall near village Lawadoni.

The project was deliberated at various levels since 1984 including the then state of Madhya Pradesh (now Chhatisgarh) through CWC, New Delhi. The idea for construction of a high dam at Baradih had not been agreed by Govt. of Chhatishgarh due to large scale submergence in the state of Chhatishgarh and hence alternative options were explored to bring the Kanhar water to the fields of Garhwa district on Jhrakhand side without creating any significant submergence on Chhatisgarh side. Alternative study had been carried out for achieving this objective and thus a way was found in 2008 whereas construction of barrage was mooted with moderate height thus creating minimum submergence to the chhatishgarh territory. Care has been taken to choose the full Supply Level of the barrage so that there shall be no submergence of any of the villages on Chhatishgarh side as well as uninterrupted drainage on the left bank of Kanhar river in the vicinity of barrage.

Serious prefeasibility study started in the year 2008 by WRD, Govt. of Jharkhand, which was based on the premise and pre-requisite to devise an alternative arrangement without creating any submergence on the Chhatishgarh site. Thereafter Pre-feasibility study of Kanhar Barrage Project has been done by Water Resources Department, Government of Jharkhand in the same year of 2008. During this period some alternatives were mooted and pre-feasibility analysis resulted in concluding for construction of Barrage near Khuri village in Chinia Block of Garhwa district about 12 km downstream of Baradih with two low level canals emanating from Lawadoni after traversing a fall of about 60.0m. The lower canal system emanating from Lawadoni forebay shall follow almost follow the same alignment as decided in 1984.

In the meantime a PIL was filed in the Hon'ble High court of Jharkhand, Ranchi for early execution of the scheme which could provide irrigation facilities as well as drinking water to the people of Garhwa district and nearby one block in the adjoin district of Palamu in the state of Jharkhand.

In the light of the PIL, the Jharkhand Government finally took a decision to abandon the project of dam construction due to large scale social repercussions of the project and non-agreement on behalf of the Government of Chhattisgarh (erstwhile Madhya Pradesh) and obtaining their consent on the dam project.

Hon'ble High Court of Jharkhand referred the matter to CWC, (Superintending Engineer - Planning, Faridabad) in the year 2011 for preparation of a Feasibility Report for suggesting alternative proposal.
The PFR was prepared by CWC, Planning Circle, Faridabad, with a barrage proposed at Khuri village, the diverted water shall be carried through a trunk canal to Lawadoni and two canals from left & right shall emanate from Lawadoni after negotiating a natural fall of 60.0m. The Culturable Command Area (CCA) in the feasibility report, under the left main canal system had been envisaged to be 42,321 ha and that under the right main canal system is 8,703 ha. The total CCA under the Kanhar irrigation system has thus been envisaged as 51,024 ha which was to be verified and confirmed in accordance with the detailed Irrigation planning during preparation of the Detailed Project Report (DPR). The prefeasibility report (PFR) as prepared by CWC, Faridabad had been appraised by CWC, New Delhi and their consent on the PFR had been issued vide CWC letter no.CWC U.O No.13/81/2013-PA(N)/2417-20 Dated 22.11.2013 confirming "in principle consent for preparation of DPR".

Thereafter, Water Resources Department (WRD), Govt. of Jharkhand had contracted Lahmeyer International (India) Pvt. Ltd. (Now Tractebel) as Consultant for preparation of Detailed Project Report (DPR) for Kanhar Barrage Project in Garhwa district of Jharkhand state. An agreement had been signed on 13thJune 2014 between WRD, Govt. of Jharkhand & Lahmeyer International India Pvt. Ltd. for preparation of DPR of Kanhar Barrage Project.

3. PROJECT PROPOSAL

The Detailed Project Report of Kanhar Barrage Project with barrage site at Khuri has been prepared largely with respect to the laid down conditions of the above referred letter as well as in accordance with guidelines of MOWR-2010 for preparation of DPR. The DPR had been submitted to WRD, Govt. of Jharkhand and the project layout and design works had been thoroughly examined in the Central Design Organization (CDO) of Water Resources Department, Govt. of Jharkhand before its submission to CWC, New Delhi with their endorsement in the prescribed format. The project layout & brief description of various components are described in the following section.

Kanhar Barrage Project envisages construction of a barrage across Kanhar River near Khuri village to impound the water up to the Full Reservoir Level (FRL) of EL. 368.60 m. The average River Bed Level is 361.00m. This will enable diversion of river water to the Main trunk canal (MTC) through right bank. A 17.10 km long Main Trunk Canal (MTC) originate from the right bank, upstream of the barrage and shall terminate in reservoir upstream of Lawadoni village after negotiating a 60.0m natural fall just upstream of the reservoir. An Earthen Dam (29.58 m height) with an ungated chute spillway, located on right bank, has been proposed at Lawadoni. Lawadoni reservoir shall act as a balancing reservoir and enable diversion of kanhar water to the Left Main Canal (LMC) and Right Main Canal (RMC).

Both the left and right main canal emanates from reservoir at Lawadoni. Total length of the left main canal (LMC) and the right main canal (RMC) are 82.227 km and 46.973 km respectively. A branch canal, called "Pratappur Branch Canal" emanating from LMC at RD.20.62 km and this is 25.70 km long. Endeavour has been made to avoid forest land and settlements in deciding the alignment to the best possible extent. Alignment in cutting has been preferred better over canal in filling. Left main Canal (LMC)/ Right Main Canal (RMC)/ Pratappur or Kholra Branch Canal (PBC) have been proposed as lined canal and the rest of the distribution system have been proposed unlined.

The Main Trunk Canal (MTC) is a carrier canal and has same section throughout the entire length. The Left Main Canal (LMC) has been divided in six reaches. The Right Main Canal (RMC) has been divided in three reaches and the Pratappur/ Kholra Branch Canal in four reaches. The canal design is based on Kennedy's theory for non-silting velocity and hence V/Vo has been kept more than unity. The velocity has been calculated by Manning's formula for certain assumed section, so as to ensure that assumed section is sufficient enough to take the designed discharge. Capacity Statement has been prepared and the canal carrying capacity is summarized in the table below:

Sl No.	Particulars	Reach	Length of Canal (Km)	Canal Carrying Capacity at 0.00M (In Cumec)
1.	Left Main Canal (LMC)	06	82.227	47.36
2.	Right Main Canal(RMC)	03	46.973	16.30
3.	Pratappur or Kholra Branch Canal	04	25.70	14.97 (Start at Rd 20.62km -LMC)

It had been established through present detailed project study that the CCA is 53,283 (LMC=42,221.80 Ha & RMC=11061.20 Ha).The arrangement of khuri barrage & lawadoni dam shall facilitate irrigation facility to 10 blocks in Garhwa District & one block in Palamu district of Jharkhand. There are total 11 beneficiary blocks.

The project will have a live storage capacity of 2.90 MCM of water at Khuri Barrage and 3.39 MCM at intermediate reservoir at Lawadoni. The proposed command area of Kanhar Barrage Project extends within its right main contour canal in south, Left main contour canal in west, Sone River in north and North Koel River in east. The total GCA under the command is 1,02,300 ha. The Geographical area of the culturable command falling in different blocks under Palamu and Garhwa district are listed in the table along with the culturable command area (CCA) in hectare (Ha) as shown below:

SL. NO.	DISTRICT	BLOCK	LMC (CCA) (IN HA)	RMC (CCA) (IN HA)	TOTAL CCA (IN HA)
1	Garhwa	Garhwa	3,761.90	5,318.10	9,080.00
2	Garhwa	Meral (Pipra Kalan)	10,287.30	2,466.50	12753.80
3	Garhwa	Ramna	5,592.60	0.00	5,592.60
4	Garhwa	Dandai	2,859.30	2,111.00	4,970.30
5	Garhwa	Nagaruntari	4,342.10	0.00	4,342.10
6	Garhwa	Bishunpura	3,416.80	0.00	3,416.80
7	Garhwa	Kandi	2,865.70	0.00	2,865.70
8	Garhwa	Majhiaon	1810.00	0.00	1810.00
9	Garhwa	Ketar	3,742.10	0.00	3,742.10
10	Garhwa	Bhawnathpur	3544	0.00	3544

SL. NO.	DISTRICT	BLOCK	LMC (CCA) (IN HA)	RMC (CCA) (IN HA)	TOTAL CCA (IN HA)
11	Palamu	Chainpur	0.00	1,165.80	1,165.80
		Total	**42,221.60**	**11,061.40**	**53,283.00**

The whole of the command area of this project fall under severe draught prone zone and there are several reservoirs in Garhwa district which are water deficient since its inception and therefore WRD, Govt. of Jharkhand has an opportunity to augment these reservoirs for its core utilization for irrigation purpose as well as supplying drinking & municipal supply. Water for Industrial purpose for upcoming thermal power station in Bhawanathpur has also been allocated and considered for upcoming industry in light of availability of water. Industrial water is to be supplied for industry from canal system as and when this is available in the Kanhar river mostly in monsoon months and as such separate storage system shall be constructed by the user agency at their cost as per the standard practice.

