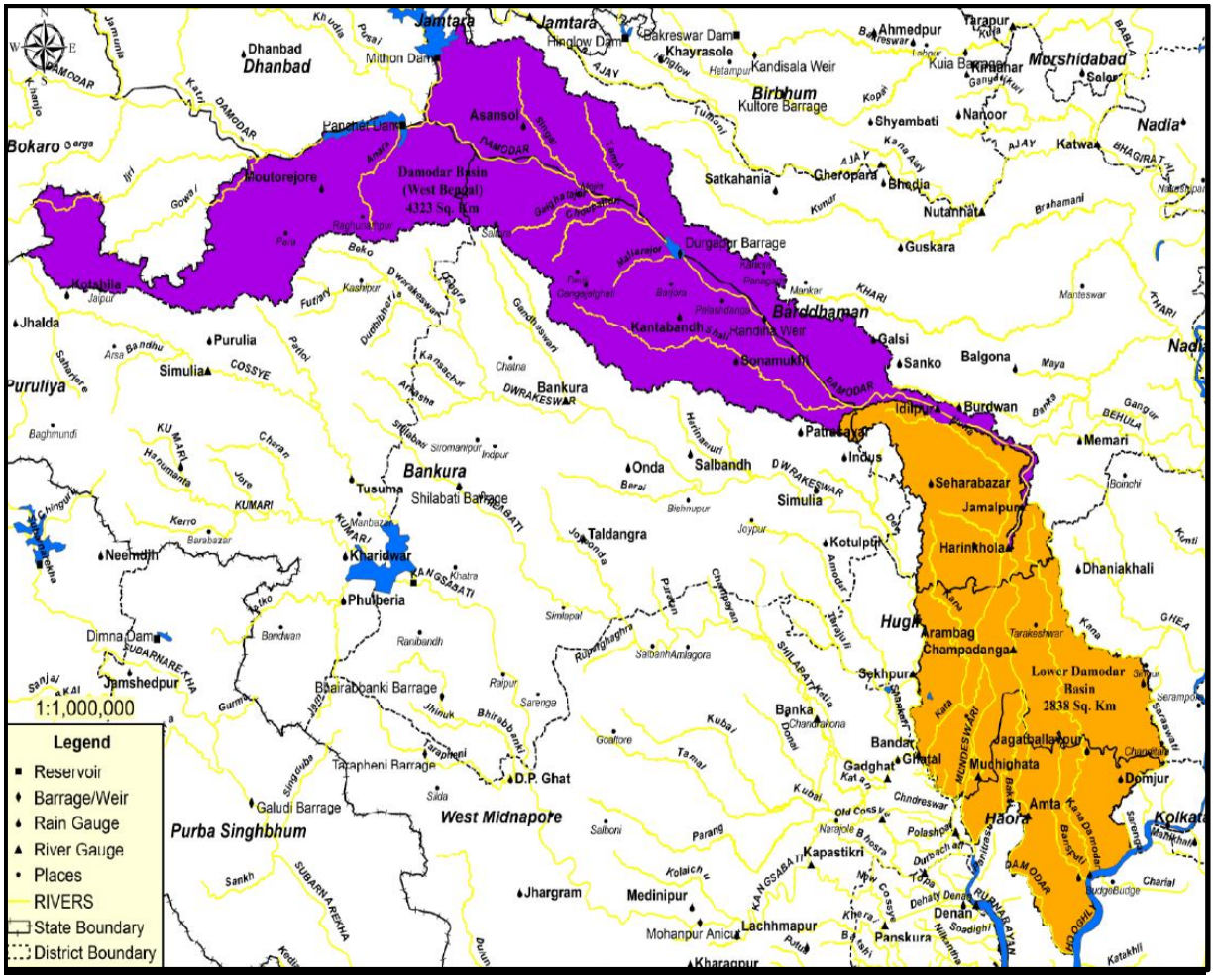
Consultancy Services for preparation of Two Stage Detailed Project Report (DPR) of National Waterway 92, Cluster - I: Damodar River

FINAL FEASIBILTY REPORT



Inland Waterway Authority of India

Cluster – I : Damodar River

Final Feasibility Report

Revision 0

November 2016

Consultancy Services for preparation of Two Stage Detailed Project Report (DPR) of National Waterway 29, Cluster - I: Damodar River

FINAL FEASIBILITY REPORT

Project **IWAI Cluster-I, Damodar River**

Owner **IWAI, Ministry of Shipping**

Consultant **Egis India Consulting Engineers**

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Ashish Khullar

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Akshat Singhal</td><td colspan="3">Project No:
PT/EIPTIWB003

Report No:
PT/EIPTIWB003/2016/FR/002

Approved by:

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LIST OF ABBREVIATIONS

IWAI	Inland Waterways Authority of India
IWT	Inland Water Transportation
MOS	Ministry of Shipping
NW	National Waterway
DPR	Detailed Project Report
WW	Waterway
AtoN	Aid to Navigation
VC	Vertical Clearance
HC	Horizontal Clearance

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SALIENT FEATURES

<table>
<tr><th>Sl. No.</th><th>Particulars</th><th>Details</th></tr>
<tr><td>1.</td><td>Name of Consultant</td><td>Egis India Consulting Engineers Pvt. Ltd.</td></tr>
<tr><td>2.</td><td>Cluster number</td><td>Cluster I</td></tr>
<tr><td>3.</td><td>Waterway stretch (from. To, total length)</td><td>Damodar River (National Waterway 29)
(From Krishak Setu, Bardhman on State Highway No 8 at Lat 23°12'39.83"N, Long 87°50'53.85"E to confluence with Hooghly river near Purbba Basudebpur at Lat 22°21'0.58"N, Long 88° 5'19.31"E);
Total Length: 135 Km</td></tr>
<tr><td>4.</td><td>Navigability status</td><td></td></tr>
<tr><td>a)</td><td>Tidal & non tidal portions (from ... to, length, average tidal variation)</td><td>Tidal portion: 0 – 1.50 Km
Non-tidal: 1.50 – 135 km.
Tidal variation: 2.5 m.</td></tr>
<tr><td>b)</td><td>LAD status
Survey period (.. to ..)
< 1.0 m (km)
1.m to 1.5 m (km)
1.5 m to 2.0 m (km)
> 2.0 m (km)</td><td>
<table>
<tr><th></th><th>0 - 30 Km</th><th>30 - 60 Km</th><th>60 – 90 Km</th><th>90 - 120 Km</th><th>120 – 135 Km</th><th>Total Km</th></tr>
<tr><td>Survey Period</td><td colspan="6">29th Jan to 3rd Feb 2016</td></tr>
<tr><td>< 1.0 m</td><td>1.40</td><td>5.45</td><td>12.43</td><td>10.69</td><td>0.00</td><td>29.97</td></tr>
<tr><td>1 to 1.5 m (km)</td><td>0.00</td><td>5.35</td><td>3.96</td><td>6.63</td><td>0.00</td><td>15.94</td></tr>
<tr><td>1.5 to 2.0 m (km)</td><td>0.00</td><td>5.05</td><td>4.94</td><td>6.24</td><td>1.09</td><td>17.32</td></tr>
<tr><td>> 2.0 m (km)</td><td>28.60</td><td>14.16</td><td>8.67</td><td>6.44</td><td>13.91</td><td>71.77</td></tr>
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Sl. No.	Particulars	Details
c)	**Cross structures** i) Dams, wires, barrages etc (number, with navigation locks or not). ii) Bridges, Power cables etc [number, HC (... to ...). VC (.. to ..)]	i) Dams, Weirs, Barrages, Locks = 1 Barrage without Lock. ii) Bridges = 12 numbers, HC (30.0m to 4.0m), VC (6.0m to 3.0m) iii) Power Cable = 7 numbers (VC = 9.0 m to 6.0 m) *Vertical clearance is above HFL on the basis of visual assessment.
d)	Avg. discharge & no. of days	Request for discharge data was made to CWC, however the same is still awaited. Shall be provided in DPR Stage.
e)	Slope (1 in ..)	Approximate slope of waterway is 1 in 7000.
f)	Consultants inference	➢ The proposed national waterway of 135 km of Damodar river is feasible for throughout the year navigation for about 66.0% of length (have >1.5 m LAD wrt CD), i.e. about 89.09 Km towards upstream of its confluence with Hooghly river. ➢ The horizontal and vertical clearance of existing cross-structures is in the range of 30m – 4m and 6.0m – 3.0m respectively. ➢ Taking in to account the water availability, 71.77 Km stretch of waterway have draft more than 2.0 m, 17.32 Km stretch have draft of 1.50 m to 2.0 m, 15.94 km have draft of 1.0 m to 1.50 m and remaining 29.97 km stretch of waterway have less than 1.0 m draft with respect to chart datum respectively. ➢ Considering the length of the river and availability of numerous minor and major industries in the hinterland, specially in the upper reaches, the river has huge economic potential for development of waterway.
5.	**Traffic potential**	
a)	Present IWT operations, ferry services, tourism, cargo, if any	Localised passenger ferry services and small cargo were operational.
b)	Important industries within 50 km	Though number of major industries is located in the upper reaches of Damodar river, no major industries are available in the lower reaches of the river, which comprises the waterway stretch.

Sl. No.	Particulars	Details
6.	Consultant's recommendation for going ahead with Stage-II (DPR preparation)	Damodar waterway is recommended for Stage – II DPR preparation in view of the following potential advantages: a) Connectivity with major industrial towns of Burdwan and Durgapur. b) Increasing cargo potential. c) Reduction in existing traffic load on rail and road infrastructure. In view of the above, it is recommended to develop the Damodar waterway for Cargo and Passenger ferry services.

1.0 CONTEXT

IWAI, Ministry of Shipping, Government of India is exploring the potential of additional waterways across the country for year round commercial navigation, for this it is planned to conduct a Feasibility Study and recommending thereafter the possibility of Composite and Integrated development of National waterways to achieve navigation and to develop water transport facilities across India. Upon completion of feasibility study, IWAI will select the stretches having potential for navigation to undertake a Detailed Project Report. The DPR stage would include detailed hydro-graphic surveys and investigation, traffic survey, proposed location for terminals and cost assessment etc.

There are 106 new waterways has been identified and declared as national waterways as per "The National Waterway Act, 2016", No. 17 of 2016, published in the Gazette of India, Part – II- Section 1 no. 18, New Delhi, Saturday, March 26/2016/Chaitra 6, 1938 (Saka), by Ministry of Law and Justice (Legislative Department).

Out of these 106 waterways, IWAI had invited international online bids for preparation of 2 stage Detailed Project Report (DPR) for National waterways, in a set of 8 Clusters from Cluster I to VIII through Tender No. IWAI/PR/40NW/2015/I. Egis Consulting Engineers was awarded the work for Cluster I and Cluster III respectively.

This feasibility report provides the technical viability of throughout the year inland navigation in the waterways, by taking into account the constraints and other functions of the rivers/canals such as water conveyance, tidal effects, floods, draughts, existing structures etc.

As stated above, 7 rivers out of 106 National waterways are clubbed in Cluster – I of two stages DPR studies for inland waterways project. The detail descriptions of these 7 waterways are presented in **Table 1**. The total length of stretches of 7 rivers under Cluster – I is 820 km. Among these 7 waterways, 5 are connected to the National Waterway 1 between Farakka to Haldia.

Table 1: National Waterways of Cluster - 1

S. No	River	National Waterway No.	Length (km)	Description
1.	Ajoy River	National Waterway 7	96	From Bridge on Morgram-Panagarh State Highway No 14 at Illambazar Lat 23°36'56.10"N, Long 87°31'58.07"E to confluence of river Ajay with river Bhagirathi at Katwa Lat 23°39'23.33"N, Long 88° 7'56.72"E
2.	Damodar River	National Waterway 29	135	From Krishak Setu, Bardhman on State Highway No 8 at Lat 23°12'39.83"N, Long 87°50'53.85"E to confluence with Hooghly river near Purbba Basudebpur at Lat 22°21'0.58"N, Long 88° 5'19.31"E
3.	Dwarekeswar River	National Waterway 35	113	From Bridge near Abantika Lat 23° 6'54.76"N, Long 87°18'46.99"E to confluence of Dwarakeswar and Silai rivers at Pratappur Lat 22°40'16.94"N, Long 87°46'42.57"E.
4.	Ichamati River	National Waterway 44	64	From Bridge on Border Main Road at Gobra near Bangladesh Border at Lat 22°53'49.64"N, Long 88°53'48.87"E to near Bangladesh Border at Bansjhari Mallikpur Lat 22°39'6.71"N, Long 88°55'35.35"E.
5.	Rupnarayan River	National Waterway 86	72	From confluence of Dwarakeswar and Silai rivers at Pratappur Lat 22°40'16.94"N, Long 87°46'42.57"E to confluence with Hooghly river at Geonkhali Lat 22°12'41.58"N, Long 88° 3'13.99"E
6.	Silabati River	National Waterway 92	26	From Barrage near Shimulia village at Lat 22°34'53.20"N, Long 87°38'30.54"E to confluence of Dwarakeswar and Silai rivers at Pratappur Lat 22°40'16.94"N, Long 87°46'42.57"E.
7.	Subarnrekha River	National Waterway 96	314	From Chandil Dam at Lat 22°58'29.39"N, Long 86° 1'14.03"E to confluence with Bay of Bengal at Lat 21°33'28.75"N, Long 87°22'58.60"E.

The detailed layout plan of the above waterways is shown in Drawing No. PT/EIPTIWB003/2016/FR/0001 submitted with Volume – III (Drawings) and provided in **Figure 1**.

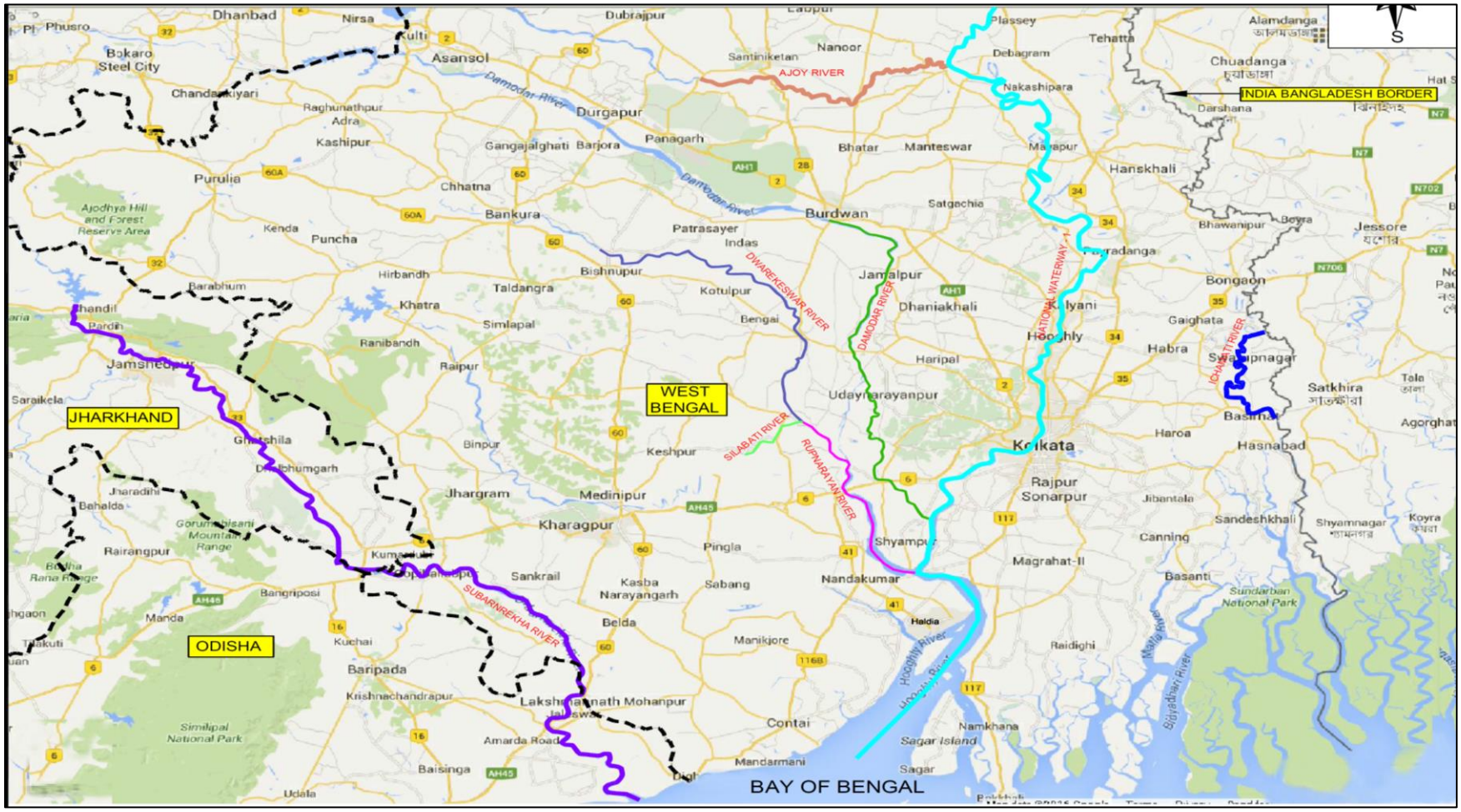

Figure 1: Layout Map of Cluster 1 National Waterways

2.0 OBJECTIVE

Government of India intends to explore the potential of additional waterways across the country for year round commercial navigation, for this it is planned to conduct a Feasibility Study and recommending thereafter the possibility of Composite and Integrated development of National waterways to achieve navigation and to develop water transport facilities across India. The whole of study comprises of two stages, feasibility and DPR as Stage-I and Stage-II as presented below.

Stage-1

1A. Reconnaissance Survey

1B. Collection and review of available data

1C. Feasibility Report

Stage-2

2A. Hydrographic Survey & hydro-morphological survey

2B. Traffic Survey & Techno economic feasibility

2C. Preparation of Detailed Project Report

The current scope for stage-I is executed as per following framework as per **Figure 2** .

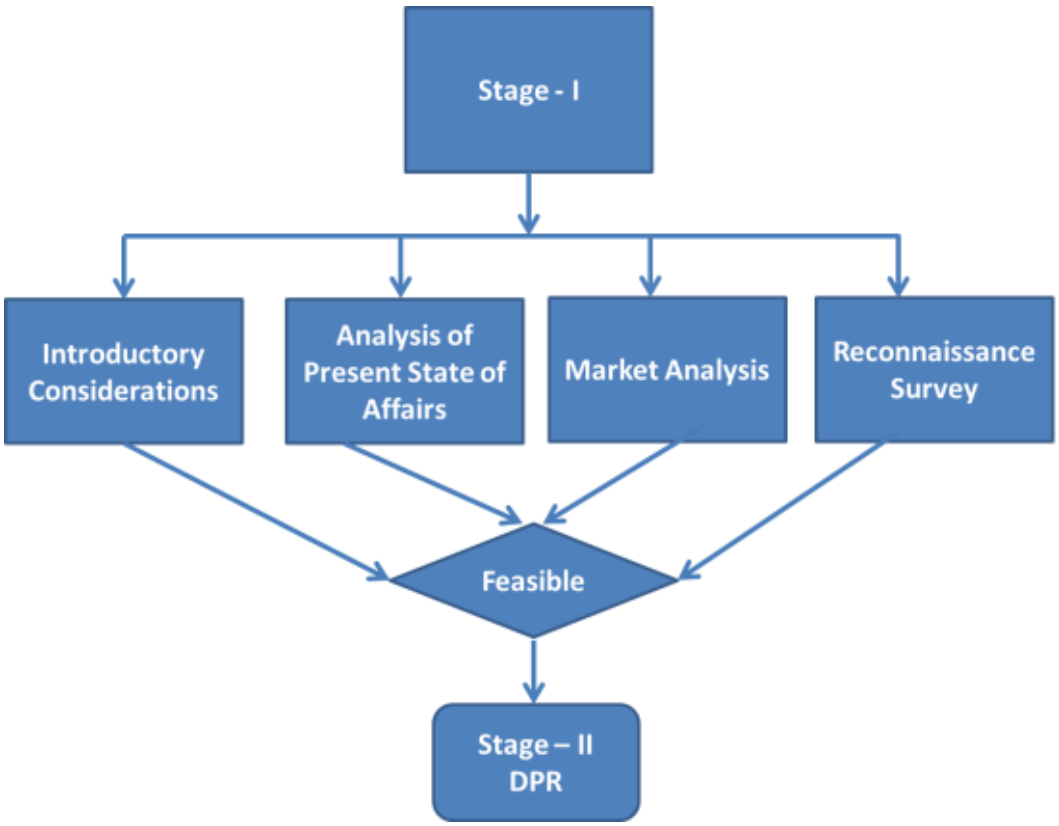

Figure 2: Framework of Studies

3.0 REPORT STRUCTURE

This report comprises of Feasibility Study for Damodar River (Length- 135 Km). The report is arranged in following main chapters,

I. **Introductory Consideration**: This section comprises of,
   1) Name of the river/canal;
   2) Length of the river/canal;
   3) State/ District through which river passes;
   4) Map;
   5) Characteristics of River;
      a. River Course: Background/Historical information, Origin, End
      b. Tributaries/ Network of Rivers/ Basin
   6) Methodology Adopted to undertake the Study;
      a. Primary Data
      b. Secondary Data

II. **Analysis of Present State of Affairs**: This section comprises of,
   1) Existing Dams, Barrages and Locks;
   2) Existing Bridges and Crossings over River;
   3) Other Cross structures, High Tension Lines, pipe-lines, cables;
   4) Hindrances/ Encroachment to the Waterway;
   5) Details of Protected Area- Wildlife, Defence;
   6) NH/SH/MDR along and/or in vicinity;
   7) Railway Line and Stations in the vicinity.

III. **Reconnaissance Survey**: This section provides the,
   1) Methodology adopted including resources and equipment;
   2) Description of Bench marks, reference levels, chart and sounding datum;
   3) Details of collected water levels, discharge data, HFL and FSL;
   4) Details and description of bathymetric and topographic survey including observations;
   5) Detail about Soil, Water and Bank characteristics.

IV. **Market Analysis**: This section comprises of,
   1) Land use pattern along Waterway;
   2) Crop/Agriculture in the region;

3) Availability of Bulk/Construction Material;
4) Existing industries along waterway;
5) Details of existing Jetties and Terminals;
6) Preliminary traffic identified;
7) Existing cargo movement;
8) Prominent City/ Town/ Places of worship/ Historical places for tourism;
9) Availability of passenger ferry services;
10) Available and probable water sport/recreational facilities.

V. **Observation and Inferences**: This section comprises of,
1) Observation on Waterway, Length, LAD, Cross-Structures;
2) Water availability for different periods and depths;
3) Cargo/Passenger/Tourism/RO-RO facility;
4) Suitability of waterway for navigation;
5) Proposed alternative methods for making waterway feasible;
6) SWOT analysis;
7) Way forward for Stage – 2 DPR studies.

In addition to the above, following digital data and charts shall also be submitted along with this report:

I. **Bathymetric Survey**: Hypack software output files with RAW, EDIT, SORT, TIDE extensions;
II. **Topographic Survey**: csv and xyz extension files;
III. **Survey Charts**: Geo-coded dxf and dwg files in scale as per width in AutoCAD formats;

4.0 INTRODUCTORY CONSIDERATIONS

The consultant discussed here, the introductory considerations for feasibility and the scope of the assignment in subsequent phase of DPR for feasible stretches.

The present feasibility report provides the technical feasibility of Damodar River, declared as National Waterway 29, clubbed under Cluster – I, as stated in earlier sections. The detail description of waterway analysed in this feasibility report are described in subsequent paragraphs.

