INLAND WATERWAYS AUTHORITY OF INDIA

FINAL TECHNICAL, ECONOMIC & FINANCIAL FEASIBILITY REPORT

DEVELOPMENT OF SUNDERBANS INLAND WATERWAYS

FEEDBACK INFRA (P) LIMITED

30th March, 2017

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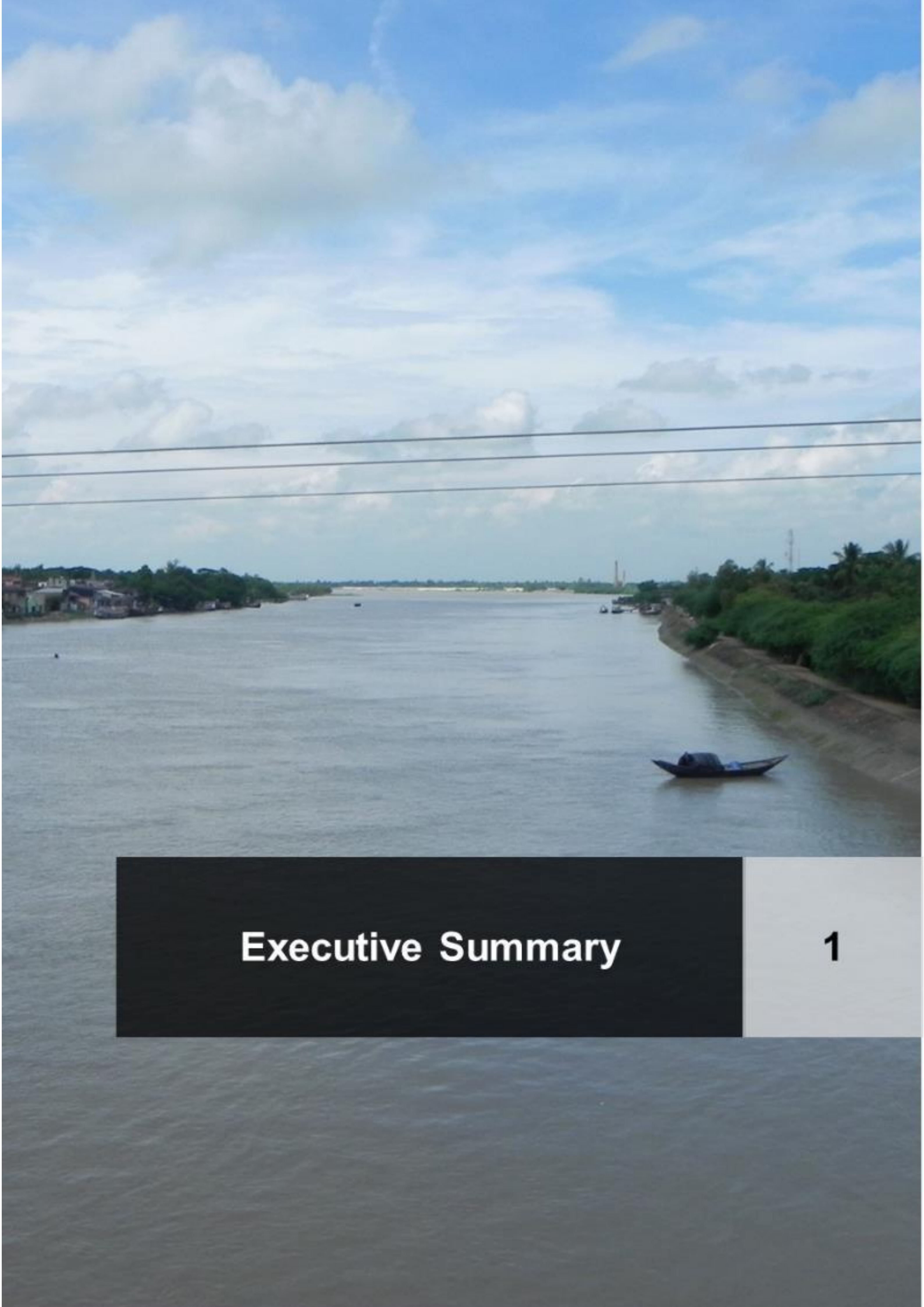
Abbreviations

ASEAN	Association of Southeast Asian Nations
BBIN MVA	Bangladesh, Bhutan, India, Nepal Motor Vehicles Agreement
BIWTA	Bangladesh Inland Water Transport Authority
CAGR	Compound Annual Growth Rate
CD	Chart Datum
CFS	Container Freight Station
CONCOR	Container Corporation of India
CRZ	Costal Regulation Zone
CSD	Cutter-Suction Dredger
CWC	Central Warehousing Corporation
DGCI&S	Directorate General of Commercial Intelligence and Statistics
DWT	Dead Weight Tons
EGL	Existing Ground Level
EPC	Engineering Procurement and Construction
EXIM	Export-Import
FCI	Food Corporation of India
FTA	Free Trade Agreement
FY	Financial Year
FYP	Five Year Plan
GDP	Gross Domestic Product
GoI	Government of India
GRT	Gross Register Tonnage
GSDP	Gross State Domestic Product
HDC	Haldia Dock Complex
HDPE	High Density Polyethylene
HP	Horse Power
ICD	Inland Container Depot
IMF	International Monetary Fund
INR	Indian Rupee
INWTG	Integrated National Waterways Transport Grid
IOCL	Indian Oil Corporation Ltd.
IRR	Internal Rate of Return
IT	Information Technology
IWAI	Inland Waterways Authority of India
IWT	Inland Water Transport
Km	Kilometre
LAD	Least Available Depth
LCS	Land Custom Station
LOA	Length Overall
LPG	Liquefied Petroleum Gas
MDONER	Ministry of Development of North Eastern Region
MDR	Major District Roads
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs

MSL	Mean Sea Level
MSME	Ministry of Micro Small and Medium Enterprises
MW	Mega Watt
NEC	North Eastern Council
NEDFi	North Eastern Development Finance Corporation Limited
NER	North East Region
NH	National Highway
NLCPR	Non-Lapsable Central Pool of Resources
NPV	Net Present Value
NW	National Waterway
ODC	Over Dimensional Cargo
ODR	Other District Roads
PIANC	The World Association for Waterborne Transport Infrastructure
POL	Petroleum, Oils, Lubricants
RCC	Reinforced Cement Concrete
RMG	Ready made Garments
RoRo	Roll-on/Roll-off
RTK	Rover and Total Station
SAARC	South Asian Association for Regional Cooperation
SH	State Highway
SOP	Standard Operating Procedures
SPT	Standard Penetration Test
SWOT	Strengths Weaknesses Opportunities Threats
TBM	Temporary Bench Mark
TCI	Trade Complementarity Index
TEU	Twenty-Foot Equivalent Unit
TSHD	Trailing Suction Hopper Dredger
UNESCO	United Nations Educational Scientific and Cultural Organization
UTM	Universal Transverse Mercator
VAT	Value Added Tax
WGS	World Geodetic System
WWF	World Wide Fund for Nature



Executive Summary

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1 Executive Summary

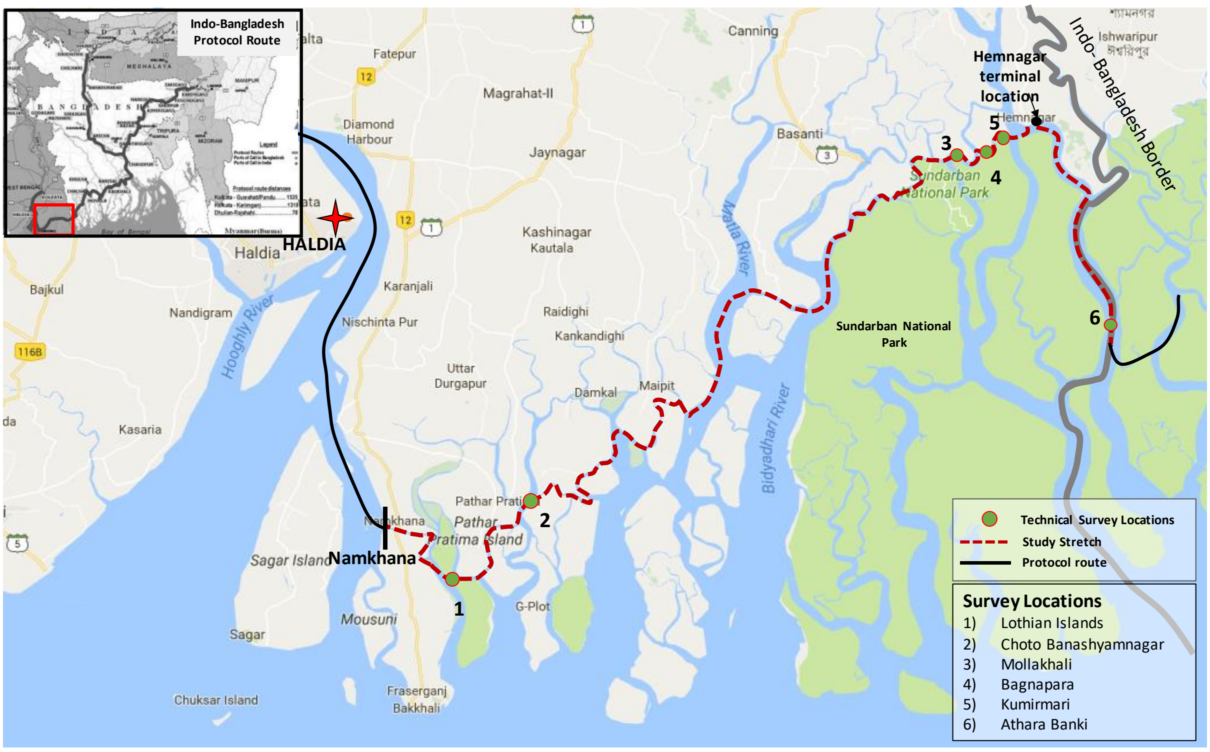
1.1 Introduction

Inland Waterway Authority of India (IWAI) has identified Sunderbans Waterways as one of the important routes for development as it provides the following essential connectivity options:
(A) International connectivity to Bangladesh – improving trade relations with Bangladesh,
(B) Transit to North-eastern states – providing shorter / cheaper transport options for cargo movement, and
(C) Travel within Sunderbans – enhancing connectivity and economic development of the local populace.

For commissioning the development of the waterways, IWAI intends to ascertain the technical, traffic, economic, social and financial requirements of the project. IWAI has selected Feedback Infra (P) Limited for 'Preparation of Technical Economic Feasibility Report for Development of Sunderbans Inland Waterways'.

As part of the mandate, technical surveys have been conducted at six identified stretches (study stretch) and on the proposed terminal site at Hemnagar as shown in the following figure. For assessment of traffic potential through the stretch, traffic assessment of the Indo-Bangladesh Protocol Route has been undertaken as Sunderbans Waterways forms part of the Protocol Route.

Figure 1: Sunderbans Waterways – Study Stretch



This document is the Final Technical, Economic and Financial Feasibility Report, which is the third output to be submitted by Feedback as a part of project engagement. It covers the transport economic & market analysis, technical investigation & analysis, financial analysis and preliminary design of proposed infrastructure at Hemnagar Terminal for the project.

1.2 Sunderbans – Overview

Sunderbans delta is shared between India and Bangladesh and is situated on the lower end of the Gangetic West Bengal. The total area of Sunderbans is ~ 10,000 sq km[1], of which 4,200 sq km[2] lies within the Indian Territory.

[1] World Heritage Convention, UNESCO (2016)
[2] http://www.sunderbans.in/Sunderbans.php, Department of Tourism, West Bengal

Indian Sunderbans Delta encompasses over two districts of West Bengal – majorly situated in South 24 Parganas southern district while some part lies in southern part of North 24 Parganas. The population of South 24 Parganas is 8,161,961[3]. Majority of working population in South 24 Parganas is employed in the primary sector (with occupations such as agriculture, fishing, extraction of honey and pisciculture).

The primary mode of transport in the region is roads, but due to difficult physiography, there is limited road connectivity at many regions within Sunderbans. Thus, the passenger and cargo movement is solely dependent on waterways beyond certain connected centres such as Canning, Sonakhali, Basanti and Godhkhali.

Due to limited connectivity and dependence on primary sector for employment, the per capita income of the district is considerably lower than that of West Bengal. **Dispersed urban settlements and low economic development in the region enhance the need to tap the huge potential for adopting waterways as a preferred mode of transportation**.

1.3 Sunderbans Waterways – Technical Assessment

Survey Locations

As a part of the technical assessment, existing navigational charts of the study areas (from Namkhana to Athara Banki) and survey locations were reviewed from River Navigation Atlas of Sunderbans Waterways (2012). The technical investigations (bathymetric, tidal, current velocity & discharge measurement and water & bottom samples surveys) were conducted at the following 6 survey locations as per the mandate.

Table 1: Coordinates of Hydrographic Survey Area

Survey Location	Geographic Coordinates		Area	
	Latitude	Longitude	Length (m)	Width (m)
Choto Bhanshyamnagar	21°47'19.94"N 21°47'42.49"N	88°23'29.90"E 88°23'59.73"E	1120	1150
Lothian Island	21°42'07.36"N 21°42'29.35"N	88°17'55.59"E 88°18'09.16"E	760	250
Kumirmari	22°11'26.55"N 22°11'24.57"N	88°56'50.94"E 88°57'03.88"E	380	270
Bagnapara	22°10'45.22"N 22°10'50.94"N	88°56'06.51"E 88°56'12.42"E	250	310
Mollakhali	22°10'26.25"N 22°10'21.22"N	88°54'01.82"E 88°54'10.35"E	290	850
Atharabanki	21°58'59.23"N 21°58'07.67"N	88°04'47.49"E 88°04'31.39"E	1670	2200

[3] Census of India, 2011

Hydrographic Survey and Soil Testing Results

Table 2: Bathymetric Survey Results

Survey Location	Min. Depth w.r.t CD	Location		Max. Depth w.r.t CD	Location	
		Easting (m)	Northing(m)		Easting (m)	Northing(m)
Chotto Bhanshyamnagar	0.3	644 080.60	2 410 158.30	1.5	644 082.28	2 411 410.21
Lothian Island	0	634 478.53	2 400 498.70	8.3	634 405.02	2 400 362.35
Kumirmari	2.6	701 157.52	2 455 281.61	3.9	701 143.44	2 455 090.64
Bagnapara	1.3	699 819.70	2 454 078.55	4.9	699 505.84	2 454 137.06
Mollakhali	9.8	695 917.56	2 452 829.74	13.5	696 238.64	2 453 492.40
Athrabanki	0.1	714 470.00	2 432 386.26	1.8	716 073.86	2 431 286.71

Table 3: Tide Measurement Results

Survey Location	Max Tide Level (m) w.r.t CD	Min Tide Level (m) w.r.t CD
Chota Banshyamnagar	3.45	1.64
Lothian Island	4.96	4.46
Bagnapara	4.047	2.757
Mollakhali	4.191	3.081
Hemnagar	5.036	1.986

Table 4: Current Velocity and Discharge Measurement Results

Survey Location	Position		Depth (D) in m w.r.t CD	Velocity (m/sec)				Average velocity (m/sec)	Discharge (m^3/sec)
	Easting	Northing		Surface	0.3 D	0.5 D	1 D		
Choto Banashyamnagar	644153.81	2410933.69	7	0.782	0.723	0.679	0.454	0.659	1996.375
Lothian Island	634558.68	2400862.48	7	0.497	0.478	0.410	0.325	0.427	79.764
Kumirmari	700912.92	2455199.17	5	0.512	0.272	0.712	0.581	0.519	313.424
Baganapara	699578.02	2454192.96	12	0.365	0.223	0.224	0.237	0.262	254.926
Mollakhali	696155.33	2453363.65	8	0.216	0.104	0.453	0.359	0.283	1278.481
Atharabanki	715508.86	2431530.86	20	0.460	0.299	0.122	0.080	0.240	6584.194

Table 5: Current Meter Measurement Results

	Max Current Velocity (m/s)		Min Current Velocity (m/s)	
Survey Location	Velocity in m/s	Depth (m) w.r.t CD	Velocity in m/s	Depth (m) w.r.t CD
Choto Banashyamnagar	0.8	Surface	0.4	5.5
Lothian Island	0.5	Surface	0.3	6
Kumirmari	0.6	2.5	0.1	1.5
Baganapara	0.4	Surface	0.1	6
Mollakhali	0.5	8 m	0.1	2.4
Atharabanki	0.5	Surface	0.1	2

Table 6: Water Samples Results

Survey Location	Avg. pH	Avg. Specific Gravity	Avg. Sediment Concentration % by Mass
Choto Banashyamnagar	7.2075	1.010675	0.000241
Lothian Island	7.29	1.013148	0.000174
Kumirmari	7.2975	1.007923	0.00013575
Baganapara	7.32	1.004763	0.00006725
Mollakhali	7.3875	1.008659	0.000095
Atharabanki	7.335	1.008202	0.0001845

Table 7: Soil Samples Results

Survey Location	pH	Specific Gravity	Grain size Distribution			Uniformity Coefficient (Cu)	Coefficient of Curvature (Cc)
			Gravel (%)	Sand (%)	Fine (Silt+Clay)%		
Choto Banashyamnagar	6.81	1.51	1.54	21.17	77.29	1.72	1.03
Lothian Island	6.89	1.39	1.60	27.86	70.54	3.40	0.94
Kumirmari	6.75	1.54	1.70	25.06	73.24	1.83	0.72
Baganapara	6.71	1.50	3.25	13.05	83.70	3.49	1.09
Mollakhali	7.10	1.52	1.0	2.0	79.0	2.10	0.25
Atharabanki	7.21	1.75	3.0	38.34	58.65	3.23	0.48

The results display considerable shoal formation and sedimentation at the survey locations. However, as there is significant tidal influence with minimal velocity, navigation through waterways is possible during high tide. The sedimentation analysis indicates significant proportion of fine particles (silt and clay).

Geotechnical Survey

Geotechnical and topographic surveys were conducted at the proposed Hemnagar Terminal. Two boreholes were carried out at Hemnagar jetty locations and the field ‘N’ values vary from 1 to 23 and 1 to 28 in the Borehole 01 and Borehole 02 respectively. The sub-soil at the site locations can be broadly classified into 5 different strata up to the maximum depth of exploration of 25 m.

Topographical Survey

The site has a fairly flat terrain (topography details available in annexure) with maximum / minimum heights in the two survey areas as indicated in the following table.

Table 8: Topographic Survey Results

Levels	Western Survey Area			Eastern Survey Area		
	Value	Easting (m)	Northing (m)	Value	Easting (m)	Northing (m)
Maximum	5.84	704387.55 E	2457019.88 N	5.4	704537.55 E	2456989.88 N
Minimum	0.48	704537.55 E	2456979.88 N	1.2	704557.83 E	2456949.96 N

1.4 Sunderbans Waterways – Existing Infrastructure and Traffic Assessment

1.4.1 Movement within Sunderbans

Traffic

There is considerable amount of passenger movement within Sunderbans as there is minimal road connectivity and due to presence of several tourist spots. This movement is by ferry across rivers, on short stretches along rivers and for tourism-based passenger traffic (cruise).

The major market areas are concentrated in Gosaba, Basanti, Sonakhali, Godhkhali, Dhamakhali, Kumirmari and Dugdugi. The people travelling to these market areas from nearby villages (Pathankhali, Chandipur, Raidighi and Sajalia) use the ferry services on a daily basis for travel.

Boat operators carry essential commodities primarily from Sonakhali market area to other market centres and population nodes. The type of commodities majorly include essential commodities such as vegetables, rice, wheat flour, maida flour, biscuits and chips and construction material such as cement (Ambuja Cement, ACC, Birla).

Infrastructure

There are multiple boat operators in the Sunderbans region who provide ferry services for passenger and commodity movement. There is also a jetty available Godhkhali (near Canning), which is the starting point of the boat journey for tourists to Sunderbans. Across the region, there are multiple small jetties used for passenger handling.

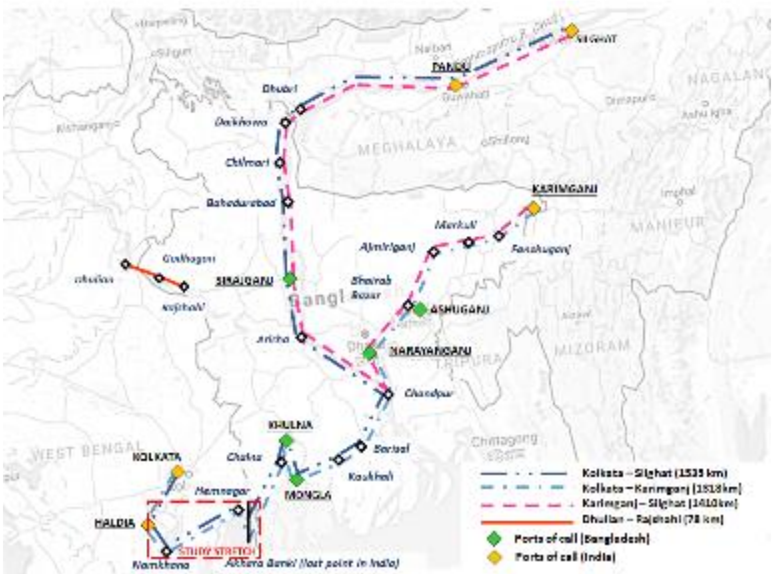
1.4.2 Movement on Indo-Bangladesh Protocol Route

Overview

In 2015, the countries decided to further strengthen trade relations and better utilize the protocol routes. The Protocol on Inland Water Transit and Trade was signed in June, 2015 and it was mutually decided to renew the Protocol automatically after every five years.

Out of the protocol routes identified by the Agreement (as captured in map below), **the Kolkata-Silghat route and Kolkata-Karimganj are relevant for the current mandate** as they traverse through the Sunderbans Waterways (and the study stretch).

Figure 2: Indo - Bangladesh Protocol Routes



Traffic

The movement on the protocol route can be classified into trade and transit traffic as explained below.

- Trade Traffic
  - The volume of goods transported through the protocol routes has increased at a CAGR of 15% from 0.54 million tons in 2006 to 1.91 million tons in 2015.
  - Currently, majority of the international cargo exported by India to Bangladesh constitute of Fly ash, Slag, Clunkers and Gypsum. These products are raw materials to cement industries and other manufacturing industries in Bangladesh.
  - As per the 2015 press release by the Ministry of Shipping (India), Fly-ash contributes ~98% of the movement through the protocol routes, majorly utilized by large cement industries in Bangladesh (Holcim Cement Ltd, Lafarge, etc). This movement is majorly from the Kolkata cluster (power plants in Kolaghat and Bandel) to various river ports in Bangladesh.

- Transit Traffic
  - India uses the Indo-Bangladesh river protocol to transport essential commodities including fuel (diesel and petrol), food grains (rice and pulses), iron rods, etc. to Tripura and other north-eastern states. The commodities are majorly transshipped through Ashuganj port (on Kolkata-Karimganj route) and moved through road to the north-eastern states. Pre-dominantly, the Food Corporation of India (FCI) uses the route for essential supply to the north-eastern states.
  - Currently, cargo between Assam and mainland India is through by both road and rail. For transit between Assam and other North-Eastern states is done through road only.
  - The current traffic on protocol route is only when some incidents hamper connectivity to the north-eastern region through the NH-8 (Assam-Agartala Highway). This is because the Indo-Bangladesh Protocol Agreement has recently been renewed to facilitate the movement to North-East via waterways. Prior to this agreement, the transit of commodities used to happen only on a case basis as initiated by the governments of both the countries. Thus, the traffic a typical year is less than ~10,000 tons and varies depending on the occurrence of maintenance works / incidents.

Infrastructure

The infrastructure facilities available at Kolkata and Haldia are given below.

Table 9: Infrastructure Facilities at Kolkata and Haldia

Particulars	Kolkata-G.R. Jetty-2	Kolkata-BISN Jetty & G.R. Jetty-1	Haldia
Berth Length	105 m (70 m, 35 m)	35 m	105 m
Waterfront Size	210 sqm	210 m	165 m
Open Storage Area	4,069 sqm	17,028 sqm	8,500 sqm
Covered Storage Area	1,200 sqm	-	400 sqm
Link Approach Road / Rail	2 km SH / 3 km	2 km SH / 3 km	6 km / 2.5 km
Water / Lighting Facilities	Drinking water / Sodium vapour lamps	Drinking water / Sodium vapour lamps	Drinking water / Sodium vapour lamps

There are limited cargo handling facilities available at Kolkata and Haldia Ports except for handling fly-ash. The movement of fly-ash is primarily done through Haldia Port and other commodities (such as fertilizers and general cargo) move via Kolkata Port. The facilities that are available at Hemnagar Terminal include an IWAI regional office, customs office, mooring facility for ships carrying cargo in Bangladesh and a passenger jetty.

1.5 Assessment of Traffic Potential

For the assessment of traffic, trade and transit movements have been considered because of the significant potential they hold for traffic on the protocol route.

1.5.1 Trade Traffic

Overview

Indo-Bangladesh trade has experienced growth at a CAGR of ~23% (2010-16), with total trade amounting to INR ~440 billion. This has been driven by factors such as overall growth in Bangladesh, trade complementarity and government initiatives such as Agreement on Coastal Shipping, BBIN MVA (Bangladesh, Bhutan, India, Nepal Motor Vehicles Agreement) and renewal of the bilateral trade agreement.

Logistics Movement

As per the overall modal split of trade between the two countries, 54% of commodities moved via sea, 40% by road and 6% by air in 2015. The value share of West Bengal in the total Indo-Bangladesh trade was 42% in 2015. For Sunderbans waterways, the relevant traffic will be the traffic diverted through Kolkata. The modal split of trade through the state is shown in the following table.

Table 10: Modal Split of trade through West Bengal [4]

Mode	Export Share by Value	Import Share by Value	Total Share by Value
Land	**92%**	**98%**	**93%**
Petrapole	78%	83%	79%
Kotwaligate	5.4%	4.5%	5%
Ghajadanga	4.5%	10%	6%
Hili	4%	0.3%	3%
Sea (Kolkata Port)	**6%**	**2%**	**5%**
Air (Kolkata Airport)	**2%**	**-**	**2%**

Owing to increased pressure on road transport and unavailability of rail transport, waterways has emerged as a potential option to enhance trade between the two countries. This has been supplemented by the renewal of the Indo-Bangladesh Protocol on Inland Water Transit & Trade and focus of the government on development of waterways.

Key Issues

The major issues with the current transportation system are as follows:

- Infrastructure Constraints – All LCSs are reported to have infrastructural problems that hinder smooth flow of traffic between the two countries. Narrow and poorly maintained roads coupled with administrative bottlenecks cause delays in transit. Petrapole, which is the major land custom station, has insufficient handling facilities and can clear only ~200-300 trucks daily (as compared to 800-1000 trucks that arrive at the port)
- Delays – The two major bottlenecks along the Indo-Bangladesh trade route are Petrapole land port and Padma river crossing primarily due to infrastructure and operation constraints. Also, Indian trucks are not allowed to carry cargo in Bangladesh and vice versa. Consequently, cargo is shifted from Indian trucks to Bangladesh trucks which further adds to the cost and travel time.
- Other administrative issues – There are other problems such as inadequate water and sanitation facilities, security risks, lack of government warehouses, frequent worker strikes, common gate for imports, exports and passengers, poor power connectivity, frequent power cuts and untrained operators for electronic data interchange.

Opportunities for Waterways

A cost comparison for road and waterways for four key routes, namely Kolkata-Dhaka (Narayanganj), Kolkata-Khulna, Kolkata-Mongla, and Kolkata-Sirajganj is given as follows. The charges do not include any custom and other government charges as these are assumed to be similar across all transportation modes.

[4] Directorate General of Commercial Intelligence and Statistics (DGCI&S)

Figure 3: Route Analysis

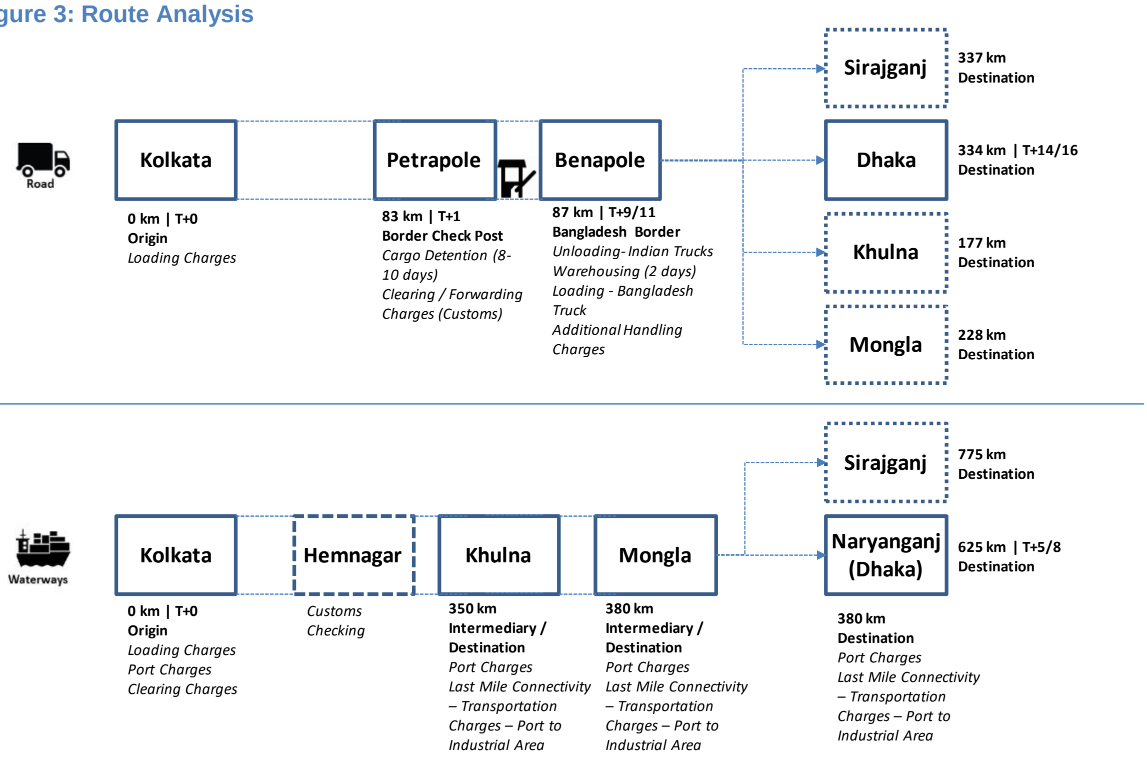


Table 11: Modal Cost Comparison

Route	Road		Waterways	
	Route Length (km)	Cost (INR / tonne) (16 MT-12 MT Truck)[5]	Route Length (km)	Cost (INR / tonne)
Kolkata – Dhaka	334	**6,000-7,000**	625	**3,200**
Kolkata – Khulna	177	**5,150-5,950**	350	**2,400**
Kolkata – Mongla	228	**5,400-6,300**	380	**2,500**
Kolkata - Sirajganj	337	**6,000-7,150**	775	**3,650**

Considering the barges currently plying on the route and based on the current tariff structure of IWAI & BIWTA and existing barge hire charges, the break-down of the total transportation cost on the Kolkata-Dhaka route via waterways and road is shown in the following table.

[5] Logistics cost via road has been calculated for a truck with design capacity of 12 MT. However, there is the market practice to overload the truck up to 16 MT and hence, cost has been computed accordingly.

Table 12: Modal Cost Comparison on Kolkata-Dhaka route under current tariff structure

Mode	Logistics Cost (INR / tonne)
Road	**6,000-7,000**
Waterways	**3,217**
First Mile Connectivity (INR 17,000 per truck till Haldia)[6]	**964**
IWAI	**17**
Fairway Charges (INR 0.02 per GRT per km)	13
Vessel related Charges (INR 1,750 per barge)[7]	1
Cargo related Charges (INR 1 per ton)	1
Equipment Hire Charges (INR 2,500 per crane for 8 hrs)	2
Barge Operators	**1,800[8]**
Bangladesh Port Authority (terminal)	**30**
Last Mile Connectivity (including handling)[9]	**406**

It is observed that while the length of waterway route is considerably longer, the transportation costs are significantly lower as compared to transportation via roads. It should also be noted that the transportation time via waterways is lesser (5-8 days via waterways compared to 14-16 days via road) despite low achievable speeds in waterway transport. The waterways costing for Kolkata-Dhaka route under the current and proposed scenarios is shown in the following table. These costs have been estimated based on no cargo return journey.

Table 13: Waterways Costing for Kolkata – Dhaka Route – Barge Economics

Particulars	Current Scenario	Optimised Scenario
Volume of Cargo (ton)	1,500	1,500
Capacity of Vessel (ton)	1,500	1,500
Distance	625	625
Speed (km / h)	10	10
Travel Time (hrs)	63	63
Total Duration in Days (including handling)	8	5
Vessel Hiring Charges per day (INR)	36,000	36,000
Operating Charges per day (INR)	16,000	16,000
Fuel Charge (per L)	61.5	61.5
Diesel Consumption (L/hr)	80	80
Total Vessel Hiring Charges (INR)	2,88,000	186,000
Total Operating Charges (INR)	1,28,000	82,667
Total Fuel Charges (INR)	3,07,500	307,500
Misc.	16,641	13,252
Total Cost	**7,40,141**	**589,419**
Total Cost (including profit @20%)	**8,88,169**	**707,302**
Cost per ton	592	472
Cost per ton per km for two-way trip	**1.9**	**1.5**

With the improvements in waterway infrastructure and reduced travel time, the barge economics would improve in the future as reflected in the optimised scenario.

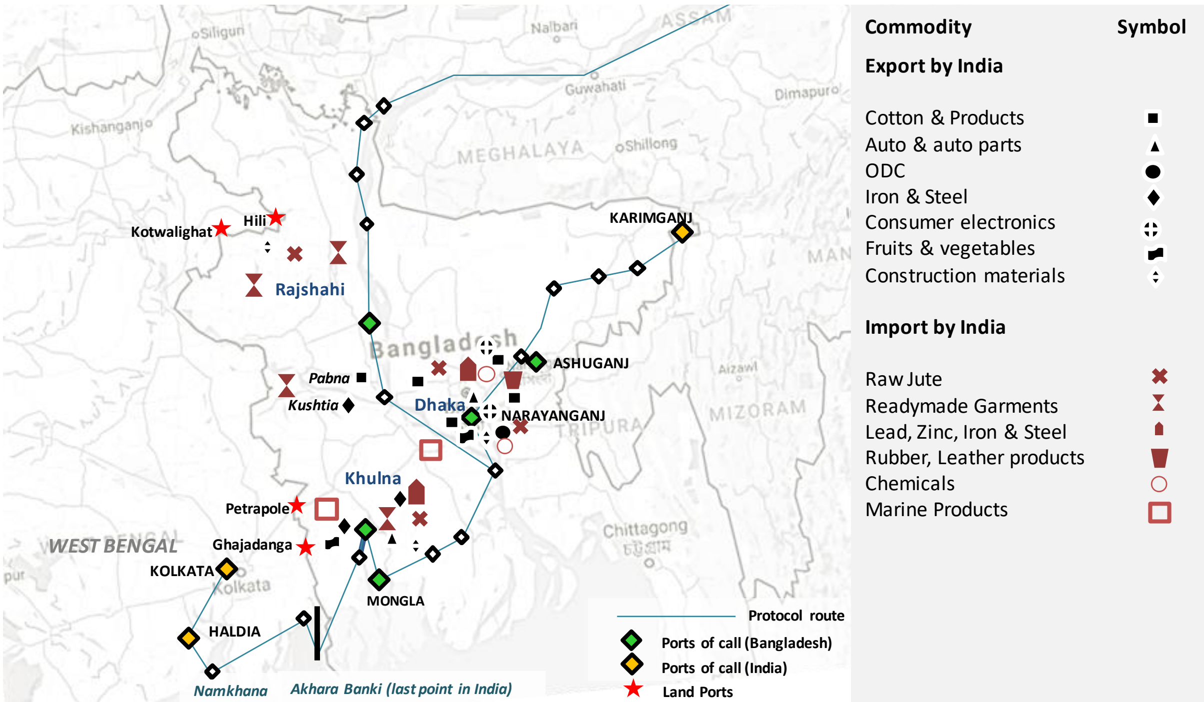
[6] For travel from Kolkata to Haldia port (~50 km) including loading / unloading at port
[7] Berthing Charges: INR 1000 for 24 hrs; Pilotage: INR 750 per pilot
[8] Prevailing Market Rates
[9] For travel from Narayanganj to Dhaka Industries (~30 km) including loading at port / unloading

Thus, the above analysis indicates that waterways has immense potential due to its numerous benefits such as economic feasibility and time savings.

Commodity Movement

The relevant catchment centres include the major administrative divisions in Bangladesh such as Khulna (districts of Khulna, Kushtia and Jessore), Dhaka (districts of Dhaka, Narayanganj, Gazipur and Narsingdi) and Rajshahi (districts of Rajshahi, Pabna, Bogra and Jaipurhat). The movement of major commodities between India and Bangladesh is shown in the following map.

Table 14: International Trade between India and Bangladesh



- **Export Traffic**
    - Essential commodities such as fruits, vegetables, spices & oils and consumer electronics & tools are imported by population nodes in Khulna, Dhaka and Rajshahi.
    - Raw cotton acts as a raw material for its textile industry which is mainly concentrated in Dhaka. Auto and auto parts are imported by renowned automobile companies engaged in manufacturing, assembling and repairing motor vehicles in Dhaka.
    - The products made up of iron and steel are required by many industries involved in manufacturing, construction, infrastructure, assembling, automobile, shipbuilding etc. in Bangladesh. There has been a growing demand for construction material in Bangladesh for the numerous upcoming infrastructure projects

- **Import Traffic**
    - Readymade garments form a significant portion of the Indian imports from Bangladesh, which employs 4.2 million Bangladeshis in this sector. Leather industry is the second largest export oriented industry in Bangladesh with exports of $1.13 billion in FY 15.
    - The Ganges delta is responsible for more than 70% of world's jute production with Bangladesh's production in FY 14 at ~1.4 million tons (MT), thus serving as a major jute exporter. Lead, zinc, iron and steel are exported by various iron and steel manufacturing companies located in Rajshahi, Dhaka and Khulna. The Bangladesh chemical industry provides valuable inputs for other industries such as textiles, paper, paints and varnishes, leather, personal care, construction, automotive and agro-chemicals in India.

The commodity wise value of trade between India and Bangladesh for 2015 is given in the following table.

Table 15: Value and Volume of trade between India and Bangladesh in 2015 (Through West Bengal)[10]

Commodity Group	Value (in INR cr)	Volume
Exported by India	**12,962**	**3,355,200 tons 64,100 TEUs**
Cotton & Products	5,408	293,384 tons
Over Dimensional Cargo	3,371	51,298 tons
Iron & Steel	1,172	480,197 tons
Foodgrains & Spices	340	108,902 tons
Flyash	-	2,260,803 tons
POL (Liquid Bulk)	547	160,616 tons
Electronics, Tools & Instruments	564	37,333 TEUs
Processed food / fruits & vegetables	136	700 TEUs
Auto & Auto Parts	1,424	26,040 TEUs
Imported by India	**2,987**	**362,100 tons 13,700 TEUs**
Raw Jute	1,817	341,489 tons
Lead, Zinc, Iron & Steel	171	14,433 tons
Rubber, Leather & Its Products	116	6,055 tons
Readymade Garments	791	11,347 TEUs
Chemicals	46	1,668 TEUS
Marine Products	46	542 TEUs

Future potential of trade with Bangladesh

Bangladesh is one of the fastest growing economies in the world with a consistent GDP CAGR of ~6% over the last decade, mainly driven by exports, remittances and leveraging of abundant workforce. The growing middle class will lead to growth in the consumer product industries like foodstuffs, consumer durables, electronic products, power and information technology in the private sector. On the other hand, in the public sector, there are large government investments planned towards infrastructure development which indicates that industries such as construction materials, utilities and essential goods hold immense potential for growth. Various initiatives and plans of major industries in Bangladesh indicate the scope of sustained trade potential between the two countries.

1.5.2 Transit Traffic

Overview

The Northeast region of India is endowed with huge untapped natural resources and includes the seven states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. There is substantial potential that exists in the Northeastern Region for its renewable natural resources to generate benefits at the regional and local levels.

Logistics Movement

In the North-eastern region, entire movement via roadway and railway materializes via the Siliguri Corridor, also called as ‘Chicken’s Neck’ which is an awkward choke point in India’s contemporary geography. Broad gauge rail connectivity is primarily till Assam. Recently (in 2016), operations on broad gauge till Agartala have commenced but connectivity to other North-eastern states is heavily dependent on road.