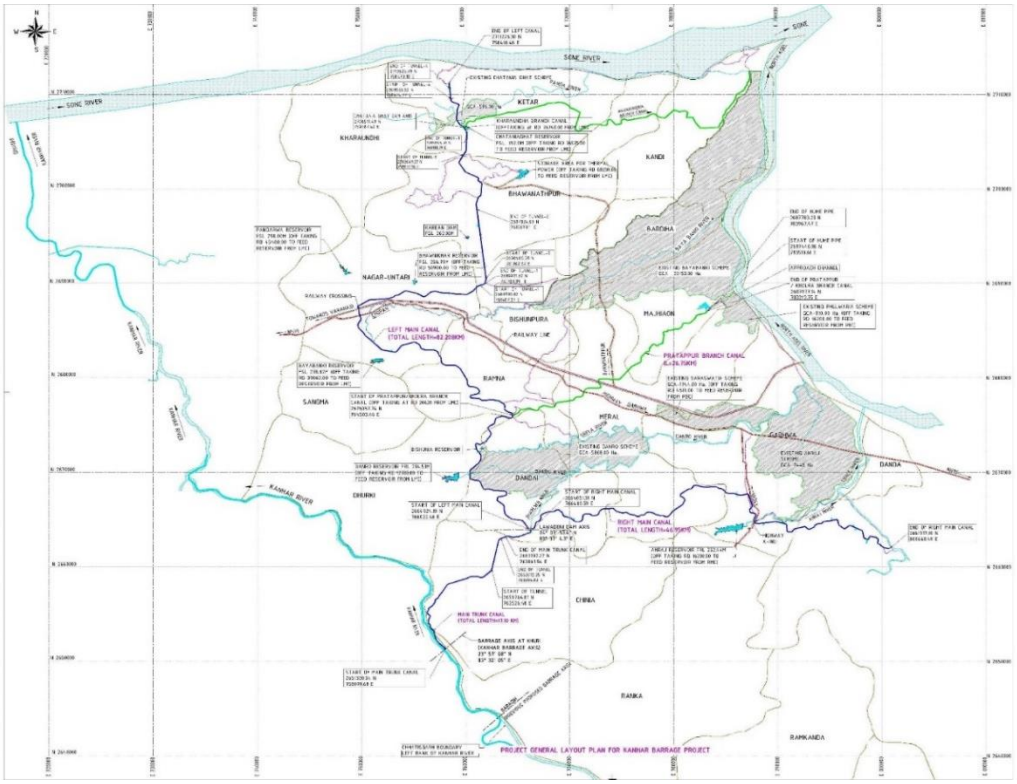
3.1. The Project Components & Capacity

Kanhar Barrage Project envisages construction of barrage across Kanhar River near Khuri village / Earthen dam at Lawadoni as balancing reservoir & canal system. The detailed survey of the project area has been carried out as per the BIS code. Kanhar Barrage Project has following components with twin storage locations firstly at Khuri Barrage & the other location is Lawadoni dam. Project components are listed as below:

i) Barrage (12.5m high and 224.0m long) across Kanhar River at Khuri village with FRL at EL368.60M.
ii) Intake Structure at Right Bank Enabling Diversion of Kanhar Water to Main Trunk Canal (MTC).
iii) 17.10 km long Main Trunk Canal (MTC) originating from the right bank and terminating into reservoir at Lawadoni.
iv) Earthen Dam (Balancing Reservoir) of 29.58m high at Lawadoni.
v) 60.0m natural fall at Lawadoni Reservoir site negotiated through a chute spillway and energy dissipater.
vi) Ungated Chute Spillway at Right Bank.
vii) Two Canals namely Left Main Canal (LMC) and Right Main Canal (RMC) emanating from Lawadoni Reservoir.
viii) Length of the Main Trunk Canal (MTC) is 17.10 Kms – Lined Canal (One Reach).
ix) Length of the Left Main Canal (LMC) is 82.227 Kms – Lined Canal (Six Reach).
x) Length of the Right Main Canal (RMC) is 46.973 Kms – Lined Canal (Three Reach).
xi) Length of “Pratappur Branch Canal (PBC)” is 25.70 Kms – Lined Canal (Four Reach).
xii) PBC offtakes from LMC at RD.20.62 Kms – Lined Canal.
xiii) The distribution system comprising Distributory/Minor/Subminors etc. are unlined.
xiv) The canal design is based on Kennedy’s theory for non-silting velocity and hence V/Vo has been kept more than unity.
xv) The velocity has been calculated by Manning’s formula so as to ensure that assumed section is sufficient enough to take the designed discharge.
xvi) Capacity Statement has been prepared and the canal carrying capacity is summarized in the table below:

SL No	Particulars	Length (Kms)	Reach	Discharge in Cumecs
1)	MTC	17.10	1	63.66
2)	LMC	82.227	6	47.36
3)	RMC	46.973	3	16.30
4)	PBC	25.70	4	14.97

A project Index Plan is shown below:



Capacity at Khuri Barrage in MCM & various levels are given below:

1) Pond level at Khuri Barrage - 368.60 M
2) Live storage capacity - 02.90 MCM

Capacity at Khuri Barrage in MCM & various levels are given below:

1) Pond level at Lawadoni Dam - 307.00 M
2) Dead Storage Level - 289.40 M
3) Live storage capacity - 3.39 MCM

3.2. Design of Barrage

The design of barrage has been done in light of approved hydrology from CWC, New Delhi. The Area Capacity Curve at the Barrage Axis near Khuri village has been considered with optimum FRL at 368.60m has been set to avoid the submergence of any village on the left bank of Chhatishgarh side. Two villages namely **Dongogha** and **Mitri** has an elevation of 370.00m and above. Hence, an elevation of EL 368.60 had been chosen to avoid any submergence in the

state of Chhatishgarh. The MWL is only 368.75m and the total width of barrage comes to be 224.0m.

This arrangement shall considerably reduce the cost of the barrage as well as consent of neighbouring state shall be obtained without any hassle as there is absolutely no rehabilitation/ resettlement issue. There is no submergence of any village on Chhatishgarh side with unobstructed drainage all along the left bank of Kanhar river.

3.3. Effect on Submergence at Barrage Location

The Area Capacity Curve at the Barrage Axis has been developed and the suggested FRL was considered to 368.60m to avoid the submergence of any village on the left bank of Chhatishgarh site. There is no displacement from submergence at Barrage at Khuri or dam at Lawadoni. The design discharge has been taken as 4914cumec corresponding to 100 yrs return period flood in view of hydraulic head being less than 12.0m.

The submergence in case of FRL at 368.60m shall be 115.44 Ha respectively. The detail of submergence has been worked out at proposed FRL of EL 368.60m. The live storage at FRL at 368.60m shall be 2.90 MCM which shall not be a deterrent to utilize 530.36 MCM (0.43 MAF) of water (Jharkhand Allocation). As the main trunk canal is a carrier canal with a natural fall of 60.0m at Lawadoni fall location, FRL at the barrage has no impact on the command as all the command for irrigation shall be covered from lower left & right canals after mitigating a 60.0 m natural fall at Lawadoni. The salient features of the barrage design is shown in Table below.

SL. NO.	DESCRIPTION	UNIT	PARAMETER
1.	Crest level of Undersluice Bays	m	361.00
2.	Crest level of Other Barrage Bays	m	362.00
3.	Number of Undersluice Bays	Nos.	02
4.	Total Number of Bays	Nos.	12
5.	Size of opening for Undersluice Bays	m	12.0 (W) × 7.6 m (H)
6.	Size of opening for Other Barrage Bays	m	12.0 (W) × 6.6 m (H)
7.	FRL (m)	EL	368.60
8.	MWL (m)	EL	368.75
9.	Top of Barrage (up to bridge deck) (m)	EL	370.75
10.	Type of Gate		Vertical Lift Gates
11.	Width of Mid pier (single)	m	3.50
12.	Width of Mid pier (double)	m	4.00
13.	Width of end piers	m	2.5 m
14.	Thickness of the u/s barrage floor	m	2.0 m
15.	Total width of barrage at top	m	224.00

The submergence detail at Khuri barrage location along with land requirement of forest and non-forest land with respect to FRL at EL368.60m is produced in Table as below.

Sl No	Area	Particulars	Total Land Requirement (Ha)				
			Non Forest		Forest		Total
			Chhatishgarh	Jharkhand	Chhatishgarh	Jharkhand	
1	Barrage	Submergence Area in River Bed	9.32	10.43	51.72	44.98	116.44

3.4. Canal Distribution System

The construction of barrage shall enable diversion of river water to the Main trunk canal (MTC) through right bank. A 17.10 km long Main Trunk Canal (MTC) originate from the right bank, upstream of the barrage and shall terminate in Lawadoni reservoir upstream of Lawadoni village. An Earthen Dam (29.58 m height) with an ungated chute spillway, located on right bank, has been proposed at Lawadoni. This will enable diversion of river water to the lower Left Main Canal (LMC) and Right Main Canal (RMC). The proposed command area of Kanhar Barrage Project extends within its right main contour canal in south, Left main contour canal in west, Sone River in north and North Koel River in east.

Both the left and right main canal emanates from reservoir at Lawadoni. Total length of the left main canal (LMC) and the right main canal (RMC) are 82.227 km and 46.973 km respectively. A branch canal, called “Pratappur Branch Canal” emanating from LMC at RD.20.62 km and this is 25.70 km long. Endeavour has been made to avoid forest land and settlements in deciding the alignment as far as possible. Alignment in cutting has been preferred better over canal in filling. Left main Canal (LMC)/ Right Main Canal (RMC)/ Pratappur or Kholra Branch Canal (PBC) have been proposed as lined canal and the rest of the distribution system are unlined.

The Left Main Canal (LMC) has been divided in six reaches. The Right Main Canal (RMC) has been divided in three reaches and the Pratappur/Kholra Branch Canal in four reaches. The canal design is based on Kennedy’s theory for non-silting velocity and hence V/Vo has been kept more than unity. The velocity has been calculated by Manning’s formula for certain assumed section, so as to ensure that assumed section is sufficient enough to take the designed discharge. Capacity Statement has been prepared and the canal carrying capacity is summarized in the table below:

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1.	Main Trunk Canal (MTC)	01	17.10	63.66
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3.	Right Main Canal(RMC)	03	46.973	16.30
4.	Pratappur or Kholra Branch Canal	04	25.70	14.97 (Start at Rd 20.62km -LMC)

It had been established through present study that the CCA is 53,283 (LMC=42,221.80 Ha & RMC=11061.20 Ha). The project layout and design works had been checked and vetted by Central Design Organization (CDO) of Water Resources Department, Govt. of Jharkhand. The

relevant CDO certificate is issued vide Memo. No. CE/D.M.P & HYD/32/2015-472 dated 25.07.2016 signed by Chief Engineer, Central Design Organization.