4.1 DETAILS OF NATIONAL WATERWAY 29 (DAMODAR RIVER)

Details of the waterways are as follows:

Table 2: Description of Rivers/ Canals

Sl. No	Name of the River	Local Name	Length of waterway (km)	State/District through which river passes
1.	Damodar River	-	135	**State: Jharkand** *Bokaro district* **State: West Bengal** *Bardhaman district* *Howrah district*

4.2 CHARACTERISTICS OF DAMODER RIVER

Characteristics of Damodar River considered for waterway is described in subsequent paragraph.

River Course: Damodar River is flowing across the Indian states of West Bengal and Jharkhand. Rich in mineral resources, the valley is home to large-scale mining and industrial activity. Earlier known as the "Sorrow of Bengal" because of its ravaging floods in the plains of West Bengal, the Damodar and its tributaries have been somewhat tamed with the construction of several dams.

Catchment Area: The total catchments area of the Damodar river system is 21,409 sq.km of which 17,086 sq.km (about 80%) is in the state of Jharkhand and 4,323 sq.km is in West Bengal. The entire catchment area of Lower Damodar Sub-basin is situated within West Bengal having an area of 2,838 sq.km. The proposed waterway stretch in Damodar River is located in lower Damodar sub-basin. The total length of Damodar from its origin to outfall is 541 km.

Tributaries: It has a number of tributaries and subtributaries, such as Barakar, Konar, Bokaro, Haharo, Jamunia, Ghari, Guaia, Khadia and Bhera. The Barakar is the most important tributary of the Damodar. It originates near Padma in Hazaribagh district and flows through Jharkhand before meeting the Damodar near Dishergarh in West Bengal. The Damodar and the Barakar trifurcates the Chota Nagpur plateau. The rivers pass through hilly areas with great force, sweeping away whatever lies in their path.

The section of the Damodar River under feasibility study for inland waterway is presented in Drawing No. PT/EIPTIWB003/2016/FR/0003A and is also presented as **Figure 3**. The detail layout maps of the waterway are shown in Drawing No. PT/EIPTIWB003/2016/FR/0003.

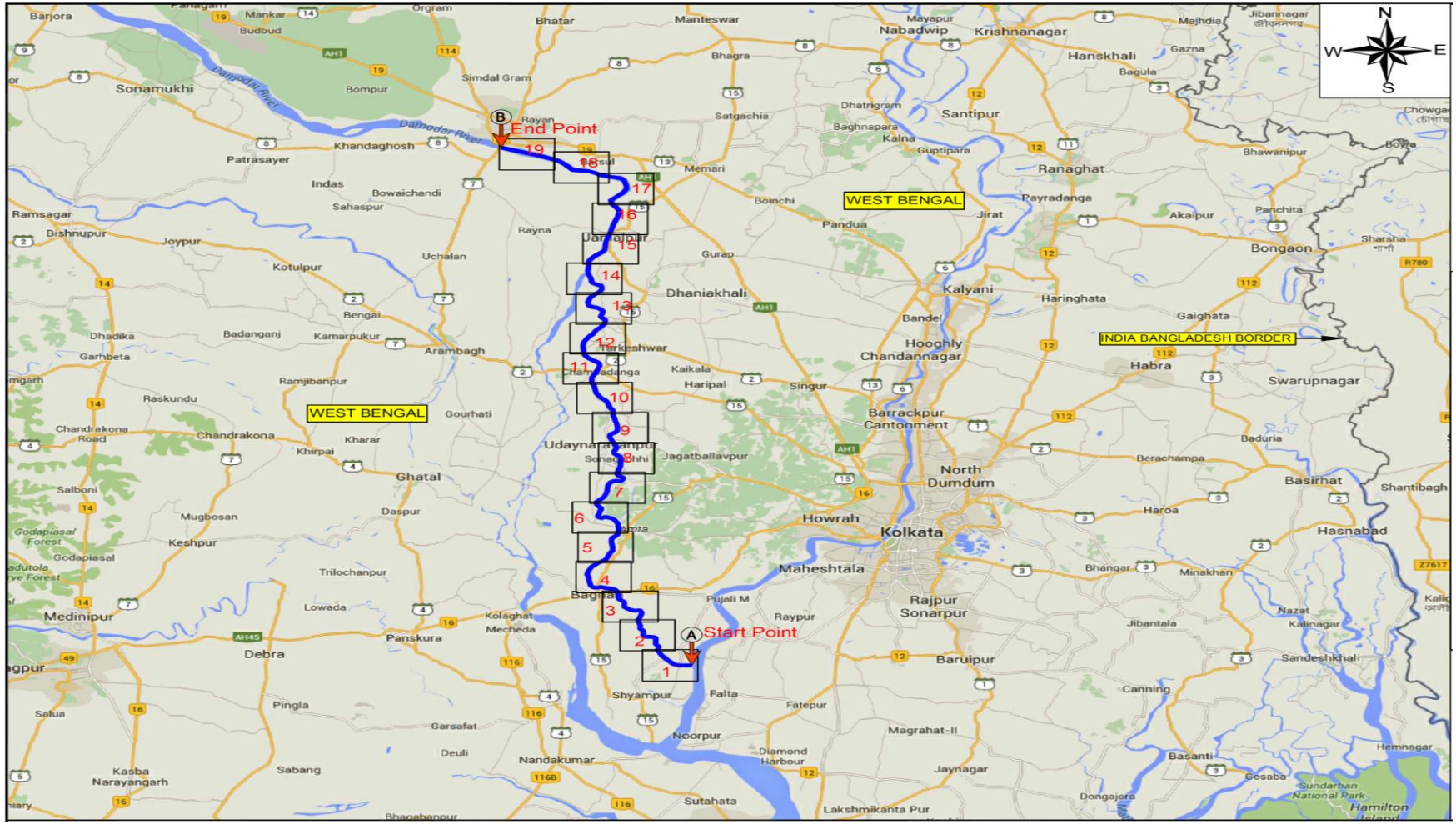

Figure 3: Layout Map of Damodar River Waterway

4.3 METHODOLOGY ADOPTED TO UNDERTAKE STUDY

A detail description on Feasibility & DPR methodology and the expected outcome in fulfilling the assignment is presented.

The feasibility study shall be carried out in accordance with TOR in the following steps:

1. Conducting Reconnaissance survey as detailed in Chapter 5.
2. Collection and review of available primary and secondary data as detailed in Chapter 6 and 7.

On the basis of detailed analysis of collected primary and secondary data, throughout the year navigability potential of the waterway is assessed and submitted in the feasibility report.

4.3.1 Classification of Waterways

The classification of waterways by Inland Waterway Authority of India is discussed below and shall be adopted in the study.

1. The waterways shall be classified in the following categories for safe plying of self-propelled vessels up to 2000 tonne Dead Weight Tonnage (DWT) and tug-barge formation in push-tow units of carrying capacity up to 8000 tonne, namely:

   a. **Class I** - Waterways with the following configuration of navigable channel:-
   - i. Rivers: Minimum of 1.2 meter depth, 30 meter bottom width, 300 meter bend radius, 4 meter vertical clearance and 30 meter horizontal clearance between piers, and
   - ii. Canals: Minimum of 1.5 meter depth, 20 meter bottom width, 300 meter bends radius, 4 meter vertical clearance and 20 meter horizontal clearance between piers.

   b. **Class II -** Waterways with the following configuration of navigable channel:-
   - i. Rivers: Minimum of 1.4 meter depth, 40 meter bottom width, 500 meter bend radius, 5 meter vertical clearance and 40 meter horizontal clearance between piers, and
   - ii. Canals: Minimum of 1.8 meter depth, 30 meter bottom width, 500 meter bend radius, 5 meter vertical clearance and 30 meter horizontal clearance between piers.

c. **Class III -** Waterways with the following configuration of navigable channel:-

i. Rivers: Minimum of 1.7 meter depth, 50 meter bottom width, 700 meter bend radius, 7 meter vertical clearance and 50 meter horizontal clearance between piers, and

ii. Canals: Minimum of 2.2 meter depth, 40 meter bottom width, 700 meter bend radius, 7 meter vertical clearance and 40 meter horizontal clearance between piers.

d. **Class IV -** Waterways with the following configuration of navigable channel:-

i. Rivers: Minimum of 2.0 meter depth, 50 meter bottom width, 800 meter bend radius, 10 meter vertical clearance and 50 meter horizontal clearance between piers, and

ii. Canals: Minimum of 2.5 meter depth, 50 meter bottom width, 800 meter bend radius, 10 meter vertical clearance and 50 meter horizontal clearance between piers.

e. **Class V** - Waterways with the following configuration of navigable channel:-

i. Rivers: Minimum of 2.0 meter depth, 80 meter bottom width, 800 meter bend radius, 10 meter vertical clearance and 80 meter horizontal clearance between piers.

f. **Class VI** - Waterways with the following configuration of navigable channel:-

i. Rivers: Minimum of 2.75 meter depth, 80 meter bottom width, 900 meter bend radius, 10 meter vertical clearance and 80 meter horizontal clearance between piers, and

ii. Canals: Minimum of 3.5 meter depth, 60 meter bottom width, 900 meter bend radius, 10 meter vertical clearance and 60 meter horizontal clearance between piers.

g. **Class VII** -Waterways with the following configuration of navigable channel:-

i. Rivers: Minimum of 2.75 meter and above depth, 100 meter and above bottom width, 900 meter bends radius, 10 meter vertical clearance and 80 meter horizontal clearance between piers.

2. Vertical clearance for power cables or telephone lines or cables for any transmission purpose for all the classes of waterways mentioned above shall be as follows:

a. Low voltage transmission lines including telephone lines - 16.5 meters

b. High voltage transmission lines, not exceeding 110 kilo volt - 19.0 meters

c. High voltage transmission line, exceeding 110 kilo volt - 19.0 meters

+1 cm extra for each additional kilovolt

3. In case of underwater pipelines, power cables and other cables, norms to be followed shall be decided as per the site conditions and navigational requirement.

Provided that this classification shall be effective for:

a. Minimum depth of channel should normally be available for about 330 days of the year.
b. Vertical clearance at cross structure over the waterway should be available at least in central 75% portion of each of the spans in entire width of the waterway.

Reference level for vertical clearance in different types of channel shall be:

a. For rivers, over Navigational High Flood Level (NHFL), this is the highest flood level at a frequency of 5% in any year over a period of last twenty years.
b. For tidal canals, over the highest high water level.
c. For other canals, over designed full supply level.

4.3.2 Measures to Improve the Depth

The basic parameters considered for the fairway design are:

- Depth
- Width
- Side slopes
- Bends

As explained above, as the classification of waterways in India is based on the experience gained in various waterways, the characteristic features of the design waterways based on studies carried out by IWAI are furnished below and the same shall be followed.

Fairway Design

The fairway depth should be good enough to ensure steerability of the vessel and to prevent bottom feel. To meet this requirement, the minimum depth that is needed in a channel would commonly be the sum of the draught (draft) of the vessel and other tolerance factors. The tolerance factors to be considered are listed as:

- Factor of keel clearance to avoid touching of the vessel to the ground and minimum free water below the keel for maintaining control on manoeuvring,
- Wave tolerance for the heaving and pitching of the vessel due to wave motion,
- Squat, increase of draft due to ship motion,
- Tolerance for siltation and dredging,
- Increase of draught due to trim and heaving due to unequal loading and steering manoeuvre respectively, and
- Tolerance for the change of draught during the transition from salt water to fresh water.

The keel clearance factor is the prime concern of the all tolerance factors considered. As per the standards laid down by German Code of practice (EAU 80), a 0.3 m layer of water column below the keel of the loaded ship is sufficient for free manoeuvrability of the vessel.

IWAI's experience in inland waterways in India and sub-continent (Bangladesh and Myanmar) shows that the under keel clearance for free manoeuvrability of the vessel varies between 0.2 and 0.5 m depending upon the soil characteristics of the channel bed and other parameters.

Width of a Channel

The total width of a navigation waterway (W) in general is expressed in terms of a beam of a vessel (B). The design width for the proposed two-way navigation can be obtained as:

$$W = BM + BM1 + C + 2C1$$

Where: W = Navigation channel width for two-way navigation.

BM = Maneuvering zone for the design vessel which takes into account the directional stability of vessel.

BM1 = Maneuvering zone for the upcoming vessel which takes into account the directional stability of vessel.

C = Width of separating zone.

C1 = Width of the security area, between the maneuvering zone and the channel side which is accounted for environmental and human factors including bank suction.

Values recommended by various authorities for the above equation vary within wide limits. Some of the recommended values are presented here:

BM = 1.3 B to 3.0 B

BM = BM1

C = 0.5 B to 1.0 B

C1 = 0.3 B to 1.5 B

Where, B = Beam of a design vessel.

Based on the experience and recommendations of experts on Inland Waterways, the factors considered for the present design are:

BM = 1.8 B

BM = BM1

C = 0.5 B

C1 = 0.5 B

The designed channel width = 1.8B+1.8B+0.5B+2x0.5B for two way navigation at draft level = 5.1B. The bottom width of the channel for two-way navigation for the design vessel can generally be considered as 5 x B.

Slopes

The selection of slope is in accordance with the soil characteristics of the bed and banks, width of the waterway etc. The adopted channel slope shall be 1:5

Width Allowance at Bends

In bends, the width of the fairway should be more than the width of the canal that is designed for a straight reach to allow for a drift of the vessel in a curved portion of the waterway. It means that the vessel occupies a greater width in bends than in a straight stretch of the waterway. The drift of the vessel depends on the radius of the bend, the speed of the vessel, wind forces, the flow pattern and the loading of the vessel. The drift angle is larger for vessels travelling in the downstream than the upstream direction. The drift angle is inversely proportional to the bend radius 'R', that is, the larger the radius the smaller the value of drift angle. Unloaded ships normally subjected to more drift and consequently take up a greater width in bends than loaded ships and therefore the proposed allowance at the keel level of the unloaded ships is larger than the loaded ships.

Dredging of Navigational Channel

The dredging quantities for the above design channel shall be worked out based on the bathymetric surveys carried out. The system and different type of navigation marks shall be proposed in the DPR are given as follows:

- Lateral marks, to mark the left and right sides of the navigation route to be followed by navigator;
- Bifurcation marks, to mark the middle ground between the navigation channel, bifurcated channel and isolated dangers in the middle of the navigational channel;
- Shore marks;
- Bank wise marks, to indicate the channel at point where it approaches a bank;
- Crossing marks, to indicated crossing and alignment of the channel from one bank to another;
- Marks of prohibited areas, to indicate no permission of entry;
- Sound signal marks, to indicate use of horning or other sound signals;
- Marks for traffic control, to control up bound or down bound vessel in one way or sequence passage or to prohibit navigation;
- Marks on bridges, to indicate the passage through bridges;
- Depth indicator marks, to indicate shallow areas ahead in the navigation channel;
- Width indicator marks, to indicate the narrow stretches ahead in the navigational channel;
- River training marks, to indicate the ongoing river training works in the river to the navigators.

4.3.3 IWT Terminal Planning

The terminal planning and design includes selection of suitable sites in the vicinity of cargo potential considering all the relevant technical variables such as choosing the type of berthing facility and providing of covered/open storage facility, cargo handling systems and other ancillary facilities required for efficient terminal operation. Based on the projected traffic, the selection of various facilities shall be planned. The cost estimate including capital and operating costs shall be estimated for each of the proposed system considering the design. These above aspects are briefly explained in the following subsequent sections.

Planning Considerations

The terminal facilities proposed for this project shall include the following:

i) Berthing Facilities for vessels;
ii) Cargo Storage Facilities;
iii) Cargo Handling Facilities;
iv) Other ancillary Facilities.

Terminal Facilities

The type of cargo handling system required at the terminal is generally dependent on the type of cargo, the annual volume required to be handled and the size of the vessels.

The various type of cargo foreseen to be handled at the proposed IWT Terminals are primarily grouped into:

i) Incoming Cargo, and
ii) Outgoing Cargo.

These above two groups are further subdivided into bulk, bagged and other miscellaneous general cargo for the purpose of planning the cargo handling equipment. The quantum and other cargo compositions shall be based on the traffic study. The same may be classified as below:

- Bulk Cargo - Construction materials such as Sand, stone, bricks, Marble, Iron steel, Machinery – Light, Heavy and ODC, Mineral Ore such as coal, lime stone, iron, fly ash, copper ore etc., bamboo, etc.
- Bagged Cargo - Cement, Fertilizer, wine and beverages, acids, cereals, cash crops, wheat, rice, Bajra, gram, pulses, cotton, etc.
- Misc. General Cargo – Consumer goods, animals, oil cake, edible oil, refined oil, paper products, jute products, etc
- Ferry – Passenger vessels for Tourists

4.3.4 Identification of IWT Terminals

Site selection is the most important as it decides the investment for establishing the terminal facilities. Hence, proper consideration has to be given to select the most optimum location which will minimise the capital investment and other recurring cost during operation. The selection of suitable site shall be carried out with the view of following considerations:

- Water availability near the terminal land throughout the year especially during lean season;
- Stable river channel with sufficient depth;
- Favourable hydraulic conditions for berthing and cargo handling;
- Availability of terminal land for infrastructure, cargo storage and handling;
- Traffic potential and cargo characteristics; and
- Navigational safety.

The proposed IWT Terminals shall be planned with the following infrastructure facilities for operation:

i) Steel Gangway resting on a floating pontoon. The detailed engineering & design of gangway arrangement shall be carried out during the construction stage. The preliminary layout drawing shall be proposed in the DPR;
ii) Administration Building and Bank protection arrangement;
iii) Covered Storage Shed/Transit Shed;
iv) Open storage area;
v) Security Shed;
vi) Forklift Trucks, Pay loaders & Dumper tracks; and
vii) Weigh Bridge, Watch and ward, Compound wall, Firefighting arrangement, Electrical & PH Facilities including DG.

The terminal shall be proposed with suitable mooring facilities, firefighting water line, water supply pipeline, power line for shore connection to barges, fenders etc. Preliminary planning and master plan shall be prepared in the DPR stage as per the relevant IS codes. It is envisaged and proposed that to the extent possible, all shore/river bank based buildings / godown are prefabricated, pre-engineered type conforming to the best standards in vogue in logistic / supply chain industry.

Other Alternatives to Improve for Navigation

Based on our earlier study for Ganga River between the reach from Allahabad to Ghazipur, there are many methods available to improve river navigation. Bandalling work – it has to follow closely falling stage of river, closing minor channels and diverting river flow in single channel to increase depth in the navigable channel in mainly due done by bandalling. In some reaches this method becomes successful but some river stretches remain shallow and need other training measures including dredging. Channelization of river and Construction of barrages at suitable locations, creating ponding conditions with required depth and navigational locks for ships and vessel movement shall be studied. The examination of various options/measures to improve the water depth shall be studied. The most suitable method for development shall be identified with consideration on the likely morphological, sediment transport, and dredging aspects of different options. This task is expected to be fed back into from the financial and economic analysis providing refinement to the proposed development until a recommended solution is reached. The most appropriate type of river development including drudging option along the river shall be identified and likely impacts of these developments on river flow depths as well as sedimentation and morphology shall be investigated. This analysis will constitute an iterative process in which problems relating to LAD will be addressed to find more successful solutions where necessary. This will however, not be an open-ended process as the

assessment of techno-economic feasibility updation only requires an indication of the likely costs of building and maintaining the structures which are shown to support achievement of LAD as intended.

4.3.5 Rapid EIA

Suitable Rapid Environmental Impact Assessment shall be performed and report shall be included in final DPR. The Rapid EIA Studies can be broadly divided in to three phases.

- The first phase involves identification of significant environmental components in the area where the project is located and assessing their baseline (pre-project or existing) status within the study zone. In case of existing projects, environmental performance of existing manufacturing / pollution control plants is also required to be covered.
- The second phase involves prediction of impacts on various identified significant environmental parameters due to proposed project.
- The third phase includes the evaluation of final impacts and delineation of an Environmental Management Plan to mitigate adverse impacts on the quality of surrounding environment.

4.3.6 Concept Design and Cost Estimates

Preliminary Design shall be performed for all the structures /developmental works proposed as per the above analysis and mathematical model studies carried out conforming to relevant IS Codes. Design drawings shall be prepared and submitted based on the preliminary design. Bill of quantities and cost estimates shall be prepared for all the proposed structures / developmental works. Based on the cargo potential and other considerations necessary for locating an IWT terminal, extent of land required for setting up of IWT terminals and other suitable locations shall be identified. Preliminary topographic survey shall be carried out and layout plan for all suggested locations shall be prepared clearly indicating all facilities e.g. jetty, approach to jetty, bank protection, covered and open storage, roads, office, sentry hut, boundary wall, bank protection, bunkering facility, water facility, turning circle for IWT vessels location of depth contours of 2m and 2.5m in the river near the terminal sites. Preliminary engineering design and drawings for setting up of terminals with related facilities including mechanical loading/ unloading at the proposed sites shall be prepared. Also inter modal cargo transfer facilities required at these terminals shall be indicated.

4.3.7 Financial and Economic Analysis

Financial and economic analysis through FIRR and EIRR of the project including SWOT analysis shall be carried out for the project. For the Financial Internal Rate of Return shall be computed as follows:

- Costs shall be calculated as total capital investment for the Project components, net rate of interest charges during construction and operations & maintenance costs for the Project;
- Income flows shall be calculated based on gross revenues of projected goods to be transported through private operators with permissible assumptions such as project life etc.;
- Economic Internal Rate of Return shall be computed taking into account the following factors;
- The assumed life of the project as per norms;
- Costs shall be calculated as Government contribution and other sources. A standard conversion factor shall be used to reduce financial costs to economic costs;
- Benefits shall be estimated as Government revenues, calculated as net profit share, royalties and tax;
- Social Benefits like fuel saving, reduction in environment pollution and carbon emission, accident reduction, decongestion of rail and roads, etc.

The financial viability and sustainability of this project depend upon the adaptation to the prevailing context in which they operate. In working out the Financial Viability and sustainability, the following factors shall be considered.

- budgeting and cost accounting systems,
- resource mobilization for capital investments,
- cost recovery and operational financing,
- cost reduction and control.

The Profitability projections and financial analysis for each of the project components shall be worked out in detail and presented in the report. The financial statements shall be prepared on the basis of the suitable assumptions. The cost benefit analysis for the proposed project shall be calculated. The Net Present Value (NPV) with interest and depreciation, IRR and preliminary expenses shall be suitably considered and estimated. Break-even analysis shall be performed and presented in the report.

4.3.8 Implementation & Monitoring Mechanism

Project financial structuring shall be worked out in detail which will examine the sources and composition of funding for the project. The Project financial structuring can involve a combination of equity, grant, debt and finance from private participation (and in some cases, contribution from user communities). The scope and options for possible debt and private sector financing shall be reviewed elaborately and presented in the report. The suitable monitoring mechanism shall be evolved.

5.0 COLLECTION AND REVIEW OF DATA

5.1 PRIMARY DATA

In order to collect primary data and to access the latest hydro-morphological condition of the waterways reconnaissance survey was done. Following aspects had been covered in the reconnaissance survey as per TOR:

a) Single line longitudinal survey (Bathymetric survey or Topographic survey) in the deepest depths or lowest height lands, with the help of DGPS using Automatic Hydrographic Survey System. Bathymetric surveys in the national waterways are to be carried out in the deepest route. Deepest route can be accessed by taking two or three longitudinal line soundings at equal interval. Topographic survey, if required, is to be taken up at lowest ground levels, which can be decided on visual assessment.

b) Details (horizontal and vertical clearances above High Flood Level of bridges, aqueducts, electric lines, telephone lines, pipe lines, cables en-route are to be collected and indicated on the chart and also included in the report along with their co-ordinates and location. Details about Barrages, Dams, Locks en-route are also to be collected horizontal and vertical clearance is to be given as approximate on visual assessment.

c) Photographs are required to be submitted in the report.

d) Topographical features of the Inland Waterways.

e) Typical physical features along the alignment i.e. land use pattern:

f) Preliminary identification of stretches having year round flow and critical depth for navigational purpose.

g) Inventory of major aspects including Inland Waterway width, Terrain, Bridges and structures across the Inland Waterways (Type, size and location), urban areas (location extent). Geologically sensitive areas environmental features. Hydrological features

h) Critical areas requiring detailed investigations and

i) Requirements for carrying out supplementary investigations

j) Soil (textural classifications) (only visual inspection at every 10km) and drainage conditions.

k) Type and extent of existing utility services along the alignment.