Key Issues

The major issues with the current transportation system are as follows:

[10] DGCI&S and Feedback Estimates

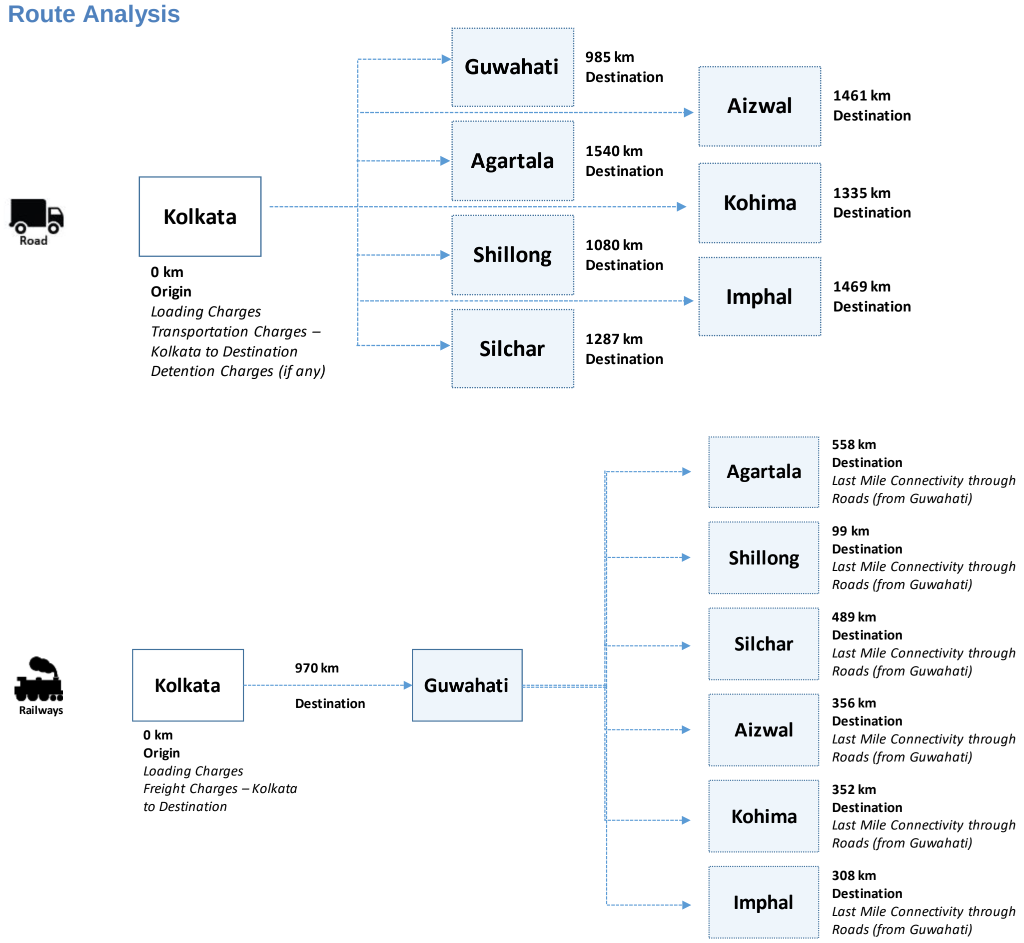
- Infrastructure Constraints – There is poor infrastructure and inadequate connectivity, both within the region as well as with the rest of the country. Chicken's Neck needs infrastructure in terms of road / rail connectivity to support and safeguard significant investments and developmental aids.
- Instability & Topography of the region - The severe topography of the region makes the railway and roads subject to damage from recurrent landslides and natural disasters

Opportunity for Waterways

North-east regions can be quicker accessed via Bangladesh as it avoids the long route via the Chicken's Neck. This provides a unique opportunity for reliable transport, quicker and cheaper mode of transportations. The protocol agreement provides scope for travel to north-east region via Bangladesh through waterways.

A cost comparison for road, railways and waterways for four key routes, namely Kolkata-Guwahati, Kolkata-Agartala, Kolkata-Shillong, and Kolkata-Silchar is given as follows. The charges do not include any custom and other government charges as these are assumed to be similar across all transportation modes.

Figure 4: Route Analysis



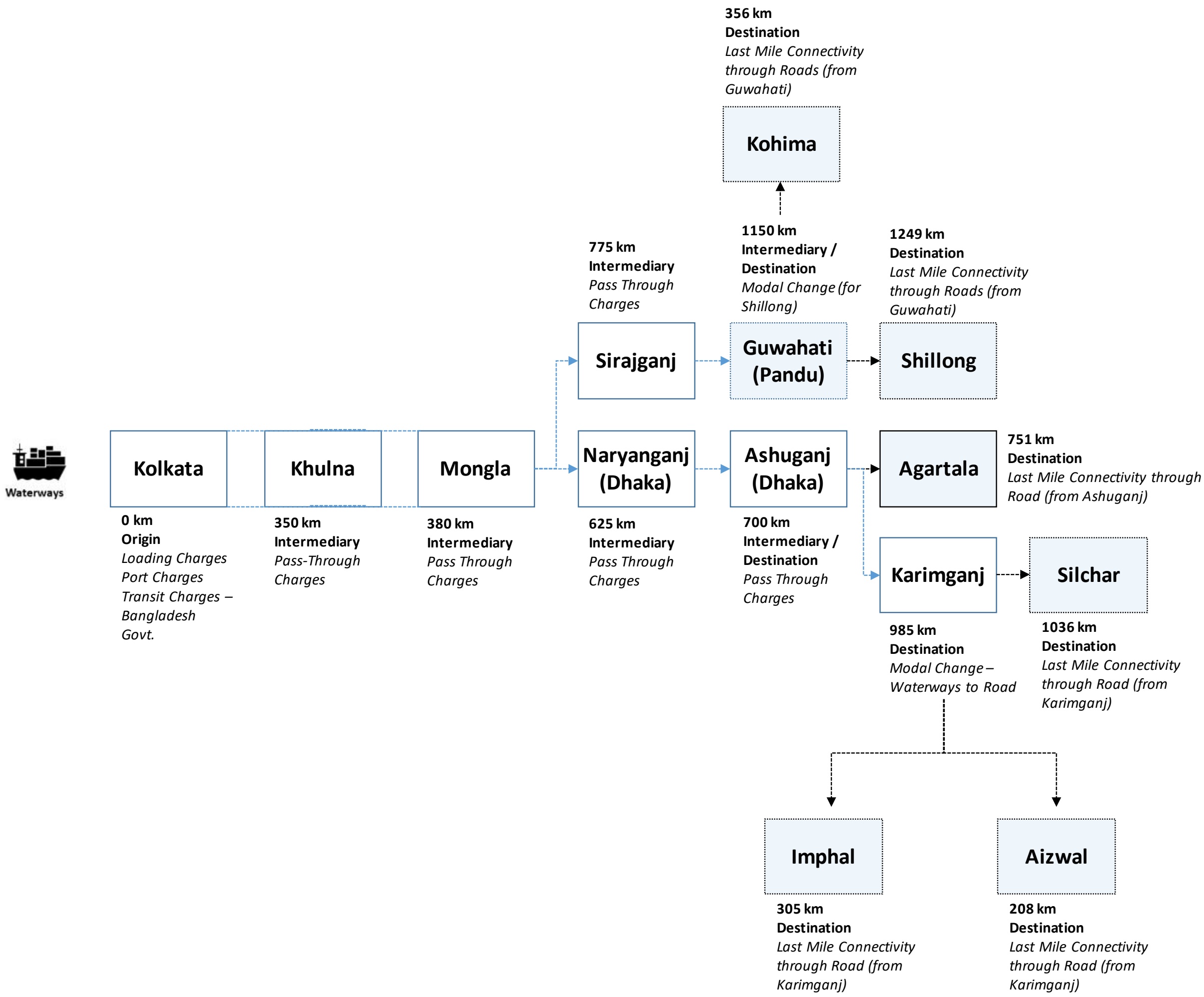


Table 16: Modal Cost Comparison

Route	Road		Railways		Waterways	
	Route Length (km)	Cost (INR / tonne) (16-12 MT truck)[11]	Route Length (km)	Cost (INR / tonne)	Route Length (km)	Cost (INR / tonne)
Primary Catchment						
Kolkata – Agartala[12]	1,540	6,550-8,600	1,528	4,015	751[13]	3,844
Kolkata – Imphal[14]	1,469	6,300-8,250	1,459	3,724	1,290[15]	5,740
Kolkata – Aizwal[11]	1,461	6,300-8,200	2,016	3,183	1,193[13]	5,367
Kolkata – Silchar[12]	1,287	5,500-7,300	1,278	2,960	1,036[15]	4,709
Kolkata – Shillong[11]	1,080	4,700-6,150	1,069	2,078	1,249[16]	5,417
Secondary Catchment						
Kolkata – Kohima[11]	1,335	5,700-7,500	1,326	3,162	1,506[16]	6,460
Kolkata – Guwahati	985	4,300-5,600	970	1,660	1,165[16]	5,076

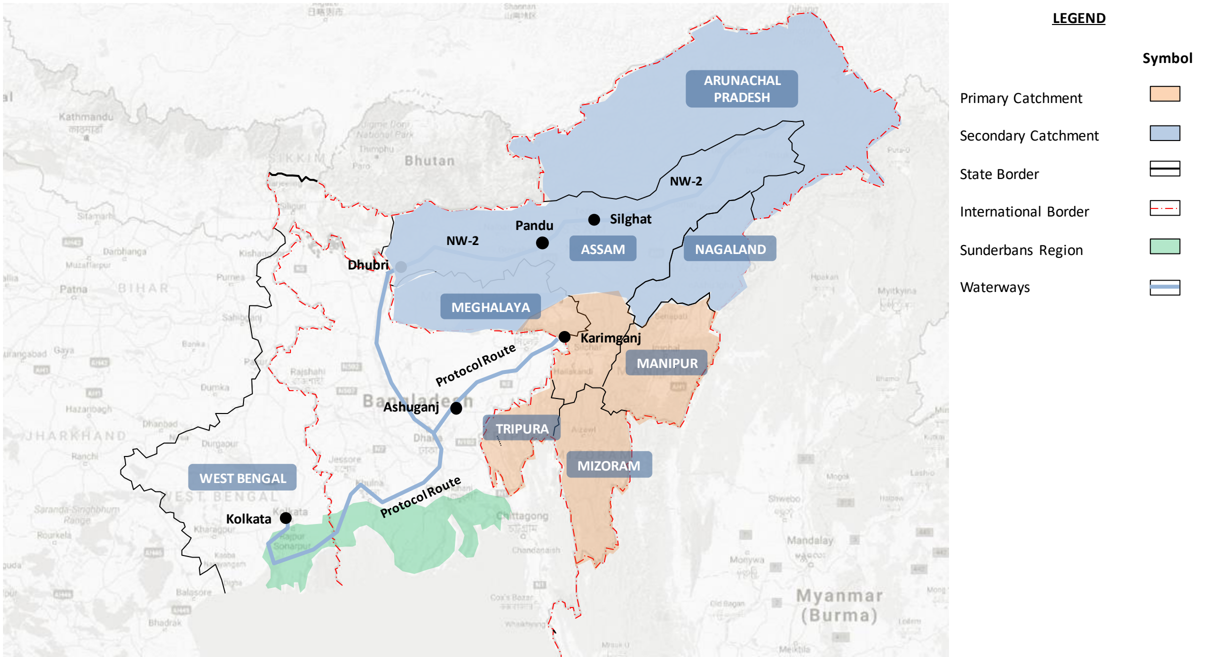
[11] Logistics cost via road has been calculated for a truck with design capacity of 12 MT. However, there is the market practice to overload the truck up to 16 MT and hence, cost has been computed accordingly.
[12] For Guwahati, direct railways cost has been considered. Although, the railway network till Silchar and Agartala has been recently commissioned, modal cost has been calculated by considering rail transport till Guwahati and last mile connectivity by road.
[13] For these routes, waterway till Ashuganj has been considered
[14] For these states, modal cost has been calculated by considering rail transport till Guwahati and last mile connectivity by road.
[15] For these routes, waterway till Karimganj has been considered
[16] For these routes, waterway till Pandu (Guwahati) has been considered

Based on logistics costs, the opportunity for waterways can be divided into the following catchments.

- **Primary catchment (Southern Assam, Tripura, Meghalaya, Mizoram and Manipur)**
  - As seen from the above table, these regions offer significant cost advantages (50%-100% reduction in costs) as compared to road.
  - While direct railway mode is cheaper, the infrastructure availability in these regions is limited. Major cargo movement is from rail till Guwahati and last mile is provided through road. Connectivity through road is also hampered during landslides / heavy monsoons.
  - Based on the above, these regions have been identified as primary catchment areas for transport through waterways (through Ashuganj and Karimganj ports)

- **Secondary catchment (Assam, Arunachal Pradesh and Nagaland)**
  - These regions have similar / lesser distances from road /rail as compared to waterways and there are no major cost savings through waterways. Also, the country risk (traversing through foreign nation) for similar costs / time shifts the preference towards using conventional modes instead of the protocol route
  - Direct rail connectivity is much cheaper and is predominantly utilized due to strong rail linkages. Additionally, capturing traffic on this route is dependent on the operational success / navigability of NW 2 (Dhubri to Sadiya).
  - For the purposes of this study, this catchment has not been considered for assessment of traffic

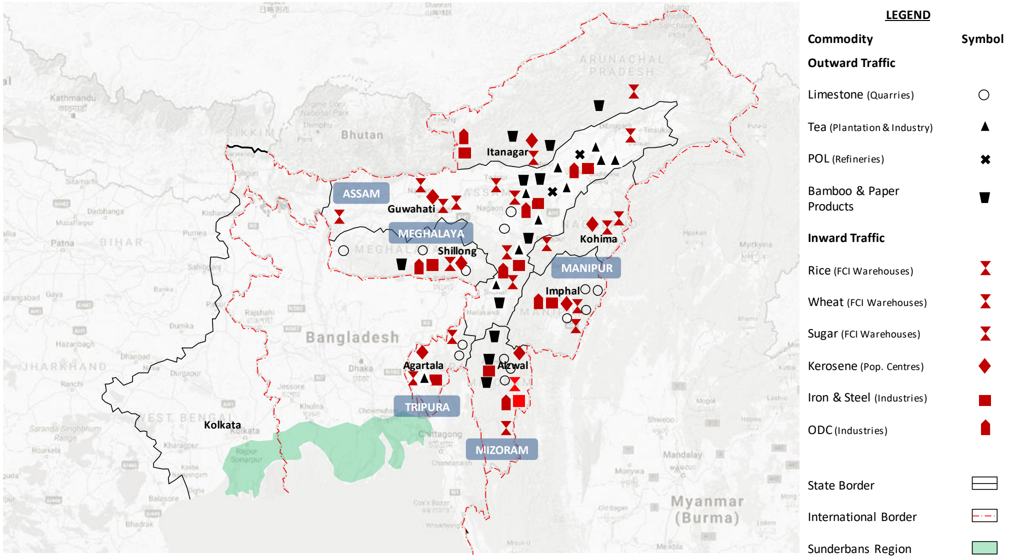
Figure 5: Inland waterways transit catchment & route to North Eastern Region



Commodity Movement

The map below represents the North-Eastern region with the primary and the secondary catchment for transit traffic movement between hinterland states of India and north-eastern states of India via protocol route and National Waterway – 2. The outward and inward traffic movement of major transit commodities between India's North-Eastern states and India's hinterland states is shown in the following figure.

Figure 6: Outward and Inward Traffic Commodities[17]



- **Inward Traffic**
  - Limestone – Huge limestone reserves are present in Meghalaya and Assam. These products are sent to India's hinterland states such as Bihar, Jharkhand, Madhya Pradesh, Uttar Pradesh and West Bengal as a raw material for the cement manufacturing plants.
  - Tea – Assam is world's one of the largest tea-growing region exports tea to PAN India.
  - Bamboo & Paper Products – Cachar Hills in Assam have abundant bamboo and paper products which are exported to hinterland states like Madhya Pradesh, Haryana, Jharkhand, Maharashtra, Orissa, Uttarakhand, Uttar Pradesh and West Bengal.
  - POL – Assam has abundance of petroleum, oils and lubricants reserves and exports these products to hinterland states like Bihar, Haryana, Jharkhand, Orissa, Uttar Pradesh and West Bengal.

- **Outward Traffic**
  - Rice, Wheat & Sugar – Assam, Manipur, Mizoram, Nagaland and Tripura import rice & wheat from states such as Haryana, Punjab and West Bengal. Assam and Nagaland import sugar from hinterland states with high sugarcane production such as Gujarat, Karnataka, Madhya Pradesh, and Maharashtra.
  - Iron & Steel Products – Assam imports these products from Chattisgarh, Delhi, Jharkhand and Orissa for industries involved in construction, automobile, ship building, heavy and light machinery etc.
  - Over Dimensional Cargo – These are imported by all of India's North Eastern states such as Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura as finished goods for various ongoing and upcoming hydro & other capital intensive projects across the region.

The commodity wise volume of outward and inward traffic of major transit commodities between India's North-Eastern states and India's hinterland states in 2015 is given in the following table.

[17] Interstate Movement/Flow of Goods, DGCI&S, M/O Commerce & Industry, GoI (2014-15); Tea Board of India; Annual Report, M/O Development of North Eastern Region, GoI (2015-16)

Table 17: Transit Traffic Movement in 2015[18]

Commodity Group	Volume (in tons)
Outbound to North-east	**11,680,511**
Rice	6,182,039
Wheat & Other Foodgrains	1,378,774
Sugar	728,774
Iron & Steel	2,776,167
Over Dimensional Cargo	614,757
Inbound from North-east	**7,725,949**
Limestone	2,407,897
Tea	2,343,442
Forest Products (Bamboo / Paper)	1,296,914
POL	1,677,696

Growth Potential in Northeast region

Ministry for Development of North Eastern Region of India aims to give concentrated attention to address the special needs of the region with development concerns are pursued through their respective Five Year and Annual Plans. In addition, projects of inter-State nature in the Region are funded through by the North-Eastern Council (NEC), which has a separate additional budget for the purpose.

Government of India has undertaken the 'Act East Policy'[19] which provides an interface between North East India and the ASEAN region to develop and strengthen connectivity of Northeast India with the ASEAN region through trade, culture, people-to-people contacts and physical infrastructure (road, airport, telecommunication, power etc.

While majority of the traders and population have limited transport options, development of inland waterways will offer an economic alternative to road transport with improved logistics. This can be capitalised to optimise traffic and improve economic opportunities via waterways. Implementation of proactive policies towards growth of industries in North-Eastern region would provide a huge potential for cargo movement via waterways.

[18] DGCI&S
[19] Annual Report 2015-16, Ministry for Development of North Eastern Region (GoI)

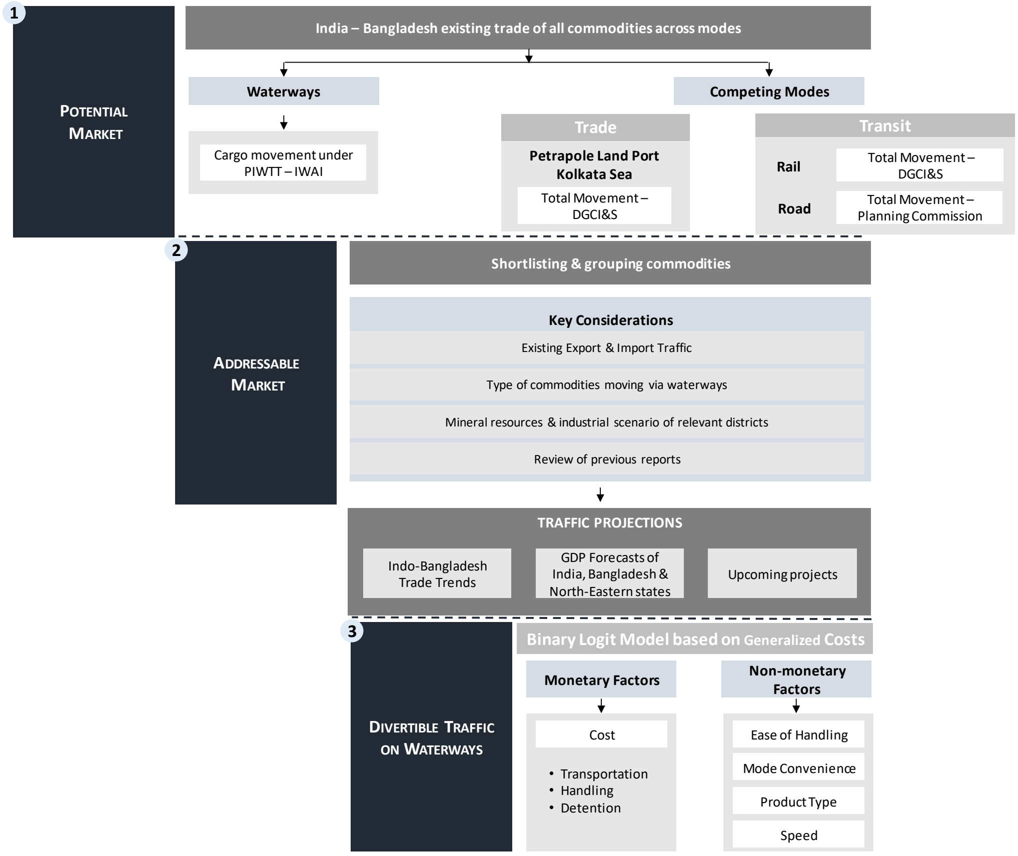
1.6 Traffic Potential Estimation

For estimating traffic, only trade and transit potential is considered as it is expected to constitute bulk of the traffic on this route.

1.6.1 Methodology

The methodology used for estimation is shown in the following figure.

Figure 7: Methodology for traffic potential estimation



Estimating the Potential Market

Trade: The export and import movements between India and Bangladesh was considered as the potential market for the waterways. The temporal analysis of commodity movement was studied with help of latest statistics as maintained by Directorate General of Commercial Intelligence and Statistics (DGCIS), Ministry of Commerce and Industry.

Transit: The inter-regional trade between states in the Northeast and other states in India was considered as the potential market for the waterways. A temporal analysis of commodity movements at an all India level across rail and road was undertaken based on rail movement data maintained by DGCIS and supplemented by the inter-state road traffic provided by Total Transport System Study Report (2014) by erstwhile Planning Commission of India.

Estimating the Addressable Market

The addressable market was estimated based on the following factors:

- Based on suitable catchment for the waterways (movement along the waterway / adjoining districts / cost economics)
- Identifying major commodities based on volume of existing traffic
- Nature of commodities suited for waterways
    - High Volume / Low Value Bulk Commodities
    - Type of commodities that are currently moving via waterways in the Region

- Mineral resources and industrial scenario of relevant districts (in the catchment)

The addressable trade was considered as trade of major commodities currently diverted through West Bengal moving to key districts of Khulna, Mongla, Dhaka and Rajshahi in Bangladesh. The addressable transit market was defined movement of certain key commodities to /from southern Assam, Meghalaya, Tripura, Manipur and Mizoram.

Estimating the Divertible Traffic on Waterways

The modal shift on to waterways has been estimated using the Binary Logit Model based on Generalised Costs which is explained as follows. The inputs for Divertibility are based on local market conditions, infrastructure availability and cost economics.

The generalised cost calculation is based on the following parameters:

- Logistics Cost (Travel, Detention and Handling Costs) – actual cost for each OD pair for trade and transit traffic
- Handling (ease of handling and infrastructure availability) – considers the type of handling such as mechanical or manual and number of times the handling is done
- Mode Convenience (mode preference for the travel distance) – the preference for a mode considered across distance slabs (based on Planning Commission Study)
- Product Type (assessment of suitability for waterways) – under the stable condition as observed for European waterways, the preference of a commodity to shift to waterways has been considered
- Speed (time taken for a commodity to reach its destination) – based on time of travel

1.6.2 Traffic Estimation

Based on the above analysis, the estimated divertible inward traffic (import and inbound from North-east) for the years 2020, 2030, 2040 and 2050 are as provided in the following table.

Table 18: Estimated Divertible Inward Traffic on Waterways

Commodity	2020	2030	2040	2050
Total Bulk (in tons)	**1,104,582**	**2,266,022**	**3,686,023**	**4,701,179**
Bulk (Import – in tons)	**112,351**	**329,407**	**531,481**	**45,160**
Raw Jute	104,967	307,372	495,928	6,29,936
Lead, Zinc & Products	5,283	13,702	22,108	28,082
Rubber, Leather & its Products	2,101	8,333	13,445	17,078
Bulk (Inbound from Northeast – in tons)	**992,231**	**1,936,615**	**3,154,542**	**813,583**
Limestone	754,250	1,545,268	2,517,078	3.212,501
Tea	58,502	97,922	159,504	203,572
Forest Products (Bamboo / Paper)	155,603	253,461	412,862	526,928
POL	23,876	39,964	65,098	83,083
Container (Import – in TEUs)	**Negligible**			

Based on the above analysis, the estimated divertible outward traffic (export and outbound to North-east) for the years 2020, 2030, 2040 and 2050 are as provided in the following table.

Table 19: Estimated Divertible Outward Traffic on Waterways

Commodity	2020	2030	2040	2050
Total Bulk (in tons)	**3,763,275**	**6,666,606**	**10,943,508**	**14,021,180**
Bulk (Export – in tons)	**31,26,895**	**54,90,746**	**90,28,155**	**115,76,651**
Cotton & Products	85,269	217,069	356,965	457,761
Fly-ash	2,803,061	4,797,966	7,890,133	10,118,075
Iron & Steel	163,684	355,325	584,323	749,319
Foodgrains & Spices	26,074	40,884	67,233	86,217
POL	48,807	79,502	129,501	165,279
Bulk (Outbound to Northeast – in tons)	**6,36,380**	**11,75,860**	**19,15,353**	**24,44,529**
Rice	395,183	747,746	1,218,000	1,554,511
Wheat & Other Food grains	36,740	62,435	101,700	129,798
Sugar	25,214	42,205	68,747	87,740
Iron & Steel	179,243	323,474	526,906	672,480
Container (Export – in TEUs)	**14,264**	**38,437**	**63,209**	**81,057**
Total ODC (in tons)	**32,329**	**68,618**	**112,102**	**143,288**
ODC (Export – in tons)	7,698	21,293	35,015	44,903
ODC (Outbound to Northeast – in tons)	24,631	47,325	77,087	98,385

After considering traffic phasing, the total traffic estimated to be handled at the terminal is as follows.

Table 20: Total Traffic Handled at Terminal

	2020	2021	2022	2023	2024	2025	2030	2040
Bulk Cargo (tons)	29,20,714	41,34,856	49,39,859	58,29,677	61,92,835	65,79,737	89,32,629	1,46,29,529
Container (TEUs)	2,853	4,724	6,953	11,515	18,012	23,398	38,437	63,209
ODC (tons)	19,397	27,838	33,721	40,358	43,487	46,877	68,618	112,103

Table 21: Barge Traffic (Number of Barges)

	2020	2021	2022	2023	2024	2025	2030	2040
Inward Traffic	553	791	955	1,140	1,225	1,317	1,892	3,078
Outward Traffic	2,243	3,182	3,817	4,545	4,902	5,262	7,212	11,831
Total Traffic	**2,796**	**3,973**	**4,772**	**5,686**	**6,128**	**6,579**	**9,104**	**14,909**

It can be summarised that in 2030, there is potential for ~1,900 inbound barges and ~7,200 outbound barges. This traffic grows to ~11,800 outbound barges and ~3,000 inbound barges by 2040. The volume of traffic is significant and can be priced competitively compared to road and rail transport in this geography.

1.7 Waterway Issues

The various issues and challenges for the successful implementation of the project are as follows.

- **Challenges in development & maintenance of fairway**
  - Dredging requirements – due to high siltation and shoal formation
  - Lack of assured fairway – speed is restricted due to unsafe and uncertain navigation channel
- **Lack of IWT Infrastructure**

- Quality of Cargo handling facilities – there are inadequate handling facilities at the Kolkata terminal – limited handling equipment and no container handling facilities
- Poor last mile connectivity – undeveloped road network for Haldia waterway port
- Lack of 24x7 Navigation Facilities – inadequate provisions for night navigation
- Administrative Constraints – issues faced during scheduling and slotting of barges for cargo

- **Operational Constraints**
  - Increased Logistics Cost due to One-Way Traffic – trade imbalance causes empty return trip by barges from Bangladesh which increase the operating costs
  - Limited Availability of Indian Barge Operators – majority of the cargo along the route is transported by Bangladeshi barge operators due to lower diesel and labour costs in Bangladesh
  - Limited Last-mile Connectivity / Lack of intermodal coordination – the physiography of Sunderbans poses several connectivity challenges
  - Transportation Delays – delays occur due to manual loading, barge operators not driving against the tide and entry of fishermen into the channel

- **Environmentally Sensitive Catchment**
  - Sunderbans falls under the CRZ-1 category as it has presence of various eco-sensitive zones and national conservation areas.
  - The current barge operations cause water and noise pollution as they are not of the desired specifications.

Keeping in view the above-mentioned challenges, the following measures are recommended to ensure smooth operations of the entire Sunderbans Waterways.

- BIWTA (Bangladesh Inland Waterways Transport Authority) should ensure adequate depth and sufficient navigation aids across the entire navigation channel.
- Maintenance of handling facilities including container services should also be undertaken.
- Indian Government should co-ordinate with the Government of Bangladesh to regularize movement of Indian trucks from Ashuganj, Bangladesh to North-Eastern states in India.

1.8 Proposed IWT Infrastructure

The navigation channel proposed is with a draught of 2.5 meters; bottom width of 45 meters with a slope of 1:5. This has been proposed keeping in view the capital investment required and the projected traffic.

Keeping the above in view, various sizes of vessels have been studied to find out the optimal size of barges that should ply on this route. Currently, barges with capacity up to 1,000 DWT are already plying on this waterway which are carrying mostly fly ash and sometimes food-grains, etc. Given the proposed draught and channel width, self-propelled barges up to 1,500 DWT should be able to ply comfortably. Additionally, with the technological advancements in design and manufacturing of barges, flat bottom barges with capacity up to 2,000 DWT could also ply on the waterways.

Based on the technical investigation and site surveys, the following river training works have been proposed.

- For the surveyed sections, the dredging requirement is estimated to be 315,687.61 m^3 (considering the channel depth requirement of 2.5 m). For the entire stretch of the waterway (from Haldia to Athara Banki), preliminary assessment based on Thalweg charts indicate a dredging requirement of 413,262.29 m^3 (for the Chainage of 0m to 172m)
- The physiography of the delta region necessitates bank protection and sand traps to minimize sedimentation and shoal formation. Considering the ecological considerations, bank protection is recommended by utilizing natural materials.
- Adequate navigation aids (channel markings, navigation buoys and night navigation) are proposed to ensure safe and secure 24x7 navigation across the channel.

1.8.1 Waterway & Terminal Infrastructure CAPEX

Based on the proposed infrastructure, it is envisioned that a total capital expenditure of INR 364 cr would be required for developing capacity to handle ~15 MTPA and 60,000 - 1 lakh TEUs by 2040.

The infrastructure proposed at Kolkata is as follows:

- Material handling equipment for improvement of efficiency at the terminal
- Administrative and Operations Building
- Refurbishment of road within terminal area
- Fencing wall for the site

The infrastructure proposed at Haldia is as follows:

- 4 Fixed Berths and 1 Floating Pontoon
- Loading / unloading and other equipment, Ancillary infrastructure
- Last Mile Road Connectivity

The infrastructure proposed at Hemnagar Terminal is as follows:

- 2 Floating Pontoons (with approach trestles)
- Administrative Building

It is understood that the infrastructure proposed by IWAI at Kolkata and Haldia terminals for NW 1 could be used for meeting the requirements of Sunderbans Waterways. Thus, no fresh capital expenditure is expected to be incurred at Kolkata and Haldia terminals for Sunderbans Waterways.

The capital expenditure for Hemnagar Terminal is estimated to be INR 12 Cr, out of which INR 5.3 Cr would be required immediately for pontoons and ancillary infrastructure at the terminal.

The summary of the capital expenditure of the project is shown in the following table. This expenditure is based on phasing and suitable market benchmarks.

Table 22: Project Capital Expenditure

Head	Total (in INR cr)
Waterway Infrastructure	12
Kolkata	48
Haldia	293
Hemnagar	12
Total Project Capex	**364**

1.8.2 Proposed Terminal Location

An integrated IWT terminal is planned by IWAI at Haldia and it would be prudent to also operate Sunderbans traffic from this terminal till it achieves its peak capacity. Post built-up of traffic, an alternate land parcel can be identified for future expansion of the terminal.

Alternatively, an integrated IWT terminal can be planned separately for handling Sunderbans traffic. This would entail leasing separate land parcel at Haldia of ~60 acres. While, indicative parcels have been identified, the final parcels would have to be finalized post discussions of IWAI with Haldia Port Trust and State Government.

Based on the current traffic situation and land availability, co-location of terminal at Haldia would ensure faster on-ground results and efficient phasing of infrastructure and funds.

1.9 Financial Feasibility

1.9.1 Survey Stretch

The survey stretch from Namkhana to Athara Banki (~170 km) has been considered for standalone feasibility. For the stretch, the capital expenditure would be for dredging and bank protection.

- Dredging requirement: 413,262.29 cu. m
- Bank Protection: ~9,000 m (on both sides of the bank in areas with sedimentation issues)

Considering only fairway revenues (INR 0.02 per GRT per km) for the stretch km while O&M costs of only dredging and bank protection measures are undertaken for analysis.

Based on the above analysis, we believe that the survey stretch should not be evaluated independently and should be evaluated in the context of the overall Indo-Bangladesh protocol route.
Thus, for establishing feasibility of the waterways, the entire 215-km stretch (Haldia to Athara Banki) has been analyzed in this report which includes terminal handling at Kolkata / Haldia.

1.9.2 Overall Feasibility – Indo Bangladesh Protocol Route

1.9.2.1 Modal Logistics Cost comparison – Potential for Increase in Terminal & Fairway charges

On comparison of logistics costs of transport through waterways and road, it is seen that waterways entail significant cost savings (40-45% of the cost of road transport). The significant cost differential in waterways and possibility of further reduction due to efficiency in waterway transport provides an opportunity for IWAI to improve tariffs and make each component of the waterway independently sustainable and feasible.

Based on the above analysis, IWAI may consider revision in the following tariffs:

- Fairway charge: As discussed in financials for survey stretch, doubling the fairway charges makes the fairway independently operational feasible. For the purposes of this study, the proposed fairway charges are INR 0.1 per GRT per ton (current tariff: INR 0.02 per GRT per ton).
- Terminal charge: There is scope for improving the terminal charges especially the cargo related charges considering the significant investments envisaged in the terminals. Based on benchmarking exercises, it is proposed that the cargo charges be revised to ~INR 30 per ton (bulk cargo) and INR 2,000 per TEU (container) (Comparable to changes in Bangladesh and KPT)

Under the proposed tariff structure, transportation cost via waterways is still significantly low (40-45% of the transportation cost via road). Further reduction in barge operator charges can be expected once the waterway is fully operational due to improved turn-around time and traffic. Hence, the above analysis indicates that even after increase in the terminal charges, transportation via waterways has significantly advantageous cost economics.

1.9.2.2 Feasibility Scenarios [20]

Considering the current tariff structure, IWAI has the capability to increase the tariff charges without jeopardizing the advantageous cost economics of transportation via waterways. Hence, financial feasibility was computed for the following two scenarios:

- Scenario A (assuming the current tariff structure) – Considering current tariff, the project has negative financial returns due to low tariffs and high O&M costs and is not financially viable
- Scenario B (assuming the proposed tariff structure) [21] – **With relevant revisions to terminal and fairway charges, the project has healthy returns with an IRR in the range of 17-18%.**

Given the potential traffic and significant integration benefits with the economy of North-East states of India and Bangladesh, the project is financial feasible with changes in the tariff structure.

1.10 Socio-Economic Analysis

The proposed project is expected to offer various direct and indirect socio-economic benefits. Direct benefits would arise from the following:

- Employment Generation – Due to the proposed project, the local economy can be promoted through income from barge / boat hires, mooring and licensing fee, canoeing, wildlife watching and other recreational activities for further tourism development.
- Lower vessel operating cost – Comparing the vessel operation cost of the three most common modes of cargo transfer, inland waterways turns out to be the cheapest mode of transport, resulting in considerable cost savings.

[20] It is proposed that existing infrastructure for NW 1 is to be utilised for Sunderbans Waterways and only capital expenditure at Hemnagar would be undertaken. However, the feasibility has been undertaken based on capex which would have been required independently for the waterways as analysed in the "Proposed IWT Infrastructure" chapter.

[21] Current tariff for dry cargo is INR 1 per tonne and container is INR 50 per TEU and fairway usage charges: INR 0.02 per GRT per ton; Proposed tariff for dry cargo is INR 30 per tonne and container is INR 2,000 per TEU and fairway usage charges: INR 0.1 per GRT per ton

In addition, several indirect benefits are also expected to arise from the proposed project such as reduced traffic congestion, lower air and noise pollution, property premium, provision of water and utilities, operational safety, and lower land usage.

1.11 Risk Analysis and Mitigation

The development and successful operation of the proposed IWT infrastructure is contingent on assumptions and externalities. Potential major risks and measures taken to mitigate them are discussed as follows.

- **Ecological Risks –** The reclamation of land from the waterway and dredging of the sediments might affect the flora and fauna in the region and might affect the structural stability of the area.
  Mitigation Strategy: A detailed study including sediment transport, siltation and environmental impact assessment needs to be carried out.
- **Maintenance Risks –** Upon completion of the construction, there needs to be periodic maintenance of the terminal and dredging of waterway route to ensure proper functioning bulk infrastructure and equipment. *Mitigation Strategy:* India and Bangladesh can enter O&M agreements with contractors and agencies for proper functioning within area of jurisdiction.
- **Safety & Security Risks –** In case of thefts and losses due to change in International boundaries and jurisdiction, operators diminishing confidence in the operations of the project leading to delay in revenues and thus reducing the expected trade movement.
  Mitigation Strategy: The government and the private operators would have to take the prerogative of setting up checks and jurisdiction in place to ensure the adherence of external contracts to stipulated quality and timelines.
- **Political Risks –** These include restrictions imposed on convertibility of currency and transfer, expropriation of the project assets by the government, and internal political stability causing physical damage to project or preventing its operation. Mitigation Strategy: Consistent interactions with Authority can help to mitigate political risks.

1.12 Conclusion

- **Sunderbans Waterways is an important route for development** as it provides the following essential connectivity options:
  - International connectivity to Bangladesh – improving trade relations with Bangladesh,
  - Transit to North-eastern states – providing shorter / cheaper transport options for cargo movement
  - Travel within Sunderbans – enhancing connectivity and economic development of the local populace.
- Dispersed urban settlements and low economic development in the region enhance the **need to tap the huge potential for adopting waterways as a preferred mode of transportation**.
- Technical assessment indicates **considerable shoal formation and sedimentation at the survey locations**. However, as there is significant tidal influence with minimal velocity, navigation through waterways is possible during high tide. The sedimentation analysis indicates significant proportion of fine particles (silt and clay).
- **Trade between India and Bangladesh involves issues such as infrastructure constraints, delays at Petrapole land port and administrative problems**. Analysis of cost economics of key routes indicates that waterways has immense potential due to its numerous benefits such as economic feasibility and time savings. Based on the trade traffic potential, trade with Bangladesh for commodities like cotton, ODC, iron & steel, food grains & spices, flyash, POL, electronics, processed food, raw jute, lead, zinc, rubber & leather products, readymade garments, chemicals and marine products can be diverted to the protocol route.
- **Cargo movement between India's North-eastern region and hinterland involves issues such as poor connectivity, inadequate infrastructure and severe topography of the North-eastern states**. Based on cost economics and infrastructure availability, the primary catchment for transit traffic through waterways has been identified as states of Southern Assam, Tripura, Meghalaya, Mizoram and Manipur. The transit commodities that can be diverted to the protocol route include rice, wheat & other food grains, sugar, iron & steel, ODC, limestone, tea, forest products and POL.
- The **waterway is proposed to be maintained with depth availability of 2.5 m throughout**. Thus, a navigation channel of 45 m wide is proposed. Given the proposed draught and channel width, self-propelled barges up to 1500 DWT should be able to ply comfortably. Additionally, with the technological improvements, flat bottom barges with cargo carrying capacity of 2,000 DWT could also ply on the

waterways. For the surveyed sections, the dredging requirement is estimated to be 315,687.61 m^3 (for overall length, dredging of 413,262.29 m^3 is estimated based on preliminary analysis of the Thalweg charts). Considering, estimated bulk cargo traffic of ~15 MTPA and ~60,000 TEUs (2040), additional 5 berths (4 fixed and 1 floating) at Haldia, 2 floating pontoons at Hemnagar Terminal and adequate handling facilities are recommended.

- Based on the above analysis, we believe that the survey stretch should not be evaluated independently and should be evaluated in the context of the overall Indo-Bangladesh protocol route. Thus, for establishing feasibility of the waterways, the entire 215-km stretch (Haldia to Athara Banki) has been analyzed in this report which includes terminal handling at Kolkata / Haldia.
- Considering the current tariff structure, IWAI has the potential to increase the tariff charges without impacting the advantageous cost economics of transportation via waterways. Hence, financial feasibility was computed for the following two scenarios:
    - Scenario A (assuming the current tariff structure) – Considering current tariff, the project has negative financial returns due to low tariffs and high O&M costs and is not financially viable.
    - Scenario B (assuming the proposed tariff structure)[22] – **With relevant revisions to terminal and fairway charges, the project has healthy returns with an IRR in the range of 17-18%.**

Given the potential traffic and significant integration benefits with the economy of North-East states of India and Bangladesh, the project is financially feasible with changes in the tariff structure.

The total capital expenditure that has been estimated for the project is INR 23 Cr excluding the capital expenditure for Kolkata and Haldia terminals. As discussed earlier, no fresh capital expenditure is expected to be undertaken for Kolkata and Haldia terminals, since the infrastructure proposed by IWAI for NW 1 would be utilized for Sunderbans Waterways. The capital expenditure for Hemnagar Terminal is INR 12 Cr, out of which INR 5.3 Cr would be required immediately for pontoons and ancillary infrastructure at the terminal.