4. HYDROLOGICAL ASPECTS

4.1. Water Availability

Kanhar Barrage Project is a diversion scheme on the Kanhar river near Khuri village. The scheme has been designed to divert water at full potential in monsoon season. The water availability at Khuri village Barrage site is derived through study of long term discharge data series of Kanhar River from 1976 to 2013 as obtained through CWC, New Delhi. The catchment area at Khuri Barrage Site is 3375 sq-km.

The Kanhar project has a historical background as discussed in preceding section and the allocation of water has already been decided by Bansagar agreement-1973 followed by its ratification through Kanhar Agreement in 1982. The agreement mandates an allocation for Jharkhand (Erstwhile Bihar) state as 0.43 MAF at Baradih site which is 12 kms upstream of the present Khuri barrage site. The agreement also mandates an allocation of 0.47 MAF of water to Chhatisgarh (erstwhile Madhya-Pradesh) state. The average monsoon rainfall is 970.0mm and the project command is under severe draught prone zone or mostly called a rain shadow area.

4.2. General Condition

The proposed Barrage at Khuri site is a small diversion structure as its gross storage (3.80 MCM) is less than 60 MCM and the hydraulic head is 7.6m which is less than 12.0 m. Hence as per the IS code, the inflow design flood for the barrage should be the flood of 100 yrs return period. SPF has been worked out to decide the upstream freeboard conditions. Also the proposed dam at Lawadoni is a medium diversion structure as its gross storage (3.535 MCM) and live storage (3.39 MCM) is less than 60 MCM and the hydraulic head is less than 30 m.

4.3. Design & Diversion Flood

The design flood at Khuri Barrage Site corresponding to different return period is as follows;

Return Period	Estimated Flood
50 year return period	4084 m^3/s
100 year return period	4914 m^3/s
500 year return period	7146 m^3/s
Standard project Flood	7573 m^3/s
Maximum Probable Flood	NA

The design flood for diversion works has been adopted for 25 years flood of 553 m^3/s, monsoon flood can be passed over the finished concrete portion of concrete spillway. Similarly the Lawadoni reservoir drains a catchment of 7.73 sq-km and a 100 yrs flood value of 105.24 cumec has been envisaged. The Project hydrology has been approved by CWC, New Delhi vide their letter no. 13/81/2013-PA(N)/289 dated 20.03.2015.

5. IRRIGATION PLANNING & CROP WATER REQUIREMENT

Major crops cultivated in Garhwa district are Paddy, Maize, Arhar, etc during Kharif season and Wheat Mustard, Gram, Lentil, Pea and Moong during Rabi season. Total land of 102934 Ha and 42162 Ha is being cultivated during Kharif and Rabi season respectively vide data provided by District Agriculture Officer, Garhwa.

Only Kharif crops are proposed to be cultivated in 53283.00 Ha while Rabi crop has not been proposed because no water can be drawn from January to May from Kanhar river being a sub-basin of Ganga whereby water drawl restrictions are applicable from month of January to May of the year. The intensity of irrigation with respect to CCA is 100%. Preliminary soil survey of the command area has been done and cropping pattern has accordingly been planned by the State Agriculture Department and is found acceptable for planning purpose. The cropping pattern before and after irrigation is compiled in table as below:

Before Irrigation			After Irrigation		
Crop	**Name of produce**	**Area in ha**	**Crop**	**Name of produce**	**Area in ha**
1	**2**	**3**	**4**	**5**	**6**
Kharif	Paddy	28140.00	Kharif	Paddy	20247.54
	Maize	0.00		Maize	20247.54
	Urad	0.00		Urad	6926.79
	Groundnut	900.00		Groundnut	3196.98
	Til	0.00		Til	2664.15
Total		**29040.00**	**Total**		**53283.00**

The crop water requirement has been worked out by Modified Penman method. The total water utilization for 53,283 ha of CCA under Kanhar Barrage scheme comes to 23481.77 Ham. Augmentation of existing Irrigation schemes shall consume 3874.19 Ham of water. The water requirement for drinking, municipal supply & industrial supply has been computed as 7644.00 Ham. Thus total water utilization from Kanhar Barrage Project to meet their irrigation, municipal and Industrial requirement be 34999.96 Ham, the detail are given in table below:

Sl No.	Particulars	Water Requirement (Ha-m)
1.	Water Requirement for Kanhar Barrage Project	23481.77
2.	Augmentation of Existing Irrigation Schemes	3874.19
3.	Water Requirement for drinking, municipal supply	4344.00
4.	Industrial Releases	3300.00
	Total	**34999.96**

Further, the existing schemes lying in the command area of Kanhar Barrage is not meeting their targeted potential. The total deficit of the existing irrigation schemes have been estimated as 3874.19 Ham. After adding this deficit of existing irrigation scheme, total water utilization from Kanhar Barrage Project worked out to be 34999.96 Ham (349.99 MCM) which is well within the allocation of 53060.00 Ham for the state of Jharkhand.

6. INTEGRATION OF EXISTING PROJECTS

Simulation study for irrigation planning integrating with three existing project has been made. The ground water dependability has been reduced as CCA of 53,283 Ha of Kanhar Barrage Project can be irrigated considering support of three existing reservoir, 10.47% of ground water support has been required.

It has been decided through technical evaluation by WRD, Govt. of Jharkhand and directions of High Level Committee on Kanhar Barrage Project (HLC) that three existing reservoirs namely Annaraj/ Danro/ Chataniaghat which is water deficient however located along the proposed canal alignment of Kanhar project, shall be augmented & integrated for simulation study. This will strengthen the existing irrigation schemes in the area by assuring kanhar-water into their reservoir whenever found surplus in the monsoon season. A similar suggestion was also been given by CWC, New Delhi in 2013 while giving in principle approval of the PFR for its onward preparation of DPR.

It had been concluded from the study that, Ground water support is required for some of the 10day period to meet the peak crop water requirement. The total 10 daily ground water requirement after simulation study combining & integrating three existing reservoirs in the command shall be 12.32 MCM. The bifurcation of this requirement in Kanhar Barrage Project shall be 10.57 MCM and the requirement in existing irrigation scheme shall be 1.74 MCM. Similarly the total annual maximum ground water requirement shall be 21.34 MCM having a bifurcation of 18.31 MCM & 3.02 MCM in Kanhar Barrage Project & Existing irrigation schemes respectively. The cost of ground water pumping arrangement has been added in the capital cost whereas the annual pumping cost has been accounted for in the operation and maintenance cost.

6.1. Compilation of Study

Based on inflow for irrigation after releasing the environment flow and integrating three existing reservoirs, 75% success, the summary of different case studies as described is tabulated below:

Sr. No	Case Study	Initial condition of Reservoirs at start of each year	Area for Irrigation of Kanhar project (Ha)	CCA of existing three resv.(Ha)	Total Area for Irrigation (Ha)	GIR for Kanhar project for CCA 53283 ha (Ham)	Total GIR (for CCA of 53283 ha_Kanhar + CCA of 8791 Ha_three res. = 62074 ha) (Ham)	No of Success Yrs.	Max Annual GW support for 75% success rate (Ham)	Max 10- day GW support corresponding to success year (Ham)
1.	Paddy started from 11th June	Khuri Barrage filled and Lawadoni & all three existing Res empty at 11th June of each year	53283	8791	62074	23481.77	27355.95	21	2133.88	1231.71
Kanhar	---	---	53283	---	53283	23481.77	--	---	1831.88	1057.27
Existing Reservoirs	---	---	---	8791	---	3874.19	---	---	302.20	174.44

7. PROVISION FOR DRINKING WATER & INDUSTRIAL WATER SUPPLY

Presently drinking water needs of the villages in the command area is being met from the existing surface water sources, hand pumps and wells. The water requirement for drinking, municipal supply has been computed as 4344.00 Ham. The drinking water requirement has been arrived with respected to projected population in Garhwa district by 2050. The industrial water requirement has been assessed as 3300.0 Ham of water has been allocated for an upcoming Thermal Power Station in Bhawanathpur being pursued by Jharkhand State Electricity Board. A demand had been raised by the authorities and the supply of water shall be at one

point during the monsoon when there is excess discharge more than the crop water requirement. The thermal power unit shall make their own arrangements for storage & utilization of water.

8. CAD works & Agriculture aspect

Kanhar DPR has been examined by Department of Agriculture, cooperation & Farmers welfare Crop Division under Ministry of Department of Agriculture & Farmers welfare and it had been suggested that Kanhar Barrage Project, Jharkhand may be incorporated under State Irrigation Plan (SIP)/ District Irrigation Plan (DIP) and duly approved by SLPP. The state may follow the guidelines of Pradhan Mantri Krishi Sinchai Yojna (PMKSY) for implementing Irrigation Projects.

The state Govt. may be advised of Water saving devices like sprinklers, Drip Irrigation to cover maximum area under irrigation in the project area. The DPR of Kanhar Barrage Project also consists of separate CAD document and “on farm development” has been submitted as Chapter-10 of the DPR.