All the above details are collected during field survey as well as by interaction with the concerned authorities from 29th January to 3rd February 2016 by the consultant.

5.2 REVIEW OF SECONDARY DATA

Location and its Catchment: The Damodar River is one of the most important rivers in West Bengal and Jharkhand. The river has its source close to the Chandwa village in Palamau district of Jharkhand in India. The river is famous all over the world for the Damodar Valley Corporation (DVC). The length of the river is 592 km or 362 miles. The river traverses important cities like Asansol, Bokaro, and Durgapur in West Bengal and Jharkhand.

The Damodar River is one of the most important rivers in eastern India. It lies on the Chota Nagpur Plateau in the state of Jharkhand in India. The river runs according to an easterly itinerary for a stretch of around 592 km, traversing Jharkhand and West Bengal to the estuary of the Hooghly River. In a number of local dialects of Jharkhand, the Damodar River is known as Damuda. The word *damu* stands for holy and *da* signifies water. Previously, the Damodar ran through West Bengal on a straight west to east itinerary and met the River Hooghly close to Kalna. Nevertheless, it has shifted its itinerary. In its lower plains, the larger portion of the water is poured into the Mundeswari River, which fuses with other streams and ultimately the largest part of the Damodar waters pours into the Rupnarayan River. The rest of the volume of water runs through what is named as Damodar into the Hooghly River, towards the south of Kolkata.

The tributaries and sub-tributaries of the Damodar include the following:

- Konar
- Barakar
- Haharo
- Bokaro
- Ghari
- Jamunia
- Khadia
- Guaia
- Bhera

The biggest tributary of the Damodar River is the Barakar. The source of Barakar is located in the vicinity of Padma in Hazaribagh district. Subsequently, the river runs through Jharkhand prior to joining the Damodar close to Dishergarh in West Bengal. The Barakar and the Damodar get the Chota Nagpur flat terrain divided into three parts. The rivers flow through mountainous regions with enormous might, overwhelming anything that comes in their way. The Barakar destroyed two bridges

close to Barhi on the Grand Trunk Road in Hazaribagh district and they are the huge rock bridge in 1913 and the succeeding iron bridge in 1946.

The catchment area of the river is about 21,400 sq. km of which about 19,000 sq. km are in uplands and 3,000 sq. km in plains which are of deltaic nature. The catchment is irregular in shape and somewhat elongated in the lower reach. The river slope is 1.86 m/km for the first 241 km; 0.57 m/km in the next 167 km and 0.16 m/km in the last reach. The lower reaches are silt covered and quite fertile. Irrigation facility has been available in the lower Damodar basin before the advent of dams by means of a diversion weir-Anderson weir-at Rhondia on river Damodar and Eden canal to the extent of 89,000 ha in the districts of Burdwan and Hoogly. The detail of its catchment is follows:

Name of River	Catchment Area (Sq. Km)	
	Total	West Bengal
Damodar	21409	4323

Source: Annual Flood Report 2014

The river Damodar originating from Palamau hills in Jharkhand and bifurcates into two channels at Beguahana. The main flow passes through Mundeswari channel and discharges into Rupnarayan. The other one Amta channel carries discharge during high flood and outfalls into the Hooghly. The river causes floods in its lower reaches in the districts of Burdwan, Hooghly and Howrah, mainly on the right bank of the river below Beguahana.

Status of CWC gauge established in Damodar river along the waterway is given below:

Name of Gauge Station	Chainage (Km)	Danger Level (DL) (m amsl)	Extreme Danger Level (EDL) (m amsl)
Jamalpur	103.923	23.24	23.54

Source: Annual Flood Report 2014
DL is considered as HFL for assessing the Minimum Vertical Clearance

Damodar, as the River of Sorrow: The average yearly precipitation on the Chhota Nagpur terrain is approximately 1400 mm, and nearly the whole amount of it takes place in the monsoon season, between June and August. The enormous quantity of water that runs through the Damodar River and its tributaries at the time of the monsoons was mighty and the flow was quite vehement in the higher basins of the plateau. However, in the lower basins, the river flooded its banks and inundated other big localities nearby.

Previously, the River had been called as the River of Sorrows. The simple reason is that the Damodar inundated different localities and urban settlements in Burdwan, Hooghly, Medinipur, and Howrah districts. On limited occasions, the floods do carry negative consequences to the lives of the inhabitants of the lower Damodar basin. Nonetheless, the catastrophe it created in the past does not take place any more.

The deluges were practically a yearly custom. However, in a particular number of years, the disaster was possibly higher and Damodar has caused a number of deluges of huge intensity in the following periods (all of them have been chronicled) – 1770, 1855, 1866, 1873-74, 1875-76, 1884-85, 1891-92, 1897, 1900, 1907, 1913, 1927, 1930, 1935 and 1943. During four of these inundations (1770, 1855, 1913, and 1943), the majority of Burdwan town was deluged.

Maharaja Kirti Chand of Burdwan signed a contract with the East India Company in 1789 in which the Maharaja was directed to pay an extra sum of Rs. 193,721 for the building and upkeep of riverbanks to stop deluges. Nevertheless, these were subject to a number of arguments. The Bengal Embankment Act came into existence in 1866 and 1873, passing the authorities to construct and preserve riverbanks to the administration.

Damodar Valley: The Damodar Valley extends over Koderma, Hazaribagh, Dhanbad, Giridih, Bokaro, and Chatra districts in Jharkhand and Burdwan district in West Bengal. The Valley encompasses Ranchi, Palamau, Dumka, and Lohardaga districts in Jharkhand and Bankura, Howrah, and Purulia districts in West Bengal in part.

The Damodar Valley is home to huge resources of mica and coal. The region is an extremely thriving industrial area. On several occasions, the Damodar Valley is denoted as the Ruhr of India due to its resemblances with the industrial and excavation belt of Ruhr in Germany.

A number of dams have been constructed on the Damodar River along with many hydroelectric power plants. Recently, the Damodar has become one of the most contaminated rivers of India, with excavation refuses, chemical substances, and poisonous wastes running into the river from industries and excavation sites situated in the basin. Initiatives are being taken to lower the extent of contamination in the river.

Industrial Status: The Damodar Valley is home to three state-of-the-art steel manufacturing plants and they are Burnpur, Bokaro, and Durgapur. All these plants belong to Steel Authority of India Limited (SAIL). In addition, there are other manufacturing plants in the basin.

The Damodar Valley is home to a range of minerals, which includes extensive resources of coal and refractory substances. The biggest (nearly the exclusive) reserves of coking coal in India are discovered in the Jharia coalmines in the Damodar Valley. The basin also produces 60% of medium grade coal in India. Coal India Limited manages the valley to a significant extent. A slew of dams have been constructed in the valley to create hydroelectric power.

Damodar Valley Corporation: Damodar Valley Corporation (DVC) was set up in July, 1948 under the Damodar Valley Corporation Act No. XIV of 1948 with the broad objective of unified development of the Damodar River basin. The principal functions of this multipurpose development are flood control, irrigation, generation, transmission and distribution of electric power. The main subsidiary activities include water supply, soil conservation, navigation and promotion of public health.

In the beginning, the stress of the Damodar Valley Corporation was on water supply, deluge management, production, transmission, and supply of electricity, preservation of ecological balance, conversion of cultivated land into forest, and generation of employment for the financial welfare of the inhabitants living in and around localities served by the Damodar Valley Corporation projects. Nevertheless, throughout the last one or two decades, generation of electricity has become the top priority. The DVC also has some other goals that are integrated into the key responsibility of the company. The Damodar Valley Corporation has a generated irrigation capacity of 3640 km^2.

The first dam on the Damodar was constructed on the Barakar River at Tilaiya. The Barakar is the principal tributary of the Damodar River. The dam started operating in 1953. The second dam was constructed over the Konar River, one more tributary of the Damodar River at Konar. The dam started operating in 1955. Two dams were constructed over the Damodar and Barakar rivers at Panchet in 1959 and Maithon in 1957. Both the dams are around 8 km upstream of the meeting point of the streams. These four important dams are regulated by DVC. On the downstream of the four dams, Durgapur Barrage was built at Durgapur over the Damodar River in 1955. The head regulators for channels on both sides were installed for supplying an all-encompassing system of distributaries and channels. The Bihar Government (prior to creation of the Jharkhand state) built the Tenughat Dam in 1978, over the Damodar River beyond the authority of the Damodar Valley Corporation. The government also is planning to build a dam over the Barakar River at Belpahari in the state of Jharkhand.

Present Scenario: At present, the Damodar is the most contaminated river in India, due to the various industries that have mushroomed on its riverbanks, which are good resources of minerals. There are a number of coal-oriented industries that are scattered over the Damodar basin. Majority of them are government-owned coal oven plants; coal washeries, important iron and steel plants in

India; glass, zinc, and cement plants; and thermal power plants. The contamination was a result of excessive excavation, oil, fly ash, poisonous metals, as well as coal dust. Defective excavation operations, outmoded processing activities, and deficiency of right upkeep were intensified by insufficient pollution check measures, and a state pollution control board that was ineffective. The inhabitants residing in the valley were gradually being poisoned due to the fact that Damodar and its tributaries were the only source of drinking water for majority of inhabitants residing in the locality.

6.0 ANALYSIS OF PRESENT STATE OF AFFAIRS

6.1 EXISTING DAMS, BARRAGE & LOCKS

Only 1 Barrage is located near Silampur at a Chainage of 1.5 km from the start point of waterway (i.e. from the confluence of Damodar River with Hooghly River).

6.2 EXISTING BRIDGES ALONG THE WATERWAY

The existing bridges and crossings encountered during survey are listed in **Table 3.**

Table 3: Details of existing Major Road and Rail Bridges over Damodar River

Sl. No	Location	Chainage (km)	Easting	Northing	Vertical Clearance w.r.t HFL (m)	Horizontal Clearance b/w piers (m)
Major Road Bridges						
1.	Chandrapur	20.50	602702.23	2485385.82	5.00	30.00
2.	Khadinan	23.50	599979.29	2486221.00	5.00	30.00
3.	Jayanti	36.60	602639.03	2496683.39	4.00	20.00
4.	Gourangachak	53.78	602631.40	2508385.80	5.00	12.00
5.	Tokapur	59.60	601639.90	2513268.90	4.00	10.00
6.	Champadanga	74.55	599455.70	2526165.60	4.00	20.00
7.	Kanaria	81.60	598026.20	2531896.70	4.00	15.00
8.	Haragobindapur	101.50	601424.40	2557190.60	5.00	15.00
9.	Jamalpur	106.84	601032.46	2551463.80	3.00	4.00
Rail Bridges						
1.	Janbar	19.75	602595.65	2484752.10	6.00	30.00
2.	Rasulpur	78.44	597916.70	2529247.80	6.00	15.00
3.	Gramdapur	111.50	601784.60	2556131.17	6.00	15.00

Vertical Clearances are on the basis of visual assessment s per Ref No. 2, page 2 of 27, replies to Pre-bid queries raised by Prospective bidders in Pre-bid meeting held on 23.04.2015, wherein it was clarified by IWAI that, "In Stage –I, horizontal and vertical clearance is to be given as approximate on visual assessment."

It can be inferred from the above table that the maximum and minimum Vertical clearance is between **6.0 m to 3.0 m**. Similarly the maximum and minimum Horizontal clearance is in the range of **30.0 m** and **4.0 m** respectively.

6.3 EXISTING HIGH TENSION LINES

During the survey high tension lines are observed at certain chainages and the same is presented in the following **Table 4**.

Table 4: Details of Existing High Tension Lines

Sl. No	Location	Chainage (km)	Easting	Northing	Vertical Clearance w.r.t HFL (m)
1.	Gopalpur	24.00	599558.12	2486171.26	8.00
2.	Gopalpur	24.30	599317.96	2486260.65	8.00
3.	Fatepur	30.30	601266.18	2491836.91	8.00
4.	Paliarah	55.00	602793.30	2510043.30	9.00
5.	Ghola	62.70	602092.70	2516687.50	6.00
6.	Sachak	71.80	598905.30	2524033.30	7.00
7.	Laskarpur	76.00	599504.20	2527923.30	9.00

6.4 HINDRANCES/ ENCROACHMENT ALONG THE WATERWAY

Hindrances/encroachments for waterway are defined as any natural or manmade structure, which can cause obstruction or danger to navigation. In order to start navigation in the waterway, these structures are either to be removed or taken care adequately. These hindrances/encroachments are may be rock outcrop from the river bed, wooden or sand bridges, etc. Major hindrances/encroachments identified en-route the Damodar waterway are wooden and bamboo bridges which are to be dismantled or re-located as per the navigational requirements. The list of these hindrances is provided in **Table 5**. Photographs of the hindrances are provided in **Annexure 4**.

Table 5: Details of Hindrances / Encroachment along the Waterway

Sr. No.	Location	Chainage (km)	Easting	Northing
1.	Begua	44.50	600459.60	2502814.30
2.	Kansona	46.00	600947.00	2503867.90
3.	Kumarchak	47.50	601466.90	2505505.20
4.	Monsuka	50.00	602926.60	2506593.70
5.	Jhanda	64.50	601343.10	2519212.80
6.	Ghola	62.50	601853.10	2517291.50
7.	Jhanda	65.50	601145.20	2519764.10
8.	Shib Chak	66.50	600594.70	2520855.50
9.	Hetam Chak	66.00	599326.10	2522856.60
10.	Kumrul	84.50	600333.40	2535737.60
11.	Paschim Kalikapur	85.50	600090.10	2536562.10
12.	Bonogram	88.00	598534.10	2538068.40
13.	Palla colony	115.50	602588.50	2561392.20
14.	Palla colony	116.00	601984.70	2561629.90
15.	Bharpota	116.50	601518.30	2561834.30
16.	Baje Salepur	119.80	598309.00	2562858.20
17.	Baje Salepur	120.00	597998.90	2563018.30
18.	Manik Hati	123.50	595069.20	2564418.90
19.	Chaitpur	125.50	593314.00	2565352.00

6.5 FOREST AREA / PROTECTED AREA / DEFENCE AREA

No forest, protected and defence areas located along the waterway stretch of Damodar River.

6.6 ROAD AND RAIL INFRASTRUCTURE

Damodar waterway is well connected with rail and road network. The details of Railway station located within 5.0 Km radius of the proposed waterway are presented in **Table 6**.

Table 6: Railway station within 5.0 Km radius of Damodar River

Sl. No.	Railway Station	Sl. No.	Railway Station
1.	Bagnan Railway Station	10.	Masagram Railway Station
2.	Kulgachia Railway Station	11.	Chanchai Railway Station
3.	Amta Railway Station	12.	Palla Road Railway Station
4.	Harshdadpur Railway Station	13.	Rasulpur Railway Station
5.	Talpur Railway Station	14.	Palsit Railway Station
6.	Takirpur Halt Railway Station	15.	Saktigarh Railway Station
7.	Math Nashipur Railway Station	16.	Gangpur Railway Station
8.	Berugram Railway Station	17.	Barddhaman Junction Railway Station
9.	Gramdadpur Railway Station		

Detail of major roads connecting to the Damodar waterway is provided in **Table 7**.

Table 7: Major Road crossing or within 5.0 Km radius of Damodar Waterway

National/State Highway	Other Major Roads
a) National Highway 2 b) National Highway 2B c) National Highway 6 d) State Highway 2 e) State Highway 7 f) State Highway 8 g) State Highway 13 h) State Highway 15	a) Uluberia Shyampur Road b) Bagnan Amta Road c) Mankur Road d) Amta Road e) Udaynarayanpur Road f) Tarkeswar Road

7.0 RECONNAISSANCE SURVEY

Egis, India carried out the reconnaissance survey as required for the feasibility studies and detailed as per TOR as below:

- Single line longitudinal survey (Bathymetric survey or Topographic survey) in the deepest depths or lowest height lands, with the help of DGPS using Automatic Hydrographic Survey System.
- Horizontal and vertical clearances above High Flood Level of bridges, aqueducts, electric lines, telephone lines, pipe lines, cables en-route are to be charted.
- Details about Barrages and Dams en-route are also to be reported.
- Topographical features of the Inland Waterways are to be reported.
- Typical physical features along the alignment i.e. land use pattern are to be reported
- Stretches having year round flow and critical depth for navigational purpose are to be reported.
- Preliminary Traffic on the Inland Waterways is to be identified.
- Inventory of major aspects including Inland Waterway width, Terrain, Bridges and structures across the Inland Waterways (Type, size and location) will be reported.
- Urban areas (location extent) are to be reported.
- Geologically sensitive areas environmental features are to be reported
- Hydrological features are to be reported.
- Critical areas requiring detailed investigations are to be reported.
- Requirements for carrying out supplementary investigations are to be reported.
- Visual inspection of Soil (textural classifications) are to be reported
- Major Drainage conditions are to be reported.
- Type and extent of existing utility services along the alignment are to be identified.
- Identification of various agencies of the govt. from whom the concerned project clearances for implementation are to be sought.

7.1 DETAIL METHODOLOGY FOR SURVEY

The surveyor deployed a team of personnel to carry out the reconnaissance survey; the detailed methodology is described in following sub sections.

7.1.1 Resource for Survey Work

Off shore Key Personal:

- Project in-charge: 1 no.
- Senior Surveyor: 4 nos.
- Survey Engineer: 3 nos.

On shore Key Personal:

- Project manager: 1 no.
- Survey manager: 2 nos.
- Reports Coordinator: 1 no.

Survey Equipment and Software:

Table 8: List of Equipment Mobilised for Survey

Sl. No.	Survey Equipment/Systems Used for the Data Acquisition	
	Equipment/System	Description/Make/Model
1.	Software / Navigation	HYPACK 2015 computer acquisition and data logging Software
2.	Positioning System	Trimble SPS 351(DGPS) & 855 RTK DGPS (One Base & Two Rover)
3.	Single beam Echo Sounder	Sonar Mite
4.	Tidal Observation	Valeport Automatic Tide Gauge/ Manual Tide Gauge
5.	Levelling	Sokkia B40 Auto Level
6.	Total Station	Trimble TS 635
7.	Data Acquisition System	Dell laptop/ HP laptop

Survey Vessel

Considering the geographical and topographical feature, length of river, shallow and dry patch, inaccessibility to survey area, due to insufficient water for regular boat, inflatable Zodiac Boat "Aqua Marina-1", "Aqua Marina 2" were used to carry out bathymetric survey. The names and specifications of the survey boats are provided in **Table 9**.

Table 9: Details of Survey Boats Used

Name of the Boat	Length (m)	Width (m)	Draft (m)
Aqua Marina - 1	3.0	1.5	0.020
Aqua Marina – 2	2.5	1.29	0.020

7.1.2 Geodetic Parameters

The geodetic parameters used for survey were as follows:-

Global Positioning System Geodetic Parameters							
Datum:	World Geodetic System 1984 (WGS84)						
Spheroid:	World Geodetic System 1984						
Semi major axis:	a = 6 378 137.000 m						
Inverse Flattening:	$^1/_f$ = 298.257 223 563						
Local Datum Geodetic Parameters							
Datum:	World Geodetic System 1984 (WGS84)						
Spheroid:	World Geodetic System 1984						
Semi major axis:	a = 6 378 137.000 m						
Inverse Flattening:	$^1/_f$ = 298.257 223 563						
Datum Transformation Parameters from WGS84 to WGS84							
Shift dX:	0.0 m	Rotation rX:	0.000	arcsec	Delta Scale :	0.0000	ppm
Shift dY:	0.0 m	Rotation rY:	0.000	arcsec			
Shift dZ:	0.0 m	Rotation rZ:	0.000	arcsec			
Local Projection and Grid Parameters [2)]							

Map Projection:	Universal Transverse Mercator
Grid System:	UTM Zone 45 N
Central Meridian:	087° 00’ 00” West
Latitude of Origin:	0° 00’ 00” North
False Easting:	500 000 m
False Northing:	0.0000
Scale factor on Central Meridian:	0.9996
Units:	metres

Notes:
1) Hypack navigation software always uses WGS84 geodetic parameters as a primary datum for any geodetic calculations.
2) This is the right-handed coordinate frame rotation convention used by the Hypack navigation software.

7.1.3 Survey Data Processing

General

The survey data was logged in HYPACK On-line Survey Software, and was processed using the HYPACK Processing, AUTOCAD and Spectra Precision Survey Office. The data was processed, checked and verified to ensure good quality data. Single Beam (SB) Editor was used for the automated and manual processing of logged data sets.

Navigation and Positioning

The DGPS Receiver Antenna was mounted exactly above the echo sounder transducer. The echo sounder transducer was mounted on the side of the boat, without any offset to ensure accuracy in the position of soundings. The bar-checks were carried out before/after each sounding session. Transducer draft was measured and recorded, and the same was used while processing. On all such occasions the error observed was zero or near zero. Therefore, no corrections were necessary.

Bathymetry

HYPACK Processing suite was used to import quality check and process the navigation, bathymetry and tidal data. The data was filtered, cleaned, and combined to create geographically positioned bathymetric data set.

7.2 DESCRIPTION OF BENCH MARKS/ REFERENCE LEVELS

Due to non-availability of any permanent BM near the project area during reconnaissance survey, benchmarks was established by DGPS observation for 12 hours using Trimble SPS 855 positioning system and post processing through AUSPOS and Spectra Precision Survey Office to get the value of the TBMs with respect to MSL. The final co-ordinates of the BM and height above MSL and other details are provided in **Table 10** as below

Table 10: Temporary Benchmark Damodar River

Sl. No.	TBM	Easting	Northing	Chainage (Km)	CD w.r.t MSL (m)	Ht above MSL (m)
1.	Krishak Setu (TBM – 1)	586858.31	2567269.25	132.41	18.844	40.638
2.	Dadpur (TBM – 2)	601501.29	2557207.14	110.37	17.202	26.123
3.	Amarpur (TBM – 3)	600241.91	2541262.66	91.872	14.328	18.99
4.	Kanaria (TBM – 4)	598159.02	2531870.73	79.34	12.571	21.804
5.	Lebutala (TBM – 5)	601823.05	2517262.56	62.53	10.704	8.693
6.	Amta (TBM – 6)	602653.31	2496786.36	36.024	6.864	2.908
7.	Khanjinan Ghat (TBM – 7)	600001.84	2486158.11	23.097	5.297	12.749
8.	Silampur (TBM – 8)	610681.08	2471981.44	1.44	3.947	6.55

7.3 LEVELLING OF TEMPORARY TIDE POLES

Eight number of temporary bench marks were established in between the course of survey at different places by using Trimble RTK SPS 855. Auto level SOKIA B-30 was used to establish the zero of the tide gauge with reference the TBMs. The observed readings in Auto Level are provided in **Annexure 1**. The water levels observed on the tide poles during reconnaissance survey are provided in **Annexure 2**. The CD/SD adopted for obtaining reduced depth along the waterway is given in **Figure 4**. Chart datum established at Sagar Island is used for establishing CD along the waterway.