[22] Current tariff for dry cargo is INR 1 per tonne and container is INR 50 per TEU and fairway usage charges: INR 0.02 per GRT per ton; Proposed tariff for dry cargo is INR 30 per tonne and container is INR 2,000 per TEU and fairway usage charges: INR 0.1 per GRT per ton

2 Introduction

2 Introduction

2.1 Inland Waterways Transport – Overview

The different transportation modes (road, rail, waterways) have inherent benefits and cost trade-offs which largely determine their usage based on transport distance, volume and nature of product / cargo transported, period / time for transport, etc.

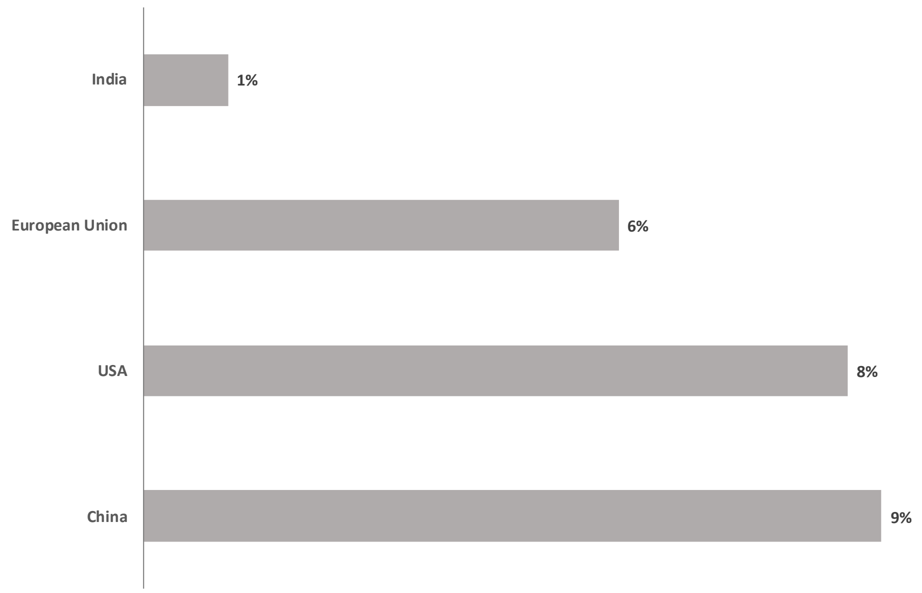
Waterways provide a unique advantage over conventional transport modes as it is cost effective (60-80% lower in cost per tonne-km as compared to rail / road), environment friendly, has limited land issues for development and de-congests existing modes of transport. Thus, development of waterways provides a good alternative to current modes of transportation by relieving pressure on existing modes and optimizing passenger and freight movement.

2.1.1 Inland Waterways in India

India has ~14,500 km of navigable inland waterways, of which 5,200 km (36%) of major rivers and 485 km (3%) of canals are conducive to the movement of mechanized vessels. With 95% of India's trade through maritime transport, there is potential for utilizing waterways to connect hinterland and ports. Currently, there are only few major stretches (National Waterway 1, 2 and 3, Goa and Mumbai waterways) which are majorly being utilized for transport with a total of 18 million tons being moved in 2014.

Thus, inland waterways in India have remained largely underutilized due to low penetration of multi-modal transportation and cargo handling, insufficient infrastructure, regulatory issues and inadequate investment. The comparison of India's modal share of IWT with other major world economies is shown in the following figure.

Figure 8: Comparison of India's modal share of IWT with other major economies[23]



Thus, there is a huge potential for adopting waterways as a preferred mode of transportation. In a bid to boost transportation of goods and passengers through waterways and make better use of the latent capacity, Indian government has taken multiple initiatives aimed at improving IWT infrastructure and operations.

2.1.2 Development Initiatives – Government of India

Realizing the potential of the IWT sector, Government of India has announced several initiatives to promote IWT in the country for developing a strong water transport network. The following major government interventions have initiated the process of systematically developing waterways for year-round navigability.

[23] World Bank Database

1) National Waterways Act 2016 – The government through this act has designated 111 rivers and canals as National waterways which are to be developed for year-round commercial navigability.
2) Integrated National Waterways Transport Grid (INWTG) – The grid seeks to connect National Waterways to National/State highways to boost the overall transportation network in the country. It includes development of the National Waterways with at least 2.5 meters Least Available Depth (LAD), upgrading/setting up of priority terminals and establishing road, rail & port connectivity.
3) Incentive Schemes by Ministry of Shipping – A committee set up by the Ministry of Shipping recommended measures to incentivize companies for shifting some portion of the cargo now carried by rail and road to coastal shipping and inland waterways to help develop them as an integral part of the country's logistics chain. It proposes to provide monetary incentives to beneficiaries when they transport certain identified commodities, containerized cargo or automobiles.
4) Sagarmala Project – It is an infrastructure-cum-policy initiative towards transforming the existing ports into modern world class ports and integrate the development of the ports, industrial clusters and efficient evacuation systems through road, rail, inland and coastal waterways resulting in ports becoming the drivers of economic activity in coastal areas.

Inland Waterways Authority of India (IWAI) is the nodal agency responsible for development and operation of IWT infrastructure in India. As a step towards achieving the objectives laid down by the Government, IWAI intends to develop key inland waterway routes which would boost the overall contribution of waterways in India's modal share and reduce logistics costs in key areas.

2.2 Project Backdrop

IWAI has identified the Sunderbans Waterways as one of the major routes which is critical to development of IWT sector in India. The Sunderbans Waterways provides essential connectivity options from the following aspects.

- International connectivity to Bangladesh – two of the four Indo-Bangladesh Trade and Transit Protocol routes fall in the Sunderbans region. With limited rail / road connectivity between India and Bangladesh, these protocol routes form a major trade link between the countries.
- Transits to the North-eastern states – the protocol routes connect NW 1 with NW 2 in Assam providing shorter / cheaper transport options for cargo movement. More importantly, as essential food commodities are transported, the reduced costs would positively impact general population.
- Internal traffic in the Sunderbans regions – with limited road connectivity due to Sunderbans' physiography, waterway network would play an important role in enhancing connectivity and economic development of the populace.

With this improved connectivity, the project is expected to entail several associated benefits. The key benefits envisaged are as follows.

- Improved trade volumes – improved connectivity is expected to boost trade volumes due to reduced logistics costs. Further, Indian ports can act as transhipment ports for several regions in Bangladesh.
- Economic development of North-eastern States – as essential food commodities are transported, the reduced logistics costs would positively impact general population. Also, joint logistic and supply benefits can be sought by companies, thereby improving industrial output.
- Socio-economic development of Sunderbans – the local populace would benefit from improved connectivity to the hinterland.
- Facilitation of tourism development – development of waterways with requisite safety standards would encourage tourism in Sunderbans. Sunderbans is a UNESCO protected world-heritage site and is home to the famous Royal Bengal Tiger. Waterway development would go a long way in development of river tourism in the catchment.

With the signing of the Protocol on Inland Water Transit and Trade in June, 2015, the traffic is expected to increase significantly, thereby increasing the importance of the route. Thus, the development of Sunderbans Waterways plays an important role for overall development of the IWT sector as envisioned by the Government and is expected to be developed through a tender process for Engineering Procurement and Construction (EPC) Contract for the Waterway development works.

2.3 Project Mandate

The key objectives of IWAI for development of Sunderbans Waterways are as follows.

- To develop the identified National Waterway for year round commercial navigation so that they can contribute to an overall efficient IWT and multimodal transport system for the country.

- To develop Sunderbans waterway in an ecologically, environmentally and economically sustainable manner and increase IWT hinterland connectivity.
- To make waterway infrastructure play a catalytic role in the achievement of the country's development objectives such as access to energy, communication, tourism, health and education services.

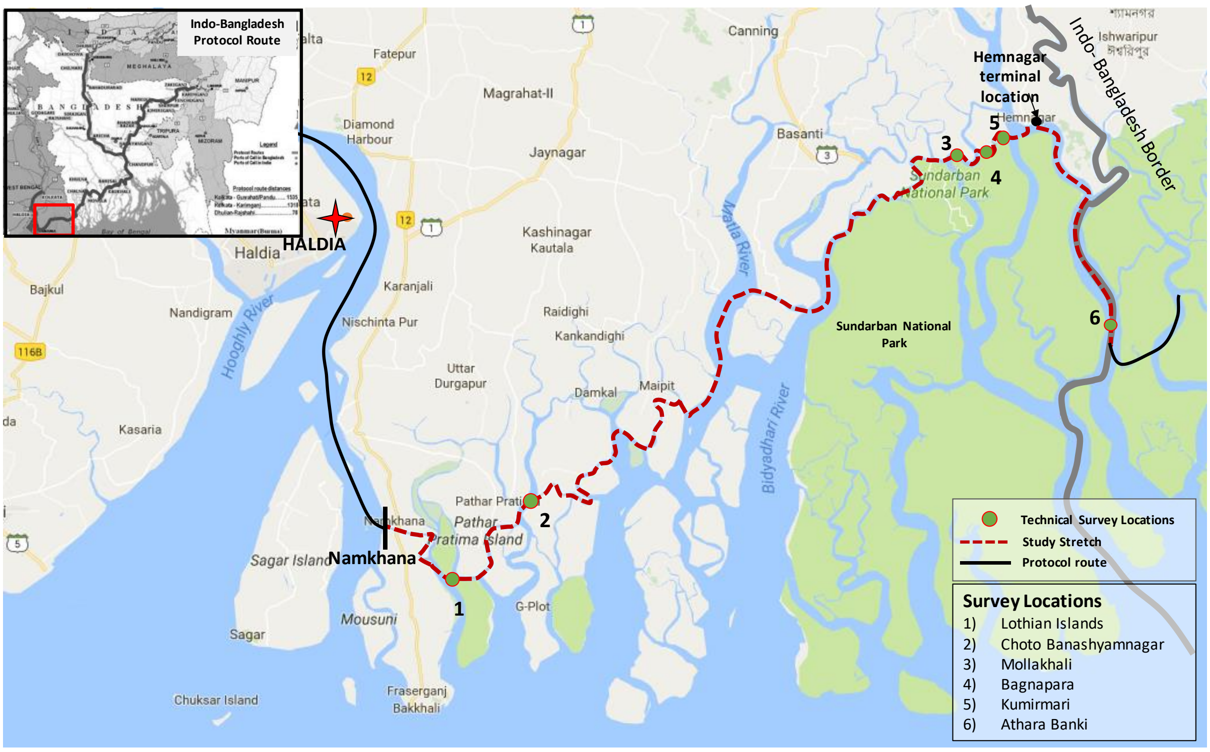
For commissioning the development of the waterways in-line with its objective, IWAI needs to ascertain the technical, traffic, economic, social and financial requirements of the project. IWAI has selected Feedback Infra (P) Limited for 'Preparation of Technical Economic Feasibility Report for Development of Sunderbans Inland Waterways'.

2.3.1 Study Stretch

For the technical investigation and analysis, six stretches of the Sunderbans Waterways were identified by IWAI. These stretches are part of the Indo-Bangladesh Protocol Route and falls within the designated National Waterway 97 (extending from Namkhana in the west to Athara Banki in the east where the waterway enters Bangladesh). The six river sections have been earmarked by IWAI, as these locations experience shoal formations causing hindrance to navigation and detailed investigation needs to be undertaken to assess infrastructure requirements for improved navigability.

The figure below shows the technical survey locations, study stretch and the protocol route.

Figure 9: Sunderbans Waterways – Study Stretch



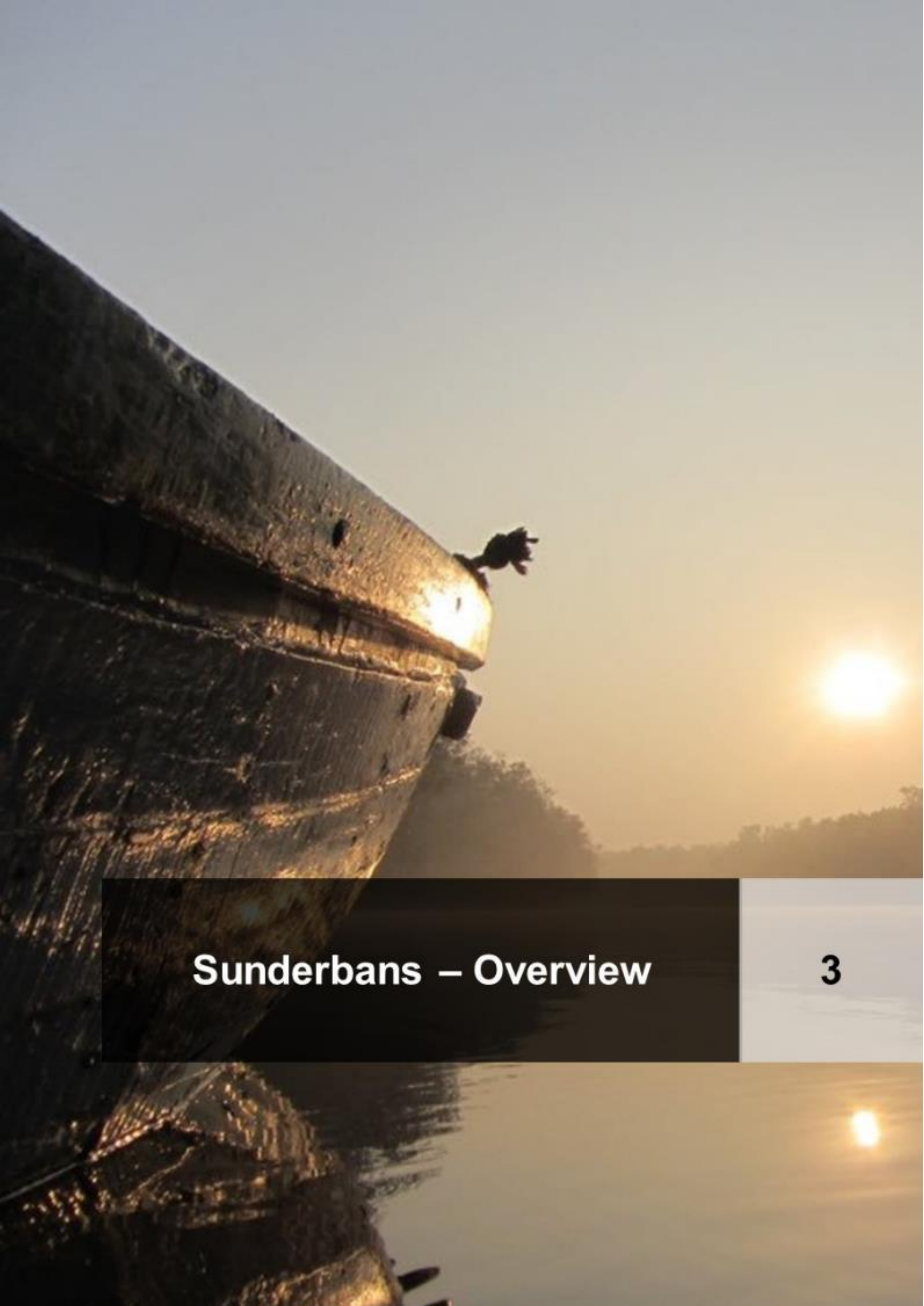
On each of the six stretches earmarked, the length of the survey sections is tabulated below.

Table 23: Survey Locations along the survey stretch

S. No.	Location	Length of Survey (km)
1.	Lothian Island	0.76
2.	Choto Banashyamnagar	1.12
3.	Mollakhali	0.29
4.	Bagnapara	0.25
5.	Kumirmari	0.38
6.	Athara Banki	1.67
	Total	**4.47**

The Sunderbans Waterways is a part of the Indo-Bangladesh protocol route. Thus, for assessing the transport economics and market for the project, catchment analysis and traffic assessment for the protocol route has been undertaken. This includes understanding the international trade and transit traffic through the protocol route and identification of drivers for growth of the same.

This document is the Final Technical, Economic and Financial Feasibility Report, which is the third output to be submitted by Feedback as a part of project engagement. It covers the transport economic & market analysis, technical investigation & analysis, financial analysis and preliminary design of proposed infrastructure at Hemnagar Terminal for the project.



Sunderbans – Overview

3

3 Sunderbans – Overview

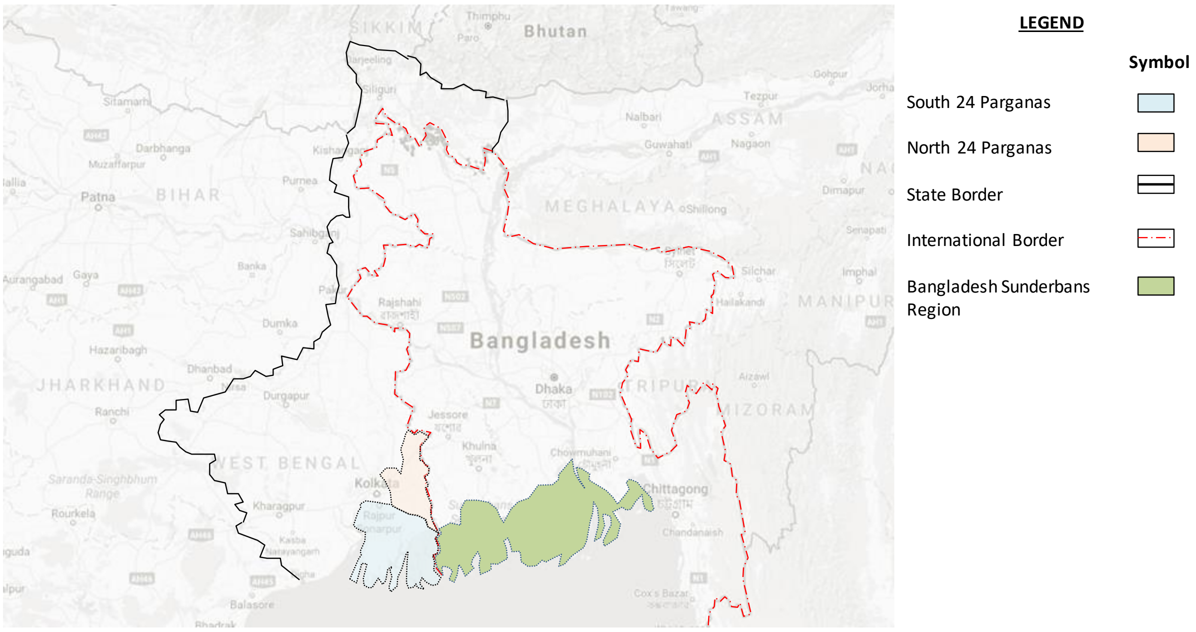
3.1 Geography

The Sunderbans, world's largest delta, is formed by the confluence of the mighty rivers – the Ganges, the Brahmaputra and the Meghna. Sunderbans delta is shared between India and Bangladesh and is situated on the lower end of the Gangetic West Bengal. The total area of Sunderbans is ~ 10,000 sq.km. [24], of which 4,200 sq.km[25]. lies within the Indian Territory. The forest stretches in a continuous belt from estuary of the Hooghly, the western most channel of Ganga, to Padda or Padma in the east, the combined channel of the Ganga, the Brahmaputra and the Meghna. The region has world's largest mangrove forest and is home to the royal Bengal tiger.

Indian side of Sunderbans is subdivided into five zones. The southern part is the Sunderbans National park, which forms part of the core area and meets Bay of Bengal down south. To the north east of the core area is the North 24 Parganas reserve forest lying within the buffer zone. The eastern face of this zone along with the national park forms border with Bangladesh.

The western edge of the North 24 Parganas reserve forest faces the wildlife sanctuary that extends further west before meeting the South 24 Parganas Forest division forming part of the buffer zone. To the north of the wildlife sanctuary is the transition zone which is the sharp interface with highly cultivated land.

Figure 10: Sunderbans Region



3.2 Physiography

Indian Sunderbans Delta has aquifer zones, which are mostly saline and brackish. It is the largest single block of tidal mangrove forest in the world. The region is characterised by a web of tidal water systems. The average tidal amplitude is between 3.5-5 m, with the highest amplitudes in July-August and the lowest in December-January. Of the rivers that dominate the landscape, only the Hugli and Ichamati-Raimangal carry water flow of some significance[26].

[24] World Heritage Convention, UNESCO (2016)
[25] http://www.sunderbans.in/Sunderbans.php, Department of Tourism, West Bengal
[26] Indian Sunderbans Delta: A Vision; Danda A., Sriskanthan G; WWF India (2011); New Delhi

3.3 Climate

The climate of the region is tropical with high relative humidity between 70-88%. The mean maximum temperature is 34^{0}C during June and the mean minimum temperature is 11^{0}C during January[27]. The region experiences occasional rains through most of the year barring January and February. The monsoon period occurs between June and October, accounting for ~80% of the annual precipitation.

Natural calamities such as cyclones, along with saline water intrusion and siltation, remain potential threats to the region. Cyclones and tidal waves cause some damage to the forest along the sea-land interface and have previously caused occasional mortality among some species of fauna.

3.4 Demographics

India Sunderbans Delta encompasses over two major districts of West Bengal i.e. North 24 Parganas and South 24 Parganas. In account of land surface area, the South 24 Parganas district is larger than the North 24 Parganas district. The sub-divisions and major population centres of North 24 Parganas and South 24 Parganas are:

Table 24: Sub-divisions & major population centres of North 24 Parganas & South 24 Parganas

Districts	Sub-Divisions	Major Population Centres
North 24 Parganas	Bongaon Barasat Barackpur Bidhannagar Basirhat	• Dhamakhali • Hemnagar
South 24 Parganas	Alipore Sadar Baruipur Canning Diamond Harbour Kakdwip	• Sagar Island • Kakdwip • Sonakhali • Basanti

The comparison of demographics of South 24 Parganas is given in the following table:

Table 25: Demographics Comparison of South 24 Parganas with West Bengal[28]

Category	South 24 Parganas	West Bengal
Area (Sq.Km.)	9,960	88,752
Population	8,161,961	91,276,115
No. of Household	1,775,756	20,309,872
Sex Ratio	956	950
Workforce Participation Rate (%)	36.32	38.08
% of Urban Population	25.58	31.87
Density of Population (Persons per sq.km.)	819	1028
Literacy (%)	77.51	76.26
Cultivators (%)	11.99	14.72
Agriculture Labourers (%)	27.21	29.32
Household Industry Workers (%)	8.13	7.09
Other Workers (%)	52.68	48.87

[27] Indian Sunderbans Delta: A Vision; Danda A., Sriskanthan G; WWF India (2011); New Delhi
[28] Census of India, 2011

Major highlights of demographic comparison of South 24 Parganas versus West Bengal are:
- Work Participation rate in South 24 Parganas is lesser than that of West Bengal state.
- Population Density in South 24 Parganas is lesser than that of West Bengal state.
- Urban Population in South 24 Parganas is lesser than that of West Bengal state.

3.5 Economic Profile

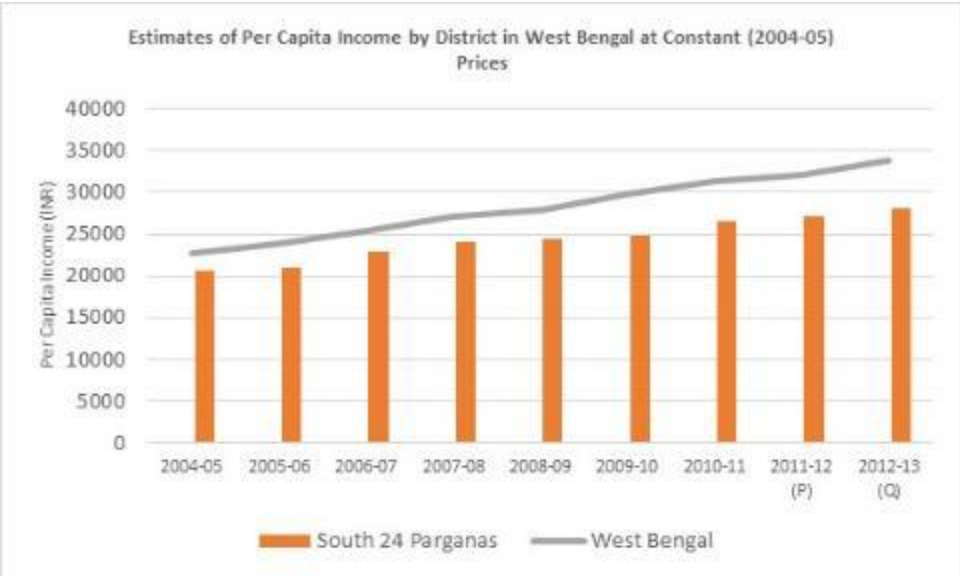
Majority of working population in Indian Sunderbans Region are employed in primary sector with occupations such as agriculture, fishing, extraction of honey and pisciculture.

The main economic activity in the Indian Sunderbans Delta is rain-fed paddy agriculture, which is made possible by the construction of the earthen embankments to keep brackish tidal water at bay. The major agricultural produce in the region comprises of paddy, jute, wheat, oil seeds, pulses and fruits.

Traditional open-access fishing is also an important basis for the livelihood. It is common to find caste fisherman to be marginal farmers and vice-versa. A few sections of population are engaged in the extraction of resources such as biomass, honey etc. from forests and water courses within forest area. Small scale pisciculture is carried out at subsistence level to cater to local markets.

The following table represents the estimates of per capita income by districts in West Bengal at Constant (2004-05) prices:

Figure 11: Estimates of Per Capita Income by District in West Bengal at Constant (2004-05) Prices[29]



P – Provisional
Q – Quick

Major highlights of per capita income comparison of South 24 Parganas versus West Bengal are:
- Per capita income of South 24 Parganas is considerably lower than that of West Bengal state.
- South 24 Parganas is economically less developed with less economic opportunities due to lack of connectivity to Kolkata.

[29] State Domestic Product & District Domestic Product of West Bengal, (2013-14); Kolkata

3.6 Existing Infrastructure

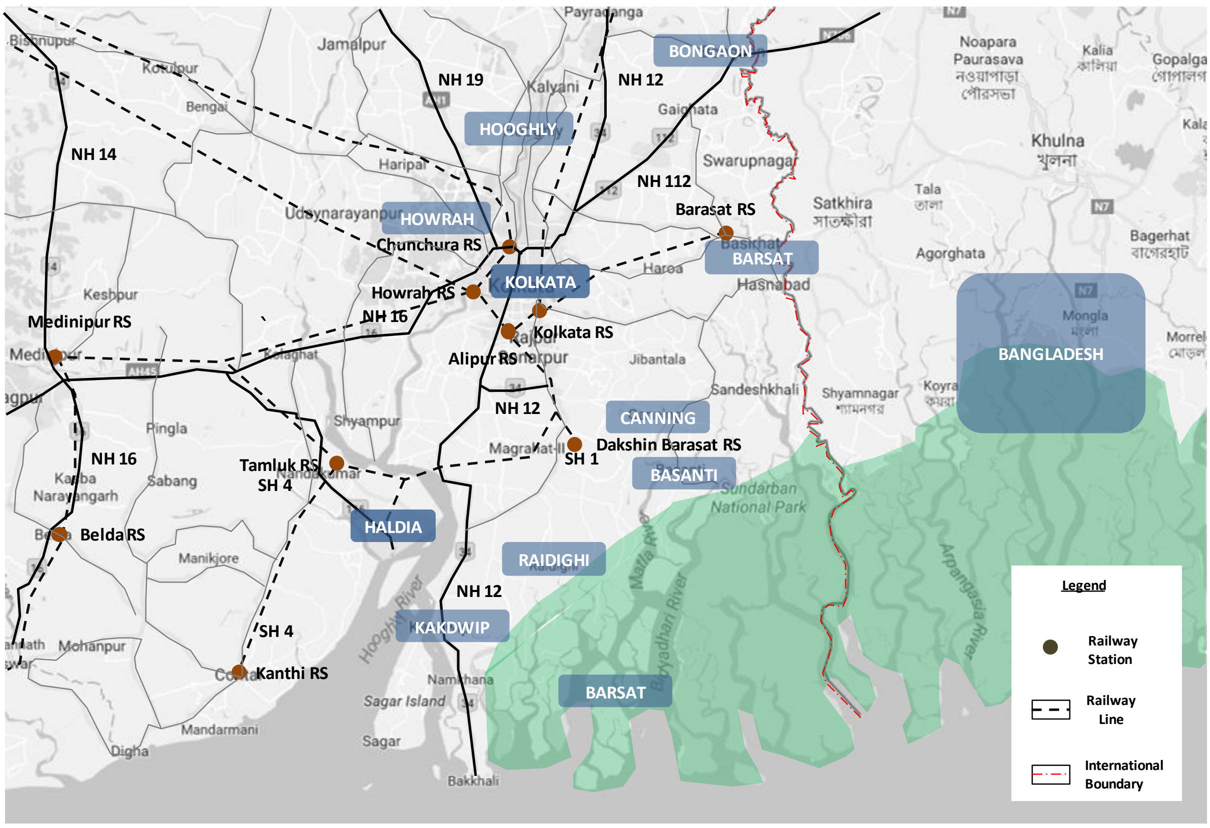
Sunderbans is moderately connected by a network of roads, railways, airports and ports. The proximity of the district with Kolkata city and the construction of The Eastern Metropolitan By-pass directly linking the district with the heart of Kolkata, have tremendously improved the flow of goods and people.

Table 26: Sunderbans District Road Lengths[30]

District	Road Type	Road Length (Km)
North 24 Parganas	National Highway (NH 34, 25)	101 Km
	State Highway (SH)	193 Km
	Major District Roads (MDR)	212 Km
	Other District Roads (ODR)	8 Km
South 24 Parganas	National Highway (NH 117)	125 Km
	State Highway (SH)	59 Km
	Major District Roads (MDR)	242 Km
	Other District Roads (ODR)	44 Km

The major centres that are connected by bituminous road in this region are Canning, Sonakhali, Basanti and Godhkhali. Tourists travel by road from Kolkata to Godhkhali Jetty (via Canning), which is the starting point of the boat journey to Sunderbans.

Figure 12: Road & Railway Network in Sunderbans



3.6.1 Ports

The major riverine port in Kolkata is the Kolkata Port. It is the oldest operating riverine port of the country, situated 232 km up-stream from the Sandheads. It is the gateway to Eastern India for the rest of the world and has one of the longest navigational channels in the world.

[30] North & South 24 Parganas, Industrial Profile, MSME (2012); Kolkata

Kolkata Port has a synergistic linkage with Kolkata metropolitan region through a network of road, railway and inland waterway, connecting all parts of the country. The port is connected with NH-6, NH-2 and NH-34 through city roads, to Eastern Railway through Sealdah and Budge Budge Sections and to National Waterway No.1 (Ganga), National Waterway No.2 (Brahmaputra) and waterways through Sunderbans. Kolkata Port handled 50.289 million tons of traffic in 2015-2016 against the traffic of 46.293 million tons handled in 2014-2015[31].

Haldia Dock Complex (HDC), a modern dock complex of Kolkata Port Trust, was set up in 1977 for handling larger vessels, carrying bulk cargo with optimum economy, thus keeping Kolkata Dock System primarily for handling break bulk cargo and containers. HDC is connected to the South Eastern Railway via Panskura. NH 41 connects Haldia with NH 6 (part of Golden Quadrilateral) at Kolaghat. From Kolaghat, NH-6 connects Orissa, Jharkhand, Kharagpur, Bankura and Purulia and Durgapur through NH-34 to North Bengal and Bangladesh via Petrapole and Bhojadanga Land Custom Stations. At Haldia Dock Complex (HDC), 33.507 million tons of traffic was handled in 2015-2016 as against 31.010 million tons in 2014-2015[32].

3.6.2 Airports

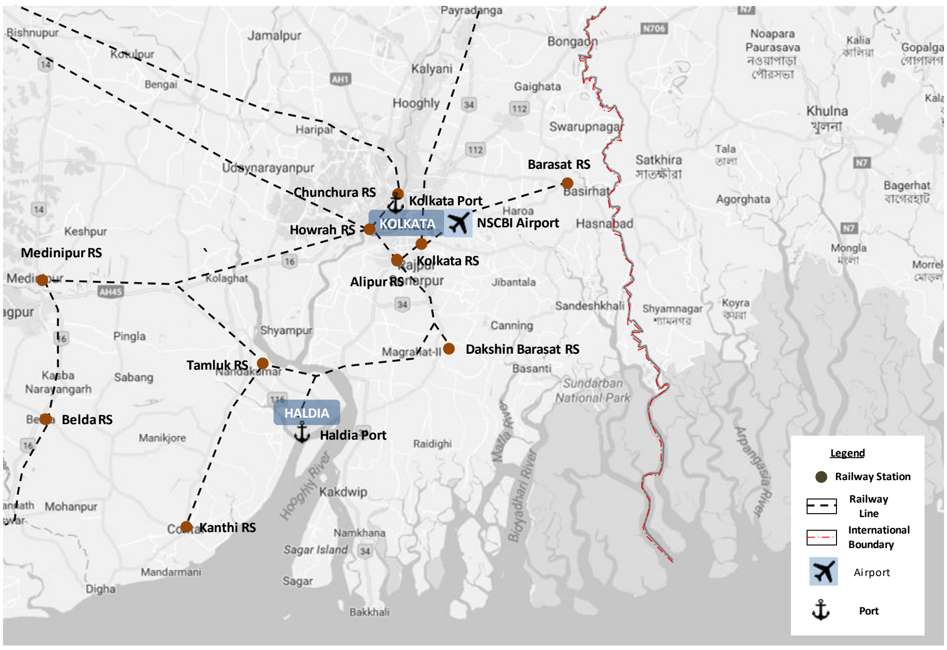
The Netaji Subhash Chandra Bose International Airport at Dum Dum in Kolkata is the closest airport to Sunderbans, operating both domestic and international flights. It is a gateway to hinterland India, North-East India and Bangladesh. The number of people using the airport has consistently increased over the last few years with ~10 million passengers in the financial year 2014-15. It is the fifth busiest airport in India in respect of aircraft movement after Delhi, Mumbai, Bangalore and Chennai.[33] The airport is 15 km from Barasat, District Headquarter of North 24 Parganas and 25 km from Alipore, District Headquarter of South 24 Parganas.

3.6.3 Railways

The electrified suburban railway network of the Eastern Railway is extensive and stretches far into the North 24 Parganas and South 24 Parganas from the neighbouring districts of Kolkata, Nadia, Howrah and Hooghly. The major railway station of the Eastern Railway in North 24 Parganas District is at Barasat (26 km from Kolkata). The major railway station of the Eastern Railway in South 24 Parganas District is at Alipore (9 km from Kolkata) and Dakshin Barasat (50 km from Kolkata). The major railway station that is used for cargo movement is at Kalighat (25 km from Kolkata).

The railway network, major ports and airport are the catchment is shown in the following map.

Figure 13: Railway Network, Major Ports and Airport in Sunderbans



[31] Cargo Statistics, Kolkata Port Trust (2016)
[32] Cargo Statistics, Kolkata Port Trust (2016)
[33] Traffic News; Airports Authority of India; (2016); New Delhi

3.6.4 Logistics

Inland Container Depots (ICDs) and Container Freight Stations (CFSs) are custom bonded in-transit facilities which are located near ports and in hinterland area. The various logistics facilities in the catchment are given in the following table.

Table 27: Logistics Facilities in Catchment[34]

Type of Logistic Hub	Location	District	Operator
Coal Dock Road & Container Freight Stations	Majerhat	South 24 Parganas	CONCOR
Inland Container Depot	Cossipore	Kolkata	CONCOR
Portside Container Terminal	Shalimar	Howrah	CONCOR
Rail linked port terminal	Haldia	Purba Medinipur	Kolkata Port Trust
Rail linked terminal with Personal Freight Terminal	Durgapur	Burdwan	CONCOR

According to the assessment of infrastructure based on primary and secondary research, there is poor connectivity by roads within Sunderbans. As a result, the passenger and cargo movement is solely dependent on waterways beyond certain connected centres. Additionally, difficult physiography with dispersed urban settlements and low economic development in the region, enhances the requirement to promote waterways for sustenance of livelihood.

Waterways provide a unique advantage over conventional transport modes as it is cost effective, environment friendly, has limited land issues for development and de-congests existing modes of transport. Hence, development of waterways provides a good alternative to current modes of transportation by relieving pressure on existing modes and optimizing passenger and freight movement.

Difficult physiography, dispersed urban settlements and low economic development enhance the **need to tap the huge potential for adopting waterways as a preferred mode of transportation** in the catchment i.e. movement within Sunderbans, Indo-Bangladesh Trade, India's North Eastern Region Transit Movement.

[34] Container Corporation of India (CONCOR), Kolkata Port Trust

4 Sunderbans Waterways – Technical Assessment

4 Sunderbans Waterways – Technical Assessment

The results of the technical surveys and inferences from the same are detailed out in this section.

4.1 Introduction – Survey Locations & Type of Surveys

The survey sites are located at six different survey locations and Hemnagar at Sunderbans, on the fringes of the world's largest mangrove forest. The Sunderbans is intersected by a complex network of tidal waterways, mudflats and small islands of salt-tolerant mangrove forests. The interconnected network of waterways makes almost every corner of the forest accessible by boat.

The Sunderbans along the Bay of Bengal has evolved over the millennia through natural deposition of upstream sediments accompanied by intertidal segregation. The physiography is dominated by deltaic formations that include innumerable drainage lines associated with surface and subaqueous levees, splays and tidal flats. There are also marginal marshes above mean tide level, tidal sandbars and islands with their networks of tidal channels, subaqueous distal bars and proto-delta clays and silt sediments.

The geographical coordinates of the 6 survey areas are shown in the following table.

Table 28: Coordinates of Hydrographic Survey Area

WGS 84 Spheroid, UTM Projection Zone 45N				
Survey Location	Geographic Coordinates		Area	
	Latitude	Longitude	Length (m)	Width (m)
Choto Bhanshyamnagar	21°47'19.94"N 21°47'42.49"N	88°23'29.90"E 88°23'59.73"E	1120	1150
Lothian Island	21°42'07.36"N 21°42'29.35"N	88°17'55.59"E 88°18'09.16"E	760	250
Kumirmari	22°11'26.55"N 22°11'24.57"N	88°56'50.94"E 88°57'03.88"E	380	270
Bagnapara	22°10'45.22"N 22°10'50.94"N	88°56'06.51"E 88°56'12.42"E	250	310
Mollakhali	22°10'26.25"N 22°10'21.22"N	88°54'01.82"E 88°54'10.35"E	290	850
Atharabanki	21°58'59.23"N 21°58'07.67"N	88°04'47.49"E 88°04'31.39"E	1670	2200

Apart from these 6 survey locations, surveys at the proposed terminal site at Hemnagar were also undertaken as part of the mandate.

The review of existing bathymetric charts and the results of the bathymetric, tidal, current velocity & discharge measurement, water & bottom samples, geotechnical and topographic surveys are explained below.

4.2 Bathymetric Survey

4.2.1 Survey Locations

1) Lothian Island

The stretch of around 760 m length and 250 m width is surveyed near the Lothian Island with the starting and ending Latitude(N) and Longitude(E) as (21 42'7.36" N, 88 17' 55.59" E) to (21 42' 29.35" N, 88 18' 9.16" E). The location is as shown in the figure.

Figure 14: Survey Location near Lothian Island

2) Choto Banashyamanagar

The section of around 1,120 m length and 1,150 m width is surveyed near the Choto Banashyamanagar with the starting and ending Latitude(N) and Longitude(E) as (21 47' 19.94" N, 88 23' 29.90" E) to (21 47' 42.49" N, 88 23' 59.73" E). The location is as shown in the following figure.

Figure 15: Survey Location near Choto Banashyamanagar

3) Mollakhali

The segment of around 290 m length and 850 m width is surveyed near the Kotka with the starting and ending Latitude (N) and Longitude (E) as (22 10' 26.25" N, 88 54' 1.82" E) to (22 10' 21.22" N, 88 54' 10.35" E). The location is as shown in the following figure.

Figure 16: Survey Location near Kotka

4) Bagnapara

The segment of around 250 m length and 310 m width is surveyed at Bagnapara with the starting and ending Latitude(N) and Longitude(E) as (22 10' 45.22" N, 88 56' 6.51" E) to (22 10' 50.94" N, 88 56' 12.42" E). The location is as shown in the following figure.

Figure 17: Survey Location – Bagnapara

5) Kumirmari

The segment of around 380 length and 270m width is surveyed at Kumirmari with the starting and ending Latitude(N) and Longitude(E) as (22 11' 26.55" N, 88 56' 50.94" E) to (22 11' 24.57" N, 88 57' 3.88" E). The location is as shown in the following figure.

Figure 18: Survey Location – Kumirmari

4.2.2 Controls for Bathymetric Survey

The survey controls that were established at the locations are explained below. The equipment's used for the survey were calibrated by the equipment supplier.

- **Sounding Datum**

  The bathymetric survey across the Rivers were carried out as per the Client specified line spacing. The main lines, that are running perpendicular to the coast, were spaced at 100 m intervals. In every area a cross line perpendicular to the main lines was run to check the sounding.