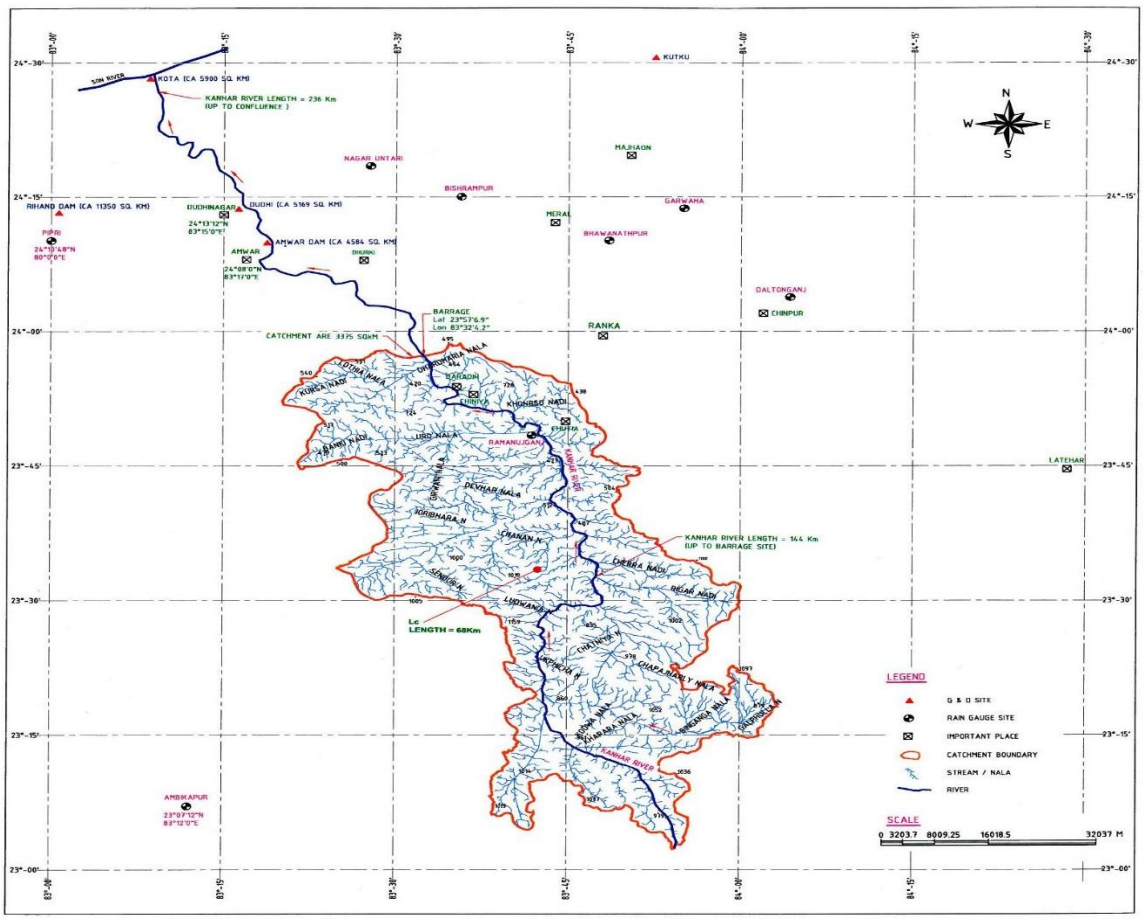
9. INTER STATE ASPECTS

The project falls in Sone Basin. The catchment of the whole river system is surrounded by the Vindhachal range in the North, the Punpun river system and the Chotanagpur plateau on the East, the Baghelkhand plateau and the Mahadeva hills on the South and the forest clad Maikal and Bhamver ranges on the West. After flowing a distance of 655 km. through the states of Chhattisgarh, Madhya Pradesh and Uttar Pradesh, the river Sone enters in Jharkhand. Its important tributaries lying in these states of Chhattisgarh, Madhya Pradesh, Uttar Pradesh and Jharkhand are Johilla, Mahanadi, Banas, Gopad, Rihand, Ghagher, Kanhar and North Koel. The river Kanhar which flows South to North and in the downstream reach forms boundaries between Jharkhand, Uttarpradesh and Chhatishgarh. After meeting with the river Kanhar (236 kms) till confluence with river Sone, the river Sone enters Jharkhand and joined by the river North Koel on its right bank. The river, thereafter, takes a sharp North-East turn and finally joins the river Ganga in the state of Bihar.

9.1. Catchment Area

The entire catchment area lies below the permanent snowline, considered at an elevation of 4500 m above mean sea level (a.m.s.l.). The Catchment area shape is elongated and mostly hilly and thickly forested. The Physiographic location of river Kanhar is shown in Table below.

Sl. No.	G&D Site/ River	Catchment Area (Sq-km)	Latitude/ Longitude
1.	Kota Kanhar River)	5900	$24^0$27’00” N $83^0$08’00” E
2.	Dudhi (Kanhar River)	5169	$24^0$13’12” N $83^0$15’0” E
3.	Amwar Dam (Kanhar River)	4584	$24^0$08’00” N $83^0$17’00” E
4.	Khuri Barrage Site (Kanhar River-Proposed Study)	3375	$24^0$57’6.9” N $83^0$32’4.2” E
5.	Baradih (Kanhar River-Dam Site)	3029	$24^0$53’20” N $83^0$35’02” E



9.2. Bansagar Water Sharing Agreement, Year 1973

Due to interstate aspect of River Sone, an agreement namely Bansagar Agreement has been executed among the concerned states on 16.09.73. State wise catchment area distribution of the river Sone is as shown in Table below.

Sl. No.	Name of State	Catchment Area (Sq-km)
1.	Chhatisgarh (earlier part of MP)	47,812
2.	Uttar Pradesh	5,668
3.	Jharkhand (earlier part of Bihar)	13,373
4.	Bihar	2,836

As per Bansagar Agreement, out of total available water of 14.25 MAF, the combined share of Bihar has been kept for 7.75 MAF. On the basis of this share allocation the erstwhile Bihar state had made policy decision of utilizing 0.43 MAF water of Kanhar River. Subsequently an agreement namely “Kanhar Agreement” was signed in 1982 among sharing states in which Bihar (now Jharkhand) state was allowed to utilize 0.43 MAF for its use at Baradih. Up to Baradih, the allocated share of the state of Madhya Pradesh (now Chhattisgarh) was fixed at 0.47 MAF.

A copy of DPR of the Kanhar Barrage project was made available to Govt. of Chhatishgarh vide Memo No. **13/81/2013-PA(N)/330-331 dated 01.09.2016 &** dated **14.10.2016** for their views. A consent of WRD, Govt. of Chhattisgarh vide Letter No. 4972 dated 28.11.2016 furnished views

of Govt. of Chhatishgarh on the DPR. The project had been consented with following two conditions;

i) the compensation of Rs.1740.64 Lakhs against 79.55 Hectares land in submergence is to be borne by state of Jharkhand with a provision of increase if the cost increases due to any change in prevailing rate.
ii) there shall be no adverse effect on the water allocation under Kanhar Water Agreement-1982.

WRD, Govt. of Jharkhand through Engineer-in-Chief Letter No.1422 dated 20.12.2016 had accepted both the condition of Chhattisgarh. A copy of DPR of the Kanhar Barrage project was also made available to WRD, Govt. of Bihar vide Memo No. 13/81/2013-PA(N)/330-331 dated 01.09.2016 & dated 14.10.2016 for their views. WRD, Govt. of Bihar vide Letter No. 4972 dated 28.11.2016 furnished their views on the DPR regarding fulfilment of priority water of 5.0 MAF under Bansagar Agreement-1973. There is no mention of Kanhar Agreement-1982 in their letter. WRD, Govt. of Jharkhand vide their letter No. 187 dated 06.03.2017 described their right on Kanhar water through inheritance under Bihar Reorganization Act-2000 as well as informed that this project was conceived at the time of united Bihar targeting the same beneficiary area and the DPR for the same had been submitted by erstwhile Govt. of Bihar to CWC, New Delhi for examination in 1984. They had also consented to abide by the provisions of Bansagar Agreement (1973). They had also informed that they are planning this project with a water utilization of 0.283 MAF (350.0 MCM) against their water allocation share of 0.43 MAF (530.6 MCM) under Kanhar Water Agreement-1982.

A meeting between officials of both the states had been organized on 15.06.2017 in the office chamber of Member (WP&P), CWC, New Delhi. Further, WRD, Govt. of Bihar requested for taking comprehensive view on any new Project undertaken in the Sone Basin System. In the meantime it is requested that the status quo with respect to the DPR of Kanhar Barrage project may be maintained and prior to offering clearance to the project, views of Bihar on its apprehension because of the impact on Sone system may please be considered". Following this another meeting of the two water sharing states (Bihar & Jharkhand) had been arranged on 25.07.2017 at CWC, New Delhi. Govt. of Jharkhand reiterated their commitment for honouring both Bansagar Agreement-1973 & Kanhar Agreement-1982 abiding by the Provisions of Agreement. It was concluded that there is no interstate issue involved between Bihar & Jharkhand as regards of proposed utilization of 0.283 MAF water through Kanhar Barrage Project.

10. INTERNATIONAL ASPECTS

There is no international aspect related with Kanhar Basin however the comments & observation have been replied by WRD, Govt. of Bihar and a formal concurrence had been obtained on the international aspect from MOWR, RD&GR vide their letter no MoWR, RD&GR - ID.No.: Z-23011/ 4/ 2014/ -Ganga/ 4926-29 Dated 21/11/2016.