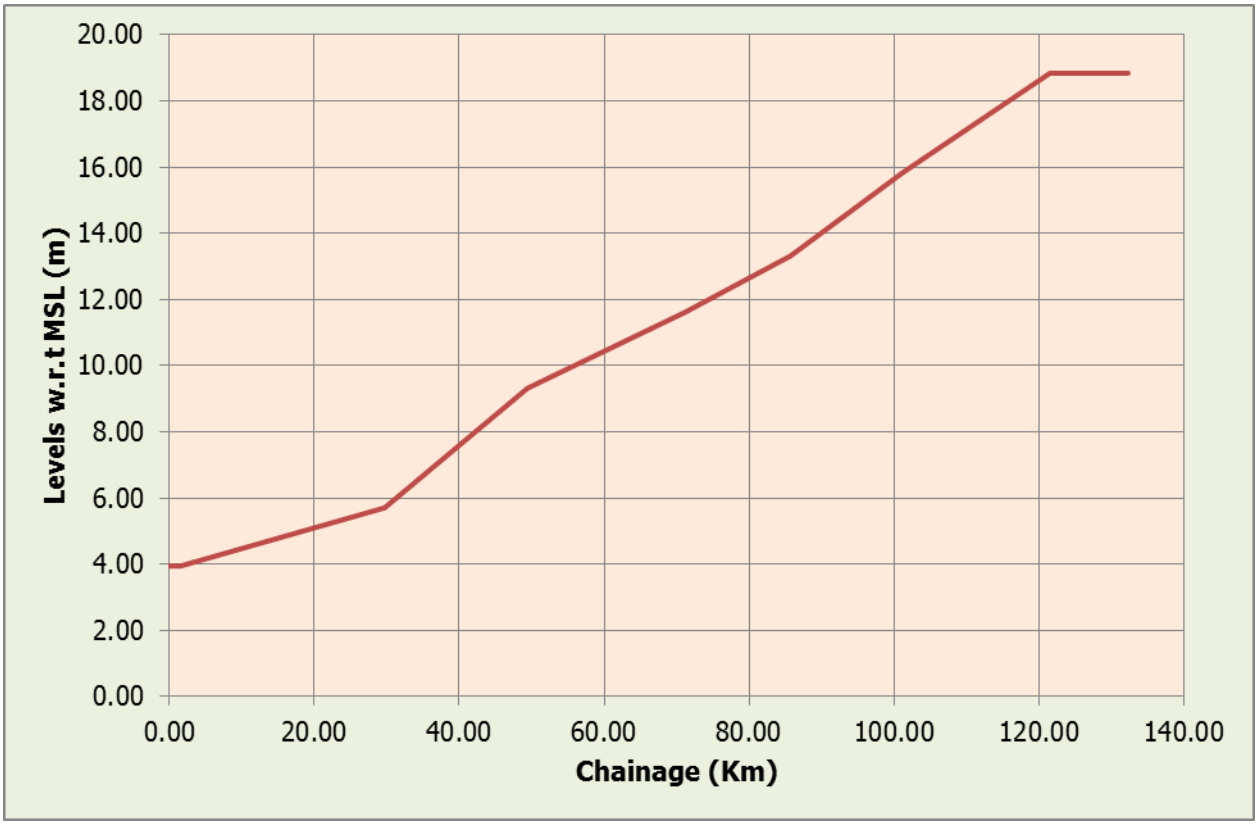

Figure 4: Graph showing Chart Datum/Sounding Datum w.r.t. MSL along Damodar River

7.4 HYDROGRAPIC SURVEY

Single line longitudinal survey Bathymetric survey in the deepest depths with the help of DGPS using Automatic Hydrographic Survey System has been carried out for the for the full length of 135.0 km of Damodar waterway.

7.5 WATER DEPTH

Water depths along the waterway have been observed during Reconnaissance survey as per the scope of works and requirement for feasibility studies. Single line longitudinal bathymetric/topographic survey has been carried out for obtaining the water depth along the deepest route or lowest height lands of waterway. The observed depth are then corrected by applying a reduction factor as provided above for different stretches to calculate the reduced water depths available for navigation. The reduced water depths at every 10 km interval are presented in **Table 11**. Detailed water depths along the Damodar waterway is also provided in **Annexure 3**.

Table 11: Water Depth along the Waterway

Chainage (Km)	Draft Variation		Length of River (Km) with following draft			
	Max. Available (m)	Min. Available (m)	<1m	1.0 -1.5m	1.5 -2.0 m	>2.0m
0 – 10	8.87	0.00	1.40	0.00	0.00	8.60
10 – 20	7.18	3.63	0.00	0.00	0.00	10.00
20 – 30	6.92	2.62	0.00	0.00	0.00	10.00
30 – 40	5.42	1.34	0.00	0.69	1.39	7.92
40 – 50	6.83	0.65	0.79	2.18	2.08	4.95
50 – 60	6.47	0.00	4.65	2.48	1.58	1.29
60 – 70	1.91	0.00	8.61	0.97	0.42	0.00
70 – 80	5.52	0.00	3.23	1.51	0.86	4.41
80-90	5.94	0.84	0.59	1.49	3.66	4.26
90-100	3.57	0.00	3.66	2.97	1.78	1.58
100-110	4.13	0.08	6.53	1.49	0.50	1.49
110-120	8.48	0.93	0.50	2.18	3.96	3.37
120-130	7.79	1.71	0.00	0.00	0.41	9.59
130-135	2.76	1.68	0.00	0.00	0.68	4.32
Total			**29.97**	**15.94**	**17.32**	**71.77**

It can be inferred from the above table that **71.77 Km stretch of waterway have draft more than 2.0 m, 17.32 Km stretch have draft of 1.50 m to 2.0 m, 15.94 Km have draft of 1.0 m to 1.50 m and remaining 29.97 Km stretch of waterway have less than 1.0 m draft with respect to chart datum** respectively.

7.6 SOIL CHARACTERISTICS

On the basis of visual assessment done during longitudinal survey, the characteristics of soil on both banks of the waterway are provided in **Table 12**.

Table 12: Soil Characteristics along Damodar River

S. No.	Chainage (Km)	Latitude	Longitude	Easting (m)	Northing (m)	Soil Type
1.	135	22°21'0.763	88°05'19.36	612104.62	2471996.41	Sand
2.	120	22°2516.59	88°01'28.29	605442.66	2479817.10	Sand
3.	110	22°28'47.10	87°58'47.21	600804.78	2486259.75	Sand
4.	100	22°32'38.40	87°59'32.04	602029.10	2493380.99	Sand
5.	90	22°36'43.47	87°58'28.32	600158.17	2500905.23	Clay Sand
6.	80	22°40'45.12	87°59'56.66	602630.46	2508353.11	Clay Sand
7.	70	22°45'26.78	87°59'36.53	601998.05	2517010.84	Clay
8.	60	22°50'15.94	87°58'04.36	599311.01	2525885.81	Dry Clay
9.	50	22°54'39.26	87°58'27.92	599929.14	2533987.78	Clay Sand
10.	40	22°58'48.54	87°58'33.06	600024.55	2541654.98	Muddy
11.	30	23°03'14.36	87°58'50.90	600477.98	2549833.09	Muddy
12.	20	23°08'01.02	88°00'02.79	602463.41	2558662.69	Muddy
13.	10	23°10'39.14	87°56'18.00	596038.56	2563483.00	Muddy
14.	0	23°12'39.98	87°50'53.82	586799.86	2567142.59	Muddy

7.7 TIDAL WATERWAY SECTION

At about 1.5 Km upstream of the river from its confluence with Hooghly River, a barrage namely Silampur Barrage is located. Due to this, only 1.5 Km of the waterway is having tidal influence from 0.00 Km Chainage. The tidal variation of 2.5 m is observed in this stretch.

8.0 MARKET ANALYSIS

Preliminary market analysis has been done on the basis of reconnaissance survey, Consultants site visit, available secondary information and published literature at the feasibility stage of the project.

8.1 LAND USE PATTERN

Land use pattern along the Damodar River can be characterized as Agricultural and Residential as presented in **Table 13**.

Table 13: Land Use Pattern along Waterway

Waterway Length (km)	Agricultural		Residential	
	Length (km)	%	Length (km)	%
135	62.1	46%	72.9	54%

8.2 CROPS /AGRICULTURE PRODUCTS

The waterway stretch passes through the major district of Bardhaman and the details about the crops/agriculture available are follows:

Bardhaman: Bardhaman is the only district in the state of West Bengal that is fortunate both in industry and agriculture. On an average about 58 percent of the total population belongs to the agricultural population while the non-agricultural sector accounts for the remaining 42 percent.

The eastern, northern, southern and central areas of the district are extensively cultivated but the soil of the western portion being of extreme lateritic type is unfit for cultivation except in the narrow valleys and depressions having rich soil and good moisture. The cultivation in the district has improved since 1953 with the implementation of the irrigation projects undertaken by the Damodar Valley Corporation. Up to 1953 the cultivation was entirely dependent on the monsoon, and irrigation facilities were rather inadequate and more or less primitive. The position has since been changed and an all-round agricultural development has become possible. Though agriculture is largely regulated by rainfall as in the other districts of the state, the developing irrigation system has been very helpful in minimizing the effects of the vagaries of nature.

Rice is the most important crop of the district and in the alluvial plains to the east little else is grown. The rice grown with its numerous varieties can broadly grouped under the three primary classes

distinguished from one another by distinct characteristics and there are : The Aus or autumn, the Aman or winter and the Boro or the summer rice. Paddy covers maximum of the gross cropped area. Among commercial crops Jute, Mesta and Sugarcane, potato, oil seeds are cultivated in marginal area

In spite of having immense potential to grow different crops of importance, the farmers of this region grow Rice and Potato mainly. In some areas commercial crops Jute, Mesta and Sugarcane, potato, oil seeds are cultivated in marginal or semi-marginal lands. Recently cultivation of former two crops is facing tremendous competition with synthetic fibres and due to lack of industry area under sugarcane cultivation is reducing remarkably.

Table 14: Bardhaman district-Average Production and Productivity of major crops (2004-08)

Name of Crop	Kharif		Rabi		Summer		Total	
	Production ('000 t)	Productivity (kg/ha)	Production ('000 t)	Productivity (kg/ha)	Production ('000 t)	Productivity (kg/ha)	Production ('000 t)	Productivity (kg/ha)
Major Field Crop								
Rice	48.1	3069	1231.1	2953	642.5	3129	1921.7	3012
Potato	-	-	1058.0	21674	-	-	1058.0	21674
Wheat	-	-	6.7	2313	-	-	6.7	2313
Oilseeds	-	-	43.1	850	-	-	43.1	850
Pulses	-	-	1.2	849	-	-	1.2	849
Jute	233.0	3019	-	-	-	-	233.0	3019

Source: Agriculture Contingency Plan

8.3 AVAILABILITY OF PASSENGER FERRY SERVICES

Locally operated passenger ferry services (boat jetty service) are noticed during Reconnaissance survey along the waterway. The locations of these ferry services are given in **Table 15**.

Table 15: Existing Ferry locations along Damodar River

S. No	Location	Chainage	Easting	Northing
1.	Tajpur Ferry Ghat	104.50	601317.80	2491921.45
2.	Boalia	127.00	607525.60	2477037.50

S. No	Location	Chainage	Easting	Northing
3.	Madhabpur	131.65	609087.00	2472997.00
4.	Chandipur	135.00	612018.00	2471966.30

8.4 EXISTING JETTIES AND TERMINALS

The ferry services operational along Damodar waterway is locally operated and used for passenger and small cargo transports like fish, vegetables, agricultural goods, bricks and locally made tiles only.

As observed during the survey, temporary structures made of wooden planks, stones are used for embarking/disembarking purposes. And no permanent structural RCC jetty is located along the waterway.

8.5 PROMINENT PLACES ALONG THE WATERWAY

The Damodar River is one of the most important rivers in West Bengal and Jharkhand. The river has its source close to the Chandwa village in Palamau district of Jharkhand in India. The river is famous all over the world for the Damodar Valley Corporation (DVC). The length of the river is 592 km or 362 miles. The following prominent City /Town falls along the study area of Damodar River:

Bardhaman: Bardhaman is a city of West Bengal state in eastern India. It is the headquarters of Bardhaman district, having become a district capital during the period of British rule. Burdwan, an alternative name for the city, has remained in use since that period.

The history of Burdwan is known from about 5000 BC. The origin of this name dates back to the 6th century BCE and is ascribed to Vardhaman Swami or Mahavira (599-527 BCE), the 24th Tirthankara of Jainism, who spent some time in Astikagrama, according to the Jain scripture of Kalpasutra. This place was renamed as Vardhamana in his honour.

8.6 HISTORICAL AND TOURIST PLACE ALONG THE WATERWAYS

Following important historical and tourist place are located along the Damodar River waterway:

Bardhaman: Bardhaman is a city of West Bengal state in eastern India. It is the headquarters of Bardhaman district, having become a district capital during the period of British rule. Burdwan, an alternative name for the city, has remained in use since that period.

During the period of Jahangir this place was named Badh-e-dewan (district capital). The city owes its historical importance to being the headquarters of the Maharajas of Burdwan, the premier noblemen of lower Bengal, whose rent-roll was upwards of 300,000. Bardhaman Raj was founded in 1657 by Sangam Rai, of a Hindu Khatri family of Kotli in Lahore, Punjab, whose descendants served in turn the Mughal Emperors and the British government. The East Indian Railway from Howrah was opened in 1855. The great prosperity of the raj was due to the excellent management of Maharaja Mahtab Chand (died 1879), whose loyalty to the government especially during the "Hul" (Santhal rebellion) of 1855-56 and the Indian rebellion of 1857 was rewarded with the grant of a coat of arms in 1868 and the right to a personal salute of 13 guns in 1877. Maharaja Bijaychand Mahtab (born 1881), who succeeded his adoptive father in 1888, earned great distinction by the courage with which he risked his life to save that of Sir Andrew Fraser, the lieutenant-governor of Bengal, on the occasion of the attempt to assassinate him made by freedom fighters of Bengal on 7 November 1908.[2]

Mahtab Chand Bahadur and later Bijoy Chand Mahtab struggled their best to make this region culturally, economically and ecologically healthier. The chief educational institution was the Burdwan Raj College, which was entirely supported out of the maharaja's estate. Sadhak Kamalakanta as composer of devotional songs and Kashiram Das as a poet and translator of the great Mahabharata were possibly the best products of such an endeavour. Pratap Chandra Roy was the publisher of the first translation in the world to translate Mahabharata in English (1883–1896).[3] The society at large also continued to gain the fruits. We find, among others, the great rebel poet Kazi Nazrul Islam and Kala-azar-famed U. N. Brahmachari as the relatively recent illustrious sons of this soil. Batukeshwar Dutt an Indian revolutionary and independence fighter in the early 1900s was born on 18 November 1910 in a village Oari in Burdwan district. He is best known for having exploded a few bombs, along with Bhagat Singh, in the Central Legislative Assembly in New Delhi on 8 April 1929. The city became an important centre of North-Indian classical music as well.

8.7 AVAILABILITY OF CONSTRUCTION MATERIAL

Major construction materials available along the waterway are Sand, Bricks and tiles.

8.8 INDUSTRIES ALONG THE WATERWAY

The Damodar Valley is home to three state-of-the-art steel manufacturing plants and they are Burnpur, Bokaro, and Durgapur. All these plants belong to Steel Authority of India Limited (SAIL). In addition, there are other manufacturing plants in the basin.

The Damodar Valley is home to a range of minerals, which includes extensive resources of coal and refractory substances. The biggest (nearly the exclusive) reserves of coking coal in India are

discovered in the Jharia coalmines in the Damodar Valley. The basin also produces 60% of medium grade coal in India. Coal India Limited manages the valley to a significant extent.

Though number of major industries is located in the upper reaches of Damodar river, no major industries are available in the lower reaches of the river, which comprises the waterway stretch. However, the major exportable items are:

1) Coal and refractory substances;
2) Steel and Iron ore products;
3) Tobacco Products;
4) Construction material like bricks and sand;
5) Agriculture products including Bittle;
6) Tin and Bronze products;
7) Copper and Aluminium

8.9 EXISTING WATER SPORT AND RECREATIONAL ACTIVITIES AND FUTURE PROBABILITY

Water recreational activities are currently not available along the waterway. However, the waterway has huge potential to be developed for water sports and recreational activities especially in the tidal stretch and upstream of Silampur Dam.

8.10 ESTIMATED CARGO MOVEMENT

Damodar waterway has huge potential for economic development considering its connectivity with various industrial and commercial places specially located in upper Damodar basin. It's connection with National Waterway -1 and thereafter with Haldia port add to its commercial advantage.

Forecasted cargo potential has been estimated on the basis of last 13 year growth pattern of Cargo movement from 2002-2003 to 2014 – 2015 for National waterway-1, as provided in the IWAI Annual reports (Refer **Table 16**). Linear correlation between existing and declared National Waterways has been done, to estimate the forecasted cargo potential. In stage – 1 of the studies a base figure of 0.0 tonnes cargo movement is assumed for estimating the forecasted figures as shown in **Figure 5**.

Table 16: Cargo Movement in National Waterway – 1 from 2002 – 2015

Sl. No.	Year	Cargo Movement for NW-1 (tonnes)
1.	2002-03	632,037
2.	2003-04	786,159

Sl. No.	Year	Cargo Movement for NW-1 (tonnes)
3.	2004-05	887,328
4.	2005-06	1,001,450
5.	2006-07	1,317,387
6.	2007-08	1,497,964
7.	2008-09	1,348,385
8.	2009-10	1,811,070
9.	2010-11	1,871,178
10.	2011-12	3,309,839
11.	2012-13	2,716,437
12.	2013-14	3,349,138
13.	2014-15	5,050,209

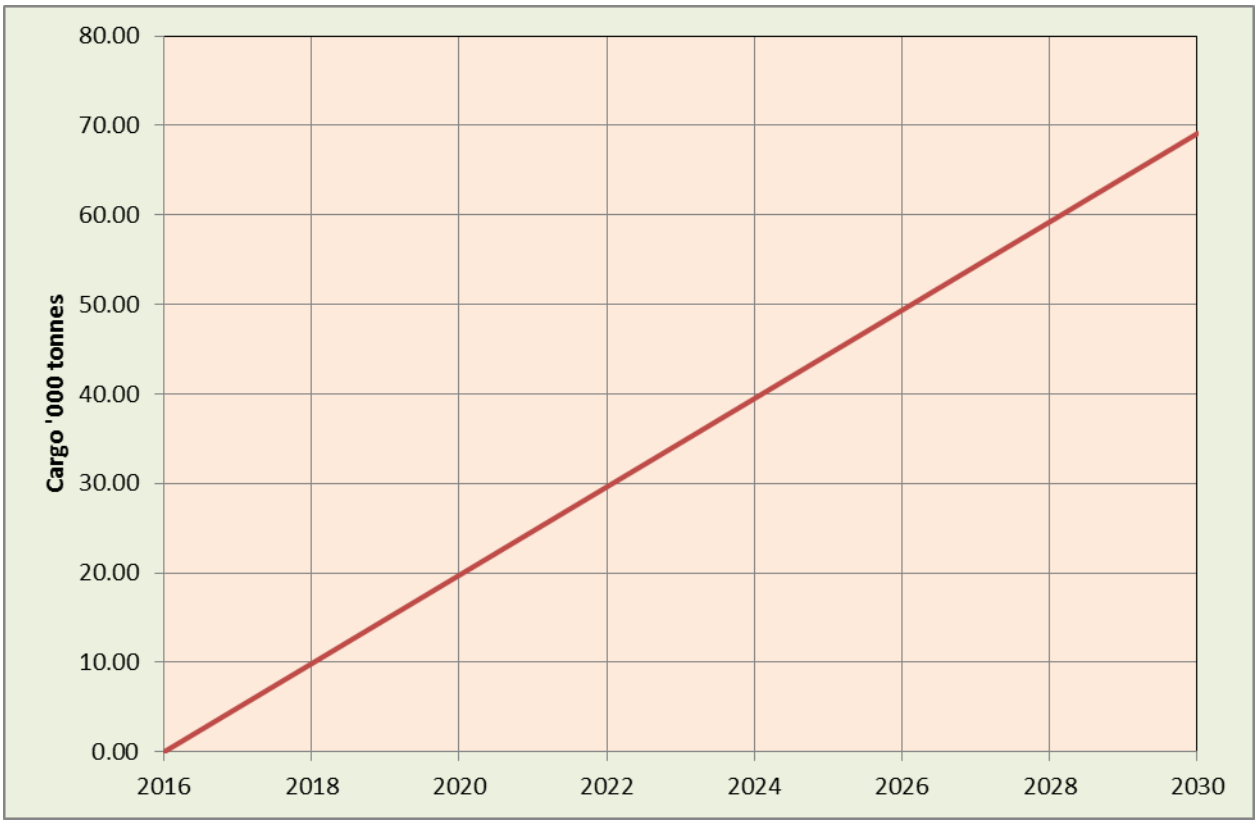

Figure 5: Forecasted Cargo Potential

With the development of waterway, industrial traffic of Damodar basin, majorly using rail and road network can be shifted to water transport considering its low operational costs. Not only there is existing traffic but also the development of waterway will trigger new traffic. Extent of development and prioritisation of inland waterways will be prepared in subsequent phase of the DPR study.

9.0 OBSERVATION AND INFERENCE

On the basis of reconnaissance survey as well as primary and secondary data collected from IWAI, central and state government departments and other stakeholders, following observations and inferences are made on the Damodar River (National Waterway 29).

9.1 WATERWAY

The Damodar River is one of the most important rivers in West Bengal and Jharkhand. The river has its source close to the Chandwa village in Palamau district of Jharkhand in India. The river is famous all over the world for the Damodar Valley Corporation (DVC). The length of the river is 592 km or 362 miles. Major industrial cities having Steel and Coal based plants are located along the river.

9.2 LEAST AVAILABLE DEPTH (LAD)

LAD of the Dwarakeswar waterway is estimated on the basis of applying exceedance probability approach on the reduced water depth. Reduced water depth is calculated after applying corrections on the water depths observed during single line hydrographic survey with reference to Chart/Sounding datums. Navigable stretch available for least available depth (LAD) of <1.0 m, 1.0 m to 1.5 m, 1.5 m to 2.0 m and >2.0 m for the waterway is presented in **Table 17**.

Table 17: Waterway length with varying LAD

Features	Results
Waterway Length	135.0 Km
Length with Topographic Survey	0.00 Km
Length with Bathymetric Survey	135.0 Km
Maximum available draft	8.87 m
Minimum available draft	0.00 m
Waterway length with <1.0 m draft	29.97 Km
Waterway length with 1.0 – 1.5 m draft	15.94 Km
Waterway length with 1.5 – 2.0 m draft	17.32 Km

Features	Results
Waterway length with >2.0 m draft	71.77 Km

9.3 CROSS - STRUCTURES

During reconnaissance survey, details of cross-structures have been collected and their minimum horizontal and vertical clearance has been evaluated on the basis of visual assessment as shown in **Table 18** below. The detailed list of cross-structures is provided in **Table 3** and **Table 4**.

Table 18: Minimum Horizontal and Vertical Clearance along Waterways

Length (km)	Dams/ Barrages/Locks	Bridges/ Crossing	Min Ver. /Hor. Clearance (m)	High-Tension Lines	Min Ver. Clearance (m)
135	1	12.0	3.0/4.0	7	6.0

Vertical clearance is with reference to the HFL.
Horizontal Clearance is the minimum distance between the bridge piers.

9.4 SWOT ANALYSIS

SWOT analysis is a technique commonly used to assist in identifying strategic direction for an organization or practice. It helps to make an assessment of internal environment and scrutiny of external environment, with an objective to take maximum benefits by having an appropriate proposition. It is preferred for the present work as it yields useful information about the future viability of the considered inland waterway system. The predictive capabilities in the technique come about from the consideration of system's strengths and weaknesses in the context of the development of Inland Waterway System, which may present opportunities and threats.