  Transfer of Sounding Datum at Hemnagar

  1. Sounding datum at the new gauge = d = m' - (M' - M) - (M x r) / R

     True Mean (Tide) Level at Springs = M = 0.5 (M.H.W.S.+ M.L.W.S.)
     M.H.W.S. = Mean High Water Spring at established gauge
     M.L.W.S. = Mean Low Water Spring at established gauge

  2. If MHWS & MLWS are not known then
     d = m' - (M' x r) / R

     +ve value means sounding datum at new gauge is above the zero
     -ve value means sounding datum at new gauge is below the zero

     Observed Mean H.W. = (b+2d+f)/4
     Observed Mean L.W. = (a+3c+3e+g)/8

Table 29: Transfer of Sounding Datum at Hemnagar

ESTABLISHED GAUGE AT SAGAR ROADS					NEW GAUGE HEMNAGAR				
Heights above Chart Datum					Heights above the Zero				
H.W.	L.W.	FACTOR	H.W.	L.W.	H.W.	L.W.	FACTOR	H.W.	L.W.

ESTABLISHED GAUGE AT SAGAR ROADS						NEW GAUGE HEMNAGAR					
Heights above Chart Datum						Heights above the Zero					
-	1.2	X	1	-	1.2	-	0.7	X	1	-	0.7
4.45	-	X	1	4.45	-	3.9	-	X	1	3.9	-
-	1.45	X	3	-	4.35	-	0.7	X	3	-	2.1
4.35	-	X	2	8.7	-	4.8	-	X	2	9.6	-
-	1.3	X	3	-	3.9	-	0.8	X	3	-	2.4
4.25	-	X	1	4.25	-	3.8	-	X	1	3.8	-
-	1.65	X	1	-	1.65	-	0.6	X	1	-	0.6
SUM				17.4	11.1	**SUM**				17.3	5.8
Mean H.W. = SUM/4				4.35	1.39	Mean H.W. = SUM/4				4.33	0.73
Mean L.W. = SUM/8						Mean L.W. = SUM/8					
Observed Mean Range = R						Observed Mean Range = r					
R = M.H.W. - M.L.W.				=	2.96	r = M.H.W. - M.L.W.				=	3.6
Observed Mean (Tide) Level = M'						Observed Mean (Tide) Level = m'					
M' = (M.H.W.+M.L.W.)/2				=	2.87	m' = (M.H.W.+M.L.W.)/2				=	2.53

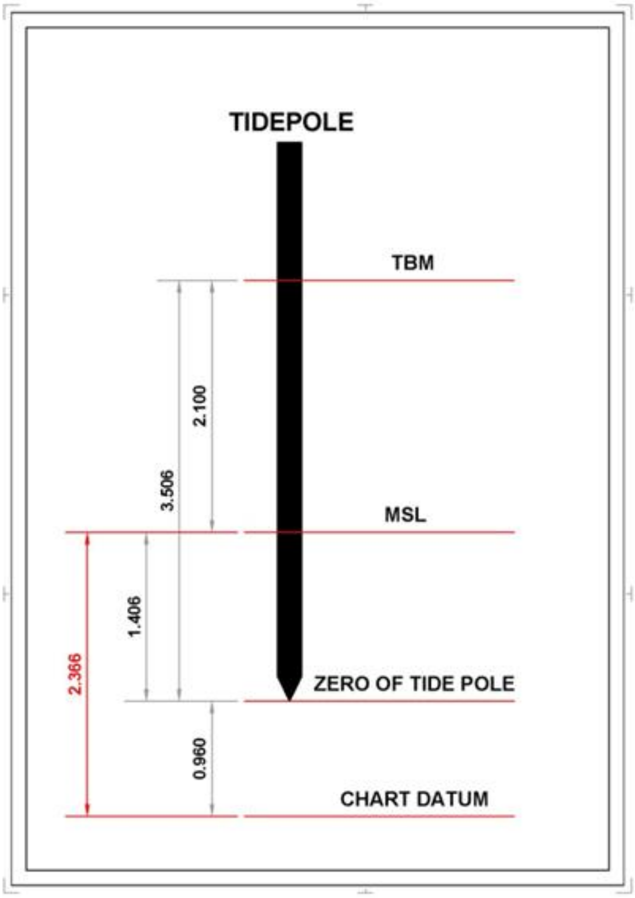
2nd Sounding datum at the new gauge = d = m' - (M' x r) / R

d=-0.96

Therefore, Sounding datum on the new gauge at Hemnagar is 0.96 m below on the gauge reading.

REDUCTION = ACTUAL READING + 0.96M

Figure 19: Diagram Showing Relationship Between Zero of Tide Pole & CD



a) TBM Value above MSL = 2.1 m

b) From the Transfer of Sounding Datum Calculations, it has been derived that Zero of the Tide Pole is 0.96 m above the Chart Datum.

c) From levelling Record it has been derived that the Zero of Tide Pole is 3.506 m below the TBM.

d) Therefore the difference between MSL & Zero of Tide pole = 3.506 m – 2.1 m
= 1.406 m

i.e Zero of Tide Pole 1.406 m below the MSL

e) Therefore, the difference between MSL and CD = 1.406 m +0.96 m
= 2.366 m

i.e. Chart Datum is 2.366 m below the MSL.

A new TBM1 was established for this project and the value of the same has been transferred to the new TBM 1 by using Auto Level. The leveling record is shown in the following tables.

Old TBM at Hemnagar Jetty was established by Base line processing during cluster 3 Survey. The elevation of the same was transferred using Transfer of Sounding Datum from Sagar**.** The value of the same is appended below

Location	Easting (m)	Northing (m)	Ht above MSL (m)	Ht above SD (m)
Hemnagar Jetty	704457.603	2456933.312	2.100	4.466

Base line Processing report is attached at Annexure – A

Leveling from Tide pole to Bench Mark

BS	FS	HI	RL	Remark
4.201		5.161	0.960	Tide Pole
	0.695		4.466	TBM

Leveling from Bench Mark to Tide Pole

BS	FS	HI	RL	Remark
0.776		5.242	4.466	TBM
	4.282		0.960	Tide Pole

The Height of TBM above SD is 4.466m.

Old BM calculation

TRANSFER OF SOUNDING DATUM AT HEMNAGAR

1. If MHWS & MLWS are not known then
   d = m' - (M' x r) / R

   +ve value means sounding datum at new gauge is above the zero
   -ve value means sounding datum at new gauge is below the zero

   Observed Mean H.W. = (b+2d+f)/4
   Observed Mean L.W. = (a+3c+3e+g)/8

	ESTABLISHED GAUGE AT SAGAR ROADS						NEW GAUGE HEMNAGAR					
	Heights above Chart Datum						Heights above the Zero					
	H.W.	L.W.	FACTOR		H.W.	L.W.	H.W.	L.W.	FACTOR		H.W.	L.W.
A	-	1.2	X	1	-	1.2	-	0.7	X	1	-	0.7
B	4.45	-	X	1	4.45	-	3.9	-	X	1	3.9	-
C	-	1.45	X	3	-	4.35	-	0.7	X	3	-	2.1
D	4.35	-	X	2	8.7	-	4.8	-	X	2	9.6	-
E	-	1.3	X	3	-	3.9	-	0.8	X	3	-	2.4
F	4.25	-	X	1	4.25	-	3.8	-	X	1	3.8	-
G	-	1.65	X	1	-	1.65	-	0.60	X	1	-	0.60
	SUM				17.4	11.1	**SUM**				17.3	5.8
	Mean H.W. = SUM/4				4.35	1.39	Mean H.W. = SUM/4				4.33	0.73
	Mean L.W. = SUM/8						Mean L.W. = SUM/8					

Established Gauge at Sagar Roads			New Gauge Hemnagar		
Observed Mean Range = R			Observed Mean Range = r		
R = M.H.W. - M.L.W.	=	2.96	r = M.H.W. - M.L.W.	=	3.60
Observed Mean (Tide) Level = M'			Observed Mean (Tide) Level = m'		

M' = (M.H.W.+M.L.W.)/2	=	2.87	m' = (M.H.W.+M.L.W.)/2	=	2.53

2nd Sounding datum at the new gauge = d = m' - (M' x r) / R

d= -0.96

Therefore, Sounding datum on the new gauge at Hemnagar is 0.96m below on the gauge reading.

REDUCTION = ACTUAL READING + 0.96M

2. TBM Value above MSL = 2.1 m
3. From the Transfer of Sounding Datum Calculations, it has been derived that Zero of the Tide Pole is 0.96 m above the Sounding Datum.
4. From leveling Record it has been derived that the Zero of Tide Pole is 3.506 m below the TBM.
5. Therefore the difference between MSL & Zero of Tide pole = 3.506 m – 2.1 m
   = 1.406 m

   i.e Zero of Tide Pole 1.406 m below the MSL
6. Therefore, the difference between MSL and SD = 1.406 m +0.96 m
   = 2.366m

   i.e. Sounding Datum is 2.366 m below the MSL.

Station Description is placed at Annexure –B

Table 30: Old TBM to TBM 1

BS	FS	HI	RL	REMARK
2.563		7.029	4.466	TBM
	0.095		6.934	TBM 1

BS – FS = 2.563 -0.095 = 2.468 m

TBM 1 is 2.468 m above the old TBM

Table 31: TBM 1 to Old TBM

BS	FS	HI	RL	REMARK
0.094		7.028	6.934	TBM 1
	2.562		4.466	TBM

BS – FS = 0.094 -2.562 = -2.468 m

Old TBM is 2.468 m below the TBM 1

Hence, the Height Difference Between Old TBM & TBM1 = (2.468+2.468)/2
= 2.468

Therefore, the Z Value of TBM 1 = Z Value of Old TBM + 2.468
= 4.466 + 2.468
= 6.934

The transferred Z value at TBM 1 is 6.934 m above CD.

TRANSFER OF SOUNDING DATUM AT CHOTO BHANSHYAM NAGAR

1. Sounding datum at the new gauge = d = m' - (M' - M) - (M x r) / R
   True Mean (Tide) Level at Spring = M = 0.5 (M.H.W.S+ M.L.W.S)
   M.H.W.S. = Mean High Water Spring at established gauge
   M.L.W.S. = Mean Low Water Spring at established gauge

2. If MHWS & MLWS are not known then = d = m' - (M' x r) / R
   +ve value means sounding datum at new gauge is above the zero

-ve value means sounding datum at new gauge is below the zero
Observed Mean H.W. = (b+2d+f)/4
Observed Mean L.W. = (a+3c+3e+g)/8

Table 32: Transfer of Sounding Datum at Choto Bhanshyamnagar

ESTABLISHED GAUGE AT SAGAR ROADS						NEW GAUGE CHOTO BHANSHYAMNAGAR					
Heights above Chart Datum						Heights above the Zero					
H.W.	**L.W.**	**FACTOR**		**H.W.**	**L.W.**	**H.W.**	**L.W.**	**FACTOR**		**H.W.**	**L.W.**
-	1.71	X	1	-	1.71	-	1.2	X	1	-	1.2
5.15	-	X	1	5.15	-	4.26	-	X	1	4.26	-
-	1.74	X	3	-	5.22	-	1.28	X	3	-	3.84
5.2	-	X	2	10.4	-	4.4	-	X	2	8.8	-
-	1.88	X	3	-	5.64	-	1.4	X	3	-	4.2
5.12	-	X	1	5.12	-	4.1	-	X	1	4.1	-
-	1.85	X	1	-	1.85	-	1.30	X	1	-	1.30
SUM				20.67	14.42	**SUM**				17.16	10.54
Mean H.W. = SUM/4				5.17	1.80	Mean H.W. = SUM/4				4.29	1.32
Mean L.W. = SUM/8						Mean L.W. = SUM/8					
Observed Mean Range = R						Observed Mean Range = r					
R = M.H.W - M.L.W				=	3.37	r = M.H.W - M.L.W				=	2.97
Observed Mean (Tide) Level = M'						Observed Mean (Tide) Level = m'					
M' = (M.H.W+ M.L.W)/2				=	3.49	m' = (M.H.W+M.L.W)/2				=	2.80

2^{nd} Sounding datum at the new gauge = d = m' - (M' x r) / R
d=-0.27

Therefore, sounding datum on the new gauge at Choto Banashyamanagar is 0.27 m below on the gauge reading.

REDUCTION = ACTUAL READING + 0.27M

Figure 20: Diagram Showing Relationship between Zero of Tide Pole & SD

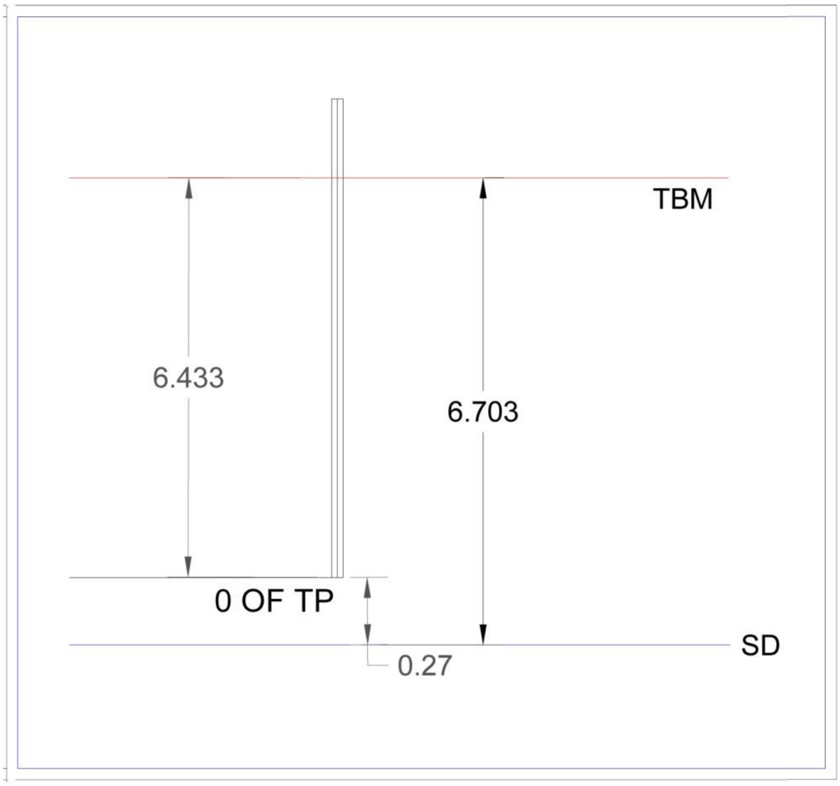


Table 33: Levelling from tide pole to TBM 2 at Choto Banashyamanagar (Leg 1)

BS	FS	HI	RL	REMARK
7.536		7.806	0.27	TIDE POLE
	1.103		6.703	TBM 2

BS – FS = 7.536 -1.103= 6.433 m
TBM is 6.433 m above the zero of the tide pole

Table 34: Levelling from TBM 2 to tide pole at Choto Banashyamanagar (Leg 2)

BS	FS	HI	RL	REMARK
0.652		7.355	6.703	TBM 2
	7.625		0.27	TIDE POLE

BS – FS = 0.625 -7.625 = -6.433 m

Zero of the Tide Pole is 6.433 m below the TBM
The average of Leg 1 & Leg 2 = (6.433 + 6.433)/2
= 12.866/2
= 6.433 m
Therefore, Zero of Tide Pole is 6.433 m below the TBM

1. From the Transfer of Sounding Datum Calculations, it has been derived that Zero of the Tide Pole is 0.27 m above the Sounding Datum.

2. From leveling Record it has been derived that the TBM is 6.433 m above the. Zero of Tide Pole

3. Therefore SD is below TBM = 0.27 m +6.433 m

   = 6.703 m

TRANSFER OF SOUNDING DATUM AT LOTHIAN ISLAND

1. Sounding datum at the new gauge = d = m' - (M' - M) - (M x r) / R
   True Mean (Tide) Level at Springs = M = 0.5 (M.H.W.S.+ M.L.W.S.)
   M.H.W.S. = Mean High Water Spring at established gauge
   M.L.W.S. = Mean Low Water Spring at established gauge

2. If MHWS & MLWS are not known then = d = m' - (M' x r) / R
   +ve value means sounding datum at new gauge is above the zero
   -ve value means sounding datum at new gauge is below the zero
   Observed Mean H.W. = (b+2d+f)/4
   Observed Mean L.W. = (a+3c+3e+g)/8

Table 35: Transfer of Sounding Datum at Lothian Island

ESTABLISHED GAUGE AT SAGAR ROADS						NEW GAUGE CHOTO BHANSHYAMNAGAR					
Heights above Chart Datum						Heights above the Zero					
H.W.	L.W.	FACTOR		H.W.	L.W.	H.W.	L.W.	FACTOR		H.W.	L.W.
-	1.89	X	1	-	1.89	-	0.72	X	1	-	0.72
4.95	-	X	1	4.95	-	3.53	-	X	1	3.53	-
-	1.91	X	3	-	5.73	-	0.75	X	3	-	2.25
4.96	-	X	2	9.92	-	3.62	-	X	2	7.24	-
-	2.08	X	3	-	6.24	-	0.62	X	3	-	1.86
4.74	-	X	1	4.74	-	3.43	-	X	1	3.43	-
-	2.07	X	1	-	2.07	-	0.71	X	1	-	0.71
SUM				19.61	15.93	SUM				14.2	5.54
Mean H.W. = SUM/4				4.90	1.99	Mean H.W. = SUM/4				3.55	0.69
Mean L.W. = SUM/8						Mean L.W. = SUM/8					
Observed Mean Range = R						Observed Mean Range = r					
R = M.H.W. - M.L.W.				=	2.91	r = M.H.W. - M.L.W.				=	2.86
Observed Mean (Tide) Level = M'						Observed Mean (Tide) Level = m'					
M' = (M.H.W.+ M.L.W.)/2				=	3.45	m' = (M.H.W.+M.L.W.)/2				=	2.12

2[nd] Sounding datum at the new gauge = d = m' - (M' x r) / R
d=-1.26

Therefore, Sounding datum on the new gauge at Lothian Island is 1.26 m below on the gauge reading.

REDUCTION = ACTUAL READING + 1.26M

Figure 21: Diagram Showing Relationship Between Zero of Tide Pole & CD

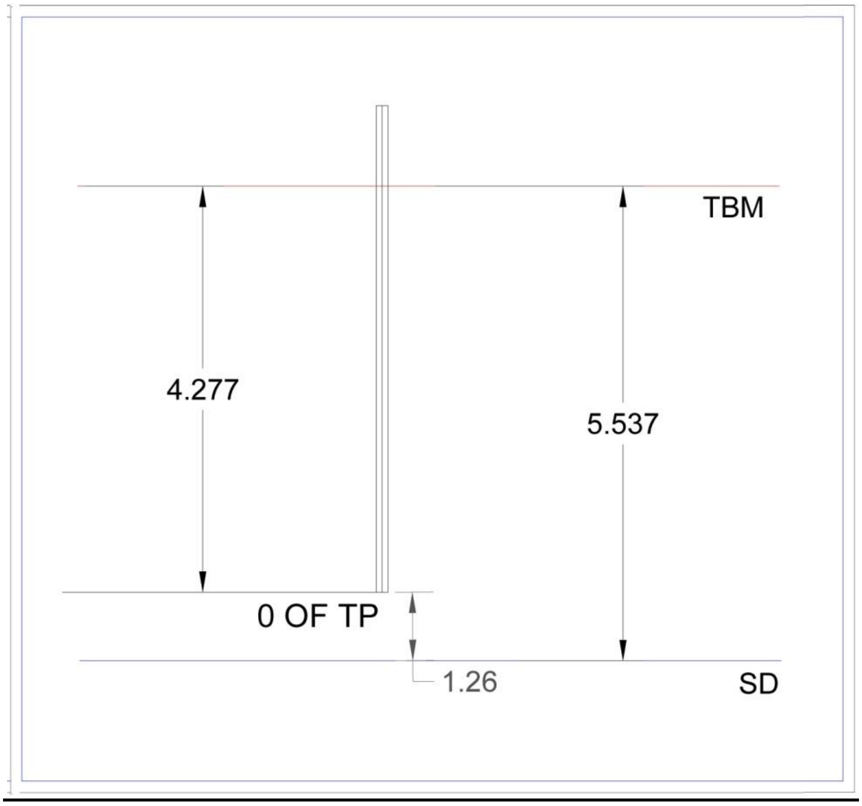


Table 36: Levelling from TBM 3 to tide pole at Lothian Island (Leg 1)

BS	FS	HI	RL	REMARK
1.286		6.823	5.537	TBM 3
	4.363		2.46	TIDE POLE

BS – FS = 1.286 -4.363= -3.077 m
Zero of the tide pole is 3.077m below the TBM

Table 37: Levelling from tide pole to TBM 3 at Lothian Island (Leg 2)

BS	FS	HI	RL	REMARK
4.352		6.812	2.46	TIDE POLE
	1.275		5.537	TBM 3

BS – FS = 4.352 -1.275 = 3.077m

TBM is 3.077 m above the zero of the tide pole
The average of Leg 1 & Leg 2 = (3.077+3.077)/2
= 6.154/2
= 3.077 m
Therefore, Zero of Tide Pole is 3.077 m below the TBM

4. From the Transfer of Sounding Datum Calculations, it has been derived that Zero of the Tide Pole is 0.27 m above the Sounding Datum.

5. From leveling Record it has been derived that the zero of tide pole is 5.433 m below the TBM.
6. Therefore SD is below TBM = 1.26 m + 3.077 m

   = 4.337 m

- **Horizontal Control**
  The following table provides the geodetic parameters adopted during the survey.

Table 38: Geodetic Parameters

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 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
Map Projection Parameters	
Map Projection:	Universal Transverse Mercator
Grid System:	UTM Zone 45 N
Central Meridian:	087° 00' 00" East
Latitude of Origin:	0° 00' 00" North
False Easting:	500 000 m
False Northing	0
Scale Factor at Central Meridian	0.999

- **Vertical Control**
  The vertical control of the survey area is based on the datum levels established by Geoservices Maritime Pvt Ltd at Hemnagar jetty during IWAI Cluster 3 Survey. Tide poles were set up at jetties near the survey areas, for the duration of survey. The tide poles remained vertical during the course of survey and no shift was observed in the poles for the duration of survey. The value of old TBM at Hemnagar Jetty was used to transfer datum (MSL/CD) to the new Base station at the top staircase of Hemnagar Jetty. New TBMs were established near each survey area. The value of these TBMs w.r.t. CD was obtained by base line processing by using Spectra software.

  The Base line processing results with respect to sounding datum of from TBM 1 to TBM 2 are placed at Annexure F.

  The final co-ordinates of these Temporary Bench Marks are shown in the following table.

Procedure for establishment of TBM 1 at Hemnagar Jetty

A 24 hour observation was carried out to establish the X Y values of TBM1 for IWAI/Feedback project and the Z value of the same has been transferred from Old TBM to TBM 1 by using Auto Level. The leveling record is as follows:-

OLD TBM TO TBM 1

BS	FS	HI	RL	REMARK
2.563		7.029	4.466	TBM
	0.095		6.934	TBM 1

BS – FS = 2.563 -0.095 = 2.468 m

TBM 1 is 2.468 m above the old TBM

TBM 1 TO OLD TBM

BS	FS	HI	RL	REMARK
0.094		7.028	6.934	TBM 1
	2.562		4.466	TBM

BS – FS = 0.094 -2.562 = -2.468 m

Old TBM is 2.468 m below the TBM 1

Hence, the Height Difference Between Old TBM & TBM1 = (2.468+2.468)/2
= 2.468

Therefore, the Z Value of TBM 1 = Z Value of Old TBM + 2.468
= 4.466 + 2.468
= 6.934

The transferred Z value at TBM 1 is 6.934 m above SD.

Table 39: Coordinates of temporary bench marks

Description	Location	Latitude (N)	Longitude (E)	Ellipsoidal Height (m)	Height above MSL (m)	Height above SD (m)
TBM 1	Hemnagar Jetty	22°12'22.594"N	88°59'00.654"E	-52.435	4.430	6.934
TBM 2	Chotto Bhanshyanagar	21°47'11.240"N	88°23'31.603"E	-53.894	3.926	6.703
TBM 3	Uttarchandanpiri	21°42'22.442"N	88°17'05.634"E	-54.716	3.416	5.537
TBM 4	Kumirmari	22°11'29.805"N	88°57'04.922"E	-52.622	4.269	6.784
TBM 5	Bagnapara	22°10'57.448"N	88°56'13.777"E	-52.535	4.366	6.867
TBM 6	Mollakhali	22°10'33.106"N	88°53'27.656"E	-52.764	4.143	6.294

Temporary bench marks were marked as shown in the following figure.

Figure 22: TBM at Lothian

Figure 23: TBM at Bagnapara

4.2.3 Survey Results

The survey at Sunderbans Island Waterways was carried out during 02 Sep to 14 Sep 2016. The Current meter observation was carried out using Valeport Current Meter at the prescribed shoal locations at the depth of surface, .5d, .3d and surface. Tide Gauge was used to record the Tidal Levels within the survey areas. Bottom Samples were collected using Van Veen Grab and the water samples were collected using Niskin Type sampler at the depth of surface, .5d, .3d and surface. The sounding data was post processed in HyPack 2011software. Soundings were reduced to CD and represented as AutoCAD Charts drawn to the scale of 1:1000 (for river width less than 500 meter) and 1:5000 (for river width more than 500 meter).

The charted soundings were found to vary in all the area. Being the delta of Bay of Bengal, the depth varies very frequently in very short span. The minimum and maximum depth of the allotted areas are appended in the following table.

Table 40: Minimum and Maximum Depth of allotted areas

Survey Location	Min. Depth w.r.t CD	Location		Max. Depth w.r.t CD	Location	
		Easting (m)	Northing(m)		Easting (m)	Northing(m)
Chotto Bhanshya mnagar	0.3	644 080.60	2 410 158.30	1.5	644 082.28	2 411 410.21
Lothian Island	0	634 478.53	2 400 498.70	8.3	634 405.02	2 400 362.35
Kumirmari	2.6	701 157.52	2 455 281.61	3.9	701 143.44	2 455 090.64
Bagnapara	1.3	699 819.70	2 454 078.55	4.9	699 505.84	2 454 137.06
Mollakhali	9.8	695 917.56	2 452 829.74	13.5	696 238.64	2 453 492.40
Athrabanki	0.1	714 470.00	2 432 386.26	1.8	716 073.86	2 431 286.71

4.3 Tide Measurement

4.3.1 Methodology

The tidal levels within the survey area were measured by installing the Tide pole at the jetty near to the survey area. Manual readings were taken at an interval of 10 min for the entire duration of the survey.

The vertical reference of the Chart Datum was correlated to the Tide pole location using Auto Level.
The observed tide variation within the survey area suggests that the fluvial dynamics of the rivers within the survey area is largely influenced by the tide.

The field records, generated during the determination of the Level of Tide pole location, are presented in Annexure G.

Table 41: Vertical Refence of Tide Pole Locations

Vertical Reference of the Tide Gauge Location	
Location of Tide Gauge	Choto Bhanshyamnagar Jetty
Vertical Reference of the Local Bench Mark with reference to Sounding Datum	+6.703m
Determined Vertical Reference of the Tide pole with respect to Sounding Datum (‘0” of TP)	+ 1.270
SD value w.r.t MSL at Tide Gauge	2.777m
Date of Observation	05 Sep 16

Vertical Reference of the Tide Gauge Location	
Location of Tide Gauge	Uttar Chandanpidi Jetty
Vertical Reference of the Local Bench Mark with reference to Chart Datum	+5.537m
Determined Vertical Reference of the Tide pole with respect to Sounding Datum (‘0” of TP)	+ 2.460m
SD value w.r.t MSL at Tide Gauge	2.121m
Date of Observation	06 Sep 16

Vertical Reference of the Tide Gauge Location	
Location of Tide Gauge	Kumir Mari Jetty

Vertical Reference of the Tide Gauge Location	
Vertical Reference of the Local Bench Mark with reference to Chart Datum	+6.784m
Vertical Reference of the Tide Gauge Location with respect to Sounding Datum (‘0” of ATG)	+2.03m
SD value w.r.t MSL at Tide Gauge	2.515m
Date of observation	08 Sep 16

Vertical Reference of the Tide Gauge Location	
Location of Tide Gauge	Bagnapar Jetty
Vertical Reference of the Local Bench Mark with reference to Chart Datum	+6.867m
Determined Vertical Reference of the Tide Gauge Location with respect to Sounding Datum (‘0” of ATG)	+ 1.457m
SD value w.r.t MSL at Tide Gauge	2.501m
Date of observation	09 Sep 16

Vertical Reference of the Tide Gauge Location	
Location of Tide Gauge	Mollakhali Jetty
Vertical Reference of the Local Bench Mark with reference to Chart Datum	+6.294m
Determined Vertical Reference of the Tide Gauge Location with respect to Sounding Datum (‘0” of ATG)	+ 2.681m
SD value w.r.t MSL at Tide Gauge	2.151m
Date of observation	10 Sep 16

Vertical Reference of the Tide Gauge Location	
Location of Tide Gauge	Hemnagar
Vertical Reference of the Local Bench Mark with reference to Chart Datum	+6.934m
Determined Vertical Reference of the Tide Gauge Location with respect to Sounding Datum (‘0” of ATG)	+ 1.696m
SD value w.r.t MSL at Tide Gauge	2.504m
Date of observation	13 Sep 16

The Tide poles were erected at each designated location and manually recorded at an interval of 10 min throughout the survey period. TBMs were established near every location and the height of tide pole were determined by levelling. The tide pole installation at Kumirmari Jetty is shown in the following figure.

Figure 24: Installation of Tide Pole at Kumirmari Jetty

Figure 25: Tide Pole erection at Lothian

4.3.2 Survey Results

The tidal measurements were carried out in the 6 locations. The maximum and minimum tidal values are as shown in the following table.

Table 42: Tidal Measurements in 6 Survey Locations

Survey Location	Max Tide Level (m)	Min Tide Level (m)
Chota Banshyamnagar	3.45	1.64
Lothian Island	4.96	4.46
Bagnapara	4.047	2.757
Mollakhali	4.191	3.081
Hemnagar	5.036	1.986

All the 6 survey locations fall under tidal influence which would facilitate better navigation during high tide. On an average, minimum tide level observation is ~2 m and maximum tide level observation is ~5 m.

4.4 Current Velocity and Discharge Measurement Survey

The current velocities survey for the proposed locations has been carried out and the details are as explained in Annexure J.

4.4.1 Methodology

A Valeport Model 106 Current Meter was used to determine the direction and speed of the current in the survey area. The current meter was deployed at six locations within the different rivers. The current meter system was configured to record the data at 10 seconds interval and the data were stored in the internal memory of the system after recovering the current meter, the internally stored data were retrieved through Data Log Software and further analysis to derive the velocity and direction of the River current. The processed data is placed at Annexure J.

Figure 26: Deploying Current Meter

4.4.2 Survey Results

Current meter observations were carried out at each location at different depths using Valeport Current meter. The observations were carried out at the deepest route of the channels. The location of the observation is shown in the following table.

Table 43: Location of current meter observations

Survey Location	Position		Depth (D) in m	Velocity (m/sec)				Average velocity (m/sec)	Discharge (m^3/sec)
	Easting	Northing		Surface	0.3 D	0.5 D	1 D		
Choto Banashyamnagar	644153.81	2410933.69	7	0.782	0.723	0.679	0.454	0.659	1996.375
Lothian Island	634558.68	2400862.48	7	0.497	0.478	0.410	0.325	0.427	79.764
Kumirmari	700912.92	2455199.17	5	0.512	0.272	0.712	0.581	0.519	313.424
Baganapara	699578.02	2454192.96	12	0.365	0.223	0.224	0.237	0.262	254.926
Mollakhali	696155.33	2453363.65	8	0.216	0.104	0.453	0.359	0.283	1278.481
Atharabanki	715508.86	2431530.86	20	0.460	0.299	0.122	0.080	0.240	6584.194

Table 44: Current meter measurements

	Max Current Velocity (m/s)		Min Current Velocity (m/s)	
Survey Location	Velocity in m/s	Depth (m)	Velocity in m/s	Depth (m)
Choto Banashyamnagar	0.8	Surface	0.4	5.5
Lothian Island	0.5	Surface	0.3	6
Kumirmari	0.6	2.5	0.1	1.5
Baganapara	0.4	Surface	0.1	6
Mollakhali	0.5	8 m	0.1	2.4
Atharabanki	0.5	Surface	0.1	2

The current velocities indicate that there would be no navigation issues on the waterways. The detailed report is placed at Annexure J.

4.5 Water and Bottom Samples

4.5.1 Methodology

The nature of the riverbed & water properties in the survey area was determined by collecting river water and bed sediment samples at various locations within the survey area. A Van Veen Grab was used to collect the sediment samples and water samples were collected using Niskin Type sampler. A total of 06 sediment samples and 24 water samples were collected from the river bed within the proposed survey area. The samples were lab tested to classify into different sedimentary sequences. The Lab report is placed at Annexure I.

Water samples were collected at four different depths using Niskin type water sampler at every location. The location of the sample collected are appended in the following table.

Table 45: Location of water samples

Location	Latitude	Longitude	Easting (m)	Northing (m)	Depth (m)
Choto Banashyamnagar	21° 47' 44.7989	88° 23' 30.8907	643889.67	2410871.71	7
	21° 47' 44.9258	88° 23' 31.0374	643893.85	2410875.65	3.5
	21° 47' 45.0619	88° 23' 31.1000	643895.61	2410879.85	2.2
	21° 47' 45.1839	88° 23' 31.1712	643897.62	2410883.62	Surface
Lothian Island	21° 42' 21.3974	88° 18' 0.2110	634476.48	2400843.95	7
	21° 42' 21.3016	88° 18' 0.0657	634472.33	2400840.97	3.5
	21° 42' 21.3016	88° 17' 59.8926	634467.29	2400848.65	2.2
	21° 42' 21.4496	88° 17' 59.8499	634466.09	2400845.47	Surface
Kumirmari	22° 11' 26.2609	88° 56' 56.5120	700938.54	2455218.21	5
	22° 11' 26.1394	88° 56' 56.4499	700936.81	2455214.45	2.5

Location	Latitude	Longitude	Easting (m)	Northing (m)	Depth (m)
	22° 11' 26.3652	88° 56' 56.2722	700931.63	2455221.33	1.5
	22° 11' 25.9770	88° 56' 56.4878	700937.96	2455209.47	Surface
Baganapara	22° 10' 52.2985	88° 56' 10.9079	699645.51	2454156.81	7
	22° 10' 52.3670	88° 56' 10.7245	699640.23	2454158.85	3.5
	22° 10' 52.4551	88° 56' 10.9722	699647.29	2454161.65	2.2
	22° 10' 52.2716	88° 56' 10.8192	699642.98	2454155.95	Surface
Mollakhali	22° 10' 28.0559	88° 54' 7.8977	696130.93	2453366.55	8
	22° 10' 28.1767	88° 54' 8.0491	696135.22	2453370.32	4
	22° 10' 28.2593	88° 54' 8.1319	696137.56	2453372.89	2.4
	22° 10' 28.3504	88° 54' 8.2106	696139.78	2453375.72	Surface
Atharabanki	21° 58' 47.1132	89° 5' 12.9398	715479.54	2432055.20	20
	21° 58' 47.2152	89° 5' 13.0197	715481.79	2432058.37	10
	21° 58' 47.3113	89° 5' 13.1062	715484.23	2432061.36	6
	21° 58' 47.2639	89° 5' 13.0473	715482.56	2432059.88	Surface

The detailed report of the same is placed in Annexure I.

Figure 27: Collected water sample

Soil Samples were collected from each designated locations by using Vanveen Grab. The location of the sample collected are shown in the following table.

Table 46: Locations of soil samples

Soil Sample				
Location	Position			
	Easting(m)	Northing(m)	Latitude	Longitude
Choto Banashyamnagar	644694.04	2410810.84	21º47'42.58"	088º23'58.88"
Lothian Island	634125.70	2400521.93	21º42'11.02"	088º17'47.91"
Kumirmari	701162.04	2455072.82	22º11'21.44"	088º57'04.25"
Baganapara	699321.48	2453982.91	21º10'46.78"	088º55'59.52"
Mollakhali	695932.99	2452841.37	21º10'11.07"	088º54'00.76"
Atharabanki	713920.96	2430883.21	21º58'09.71"	089º04'18.07"

The detailed report is placed in Annexure I.

4.5.2 Survey Results

The survey results of the water sample are shown in the following table.

Survey Location	Avg. pH	Avg. Specific Gravity	Avg. Sediment Concentration % by Mass
Choto Banashyamnagar	7.2075	1.010675	0.000241
Lothian Island	7.29	1.013148	0.000174
Kumirmari	7.2975	1.007923	0.00013575
Baganapara	7.32	1.004763	0.00006725
Mollakhali	7.3875	1.008659	0.000095
Atharabanki	7.335	1.008202	0.0001845

The survey results of the soil sample are shown in the following table.

Survey Location	pH	Specific Gravity	Grain size Distribution			Uniformity Coefficient (Cu)	Coefficient of Curvature (Cc)
			Gravel (%)	Sand (%)	Fine (Silt+Clay)%		
Choto Banashyamnagar	6.81	1.51	1.54	21.17	77.29	1.72	1.03
Lothian Island	6.89	1.39	1.60	27.86	70.54	3.40	0.94
Kumirmari	6.75	1.54	1.70	25.06	73.24	1.83	0.72
Baganapara	6.71	1.50	3.25	13.05	83.70	3.49	1.09
Mollakhali	7.10	1.52	1.0	2.0	79.0	2.10	0.25
Atharabanki	7.21	1.75	3.0	38.34	58.65	3.23	0.48

The two surveys conducted at the proposed Hemnagar Terminal were geotechnical and topographic surveys. The survey location is shown in the following table.

Table 47: Coordinates of Topographic Survey Area

Description	WGS 84 Spheroid, UTM Projection Zone 45N Geographic Coordinates		Area	
	Latitude	Longitude	Length (M)	Width (M)
Hemnagar	22°12'23.67"N	88°59'0.08"E	400	150

These surveys have been explained below.

4.6 Geotechnical Survey

Two boreholes were carried out at Hemnagar jetty locations and the field ‘N’ values vary from 1 to 23 and 1 to 28 in the BH – 01 and BH – 02 respectively. The sub-soil at the site locations can be broadly classified into 5 different strata up to the maximum depth of exploration of 25 m.

- At the jetty site, below the top, 0.3 m thick top soil, there exists a ‘very soft’, bluish grey, organic, silty clay deposit (Stratum-I) continued upto a depth of 11 m from the Existing Ground Level (EGL), with SPT ‘N’ value as low as 1, followed by a bluish grey, ‘soft’, organic, silty clay deposit (Stratum-II) extended upto a design depth of 15.5 m.
- Below this, there exists a medium stiff to stiff, bluish grey, silty Clay deposit (Stratum-III), observed upto a design depth of 19.5 m.

- This is followed by a seam of bluish grey, silty sand deposit (Stratum-IV) upto 21.7 m depth. Below this & upto the maximum depth of exploration of 25 m, there exists a medium stiff to stiff, bluish grey, silty clay deposit (Stratum-V).

Further details of the geo-technical analysis are presented in Annexure K. The laboratory results of the soil sample are given in Annexure L.

Figure 28: Erection of Tripod for Geotechnical Investigation

Figure 29: Cored Sample at Hemnagar

Figure 30: Collected Soil Sample

4.7 Topographic Survey

4.7.1 Methodology

Topographic survey of area within the client given boundary coordinates was carried out using reference point TBM 1 at Hemnagar jetty with the help of RTK Rover and Total Station. The required datasets were logged into the survey data loggers of RTK SPS855 by placing the Rover antenna pole on ground and permanent feature such as roads, drains, structures, etc. within the survey area. Total station was used in the areas covered with dense forest where RTK observations were not possible.

The horizontal & vertical coordinates (i.e X, Y & Z values) of all required existing structures as well as spot levels were recorded in the data loggers.

Topographic details such as spot heights of roads, tree, fence, existing pillars, structures, mounds were recorded and have been detailed out in the annexures.

Levelling was carried out within the survey areas using an Auto Level. All levels are with reference to CD Level. The other topographic features include Hemnagar Jetty, pond, Electric pole, IWAI Office, Govt School, kaccha (non-concrete) roads, Mangroves, trees (Coconut, Palm) and waste lands. All the features were mapped during the topographic survey and placed in AutoCAD Drawings.