11. CONJUNCTIVE UTILISATION OF GROUND WATER

The project authorities have proposed use of ground water in conjunction with surface water for some of the 10-day period in accordance with meting the peak crop water requirement in deficit years. 10 daily ground water requirement after simulation study combining three existing reservoirs in the command shall be 10.57 MCM and total maximum annual ground water requirement shall be 18.31 MCM.
The cost of ground water pumping arrangement has been added in the capital cost under head special tools and plants whereas the pumping cost has been accounted for in the operation and maintenance cost. Water for irrigation and drinking purpose can be supplemented through the existing reservoirs to meet the deficit in a way that these existing reservoirs are being taken on lease for 10 daily period strictly adhering and meeting its own water requirement with first priority and storing water whenever there is surplus water in Kanhar river. However 432 Nos. of tube wells are proposed in the tail end command area to supplement the deficit in 10 daily period to

meet the Irrigation Planning. The information regarding ground water availability has been derived from publication of Central Ground Water Board, MOWR, GOI. The net ground water availability for future irrigation has been assessed more than 175.62 MCM, which was revised by same Govt. agency in Sept. 2013 and the net ground water availability for future irrigation has been assessed as 193.05 MCM. The variation of groundwater levels will take place after introduction of canal irrigation. During the implementation of the irrigation system, monitoring of the ground water would be done in the project command by WRD, Govt. of Jharkhand through ground water wing of the department.
The DPR has been examined in Central Ground Water Board (CGWB).CGWB observed and recommended:

(I) Area of irrigation project falls under safe category of blocks.
(II) The additional input of 23481.77 ham of water will not affect rise in water table in a big way within the command area, but there is a little chance to develop water logging condition in the areas having shallow water levels. Therefore, conjunctive use of surface water and ground water is recommended to avoid the possibility of water logging in future. In such areas the canal water may be released in regulated manner.
(III) Installation of “piezometers with appropriate numbers may be constructed in command area having shallow water levels for periodic monitoring of groundwater levels and water quality in consultation with CGWB regional office and collected data should be shared with CGWB”.
(IV) Formation of “A committee including representatives from central and state groundwater departments and implementing agency may be constituted to look into the aspect of conjunctive use or surface and ground water and periodic review of groundwater scenario in the command area.”
(V) Compliance of above may be incorporated in the Project Report.

12. PROVISION FOR HYDRO POWER GENERATION

In the earlier DPR of 1984, the trunk canal off-taking from the right bank of the dam structure at Baradih have a natural drop of 100m at Lawadoni, where a pumped storage hydro power plant of 302 MW capacity has been proposed. The drop in case of Khuri barrage is about 60.0m at same location of Lawadoni and hydro power potential in Kanhar Barrage Project with a plant capacity upto 21.0 MW appears feasible. It is therefore a possibility to explore viable means of hydropower development and utilization plan at this stage.

Pumping has been envisaged in the past for better utilization of stored water during peak hours through creation of a lower forebay and an upper forebay. However it is being put on record that right now hydro power aspect has not been considered for project analysis. The hydropower potential may be exploited separately.

13. BRIEF OF SURVEY & INVESTIGATION CARRIED OUT FOR PROJECT PLANNING

Garhwa district has a highly rugged topography with thick green forests all over the area. It has widely scattered hills and in the southern parts, the hills rise upto 1164 meters above mean sea level. In the district the average height of the hills is 700 to 900 m and the average elevation in the plains ranges between 200- 500 m. The general slope is in the direction of North. The general drainage line is from south to north towards the Sone river, which forms part of the northern boundary of the district. The main river system in the district comprises North Koel and its tributaries. Necessary survey, investigation and 10% of the canal structures have been investigated in detail and examined by Water Resources Department, Govt. of Jharkhand covering Khuri Barrage site/ Khuri Submergence Area/ Lawadoni Dam/ Lawadoni Reservoir Area/ Main Trunk Canal Alignment/ Left Main Canal Alignment /Right Main Canal Alignment/ Pratappur Branch Canal Alignment/ Command Area.

Total Station Survey has been carried out to finalize the topographical surveys, submergence area and canal alignment of the Project. To fix the alignment of the Barrage, the levels were taken at 5m X 5m interval at three alternate sites and the most suitable site has been selected. Detail Survey for all major structures has been done using total station at 30 m X 30m grid for the purpose of finalizing the design. Number of structures, location and basic arrangement of the structures on main canal has been finalized on the basis of detailed surveys and investigations. For designing main canal and water conductor system the L section of main canal and distributaries are taken and plotted on 1:2000 horizontal scale and 1:100 on vertical scale. Similarly for canal structures a grid plan is prepared on a scale of 1:2000 and contour interval of 0.5 m. In addition to this, survey for availability of resources, materials was taken care of at the time of planning phase of the project. Subsequently detail studies were carried out for availability of construction material soil and sub soil conditions etc. **Topographic survey have been completed at following locations;**

- Barrage Area.
- Lawadoni Reservoir Area.
- Submergence Area upstream of Barrage.
- Main Trunk canal (17.10 Kms).
- Left Main Canal (82.227 Kms).
- Right Main Canal (46.973 Kms).
- Pratappur/ Kholra Branch Canal (25.70 Kms).

14. GEOLOGICAL INVESTIGATION

Garhwa district is underlain by hard rock belonging to Archean and Precambrian period, overlain by clayey bed at places which forms as a result of weathering of bedrock. Recent alluvium has been observed along the river course. Groundwater occurs in the district within weathered mantle of hard rocks. Groundwater in alluvial deposits occurs along the Sone and North Koel rivers.
Geologically, Left and right bank of River Kanhar at the barrage axis are covered with scree/ regolith admixture with river sand, deposited during the flood. Scattered but extensive outcrop of quartz-mica schist with underlying quartzite have been observed along both the abutments. Scattered outcrop of bed rocks are observed in the nala bed and on both the abutments. Both the banks exhibit an average height of about 50-70m from the exposed nala bed. Generally the geological formations as encountered during investigation suggest a competent geological formation conducive for project implementation. Following geological, geotechnical Survey & Investigation work have been done;

- Surface Geological Mapping of all relevant areas.
- Khuri Barrage location has been explored with 17 exploratory drill holes @ 30.0m.
- Lawadoni Dam Location has been explored with 13 exploratory drill holes @ 30.0m.
- 17.10 Km long main trunk canal explored through 5 drill holes and 5 trial pits.
- LMC of 82.227 Km has been explored by 137 trial pits and 61 drill holes.
- RMC of 46.973 km length explored through 98 trial pits and 2 bore holes.
- PBC of 25.70 Km explored through 56 trial pits and 26 bore holes.
- Total Exploratory Drill Holes (Rock Drilling – 1220.0m, Hard Soil – 1080m).
- Total Exploratory Excavation Pits (326 Trial Pits).
- Structures Location marked on Canal Alignment.
- All Core Boxes have been preserved and under possession with WRD, GoJ.

15. SOIL & CONSTRUCTION MATERIAL TESTING

Soil investigation had been carried out along with mechanical tests in the drill hole at the barrage/ dam axis locations in order to determine the foundation of dam and barrage being laid on the fresh rock after removing the overburden material. Further, permeability test had been done to ensure the seepage losses through the foundation within the permissible limits.
The suitability of the borrow materials for construction of dam, the soil samples collected form the potential borrow areas according to IS:6955 and various laboratory tests such as grain size

analysis, Atterberg limits, proctor compaction, shrinkage limits, laboratory permeability, triaxial shear tests, consolidation tests, chemical analysis and soil dispersivity identification tests, had been conducted.

The soil investigation has been carried out through trial pits along the canal alignment. Core samples recovered from the exploratory drilling at the Khuri barrage area and Lawadoni dam site have been tested in laboratory for knowing the engineering properties of the rock mass like water absorption, uniaxial compression strength (UCS), Porosity and density.
Total quantity of concreting is about 5.78 lakh cum (i.e. M10: 0.24 lakh cum, M15: 3.04 lakh cum, M20: 1.98 lakh cum, M25: 0.52 lakh cum) consisting of various grades. To meet the requirement, five rock quarries for coarse aggregate and four river sand quarries for fine aggregate had been identified and these quarries were tested for finding their suitability. A quarry view is shown below:

38% losses had been considered for assessing the construction material requirement for Coarse aggregate. Construction material is adequately available in project area. Kanhar project canal network is linearly spread in about 350km and therefore construction material quarries have been identified in the entire project area at different locations to cater the entire project components viz. barrage, dam and all canals in a way to optimize the economy in terms of haulage time and distance.

Kanhar river water is proposed to be used for both mixing and curing purpose. The test result of river water sample is meeting the specification requirements as per BIS: 456 for use in concrete. The guidelines pertaining to the construction materials survey as per the BIS 11150 (1993): construction of concrete barrages code of practice, other preliminary investigation specified BIS 13578 (2008): Subsurface exploration for barrages and weirs–Code of practice and BIS 7720 (1991) criteria for investigation, planning and layout for barrages and weir, had been followed. Project authorities have reported the Petrographic report for review. Petrographic analysis and Alkali Aggregate Reactivity Test (AAR) has also been completed as per IS 2386- Part VII for all coarse and fine aggregate samples. Additional tests had been conducted for alkali silica reactivity test as per ASTM C 1260 from all quarries for both coarse & fine aggregate.

Additional soil tests had been conducted for Lawadoni dam for clay core and shell material requirement in light of soil quantity of 170000cum and 320000cum respectively. The soil compressibility characteristics/ consolidation characteristics/ chemical analysis and dispersivity characteristics of clay core material have been done. Consolidated Un-drained (CU) &Consolidated Drained (CD) along with the shear strength parameter had also been conducted to determine long term stability of the structure.

Additional soil investigation from the borrow area investigation in filling reaches of canal had been conducted. Additional investigation required for cutting reaches of canal include soil classification insitu density, in-situ permeability in addition to strength and consolidation tests on undisturbed samples had also been conducted. These all soil investigations & other

investigations as advised by CSMRS had been accomplished and their consent had been obtained which is listed as below:

(i) The foundation of dam and barrage shall be laid on the fresh rock after removing the overburden material. It has been advised to assure the seepage losses through the foundation under permissible limit.
(ii) The cement to be used shall be tested from time to time as per the relevant standards and the test results should be checked for its conformity with relevant standards and manufacturers test report.
(iii) In view of the durability considerations of concrete, possibilities of cement blended with supplementary cementitious materials such as fly ash, blast furnace slag etc., must be explored. These materials should also be tested before using in the project as per the relevant standards.
(iv) Project authorities have proposed to use Kanhar water for mixing and curing purpose. The test result of river water sample is meeting the specification requirements as per BIS: 456 for use in concrete. The project authorities are advised to test the water samples frequently during the construction.
(v) Project authorities have reported the requirement of reinforcement about 25909.00 MT. The structural steel, reinforcing steel and high tensile steel which are to be used for different components of the proposed structure should be tested as per the relevant standards and checked for its conformity with relevant standards and manufacturer test certificate.
(vi) Proportioning of design mix concrete for various grades should be carried out as per the guidelines recommended for mix design in IS:10262-2009. If any admixtures are used in the concrete mix for getting the desired properties, the same shall have to be tested in the laboratory as per the relevant standards and compared with the manufacturer's test certificate.