The strengths and weaknesses of a system are determined by the internal elements, whereas external forces dictate opportunities and threats. Strengths can be defined as any available resource that can be used to improve its performance. Weaknesses are flaws/shortcomings of any system that may cause to lose a competitive advantage, efficiency or resources. Sometimes it is recommended to identify opportunities and threats first in order to more quickly ring to light the system's strengths and weaknesses. Many of the threats are based on weaknesses. Further, SWOT analysis helps in categorizing the key internal and external factors that are important to achieving the objective. With regards to assessing the feasibility of proposed waterway for navigation, this exercise will help us

identify the important factors to be considered while designing the future action for DPR study in Stage 2 and strategic plan for its development.

	INTERNAL	
POSITIVE	**STRENGTH**	**WEAKNESS**
	➢ Commitment of Govt. of India for Developing Inland Waterways Sector. ➢ Environmental friendly mode of Transport ➢ Increase in Infrastructure Facilities as alternative mode of transport. ➢ Comparatively high level of transport safety. ➢ Reliable services under predictable weather conditions. ➢ Low transport costs (per km) for bulk shipments. ➢ Long term effective cost control measures (O&M). ➢ Capable of bringing down decongestion from the Road and Rail Transport. ➢ Location of waterway with respect to Major Industrial cities and Steel and coal plants. ➢ **Silampur Barrage** which maintains the draft required for navigation on U/s of barrage.	➢ Huge Initial Investment ➢ High Maintenance Cost ➢ High tariff structure for Inland Transport. ➢ Limited knowledge of IWT among shippers. ➢ Dependence on inter-modality for door-to door services. ➢ Substantial cost differentials w.r.t other transports. ➢ Water level fluctuations having impacts on Ships Ballast /Loading conditions. ➢ Dredging capability of GoI is 16% of National requirement. ➢ Availability of water throughout the year. ➢ River pollution due to release of effluents from industries located along the river. ➢ **Silampur Barrage** which obstructs the nautical continuity and blocks the navigational connectivity of waterway with Hooghly River.
	➢ Trigger new traffic in the hinterland ➢ Boost International and National trade of commodities. ➢ Improvement of the capacity/quality of the Infrastructure. ➢ Integration of Ports with Roads & Railways. ➢ Enhance inter-modality. ➢ Implementation of infrastructure links. ➢ Improved Supply-Demand logistic chains ➢ Creation of reliable employment for the people.	➢ Lack of Skilled Man-power. ➢ Environmental policy restrictions on transport infrastructure policies. ➢ Limited financial means. ➢ Fast growing economic sectors often road oriented: low IWT affinity. ➢ Priority of investments in road/ rail infrastructure as per the present scenario. ➢ Land Acquisition
NEGATIVE	**OPPORTUNITY**	**THREAT**
	EXTERNAL	

Figure 6: SWOT Analysis

9.5 SUMMARY

The salient features of the feasibility study for 135 km stretch of Damodar as national waterway are,

- The proposed national waterway of 135 km of Damodar river is feasible for throughout the year navigation for about 66.0% of length (have >1.5 m LAD wrt CD), i.e. about 89.09 Km towards upstream of its confluence with Hooghly river.
- The horizontal and vertical clearance of existing cross-structures is in the range of 30m – 4m and 6.0m – 3.0m respectively.
- Taking in to account the water availability, 71.77 Km stretch of waterway have draft more than 2.0 m, 17.32 Km stretch have draft of 1.50 m to 2.0 m, 15.94 km have draft of 1.0 m to 1.50 m and remaining 29.97 km stretch of waterway have less than 1.0 m draft with respect to chart datum respectively.
- Considering the length of the river and availability of numerous minor and major industries in the hinterland, specially in the upper reaches, the river has huge economic potential for development of waterway.

9.6 CRITICAL AREAS REQUIRING DETAILED INVESTIGATIONS

Critical areas along the waterways, requiring detailed investigations during Stage – II, are identified on the basis of draft availability, location of hindrances, areas requiring clearances etc. On the basis of above, following locations require detailed investigations during stage –II of the study:

Table 19: Locations along the waterway requiring detail investigation in Stage-II

Sr. No.	Location	Chainage (km)	Easting	Northing
1.	Begua	44.50	600459.60	2502814.30
2.	Kansona	46.00	600947.00	2503867.90
3.	Kumarchak	47.50	601466.90	2505505.20
4.	Monsuka	50.00	602926.60	2506593.70
5.	Jhanda	64.50	601343.10	2519212.80
6.	Ghola	62.50	601853.10	2517291.50
7.	Jhanda	65.50	601145.20	2519764.10

Sr. No.	Location	Chainage (km)	Easting	Northing
8.	Shib Chak	66.50	600594.70	2520855.50
9.	Hetam Chak	66.00	599326.10	2522856.60
10.	Kumrul	84.50	600333.40	2535737.60
11.	Paschim Kalikapur	85.50	600090.10	2536562.10
12.	Bonogram	88.00	598534.10	2538068.40
13.	Palla colony	115.50	602588.50	2561392.20
14.	Palla colony	116.00	601984.70	2561629.90
15.	Bharpota	116.50	601518.30	2561834.30
16.	Baje Salepur	119.80	598309.00	2562858.20
17.	Baje Salepur	120.00	597998.90	2563018.30
18.	Manik Hati	123.50	595069.20	2564418.90
19.	Chaitpur	125.50	593314.00	2565352.00

In addition to the above, the length of the waterway having flow depth of less than 1 m w.r.t Chart Datum also requires detail investigation during DPR stage studies.

9.7 SURVEY AND INVESTIGATIONS REQUIRED FOR STAGE – II STUDIES

Following survey and investigations are required to be done during Stage – II studies:

i) Hydrographic and Hydro morphological Survey, as per TOR, comprising of:

a) Erection of bench mark pillars and water level gauges and observing reading.
b) Detailed bathymetric and topographic survey.
c) Current velocity and discharge measurement.
d) Collection of water and bottom samples and testing.
e) Collection of topographical features.

ii) Traffic Survey.

iii) Geo-tech investigation on proposed locations for Jetties and Terminal structures.

iv) Environmental impact assessment (EIA).

9.8 WAY FORWARD: WATERWAY DEVELOPMENT

The Combining knowledge on the physical constraints, actual and future uses of the river and the valley, economic potential and needs, or absence thereof, allows the characterization of the river for development as a waterway. The reconnaissance survey data collected with regard to physical constraints can be turned into cost to make a river navigable. Although several challenges do exist to make Damodar as National waterway, but with respect to long-term economic interest of the nation the financial investment is advisable.

Economic Interest / **Financial Investment**	Local	Regional	National	International
Low				
Moderate			Damodar Waterway	
High				
Very High				

Damodar waterway is recommended for Stage – II DPR preparation in view of the following potential advantages:

- Connectivity with major industrial towns of Burdwan and Durgapur.
- Increasing cargo potential.
- Reduction in existing traffic load on rail and road infrastructure.

In view of the above, it is recommended to develop the Damodar waterway for Cargo and Passenger ferry services.

Annexure 1: Levelling Results

LEVELLING BETWEEN TEMPORARY BENCH MARK 1 & TIDE POLE

BS	FS	HI	RL	REMARK
0.412		41.05	40.638	TBM 1
0.863	2.894	39.019	38.156	CP 1
0.735	3.751	36.003	35.268	CP 2
0.978	2.532	34.449	33.471	CP 3
0.714	3.03	32.133	31.419	CP 4
0.547	3.041	29.639	29.092	CP 5
0.234	3.514	26.359	26.125	CP 6
	2.614		23.745	TIDE POLE

BS	FS	HI	RL	REMARK
3.896		27.641	23.745	TIDE POLE
4.138	0.431	31.348	27.21	CP 7
4.561	0.434	35.475	30.914	CP 8
3.821	0.448	38.848	35.027	CP 9
3.642	0.589	41.901	38.259	CP 10
	1.263	40.638	40.638	TBM 1

LEVELLING BETWEEN TEMPORARY BENCH MARK 2 & TIDE POLE

BS	FS	HI	RL	REMARK
0.11		26.233	26.123	TBM 2
0.214	3.894	22.553	22.339	CP 1
0.184	3.751	18.986	18.802	CP2
	3.303		15.683	TIDE POLE

BS	FS	HI	RL	REMARK
4.489		20.172	15.683	TIDE POLE
3.892	0.146	23.918	20.026	CP 3
2.527	0.173	26.272	23.745	CP 4
	0.149		26.123	TBM 2

LEVELLING BETWEEN TEMPORARY BENCH MARK 3 & TIDE POLE

BS	FS	HI	RL	REMARK
0.11		19.1	18.99	TBM 3
0.214	3.894	15.42	15.206	CP 1
	3.524	11.896	11.896	TIDE POLE

BS	FS	HI	RL	REMARK
4.489		16.385	11.896	TIDE POLE
3.178	0.146	19.417	16.239	CP 2
	0.427		18.99	TBM 3

LEVELLING BETWEEN TEMPORARY BENCH MARK 4 & TIDE POLE

BS	FS	HI	RL	REMARK
0.418		22.222	21.804	TBM 4
0.704	3.83	19.096	18.392	CP 1
0.771	3.713	16.154	15.383	CP 2
0.223	3.513	12.864	12.641	CP 3
	3.833	9.031	9.031	TIDE POLE

BS	FS	HI	RL	REMARK
3.955		12.986	9.031	TIDE POLE
3.672	0.405	16.253	12.581	CP 4
3.49	0.374	19.369	15.879	CP 5
3.067	0.324	22.112	19.045	CP 6
	0.308	21.804	21.804	TBM 4

LEVELLING BETWEEN TEMPORARY BENCH MARK 5 & TIDE POLE

BS	FS	HI	RL	REMARK
0.653		9.346	8.693	TBM 5
	2.984		6.362	TIDE POLE

BS	FS	HI	RL	REMARK
2.934		9.296	6.362	TIDE POLE
	0.603		8.693	TBM 5

LEVELLING BETWEEN TEMPORARY BENCH MARK 6 & TIDE POLE

BS	FS	HI	RL	REMARK
1.436		4.344	2.908	TBM 6
	2.601		1.743	TIDE POLE

BS	FS	HI	RL	REMARK
2.354		4.097	1.743	TIDE POLE
	1.189		2.908	TBM 6

LEVELLING BETWEEN TEMPORARY BENCH MARK 7 & TIDE POLE

BS	FS	HI	RL	REMARK
0.356		13.105	12.749	TBM 7
0.653	4.864	8.894	8.241	CP 1
0.435	4.789	4.54	4.105	CP 2
	3.321	1.219	1.219	TIDE POLE

BS	FS	HI	RL	REMARK
3.365		4.584	1.219	TIDE POLE
4.893	0.552	8.925	4.032	CP 3
4.729	0.519	13.135	8.406	CP 4
	0.386	12.749	12.749	TBM 7

LEVELLING BETWEEN TEMPORARY BENCH MARK 8 & TIDE POLE

BS	FS	HI	RL	REMARK
0.226		6.776	6.55	TBM 8
0.157	3.456	3.477	3.32	CP 1
	3.813		-0.336	TIDE POLE

BS	FS	HI	RL	REMARK
3.743		3.407	-0.336	TIDE POLE
3.963	0.134	7.236	3.273	CP 2
	0.686		6.55	TBM 8

Annexure 2: Observed Water Levels on Tide Pole

Krishak Setu TBM - 1 Time (IST) in hh:mm & Hts are in Mtrs. Water Level are w.r.t. to MSL.		
TIME	DATE	WATER LEVEL
10:00	30-Jan-16	24.115
10:15	30-Jan-16	24.115
10:30	30-Jan-16	24.115
10:45	30-Jan-16	24.115
11:00	30-Jan-16	24.115
11:15	30-Jan-16	24.115
11:30	30-Jan-16	24.115

Dadpur TBM - 2 Time (IST) in hh:mm & Hts are in Mtrs. Water Level are w.r.t. to MSL.		
TIME	DATE	WATER LEVEL
12:00	30-Jan-16	16.477
12:15	30-Jan-16	16.477
12:30	30-Jan-16	16.477
12:45	30-Jan-16	16.477
13:00	30-Jan-16	16.477
13:15	30-Jan-16	16.477
13:30	30-Jan-16	16.477

Amarpur TBM - 3 Time (IST) in hh:mm & Hts are in Mtrs. Water Level are w.r.t. to MSL.		
TIME	DATE	WATER LEVEL
10:15	31-Jan-16	12.190
10:30	31-Jan-16	12.190
10:45	31-Jan-16	12.190
11:00	31-Jan-16	12.190
11:15	31-Jan-16	12.190
11:30	31-Jan-16	12.190
11:45	31-Jan-16	12.190

Kanaria TBM - 4 Time (IST) in hh:mm & Hts are in Mtrs. Water Level are w.r.t. to MSL.		
TIME	DATE	WATER LEVEL
12:30	31-Jan-16	9.165
12:45	31-Jan-16	9.165
13:00	31-Jan-16	9.165
13:15	31-Jan-16	9.165

Kanaria TBM - 4 Time (IST) in hh:mm & Hts are in Mtrs. Water Level are w.r.t. to MSL.		
TIME	DATE	WATER LEVEL
13:30	31-Jan-16	9.165
13:45	31-Jan-16	9.165
14:00	31-Jan-16	9.165

Lebutala TBM - 5 Time (IST) in hh:mm & Hts are in Mtrs. Water Level are w.r.t. to MSL.		
TIME	DATE	WATER LEVEL
12:30	1-Feb-16	6.777
14:00	1-Feb-16	6.777
15:30	1-Feb-16	6.777
17:00	1-Feb-16	6.777

Amta TBM - 6 Time (IST) in hh:mm & Hts are in Mtrs. Water Level are w.r.t. to MSL.		
TIME	DATE	WATER LEVEL
12:30	2-Feb-16	2.003
14:00	2-Feb-16	2.003
15:30	2-Feb-16	2.003
17:00	2-Feb-16	2.003

Khajinan Ghat TBM - 7 Time (IST) in hh:mm & Hts are in Mtrs. Water Level are w.r.t. to MSL.		
TIME	DATE	WATER LEVEL
12:30	3-Feb-16	2.078
14:00	3-Feb-16	2.078
15:30	3-Feb-16	2.078
17:00	3-Feb-16	2.078

Silampur TBM - 8 Time (IST) in hh:mm & Hts are in Mtrs. Water Level are w.r.t. to MSL.		
TIME	DATE	WATER LEVEL
13:25	3-Feb-16	1.689
13:45	3-Feb-16	1.649
14:00	3-Feb-16	1.619
14:25	3-Feb-16	1.604
16:45	3-Feb-16	2.319

Annexure 3: Water Depth along Damodar Waterway

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
0.00	0.53	3.947	10.397	6.45	0.00
0.10	0.59	3.947	10.397	6.45	0.00
0.20	1.52	3.947	10.397	6.45	0.00
0.30	1.26	3.947	10.397	6.45	0.00
0.40	1.78	3.947	10.397	6.45	0.00
0.50	1.53	3.947	10.397	6.45	0.00
0.60	1.38	3.947	10.397	6.45	0.00
0.70	1.48	3.947	10.397	6.45	0.00
0.80	1.57	3.947	10.397	6.45	0.00
0.90	2.26	3.947	10.397	6.45	0.00
1.00	1.01	3.947	10.397	6.45	0.00
1.10	1.12	3.947	10.397	6.45	0.00
1.20	1.28	3.947	10.397	6.45	0.00
1.30	1.95	3.947	10.397	6.45	0.00
1.40	2.05	3.947	10.397	6.45	0.00
1.50	3.55	3.947	2.078	-1.87	5.42
1.60	3.48	3.953	2.086	-1.87	5.35
1.70	3.98	3.959	2.094	-1.87	5.85
1.80	3.91	3.966	2.102	-1.86	5.77
1.90	4.75	3.972	2.110	-1.86	6.61
2.00	4.12	3.978	2.118	-1.86	5.98
2.10	3.85	3.984	2.126	-1.86	5.71
2.20	3.86	3.991	2.134	-1.86	5.72
2.30	4.07	3.997	2.142	-1.86	5.93
2.40	4.40	4.003	2.150	-1.85	6.25
2.50	4.94	4.009	2.158	-1.85	6.79
2.60	5.32	4.016	2.166	-1.85	7.17
2.70	5.54	4.022	2.174	-1.85	7.39
2.80	5.47	4.028	2.182	-1.85	7.32
2.90	5.59	4.034	2.190	-1.84	7.43
3.00	5.16	4.041	2.198	-1.84	7.00
3.10	4.72	4.047	2.206	-1.84	6.56
3.20	5.13	4.053	2.214	-1.84	6.97
3.30	4.56	4.059	2.222	-1.84	6.40

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
3.40	4.61	4.066	2.230	-1.84	6.45
3.50	4.94	4.072	2.238	-1.83	6.77
3.60	5.17	4.078	2.246	-1.83	7.00
3.70	4.42	4.084	2.254	-1.83	6.25
3.80	4.18	4.091	2.262	-1.83	6.01
3.90	4.12	4.097	2.270	-1.83	5.95
4.00	4.34	4.103	2.278	-1.83	6.17
4.10	4.87	4.109	2.286	-1.82	6.69
4.20	5.76	4.116	2.294	-1.82	7.58
4.30	5.36	4.122	2.302	-1.82	7.18
4.40	5.72	4.128	2.310	-1.82	7.54
4.50	5.27	4.134	2.318	-1.82	7.09
4.60	5.07	4.141	2.326	-1.81	6.88
4.70	5.17	4.147	2.334	-1.81	6.98
4.80	5.30	4.153	2.342	-1.81	7.11
4.90	5.03	4.159	2.350	-1.81	6.84
5.00	5.25	4.166	2.358	-1.81	7.06
5.10	6.29	4.172	2.366	-1.81	8.10
5.20	6.33	4.178	2.374	-1.80	8.13
5.30	5.24	4.184	2.382	-1.80	7.04
5.40	5.31	4.191	2.390	-1.80	7.11
5.50	5.67	4.197	2.398	-1.80	7.47
5.60	4.43	4.203	2.406	-1.80	6.23
5.70	2.29	4.209	2.414	-1.80	4.09
5.80	1.83	4.216	2.422	-1.79	3.62
5.90	2.08	4.222	2.430	-1.79	3.87
6.00	2.63	4.228	2.438	-1.79	4.42
6.10	3.57	4.234	2.446	-1.79	5.36
6.20	5.48	4.241	2.454	-1.79	7.27
6.30	4.91	4.247	2.462	-1.79	6.70
6.40	5.38	4.253	2.470	-1.78	7.16
6.50	4.85	4.259	2.478	-1.78	6.63
6.60	3.29	4.266	2.486	-1.78	5.07
6.70	3.11	4.272	2.494	-1.78	4.89

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
6.80	4.10	4.278	2.502	-1.78	5.88
6.90	4.94	4.284	2.510	-1.77	6.71
7.00	4.61	4.291	2.518	-1.77	6.38
7.10	4.12	4.297	2.526	-1.77	5.89
7.20	3.81	4.303	2.534	-1.77	5.58
7.30	3.83	4.309	2.542	-1.77	5.60
7.40	3.76	4.316	2.550	-1.77	5.53
7.50	4.03	4.322	2.558	-1.76	5.79
7.60	4.59	4.328	2.566	-1.76	6.35
7.70	4.43	4.334	2.574	-1.76	6.19
7.80	4.56	4.341	2.582	-1.76	6.32
7.90	4.71	4.347	2.590	-1.76	6.47
8.00	5.45	4.353	2.598	-1.76	7.21
8.10	4.49	4.359	2.606	-1.75	6.24
8.20	4.10	4.366	2.614	-1.75	5.85
8.30	3.95	4.372	2.622	-1.75	5.70
8.40	3.74	4.378	2.630	-1.75	5.49
8.50	4.47	4.384	2.638	-1.75	6.22
8.60	4.89	4.391	2.646	-1.74	6.63
8.70	7.13	4.397	2.654	-1.74	8.87
8.80	5.15	4.403	2.662	-1.74	6.89
8.90	5.55	4.409	2.670	-1.74	7.29
9.00	5.76	4.416	2.678	-1.74	7.50
9.10	5.71	4.422	2.686	-1.74	7.45
9.20	4.93	4.428	2.694	-1.73	6.66
9.30	5.17	4.434	2.702	-1.73	6.90
9.40	6.75	4.441	2.710	-1.73	8.48
9.50	3.99	4.447	2.718	-1.73	5.72
9.60	3.14	4.453	2.726	-1.73	4.87
9.70	4.10	4.459	2.734	-1.73	5.83
9.80	4.52	4.466	2.742	-1.72	6.24
9.90	4.74	4.472	2.750	-1.72	6.46
10.00	2.55	4.478	2.758	-1.72	4.27
10.10	2.30	4.484	2.766	-1.72	4.02

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
10.20	2.00	4.491	2.774	-1.72	3.72
10.30	2.15	4.497	2.782	-1.72	3.87
10.40	2.96	4.503	2.790	-1.71	4.67
10.50	4.34	4.509	2.798	-1.71	6.05
10.60	3.51	4.516	2.806	-1.71	5.22
10.70	2.28	4.522	2.814	-1.71	3.99
10.80	2.13	4.528	2.822	-1.71	3.84
10.90	2.37	4.534	2.830	-1.70	4.07
11.00	3.57	4.541	2.838	-1.70	5.27
11.10	4.58	4.547	2.846	-1.70	6.28
11.20	4.86	4.553	2.854	-1.70	6.56
11.30	4.54	4.559	2.862	-1.70	6.24
11.40	3.74	4.566	2.870	-1.70	5.44
11.50	2.70	4.572	2.878	-1.69	4.39
11.60	2.74	4.578	2.886	-1.69	4.43
11.70	3.14	4.584	2.894	-1.69	4.83
11.80	3.64	4.591	2.902	-1.69	5.33
11.90	3.67	4.597	2.910	-1.69	5.36
12.00	2.96	4.603	2.918	-1.69	4.65
12.10	3.29	4.609	2.926	-1.68	4.97
12.20	4.05	4.616	2.934	-1.68	5.73
12.30	4.26	4.622	2.942	-1.68	5.94
12.40	4.71	4.628	2.950	-1.68	6.39
12.50	4.72	4.634	2.958	-1.68	6.40
12.60	3.66	4.641	2.966	-1.67	5.33
12.70	3.56	4.647	2.974	-1.67	5.23
12.80	3.38	4.653	2.982	-1.67	5.05
12.90	3.45	4.659	2.990	-1.67	5.12
13.00	3.27	4.666	2.998	-1.67	4.94
13.10	3.61	4.672	3.006	-1.67	5.28
13.20	3.24	4.678	3.014	-1.66	4.90
13.30	3.08	4.684	3.022	-1.66	4.74
13.40	3.41	4.691	3.030	-1.66	5.07
13.50	3.76	4.697	3.038	-1.66	5.42

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
13.60	3.68	4.703	3.046	-1.66	5.34
13.70	3.58	4.709	3.054	-1.66	5.24
13.80	3.70	4.716	3.062	-1.65	5.35
13.90	3.87	4.722	3.070	-1.65	5.52
14.00	3.85	4.728	3.078	-1.65	5.50
14.10	4.05	4.734	3.086	-1.65	5.70
14.20	4.65	4.741	3.094	-1.65	6.30
14.30	4.21	4.747	3.102	-1.65	5.86
14.40	3.61	4.753	3.110	-1.64	5.25
14.50	2.97	4.759	3.118	-1.64	4.61
14.60	4.05	4.766	3.126	-1.64	5.69
14.70	4.46	4.772	3.134	-1.64	6.10
14.80	4.12	4.778	3.142	-1.64	5.76
14.90	3.75	4.784	3.150	-1.63	5.38
15.00	3.99	4.791	3.158	-1.63	5.62
15.10	3.87	4.797	3.166	-1.63	5.50
15.20	3.78	4.803	3.174	-1.63	5.41
15.30	3.57	4.809	3.182	-1.63	5.20
15.40	4.24	4.816	3.190	-1.63	5.87
15.50	3.51	4.822	3.198	-1.62	5.13
15.60	3.03	4.828	3.206	-1.62	4.65
15.70	2.58	4.834	3.213	-1.62	4.20
15.80	2.33	4.840	3.221	-1.62	3.95
15.90	2.56	4.847	3.229	-1.62	4.18
16.00	3.01	4.853	3.237	-1.62	4.63
16.10	3.02	4.859	3.245	-1.61	4.63
16.20	3.06	4.865	3.253	-1.61	4.67
16.30	3.80	4.872	3.261	-1.61	5.41
16.40	4.28	4.878	3.269	-1.61	5.89
16.50	4.66	4.884	3.277	-1.61	6.27
16.60	5.57	4.890	3.285	-1.61	7.18
16.70	4.14	4.897	3.293	-1.60	5.74
16.80	2.96	4.903	3.301	-1.60	4.56
16.90	3.31	4.909	3.309	-1.60	4.91