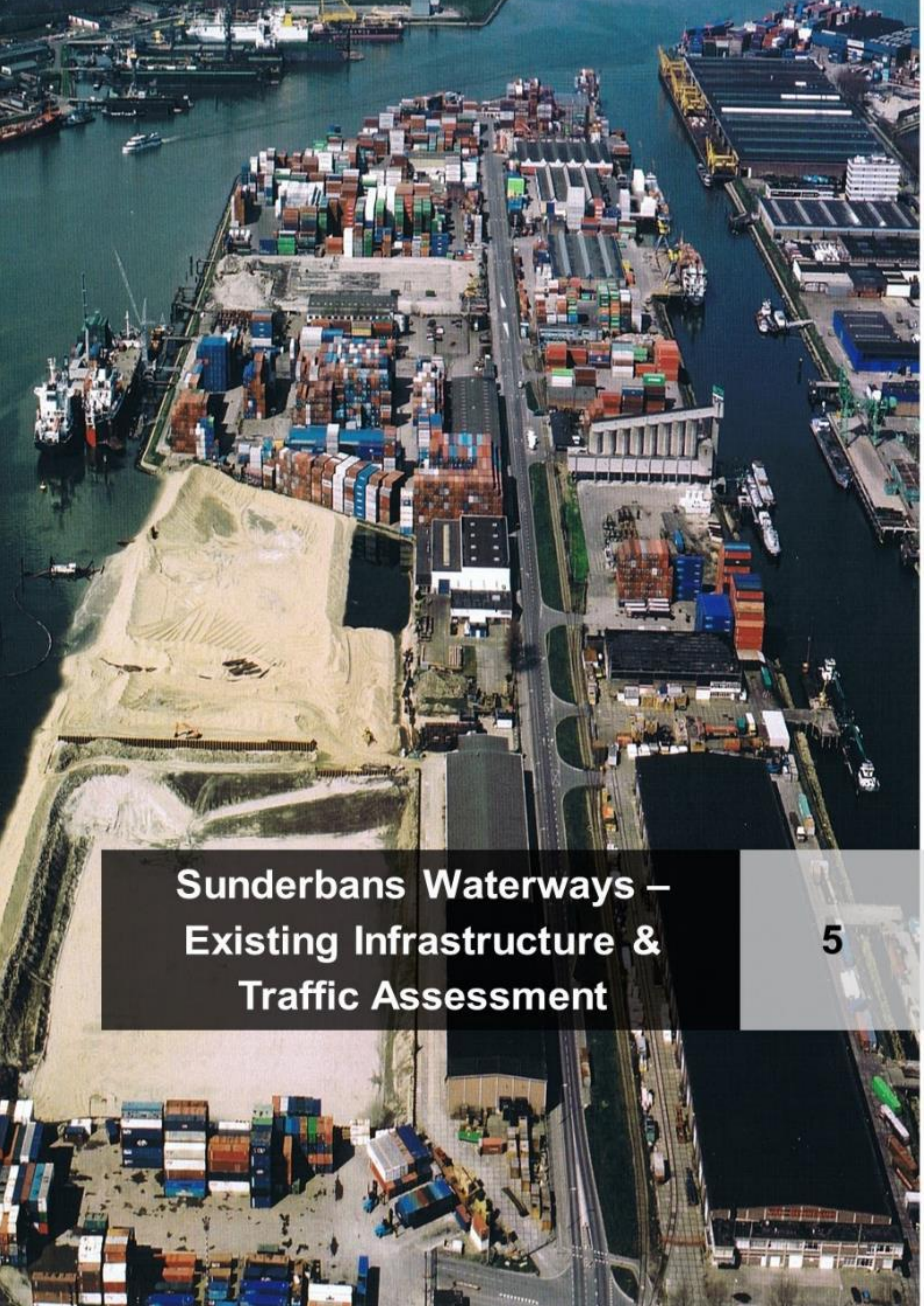
4.7.2 Survey Results

The following table summarizes the level measurements.

Table 48: Summary of Levelling Observations

Summary of Levelling Observations						
Levels	Western Survey Area			Eastern Survey Area		
	Value	Easting(m)	Northing(m)	Value	Easting(m)	Northing(m)
Maximum	5.84	704387.55 E	2457019.88 N	5.43	704537.55 E	2456989.88 N
Minimum	0.48	704537.55 E	2456979.88 N	1.2	704557.83 E	2456949.96 N

The results display considerable shoal formation and sedimentation at the survey locations. However, as there is significant tidal influence with minimal velocity, navigation through waterways is possible during high tide. The sedimentation analysis indicates significant proportion of fine particles (silt and clay).



5

Sunderbans Waterways – Existing Infrastructure & Traffic Assessment

5 Sunderbans Waterways – Existing Infrastructure and Traffic Assessment

5.1 Sunderbans – Traffic Overview

5.1.1 Movement within Sunderbans

Passenger Traffic

There is considerable amount of passenger movement within Sunderbans, mainly because tourism and work. This movement is by ferry across rivers, on short stretches along rivers and tourism-based passenger traffic.

As per press release by Alapan Bandyopadhyay, Principal Secretary of the State Transport Department, daily 40,000 people use the waterways operated by the West Bengal Surface Transport Corporation Limited and the Hooghly Nadi Jalpath Paribahan Samabay Samity Limited.[35] It is estimated that ~2 lakh tourists visited Sunderbans in the last financial year.

The major market areas are concentrated in Gosaba, Basanti, Sonakhali, Godhkhali, Dhamakhali, Kumirmari and Dugdugi. The people working in these market areas are residents of Pathankhali, Chandipur, Raidighi and Sajalia. They use the ferry services to travel to and fro for work on a daily basis at a price of INR 5-10 per trip.

The major centres that are connected by bituminous road in this region are Canning, Sonakhali, Basanti and Godhkhali. Tourists travel by road from Kolkata to Godhkhali Jetty (via Canning), which is the starting point of the boat journey to Sunderbans.

Table 49: Road Distance of Connected Market Centers from Kolkata (in km)

Market Center	Distance (in km)
Sonakhali	94
Canning	57
Gosaba	108
Basanti	95
Godhkhali	101

Commodity Traffic

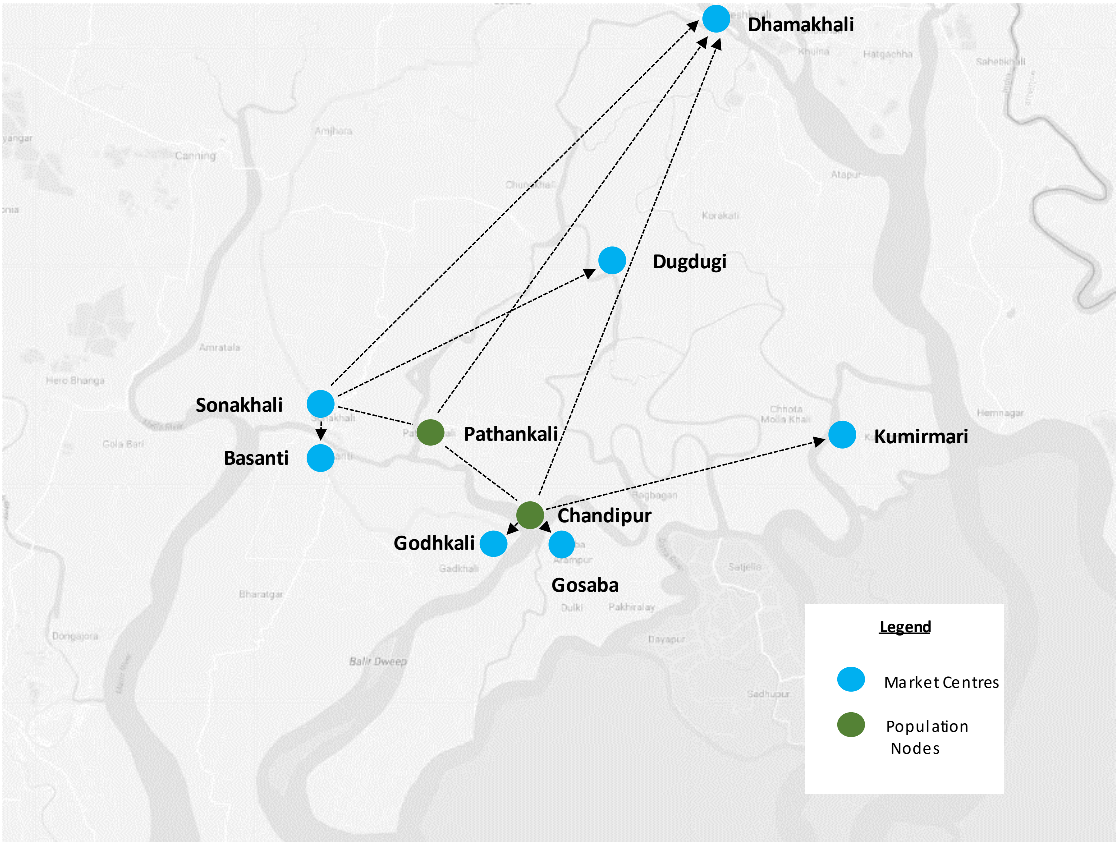
There are few operators in Sonakhali market area that send commodities to Basanti via boats. They have a fleet of 15 boats, each with a capacity of 15 tons. The daily average traffic to Gosaba is 125 tons.

The commodities carried by these boats mainly include vegetables (majorly potatoes), rice, cement (Ambuja Cement, ACC, Birla), wheat flour (atta), maida flour, biscuits and chips. Rice is sent by Food Corporation of India (FCI) from Sonakhali to Gosaba, Rangabali, Bali, Beltala, Pathankhali.

The major population centres and market areas within Sunderbans are shown in the following map.

[35] https://www.telegraphindia.com/1161002/jsp/7days/story_111341.jsp – October, 2016

Figure 31: Passenger and Commodity movement within Sunderbans



5.2 Movement on Indo-Bangladesh Protocol Route

5.2.1 Protocol Agreement – Overview

An Indo-Bangladesh Protocol on Inland Water Transit & Trade exists as a mutually beneficial agreement under which inland vessels of one country can transit through the specified routes of the other country. It was undertaken to enhance bilateral trade between the two countries by bringing down the transportation cost of EXIM cargo. The first protocol on Inland Water Transit and Trade between India & Bangladesh was signed in 1972 and was renewable every two years.

In 2015, the countries decided to further strengthen trade relations and better utilize the protocol routes. The Protocol on Inland Water Transit and Trade was signed in June, 2015 and it was mutually decided to renew the Protocol automatically after every five years.

Under the Protocol Agreement both the countries agreed for the following:

- Each country will maintain the river routes falling within its territory in a navigable condition and will provide all the essential pilotage and conservancy services including hydrographic surveys and supply of charts.
- Both the Governments shall share equal carriage of inter-country trade and transit cargo on equal tonnage basis (50:50).

Protocol Routes

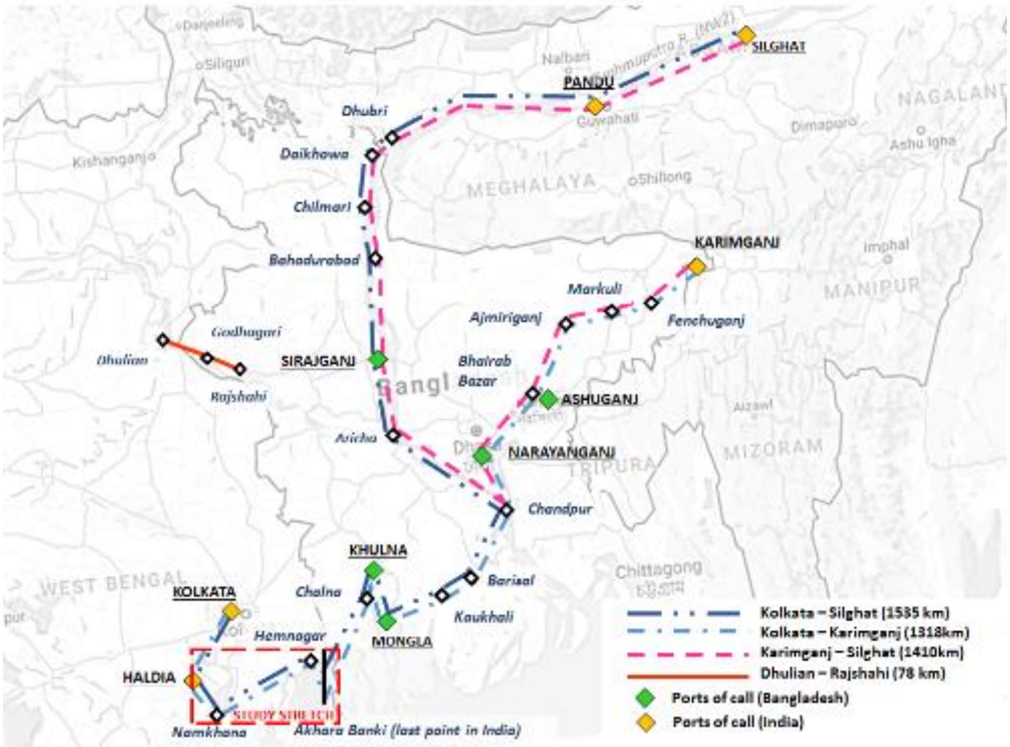
The protocol routes defined under Protocol Agreement are connected through 10 ports of call equally divided among two countries. The routes are:

- **Kolkata - Silghat (1,535 km)** – this route acts as a bridge between NW1 (Allahabad - Haldia) and NW2 (Dhubri - Sadiya) by connecting them in Assam. It moves eastwards till Chandpur, Bangladesh and then moves northwards joining Silghat, Assam.
- **Kolkata - Karimganj (1,318 km)** – this runs along Kolkata - Silghat route and diverts from Chandpur, Bangladesh to move eastwards through Ashuganj, Bangladesh, finally connecting Karimganj, Assam

- **Silghat – Karimganj (1,410 km)** – It is a transit route from Karimganj in Assam to Silghat in Assam and runs along the above two protocol routes.
- **Dhulian – Rajshahi (78 km)** – it is a short transit cargo route on the western side of Bangladesh.

Out of the above routes, **the Kolkata-Silghat and Kolkata-Karimganj routes are relevant for the current mandate** as they traverse through the Sunderbans Waterways (and the study stretch).

Figure 32: India – Bangladesh Protocol Routes

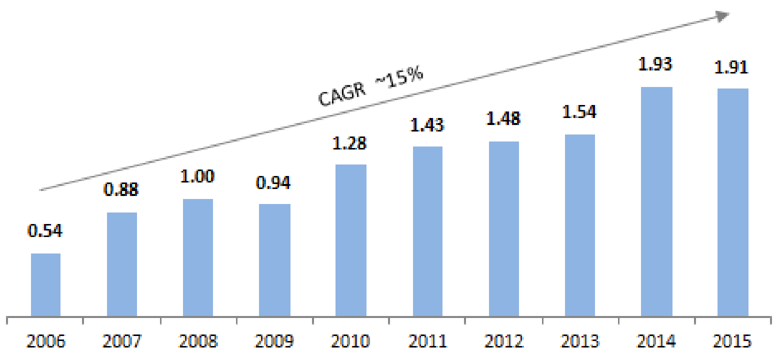


The movement on the protocol route can be classified into trade and transit traffic as explained below.

5.2.2 Trade Cargo

As mentioned earlier, the Indo-Bangladesh protocol route is the major contributor towards Indo-Bangladesh trade through waterways. The volume of goods transported through the protocol routes has increased at a CAGR of 15% from 0.54 million tons in 2006 to 1.91 million tons in 2015. Based on the statistics published by Bangladesh Inland Water Transport Authority, the international trade volume in the last 10 years through the protocol routes is as shown in the following figure.

Figure 33: Protocol Route International Trade Volume in (Mn tons)



As indicated in the below table, majority of the trade between the countries is carried by Bangladesh vessels (~ 99% in the last 5 years). The contribution of Indian vessels has rapidly declined **from levels of 40-50% in early 2000s to almost negligible in the last 5 years.**

Table 50: Vessel Movement Statistics

Year	Cargo Volume (mn tons)	Trips by Bangladeshi Vessels	Trips by Indian Vessels	Ratio of Volume by Bangladesh : India Vessels
2002	0.11	170	258	45:55
2003	0.21	458	390	58:42
2004	0.18	372	120	66:34
2005	0.41	1,142	90	91:09
2006	0.54	1,492	-	100:00
2007	0.88	1,540	-	100:00
2008	1.00	1,976	02	99:01
2009	0.94	1,329	11	98:02
2010	1.28	1,918	16	99:01
2011	1.44	2,063	21	99:01
2012	1.49	2,033	36	96:04
2013	1.55	1,977	32	97:03
2014	1.93	2,332	31	99:01

The dominance of Bangladeshi operators is due to one-way traffic / lop-sided demand of cargo from Bangladesh, low vessel operating cost (cheaper diesel cost, cheaper labour cost, etc.) of Bangladesh vessels vis-a-vis Indian vessels.

Major Commodities on Protocol Route

Currently, majority of the international cargo exported by India to Bangladesh constitute of Fly ash, Slag, Clinkers and Gypsum. These products are raw materials to Cement industries and other manufacturing industries in Bangladesh. As per the 2015 press release by the Ministry of Shipping (India), Fly-ash contributes ~98% of the movement through the protocol routes majorly utilized by large cement industries in Bangladesh (Holcim Cement Ltd, Lafarge, etc). This movement is majorly from the Kolkata cluster to various river ports in Bangladesh.

Some of indicative long-standing linkages between industries in the region are as follows.

- Fly ash – from Kolaghat and Bandal coal-fired power plants (West Bengal Power Development Corporation Limited)

- Gypsum – from chemical industries cluster in Haldia
- Clinker – from cement industries (Ambuja, ACC Cement, etc.)
- Granulated slag – from steel plants in Kolkata cluster

The following table depicts the major commodities on protocol route.

Table 51: Cargo Movement on Indo-Bangladesh Protocol Route (in tons)[36]

Commodity / Year	2011-12	2012-13	2013-14	2014-15	2015-16
Fly Ash	15,22,430	16,01,769	18,62,683	19,61,311	22,60,803
Iron Ingots	-	79,679	-	-	-
Galvanized Steel Sheets, Coils, Columns, Beams, Angles	-	-	2,502	13,065	8,024
Coal	-	-	9,083	8,142	-
Iron Ore	-	-	1,705	6,077	6,292
Iron Ore Fines	-	-	10,935	-	-
Tyres	-	-	-	10,565	-
ODC Cargo	1,205	6,590	-	-	-
Cement	-	-	2,222	150	4,934
HDPE Bags	622	1,297	-	-	-
Cement Clinker	1,840	-	-	-	-
Machinery & Spares	-	-	-	-	1,450
Dolomite Powder	1,225	-	-	-	-
Jute Carpet Baking Cloth	1,173	-	-	-	-
Stone Chips	-	2	-	-	-
Total	**15,28,494**	**16,89,336**	**18,89,131**	**19,99,310**	**22,81,504**

5.2.3 Transit Cargo

Cargo Profile

India uses the Indo-Bangladesh river protocol to transport essential commodities including fuel (diesel and petrol), food grains (rice and pulses), iron rods, etc. to Tripura and other north-eastern states. The commodities are majorly transshipped through Ashuganj port (on Kolkata-Karimganj route) and moved through road to the north-eastern states. Pre-dominantly, the Food Corporation of India (FCI) uses the route for essential supply to the north-eastern states. As per the discussion with FCI, they are currently transporting foodgrains mainly by rail from Northern States of Punjab / Haryana to the North-Eastern states. The riverine routes are used only on a need basis due to issues such as multiple handling, lack of requisite infrastructure and navigational constraints. Currently, for transportation of foodgrains through waterways, cargo is moved via rail till Kalighat (near Kolkata) and loaded at Kolkata IWT jetty for riverine transport.

The protocol route was also used for transportation of capital goods for certain turnkey projects (heavy machinery, turbines and over-dimensional cargoes). For example, capital goods for development of 726 MW gas-based thermal power plant at Palatna, Tripura was transported through the protocol route.

Current Traffic

The volume of transit cargo transported through the protocol routes has varied widely across the years. As with the case in international cargo movements, the Bangladeshi vessel operators dominate the transit traffic carried, especially in instances of high cargo movements. As per the statistics provided by Bangladesh Inland Water Transport Authority, the transit trade volume through the protocol routes are as shown in the figures below.

[36] IWAI

Figure 34: Protocol Route Transit Cargo Volume in (tons)

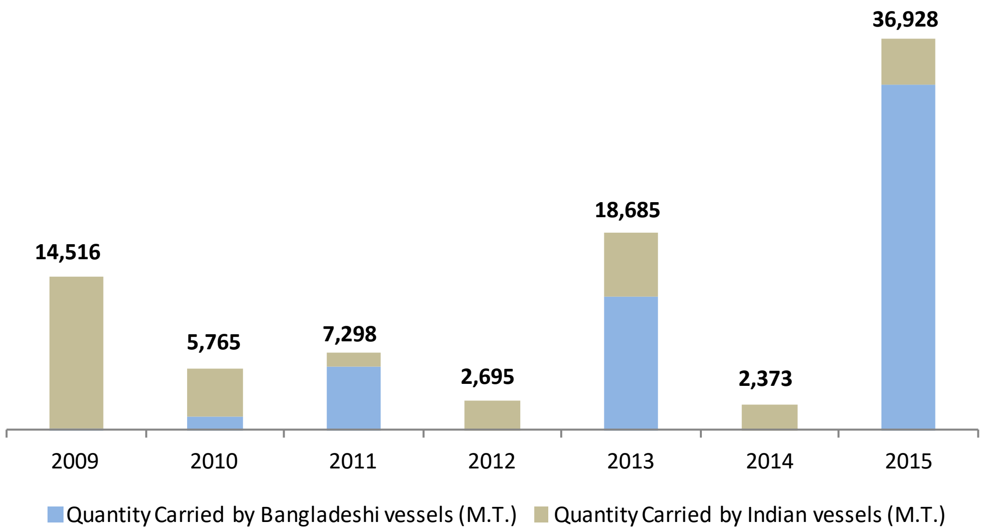


Table 52: Route-wise Transit Cargo Statement under Indo-Bangladesh Protocol Route (in tons)

Route	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Kolkata- Dhubri (Pandu)	7,000	1,305	600	300	2,992	-	140	1,118	2,373	4,322	2,430
Dhubri (Pandu)- Kolkata	1,500	7,700	3,188	-	-	-	-	-	-	-	-
Kolkata- Karimganj	-	3,550	1,642	14,328	1,482	590	2,055	14,397	-	12,928	3,495
Karimgonj-Kolkata	-	2	2,800	0.2	-	-	500	3,170	-	-	-
Kolkata- Ashuganj- Agartala (By modal waterways & road)	-	-	-	-	-	7,298	-	-	-	19,537	1,004
Total	**8,500**	**12,557**	**8,230**	**14,628**	**4,474**	**7,888**	**2,695**	**18,685**	**2,373**	**36,788**	**6,929**

Currently, cargo between Assam (and other north-eastern states) and mainland India (mainly Kolkata) is through by road. The current traffic on protocol route is only when some incidents hamper connectivity to the north-eastern region through the NH-8 (Assam-Agartala Highway). Thus, the traffic a typical year is less than ~10,000 tons and varies depending on the occurrence of maintenance works / incidents.

However, the utilizing the protocol route has a lot of potential as even road / rail connectivity to north-eastern states is poor and waterways provides a good alternative due to time and cost savings.

The following initiatives are expected to improve the transit traffic.

- Improvement of round-the-year navigability – capital and infrastructure improvements, channel dredging and installation of safety facilities on the protocol route.
- Development of Ashuganj as a trans-shipment hub under the recently signed protocol
- Government initiatives such as incentive schemes / support for transportation of cargo, capital work, barge operations, etc.

The potential of trade and transit traffic on the Indo-Bangladesh protocol route is detailed in the following section.

5.3 Existing IWT Infrastructure Facilities

5.3.1 Kolkata

There are two jetties available in Kolkata which are G.R Jetty-2 and BISN Jetty & G.R Jetty-1. The total land area for both the facilities totals to 35,000 sqm. G.R jetty-2 is of RCC and is of fixed kind. BISN Jetty is floating kind and is a steel construction. These facilities are used for loading of Fly-ash, fertilizer and general cargo by Bangladesh and Indian vessels.

The infrastructure facilities available at the two jetties are given below.

Table 53: Infrastructure Facilities at Kolkata

Particulars	G.R. Jetty-2	BISN Jetty & G.R. Jetty-1
Berth Length	105 m (70 m, 35 m)	35 m
Waterfront Size	210 sqm	210 m
Open Storage Area	4,069 sqm	17,028 sqm
Covered Storage Area	1,200 sqm	-
Link Approach Road / Rail	2 km SH / 3 km	2 km SH / 3 km
Water / Lighting Facilities	Drinking water / Sodium vapour lamps	Drinking water / Sodium vapour lamps

Figure 35: Infrastructure facilities at Kolkata

5.3.2 Haldia

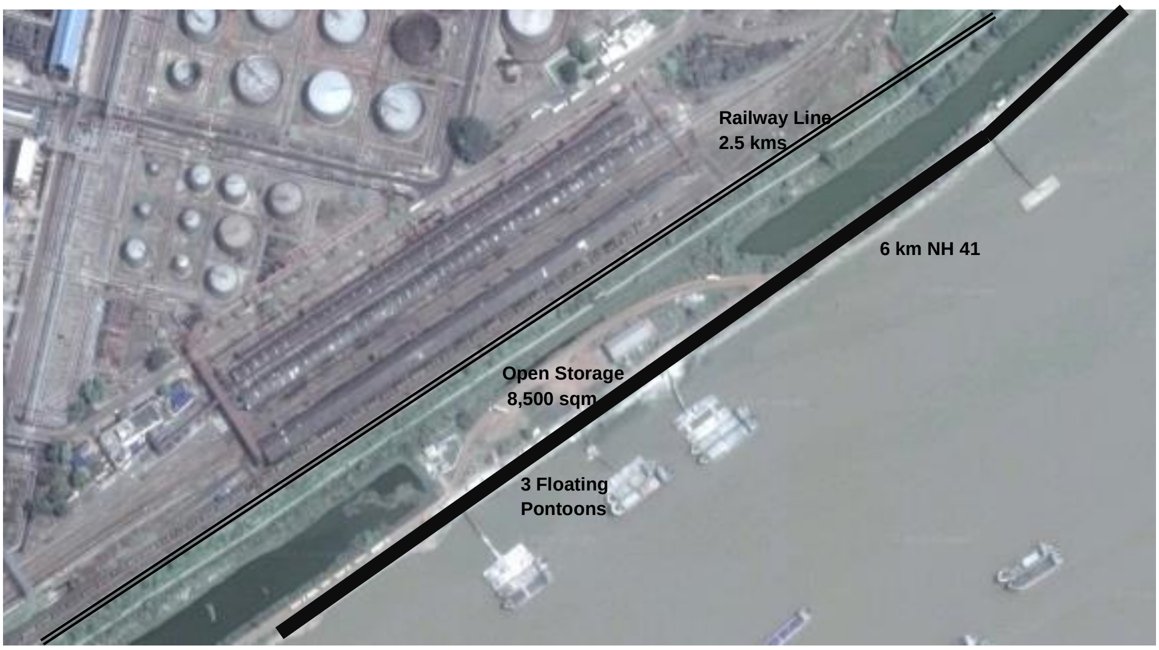
Total land area of Haldia facility is 10,319 sqm. The loading facility, which includes 3 pontoons is facilitated by double sided pipeline loading and is mainly used for loading of Fly-ash, fertilizers and general cargo by Bangladesh and Indian vessels.

The infrastructure facilities available at the Haldia facility are given below.

Table 54: Infrastructure Facilities at Haldia

Particulars	Haldia
Berth Length	105 m
Waterfront Size	165 m
Number of Pontoon Barges	3 Floating (1 Bamboo and 2 Steel)
Open Storage Area	8,500 sqm
Covered Storage Area	400 sqm
Link Approach Road / Rail	6 km / 2.5 km
Water / Lighting Facilities	Drinking water / Sodium vapour lamps
Handling Facility	Pneumatic

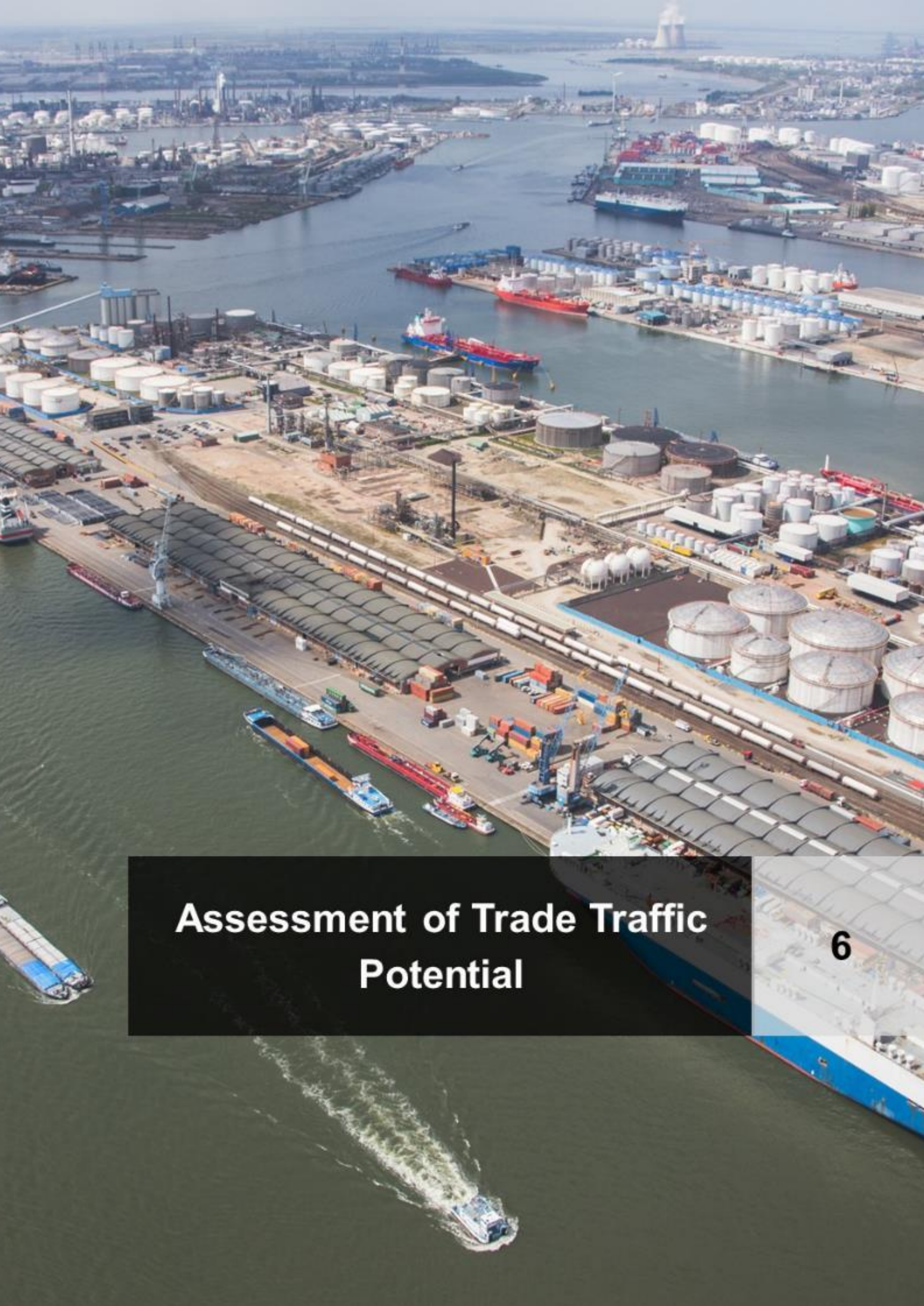
Figure 36: Infrastructure facilities at Haldia



5.3.3 Hemnagar Terminal

The facilities that are available at Hemnagar Terminal include an IWAI regional office, customs office, mooring facility for ships carrying cargo in Bangladesh and a passenger jetty.

Figure 37: Facilities at Hemnagar Terminal



6 Assessment of Trade Traffic Potential

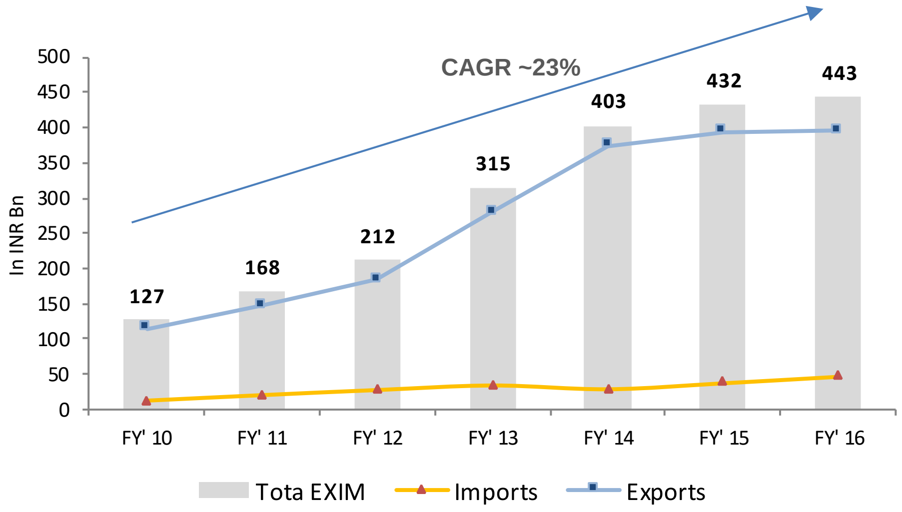
6 Assessment of Trade Traffic Potential

6.1 Overview

India and Bangladesh share ~ 4,100 km of contiguous border, out of which 1,741 km is shared with North East Indian Region and 2,217 km is shared with West Bengal. Owing to its geographic location, Bangladesh is one of the major SAARC trading partners of India as it provides a growing market to Indian products and a transit route to the North East Indian region.

While a full-fledged FTA (Free Trade Agreement) has not yet been put into place, gradual liberalization has given significant impetus to Indo-Bangladesh trade which has experienced growth at a CAGR of ~23% (2010-16) amounting to INR ~440 billion. The following figure depicts Indo-Bangladesh EXIM trade value data.

Figure 38: Indo-Bangladesh EXIM statistics[37]



As evident, the trade imbalance between India and Bangladesh is significant with Indian exports outweighing imports from Bangladesh. However, efforts are being made to curb the trade imbalance by encouraging Indian investment in Bangladesh, increased cooperation between the two countries and development of infrastructure. The following section explains the major commodities, trade routes, issues, and opportunities for Indo-Bangladesh trade in context of the current engagement.

6.2 Indo-Bangladesh Trade Drivers and Government Initiatives

Bangladesh is one of the most important markets for India's exports. For the past several decades, it has been the largest export market for India in the SAARC region. Some of the major drivers for this trade include:

- **Overall growth in Bangladesh**
  According to IMF, the economy of Bangladesh is the second fastest growing economy of 2016, with a rate of ~7%[38]. Its imports as a percentage of the imports of world and SAARC countries has been increasing over the years, with India as the principal source of imports.
- **Trade Complementarity**[39]
  The potential of bilateral trade between the two countries, as deduced from trade complementarity index (TCI) between them, is high. TCI assesses how well the structure of one country's export structure matches the import structure of the other country. The index consistently being higher than critical value of 40 indicates clear export complementarity maintained by India. However, growth in trade of certain product categories such as coffee, wheat, rice, sugar, cotton yarn and insulated wires, has not been as

[37] Ministry of Commerce and Industry
[38] World Economic Forum
[39] India-Bangladesh Trade Complementarity-CUTS International, 2014

high as expected. The true bilateral trade potential between the two countries which is indicated by indicators such as TCI, has been adversely affected by high trade costs.

Recognizing the above drivers of trade between the two countries, the Government of India has undertaken the following initiatives to improve trade relations with Bangladesh.

- **Agreement on Coastal Shipping**
  India and Bangladesh signed the Standard Operating Procedure (SOP) in New Delhi on 15th November 2015, to operationalize the "Agreement on Coastal Shipping" signed between the two countries in June, 2015. The Standard Operating Procedure will pave the way to promote coastal shipping between India and Bangladesh and would enhance bilateral trade between the two countries by bringing down the cost of transportation of EXIM cargo.
- **Bangladesh, Bhutan, India, Nepal Motor Vehicles Agreement (BBIN MVA)**
  BBIN MVA was signed by the 4 countries in 2015 for regulation of passenger, personal and cargo vehicular traffic amongst the sub-regions. This would contribute towards enhancing trade facilitation and transport efficiency by promoting economically efficient and environmentally safe road transport in these regions. Thus, these countries would reap benefits of increased movement of goods and passengers by strengthening connectivity.[40] Bhutan's Upper House has rejected a move to have the country join BBIN MVA due to environmental concerns. The government is determined to ratify the BBIN MVA by opening gates of co-operation in other areas.
- **Renewal of Bilateral Trade Agreement**
  Through renewal of the 'Framework Agreement on Cooperation for Development between India and Bangladesh', the two countries have added new trade facilitation procedures to remove all barriers for seamless bilateral trade.

The Government of India intends to achieve the following objectives through the above initiatives:

- Increase the total trade in India by improving the business environment
- Optimize multi-modal transport to reduce the cost of domestic cargo
- Minimize the time and cost of export-import cargo logistics.

6.3 Assessment of Current Trade

Trade between India and Bangladesh in FY16 stood at INR ~440 Bn by value. About 54% of the commodities were moved via sea while road accounted for 40% and air accounted for 6%. The trade movement via rail was non-existent due to absence of rail transit between India and Bangladesh. Trade directed through West Bengal accounted for 42% of the total volumes. Further analysis revealed that the country had received ~63% of the imports while routing ~40% of the total exports from India.

6.3.1 Overall Modal Split

The overall modal split of the trade between India and Bangladesh is shown in the following table.

Table 55: Overall Modal Split - Indo-Bangladesh EXIM (July 2015 to July 2016)[41]

Mode	Export Share by Value	Import Share by Value
Land		
Petrapole	36%	62%
Kotwaligate	3%	3%
Ghajadanga	2%	7%
Hili	2%	0.2%
Sea		
Kolkata Port	3%	1.4%
Nhava Sheva Port	13%	3%
Mundra Port	6%	0.5%
Chennai Port	3%	2%

[40] Observer Research Foundation, Indian Council of World Affairs
[41] DGCI&S

Mode	Export Share by Value	Import Share by Value
Air		
Kolkata Airport	1%	0.02%
Mumbai Airport	1%	1%
Delhi Airport	1%	0.5%

6.3.2 Share of West Bengal in total trade

The value share of West Bengal in the total Indo-Bangladesh trade was 42% in FY16 (till July 2016). A study of the modal split of the commodities moving via West Bengal was carried out to gain an insight into the trade movement in the region. West Bengal accounted for nearly all of road EXIM traffic taking place between India and Bangladesh. At the same time, ~24% of the total cargo transported via air was routed through West Bengal. Sea bound cargo movement through West Bengal stood at ~5% of country's total traffic.

Table 56: Share of West Bengal in Indo-Bangladesh EXIM (July 2015 to July 2016)[42]

Region	Value (INR Bn)	Share by Value
India	443	**100%**
West Bengal	186	**42%**
Others	257	**58%**

6.3.3 West Bengal Trade – Modal Split

As per DGCI&S, India, out of the total commodities traded between West Bengal and Bangladesh (July' 15 – July' 16), ~93% of the entire cargo was moved via land with Petrapole land port having the maximum share of 79%, whereas the remaining land ports of Kotwaligate, Ghajadanga and Hili accounted for ~14%. Kolkata Port and Kolkata Airport accounted for 6% and 2% respectively towards the total trade via West Bengal. Recently, waterways has been emerging as a potential option to enhance trade between the two countries with the renewal of the Indo-Bangladesh Protocol on Inland Water Transit & Trade and focus of the government on development of waterways.

Table 57: Modal Split of trade through West Bengal [43]

Mode	Export Share by Value	Import Share by Value	Total Share
Land	**92%**	**98%**	**93%**
Petrapole	78%	83%	79%
Kotwaligate	5.4%	4.5%	5%
Ghajadanga	4.5%	10%	6%
Hili	4%	0.3%	3%
Sea (Kolkata Port)	**6%**	**2%**	**5%**
Air (Kolkata Airport)	**2%**	**-**	**2%**

6.3.4 Emergence of Waterways as suitable option

Owing to increased pressure on road transport and unavailability of rail transport, waterways are emerging as an alternative mode of transport. Further, heavy traffic and limited infrastructure on existing land port(s) have put a toll on the existing facilities leading to higher waiting times. The Government of India along with the Government of Bangladesh aim to capitalize on the internal network of rivers and canals connecting the two countries.

[42] DGCI&S
[43] DGCI&S

6.4 Key Issues – Limitation of Trade through Land Route

As mentioned earlier, a large amount of trade between India and Bangladesh is carried out by road. There are officially 35 Land Customs Stations (LCS) through which trade between India and Bangladesh is carried out. Petrapole (in West Bengal, India) and Benapole (in Bangladesh) are the busiest LCSs between India and Bangladesh. About 40-50% of India's total export by value to Bangladesh are made via three land border routes; Petrapole, Hili and Changrabanda. Additonally, Mahedipur in Malda district and Ranaghat in Nadia district are important LCSs.

The major issues with the current transportation system are infrastructure constraints and delays, as detailed out below.[44]

Infrastructure Constraints

All LCSs are reported to have infrastructural problems that hinder smooth flow of traffic between the two countries. Narrow and poorly maintained roads coupled with administrative bottlenecks cause delays in transit. The most important of the customs posts with comprehensive customs clearance powers is at Benapole, which borders Petrapole on the Indian side and is on main roads linking Kolkata with Jessore and Dhaka. It handles around 40% of India's exports to Bangladesh and close to 70% of Bangladesh's exports, as per DGCI&S.

Some of the general infrastructural problems that have been identified are as follows:

- *Poor quality of approach roads and poor standard of trade services at the LCSs*
  The roads leading to the LCSs pass through very congested towns. One of the major issues is the narrow approach road to the check post. The arterial road connecting Barasat in West Bengal to Jessore in Bangladesh through which the consignments are moved fails to meet the standards of an international trade link road. This results in transportation and clearance delays with consequential increase in costs.
- *Inadequate parking facility*
  Petrapole can accommodate 800 trucks in the export zone and 150 trucks in the import zone. These insufficient parking facilities and processing constraints create traffic jams at border crossings. Also, there is no Central Warehouse Corporation parking facility in Ghajdanga LCS and all privately-owned parking spaces are different in size and dispersed.

Traders have reported other problems such as inadequate water and sanitation facilities, security risks, lack of government warehouses, frequent worker strikes, common gate for imports, exports and passengers, poor power connectivity, frequent power cuts and untrained operators for electronic data interchange. These issues create a necessity for modal shift of traffic between Bangladesh and India through West Bengal.