There were some suggestions given by CSMRS which is based on codal provisions and are as below:

The project authorities are advised to follow the guidelines pertaining to the construction material survey as per BIS 11150 (1993): construction of concrete barrage code of practice, other preliminary investigation specified BIS 13578 (2008): subsurface exploration of barrages and weirs – code of practice and BIS: 7720 (1991) - criteria for investigation, planning and layout for barrages and weir. Project authorities are advised to carry-out the canal system keeping in view of the following suggestions:

a) Soil in all reaches shall be tested for sodium sulphate content and take necessary measures as per BIS 3873 and BIS 456.
b) All the mixes proposed must be properly designed and conform to the requirement of IS 456.
c) The laying of concrete lining must be carried out as per the procedure laid in BIS 3873and ensure close control on the consistency and workability.
d) All absorptive surface against which concrete is to be laid should be moistened thoroughly so that moisture will not withdraw from freshly placed concrete. The surfaces however, should be free from standing water and mud and 1:3 cement slurry shall be spread over the moist subgrade before placing or laying low density polythene (LDPE) based on sub-grade condition. The condition laid in BIS: 3873 regarding placing and placing time shall be ensured by the engineer-in-charge.
e) If hand placing of concrete is adopted for sides and bed, it should be done in alternate panels and ensure proper compaction as per BIS 3843. This will cater for initial shrinkage and cracks.

f) The surface of concrete finished against forms should be smooth and free from projections, honeycombing and other objectionable defects. In case of these type of defects treatment as per BIS 3873 shall be carried out.

g) All the construction joints shall be suitably laid as per BIS 3873.The sealing shall be taken up after curing period is over. The sealing shall be done as per BIS 5256and the scaling compound should conform to BIS: 13143.

h) The curing shall be carried after 12 hours of laying of concrete lining and should be cured for at least 28 days. The continuous curing of bed lining/ side lining with suitable methods shall be ensured (i.e. small earthen bunds, drain with weep holes, perforated pipes, sprinklers etc.,)

i) The concrete core shall be collected from the side/bed shall be tested for its strength and permeability to ensure quality and durability.

j) To achieve sound and impermeable lining, systematic quality control measures to be adopted during the construction by taking the advices from quality control experts.

k) Project authorities are advised to keep in view of the fact, that even regular sampling of the aggregate production may fail to detect a localized feature within the quarry which might have significant effect on the quality and durability of aggregate. Hence, geological inspection and testing of soundness, Alkalify Silica Reactivity (motor-bar expansion) and detailed petrography examination of aggregates must also be done as a part of the routine assessment at the time of construction stage.

l) Implementation of systematic quality control measures during the construction by taking advices from quality control experts time to time.

16. NAVIGATION

Navigation aspect has not been included in this DPR as this is a pure irrigation project. This aspect needs to be separately handled through separate studies under Inland Waterways. If navigation is being formulated in future through separate study, the same may be incorporated by making a “Navigation Lock” at left bank of the barrage structure. There are situation corroborated from the river discharge data that the river is almost dry with little surface flow from the month of January to May in each year.

17. DRAINAGE

Large number of nallas and drains exist in command area therefore field drainage may not pose any problem. Both the left & right main canal runs as a contour canal throughout. There are numerous river system joined by nallahs in the command as Annaraj/ Danro/ Left Banki, Pandarwa, Bhawanikhand which provide an excellent drainage to the whole of the command. The topography of the command area is gradually sloping towards Danro & Amanat River.

In addition to the rolling topography, the hydraulic gradient is also steep nearer the river. The command consists of soil which has good self-drainage capacity. Hence, no separate provision for drainage works has been kept in the project.

18. DESIGN ASPECTS

The DPR of Kanhar Barrage Project was examined in Central Design Organization (CDO), WRD, Govt. of Jharkhand on design aspect by Barrage and Canal Design their respective Directorate. During the examination and discussion with Project Authority, the suggested modification had been incorporated. The suggestions were mainly focused to stabilize the existing irrigation projects in the command area and three existing projects namely Annaraj, Danro & Chatanighat has been identified to be augmented through this proposed canal system under Kanhar Barrage Project.

The Project Authority has submitted Central Design Organisation (CDO), WRD, Govt. of Jharkhand certificate vide Memo. No. 178/W/D-4/2014 dated 31.08.2016 signed by Chief Engineer, Central Design Organization, WRD, Govt. of Jharkhand. Hence, the performance and

safety with respect to various components of the project for structural, hydraulic, mechanical and electrical aspects would be the responsibility of the State Government / Project Authority.

19. CONSTRUCTION PROGRAM, MANPOWER & PLANT PLANNING

Construction methodology and selection of equipment has been planned for a total construction period of five years which includes six (6) months of mobilization and infrastructure work. The main infrastructure development work is proposed to be carried out within a period of 6 months. The construction of the Project proposed to commence from the 7th month after initial mobilization and the project shall be commissioned in 60 months (5 years).

Working period has been planned for the months of November to June only (eight months) which fully covers the non-monsoon season for construction activities except tunnel works for which 10 months of working period has been considered, however all planning & scheduling have been drawn on 8 months working period. During the infrastructure development period, construction/improvement of roads, bridges, culverts and arrangements for construction power of the project site will be undertaken. The construction power at all the project components is proposed to be supplied by DG sets. After the infrastructure setup has been created to the required extent for start of the construction activities, the proposed construction of main components of the project will be taken up.

20. ENVIRONMENT, ECOLOGICAL ASPECT

The project requires Environmental Clearance under the EIA Notification, 2006 and its subsequent amendment in 2009 of the Ministry of Environment and Forests, Government of India. Towards this, a comprehensive EIA study is being carried out by an independent agency in accordance with the TOR issued by the MOEF. The total land requirement for Kanhar Barrage Project is 1086.49 ha. This comprises the land requirement for Barrage at Khuri Village, Main Trunk Canal (MTC), Reservoir at Lawadoni, Left Main Canal (LMC), Right Main Canal (RMC), Pratappur (Kholra) Branch Canal and all distributaries and all minors etc. Separate EIA/EMP study has been done for this project and public hearing is being organized as per the provisions in both the states namely Chhattisgarh and Jharkhand.

21. ENVIRONMENTAL RELEASE

Ministry of Environment & Forest vide their Terms of Reference (TOR) for study of environmental impact assessment issued by MOEF (Ref: MOEF, No. J-12011/17/2015-IA-1 dated 31st August, 2015) recommended a release pattern of Environmental flow as 20% of the average of the 4 lean months of 90% dependable year during the lean season and 30% of Monsoon flow during monsoon season. For remaining months, the flow shall be decided by the Committee based on the hydrology and available discharge. Apparently the new release pattern due to environment flow had necessitated to reassess the water availability and thus modified accordingly. The Year has been divided into three periods as defined below:

1. Monsoon Period : June to September
2. Lean Period : December to March
3. Non-lean, Non-monsoon period : Oct to Nov. & April to May

For the non-lean, non-monsoon period, environmental release will be decided by committee as recommended by the Environmental Appraisal Committee (EAC) however for this computational purpose, Environmental flow of Non Lean, Non Monsoon period has been take as 25% of the average flow in 90% dependable year in light of some precedence of Badaun Canal System. It is to be noted that the discharge contribution from the intermittent catchment i.e. Baradih dam site to Khuri barrage site (346.5 sq.km) shall also proposed to be released downstream of Khuri barrage.

Also, as per Ganga Basin agreement, water shall not be extracted/ diverted from river during January to May period. Therefore, all discharges flowing in the river from 1st January to 31st May

in each of the year shall be released without any diversion for the project utilization which cater the environmental release during these lean periods.

22. IMPACT ON WATER AVAILABILITY DUE TO ENVIRONMENT RELEASE

Based on average 10- day flow, from the long term water series, net water available for Kanhar Irrigation purpose after deducting environmental release from June to December have been reassessed. The comparison of water utilized for irrigation as in DPR and the present study including the contribution from intermediate catchment and after ecological release for the year 1976-77 to 2012-13 have been considered for irrigation planning and other uses.

The impact of environment flow on the water availability had been extensively incorporated in Irrigation Planning and an environment flow had been ensured to be released from Kanhar Barrage in fulfilment of the TOR as prescribed by MOEF.

23. E-FLOW

Regarding compliance of e-flow, Project Authority takes note of the fact that a Committee is presently working out e-flows for various river systems in the country and Project Authority have certified that the decisions of the Committee for area specific, river specific and site specific e-flows will be honoured and maintained by the Project Authority at the time of operation of project. The certificate from Project Authority (WRD, Govt. of Jharkhand) in this regard has been issued and placed before the advisory committee of MoWR, RD&GR.

24. ENVIRONMENTAL AND FOREST CLEARANCE

The project also requires Forest Clearance from the MoEF&CC under the Forest Conservation Act, 1980 as it involves diversion of 348.25 ha forest land. The total forest land required for the project, 51.72 ha falls in the State of Chhatisgarh while the remaining 296.53 ha falls in the state of Jharkhand. Forest Clearance from MoEF&CC is yet to be obtained by project authority however it has been informed through declaration of WRD, Govt. of Jharkhand that action has been initiated for Forest Clearance. Registration Confirmation for submitting application for seeking prior Forest Clearances had been completed on 27.11.2014. The requirement of forest land has been identified. WRD, Govt. of Jharkhand is in process of identifying land for compensatory afforestation to fill up information as required in application for forest land transfer in the prescribed format of “FORM-A.