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
17.00	3.52	4.915	3.317	-1.60	5.12
17.10	3.38	4.922	3.325	-1.60	4.98
17.20	3.25	4.928	3.333	-1.59	4.84
17.30	3.19	4.934	3.341	-1.59	4.78
17.40	3.10	4.940	3.349	-1.59	4.69
17.50	3.46	4.947	3.357	-1.59	5.05
17.60	3.77	4.953	3.365	-1.59	5.36
17.70	3.74	4.959	3.373	-1.59	5.33
17.80	2.95	4.965	3.381	-1.58	4.53
17.90	2.72	4.972	3.389	-1.58	4.30
18.00	2.94	4.978	3.397	-1.58	4.52
18.10	2.99	4.984	3.405	-1.58	4.57
18.20	3.15	4.990	3.413	-1.58	4.73
18.30	3.13	4.997	3.421	-1.58	4.71
18.40	3.14	5.003	3.429	-1.57	4.71
18.50	2.94	5.009	3.437	-1.57	4.51
18.60	2.51	5.015	3.445	-1.57	4.08
18.70	2.54	5.022	3.453	-1.57	4.11
18.80	2.15	5.028	3.461	-1.57	3.72
18.90	2.12	5.034	3.469	-1.56	3.68
19.00	2.23	5.040	3.477	-1.56	3.79
19.10	2.70	5.047	3.485	-1.56	4.26
19.20	3.15	5.053	3.493	-1.56	4.71
19.30	3.60	5.059	3.501	-1.56	5.16
19.40	5.00	5.065	3.509	-1.56	6.56
19.50	2.81	5.072	3.517	-1.55	4.36
19.60	2.30	5.078	3.525	-1.55	3.85
19.70	2.08	5.084	3.533	-1.55	3.63
19.80	2.15	5.090	3.541	-1.55	3.70
19.90	2.49	5.097	3.549	-1.55	4.04
20.00	4.55	5.103	3.557	-1.55	6.10
20.10	2.64	5.109	3.565	-1.54	4.18
20.20	3.37	5.115	3.573	-1.54	4.91
20.30	4.27	5.122	3.581	-1.54	5.81

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
20.40	3.85	5.128	3.589	-1.54	5.39
20.50	3.97	5.134	3.597	-1.54	5.51
20.60	3.56	5.140	3.605	-1.54	5.10
20.70	3.04	5.147	3.613	-1.53	4.57
20.80	2.78	5.153	3.621	-1.53	4.31
20.90	5.39	5.159	3.629	-1.53	6.92
21.00	4.71	5.165	3.637	-1.53	6.24
21.10	4.50	5.172	3.645	-1.53	6.03
21.20	4.50	5.178	3.653	-1.52	6.02
21.30	4.70	5.184	3.661	-1.52	6.22
21.40	2.87	5.190	3.669	-1.52	4.39
21.50	2.42	5.197	3.677	-1.52	3.94
21.60	2.33	5.203	3.685	-1.52	3.85
21.70	2.16	5.209	3.693	-1.52	3.68
21.80	2.26	5.215	3.701	-1.51	3.77
21.90	1.99	5.222	3.709	-1.51	3.50
22.00	1.92	5.228	3.717	-1.51	3.43
22.10	1.78	5.234	3.725	-1.51	3.29
22.20	1.64	5.240	3.733	-1.51	3.15
22.30	2.02	5.247	3.741	-1.51	3.53
22.40	2.23	5.253	3.749	-1.50	3.73
22.50	2.46	5.259	3.757	-1.50	3.96
22.60	1.91	5.265	3.765	-1.50	3.41
22.70	1.98	5.272	3.773	-1.50	3.48
22.80	2.25	5.278	3.781	-1.50	3.75
22.90	3.13	5.284	3.789	-1.49	4.62
23.00	3.51	5.290	3.797	-1.49	5.00
23.10	3.13	5.297	3.805	-1.49	4.62
23.20	2.41	5.303	3.813	-1.49	3.90
23.30	3.70	5.309	3.821	-1.49	5.19
23.40	3.34	5.315	3.829	-1.49	4.83
23.50	4.04	5.322	3.837	-1.48	5.52
23.60	1.97	5.328	3.845	-1.48	3.45
23.70	3.09	5.334	3.853	-1.48	4.57

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
23.80	2.30	5.340	3.861	-1.48	3.78
23.90	2.06	5.347	3.869	-1.48	3.54
24.00	1.95	5.353	3.877	-1.48	3.43
24.10	2.34	5.359	3.885	-1.47	3.81
24.20	2.73	5.365	3.893	-1.47	4.20
24.30	2.71	5.372	3.901	-1.47	4.18
24.40	2.77	5.378	3.909	-1.47	4.24
24.50	2.49	5.384	3.917	-1.47	3.96
24.60	1.98	5.390	3.925	-1.47	3.45
24.70	1.79	5.397	3.933	-1.46	3.25
24.80	1.90	5.403	3.941	-1.46	3.36
24.90	2.38	5.409	3.949	-1.46	3.84
25.00	2.55	5.415	3.957	-1.46	4.01
25.10	2.26	5.422	3.965	-1.46	3.72
25.20	2.46	5.428	3.973	-1.45	3.91
25.30	2.46	5.434	3.981	-1.45	3.91
25.40	1.96	5.440	3.989	-1.45	3.41
25.50	1.88	5.447	3.997	-1.45	3.33
25.60	1.72	5.453	4.005	-1.45	3.17
25.70	1.98	5.459	4.013	-1.45	3.43
25.80	1.55	5.465	4.021	-1.44	2.99
25.90	1.18	5.472	4.029	-1.44	2.62
26.00	1.31	5.478	4.037	-1.44	2.75
26.10	1.64	5.484	4.045	-1.44	3.08
26.20	1.37	5.490	4.053	-1.44	2.81
26.30	2.19	5.497	4.061	-1.44	3.63
26.40	2.52	5.503	4.069	-1.43	3.95
26.50	2.19	5.509	4.077	-1.43	3.62
26.60	2.03	5.515	4.085	-1.43	3.46
26.70	2.64	5.522	4.093	-1.43	4.07
26.80	2.12	5.528	4.101	-1.43	3.55
26.90	2.09	5.534	4.109	-1.42	3.51
27.00	1.65	5.540	4.117	-1.42	3.07
27.10	1.88	5.547	4.125	-1.42	3.30

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
27.20	1.92	5.553	4.133	-1.42	3.34
27.30	2.03	5.559	4.141	-1.42	3.45
27.40	2.67	5.565	4.149	-1.42	4.09
27.50	2.63	5.572	4.157	-1.41	4.04
27.60	2.42	5.578	4.165	-1.41	3.83
27.70	1.99	5.584	4.173	-1.41	3.40
27.80	2.16	5.590	4.181	-1.41	3.57
27.90	1.81	5.597	4.189	-1.41	3.22
28.00	1.63	5.603	4.197	-1.41	3.04
28.10	1.85	5.609	4.205	-1.40	3.25
28.20	2.66	5.615	4.213	-1.40	4.06
28.30	1.27	5.622	4.221	-1.40	2.67
28.40	2.21	5.628	4.229	-1.40	3.61
28.50	2.76	5.634	4.237	-1.40	4.16
28.60	2.43	5.640	4.245	-1.40	3.83
28.70	2.25	5.647	4.253	-1.39	3.64
28.80	2.22	5.653	4.261	-1.39	3.61
28.90	2.45	5.659	4.269	-1.39	3.84
29.00	1.81	5.665	4.277	-1.39	3.20
29.10	1.34	5.672	4.285	-1.39	2.73
29.20	1.39	5.678	4.293	-1.38	2.77
29.30	1.67	5.684	4.301	-1.38	3.05
29.40	2.04	5.690	4.309	-1.38	3.42
29.50	2.10	5.697	4.317	-1.38	3.48
29.60	1.74	5.703	4.325	-1.38	3.12
29.70	1.80	5.709	4.333	-1.38	3.18
29.80	2.11	5.727	4.357	-1.37	3.48
29.90	2.35	5.746	4.381	-1.36	3.71
30.00	2.08	5.764	4.406	-1.36	3.44
30.10	1.67	5.782	4.430	-1.35	3.02
30.20	1.70	5.801	4.454	-1.35	3.05
30.30	1.74	5.819	4.478	-1.34	3.08
30.40	1.66	5.837	4.503	-1.33	2.99
30.50	1.75	5.856	4.527	-1.33	3.08

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
30.60	1.52	5.874	4.551	-1.32	2.84
30.70	1.81	5.892	4.575	-1.32	3.13
30.80	2.12	5.911	4.600	-1.31	3.43
30.90	1.67	5.929	4.624	-1.31	2.98
31.00	1.92	5.947	4.648	-1.30	3.22
31.10	1.87	5.966	4.672	-1.29	3.16
31.20	2.14	5.984	4.697	-1.29	3.43
31.30	2.04	6.002	4.721	-1.28	3.32
31.40	1.86	6.021	4.745	-1.28	3.14
31.50	2.18	6.039	4.769	-1.27	3.45
31.60	1.85	6.057	4.794	-1.26	3.11
31.70	1.69	6.076	4.818	-1.26	2.95
31.80	1.63	6.094	4.842	-1.25	2.88
31.90	1.85	6.112	4.866	-1.25	3.10
32.00	1.89	6.131	4.890	-1.24	3.13
32.10	1.00	6.149	4.915	-1.23	2.23
32.20	1.36	6.167	4.939	-1.23	2.59
32.30	1.85	6.186	4.963	-1.22	3.07
32.40	2.17	6.204	4.987	-1.22	3.39
32.50	2.58	6.222	5.012	-1.21	3.79
32.60	2.12	6.241	5.036	-1.20	3.32
32.70	1.90	6.259	5.060	-1.20	3.10
32.80	2.37	6.277	5.084	-1.19	3.56
32.90	2.84	6.296	5.109	-1.19	4.03
33.00	1.92	6.314	5.133	-1.18	3.10
33.10	1.67	6.332	5.157	-1.18	2.85
33.20	2.22	6.351	5.181	-1.17	3.39
33.30	1.34	6.369	5.206	-1.16	2.50
33.40	1.63	6.387	5.230	-1.16	2.79
33.50	1.92	6.406	5.254	-1.15	3.07
33.60	2.13	6.424	5.278	-1.15	3.28
33.70	2.84	6.442	5.303	-1.14	3.98
33.80	1.96	6.461	5.327	-1.13	3.09
33.90	1.71	6.479	5.351	-1.13	2.84

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
34.00	1.25	6.497	5.375	-1.12	2.37
34.10	2.40	6.516	5.399	-1.12	3.52
34.20	2.37	6.534	5.424	-1.11	3.48
34.30	2.10	6.552	5.448	-1.10	3.20
34.40	1.84	6.571	5.472	-1.10	2.94
34.50	2.12	6.589	5.496	-1.09	3.21
34.60	2.93	6.607	5.521	-1.09	4.02
34.70	2.96	6.626	5.545	-1.08	4.04
34.80	3.33	6.644	5.569	-1.07	4.40
34.90	3.32	6.662	5.593	-1.07	4.39
35.00	2.90	6.681	5.618	-1.06	3.96
35.10	3.32	6.699	5.642	-1.06	4.38
35.20	3.74	6.717	5.666	-1.05	4.79
35.30	1.81	6.736	5.690	-1.05	2.86
35.40	1.92	6.754	5.715	-1.04	2.96
35.50	1.86	6.772	5.739	-1.03	2.89
35.60	1.71	6.791	5.763	-1.03	2.74
35.70	1.89	6.809	5.787	-1.02	2.91
35.80	2.86	6.827	5.812	-1.02	3.88
35.90	2.56	6.846	5.836	-1.01	3.57
36.00	1.54	6.864	5.860	-1.00	2.54
36.10	2.21	6.882	5.884	-1.00	3.21
36.20	2.05	6.901	5.909	-0.99	3.04
36.30	1.57	6.919	5.933	-0.99	2.56
36.40	1.27	6.937	5.957	-0.98	2.25
36.50	1.88	6.956	5.981	-0.97	2.85
36.60	3.37	6.974	6.005	-0.97	4.34
36.70	4.46	6.992	6.030	-0.96	5.42
36.80	3.34	7.011	6.054	-0.96	4.30
36.90	0.76	7.029	6.078	-0.95	1.71
37.00	1.22	7.047	6.102	-0.95	2.17
37.10	1.13	7.066	6.127	-0.94	2.07
37.20	0.80	7.084	6.151	-0.93	1.73
37.30	1.06	7.102	6.175	-0.93	1.99

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
37.40	1.15	7.121	6.199	-0.92	2.07
37.50	1.13	7.139	6.224	-0.92	2.05
37.60	1.36	7.157	6.248	-0.91	2.27
37.70	1.39	7.176	6.272	-0.90	2.29
37.80	1.40	7.194	6.296	-0.90	2.30
37.90	1.12	7.212	6.321	-0.89	2.01
38.00	0.91	7.231	6.345	-0.89	1.80
38.10	1.03	7.249	6.369	-0.88	1.91
38.20	0.89	7.267	6.393	-0.87	1.76
38.30	1.37	7.286	6.418	-0.87	2.24
38.40	0.76	7.304	6.442	-0.86	1.62
38.50	0.94	7.322	6.466	-0.86	1.80
38.60	0.62	7.341	6.490	-0.85	1.47
38.70	0.58	7.359	6.514	-0.84	1.42
38.80	1.07	7.377	6.539	-0.84	1.91
38.90	0.65	7.396	6.563	-0.83	1.48
39.00	0.71	7.414	6.587	-0.83	1.54
39.10	0.97	7.432	6.611	-0.82	1.79
39.20	0.53	7.451	6.636	-0.82	1.35
39.30	0.53	7.469	6.660	-0.81	1.34
39.40	0.71	7.487	6.684	-0.80	1.51
39.50	0.85	7.506	6.708	-0.80	1.65
39.60	1.25	7.524	6.733	-0.79	2.04
39.70	0.86	7.543	6.757	-0.79	1.65
39.80	1.18	7.561	6.781	-0.78	1.96
39.90	1.64	7.579	6.805	-0.77	2.41
40.00	1.19	7.598	6.830	-0.77	1.96
40.10	1.01	7.616	6.854	-0.76	1.77
40.20	2.12	7.634	6.878	-0.76	2.88
40.30	3.58	7.653	6.902	-0.75	4.33
40.40	1.97	7.671	6.927	-0.74	2.71
40.50	0.74	7.689	6.951	-0.74	1.48
40.60	1.64	7.708	6.975	-0.73	2.37
40.70	1.36	7.726	6.999	-0.73	2.09

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
40.80	1.87	7.744	7.023	-0.72	2.59
40.90	1.97	7.763	7.048	-0.71	2.68
41.00	3.20	7.781	7.072	-0.71	3.91
41.10	3.95	7.799	7.096	-0.70	4.65
41.20	3.28	7.818	7.120	-0.70	3.98
41.30	4.82	7.836	7.145	-0.69	5.51
41.40	1.57	7.854	7.169	-0.69	2.26
41.50	1.36	7.873	7.193	-0.68	2.04
41.60	1.51	7.891	7.217	-0.67	2.18
41.70	1.61	7.909	7.242	-0.67	2.28
41.80	1.78	7.928	7.266	-0.66	2.44
41.90	1.28	7.946	7.290	-0.66	1.94
42.00	1.99	7.964	7.314	-0.65	2.64
42.10	1.69	7.983	7.339	-0.64	2.33
42.20	1.78	8.001	7.363	-0.64	2.42
42.30	2.47	8.019	7.387	-0.63	3.10
42.40	3.61	8.038	7.411	-0.63	4.24
42.50	4.39	8.056	7.436	-0.62	5.01
42.60	3.10	8.074	7.460	-0.61	3.71
42.70	1.87	8.093	7.484	-0.61	2.48
42.80	1.19	8.111	7.508	-0.60	1.79
42.90	1.10	8.129	7.532	-0.60	1.70
43.00	3.47	8.148	7.557	-0.59	4.06
43.10	3.10	8.166	7.581	-0.58	3.68
43.20	0.88	8.184	7.605	-0.58	1.46
43.30	1.85	8.203	7.629	-0.57	2.42
43.40	4.63	8.221	7.654	-0.57	5.20
43.50	1.72	8.239	7.678	-0.56	2.28
43.60	1.42	8.258	7.702	-0.56	1.98
43.70	0.95	8.276	7.726	-0.55	1.50
43.80	1.04	8.294	7.751	-0.54	1.58
43.90	1.12	8.313	7.775	-0.54	1.66
44.00	0.92	8.331	7.799	-0.53	1.45
44.10	0.95	8.349	7.823	-0.53	1.48

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
44.20	1.15	8.368	7.848	-0.52	1.67
44.30	1.73	8.386	7.872	-0.51	2.24
44.40	1.64	8.404	7.896	-0.51	2.15
44.50	0.91	8.423	7.920	-0.50	1.41
44.60	1.39	8.441	7.945	-0.50	1.89
44.70	1.09	8.459	7.969	-0.49	1.58
44.80	0.79	8.478	7.993	-0.48	1.27
44.90	0.85	8.496	8.017	-0.48	1.33
45.00	1.16	8.514	8.042	-0.47	1.63
45.10	0.94	8.533	8.066	-0.47	1.41
45.20	1.72	8.551	8.090	-0.46	2.18
45.30	1.81	8.569	8.114	-0.46	2.27
45.40	1.87	8.588	8.138	-0.45	2.32
45.50	2.62	8.606	8.163	-0.44	3.06
45.60	3.38	8.624	8.187	-0.44	3.82
45.70	0.55	8.643	8.211	-0.43	0.98
45.80	1.00	8.661	8.235	-0.43	1.43
45.90	1.52	8.679	8.260	-0.42	1.94
46.00	1.88	8.698	8.284	-0.41	2.29
46.10	3.02	8.716	8.308	-0.41	3.43
46.20	0.79	8.734	8.332	-0.40	1.19
46.30	0.62	8.753	8.357	-0.40	1.02
46.40	1.58	8.771	8.381	-0.39	1.97
46.50	0.50	8.789	8.405	-0.38	0.88
46.60	1.52	8.808	8.429	-0.38	1.90
46.70	0.67	8.826	8.454	-0.37	1.04
46.80	0.88	8.844	8.478	-0.37	1.25
46.90	1.24	8.863	8.502	-0.36	1.60
47.00	0.76	8.881	8.526	-0.35	1.11
47.10	0.80	8.899	8.551	-0.35	1.15
47.20	0.53	8.918	8.575	-0.34	0.87
47.30	0.67	8.936	8.599	-0.34	1.01
47.40	0.97	8.954	8.623	-0.33	1.30
47.50	3.76	8.973	8.647	-0.33	4.09

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
47.60	2.35	8.991	8.672	-0.32	2.67
47.70	1.48	9.009	8.696	-0.31	1.79
47.80	1.73	9.028	8.720	-0.31	2.04
47.90	0.67	9.046	8.744	-0.30	0.97
48.00	2.78	9.064	8.769	-0.30	3.08
48.10	1.61	9.083	8.793	-0.29	1.90
48.20	1.36	9.101	8.817	-0.28	1.64
48.30	0.85	9.119	8.841	-0.28	1.13
48.40	1.22	9.138	8.866	-0.27	1.49
48.50	3.95	9.156	8.890	-0.27	4.22
48.60	2.71	9.174	8.914	-0.26	2.97
48.70	3.71	9.193	8.938	-0.25	3.96
48.80	6.58	9.211	8.963	-0.25	6.83
48.90	2.50	9.229	8.987	-0.24	2.74
49.00	2.05	9.248	9.011	-0.24	2.29
49.10	1.78	9.266	9.035	-0.23	2.01
49.20	2.03	9.284	9.060	-0.22	2.25
49.30	1.33	9.303	9.084	-0.22	1.55
49.40	1.07	9.321	9.108	-0.21	1.28
49.50	1.03	9.332	9.126	-0.21	1.24
49.60	0.89	9.342	9.143	-0.20	1.09
49.70	1.42	9.353	9.161	-0.19	1.61
49.80	1.28	9.363	9.178	-0.19	1.47
49.90	0.47	9.374	9.196	-0.18	0.65
50.00	1.28	9.384	9.213	-0.17	1.45
50.10	0.64	9.395	9.231	-0.16	0.80
50.20	3.55	9.405	9.248	-0.16	3.71
50.30	1.78	9.416	9.266	-0.15	1.93
50.40	0.86	9.427	9.283	-0.14	1.00
50.50	1.42	9.437	9.301	-0.14	1.56
50.60	1.09	9.448	9.318	-0.13	1.22
50.70	0.98	9.458	9.336	-0.12	1.10
50.80	0.86	9.469	9.353	-0.12	0.98
50.90	0.68	9.479	9.371	-0.11	0.79

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
51.00	0.52	9.490	9.388	-0.10	0.62
51.10	2.11	9.500	9.406	-0.09	2.20
51.20	2.86	9.511	9.423	-0.09	2.95
51.30	1.70	9.522	9.441	-0.08	1.78
51.40	0.64	9.532	9.458	-0.07	0.71
51.50	0.76	9.543	9.476	-0.07	0.83
51.60	1.06	9.553	9.493	-0.06	1.12
51.70	2.95	9.564	9.511	-0.05	3.00
51.80	4.63	9.574	9.528	-0.05	4.68
51.90	6.43	9.585	9.546	-0.04	6.47
52.00	0.73	9.595	9.563	-0.03	0.76
52.10	2.84	9.606	9.581	-0.03	2.87
52.20	0.86	9.617	9.598	-0.02	0.88
52.30	1.49	9.627	9.616	-0.01	1.50
52.40	1.84	9.638	9.633	0.00	1.84
52.50	2.14	9.648	9.651	0.00	2.14
52.60	2.32	9.659	9.668	0.01	2.31
52.70	2.35	9.669	9.686	0.02	2.33
52.80	1.78	9.680	9.703	0.02	1.76
52.90	2.14	9.691	9.721	0.03	2.11
53.00	1.76	9.701	9.738	0.04	1.72
53.10	1.46	9.712	9.756	0.04	1.42
53.20	0.79	9.722	9.773	0.05	0.74
53.30	1.60	9.733	9.791	0.06	1.54
53.40	1.00	9.743	9.808	0.06	0.94
53.50	0.88	9.754	9.826	0.07	0.81
53.60	1.60	9.764	9.843	0.08	1.52
53.70	1.33	9.775	9.861	0.09	1.24
53.80	1.82	9.786	9.878	0.09	1.73
53.90	1.37	9.796	9.896	0.10	1.27
54.00	1.46	9.807	9.913	0.11	1.35
54.10	0.71	9.817	9.931	0.11	0.60
54.20	0.74	9.828	9.948	0.12	0.62
54.30	1.33	9.838	9.966	0.13	1.20