Delays

The turnaround time for the total journey depends on the route length, bottlenecks, and loading / unloading times. As mentioned above, there are two major bottlenecks along the Indo-Bangladesh trade route; Petrapole land port and Padma river crossing primarily due to infrastructure and operation constraints. The infrastructure and operations assessment of the bottlenecks is as follows.

On an average, 400-500 trucks travel daily through the Kolkata-Bangladesh road which passes through densely populated towns like Barasat, Dutta Pukur, Ashoknagar, Habra and Bongaon on the outskirts of Kolkata. Further, hawkers in Habra and Bongaon and three railway crossings en route slow down the movement of trucks. Another major hurdle in transportation is the narrow Naobhasa Bridge, which is located 3 kilometres prior to Petrapole which allows passage of only one truck at a time. Moreover, heavy trucks with carrying capacity of 15 to 18 tons or more cannot pass through this bridge due to its poor condition. This results in transhipment either in Kolkata or Bongaon incurring additional transportation time and cost.

Merchandisers have to face substantial loss of time at the border. The delay takes place at the parking lot, in customs clearance and at the entry/exit point. It is mandatory for the trucks coming from Kolkata during daytime to park at Bongaon Municipality Parking instead of moving directly towards the Central Warehousing Corporation (CWC) parking lot which is situated near the border gate and adjacent to the Indian Customs House. The trucks are allowed to move serially towards the Petrapole border based on their entry coupons only after 11 PM in summer and after 10 PM in winter. At the border, the trucks are again made to park at the parking space of CWC.

[44] India-Bangladesh Trade Complementarity-CUTS International, 2014

The entry point at the border has one single gate, which is used for exports, imports as well as for passenger movement. At a time, only one truck can pass through the gate. As a result, the entry point remains very congested. The Indian trucks after unloading at Benapole (in Bangladesh) are allowed to enter India only after 7 PM or are allowed to return to India before the start of exports from India (i.e. 10 AM). This results in wastage of time and additional payment of detention charges.

The Padma river crossing through ferries also takes up significant time as heavy traffic and limited barges leads to long queuing. All the above factors contribute to a total journey time of 10-15 days out of which ~90% of the time is idle time.

On the other hand, transport through waterway has no significant bottlenecks. Barge operators wait for high tide conditions to set sail including which it takes ~ 5-8 days to reach Dhaka.

6.5 Opportunities for Inland Waterways

6.5.1 Advantageous Cost Economics

As mentioned earlier, the current catchment profile includes trade originating in India and going to Bangladesh either through Petrapole land port or through existing waterways and vice versa. To compare modal advantages, one of the busiest Indo-Bangladesh trade routes viz. Kolkata to Dhaka has been considered. Further, Kolkata and Dhaka represent the final transhipment points for majority of the cargo volume coming from different parts of India and Bangladesh.

Petrapole-Benapole Land Customs Station is the busiest land port between India and Bangladesh. On an average, the integrated check post witnesses a daily traffic of ~500 trucks. However, owing to infrastructure constrains and operational issues only 200-300 trucks are cleared daily. Additionally, owing to trade restrictions, Indian trucks are not allowed to carry cargo in Bangladesh and vice versa. Consequently, cargo is shifted from Indian trucks to Bangladesh trucks and vice versa which further adds to the cost and travel time. Thus, a distance of ~350 km (Kolkata – Dhaka) takes about 10-15 days on road as compared to 900 km via waterway which takes only 5-8 days. The following section discusses in detail the various parameters for modal comparison.

Logistics Costs

Typical logistic costs can be categorised into the following:

- Transportation cost – Primarily constitute fuel and sustenance cost
- Handling charges – Loading and unloading charges
- Charges at Petrapole land port
- Customs and other administrative charges
- User charges such as parking, equipment etc.

Transport cost essentially depends on the distance travelled. However, additional factors such as load carried, road conditions, traffic congestion, fuel efficiency etc. also affect fuel consumption and hence the transport costs. Waterway vessels are more fuel efficient than travel by road and / or rail. As per estimates, with all things constant, one liter of fuel can transport ~100 tons of load for 1 km through waterways as compared to only 24 tons by road. This is primarily due to the lower friction that an object moving in water must move against as compared to travel by road. Further, waterway vessels utilize the flow of the river and high tide conditions to help in travel, ultimately reducing fuel consumption. An additional advantage of waterway travel is the load capacity of barges as compared to load capacity of trucks. Waterway barges can carry more load and volume which ultimately reduces fleet size and overall transport costs for a large consignment.

Handling charges are basically loading and unloading charges. While these remain fairly uniform for a commodity across transport modes, multiple handling at the Petrapole land port further increases this cost for road transport. Similarly, while customs duty remains uniform across transport modes, facility charges at Petrapole land port are high and bring up the overall transportation cost. With parking charges as high as INR 200 – 500 per day and average waiting time of 8-10 days, overall transport costs are affected.

On the other hand, basic transportation costs for Waterways are less as there is no multiple handling and waiting at check points despite the difference in total route length. Typical costs are as follows:

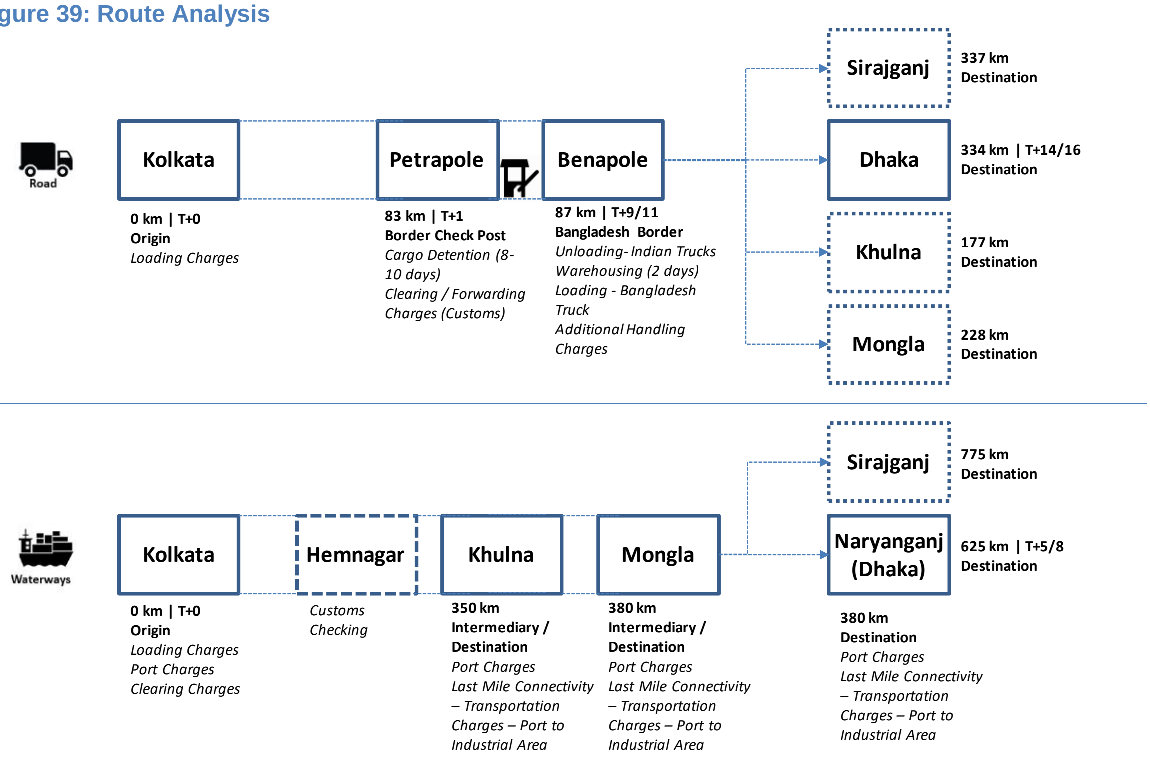
- Waterway Usage Charges
- Vessel Related Charges

- Terminal Charges
- Cargo Handling Charges (Cranes, forklift, etc.)
- Miscellaneous Charges (Cargo handling at port, last mile connectivity, etc.)

The waterway usage charges are borne by the transport service provider. Vessel related charges, terminal charges (i.e. port charges) and cargo handling at port are paid at the source and destination ports. Last mile connectivity from the destination port to destination clusters through road has been considered to arrive at a comprehensive cost comparison.

A cost comparison for both modes for four routes, namely Kolkata-Dhaka (Narayanganj), Kolkata-Khulna, Kolkata-Mongla, and Kolkata-Sirajganj is as given in the following figures. The tariff sheet as per Bangladesh Inland Water Transport Authority that has been used for calculations is given in Annexure D. The charges do not include any custom and other government charges as these are assumed to be similar across all transportation modes.

Figure 39: Route Analysis



The transportation charges have been computed for the four key routes and details of Kolkata – Dhaka route are as shown in the following tables.

Table 58: Transportation Charges – Roads *(Kolkata – Dhaka)*

Charges (INR per tonne)	12 MT Truck	16 MT Truck
First Mile Connectivity (INR 32,400 per truck including loading charges)	2,650	2,025
Detention Charges – *Petrapole (*INR 2,000 per truck per day; ~10 days)	1,250	1,250
Loading / Unloading *(Benapole)* (INR 4,000 per truck)	250	250
Warehousing *(4 days)* (INR 250 per tonne per day)	1,000	1,000
Transportation Charges – *Benapole – Dhaka* (INR 24,222 per truck including loading charges)	1,977	1,514
Total Transportation Charges (per Tonne)	**7,000**	**6,000**

Table 59: Transportation Charges – Waterways *(Kolkata – Dhaka)*

Charges (INR per tonne)	Kolkata - Dhaka (Narayanganj)
First Mile Connectivity (INR 17,000 per truck till Haldia)[45]	**964**
IWAI	**17**
Fairway Charges (INR 0.02 per GRT per km)	13
Vessel related Charges (INR 1,750 per barge)[46]	1
Cargo related Charges (INR 1 per ton)	1
Equipment Hire Charges (INR 2,500 per crane for 8 hrs)	2
Barge Operators[47]	**1,800**
Bangladesh Port Authority (Terminal)	**30**
Vessel Related Charges (INR 449 per barge)[48]	0.30
Cargo related Charges (INR 29.5 per tonne)	29.5
Fork Lift (INR 157.30 per hour)	0.21
Last Mile Connectivity (including handling)[49]	**406**
Total Transportation Charges (per Tonne)	**3,217**

The summary of the modal cost comparison for the four routes is given in the following table.

Table 60: Modal Cost Comparison

Route	Road		Waterways	
	Route Length (km)	Cost (INR / tonne) (16 MT-12 MT Truck)[50]	Route Length (km)	Cost (INR / tonne)
Kolkata – Dhaka	334	**6,000-7,000**	625	**3,200**
Kolkata – Khulna	177	**5,150-5,950**	350	**2,400**
Kolkata – Mongla	228	**5,400-6,300**	380	**2,500**
Kolkata - Sirajganj	337	**6,000-7,150**	775	**3,650**

It is observed that while the length of waterway route is considerably longer in all the four examples, the transportation costs are significantly lower as compared to transportation via roads. It should also be noted that the difference in transportation time is smaller despite low achievable speeds in waterway transport due to long idle periods in cargo detention at Petrapole.

The waterways costing for Kolkata-Dhaka route under the current and proposed scenarios is shown in the following table. These costs have been estimated based on no cargo return journey.

Table 61: Waterways Costing for Kolkata – Dhaka Route – Barge Economics

Particulars	Current Scenario	Optimised Scenario
Volume of Cargo (ton)	1,500	1,500
Capacity of Vessel (ton)	1,500	1,500
Distance	625	625
Speed (km / h)	10	10
Travel Time (hrs)	63	63

[45] For travel from Kolkata to Haldia port (~50 km) including loading / unloading at port
[46] Berthing Charges: INR 1000 for 24 hrs; Pilotage: INR 750 per pilot
[47] Prevailing Market Rates
[48] Berthing Charges: INR 107 for 24 hrs; Pilotage: INR 342 per pilot
[49] For travel from Narayanganj to Dhaka Industries (~30 km) including loading at port / unloading
[50] Logistics cost via road has been calculated for a truck with design capacity of 12 MT. However, there is the market practice to overload the truck up to 16 MT and hence, cost has been computed accordingly.

Particulars	Current Scenario	Optimised Scenario
Total Duration in Days (including handling)	8	5
Vessel Hiring Charges per day (INR)	36,000	36,000
Operating Charges per day (INR)	16,000	16,000
Fuel Charge (per L)	61.5	61.5
Diesel Consumption (L/hr)	80	80
Total Vessel Hiring Charges (INR)	2,88,000	186,000
Total Operating Charges (INR)	1,28,000	82,667
Total Fuel Charges (INR)	3,07,500	307,500
Misc. (INR)	16,641	13,252
Total Cost (INR)	**7,40,141**	**589,419**
Total Cost (including profit @20%) (INR)	**8,88,169**	**707,302**
Cost per ton (INR)	592	472
Cost per ton per km for two-way trip	**1.9**	**1.5**

With the improvements in waterway infrastructure and reduced travel time, the barge economics would improve in the future as reflected in the optimised scenario.

Efficient Alternative
Flexibility of reliability essentially represents the potential risk of loss of cargo either through road or waterways as well as the operational flexibility of a transportation mode for availability on immediate basis.

As mentioned above, owing to infrastructure and operational constraints, the operational flexibility of road transport through Petrapole road is extremely inelastic. Traders often must wait 8-10 days for their consignment to be accepted by logistic players. Additionally, the risk of loss of cargo via road due to accidents is significant with ~5 lakh road accidents occurring every year. Poor infrastructure and heavy traffic congestion further increase the risk of road accidents. As compared to travel via waterways, the number of annual accidents range from 40 – 80 which is significantly less.

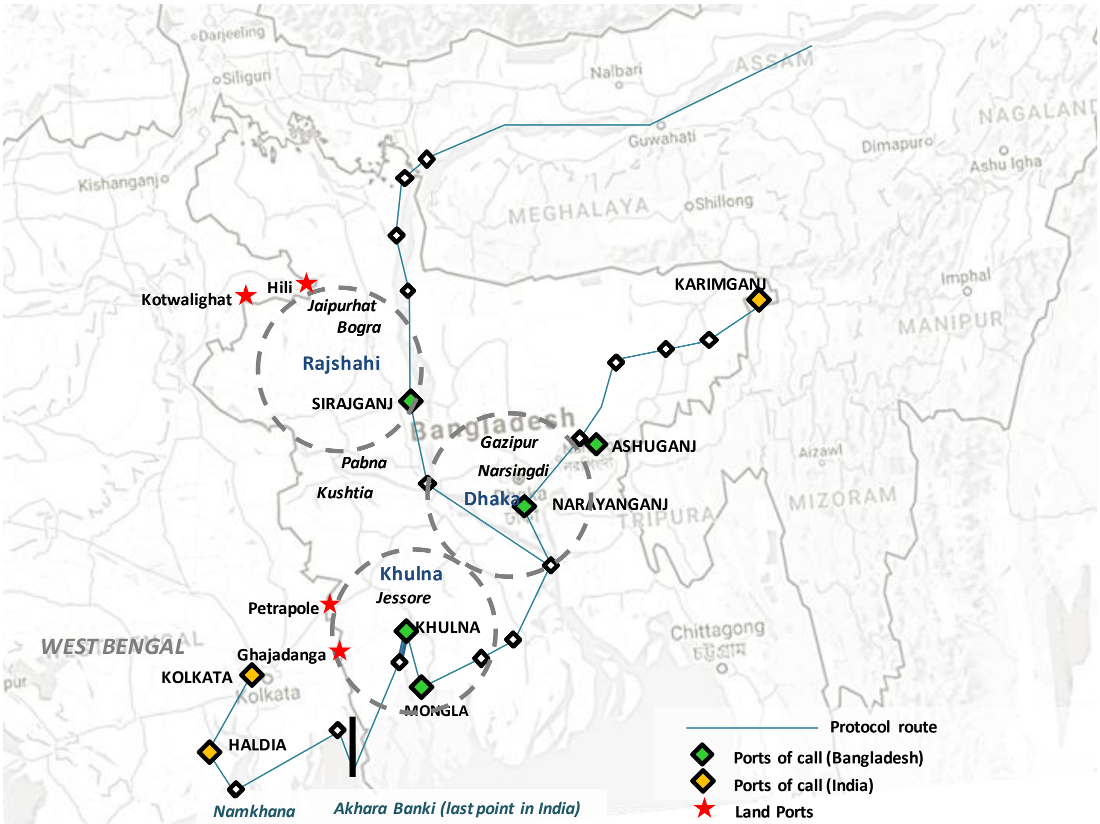
While majority traders have limited transport options, development of inland waterways will offer an economic alternative to road transport. This can be capitalised to optimise traffic at Petrapole land port as well.
Thus, the above analysis indicates that waterways has immense potential due to its numerous benefits such as **economic feasibility and time savings**.

6.6 Catchment Definition

The catchment area for bi-lateral trade through waterways is defined based on the alignment of Sunderbans Waterways as well as trade linkages with Bangladesh. The proposed waterway assumes significance in Indo-Bangladesh trade as it constitutes the initial leg of the Indo-Bangladesh protocol route which has been identified as the primary waterway route for trade between the two countries.

As defined under the scope of the current engagement an area of ~100 km on either side of the waterway has been considered as the study area. The district wise demand assessment for Bangladesh is given in Annexure A. The following map depicts the Indo-Bangladesh protocol route along with key centres of trade.

Figure 40: International Trade - Study Area



As evident in the map above, the Indo-Bangladesh protocol routes runs through several districts / divisions in West Bengal and Bangladesh. The relevant catchment centres include the administrative divisions in Bangladesh such as Khulna (districts of Khulna, Kushtia and Jessore), Dhaka (districts of Dhaka, Narayanganj, Gazipur and Narsingdi) and Rajshahi (districts of Rajshahi, Pabna, Bogra and Jaipurhat). These are presently served through Petrapole, Hili, Kotwalighat and Ghajadanga land ports in West Bengal.

These regions will be the primary beneficiaries of the Indo-Bangladesh protocol route with direct access to the waterway.

Owing to the proximity of Petrapole land port to Kolkata and Haldia ports of call, as well as infrastructure constraints at the cross-border check point, there is a potential for traffic shift from Petrapole to NW 97.

6.7 Commodity Movement

The trade profiles of Bangladesh and India are different from each other. While Bangladesh's overall export is dominated by labour-intensive manufacturing, its export to India is dominated by primary commodities such as textile fibres, marine products and apparel. Primary commodities such as raw cotton, cereals, sugar and machinery dominate Bangladesh's total import from India as well.

Bangladesh is rich in natural gas, coal, limestone, hardrock, gravel, boulder, glass sand etc. Primary crops are rice, jute, maize and vegetables. The details of mineral reserves in Bangladesh are shown in the following table.

Table 62: Mineral Reserves in Bangladesh

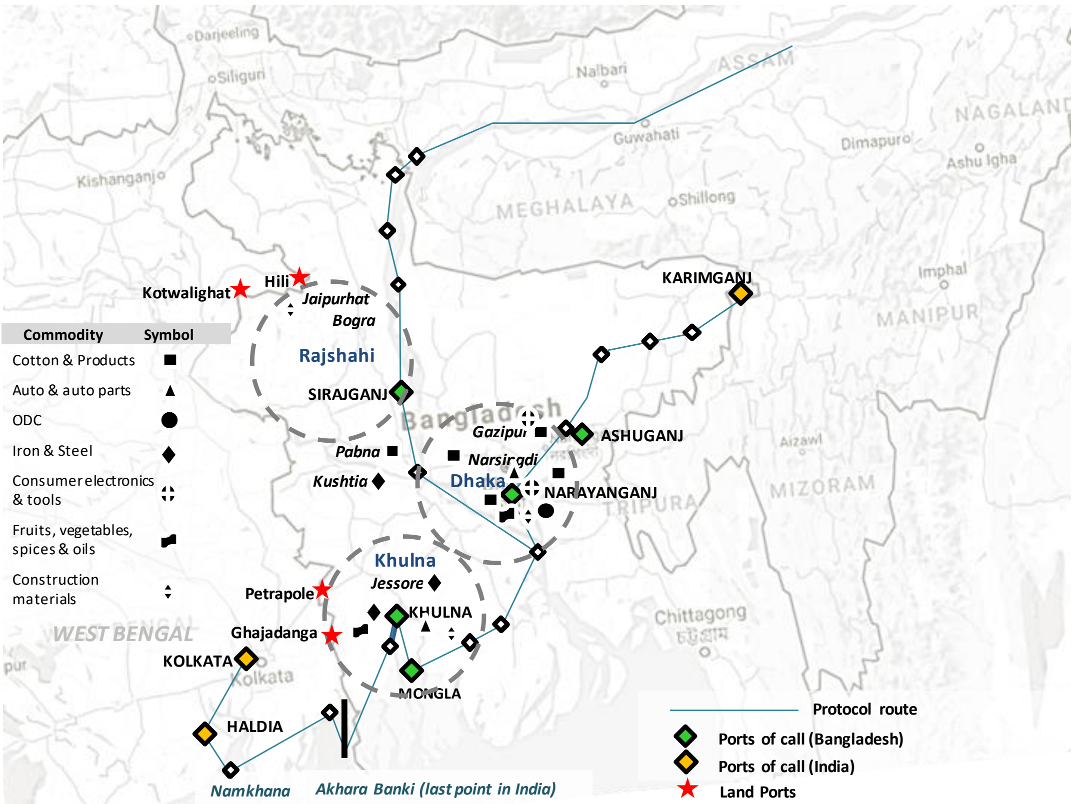
Mineral	Reserves	Administrative Division	Related Major Industry
Natural Gas	~ 21.05 trillion cubic feet	Barisal, Sylhet, Chittagong	Power sector, Fertilizer,

Mineral	Reserves	Administrative Division	Related Major Industry
Coal	1882 million tons	Barisal, Rangpur	Power sector, Brickfields
Limestone	~ 100 million tons	Nagaon, Karbi Anglong, Kamrup, Goalpara, Rajshahi	-
Hardrock	-	Rangpur	Construction Materials
Peat	170 million tons	Khulna, Dhaka	Brickfields, Boilers, Domestic purposes
Metallic Minerals, Construction Sand	-	Chittagong, Barisal	Construction Industry
Gravel	~ 10 million cubic metre	-	-
Glass Sand	~ 109 million tons	Sylhet, Rangpur	Glass Industry

6.7.1 Export Commodities

The following map shows the major districts in Bangladesh to which these commodities are exported. They are mainly routed to 3 major administrative divisions – Khulna, Dhaka and Rajshahi.

Figure 41: Export Commodity Flow to major centres in Bangladesh



Cotton & Products (*Raw cotton, cotton yarn, woollen yarn)*

Bangladesh imports raw cotton from India which acts as a raw material for its textile industry which is mainly concentrated in Dhaka. It imports approximately 97% of its cotton requirement. Its garment factories are located in districts of Dhaka, Narayanganj, Gazipur and Pabna. The major industries importing these raw products in these districts are Fortuna Group, Starlight Sweaters, Viyellatex Group, R,K.Group of industries, Suad Garments Industries and Modele De Capital Industries.

Auto & Auto Parts (*Auto components, tyres, tubes)*

Automobile is a growing sector in Bangladesh, with companies engaged in manufacturing, assembling and repairing motor vehicles. Auto and auto parts are imported by its renowned automobile companies such as Pragoti Industries Limited (Dhaka, Bogra and Jessore), Runner Automobiles Limited (Dhaka), Walton Hi-Tech Industries Limited (Dhaka), Aftab Automobiles Limited (Dhaka), Atlas Bangladesh Limited (Gazipur) and Uttara Automobile Manufacturers Limited (Dhaka).

Over Dimensional Cargo (*Capital machinery, motor vehicles)*

There is great need for infrastructure investment in Bangladesh with two-fifth of the population without electricity access as per World Bank. The country received a credit line worth ~$25 billion from China and India to finance multiple infrastructure projects including a 1,320 megawatt (MW) plant in Khulna and a deep sea port. Thus there has been a boost in ODC movement towards Khulna district. Motor vehicles are imported for the urban settlements in Khulna and Dhaka.

Iron & Steel (*Products made up of iron & steel such as billets, ingots, coils, sheets, plates)*

The products made up of iron and steel are required by many industries involved in manufacturing, construction, infrastructure, assembling, automobile, shipbuilding etc. This need is catered through imports by industries in Dhaka and Khulna such as Koreshi Steel Industries, GPH Ispat limited and other industries mentioned in the automobile sector.

Consumer Electronics & Tools (*Consumer electronics, medical instruments, batteries)*

The urban nodes of Khulna, Dhaka and Rajshahi serve as major consumption centres for consumer goods, tools and instruments imports.

Fruits, Vegetables, Spices & Oils (*Rice, cereals, sugar, cocoa products, processed fruits & vegetables)*

These essential commodities are imported by consumption centres of Khulna, Dhaka and Rajshahi.

Construction Materials (*Fly ash, cement, clinker, mica)*

There has been a growing demand for construction material in Bangladesh for the numerous upcoming infrastructure projects These materials are imported by districts of Gazipur, Dhaka, Khulna and Jaipurhat. The major factories and industries that require such materials in these districts include Seven Circle, Akij Cement Factory, Holcim Cement Bangladesh, Lafarge Surma Cement, Premier Cement and Meghna Cement Mills.

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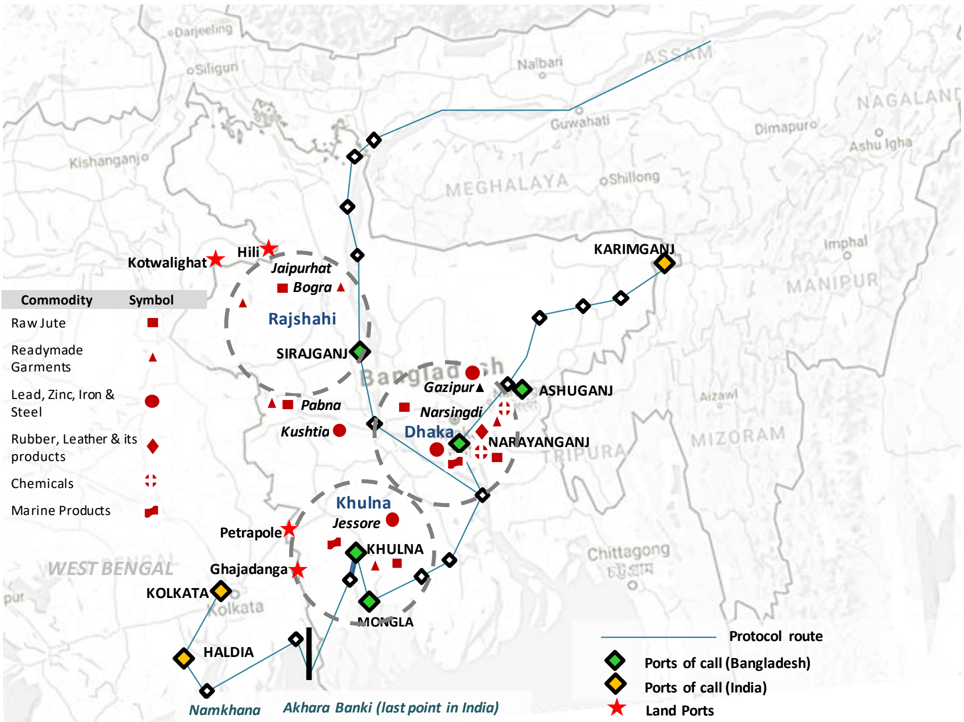
6.7.2 Import Commodities

Readymade garments (RMG) and knitwear are the biggest contributor to the exports earning of Bangladesh followed by frozen food, jute goods and leather.

The following map shows the major districts in Bangladesh from which these commodities are imported. They are mainly routed through 3 major administrative divisions – Khulna, Dhaka and Rajshahi.

Figure 42: Import Commodity Flow from major centres in Bangladesh



Raw Jute (*Jute yarn, jute hessian)*

The Ganges delta is responsible for more than 70% of world's jute production with Bangladesh's production in FY 14 at ~1.4 million tons (MT). Majority of the superlative quality jute production takes place in the district of Dhaka. Jute production of intermediate quality, based on fiber strength and roughness, is spread across Khulna, Rajshahi, Narayanganj, Jessore, Pabna and Bogra districts. Northern districts' jute production is majorly of lower quality. India's Bangladeshi jute import via Petrapole originates from central and south western districts part of Dhaka and Khulna division. The major jute mills in these districts are Peoples Jute Mills, Star Jute Mills, Karim Jute Mills, Bangladesh Jute Mills, Jessore Jute Industries, Anwar Jute Mills, Alhaj Jute Mills, Janata Jute Mills and Bakshigonj Jute Spinners.

Readymade Garments (*Made up of cotton, wool, silk, manmade fibres)*

RGM export accounted for ~82% of Bangladesh's total exports in FY 16. This segment, including knitwear, employs nearly 4.2 million Bangladeshis and is concentrated in administrative divisions which can cater to exports. Khulna contains majority of the export oriented units with Dhaka also being a major production center. Despite India majorly importing primary goods from Bangladesh, RMG forms a significant portion of the imports. These imports channel through Petrapole land port due to absence of other reliable modes of transport from Khulna division. The major RMG manufacturing units in these districts are GMS Composite Knitting Industries, MinMax Textile, Zara Socks Industries, Grasp Garments, T-Tex International, Team Sourcing Company and AP Plus Industries.

Lead, Zinc, Iron & Steel (*Products made up of these metals)*

Bangladesh is considered as a globally emerging player in these commodities. Such products are exported by various iron and steel manufacturing companies located in Rajshahi, Dhaka and Khulna. These include Confidence Steel Limited, HRS Global, Meghna Group of Industries, Olympic Industries Limited, Rangpur Foundry Limited, Istanbul Multi Trade and Ananta Bangla Industries, Moazzem & Brothers and Ali Hossain.

Rubber, Leather & its products (*Footwear & other finished products)*

Leather industry is the second largest export oriented industry in Bangladesh with exports figure reaching $1.13 billion in FY 15. Tanneries are majorly concentrated in the Hazaribagh region of Dhaka. These tanneries are being forced to shift new industrial park at Savar by European Union over environmental concerns. Export Processing Zone at Savar directs the leather and its product related exports from the region. The major rubber industries include Serdid International, Panama Rubber Industries, Codes & Labels Limited and Universal Rubber Industry. The major leather products manufacturing industries include All Right Leather Corporation, Shafiq Leather Corporation, AB Leather Agency, Bata Shoe Company, Bengal Leathers Complex and Accenture Footwear.

Chemicals (*Inorganic chemicals)*

The chemical industry provides valuable inputs for other industries such as textiles, paper, paints and varnishes, leather, personal care, construction, automotive, agro-chemicals etc. The major industries as concentrated in districts of Gazipur and Dhaka include Smart Metal and Chemical Industry, ASM Chemical Industries, Samuda Chemical Complex, Chemitrade Corporation, Rahnik Chemicals Private Limited and Haque Paint Agency.

Marine Products (*Sea food – fish, shrimp, squid etc.)*

Shrimp culture has played an important role in the fisheries sector of Bangladesh economy as the second largest export industry after RMG. Bangladesh is the twelfth largest shrimp producer in the world and has 162 fish processing plants of which 96 plants are Government licensed. Shrimp culture is an old practice in coastal areas of Khulna, Satkhira, Bagerhat and Cox's Bazar districts.

The commodity wise value and volume of trade between India and Bangladesh for 2015 is given in the following table.

Table 63: Value and Volume of trade between India and Bangladesh in 2015 (Through West Bengal)[51]

Commodity Group	Value (in INR cr)	Volume
Exported by India	**12,962**	**3,355,200 tons 64,100 TEUs**
Cotton & Products	5,408	293,384 tons
Over Dimensional Cargo	3,371	51,298 tons
Iron & Steel	1,172	480,197 tons
Foodgrains & Spices	340	108,902 tons
Flyash	-	2,260,803 tons
POL (Liquid Bulk)	547	160,616 tons
Electronics, Tools & Instruments	564	37,333 TEUs
Processed food / fruits & vegetables	136	700 TEUs
Auto & Auto Parts	1,424	26,040 TEUs
Imported by India	**2,987**	**362,100 tons 13,700 TEUs**
Raw Jute	1,817	341,489 tons
Lead, Zinc, Iron & Steel	171	14,433 tons
Rubber, Leather & Its Products	116	6,055 tons
Readymade Garments	791	11,347 TEUs
Chemicals	46	1,668 TEUS
Marine Products	46	542 TEUs

6.7.3 Future Potential of Trade with Bangladesh

Bangladesh has experienced a consistent GDP CAGR of ~6% over the last decade, mainly driven by exports, remittances and leveraging of abundant workforce. With a positive economic outlook, its real annual GDP growth

[51] DGCI&S and Feedback Estimates

is expected at ~7% between 2014-18. The country has plans to diversify and encourage investments in sectors apart from its garment industry, such as, electronics, power, frozen foods and light engineering.

Its economy is backed by strong fundamentals such as competitive price levels, available capacity, low-cost labour and potential to develop a skilled labour force. The growing middle class would play a major role in the future growth of the country. As per World Bank, per capita household consumption expenditure (at constant 2000 US $) in Bangladesh witnessed average CAGR of ~4% between 2003 and 2015 against a world average of ~1.4%. There has been a major focus on developing consumer product oriented industries like foodstuffs, consumer durables, electronic products, power and information technology in the private sector.

On the other hand, in the public sector, there are large government investments planned towards infrastructure development. The 7th Five Year Plan (FYP) estimates that ~US$ 410 billion financing would be required for developing the country's infrastructure[52]. Major planned projects include Padma bridge, 26km Dhaka elevated expressway, 826 km new rail track, Rooppur nuclear plant, Payra sea port etc. Power sector has been identified as a major investment sector. The government is targeting 12,584 MW (61 per cent from the public sector and 39 per cent from the private sector) generation capacity addition in the current FYP[53]. These drivers indicate that industries such as construction materials, utilities and essential goods hold immense potential for growth.

One of the main objectives of the 7th FVP is to gradually move towards a manufacturing – based economy. Government of Bangladesh aims to increase secondary sector's contribution to GDP to 33% in 2020 from 27.6% currently. Various initiatives and plans of major industries in Bangladesh indicate the scope of sustained trade potential between the two countries.

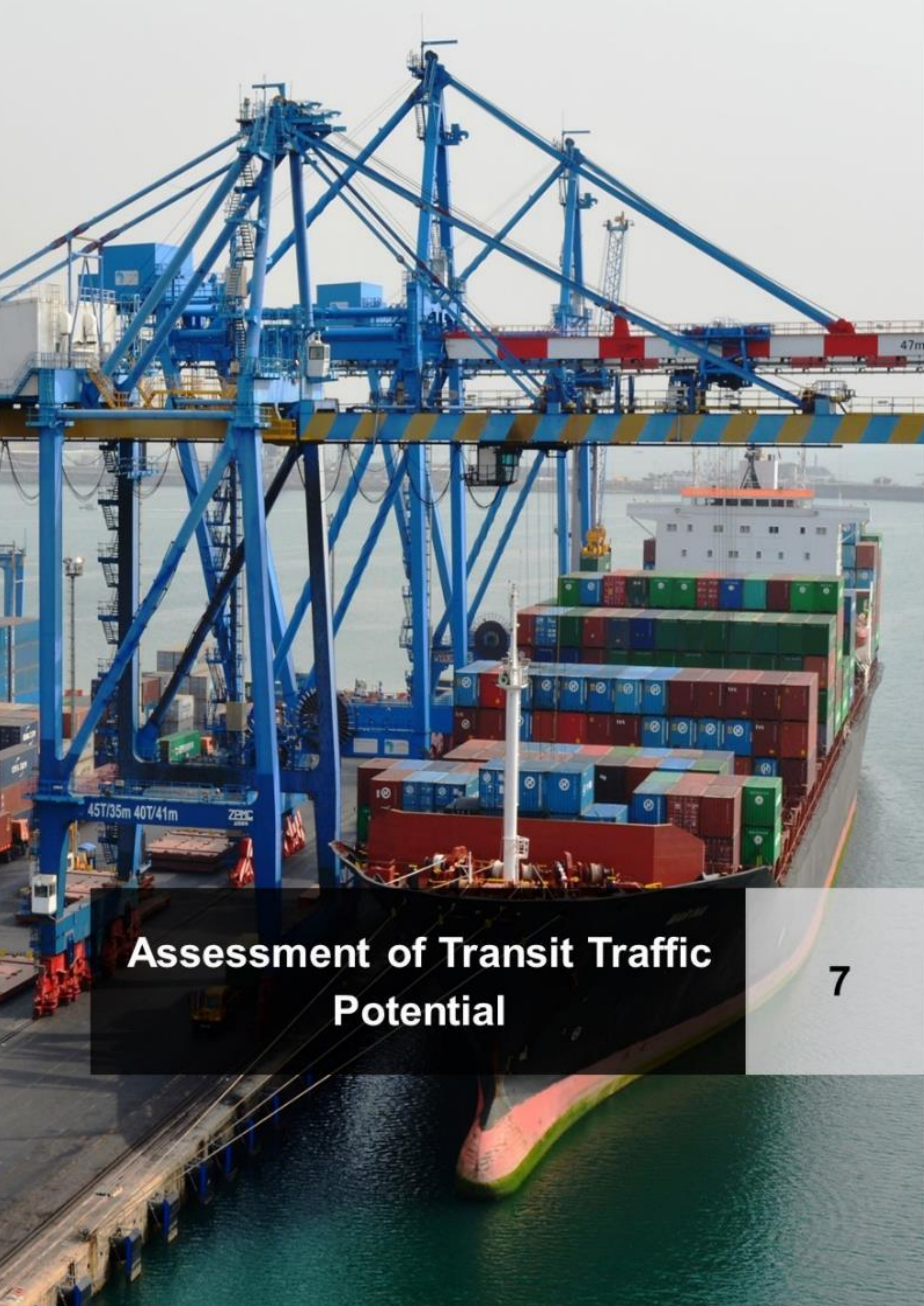
The leather industry of Bangladesh is the second largest export contributor in the country. In fiscal 2015-16, as per data from the Export Promotion Bureau export of leather, leather goods and footwear were USD 1.16 billion. In recent years, the exporters have been doing well in India, Japan, Nepal and Australian markets. Currently ~66% of the business is coming from the unorganized sector[54]. There is a huge scope for capacity expansion through setting up of large scale organized manufacturing units. Historically, production of finished goods in this industry has shifted to countries with cheap labour. At present, Bangladesh has one of the lowest cost of labour and electricity in the sub-continent. More than 50 foreign companies have expressed interest in establishing join venture footwear units in Bangladesh. The country has emerged as one of the ideal site for relocation of Chinese firms which are looking to set up more cost effective manufacturing units following increase in production cost in China.

RMG exports of Bangladesh, which accounts for two-thirds of the country's export earnings, grew at ~8% from FY 2015 to 2016 despite exports shrinking worldwide. As per Sagarmala National Perspective Plan, majority of Chief Purchasing Officers in the Indian Apparel industry want to move part of their sourcing out of China in the coming years. Bangladesh is emerging as the most preferred sourcing market for them. This change is expected to increase trade between the two countries.

Large players such as Abul Khair and Bangladesh Steel Re-Rolling Mills (BSRM) are reported to have already commissioned high-capacity induction and electric arc furnaces which would expand crude steel production significantly. Scrap will be a major raw material for steel smelting units based in Bangladesh, with expected imports to rise ~to 2.5 million tons in 2016, making Bangladesh the 4th largest scrap importer in Asia.

Jute industry was declared a priority sector according to the government's Industrial Policy Order 2010 with multiple export friendly incentives including 10% export value subsidy, 100% VAT exemption and 15% income tax rate (against standard 37.5%). These incentives coupled with cheap labor makes Bangladeshi jute more economical than Indian jute. To boost the production of jute goods, Government of Bangladesh launched a project titled Balancing, Modernization, Rehabilitation and Expansion (BMRE) of Public Sector Mills at an estimated cost of US$340 million[55]. Increase in production will in turn increase jute and jute goods export from the country.

[52] World Bank Database
[53] http://print.thefinancialexpress-bd.com/2015/09/30/109741
[54] http://www.daily-sun.com/arcprint/details/173564/Bangladesh%E2%80%99s-share-in-global-footwear-market-meagre/2016-10-09
[55] http://archive.dhakatribune.com/business/2016/jul/27/government-upgrade-jute-mills-boost-production



Assessment of Transit Traffic Potential

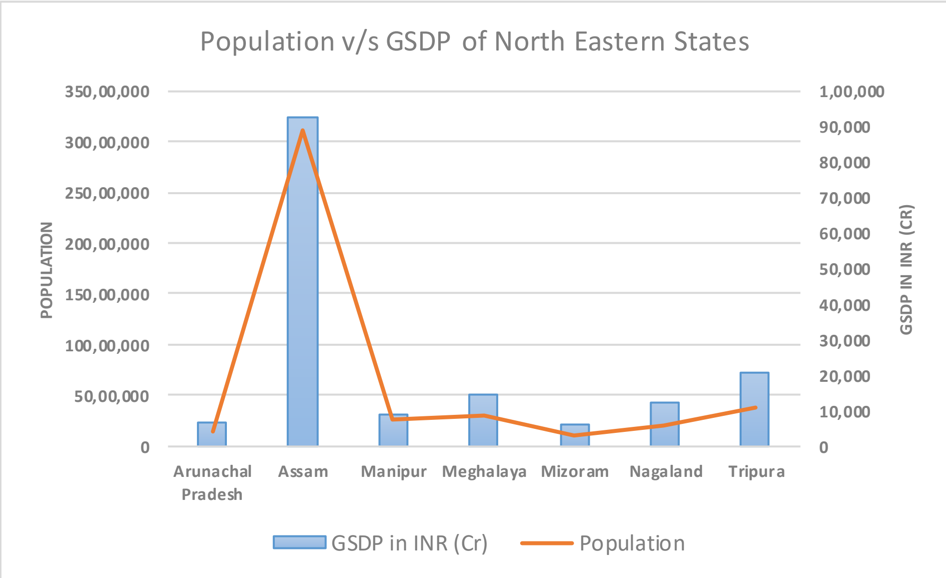
7

7 Assessment of Transit Traffic Potential

7.1 India's North-Eastern Region Overview

India's North East Region is enriched with vast unexploited natural resources and is accredited as the eastern gateway for India's economic growth and development. It stretches from the foothills of the Himalayas in the eastern range and is surrounded by Bangladesh, Bhutan, China, Nepal and Myanmar. It includes the seven sisters - Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. The following figure shows a comparison of Census of India 2011 population and Gross State Domestic Product 2014-15 of North-Eastern states of India.