25. DETAIL OF SUBMERGENCE & LAND REQUIREMENT

The total land requirement for Kanhar Barrage Project, consisting of “Barrage at Khuri Village/ Main Trunk canal (MTC)/ Reservoir at Lawadoni/ Left Main Canal (LMC)/ Right Main Canal (RMC)/ Pratappur (Kholra) Branch Canal/ All distributories/ All minors etc., have been assessed. The submergence at Khuri barrage site also extends to geographical territory of the state of Chhatishgarh and separate assessment of submergence in Chhatishgarh has been made at barrage site and land category has been assessed as below:
The land is broadly categorized as:

- Forest Area In Jharkhand : 302.08 Ha
- Forest Area In Chhatishgarh : 28.15 Ha (Only at Barrage)
- **Total Forest Area in Project** **: 330.23 Ha**

- Non-Forest Area in Jharkhand : 728.12 Ha
- Non-Forest Area in Chhatishgarh : 29.86 Ha (only at Barrage)
- **Total Forest Area** **: 757.98 Ha**

Sl No.	Project Components	Forest Land in Jharkhand (Ha.)	Non-Forest Land in Jharkhand (Ha.)	Total Land (Ha.)
1.	Barrage	47.33	10.09	57.42
2.	Main Trunk Canal (MTC)	59.90	4.37	64.27
3.	Lawadoni Dam & Reservoir	32.33	06.09	38.41
4.	Left Main Canal (LMC)	73.97	243.79	317.75
5.	Distributaries/Minor to Left Main Canal	21.42	81.96	103.37
6.	Pratappur Branch Canal	15.53	81.02	96.55
7.	Distributaries/Minors of Pratappur Branch canal	2.11	133.81	135.92
8.	Right Main Canal (RMC)	39.03	136.24	175.27
9.	Distributaries/ Minors of Right Main Canal	10.47	30.76	41.23
	TOTAL	**302.08**	**728.12**	**1030.20**

An provision of Rs.19791.94 Lakhs has been made for Land as per the “Right to Fair compensation and Transparency in Land acquisition, Rehabilitation & Resettlement Act, 2013”, by adopting the circle rate in Garhwa district of the Jharkhand State.

26. RESETTLEMENT ACTION PLAN (RAP) & TRIBAL DEVELOPMENT PLAN (TDP)

The project proponent has prepared the R&R benefits & plan for Project Affected Families (PAF) as per the “Right to Fair compensation and Transparency in Land acquisition, Rehabilitation & Resettlement Act, 2013”. This activity has been completed with focus group discussions and extensive interaction with the local people. Construction of the project will require acquisition of land from the villages located along the project alignment. As per the R&R study carried out for the project, a total of 2581 households (PAHs) and 13295 persons (PAPs) will be affected by the project. The Report on Resettlement Action Plan (RAP) & Tribal Development Plan (TDP) has been submitted. The document has been examined by Ministry of Tribal Affair (MOTA), Govt. of India and approval has been sanctioned vide their letter no. 21/03/2017-M&J/FRA Dated 28th July 2018. Cost on this account had been incorporated in the Project Costing.

27. ESTIMATED COST & FINANCIAL RESOURCES

The project shall create irrigation facility to 53,283 ha of land thereby has the potential of bringing a major boost in the irrigation sector in the state of Jharkhand. The time for completion of the project has been envisaged as 60 months and the project is a government sector project being implemented by Water Resources Department, Govt. of Jharkhand and primarily shall be funded from its own financial resources or aid from central government as the case may be. The funding by some external agency e.g. World Bank/Asian Development Bank (ADB) may be a possibility in future but at this stage of the project there is no such consideration including the foreign exchange element and hence this aspect has not been considered in project analysis. State Government can easily mobilize the resources for construction of Kanhar Barrage Project.

This is once again reiterated that a PIL has been filed in the Hon'ble High court of Jharkhand, Ranchi for early execution of this scheme which could provide irrigation facilities as well as drinking water to the people of Garhwa district and also to nearby district. Water Resources Department is somehow committed to implement the project at the earliest once the statutory clearances are obtained from different agencies. After completion of Kanhar Barrage Project, a sizeable area of state of Jharkhand will came under assured irrigation which will boost the economic growth of the region. The abstract of cost prepared on the prevailing schedule of rate - 2016 in Jharkhand state and on the basis of guideline-2017 prescribed by Ministry of Water Resources, Govt. of India suggests a total estimated project cost of Rs.190884.46 Lakhs.

The project has various project components and the cost of each components had also been derived and their total estimated cost comes to Rs.150358.23 Lacs. The breakup of the estimated cost is described as below.

Sl No.	Classification of Project Components	Project Components & Works	Estimated Cost (in Lakhs)
1	Project Component – I	Barrage at Khuri	13302.82
2	Project Component – II	Main Trunk Canal (MTC)	13454.61
3	Project Component – III	Earthen Dam at Lawadoni	5011.76
4	Project Component – IV	Left Outlet at Lawadoni	487.67
5	Project Component – V	Right Outlet at Lawadoni	437.33
6	Project Component – VI	Main Spillway at Lawadoni	449.98
7	Project Component – VII	Left Main Canal (LMC)	39783.04
8	Project Component – VIII	Right Main Canal (RMC)	11233.27
9	Project Component – IX	Pratappur Branch Canal (PBC)	6208.12
10	Project Component – X	Canal Distribution System	45408.00
11	Project Component – XI	Ground Water Pumping Arrangement	3764.18
12	Project Component – XII	CAD Works	10817.46
		Total	**150358.23**

28. REVENUES

The benefits from this project have been identified through increase in yield of crop production (Agricultural Produce) post implementation of the project. The cost incurred on supplying water for augmenting domestic water through the existing reservoirs have been excluded from the project cost, however the supply of water for industrial purpose have been considered and accounted for through projected revenue at the prescribed rate for supply of industrial water by the state of Jharkhand. Administrative charges for collection of revenues have not been considered separately. The revenue shall start accruing at the end of 60 months of the construction period and shall be recoverable from the very next year thereof.

29. APPORTIONMENT OF COST

33.00 MCM of industrial water has been earmarked from the proposed Project through canal system as and when the water is available with basic premise that the necessary infrastructure for storage of water to enable its utilization spread over the year shall be developed by the user

agency. The cost incurred on supplying water for augmenting irrigation water to the existing command and domestic water supply through the existing reservoirs or otherwise, have been excluded from the project cost for B C Ratio calculations.

No allocation of cost has been made for industrial water supply however quantum of water supplied to the industries be charged at the rates fixed by state government. Total Benefit of Rs.8209.29 Lakhs has been envisaged from industrial water supply after construction of the project. Rate of Industrial water has been derived vide Gazette Notification, WRD, Govt. of Jharkhand Dated 19th April 2011 effective from 01st April 2012.

30. COST ESTIMATE AND STATE FINANCE CONCURRENCE

The project cost has been finalized by CWC for Rs.190884.46 Lakhs (PL 2016-17). The finalized cost is subjected to correctness of quantities, correctness of supporting documents submitted by State Govt. The Cost of CAD works is Rs.10817.46 Lakhs.

(i) The Cost Estimate is based on prevailing Schedule of Rates (SOR) 2016 in the state of Jharkhand. The Project Authorities have submitted a certificate stating therein that Schedule of Rates (SOR) 2016 used for preparation of cost estimate of the project is still valid and no further updating in SOR has been done thereafter, as such, the provisioned price level for the cost estimate of the project will hold good. A certificate regarding the correctness of Bill of Quantity/Schedule of Rate and other aspect had been submitted by Chief Engineer, WRD, Medninagar, Govt. of Jharkhand. The declaration is as below:

(ii) The quantities have been evaluated for various components based on the drawings and designs, as approved by the competent authority, has been taken for cost estimation and is correct.

(iii) The rates not available in SOR are taken as per current market rates for estimation of cost.

(iv) The provision of Deep Tubewells is completely part of this project and shall not be funded under any other Central/ State Govt. Department.

(v) Concurrence of State Finance Department for above cost is yet to be submitted by state Govt.

31. PLAN PROVISION

Kanhar Barrage Project has a potential to bring major boost in assuring irrigation to the worst drought prone district of Garhwa in the state of Jharkhand and shall bolster the agriculture production. The project is proposed to be completed in next 5 years. There should be no difficulty in accommodating this project in the ambit of annual state planning considered for Water Resources Department, Govt. of Jharkhand. It is put on record that decision for construction of Kanhar Barrage had already been taken in light of PIL in Hon'ble High Court of Jharkhand and there is a continuous monitoring under the aegis of Hon'ble high Court is being done under the directions of Hon'ble High Court of Jharkhand. Proposed year wise phasing of expenditure submitted by project authority is as under:

Sl No.	Year	Expenditure (Rs. in Lakhs)	Cumulative Expenditure (Rs. in Lakhs)
1	1st Year	39996.64	39996.64
2	2nd Year	40586.00	80582.64
3	3rd Year	45293.86	125876.50
4	4th Year	37881.96	163758.46
5	5th Year	37943.46	201701.92

32. BENEFIT COST RATIO/ FINANCIAL RETURN

Benefit Cost Ratio has been computed in accordance with laid down principles stipulated vide guideline for preparation of DPR by MOWR in 2010. The benefit from the irrigation component of the project has been assessed using the information provided by State Agriculture Department through Director, Dept. of Agriculture, Govt. of Jharkhand. Benefit of fish production has been taken in calculation of B.C. Ratio. The rate of fish production has been issued by the State Fisheries department.