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
54.40	2.03	9.849	9.983	0.13	1.90
54.50	0.55	9.859	10.001	0.14	0.41
54.60	0.76	9.870	10.018	0.15	0.61
54.70	1.15	9.881	10.036	0.16	0.99
54.80	1.18	9.891	10.053	0.16	1.02
54.90	0.97	9.902	10.071	0.17	0.80
55.00	0.82	9.912	10.088	0.18	0.64
55.10	2.38	9.923	10.106	0.18	2.20
55.20	1.81	9.933	10.123	0.19	1.62
55.30	1.12	9.944	10.141	0.20	0.92
55.40	1.24	9.954	10.158	0.20	1.04
55.50	1.27	9.965	10.176	0.21	1.06
55.60	1.10	9.976	10.193	0.22	0.88
55.70	1.06	9.986	10.211	0.22	0.84
55.80	1.60	9.997	10.228	0.23	1.37
55.90	1.49	10.007	10.246	0.24	1.25
56.00	1.37	10.018	10.263	0.25	1.12
56.10	2.03	10.028	10.281	0.25	1.78
56.20	1.85	10.039	10.298	0.26	1.59
56.30	1.09	10.049	10.316	0.27	0.82
56.40	1.34	10.060	10.333	0.27	1.07
56.50	0.16	10.071	10.351	0.28	0.00
56.60	1.19	10.081	10.368	0.29	0.90
56.70	1.06	10.092	10.386	0.29	0.77
56.80	1.07	10.102	10.404	0.30	0.77
56.90	0.98	10.113	10.421	0.31	0.67
57.00	0.68	10.123	10.439	0.32	0.36
57.10	0.61	10.134	10.456	0.32	0.29
57.20	0.59	10.144	10.474	0.33	0.26
57.30	0.92	10.155	10.491	0.34	0.58
57.40	0.98	10.166	10.509	0.34	0.64
57.50	1.07	10.176	10.526	0.35	0.72
57.60	1.37	10.187	10.544	0.36	1.01
57.70	0.56	10.197	10.561	0.36	0.20

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
57.80	1.06	10.208	10.579	0.37	0.69
57.90	1.30	10.218	10.596	0.38	0.92
58.00	0.72	10.229	10.614	0.38	0.34
58.10	3.79	10.240	10.631	0.39	3.40
58.20	2.25	10.250	10.649	0.40	1.85
58.30	2.06	10.261	10.666	0.41	1.65
58.40	1.95	10.271	10.684	0.41	1.54
58.50	1.84	10.282	10.701	0.42	1.42
58.60	1.89	10.292	10.719	0.43	1.46
58.70	1.64	10.303	10.736	0.43	1.21
58.80	1.62	10.313	10.754	0.44	1.18
58.90	1.52	10.324	10.771	0.45	1.07
59.00	1.53	10.335	10.789	0.45	1.08
59.10	1.32	10.345	10.806	0.46	0.86
59.20	1.12	10.356	10.824	0.47	0.65
59.30	1.51	10.366	10.841	0.47	1.04
59.40	1.36	10.377	10.859	0.48	0.88
59.50	1.28	10.387	10.876	0.49	0.79
59.60	1.51	10.398	10.894	0.50	1.01
59.70	1.23	10.408	10.911	0.50	0.73
59.80	1.21	10.419	10.929	0.51	0.70
59.90	1.27	10.430	10.946	0.52	0.75
60.00	2.02	10.440	10.964	0.52	1.50
60.10	1.36	10.451	10.981	0.53	0.83
60.20	1.72	10.461	10.999	0.54	1.18
60.30	1.33	10.472	11.016	0.54	0.79
60.40	1.43	10.482	11.034	0.55	0.88
60.50	1.18	10.493	11.051	0.56	0.62
60.60	0.91	10.503	11.069	0.57	0.34
60.70	1.28	10.514	11.086	0.57	0.71
60.80	1.09	10.525	11.104	0.58	0.51
60.90	1.47	10.535	11.121	0.59	0.88
61.00	1.25	10.546	11.139	0.59	0.66
61.10	1.09	10.556	11.156	0.60	0.49

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
61.20	1.40	10.567	11.174	0.61	0.79
61.30	1.80	10.577	11.191	0.61	1.19
61.40	0.79	10.588	11.209	0.62	0.17
61.50	1.03	10.598	11.226	0.63	0.40
61.60	0.69	10.609	11.244	0.63	0.06
61.70	1.02	10.620	11.261	0.64	0.38
61.80	0.79	10.630	11.279	0.65	0.14
61.90	1.02	10.641	11.296	0.66	0.36
62.00	1.43	10.651	11.314	0.66	0.77
62.10	0.77	10.662	11.331	0.67	0.10
62.20	1.40	10.672	11.349	0.68	0.72
62.30	1.47	10.683	11.366	0.68	0.79
62.40	1.09	10.693	11.384	0.69	0.40
62.50	1.11	10.704	11.401	0.70	0.41
62.60	1.72	10.715	11.419	0.70	1.02
62.70	0.90	10.725	11.436	0.71	0.19
62.80	0.71	10.736	11.454	0.72	0.00
62.90	0.68	10.746	11.471	0.73	0.00
63.00	0.71	10.757	11.489	0.73	0.00
63.10	1.64	10.767	11.506	0.74	0.90
63.20	0.80	10.778	11.524	0.75	0.05
63.30	0.86	10.789	11.541	0.75	0.11
63.40	1.16	10.799	11.559	0.76	0.40
63.50	0.89	10.810	11.576	0.77	0.12
63.60	0.61	10.820	11.594	0.77	0.00
63.70	0.90	10.831	11.611	0.78	0.12
63.80	1.62	10.841	11.629	0.79	0.83
63.90	0.84	10.852	11.647	0.79	0.05
64.00	0.75	10.862	11.664	0.80	0.00
64.10	0.82	10.873	11.682	0.81	0.01
64.20	0.84	10.884	11.699	0.82	0.02
64.30	0.87	10.894	11.717	0.82	0.05
64.40	1.18	10.905	11.734	0.83	0.35
64.50	1.39	10.915	11.752	0.84	0.55

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
64.60	1.07	10.926	11.769	0.84	0.23
64.70	0.79	10.936	11.787	0.85	0.00
64.80	0.75	10.947	11.804	0.86	0.00
64.90	0.60	10.957	11.822	0.86	0.00
65.00	0.57	10.968	11.839	0.87	0.00
65.10	0.62	10.979	11.857	0.88	0.00
65.20	1.56	10.989	11.874	0.88	0.68
65.30	1.03	11.000	11.892	0.89	0.14
65.40	1.25	11.010	11.909	0.90	0.35
65.50	0.99	11.021	11.927	0.91	0.08
65.60	1.44	11.031	11.944	0.91	0.53
65.70	1.87	11.042	11.962	0.92	0.95
65.80	1.23	11.052	11.979	0.93	0.30
65.90	1.57	11.063	11.997	0.93	0.64
66.00	0.59	11.074	12.014	0.94	0.00
66.10	1.13	11.084	12.032	0.95	0.18
66.20	1.10	11.095	12.049	0.95	0.15
66.30	0.61	11.105	12.067	0.96	0.00
66.40	0.70	11.116	12.084	0.97	0.00
66.50	1.04	11.126	12.102	0.98	0.06
66.60	1.39	11.137	12.119	0.98	0.41
66.70	1.03	11.147	12.137	0.99	0.04
66.80	0.91	11.158	12.154	1.00	0.00
66.90	0.96	11.169	12.172	1.00	0.00
67.00	0.81	11.179	12.189	1.01	0.00
67.10	1.12	11.190	12.207	1.02	0.10
67.20	0.85	11.200	12.224	1.02	0.00
67.30	0.93	11.211	12.242	1.03	0.00
67.40	0.90	11.221	12.259	1.04	0.00
67.50	0.67	11.232	12.277	1.04	0.00
67.60	0.60	11.242	12.294	1.05	0.00
67.70	1.27	11.253	12.312	1.06	0.21
67.80	0.89	11.264	12.329	1.07	0.00
67.90	0.79	11.274	12.347	1.07	0.00

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
68.00	0.85	11.285	12.364	1.08	0.00
68.10	1.20	11.295	12.382	1.09	0.11
68.20	0.72	11.306	12.399	1.09	0.00
68.30	0.81	11.316	12.417	1.10	0.00
68.40	0.65	11.327	12.434	1.11	0.00
68.50	1.24	11.338	12.452	1.11	0.13
68.60	1.03	11.348	12.469	1.12	0.00
68.70	0.91	11.359	12.487	1.13	0.00
68.80	2.59	11.369	12.504	1.14	1.45
68.90	0.77	11.380	12.522	1.14	0.00
69.00	1.52	11.390	12.539	1.15	0.37
69.10	1.98	11.401	12.557	1.16	0.82
69.20	1.70	11.411	12.574	1.16	0.54
69.30	2.54	11.422	12.592	1.17	1.37
69.40	3.09	11.433	12.609	1.18	1.91
69.50	3.06	11.443	12.627	1.18	1.88
69.60	2.30	11.454	12.644	1.19	1.11
69.70	2.31	11.464	12.662	1.20	1.11
69.80	2.75	11.475	12.679	1.20	1.55
69.90	2.39	11.485	12.697	1.21	1.18
70.00	2.36	11.496	12.714	1.22	1.14
70.10	2.66	11.506	12.732	1.23	1.43
70.20	3.23	11.517	12.749	1.23	2.00
70.30	3.29	11.528	12.767	1.24	2.05
70.40	3.37	11.538	12.784	1.25	2.12
70.50	1.55	11.549	12.802	1.25	0.30
70.60	5.19	11.559	12.819	1.26	3.93
70.70	3.22	11.570	12.837	1.27	1.95
70.80	3.76	11.580	12.854	1.27	2.49
70.90	3.60	11.591	12.872	1.28	2.32
71.00	5.07	11.601	12.889	1.29	3.78
71.10	4.97	11.612	12.907	1.30	3.68
71.20	1.95	11.624	12.902	1.28	0.67
71.30	1.83	11.635	12.897	1.26	0.57

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
71.40	1.97	11.647	12.892	1.25	0.72
71.50	1.34	11.659	12.887	1.23	0.11
71.60	2.46	11.670	12.882	1.21	1.25
71.70	2.11	11.682	12.878	1.20	0.91
71.80	2.90	11.694	12.873	1.18	1.72
71.90	2.65	11.706	12.868	1.16	1.49
72.00	3.36	11.717	12.863	1.15	2.21
72.10	2.39	11.729	12.858	1.13	1.26
72.20	2.84	11.741	12.853	1.11	1.73
72.30	3.32	11.752	12.848	1.10	2.22
72.40	3.26	11.764	12.843	1.08	2.18
72.50	2.24	11.776	12.838	1.06	1.18
72.60	2.33	11.787	12.833	1.05	1.28
72.70	1.39	11.799	12.828	1.03	0.36
72.80	1.70	11.811	12.824	1.01	0.69
72.90	0.98	11.823	12.819	1.00	0.00
73.00	0.92	11.834	12.814	0.98	0.00
73.10	1.29	11.846	12.809	0.96	0.33
73.20	1.19	11.858	12.804	0.95	0.24
73.30	0.74	11.869	12.799	0.93	0.00
73.40	1.16	11.881	12.794	0.91	0.25
73.50	1.27	11.893	12.789	0.90	0.37
73.60	1.29	11.904	12.784	0.88	0.41
73.70	0.73	11.916	12.779	0.86	0.00
73.80	0.65	11.928	12.774	0.85	0.00
73.90	1.03	11.940	12.769	0.83	0.20
74.00	1.21	11.951	12.765	0.81	0.40
74.10	0.67	11.963	12.760	0.80	0.00
74.20	0.64	11.975	12.755	0.78	0.00
74.30	1.79	11.986	12.750	0.76	1.03
74.40	5.73	11.998	12.745	0.75	4.98
74.50	3.51	12.010	12.740	0.73	2.78
74.60	2.71	12.021	12.735	0.71	2.00
74.70	1.46	12.033	12.730	0.70	0.76

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
74.80	0.70	12.045	12.725	0.68	0.02
74.90	0.66	12.057	12.720	0.66	0.00
75.00	1.18	12.068	12.715	0.65	0.53
75.10	1.55	12.080	12.711	0.63	0.92
75.20	0.89	12.092	12.706	0.61	0.28
75.30	0.52	12.103	12.701	0.60	0.00
75.40	0.61	12.115	12.696	0.58	0.03
75.50	0.62	12.127	12.691	0.56	0.06
75.60	0.57	12.138	12.686	0.55	0.02
75.70	1.47	12.150	12.681	0.53	0.94
75.80	1.96	12.162	12.676	0.51	1.45
75.90	2.08	12.174	12.671	0.50	1.58
76.00	2.35	12.185	12.666	0.48	1.87
76.10	2.30	12.197	12.661	0.46	1.84
76.20	2.66	12.209	12.657	0.45	2.21
76.30	2.50	12.220	12.652	0.43	2.07
76.40	2.92	12.232	12.647	0.41	2.51
76.50	3.19	12.244	12.642	0.40	2.79
76.60	3.37	12.255	12.637	0.38	2.99
76.70	3.49	12.267	12.632	0.36	3.13
76.80	3.36	12.279	12.627	0.35	3.01
76.90	3.16	12.291	12.622	0.33	2.83
77.00	2.57	12.302	12.617	0.32	2.25
77.10	4.30	12.314	12.612	0.30	4.00
77.20	4.39	12.326	12.607	0.28	4.11
77.30	4.00	12.337	12.603	0.27	3.73
77.40	4.01	12.349	12.598	0.25	3.76
77.50	2.31	12.361	12.593	0.23	2.08
77.60	2.37	12.372	12.588	0.22	2.15
77.70	1.82	12.384	12.583	0.20	1.62
77.80	4.77	12.396	12.578	0.18	4.59
77.90	1.11	12.408	12.573	0.17	0.94
78.00	1.17	12.419	12.568	0.15	1.02
78.10	1.78	12.431	12.563	0.13	1.65

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
78.20	2.09	12.443	12.558	0.12	1.97
78.30	2.29	12.454	12.553	0.10	2.19
78.40	2.40	12.466	12.549	0.08	2.32
78.50	2.27	12.478	12.544	0.07	2.20
78.60	2.88	12.489	12.539	0.05	2.83
78.70	4.50	12.501	12.534	0.03	4.47
78.80	3.84	12.513	12.529	0.02	3.82
78.90	2.27	12.524	12.524	0.00	2.27
79.00	0.72	12.536	12.519	-0.02	0.74
79.10	5.49	12.548	12.514	-0.03	5.52
79.20	1.35	12.560	12.509	-0.05	1.40
79.30	1.17	12.571	12.504	-0.07	1.24
79.40	0.99	12.583	12.499	-0.08	1.07
79.50	2.73	12.595	12.494	-0.10	2.83
79.60	2.38	12.606	12.490	-0.12	2.50
79.70	0.92	12.618	12.485	-0.13	1.05
79.80	2.88	12.630	12.480	-0.15	3.03
79.90	0.96	12.641	12.475	-0.17	1.13
80.00	0.85	12.653	12.470	-0.18	1.03
80.10	1.10	12.665	12.465	-0.20	1.30
80.20	1.25	12.677	12.460	-0.22	1.47
80.30	0.61	12.688	12.455	-0.23	0.84
80.40	1.52	12.700	12.450	-0.25	1.77
80.50	0.63	12.712	12.445	-0.27	0.90
80.60	3.22	12.723	12.440	-0.28	3.50
80.70	2.32	12.735	12.436	-0.30	2.62
80.80	0.52	12.747	12.431	-0.32	0.84
80.90	1.10	12.758	12.426	-0.33	1.43
81.00	2.15	12.770	12.421	-0.35	2.50
81.10	1.45	12.782	12.416	-0.37	1.82
81.20	1.05	12.794	12.411	-0.38	1.43
81.30	1.30	12.805	12.406	-0.40	1.70
81.40	1.49	12.817	12.401	-0.42	1.91
81.50	0.94	12.829	12.396	-0.43	1.37

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
81.60	1.59	12.840	12.391	-0.45	2.04
81.70	2.07	12.852	12.386	-0.47	2.54
81.80	3.60	12.864	12.382	-0.48	4.08
81.90	0.92	12.875	12.377	-0.50	1.42
82.00	1.38	12.887	12.372	-0.52	1.90
82.10	1.30	12.899	12.367	-0.53	1.83
82.20	1.29	12.911	12.362	-0.55	1.84
82.30	1.22	12.922	12.357	-0.57	1.79
82.40	1.26	12.934	12.352	-0.58	1.84
82.50	1.42	12.946	12.347	-0.60	2.02
82.60	1.30	12.957	12.342	-0.62	1.92
82.70	1.13	12.969	12.337	-0.63	1.76
82.80	1.41	12.981	12.332	-0.65	2.06
82.90	1.26	12.992	12.328	-0.66	1.92
83.00	1.81	13.004	12.323	-0.68	2.49
83.10	0.69	13.016	12.318	-0.70	1.39
83.20	0.82	13.028	12.313	-0.71	1.53
83.30	0.71	13.039	12.308	-0.73	1.44
83.40	0.91	13.051	12.303	-0.75	1.66
83.50	1.11	13.063	12.298	-0.76	1.87
83.60	2.47	13.074	12.293	-0.78	3.25
83.70	0.69	13.086	12.288	-0.80	1.49
83.80	1.28	13.098	12.283	-0.81	2.09
83.90	1.37	13.109	12.278	-0.83	2.20
84.00	2.53	13.121	12.273	-0.85	3.38
84.10	2.10	13.133	12.269	-0.86	2.96
84.20	5.06	13.145	12.264	-0.88	5.94
84.30	0.83	13.156	12.259	-0.90	1.73
84.40	1.00	13.168	12.254	-0.91	1.91
84.50	1.24	13.180	12.249	-0.93	2.17
84.60	3.20	13.191	12.244	-0.95	4.15
84.70	1.21	13.203	12.239	-0.96	2.17
84.80	0.88	13.215	12.234	-0.98	1.86
84.90	1.16	13.226	12.229	-1.00	2.16

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
85.00	3.43	13.238	12.224	-1.01	4.44
85.10	1.20	13.250	12.219	-1.03	2.23
85.20	1.03	13.262	12.215	-1.05	2.08
85.30	0.67	13.273	12.210	-1.06	1.73
85.40	0.86	13.285	12.205	-1.08	1.94
85.50	0.98	13.297	12.200	-1.10	2.08
85.60	0.96	13.308	12.195	-1.11	2.07
85.70	0.70	13.320	12.190	-1.13	1.83
85.80	0.90	13.336	12.218	-1.12	2.02
85.90	0.85	13.353	12.245	-1.11	1.96
86.00	0.56	13.369	12.273	-1.10	1.66
86.10	0.80	13.385	12.301	-1.08	1.88
86.20	0.71	13.401	12.328	-1.07	1.78
86.30	0.54	13.418	12.356	-1.06	1.60
86.40	0.65	13.434	12.384	-1.05	1.70
86.50	1.07	13.450	12.411	-1.04	2.11
86.60	1.23	13.466	12.439	-1.03	2.26
86.70	0.87	13.483	12.467	-1.02	1.89
86.80	1.55	13.499	12.494	-1.00	2.55
86.90	0.87	13.515	12.522	-0.99	1.86
87.00	1.07	13.531	12.550	-0.98	2.05
87.10	1.54	13.548	12.577	-0.97	2.51
87.20	1.63	13.564	12.605	-0.96	2.59
87.30	1.40	13.580	12.633	-0.95	2.35
87.40	1.58	13.596	12.660	-0.94	2.52
87.50	1.27	13.613	12.688	-0.92	2.19
87.60	1.52	13.629	12.716	-0.91	2.43
87.70	1.32	13.645	12.743	-0.90	2.22
87.80	1.13	13.662	12.771	-0.89	2.02
87.90	1.13	13.678	12.798	-0.88	2.01
88.00	0.96	13.694	12.826	-0.87	1.83
88.10	0.95	13.710	12.854	-0.86	1.81
88.20	1.05	13.727	12.881	-0.85	1.90
88.30	0.78	13.743	12.909	-0.83	1.61

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
88.40	1.42	13.759	12.937	-0.82	2.24
88.50	1.32	13.775	12.964	-0.81	2.13
88.60	1.04	13.792	12.992	-0.80	1.84
88.70	1.22	13.808	13.020	-0.79	2.01
88.80	1.30	13.824	13.047	-0.78	2.08
88.90	1.23	13.840	13.075	-0.77	2.00
89.00	0.90	13.857	13.103	-0.75	1.65
89.10	0.90	13.873	13.130	-0.74	1.64
89.20	1.03	13.889	13.158	-0.73	1.76
89.30	0.77	13.906	13.186	-0.72	1.49
89.40	0.85	13.922	13.213	-0.71	1.56
89.50	0.76	13.938	13.241	-0.70	1.46
89.60	0.56	13.954	13.269	-0.69	1.25
89.70	0.58	13.971	13.296	-0.67	1.25
89.80	0.63	13.987	13.324	-0.66	1.29
89.90	0.54	14.003	13.352	-0.65	1.19
90.00	0.66	14.019	13.379	-0.64	1.30
90.10	1.28	14.036	13.407	-0.63	1.91
90.20	0.87	14.052	13.435	-0.62	1.49
90.30	0.53	14.068	13.462	-0.61	1.14
90.40	0.62	14.084	13.490	-0.59	1.21
90.50	0.99	14.101	13.518	-0.58	1.57
90.60	1.29	14.117	13.545	-0.57	1.86
90.70	1.25	14.133	13.573	-0.56	1.81
90.80	1.52	14.149	13.601	-0.55	2.07
90.90	0.98	14.166	13.628	-0.54	1.52
91.00	0.90	14.182	13.656	-0.53	1.43
91.10	0.96	14.198	13.684	-0.51	1.47
91.20	1.24	14.215	13.711	-0.50	1.74
91.30	1.15	14.231	13.739	-0.49	1.64
91.40	0.74	14.247	13.767	-0.48	1.22
91.50	0.98	14.263	13.794	-0.47	1.45
91.60	1.04	14.280	13.822	-0.46	1.50
91.70	0.68	14.296	13.849	-0.45	1.13

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
91.80	0.58	14.312	13.877	-0.43	1.01
91.90	0.62	14.328	13.905	-0.42	1.04
92.00	0.52	14.345	13.932	-0.41	0.93
92.10	1.54	14.361	13.960	-0.40	1.94
92.20	1.22	14.377	13.988	-0.39	1.61
92.30	0.74	14.393	14.015	-0.38	1.12
92.40	1.43	14.410	14.043	-0.37	1.80
92.50	0.52	14.426	14.071	-0.36	0.88
92.60	0.61	14.442	14.098	-0.34	0.95
92.70	1.10	14.459	14.126	-0.33	1.43
92.80	1.87	14.475	14.154	-0.32	2.19
92.90	0.95	14.491	14.181	-0.31	1.26
93.00	0.68	14.507	14.209	-0.30	0.98
93.10	1.34	14.524	14.237	-0.29	1.63
93.20	1.12	14.540	14.264	-0.28	1.40
93.30	1.31	14.556	14.292	-0.26	1.57
93.40	1.33	14.572	14.320	-0.25	1.58
93.50	0.80	14.589	14.347	-0.24	1.04
93.60	1.10	14.605	14.375	-0.23	1.33
93.70	0.67	14.621	14.403	-0.22	0.89
93.80	0.61	14.637	14.430	-0.21	0.82
93.90	0.89	14.654	14.458	-0.20	1.09
94.00	1.12	14.670	14.486	-0.18	1.30
94.10	1.28	14.686	14.513	-0.17	1.45
94.20	1.43	14.702	14.541	-0.16	1.59
94.30	1.57	14.719	14.569	-0.15	1.72
94.40	2.30	14.735	14.596	-0.14	2.44
94.50	1.24	14.751	14.624	-0.13	1.37
94.60	0.47	14.768	14.652	-0.12	0.59
94.70	1.24	14.784	14.679	-0.10	1.34
94.80	0.53	14.800	14.707	-0.09	0.62
94.90	0.59	14.816	14.735	-0.08	0.67
95.00	1.15	14.833	14.762	-0.07	1.22
95.10	1.00	14.849	14.790	-0.06	1.06