Figure 43: Population v/s GSDP of North Eastern States of India[56]



The region enjoys fertile land and water resources, an ideal habitat for horticulture and a rich cultural and natural heritage that could be explored further for development. The region is recovering from succession of insurgencies and is isolated from the economic resurgence that the rest of the country has been experiencing. The World Bank describes conditions in the region as a low-level equilibrium of poverty, non-development, civil conflict and lack of faith in political leadership[57].

For transit movement, relevant study area has been further narrowed down to the major industrial centres and the major population centres which are accessible through inland waterways and last mile connectivity by existing roadway and railway.

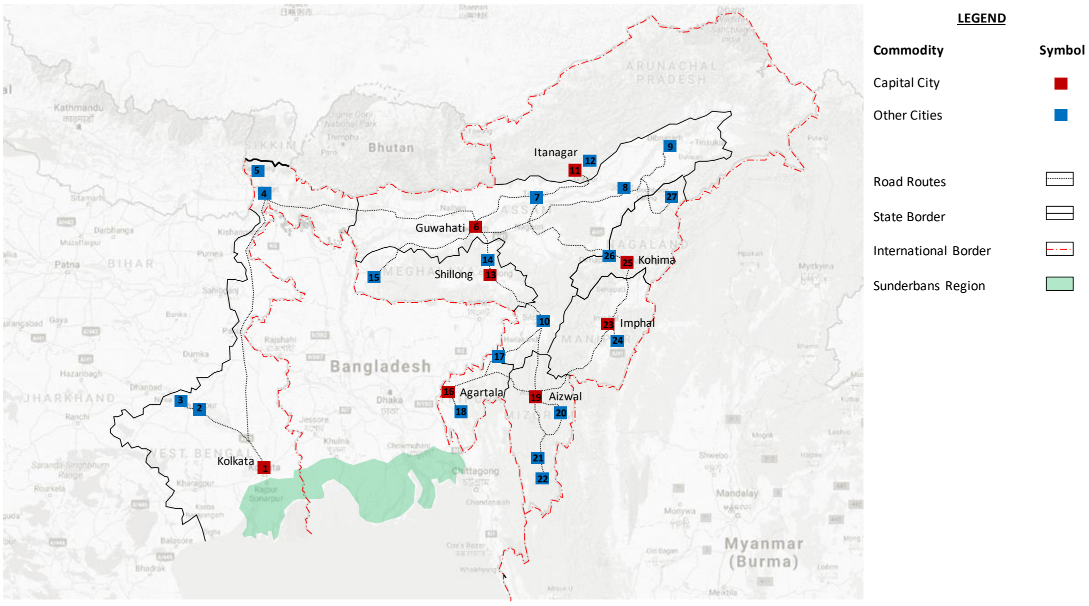
7.1.1 Population Centres in North East Region

According to Census of India 2011, Guwahati, Agartala, Shillong, Aizawl, Imphal, Silchar, Dibrugarh, Nagaon, Jorhat, Dimapur, Gangtok and Kohima represent the biggest and most vibrant metropolitan areas of the region[58]. Although there is great ethnic and religious diversity within the region, they bear similarities in the political, social and economic spheres. The following map depicts the India's North East Region transit protocol route along with key population centres.

As characterized in figure below, India's North East Region's protocol catchment spreads over several districts in West Bengal, Assam, Meghalaya, Tripura, Manipur, Mizoram, Nagaland and Arunachal Pradesh. These regions will be the primary beneficiaries of the Indo-Bangladesh protocol route with direct and indirect access to the waterway.

[56] Census of India 2011; NITI Aayog, GSDP (2014-15)
[57] India's North East Diversifying Growth Opportunities, Indian Chamber of Commerce (2013)
[58] Census of India, 2011

Figure 44: India's North East Region Transit Movement - Catchment Area



The following table lists the relevant major population centres in each state with road distance from Kolkata corresponding serial numbers in above Figure.

Table 64: Major Population Centres in North East Region[59]

Sr. No.	State	City (Population Centres)	Road Distance via India (Km)
1	West Bengal	Kolkata	0
2		Durgapur	171
3		Asansol	212
4		Siliguri	558
5		Darjeeling	614
6	Assam	Guwahati	986
7		Tezpur	1089
8		Johrat	1252
9		Dibrugarh	1391
10		Silchar	1287
11	Arunachal Pradesh	Itanagar	1289
12		Naharlagun	1277
13	Meghalaya	Shillong	1079
14		Mawlai	981
15		Tura	863
16	Agartala	Tripura	1442
17		Dharmanagar	1373
18		Udaipur	1552
19	Mizoram	Aizwal	1575
20		Champhai	1759
21		Lunglei	1745
22		Lawngtlai	1823
23	Manipur	Imphal	1469
24		Thoubal	1514
25	Nagaland	Kohima	1335
26		Dimapur	1270

[59] Census of India (2011)

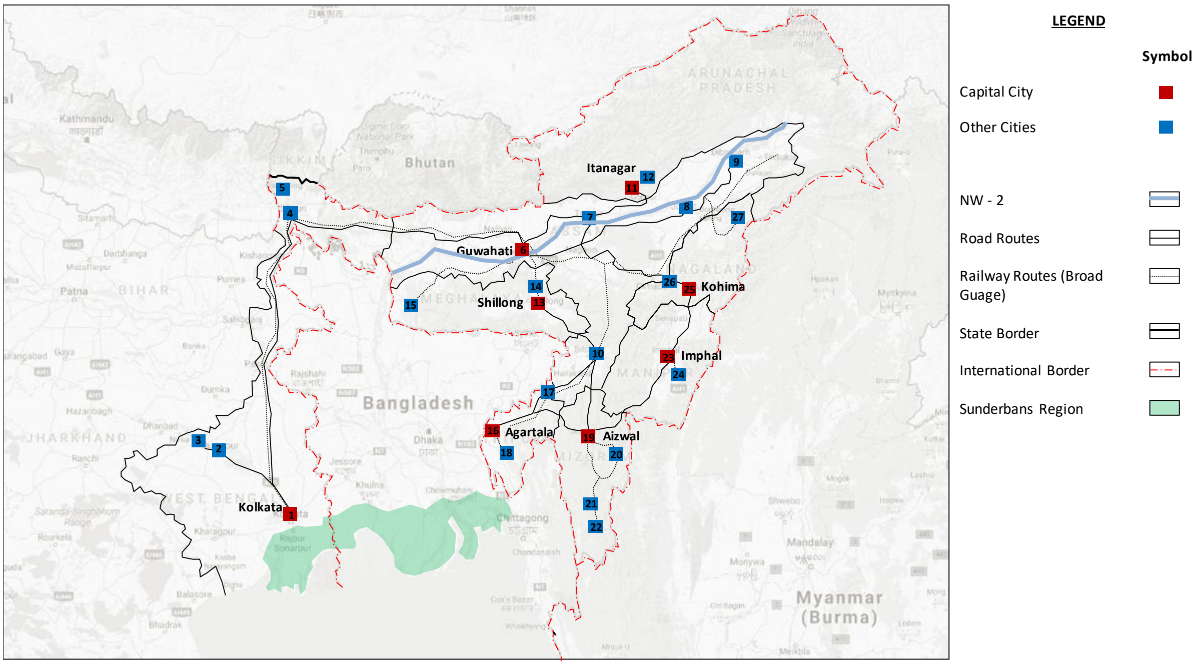
Sr. No.	State	City (Population Centres)	Road Distance via India (Km)
27		Mon	1423

7.2 Logistics Route to India's North-Eastern Region

Indian political geography has made it rather challenging for Government of India to effectively integrate the North-Eastern states where entire movement via roadway and railway materializes via the Siliguri Corridor, also called as 'Chicken's Neck' which is an awkward choke point in India's contemporary geography. The Siliguri, at its slimmest point, around 23 Km between the Bangladesh and Nepal international borders.

The strategic instability & topography of the region is the root cause for a single-line railway is all that transports rail-based freight across the Siliguri. The severe topography of the region makes the railway and roads subject to damage from recurrent landslides and natural disasters as India's North-East region receives record-breaking levels of rainfall. The figure below illustrates the movement routes of commodities and passengers through vulnerable Siliguri Corridor.

Figure 45: Existing Logistic Route to India's North Eastern Region

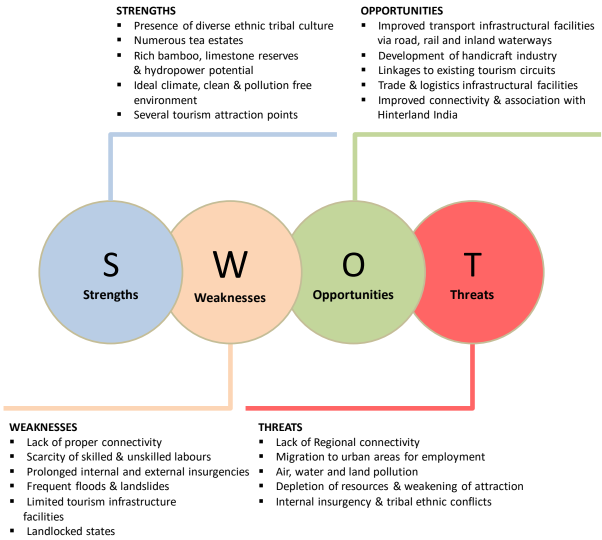


7.3 Issues/Challenges for in India's North Eastern Region

Key limitations to the development of India's North Eastern Region have been poor infrastructure and inadequate connectivity, both within the region as well as with the rest of the country. The region, connected to the rest of India by a narrow stretch of land called the 'chicken's neck', needs infrastructure to support and safeguard significant investments and developmental aids.

The region is endowed with a wide-ranging topography and agro-climactic environments which offer vast potential for agriculture, horticulture and forestry. However, the region is lagging in agricultural development contrary to the national growth. Reasons comprise lack of appropriate strategies for the development of natural resources, inadequate infrastructure facilities and low implementation of improved technology.

Figure 46: SWOT Analysis of Development in North Eastern Region



The following road / rail expansions have been planned in the North-Eastern states to improve connectivity.

Road

- 10 greenfield highway projects have been planned by the Indian Government with Japanese International Cooperative Agency (JICA). These include a 400-km highway project in Mizoram between Aizwal and Tuipang, a 150-km highway in Meghalya, two projects in Manipur, and one each in Tripura, Nagaland and Assam.
- Four-laning of Jorabat-Barapani highway to improve road connectivity between Guwahati and Shillong.

Railways

- Commissioning of Guwahati-Lumding-Badarpur-Kumarghat-Agartala broad gauge link.
- 15.06 km rail line between Agartala and Akhaura in Bangladesh.
- Railway electrification from Guwahati to Dibrugarh.

However, due to the physiography of the region, transportation via road and railways in these states would remain constrained to a certain extent.

7.4 Opportunities for Inland Waterways

The utilization of the protocol route has a lot of potential as road / rail connectivity to north-eastern states is poor and waterways provides a good alternative due to time and cost savings. The following initiatives are expected to improve the transit traffic:

- **Improvement of round-the-year navigability – capital and infrastructure improvements, channel dredging and installation of safety facilities on the protocol route.**
- **Development of Ashuganj as a trans-shipment hub under the recently signed protocol to transit goods to North-Eastern states of India via Bangladesh.**
- **Government initiatives such as incentive schemes/support for transportation of cargo, capital work, barge operations etc.**

A modal shift from railways / roads would be required to leverage the benefits offered by the protocol route for transit of cargo flowing to the North-Eastern states. Some of the parameters to evaluate potential benefits of such a modal shift are as follows:

- **Cost –** Essentially includes all costs incurred while transporting cargo from origin to destination. Various type of costs are transportation costs, handling charges, detention charges among others.
- **Time –** The total time required to complete the journey including detention time among others.
- **Flexibility or Reliability –** This parameter represents the availability of a mode for transport. It considers all factors that might hinder normal business operations such as infrastructure constraints, staff skill level

etc. which might increase idle time or may lead to high waiting times for a mode of transport.

The target catchment region includes key industrial clusters and centres in North East India, currently serviced through roads / railways. To compare modal advantages, several important routes, viz. Kolkata-Guwahati, Kolkata-Agartala, Kolkata-Shillong and Kolkata-Silchar, have been considered.

Costs

Typical logistic costs can be categorized into the following:

Roads

- Transportation cost – Primarily constitute fuel and sustenance cost
- Handling charges – Loading and unloading charges
- Detention Charges – occurring due to unforeseen events such as landslides, etc.

Waterways

- Waterway Usage Charges
- Vessel Related Charges
- Terminal Charges
- Cargo Handling Charges (Cranes, forklift, etc.)
- Miscellaneous Charges (Cargo handling at port, last mile connectivity, etc.)
- Transit Charges in Bangladesh
- Pass-through charges (at every port in Bangladesh)

Railways

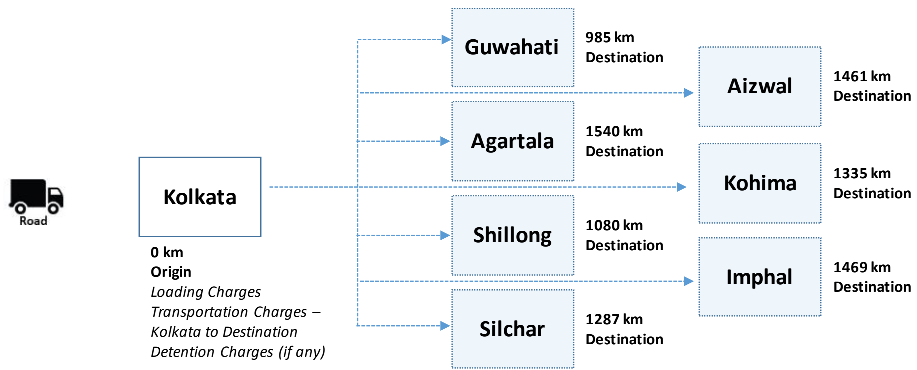
- Handling charges – Loading and unloading charges
- Freight Charges

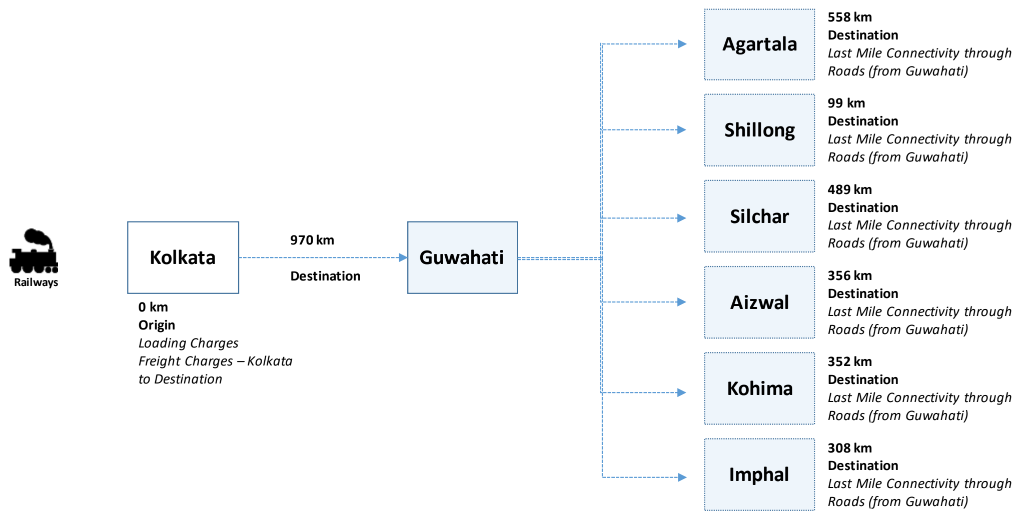
Transport cost essentially depends on the distance travelled. However, additional factors such as load carried, road conditions, traffic congestion, fuel efficiency etc. also affect fuel consumption and hence the transport costs. Waterway vessels are more fuel efficient than travel by road and / or rail. The charges do not include any custom and other government charges as these are assumed to be similar across all transportation modes.

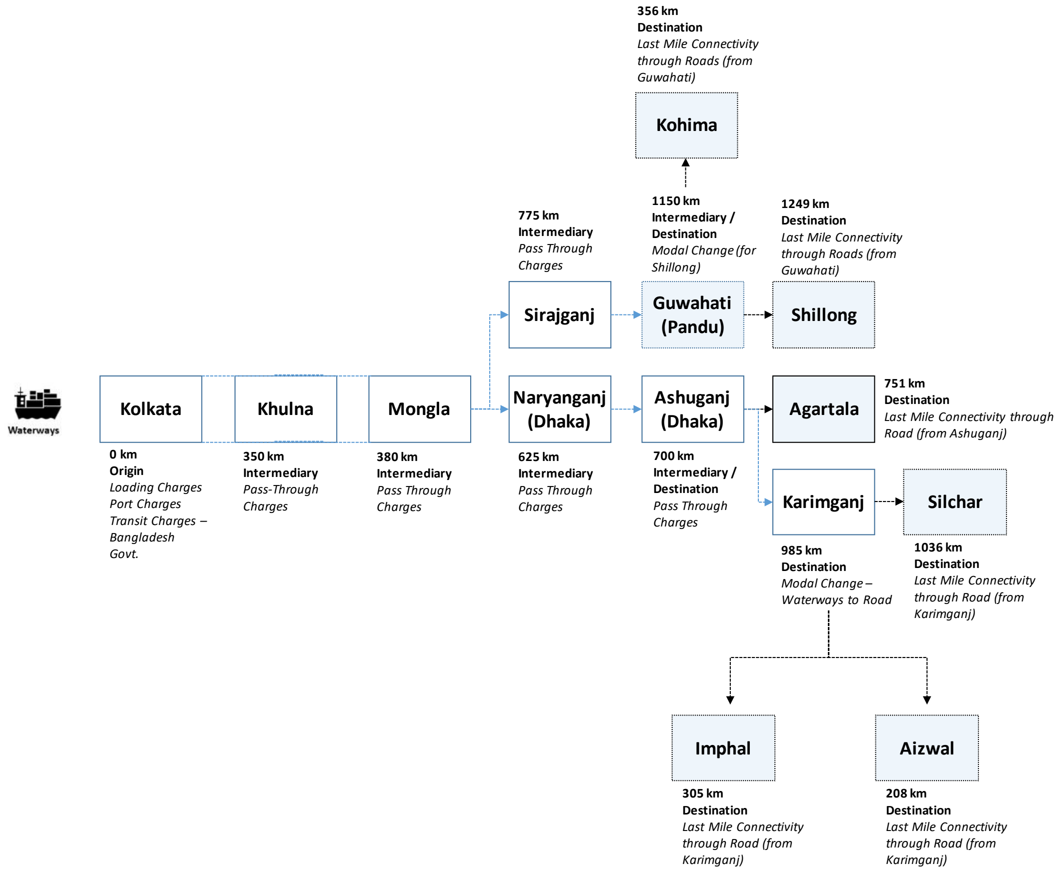
The following figure gives a modal comparison of the trade route.

Figure 47: Route Analysis

Modal Cost Comparison







The transportation charges for the key routes were computed and details of Kolkata – Agartala route are as shown in the following tables.

Table 65: Transportation Charges – Roads (Kolkata – Agartala)

Charges (INR per tonne)	12 MT Truck	16 MT Truck
Transportation Charges – *Kolkata – Agartala* (INR 102,400 per truck including loading / unloading charges)	8,483	6,400
Loading / Unloading Charges (INR 2,400 per truck)	150	150
Total Transportation Charges (per Tonne)	**~8,633**	**6,550**

Table 66: Transportation Charges – Railways (Kolkata – Agartala)

Charges (INR per tonne)	Kolkata – Agartala
First Mile Connectivity (INR 3,000 per truck including loading / unloading charges)	300
Freight Charges – Kolkata – Agartala (INR 1,210 per tonne in the distance range of 951-1,000 km)	1,210
Last Mile Connectivity (INR 130,000 per truck including loading / unloading charges)	2,505
Total Transportation Charges (per Tonne)	**~4,100**

Table 67: Transportation Charges – Waterways (Kolkata – Agartala)

Charges (INR per tonne)	Kolkata – Agartala
First Mile Connectivity (INR 17,000 per truck till Haldia)[60]	**964**
IWAI	**18**
Fairway Charges (INR 0.02 per GRT per km)	14
Vessel related Charges (INR 1,750 per barge)[61]	1
Cargo related Charges (INR 1 per ton)	1
Equipment Hire Charges (INR 2,500 per crane for 8 hrs)	2
Barge Operators[62]	**2160**
Transit Charges	**165**
Bangladesh Port Authority (Terminal)	**30**
Vessel Related Charges (INR 449 per barge)[63]	0.30
Cargo related Charges (INR 29.5 per tonne)	29.50
Fork Lift (INR 157.30 per hour)	0.20
Last Mile Connectivity (including handling)	**507**
Total Transportation Charges (per Tonne)	**3,844**

The summary of the modal cost comparison of the key routes is given in the following table.

[60] For travel from Kolkata to Haldia port (~50 km) including loading / unloading at port
[61] Berthing Charges: INR 1000 for 24 hrs; Pilotage: INR 750 per pilot
[62] Prevailing Market Rates
[63] Berthing Charges: INR 107 for 24 hrs; Pilotage: INR 342 per pilot

Table 68: Modal Cost Comparison

Route	Road		Railways		Waterways	
	Route Length (km)	Cost (INR / tonne) (16-12 MT truck)[64]	Route Length (km)	Cost (INR / tonne)	Route Length (km)	Cost (INR / tonne)
Primary Catchment						
Kolkata – Agartala[65]	1,540	6,550-8,600	1,528	4,015	751[66]	3,844
Kolkata – Imphal[67]	1,469	6,300-8,250	1,459	3,724	1,290[68]	5,740
Kolkata – Aizwal[57]	1,461	6,300-8,200	2,016	3,183	1,193[56]	5,367
Kolkata – Silchar[55]	1,287	5,500-7,300	1,278	2,960	1,036[58]	4,709
Kolkata – Shillong[57]	1,080	4,700-6,150	1,069	2,078	1,249[69]	5,417
Secondary Catchment						
Kolkata – Kohima[57]	1,335	5,700-7,500	1,326	3,162	1,506[59]	6,460
Kolkata – Guwahati	985	4,300-5,600	970	1,660	1,165[59]	5,076

It can be observed that railways appear as the cheapest of all the three options due to nominal freight charges. Among the other two modes, waterways provide a marginal cost advantage of ~15-17% along Guwahati & Shillong while providing a significant cost advantage along Agartala & Silchar (~100% & 50% respectively), suggesting that waterways can serve as a suitable mode for some of the locations in the target region (located towards south of Assam with a proximity to river ports in Bangladesh). With the improvements in waterway infrastructure and reduced travel time, the barge economics would further improve in the future, as detailed out in Annexure D.

7.5 Identification of Catchment Region

In 2015, India and Bangladesh decided to further strengthen trade relations and better utilize the protocol routes. The Protocol on Inland Water Transit and Trade was signed in June, 2015 and it was mutually decided to renew the Protocol automatically after every five years.

Out of the protocol routes identified by the Agreement (as represented in the figure below), **the Kolkata-Karimganj and the Kolkata-Silghat route are relevant for the current mandate** as they traverse through the Sunderbans Waterways (and the study stretch).

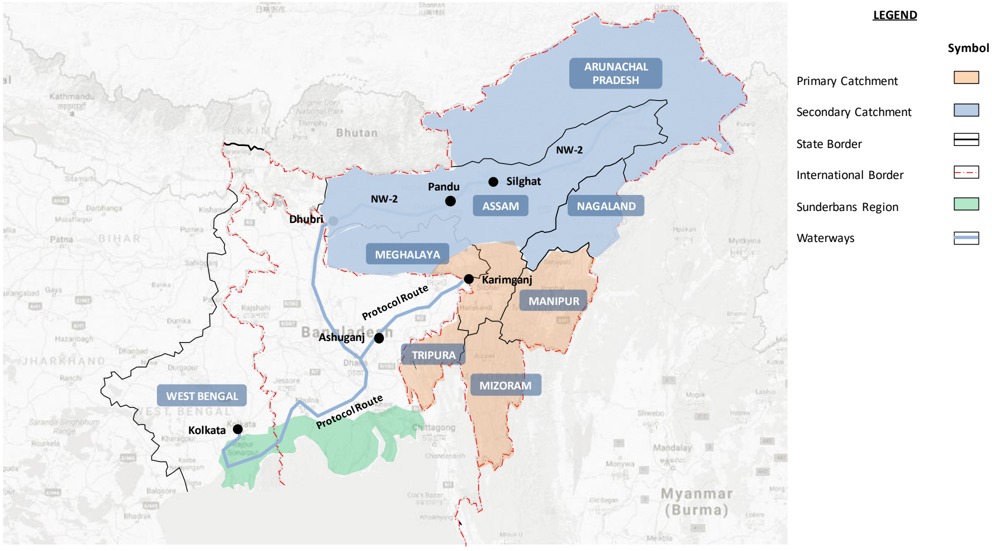
With better provision of IWT infrastructure, there is a potential to decrease the turn-around time, thereby enabling increased utilization and traffic movement through the route. To improve the traffic and transit-trade between hinterland states and north-eastern states, considerable improvement in IWT infrastructure needs to be undertaken. Based on the time-cost analysis, two catchment waterways routes have been considered:

- **Kolkata - Karimganj (1,318 km)** – this waterway protocol route runs along Kolkata - Silghat route and diverts from Chandpur, Bangladesh to move eastwards through Ashuganj, Bangladesh, finally connecting Karimganj, Assam. This route and the region surrounding is defined as the **Primary Catchment** for the mandate.
- **Kolkata - Silghat (1,535 km)** – this waterway route (National Waterway 2) acts as a bridge between NW1 (Allahabad - Haldia) and NW2 (Dhubri - Sadiya) by connecting them in Assam. It moves eastwards till Chandpur, Bangladesh and then moves northwards joining Silghat, Assam. This route and the region surrounding is defined as the **Secondary Catchment** for the mandate.

The map below represents the North-Eastern region with the primary and the secondary catchment for transit traffic movement between hinterland states of India and north-eastern states of India via protocol route and National Waterway – 2.

[64] Logistics cost via road has been calculated for a truck with design capacity of 12 MT. However, there is the market practice to overload the truck up to 16 MT and hence, cost has been computed accordingly.
[65] For Guwahati, direct railways cost has been considered. Although, the railway network till Silchar and Agartala has been recently commissioned, modal cost has been calculated by considering rail transport till Guwahati and last mile connectivity by road.
[66] For these routes, waterway till Ashuganj has been considered
[67] For these states, modal cost has been calculated by considering rail transport till Guwahati and last mile connectivity by road.
[68] For these routes, waterway till Karimganj has been considered
[69] For these routes, waterway till Pandu (Guwahati) has been considered

Figure 48: Inland waterways transit route to North Eastern Region



Utilization of the protocol route via Ashuganj and Karimganj has a lot of potential as road / rail connectivity to north-eastern states is poor and waterways provides a good alternative due to potential time and cost savings thereby enabling increased utilization and traffic movement through the protocol route.

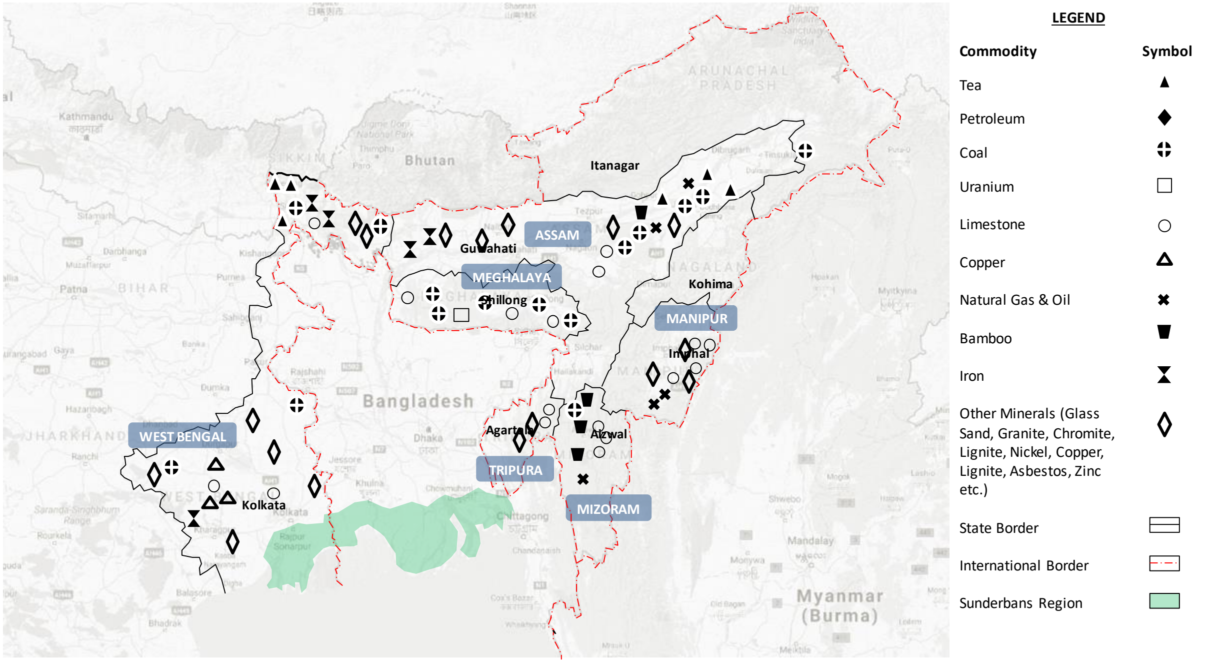
7.6 Movement of Goods in India’s North Eastern Region

Roadways are the backbone of transport and communication in the North-Eastern Region, principally due to terrain and sparse distribution of population. Rail and air are rather recent phenomena. Market locations and centres of productivity in the North East got disconnected from India’s hinterland by an ethnic and political division despite rich abundance of natural resources and several large industries. This has led to severe consequences on the livelihood of people in the entire region. The district wise demand assessment in the North-Eastern region is given in Annexure A.

7.6.1 Natural Resources in India’s North Eastern Region

North Eastern Region of India has huge untapped natural resources with a wide-ranging topography and agro-climactic environments. The major abundant natural resources available in North Eastern Region of India are tea, limestone, mineral oil, bamboo along with minor natural resources like iron, coal, glass sand, uranium etc. The following map represents the availability of natural resources in the catchment area:

Figure 49: Availability of Natural Resources in Catchment Area[70]

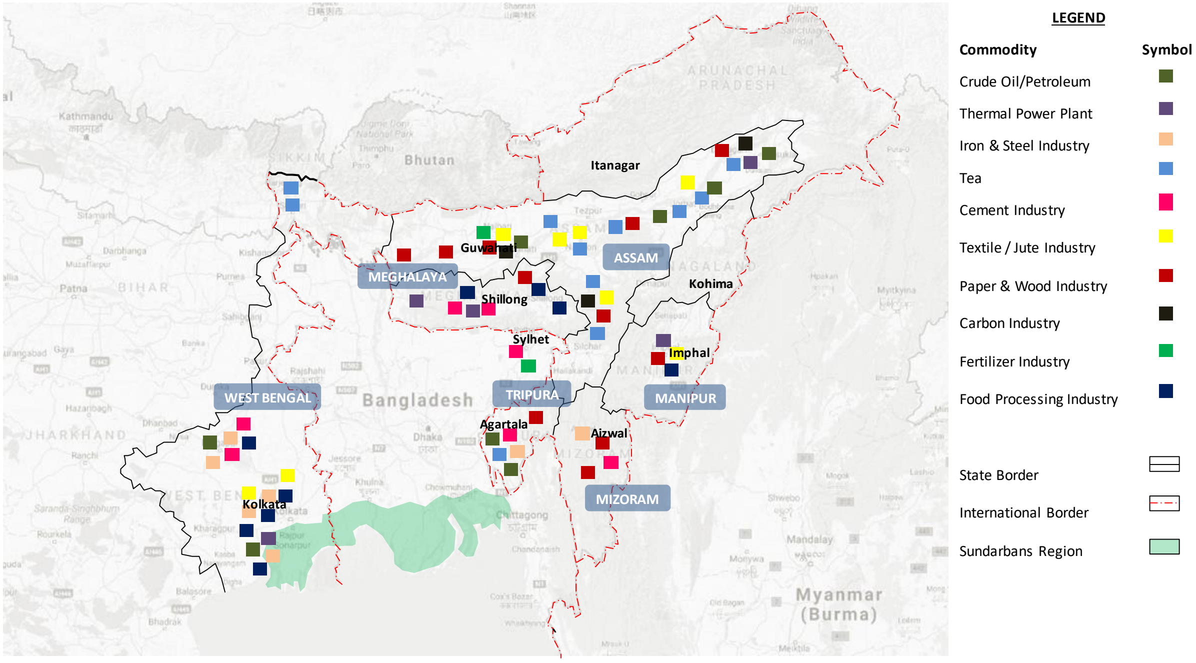


7.6.2 Major Industries in India's North Eastern Region

North Eastern Region has abundant rich quality natural resources like limestone, tea, & mineral oil and proximity to some neighbouring countries such as Bangladesh, Nepal and Bhutan, benefits its trade. The major industries in the region are tea, iron & steel, textile/jute industry, food processing industry etc. The following map represents the presence of industries in the region:

70 Interstate Movement/Flow of Goods, DGCI&S, M/O Commerce & Industry, GoI (2014-15); Tea Board of India; Annual Report, M/O Development of North Eastern Region, GoI (2015-16)

Figure 50: Major Industries in Catchment Area[71]



Due to abundance of rich natural resources and corresponding manufacturing industries, there is inward and outward movement of various raw material and finished products in the north-eastern region. The major inwards commodities in India's north-eastern region are rice, wheat, sugar, kerosene, iron & steel and ODC whereas the major outward commodities are limestone, tea, petroleum, oils and lubricants (POL), and bamboo-paper products.

Limestone

Assam has huge limestone reserves (~ 670 million tons) and export movement of Limestone is from Assam to India's hinterland states such as Bihar, Jharkhand, Madhya Pradesh, Uttar Pradesh, West Bengal as a raw material to the cement manufacturing plants and hence the catchment indicates a lot of potential for movement through waterways.

Table 69: Limestone - Transit Traffic Movement

Type of Traffic Movement	India's North Eastern States	India's Hinterland States	Major Industry Location in Hinterland
Outward Traffic	Assam	- West Bengal - Uttar Pradesh - Bihar - Madhya Pradesh - Jharkhand	- ACC, Durgapur - Ultratech, Durgapur - Ambuja, Dadri - Ultratech, Aligarh - Ultratech, Jawad - ACC, Chairbasa - Lafarge, Jojobera

Tea

Tea is exported from India's North Eastern Region state Assam to the hinterland. The state of Assam is the world's one of the largest tea-growing region, lying on either side of the Brahmaputra River and is exported to PAN India and also internationally exported to Commonwealth of Independent States, Europe, North America etc.

71 Interstate Movement/Flow of Goods, DGCI&S, M/O Commerce & Industry, GoI (2014-15); Tea Board of India; Annual Report, M/O Development of North Eastern Region, GoI (2015-16)

Petroleum, Oils & Lubricants (POL)

Assam has abundance of petroleum, oils and lubricants (POL) reserves and is exported to hinterland states like Bihar, Chattisgarh, Delhi, Goa, Haryana, Jharkhand, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Uttar Pradesh, West Bengal and hence the catchment indicates a lot of potential for movement through waterways.

Table 70: POL - Transit Traffic Movement

Type of Traffic Movement	India's North Eastern States	India's Hinterland States	Major Industry Location in Hinterland
Outward Traffic	Assam	- West Bengal - Uttar Pradesh - Haryana - Jharkhand - Bihar - Orissa	- IOCL Refinery, Haldia - IOCL Refinery, Mathura - IOCL Refinery, Panipat - IOCL Refinery, Barauni

Bamboo & Paper products

Assam has abundance of bamboo and paper products is exported to hinterland states like Madhya Pradesh, Haryana, Jharkhand, Maharashtra, Orissa, Uttarakhand, Uttar Pradesh and West Bengal. Thus, the catchment indicates a lot of potential for movement through waterways.

Table 71: Bamboo & Paper Products - Transit Traffic Movement

Type of Traffic Movement	India's North Eastern States	India's Hinterland States	Major Industry Location in Hinterland
Outward Traffic	Assam	- Madhya Pradesh - Haryana - Uttarakhand - Orissa - Jharkhand - Uttar Pradesh - Gujarat - Maharashtra - West Bengal	- Aacharan Industries, Gwalior - Ballarpur Industries, Gurgaon - Century Industries, Noida - Rainbow Papers, Ahmedabad - Ranjana Industries, Haldwani

Rice & Wheat

Rice and wheat is one of the major food consumption in India's North Eastern Region. North Eastern states such as Assam, Manipur, Mizoram, Nagaland, Tripura import rice from hinterland states such as Chattisgarh, Chandigarh, Delhi, Haryana, Maharashtra, Punjab, Rajasthan, Uttarakhand, Uttar Pradesh, West Bengal whereas wheat is imported from hinterland states such as Haryana, Madhya Pradesh, Punjab, Uttar Pradesh, West Bengal. Rice and wheat movement have a good compatibility with waterways and hence the catchment directs a huge potential for movement through waterways.

Sugar

Sugar is also another major food consumption in India's North Eastern Region. States such as Assam and Nagaland import sugar from hinterland states with high sugarcane production such as Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh. Sugar movement through waterways would seek a huge potential for movement via waterways.

Kerosene

Kerosene is imported by India's North Eastern states such as Assam, Nagaland, Tripura from hinterland states such as Haryana, Uttar Pradesh, West Bengal. Movement of Kerosene is utilised as a raw material for various industrial use as well as domestic use and would direct a huge potential for movement through waterways.

Iron & Steel

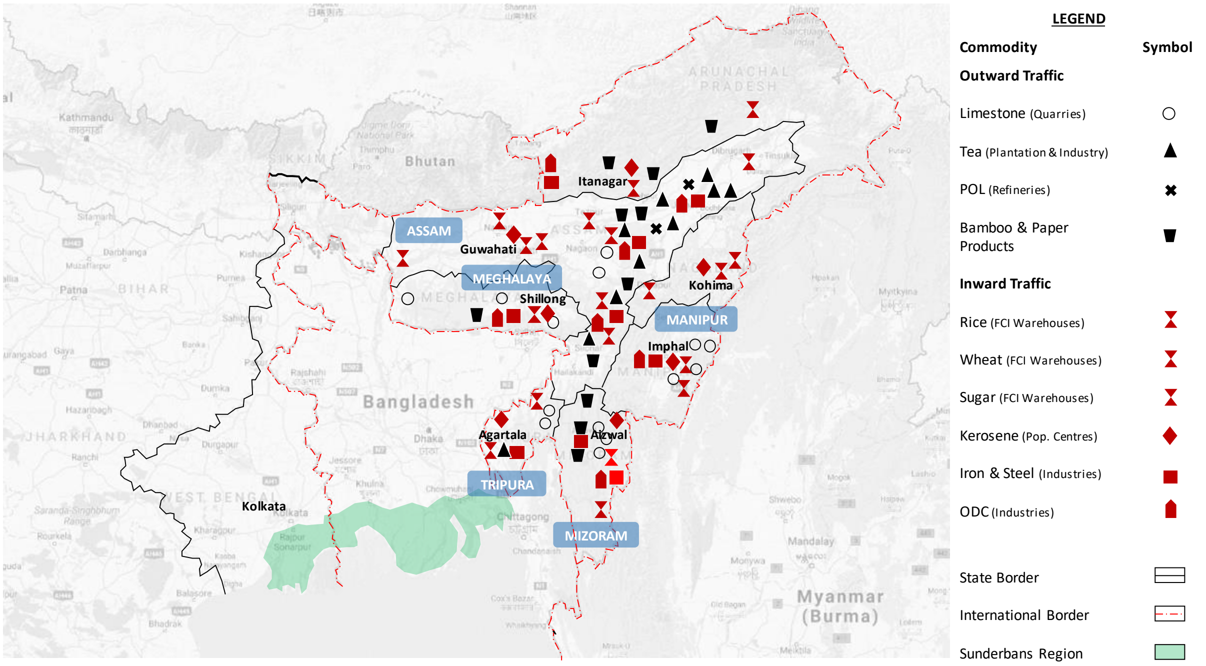
Assam has presence of several large industries and imports iron and steel from hinterland states such as Chattisgarh, Delhi, Jharkhand, Orissa, West Bengal for industrial and other manufacturing use.