The additional food grains produced after completion of the project would be 144521.37 MT. This will also bolster an economic growth in the one of the most backward area of state of Jharkhand inhabited with tribal population, which is a proven draught prone zone and only a project of this magnitude shall bring prosperity to the area. Interest on capital cost has been taken as 10%. Depreciation has been considered as 2% of the project cost. Annual O&M Cost has been considered as Rs.1175/- per Ha. Beside this annual operation and maintenance cost of 346 numbers of deep tube well has been considered as 1048.98 Lakhs per annum. Also a provision of maintenance of head-works @ 1% of its cost has been considered. B C Ratio at the rate of 10% interest charges comes out to be 1.07.

Particulars		**Amount (in Lakhs)**		
Estimated Cost of the Project		**190884.46**		
Cost Excluded from Project Cost for Drinking Water/ Municipal Supply/ Water to Existing Irrigation Projects		**15116.72**		
Total Effective Estimated Cost for Kanhar Barrage Project		**175767.74**		
CCA (Ha)	53283			
Cost of CAD @ Rs.20301.89 / per Ha.		10817.46		
Total		**186585.19**		
	Before Irrigation/ Pre-Project		**After Irrigation/ Post-Project**	
A. Gross Receipts		**Amount (In Lakhs)**		**Amount (In Lakhs)**
1. Gross Value of Farm Produce		7658.71		31208.36
2. Dung Receipt @ 30% of Fodder Expenditure		344.64		936.25
Total (A) Gross Receipt (1 + 2)		**8003.35**		**32144.61**
B. Expenses				
1. Expenditure on Seeds		469.06		985.88
2. Expenditures on Fertilizers		836.75		1483.80
3. Expenditure on Hire of labour & Bullock		4565.40		9050.12

Particulars		Amount (in Lakhs)		
4. Fodder Expenses		1148.81		3120.84
5. Depreciation on Implements		206.79		842.63
6. Share and Cash Rent		382.94		936.25
7. Land Revenue		153.17		624.17
Total (B) Expenses (1 to 7)		**7762.91**		**17043.69**
C. Net Value of Agricultural Produce				
1. Total Gross Receipts		8003.35		32144.61
2. Minus Total Expenses		7762.91		17043.69
3. Net Value of Produce		240.45		15100.93
D. Annual Agriculture Benefits				
1. Net Value After Irrigation				15100.93
2. Net Value Before Irrigation				240.45
3. Net Annual Benefits				14860.48
E. Other Benefits				
Drinking water				0
Industrial Water				8209.29
Fisheries				1869.44
Horticulture				964.33
Animal Husbandry & Livestock				0.00
Net Annual Benefits				**25903.54**
G. Annual Cost				
1. Interest on Capital @ 10%				18658.52
2. Depreciation of the Project @ 2% of cost of the project				3731.70
3. Annual O & M Charges @ Rs.483/Ha of CCA				626.08
4. Annual Pumping Cost for Ground Water Extraction				1048.98
5. Maintenance of Head-works @ 1% of its cost				183.15
Total (G) Annual Cost (1 to 4)				**24248.42**

Particulars		Amount (in Lakhs)		
Benefit Cost Ratio with all Benefits : Annual Benefit/ Annual Cost:				
			B C Ratio With CAD	**1.07**
			B C Ratio Without CAD	**1.13**

Kanhar Barrage Project proposal has been appraised in CWC for determining its technical feasibility and economic viability. The examination is based on data submitted by the State and clarification furnished by the project authorities during the processing of the proposal. It is presumed that the data furnished is accurate and has been collected reliably after carrying out detailed investigation & field surveys under the supervision of competent personnel. The scrutiny does not cover the examination of detailed designs, working drawing of individual components in regard to the structural, hydraulic and mechanical performance and safety, which have to be ensured by the project authorities. The cost of the project has been finalized for **Rs.190884.46** Lakhs (prevailing schedule rate effective from 1st April 2016). The B.C ratio at 10% interest rate works out to 1.07.

Project Authority has submitted CDO, WRD Govt. of Jharkhand certificate vide Memo. No. CE/D.M.P & HYD/32/2015-472 dated 25.07.2016 signed by Chief Engineer, Central Design Organization. Hence, the performance and safety with respect to various components of the project for structural, hydraulic, mechanical and electrical aspects would be the responsibility of the State Government/ Project Authority. Project authorities had also submitted certificate regarding the correctness of Bill of Quantity/ Schedule of Rate and other aspect by Chief Engineer, WRD, Medninagar, Govt. of Jharkhand. Project Authority has submitted Certificate regarding status of action taken for Statutory Clearances on following aspects of the project.

(i) EIA/EMP
(ii) Forest Clearance from MoEF&CC:
(iii) Clearance in respect of R&R of Tribal population from MoTA

33. RECOMMENDATION BEFORE ADVISORY COMMITTEE, (MoWR, RD&GR)

Kanhar Barage Project would serve the worst drought prone district of Garhwa in the state of Jharkhand predominantly inhabited by Tribal population. This will also give fillip to industrial growth besides providing drinking water to habitants of this district. The project will provide assured irrigation to the good agricultural area of the Garhwa district. This district is termed as “Chronic Draught Prone Area” and also inhabited with tribal population. The recurrent draught almost every other year have shattered the economy of the people of the area resulting in mass exodus of habitants. The project will go a long way in providing assured irrigation in the area and thus help economic upliftment of the people of this are to great extent.

There is a provision of Industrial Water for a proposed thermal power station by JSEB in Bhawanathpur block under Garhwa district and also “Bhawanathpur Industrial Complex” fall in the command area.

The area during summer lacks in drinking water and since most of the rivers, wells and ponds dry up, requiring carriage of water by Road and Rails. The project with its network of distribution system will help solving this problem to a great extent. Also the execution of such large project will open up new avenues of employment.

Also there are few existing reservoirs in proposed command area of Kanhar Sub-basin and mainly these structures are either diversion works or small dams. These reservoirs are water deficient as recorded by WRD, Govt. of Jharkhand. Hence, they do not serve the area in a dependable manner. It is primarily due to lack of assured water supply during critical period of irrigation which has a direct impact slowing down the irrigation activity. The proposed Kanhar Barrage Project on Kanhar River will provide substantial assurance of timely water supplied in

the new command besides augmenting the existing irrigation projects or under execution in the area. However following conditions are recommended.

(i) Submission of SFC is yet to be submitted by State Govt.
(ii) Participatory irrigation Management (PIM) may be encouraged by State Govt. and Water Users Associations (WUAs) shall be formed at appropriate stage to ensure awareness and participation of farmers in order to achieve the specific objectives. Later on, once project is completed WUAs may be involved in Operation and Maintenance of canals, Warabandi etc. to ensure PIM.
(iii) Water charges from the farmers shall be collected and this revenue shall be used for Operation & Maintenance (O&M) of project in the future.
(iv) Minimum environmental flow in the downstream of the river may be ensured as per the prevailing law / as per the terms and conditions stipulated by MoEF&CC.
(v) Environment Clearance and Forest Clearance may be obtained from MoEF&CC.
(vi) Possibility of Micro Irrigation may be explored as far as possible while implementing the project.
(vii) Tribal Clearance on R&R of tribal population may be obtained from Ministry of Tribal Affairs.
(viii) Project may be completed within stipulated completion time of 5 years.

34. ACCEPTANCE OF PROJECT PROPOSAL BY ADVISORY COMMITTEE OF MOWR, RD&GR

The project was deliberated in detail before the Advisory Committee on Irrigation, Flood Control & Multipurpose Projects of MoWR, RD&GR held on 12th March 2018. It was informed before the committee that all the aspects of the project had been accepted during appraisal. However, statutory clearances from MoEF&CC and MoTA are yet to be submitted by the state Govt. of Jharkhand. Project authorities informed that the process of obtaining clearances from the concerned Ministries was in progress.

Secretary (MoWR, RD & GR) and Chairman, Advisory Committee observed that as per the storage data shown in the presentation all the 3 reservoirs namely Anraj, Danro and chataniyaghat got filled up by approximately 30% of their live storage during last 7 years and enquired about reason for their shortage. It was informed that these reservoirs had been constructed in 1970s and hydrology of these reservoirs was arrived at based on empirical formula. In this context, Secretary MoWR, RD & GR and Chairman, Advisory Committee emphasized that the hydrology of the project needs to be finalized carefully.

Advisory Committee of MoWR, RD & GR emphasized that the B.C.Ratio (1.07:1) of the project is marginally above the threshold value. In order to maintain the B.C.Ratio, it is advisable that the project implementation is strictly monitored to adhere to the approved cost and schedule. Only through an effective and efficient project management, the viability of the project as planned can be achieved. After deliberations, the Advisory Committee accepted the Project proposal for an estimated cost of Rs.1908.84 Crores @ PL 2016-17 subject to following conditions:

1. Submission of Concurrence of State Finance Department for the finalized cost.
2. Submission of Environment Clearance and Forest Clearance from MoEF&CC.
3. Submission of Tribal Clearance on R&R of tribal population from Ministry of Tribal Affairs.
4. The project is accepted without any commitment of funding from the Central Government.

General Conditions:

(i) Participatory irrigation Management (PIM) may be encouraged by State Govt. and Water Users Associations (WUAs) shall be formed at appropriate stage to ensure awareness and participation of farmers in order to achieve the specific objectives. Later on, once project is completed WUAs may be involved in Operation and Maintenance of canals, Warabandi etc. to ensure PIM.

(ii) Water charges from the farmers shall be collected and this revenue shall be used for Operation & Maintenance (O&M) of project in the future.
(iii) Minimum environmental flow in the downstream of the river may be ensured as per the prevailing law / as per the terms and conditions stipulated by MoEF&CC.
(iv) Possibility of Micro Irrigation may be explored as far as possible while implementing the project.
(v) Project may be completed within stipulated completion time of 5 years.