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
95.20	1.37	14.865	14.818	-0.05	1.42
95.30	2.75	14.881	14.845	-0.04	2.79
95.40	2.87	14.898	14.873	-0.02	2.89
95.50	1.12	14.914	14.900	-0.01	1.13
95.60	0.65	14.930	14.928	0.00	0.65
95.70	0.64	14.946	14.956	0.01	0.63
95.80	0.62	14.963	14.983	0.02	0.60
95.90	0.59	14.979	15.011	0.03	0.56
96.00	0.85	14.995	15.039	0.04	0.81
96.10	1.66	15.012	15.066	0.05	1.61
96.20	1.36	15.028	15.094	0.07	1.29
96.30	1.39	15.044	15.122	0.08	1.31
96.40	0.65	15.060	15.149	0.09	0.56
96.50	2.78	15.077	15.177	0.10	2.68
96.60	3.68	15.093	15.205	0.11	3.57
96.70	3.35	15.109	15.232	0.12	3.23
96.80	0.70	15.125	15.260	0.13	0.57
96.90	1.03	15.142	15.288	0.15	0.88
97.00	1.12	15.158	15.315	0.16	0.96
97.10	0.88	15.174	15.343	0.17	0.71
97.20	0.98	15.190	15.371	0.18	0.80
97.30	1.27	15.207	15.398	0.19	1.08
97.40	0.80	15.223	15.426	0.20	0.60
97.50	0.74	15.239	15.454	0.21	0.53
97.60	0.70	15.255	15.481	0.23	0.47
97.70	0.89	15.272	15.509	0.24	0.65
97.80	0.16	15.288	15.537	0.25	0.00
97.90	1.31	15.304	15.564	0.26	1.05
98.00	1.00	15.321	15.592	0.27	0.73
98.10	0.62	15.337	15.620	0.28	0.34
98.20	1.73	15.353	15.647	0.29	1.44
98.30	2.20	15.369	15.675	0.31	1.89
98.40	2.33	15.386	15.703	0.32	2.01
98.50	3.37	15.402	15.730	0.33	3.04

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
98.60	2.98	15.418	15.758	0.34	2.64
98.70	1.24	15.434	15.786	0.35	0.89
98.80	0.71	15.451	15.813	0.36	0.35
98.90	0.59	15.467	15.841	0.37	0.22
99.00	0.53	15.483	15.869	0.39	0.14
99.10	2.00	15.499	15.896	0.40	1.60
99.20	2.47	15.516	15.924	0.41	2.06
99.30	3.73	15.532	15.951	0.42	3.31
99.40	3.26	15.548	15.979	0.43	2.83
99.50	3.07	15.565	16.007	0.44	2.63
99.60	2.87	15.581	16.034	0.45	2.42
99.70	1.28	15.597	16.062	0.47	0.81
99.80	1.10	15.613	16.090	0.48	0.62
99.90	0.55	15.630	16.117	0.49	0.06
100.00	0.92	15.646	16.145	0.50	0.42
100.10	1.51	15.662	16.173	0.51	1.00
100.20	1.63	15.678	16.200	0.52	1.11
100.30	1.54	15.695	16.228	0.53	1.01
100.40	1.91	15.711	16.256	0.54	1.37
100.50	1.85	15.727	16.283	0.56	1.29
100.60	1.09	15.743	16.311	0.57	0.52
100.70	1.00	15.760	16.339	0.58	0.42
100.80	0.67	15.776	16.366	0.59	0.08
100.90	1.18	15.792	16.394	0.60	0.58
101.00	1.16	15.808	16.422	0.61	0.55
101.10	1.22	15.825	16.449	0.62	0.60
101.20	0.86	15.841	16.477	0.64	0.22
101.30	0.90	15.856	16.481	0.63	0.27
101.40	1.26	15.871	16.485	0.61	0.65
101.50	0.78	15.885	16.489	0.60	0.18
101.60	0.79	15.900	16.492	0.59	0.20
101.70	0.84	15.915	16.496	0.58	0.26
101.80	0.94	15.930	16.500	0.57	0.37
101.90	0.84	15.945	16.504	0.56	0.28

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
102.00	0.91	15.959	16.508	0.55	0.36
102.10	1.08	15.974	16.512	0.54	0.54
102.20	1.38	15.989	16.516	0.53	0.85
102.30	1.28	16.004	16.520	0.52	0.76
102.40	1.20	16.019	16.523	0.50	0.70
102.50	0.99	16.033	16.527	0.49	0.50
102.60	1.01	16.048	16.531	0.48	0.53
102.70	0.59	16.063	16.535	0.47	0.12
102.80	0.90	16.078	16.539	0.46	0.44
102.90	0.87	16.092	16.543	0.45	0.42
103.00	1.03	16.107	16.547	0.44	0.59
103.10	1.07	16.122	16.551	0.43	0.64
103.20	0.82	16.137	16.554	0.42	0.40
103.30	1.02	16.152	16.558	0.41	0.61
103.40	1.12	16.166	16.562	0.40	0.72
103.50	1.19	16.181	16.566	0.38	0.81
103.60	1.13	16.196	16.570	0.37	0.76
103.70	1.16	16.211	16.574	0.36	0.80
103.80	3.92	16.226	16.578	0.35	3.57
103.90	3.08	16.240	16.582	0.34	2.74
104.00	1.02	16.255	16.585	0.33	0.69
104.10	1.82	16.270	16.589	0.32	1.50
104.20	0.55	16.285	16.593	0.31	0.24
104.30	0.75	16.300	16.597	0.30	0.45
104.40	0.73	16.314	16.601	0.29	0.44
104.50	0.61	16.329	16.605	0.28	0.33
104.60	0.71	16.344	16.609	0.26	0.45
104.70	0.72	16.359	16.613	0.25	0.47
104.80	0.81	16.374	16.616	0.24	0.57
104.90	0.66	16.388	16.620	0.23	0.43
105.00	0.64	16.403	16.624	0.22	0.42
105.10	0.66	16.418	16.628	0.21	0.45
105.20	1.00	16.433	16.632	0.20	0.80
105.30	1.04	16.448	16.636	0.19	0.85

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
105.40	1.18	16.462	16.640	0.18	1.00
105.50	1.16	16.477	16.643	0.17	0.99
105.60	0.99	16.492	16.647	0.16	0.83
105.70	0.74	16.507	16.651	0.14	0.60
105.80	0.77	16.521	16.655	0.13	0.64
105.90	1.19	16.536	16.659	0.12	1.07
106.00	1.05	16.551	16.663	0.11	0.94
106.10	0.99	16.566	16.667	0.10	0.89
106.20	2.16	16.581	16.671	0.09	2.07
106.30	2.35	16.595	16.674	0.08	2.27
106.40	1.01	16.610	16.678	0.07	0.94
106.50	1.58	16.625	16.682	0.06	1.52
106.60	2.49	16.640	16.686	0.05	2.44
106.70	2.12	16.655	16.690	0.04	2.08
106.80	3.28	16.669	16.694	0.02	3.26
106.90	3.61	16.684	16.698	0.01	3.60
107.00	1.88	16.699	16.702	0.00	1.88
107.10	0.87	16.714	16.705	-0.01	0.88
107.20	1.48	16.729	16.709	-0.02	1.50
107.30	1.97	16.743	16.713	-0.03	2.00
107.40	1.96	16.758	16.717	-0.04	2.00
107.50	1.70	16.773	16.721	-0.05	1.75
107.60	1.89	16.788	16.725	-0.06	1.95
107.70	1.23	16.803	16.729	-0.07	1.30
107.80	1.11	16.817	16.733	-0.08	1.19
107.90	1.01	16.832	16.736	-0.10	1.11
108.00	0.55	16.847	16.740	-0.11	0.66
108.10	0.60	16.862	16.744	-0.12	0.72
108.20	0.83	16.877	16.748	-0.13	0.96
108.30	1.07	16.891	16.752	-0.14	1.21
108.40	1.00	16.906	16.756	-0.15	1.15
108.50	1.20	16.921	16.760	-0.16	1.36
108.60	0.57	16.936	16.764	-0.17	0.74
108.70	1.06	16.950	16.767	-0.18	1.24

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
108.80	2.02	16.965	16.771	-0.19	2.21
108.90	3.88	16.980	16.775	-0.20	4.08
109.00	3.91	16.995	16.779	-0.22	4.13
109.10	3.78	17.010	16.783	-0.23	4.01
109.20	2.52	17.024	16.787	-0.24	2.76
109.30	0.93	17.039	16.791	-0.25	1.18
109.40	0.53	17.054	16.794	-0.26	0.79
109.50	0.98	17.069	16.798	-0.27	1.25
109.60	0.58	17.084	16.802	-0.28	0.86
109.70	0.62	17.098	16.806	-0.29	0.91
109.80	0.61	17.113	16.810	-0.30	0.91
109.90	0.65	17.128	16.814	-0.31	0.96
110.00	0.78	17.143	16.818	-0.33	1.11
110.10	0.75	17.158	16.822	-0.34	1.09
110.20	0.58	17.172	16.825	-0.35	0.93
110.30	0.95	17.187	16.829	-0.36	1.31
110.40	1.12	17.202	16.833	-0.37	1.49
110.50	1.44	17.217	16.837	-0.38	1.82
110.60	0.84	17.232	16.841	-0.39	1.23
110.70	1.02	17.246	16.845	-0.40	1.42
110.80	0.89	17.261	16.849	-0.41	1.30
110.90	0.56	17.276	16.853	-0.42	0.98
111.00	0.70	17.291	16.856	-0.43	1.13
111.10	1.81	17.306	16.860	-0.45	2.26
111.20	3.08	17.320	16.864	-0.46	3.54
111.30	0.60	17.335	16.868	-0.47	1.07
111.40	0.59	17.350	16.872	-0.48	1.07
111.50	0.56	17.365	16.876	-0.49	1.05
111.60	1.70	17.379	16.880	-0.50	2.20
111.70	1.29	17.394	16.884	-0.51	1.80
111.80	1.03	17.409	16.887	-0.52	1.55
111.90	1.39	17.424	16.891	-0.53	1.92
112.00	0.97	17.439	16.895	-0.54	1.51
112.10	1.28	17.453	16.899	-0.55	1.83

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
112.20	1.26	17.468	16.903	-0.57	1.83
112.30	1.34	17.483	16.907	-0.58	1.92
112.40	0.59	17.498	16.911	-0.59	1.18
112.50	0.92	17.513	16.915	-0.60	1.52
112.60	1.13	17.527	16.918	-0.61	1.74
112.70	0.69	17.542	16.922	-0.62	1.31
112.80	0.84	17.557	16.926	-0.63	1.47
112.90	1.23	17.572	16.930	-0.64	1.87
113.00	0.52	17.587	16.934	-0.65	1.17
113.10	0.80	17.601	16.938	-0.66	1.46
113.20	0.82	17.616	16.942	-0.67	1.49
113.30	0.96	17.631	16.946	-0.69	1.65
113.40	0.87	17.646	16.949	-0.70	1.57
113.50	0.95	17.661	16.953	-0.71	1.66
113.60	0.91	17.675	16.957	-0.72	1.63
113.70	0.58	17.690	16.961	-0.73	1.31
113.80	1.55	17.705	16.965	-0.74	2.29
113.90	0.58	17.720	16.969	-0.75	1.33
114.00	0.70	17.735	16.973	-0.76	1.46
114.10	0.63	17.749	16.976	-0.77	1.40
114.20	1.06	17.764	16.980	-0.78	1.84
114.30	0.93	17.779	16.984	-0.79	1.72
114.40	0.79	17.794	16.988	-0.81	1.60
114.50	0.85	17.808	16.992	-0.82	1.67
114.60	0.81	17.823	16.996	-0.83	1.64
114.70	0.99	17.838	17.000	-0.84	1.83
114.80	0.53	17.853	17.004	-0.85	1.38
114.90	7.62	17.868	17.007	-0.86	8.48
115.00	0.68	17.882	17.011	-0.87	1.55
115.10	3.39	17.897	17.015	-0.88	4.27
115.20	1.12	17.912	17.019	-0.89	2.01
115.30	0.45	17.927	17.023	-0.90	1.35
115.40	0.72	17.942	17.027	-0.91	1.63
115.50	1.19	17.956	17.031	-0.93	2.12

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
115.60	1.36	17.971	17.035	-0.94	2.30
115.70	1.20	17.986	17.038	-0.95	2.15
115.80	4.29	18.001	17.042	-0.96	5.25
115.90	1.90	18.016	17.046	-0.97	2.87
116.00	0.68	18.030	17.050	-0.98	1.66
116.10	2.19	18.045	17.054	-0.99	3.18
116.20	0.53	18.060	17.058	-1.00	1.53
116.30	1.17	18.075	17.062	-1.01	2.18
116.40	1.29	18.090	17.066	-1.02	2.31
116.50	0.89	18.104	17.069	-1.03	1.92
116.60	0.77	18.119	17.073	-1.05	1.82
116.70	0.97	18.134	17.077	-1.06	2.03
116.80	0.86	18.149	17.081	-1.07	1.93
116.90	1.74	18.164	17.085	-1.08	2.82
117.00	0.63	18.178	17.089	-1.09	1.72
117.10	0.86	18.193	17.093	-1.10	1.96
117.20	0.94	18.208	17.097	-1.11	2.05
117.30	0.59	18.223	17.100	-1.12	1.71
117.40	0.70	18.237	17.104	-1.13	1.83
117.50	0.76	18.252	17.108	-1.14	1.90
117.60	1.20	18.267	17.112	-1.16	2.36
117.70	0.66	18.282	17.116	-1.17	1.83
117.80	0.58	18.297	17.120	-1.18	1.76
117.90	0.93	18.311	17.124	-1.19	2.12
118.00	0.63	18.326	17.127	-1.20	1.83
118.10	2.32	18.341	17.131	-1.21	3.53
118.20	2.40	18.356	17.135	-1.22	3.62
118.30	0.65	18.371	17.139	-1.23	1.88
118.40	0.75	18.385	17.143	-1.24	1.99
118.50	0.67	18.400	17.147	-1.25	1.92
118.60	0.71	18.415	17.151	-1.26	1.97
118.70	1.01	18.430	17.155	-1.28	2.29
118.80	0.83	18.445	17.158	-1.29	2.12
118.90	1.17	18.459	17.162	-1.30	2.47

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
119.00	0.69	18.474	17.166	-1.31	2.00
119.10	0.63	18.489	17.170	-1.32	1.95
119.20	0.72	18.504	17.174	-1.33	2.05
119.30	0.92	18.519	17.178	-1.34	2.26
119.40	1.09	18.533	17.182	-1.35	2.44
119.50	1.36	18.548	17.186	-1.36	2.72
119.60	1.01	18.563	17.189	-1.37	2.38
119.70	0.71	18.578	17.193	-1.38	2.09
119.80	1.70	18.593	17.197	-1.40	3.10
119.90	1.43	18.607	17.201	-1.41	2.84
120.00	1.56	18.622	17.205	-1.42	2.98
120.10	0.68	18.637	17.209	-1.43	2.11
120.20	0.40	18.652	17.213	-1.44	1.84
120.30	0.82	18.666	17.217	-1.45	2.27
120.40	1.30	18.681	17.220	-1.46	2.76
120.50	0.53	18.696	17.224	-1.47	2.00
120.60	0.94	18.711	17.228	-1.48	2.42
120.70	0.22	18.726	17.232	-1.49	1.71
120.80	0.55	18.740	17.236	-1.50	2.05
120.90	0.52	18.755	17.240	-1.52	2.04
121.00	1.10	18.770	17.244	-1.53	2.63
121.10	0.60	18.785	17.248	-1.54	2.14
121.20	0.64	18.800	17.251	-1.55	2.19
121.30	0.95	18.814	17.255	-1.56	2.51
121.40	0.62	18.829	17.259	-1.57	2.19
121.50	0.58	18.844	17.263	-1.58	2.16
121.60	0.77	18.844	17.263	-1.58	2.35
121.70	0.47	18.844	17.263	-1.58	2.05
121.80	0.63	18.844	17.263	-1.58	2.21
121.90	0.58	18.844	17.263	-1.58	2.16
122.00	0.97	18.844	17.263	-1.58	2.55
122.10	0.68	18.844	17.263	-1.58	2.26
122.20	1.09	18.844	17.263	-1.58	2.67
122.30	0.83	18.844	17.263	-1.58	2.41

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
122.40	0.79	18.844	17.263	-1.58	2.37
122.50	1.33	18.844	17.263	-1.58	2.91
122.60	0.50	18.844	17.263	-1.58	2.08
122.70	0.80	18.844	17.263	-1.58	2.38
122.80	0.52	18.844	17.263	-1.58	2.10
122.90	1.08	18.844	17.263	-1.58	2.66
123.00	0.97	18.844	17.263	-1.58	2.55
123.10	0.71	18.844	17.263	-1.58	2.29
123.20	1.99	18.844	17.263	-1.58	3.57
123.30	1.12	18.844	17.263	-1.58	2.70
123.40	0.82	18.844	17.263	-1.58	2.40
123.50	0.59	18.844	17.263	-1.58	2.17
123.60	0.93	18.844	17.263	-1.58	2.51
123.70	0.77	18.844	17.263	-1.58	2.35
123.80	0.88	18.844	17.263	-1.58	2.46
123.90	0.75	18.844	17.263	-1.58	2.33
124.00	0.72	18.844	17.263	-1.58	2.30
124.10	0.62	18.844	17.263	-1.58	2.20
124.20	0.52	18.844	17.263	-1.58	2.10
124.30	0.60	18.844	17.263	-1.58	2.18
124.40	0.91	18.844	17.263	-1.58	2.49
124.50	0.60	18.844	17.263	-1.58	2.18
124.60	0.61	18.844	17.263	-1.58	2.19
124.70	0.85	18.844	17.263	-1.58	2.43
124.80	0.56	18.844	17.263	-1.58	2.14
124.90	0.78	18.844	17.263	-1.58	2.36
125.00	0.89	18.844	17.263	-1.58	2.47
125.10	0.63	18.844	17.263	-1.58	2.21
125.20	0.70	18.844	17.263	-1.58	2.28
125.30	1.38	18.844	17.263	-1.58	2.96
125.40	0.57	18.844	17.263	-1.58	2.15
125.50	1.16	18.844	17.263	-1.58	2.74
125.60	0.79	18.844	17.263	-1.58	2.37
125.70	0.53	18.844	17.263	-1.58	2.11

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
125.80	0.56	18.844	17.263	-1.58	2.14
125.90	0.96	18.844	17.263	-1.58	2.54
126.00	0.53	18.844	17.263	-1.58	2.11
126.10	0.63	18.844	17.263	-1.58	2.21
126.20	0.57	18.844	17.263	-1.58	2.15
126.30	0.56	18.844	17.263	-1.58	2.14
126.40	0.74	18.844	17.263	-1.58	2.32
126.50	0.49	18.844	17.263	-1.58	2.07
126.60	0.65	18.844	17.263	-1.58	2.23
126.70	0.79	18.844	17.263	-1.58	2.37
126.80	0.77	18.844	17.263	-1.58	2.35
126.90	0.79	18.844	17.263	-1.58	2.37
127.00	0.64	18.844	17.263	-1.58	2.22
127.10	0.55	18.844	17.263	-1.58	2.13
127.20	0.61	18.844	17.263	-1.58	2.19
127.30	0.73	18.844	17.263	-1.58	2.31
127.40	0.88	18.844	17.263	-1.58	2.46
127.50	0.86	18.844	17.263	-1.58	2.44
127.60	0.68	18.844	17.263	-1.58	2.26
127.70	1.31	18.844	17.263	-1.58	2.89
127.80	1.15	18.844	17.263	-1.58	2.73
127.90	0.55	18.844	17.263	-1.58	2.13
128.00	1.04	18.844	17.263	-1.58	2.62
128.10	1.12	18.844	17.263	-1.58	2.70
128.20	0.61	18.844	17.263	-1.58	2.19
128.30	0.79	18.844	17.263	-1.58	2.37
128.40	0.83	18.844	17.263	-1.58	2.41
128.50	0.66	18.844	17.263	-1.58	2.24
128.60	0.58	18.844	17.263	-1.58	2.16
128.70	0.54	18.844	17.263	-1.58	2.12
128.80	0.95	18.844	17.263	-1.58	2.53
128.90	2.48	18.844	17.263	-1.58	4.06
129.00	3.78	18.844	17.263	-1.58	5.36
129.10	5.19	18.844	17.263	-1.58	6.77

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
129.20	3.75	18.844	17.263	-1.58	5.33
129.30	6.21	18.844	17.263	-1.58	7.79
129.40	1.09	18.844	17.263	-1.58	2.67
129.50	0.79	18.844	17.263	-1.58	2.37
129.60	0.76	18.844	17.263	-1.58	2.34
129.70	1.22	18.844	17.263	-1.58	2.80
129.80	0.66	18.844	17.263	-1.58	2.24
129.90	0.50	18.844	17.263	-1.58	2.08
130.00	0.84	18.844	17.263	-1.58	2.42
130.10	0.77	18.844	17.263	-1.58	2.35
130.20	0.65	18.844	17.263	-1.58	2.23
130.30	0.74	18.844	17.263	-1.58	2.32
130.40	1.18	18.844	17.263	-1.58	2.76
130.50	0.85	18.844	17.263	-1.58	2.43
130.60	1.18	18.844	17.263	-1.58	2.76
130.70	0.97	18.844	17.263	-1.58	2.55
130.80	0.68	18.844	17.263	-1.58	2.26
130.90	0.56	18.844	17.263	-1.58	2.14
131.00	0.16	18.844	17.263	-1.58	1.74
131.10	0.71	18.844	17.263	-1.58	2.29
131.20	0.92	18.844	17.263	-1.58	2.50
131.30	0.66	18.844	17.263	-1.58	2.24
131.40	0.85	18.844	17.263	-1.58	2.43
131.50	0.99	18.844	17.263	-1.58	2.57
131.60	1.17	18.844	17.263	-1.58	2.75
131.70	1.13	18.844	17.263	-1.58	2.71
131.80	1.02	18.844	17.263	-1.58	2.60
131.90	0.72	18.844	17.263	-1.58	2.30
132.00	0.73	18.844	17.263	-1.58	2.31
132.10	0.95	18.844	17.263	-1.58	2.53
132.20	0.10	18.844	17.263	-1.58	1.68
132.30	0.10	18.844	17.263	-1.58	1.68

Annexure 4: Photographs along Damodar Waterway

BEGUA BAMBOO BRIDGE CHAINAGE AT 44.0 KM

KANSONA BAMBOO BRIDGE CHAINAGE AT 46.0 KM

KUMARCHAK BAMBOO BRIDGE CHAINAGE AT 47.0 KM

GOURANGACHAK MAJOR BRIDGE & HIGH TENSION LINE CHAINAGE AT 52.0 KM

MAJOR RAILWAY BRIDGE CHAINAGE AT 55.0 KM

TOKAPUR HIGH TENSION LINE CHAINAGE AT 57.0 KM

KUMRUL BAMBOO BRIDGE CHAINAGE AT 84.0 KM

BONOGRAM BAMBOO BRIDGE CHAINAGE AT 88.0 KM

BAMBOO BRIDGE CHAINAGE AT 96.0 KM

BAJE SALEPUR SAND MINING AREA CHAINAGE INAT 121.0 KM

MANIK HATI WOODEN BRIDGE CHAINAGE AT 124.0 KM

BAMBOO BRIDGE CHAINAGE AT 58.0 KM