Over-dimension Cargo (ODC)

Over-dimension Cargo (ODC) is imported by all of India's North Eastern states such as Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura as finished goods for various industrial and other manufacturing use across the North-Eastern Region. These cargo products have good compatibility with waterways and consequently the catchment shows a considerable measure of potential for movement through waterways.

The Figure below represents the outward and inward traffic movement of major transit commodities between India's North-Eastern states and India's hinterland states:

Figure 51: Inward and Outward Traffic Commodities[72]



The following table lists the major commodities traffic:

Table 72: Major commodities for NER for outward & inward traffic[73]

Commodity	India's North Eastern Region State	India's Hinterland States	Related Major Industry/Consumption
Outward Traffic			
Limestone	Assam	West Bengal, Uttar Pradesh, Bihar, Madhya Pradesh, Jharkhand	Cement Industry
Tea	Assam	PAN India	Tea Industry and Tea Consumption
POL	Assam	West Bengal, Uttar Pradesh, Haryana, Jharkhand, Bihar, Orissa	Oil Refineries

[72] Interstate Movement/Flow of Goods, DGCI&S, M/O Commerce & Industry, GoI (2014-15); Tea Board of India; Annual Report, M/O Development of North Eastern Region, GoI (2015-16)
[73] Interstate Movement/Flow of Goods, DGCI&S, M/O Commerce & Industry, GoI (2014-15); Tea Board of India; Annual Report, M/O Development of North Eastern Region, GoI (2015-16)

Commodity	India's North Eastern Region State	India's Hinterland States	Related Major Industry/Consumption
Bamboo & Paper Products	Assam	Madhya Pradesh, Haryana, Uttarakhand, Orissa, Jharkhand, Uttar Pradesh, Gujarat, Maharashtra	Paper Industry & Paper Consumption
Inward Traffic			
Rice	Assam, Manipur, Mizoram, Nagaland, Tripura	Punjab, Haryana, Chattisgarh, Uttar Pradesh, Uttarakhand, Maharashtra, Delhi	Food Consumption
Wheat	Assam, Manipur, Mizoram, Nagaland, Tripura	Punjab, Uttar Pradesh, Haryana, Madhya Pradesh, West Bengal	Food Consumption
Sugar	Assam, Nagaland	Maharashtra, Karnataka, Madhya Pradesh, Uttar Pradesh	Food Consumption
Kerosene	Assam, Nagaland, Tripura	Uttar Pradesh, Haryana, West Bengal	Fuel Consumption
Iron & Steel	Assam	Jharkhand, Orissa, Chattisgarh, West Bengal	Manufacturing Industry
ODC	Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura	Tamil Nadu, Haryana, Uttarakhand, Maharashtra	Manufacturing Industry

The commodity wise volume of outward and inward traffic of major transit commodities between India's North-Eastern states and India's hinterland states in 2015 is given in the following table.

Table 73: Transit Traffic Movement in 2015[74]

Commodity Group	Volume (in tons)
Outbound to North-east	**11,680,511**
Rice	6,182,039
Wheat & Other Foodgrains	1,378,774
Sugar	728,774
Iron & Steel	2,776,167
Over Dimensional Cargo	614,757
Inbound from North-east	**7,725,949**
Limestone	2,407,897
Tea	2,343,442
Forest Products (Bamboo / Paper)	1,296,914
POL	1,677,696

The Total Transport System Study Report (2014) by erstwhile Planning Commission of India has been referred for the modal split of the transit traffic movement. The state-wise modal split for every commodity as per the study is given in Annexure A.

Based on the traffic estimation and type of goods expected to navigate through the waterways with the availability of various natural resources and presence of several large industries in in the catchment, there is a large potential to transport essential commodities for domestic use and raw materials and finished goods for industrial use through the waterways for better connectivity and association between the catchment region of North-Eastern states and the hinterland states of India.

[74] DGCI&S

7.7 Growth Potential in North East India

The Northeast region of India is endowed with huge untapped natural resources and is acknowledged as the eastern gateway of India's Look-East Policy. There exists significant potential in the Northeastern Region due to its renewable natural resources to generate benefits at the regional and local levels.

Ministry for Development of North Eastern Region of India aims to give concentrated attention to address the special needs of the region with development concerns are pursued through their respective Five Year and Annual Plans. In addition, projects of inter-State nature in the Region are funded through by the North-Eastern Council (NEC), which has a separate additional budget for the purpose.

Ministry for Development of North Eastern Region of India acts as a facilitator between the Central Agencies and the State Agencies of the Region towards the economic development and removal of infrastructure bottlenecks of basic minimum services, creating an environment for private investment with lasting peace and security. The Union Ministry has fixated on time bound completion of critical infrastructure, i.e. road, rail, inland water transport, power, airports and air connectivity, telecom connectivity, etc. The major activities/functions are:

- Coordination with the Central Ministries and the State Govts. of the north-eastern states.
- Capacity Building.
- Advocacy and Publicity.
- International Cooperation.
- Enterprises of the Department.

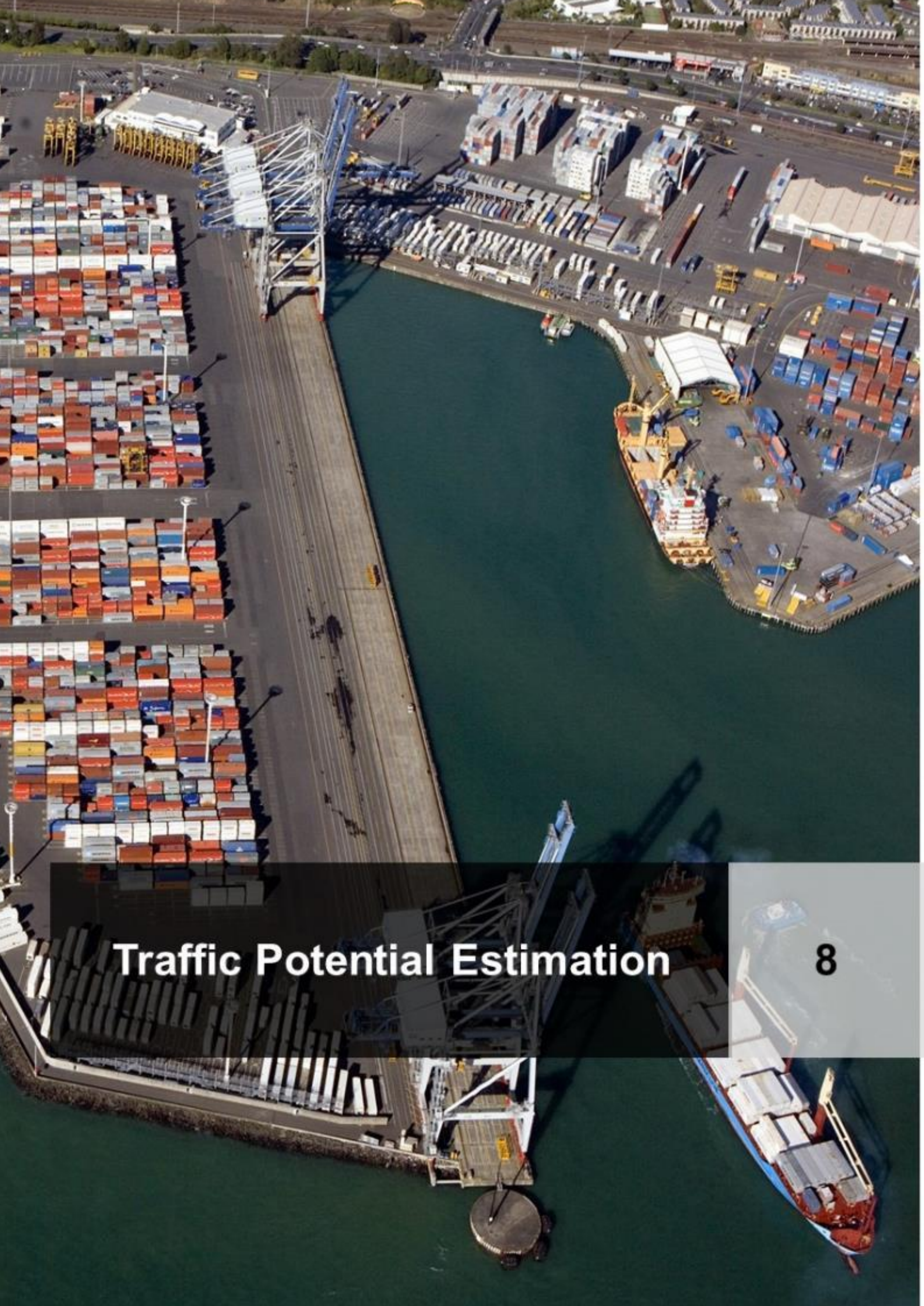
The major bodies/ functionaries are:

- North Eastern Council (NEC).
- Non-Lapsable Central Pool of Resources (NLCPR).
- North Eastern Development Finance Corporation Ltd. (NEDFi).

Government of India has also proactively engaged initiatives for promoting linkages with other parts of the country and for close bilateral relations with the neighbouring countries and other South East Asian countries in undertaking of the 'Act East Policy'[75]. The Act East Policy emphasizes on the extended neighbourhood in the Asia-Pacific Region to encourage economic cooperation, cultural ties and develop strategic relationship with countries in the Asia-Pacific region through continuous engagement at bilateral, regional and multilateral levels thereby providing enhanced connectivity to the States of North Eastern Region with other countries in our neighbourhood. Act East Policy provides an interface between North East India and the ASEAN region to develop and strengthen connectivity of Northeast India with the ASEAN region through trade, culture, people-to-people contacts and physical infrastructure (road, airport, telecommunication, power etc.

While majority traders and population have limited transport options, development of inland waterways will offer an economic alternative to road transport with improved logistics. This can be capitalised to optimise traffic and improved economic opportunities via waterways and via road & railway as well. Implementation of proactive policies towards growth of industries in North-Eastern region would seek a huge potential for cargo movement via waterways.

[75] Annual Report 2015-16, Ministry for Development of North Eastern Region (GoI)



Traffic Potential Estimation 8

8 Traffic Potential Estimation

The following section estimates the traffic along the Indo-Bangladesh protocol route based on commodity flows and industry assessment.

8.1 Traffic Definition

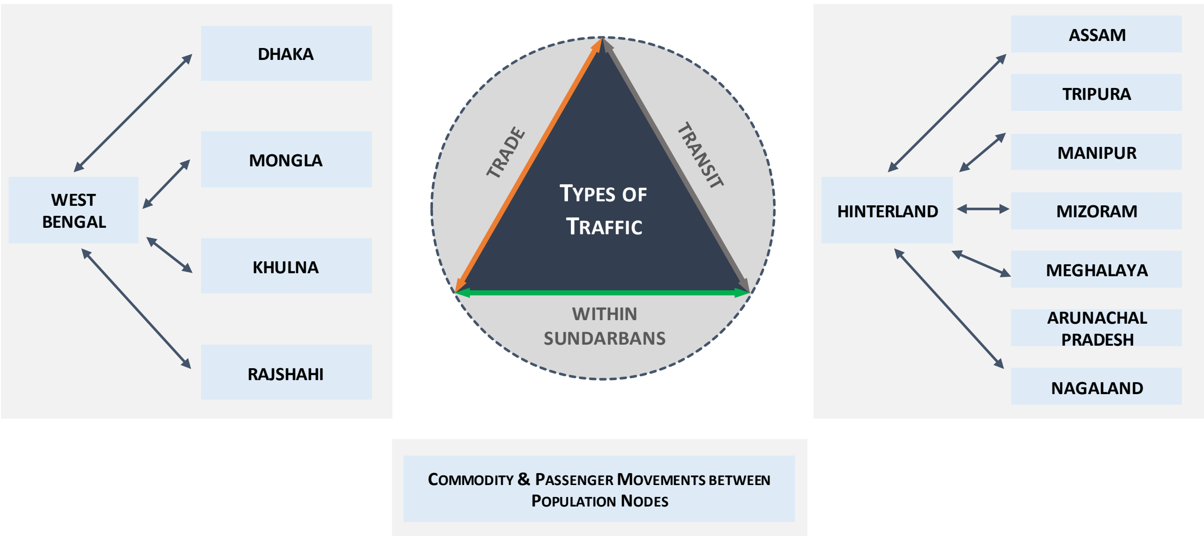
The traffic along the protocol route can be broadly classified into three categories as shown in the following figure.

(a) Trade traffic – includes commodity movement between Kolkata (via Petrapole Land Port, Kolkata Sea and waterways) and Bangladesh.

(b) Transit traffic – includes commodity movement between the hinterland and North-Eastern states such as Assam, Tripura, Manipur, Mizoram, Meghalaya and Arunachal Pradesh.

(c) Traffic within Sunderbans – Includes the passenger and commodity movement between major population nodes of Sunderbans.

Figure 52: Types of traffic along Indo-Bangladesh Protocol Route

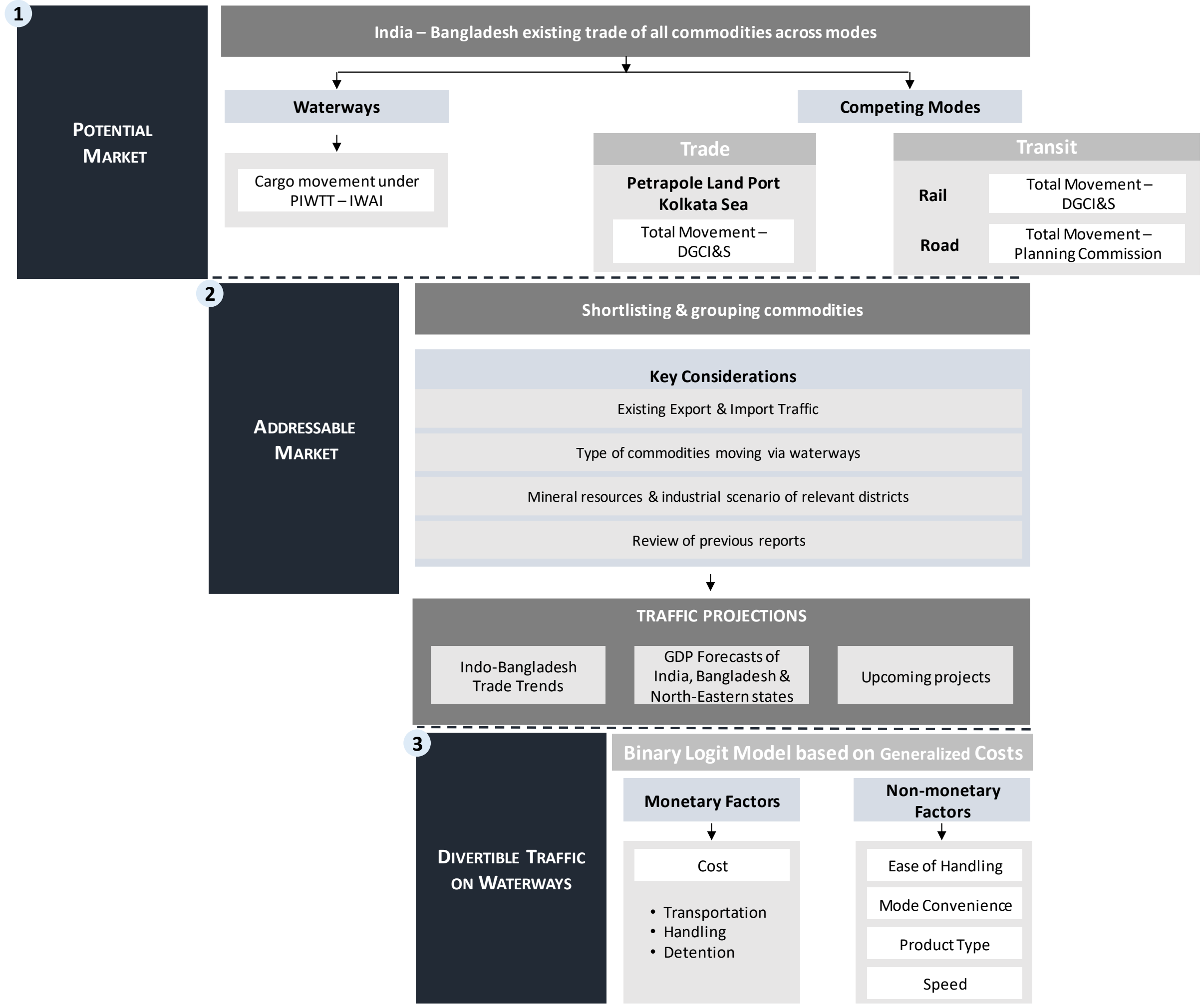


For estimating traffic, only trade and transit potential is considered as it is expected to constitute bulk of the traffic on this route.

8.2 Methodology

The methodology for estimation of trade traffic for the Sunderbans waterways employs the modules as shown in the following figure.

Figure 53: Methodology for trade traffic estimation



8.2.1 Potential Market

Trade

A temporal analysis of commodity movements at an all India level across roadway and waterways was carried out. Total market was analysed to understand the movement of commodities between India and Bangladesh. The export and import movements between India and Bangladesh via Petrapole Land Port and Kolkata Sea were studied for 72 commodities as per the classification made by DGCI&S. This was supplemented by the existing waterways traffic on the protocol route as provided by IWAI.

Transit

A temporal analysis of commodity movements at an all India level across roadway, railway and waterways was carried out. Total market was analysed to understand the movement of commodities between hinterland India and India's North Eastern Region. The export and import movements between hinterland India and India's North Eastern Region were studied for 72 commodities as per the classification made by DGCI&S and Planning Commission study on North Eastern Region movement. This was supplemented by the existing waterways traffic on the protocol route as provided by IWAI.

8.2.2 Estimating the Addressable Market

Given the catchment definition, the commodity movements were analysed in detail between Kolkata and major administrative divisions of Bangladesh. In order to shortlist major commodities that hold greater potential for capturing traffic, following factors were considered:

- **Volume of existing traffic**
  The commodities accounting for at least 85% of the total value and volume of export and import traffic were classified into 12 commodity groups.

- **Nature of commodities that can move via waterways**
  - *High Volume / Low Value Bulk Commodities*
    Inland waterways have the ability to carry large volumes of bulk commodities over long distances. This inherent ability to move more cargo per shipment makes IWT both fuel efficient and environmentally advantageous. These commodities mainly include raw materials or primary manufactured products that are typically stored for further processing or consumption, or are transshipped for overseas markets. Such type of cargo includes coal, POL, foodgrains & other agri-based products, construction materials (stone, sand, gravel), metal ores and minerals. For such commodities, regularity rather than speed of movement is of importance.

  - *Commodities currently moving on Indo-Bangladesh Protocol Route*
    The traffic statistics of the type of cargo that is moving along the Indo-Bangladesh Protocol route indicate that the major commodities which are currently using the trade route are fly ash, iron & steel, foodgrains and project / ODC cargo.

- **Type of commodities that are currently moving via waterways**
  - *Major commodities currently moving on National Waterways of India*
    The type of cargo that is moving along NW-1, NW-2 and NW-3 is given in the following table, which mainly comprises of fly ash, construction materials, iron & steel, POL, foodgrains & other essential commodities, and ODC / project cargo.

Table 74: Type of Cargo moving along NW-1, NW-2 and NW-3[76]

Stretch	Type of Cargo
NW-1 (The Ganga)	Cement, Fly ash, Iron Ore, Coal, Steel, Stone Chips, POL, Foodgrains, Coal & Coke, ODC
NW-2 (The Brahmaputra)	Bamboo, Cement, Building Material, Fertilizers, Foodgrains, Milk & Other Essential Commodities
NW-3 (West Coast Canal)	Chemicals, Zinc, Containerized goods, POL, Lime shell with clay, Potable Water

  - *Major commodities currently moving on waterways in other countries*
    - USA – Stone, Sand, Iron, Coal, Cement, POL
    - China – Coal, Steel, Cement, Containers, LPG, Automobiles, Liquid Bulk Cargo
    - European Countries – Dry bulk cargo such as coal, iron ore, foodgrains, pellets; liquid bulk cargo such as crude oil, gasoline, fuel diesel, chemicals, vegetable oils, biodiesel, and ethanol; specialized project cargo (construction equipment, industrial plant & machinery)

- **Mineral Resources and Industrial Scenario of relevant districts**

8.2.3 Divertible Traffic

To understand the divertibility of the traffic across each mode, binary logit model was run based on the generalised cost method. Binary logit model[77] is the simplest form of mode choice, where the travel choice between two modes is made based on assigned utility for the modes. If the utility of one mode is higher than the other, then that mode is preferred.

The modal shift on to waterways has been estimated using the Binary Logit Model based on Generalised Costs which is explained as follows. The modal share between OD pairs i and j is determined by the following equation:

Modal Share = $\underline{\quad e^{-\beta c1_{ij}} \quad}$

[76] IWAI
[77] Mathew T., Rao K.V.; Introduction to Transportation Engineering, NPTEL; (2007)

$$e^{-\beta c1_{ij}} + e^{-\beta c2_{ij}}$$

where,

- C_{ij} is the generalised cost for travel between i to j
    - C_1 is the generalised cost of waterways and,
    - C_2 is the generalised cost of the competing mode
- β is the relative weight assigned for each cost item in generalized cost

The generalised cost calculation is based on the following parameters:

- Logistics Cost (Travel, Detention and Handling Costs) – actual cost for each OD pair for trade and transit traffic
- Handling (ease of handling and infrastructure availability) – considers the type of handling such as mechanical or manual and number of times the handling is done
- Mode Convenience (mode preference for the travel distance) – the preference for a mode considered across distance slabs (based on Planning Commission Study)
- Product Type (assessment of suitability for waterways) – under the stable condition as observed for European waterways, the preference of a commodity to shift to waterways has been considered
- Speed (time taken for a commodity to reach its destination) – based on time of travel including waiting time / detention time

In this study the potential for inland navigation was determined from the perspective of the demand side of freight flows. The limiting factors (β / relative weight) can have a substantial impact on the shares of the transport modes and are as shown in the following table. The numeric values to the limiting factors have been derived from the study based on calculating divertibility on European Waterways – Modal Shift Target for Freight Transport above 300 Km: An Assessment; (2011) by Tavasszy L.

Table 75: Influence of condition surrounding transport on potential

Limiting Factors	Relative
Logistics costs	1
Handling (Quantum and Infra)	0.87
Mode Convenience	0.61
Product Type	0.5
Mode Speed	0.35
Reliability	0.35

Example

Focusing of the potential of inland navigation, Binary logit divertibility model is run for trade and transit movement for major commodities considering limiting factors influencing the condition of surrounding transport potential. An example for trade movement from Kolkata to Dhaka for rice is as shown as below:

- **Logistics costs –** Considering current market prices of loading/unloading, transportation charges, detention charges, warehousing charges etc., logistics costs are computed for waterways and roadways. In this example, logistics cost of roadways is higher than waterways from Kolkata to Dhaka.
- **Handling (Quantum and Infra) –** In this factor, quantum of handling and infrastructure is considered. Waterways has higher number of loading/unloading as compared to roadways as last mile connectivity of waterways is provided by roadways.
- **Mode Convenience –** Modal convenience is based on the travel distance. For this example, preferred mode is roadways and hence limiting factor has been assigned to waterways.
- **Product Type –** Product type is based on European standards for inland navigation for various commodities. In this example, limiting factor is assigned to waterways as it is at a disadvantage for the considered commodity.
- **Mode Speed –** Mode speed is based on the time taken for commodity to reach the destination excluding waiting period. In this example, limiting factor has been assigned to roadways due to higher waiting period at Petrapole.

Table 76: Divertibility of Rice from Kolkata to Dhaka

Limiting Factors	Relative	Waterways	Roadways
Logistics costs	1	1	2
Handling (Quantum and Infra)	0.87	1	1
Mode Convenience	0.61	4	1
Product Type	0.5	1	2
Mode Speed	0.35	3	1
Reliability	0.35	2	1
Generalized Costs		**6.56**	**5.18**

The divertibility of rice movement from Kolkata to Dhaka from roadways to inland waterways is ~20%. Similarly, for all origins and destinations for all major commodities for trade movement and transit movement are computed.

8.3 Trade Traffic Estimation

The modal shift on to waterways has been estimated based on comparison of various monetary and non-monetary considerations across the three modes. These include the monetary factor of cost (overall transportation cost, handling charges, detention cost, losses). Certain non-monetary factors considered include reliability / convenience, safety, carbon emissions and nature of commodities.

Based on the above analysis, the traffic estimation for the 12 commodity groups for the years 2020, 2030, 2040 and 2050 are as provided in the following table.

Table 77: Estimated Divertible Trade Traffic on Waterways (in tons)

Export	2020	2030	2040	2050
Bulk	**31,26,895**	**54,90,746**	**90,28,154**	**115,76,651**
Cotton & Products	85,269	2,17,069	3,56,965	457,761
Flyash	28,03,061	47,97,966	78,90,133	10,118,075
Iron & Steel	1,63,684	3,55,325	5,84,323	749,319
Food Grains & Spices	26,074	40,884	67,233	86,217
POL	48,807	79,502	1,29,501	165,279
Container	**14,264**	**38,437**	**63,209**	**81,057**
ODC / RoRo	**32,329**	**68,618**	**112,102**	**143,288**
Import	**2020**	**2030**	**2040**	**2050**
Bulk	**1,12,351**	**3,29,407**	**5,31,481**	**6,75,095**
Raw Jute	1,04,967	3,07,372	4,95,928	6,29,936
Lead, Zinc, Iron & Steel	5,283	13,702	22,108	28,082
Rubber, Leather & its products	2,101	8,333	13,445	17,078
Container	Negligible			

8.4 Transit Traffic Estimation

Estimating the Divertible Traffic on Waterways

The modal shift on to waterways has been estimated based on comparison of various monetary and non-monetary considerations across the three modes. These include the monetary factor of cost (overall transportation cost, handling charges, detention cost, losses). Certain non-monetary factors considered include reliability / convenience, safety, carbon emissions and nature of commodities.

Based on the above analysis, the estimation of traffic divertible on waterways for the 9 commodities for the years 2020, 2030, 2040 and 2050 are as provided in the following table.

Table 78: Estimated Divertible Transit Traffic on Waterways

Outward Traffic	2020	2030	2040	2050
Bulk	6,36,380	11,75,860	19,15,353	24,44,529
Rice	3,95,183	7,47,746	12,18,000	1,554,511
Wheat	36,740	62,435	1,01,700	129,798
Sugar	25,214	42,205	68,747	87,740
Iron & Steel	1,79,243	3,23,474	5,26,906	672,480
ODC / RoRo	24,631	47,325	77,087	98,385
Inward Traffic	**2020**	**2030**	**2040**	**2050**
Bulk	9,92,230	19,36,615	31,54,542	40,26,084
Limestone	7,54,250	15,45,268	25,17,078	3.212,501
Tea	58,502	97,922	1,59,504	203,572
Bamboo/Paper	1,55,603	2,53,461	4,12,862	526,928
POL	23,876	39,964	65,098	83,083

Based on the above analysis, the estimated divertible inward traffic (import and inbound from North-east) for the years 2020, 2030, 2040 and 2050 are as provided in the following table.

Table 79: Estimated Divertible Inward Traffic on Waterways

Commodity	2020	2030	2040	2050
Total Bulk (in tons)	**1,104,582**	**2,266,022**	**3,686,023**	**4,701,179**
Bulk (Import – in tons)	**112,351**	**329,407**	**531,481**	**45,160**
Raw Jute	104,967	307,372	495,928	6,29,936
Lead, Zinc & Products	5,283	13,702	22,108	28,082
Rubber, Leather & its Products	2,101	8,333	13,445	17,078
Bulk (Inbound from Northeast – in tons)	**992,231**	**1,936,615**	**3,154,542**	**813,583**
Limestone	754,250	1,545,268	2,517,078	3.212,501
Tea	58,502	97,922	159,504	203,572
Forest Products (Bamboo / Paper)	155,603	253,461	412,862	526,928
POL	23,876	39,964	65,098	83,083
Container (Import – in TEUs)	**Negligible**			

Based on the above analysis, the estimated divertible outward traffic (export and outbound to North-east) for the years 2020, 2030, 2040 and 2050 are as provided in the following table.

Table 80: Estimated Divertible Outward Traffic on Waterways

Commodity	2020	2030	2040	2050
Total Bulk (in tons)	**3,763,275**	**6,666,606**	**10,943,508**	**14,021,180**
Bulk (Export – in tons)	**31,26,895**	**54,90,746**	**90,28,155**	**115,76,651**
Cotton & Products	85,269	217,069	356,965	457,761
Fly-ash	2,803,061	4,797,966	7,890,133	10,118,075
Iron & Steel	163,684	355,325	584,323	749,319
Foodgrains & Spices	26,074	40,884	67,233	86,217
POL	48,807	79,502	129,501	165,279
Bulk (Outbound to Northeast – in tons)	**6,36,380**	**11,75,860**	**19,15,353**	**24,44,529**
Rice	395,183	747,746	1,218,000	1,554,511
Wheat & Other Food grains	36,740	62,435	101,700	129,798
Sugar	25,214	42,205	68,747	87,740
Iron & Steel	179,243	323,474	526,906	672,480
Container (Export – in TEUs)	**14,264**	**38,437**	**63,209**	**81,057**
Total ODC (in tons)	**32,329**	**68,618**	**112,102**	**143,288**
ODC (Export – in tons)	7,698	21,293	35,015	44,903
ODC (Outbound to Northeast – in tons)	24,631	47,325	77,087	98,385

8.5 Traffic Projection at Terminal

8.5.1 Traffic Phasing

In initial years of operations, there would an inertia for diverting traffic to waterways as there are current logistics systems and long-term contracts in place. Also, there would be operational challenges such as barge availability and availability of handling infrastructure. The traffic phasing for container operation is assumed to rise relatively slower than bulk cargo and ODC as infrastructure developments on Indian and Bangladesh side would take some time. Thus, for the terminal at Haldia / Kolkata, the following phasing has been assumed.

The traffic phasing of the project has been done by incorporating these factors and is shown in the following table.

Table 81: Traffic Phasing

	2020	2021	2022	2023	2024	2025	2030	2050
Inward Traffic Phasing								
Bulk Cargo (tons)	60%	80%	90%	100%	100%	100%	100%	100%
Container (TEUs)	20%	30%	40%	60%	85%	100%	100%	100%
Outward Traffic Phasing								
Bulk Cargo (tons)	60%	80%	90%	100%	100%	100%	100%	100%
Container (TEUs)	20%	30%	40%	60%	85%	100%	100%	100%
ODC (tons)	60%	80%	90%	100%	100%	100%	100%	100%

8.5.2 Traffic at Terminal

The traffic expected at the terminal (Haldia / Kolkata) is as captured in the following table.

Table 82: Traffic Phasing

	2020	2021	2022	2023	2024	2025	2030	2040
Inward Traffic Phasing								
Bulk Cargo (tons)	662,749	948,412	1,145,421	1,366,615	1,467,842	1,576,969	2,266,022	3.686,023
Container (TEUs)	Negligible							
Outward Traffic Phasing								
Bulk Cargo (tons)	2,257,965	3,186,444	3,794,438	4,463,062	4,724,993	5,002,768	66,66,607	10,943,506
Container (TEUs)	2,853	4,724	6,953	11,515	18,012	23,398	38,437	63,209
ODC (tons)	19,397	27,838	33,721	40,358	43,487	46,877	68,618	112,103

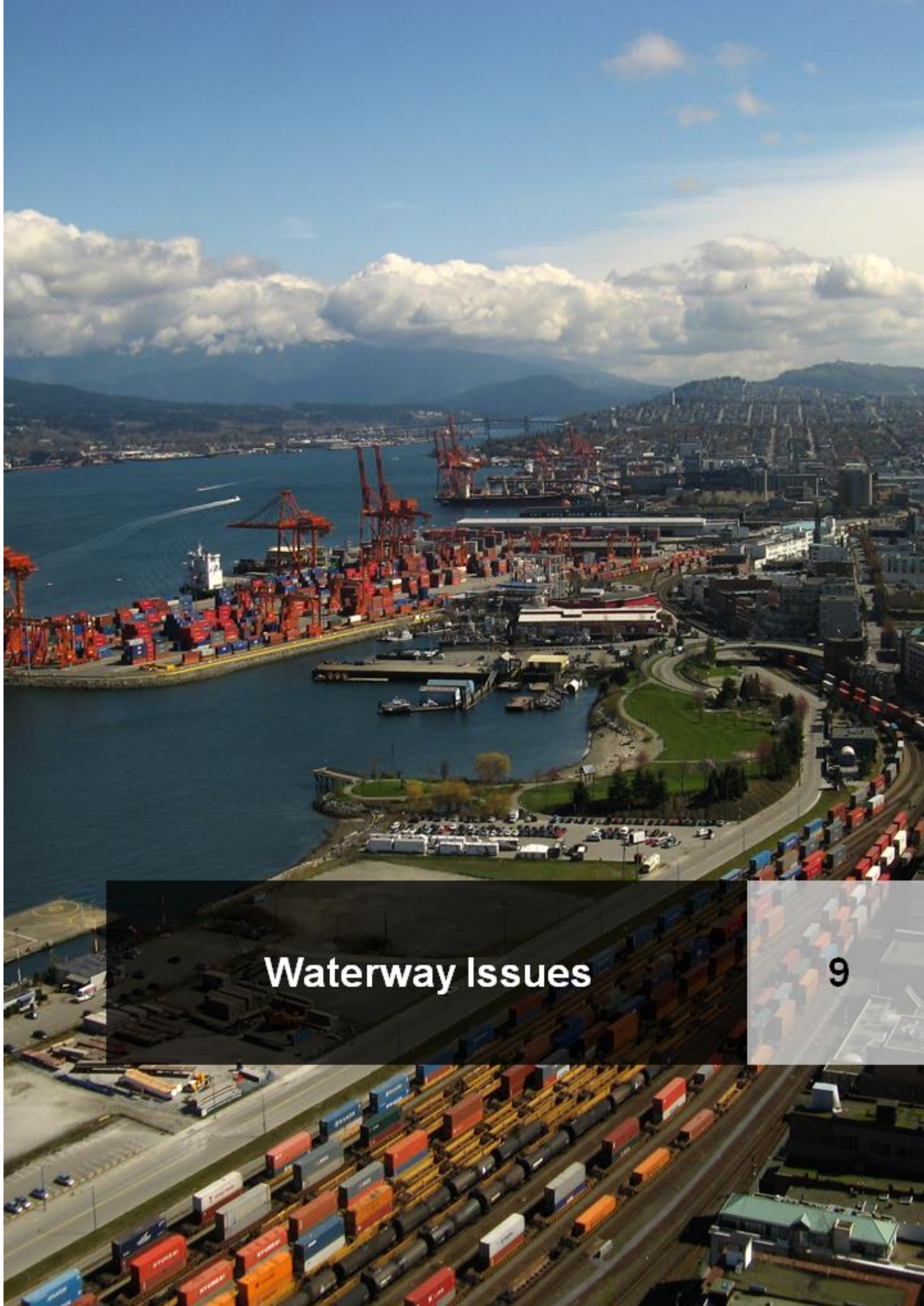
8.5.3 Barge Traffic

Based on the above expected traffic, calculations for number of barges is shown as under for both inward and outward phasing. A bulk loading factor has been considered for commodities wherever necessary. Barges have been assumed of 1,500 DWT with 1,200 tons as load carrying capacity. It has been assumed that a barge can carry container volume of 75 TEUs and ODC volume of 60 tons.

Table 83: Barge Traffic (Number of Barges)

	2020	2021	2022	2023	2024	2025	2030	2040
Inward Traffic	553	791	955	1,140	1,225	1,317	1,892	3,078
Outward Traffic	2,243	3,182	3,817	4,545	4,902	5,262	7,212	11,831
Total Traffic	**2,796**	**3,973**	**4,772**	**5,686**	**6,128**	**6,579**	**9,104**	**14,909**

It can be summarised that in 2030, there is potential for ~1,900 inbound barges and ~7,200 outbound barges. This traffic grows to ~11,800 outbound barges and ~3,000 inbound barges by 2040. The volume of traffic is significant and is competitively priced compared to road and rail transport in this geography.



Waterway Issues

9

9 Waterway Issues

The viability of IWT based cargo movement is dependent on technological & physical viability, commercial potential, and conducive operational policies & associated agencies. Operational economics are affected by availability of right-of-way (waterway), carriers (navigational vessels), terminal facilities (ports and jetties) and managerial & supporting infrastructure systems. The protocol emphasises on the trade aspect between the countries but lacks in controlling the technical aspect of the operations. The issues / challenges for successful implementation of the project are as follows.

9.1 Fairway Development and Maintenance

Being a river delta region, there is occurrence of high siltation and shoal formation in Sunderbans. This majority of the routes for daily commute are not available for year-round navigation. Due to the physiology of the region, the following are the issues for fairway development.

- **High Dredging Requirements** – High tide is available for only 4 hours during the day and 4 hours during the night. Thus, the route requires regular dredging of the rivers at frequent intervals which increase maintenance costs. There is non-availability of requisite draft at Namkhana and Patharpratima, due to which the vessels cannot load more than 1,000 tons while going downstream. Vessels destined for Dhubri / Pandu cannot load more than 500-600 tons due to navigation constraints in the route between Mohanpur / Ganga-Meghna confluence and Saheberagla (entry / exit point at the border). Also, the route between Ashuganj / Bhairab Bazar and Zakirganj (entry / exit point at the border) can be used only from July to October (monsoon period).
- **Lack of Assured Fairway**– Unsafe and uncertain navigation channels restrict speed and cause frequent groundings. This increases the operational costs due to proportionately higher fuel and maintenance costs.

9.2 Infrastructure Limitations

Traffic potential and infrastructure are strongly correlated. For development of the waterway, the following infrastructure limitations should be assessed.

- **Lack of Infrastructure at Hemnagar Terminal** – Currently, the terminal provides a temporary mooring facility to assist in customs checking of seals. However, the lack of depth availability at terminal limits the operations to high-tide hours. The terminal lacks basic utility and administration facilities, leading to delays in customs checking and processing.
- **Limited Handling Equipment at Kolkata and Haldia Terminal** - Apart from pneumatic handling for fly-ash, both the terminal lacks in availability of handling equipment. Manual handling and poor efficiency in loading / unloading at the terminals increases the handling time and effort.
- **Poor Last Mile Connectivity in Haldia Terminal** – The road network providing access to Haldia terminal is in a poor condition and requires major upgradation.

9.3 Operational Constraints

Currently, the riverine routes are used only on a need basis, especially for the movement of foodgrains (by FCI) as other modes of transport are relatively more economical due to the following operational issues in case of movement via waterways.

- **Limited Availability of Indian Barge Operators –** Despite a 50:50 cargo ratio as per protocol, majority of the cargo (~98%) is transported through Bangladeshi barge operators. According to the barge operators, Indian vessels are not economically viable, (both in terms of capital and operational expenditure) as a barge with capacity of 1,000 tons costs INR 6 Cr in India, but only INR 2.5 Cr in Bangladesh. Bangladeshi vessels are considerably cheaper because they are made up of second half plates and have a Chinese engine which results in lower fuel consumption (20% cost difference as compared to India). Thus, the lower diesel and labour costs in Bangladesh, dissuades Indian vessel operators. While, increased traffic to India would encourage Indian barge operators, suitable demand / supply side incentives and state support would go a long way to improve availability of Indian barges.
- **Increased Logistics Cost due to One-Way Traffic –** Due to trade imbalance**,** the traffic through waterway in Indo-Bangladesh trade has remained largely one-way with majority of cargo goods transported from India to Bangladesh. This results in increased cost of logistics as the barge makes an empty return trip.

- **Environmentally Sensitive Catchment**
  - The Sunderbans ecosystem has presence of several eco-sensitive zones and national conservation areas. It is a national park, tiger reserve and a biosphere reserve. It is included in the CRZ-1 category since it is a mangrove forest. The permissible activities for this category include storage of non-hazardous cargo such as edible oil, fertilizers and food grain within notified ports, construction of jetties etc. The details of environmental screening and clearance procedure are given in Annexure E.
  - Current barge operations are not of desired specification and cause ecological degradation (operate on diesel) and noise pollution. Additionally, increased level of water pollution may be caused due to discharge of oily bilge water, accidental oil spills from ships and effluence of toxic substances. These can be mitigated through safer navigation, safer loading and unloading operations and improved training of inland vessel operators.
  - Specific consideration would be required during embankment measures and disposal of dredging material due to ecological considerations.
  - While improving the IWT infrastructure, it would be critical to maintain a suitable balance between environment sustainability, logistics costs and overall route feasibility.

In addition to the above-mentioned challenges, the following measures are recommended to ensure smooth operations of the entire Sunderbans Waterways.

- BIWTA (Bangladesh Inland Waterways Transport Authority) should ensure adequate depth and sufficient navigation aids across the entire navigation channel**.**
- Maintenance of handling facilities including container services should also be undertaken.
- Indian Government should co-ordinate with the Government of Bangladesh to **r**egularize movement of Indian trucks from Ashuganj, Bangladesh to North-Eastern states in India.

Proposed IWT Infrastructure

10

10 Proposed IWT Infrastructure

10.1 Waterway Infrastructure

10.1.1 IWAI / PIANC Waterways Classification

IWAI Classification

The Inland waterways in India are classified into seven categories for rivers as well as canals as per the 'The Inland Waterways Authority of India Act, 1985' for safe plying of self-propelled vessels. The details of the classification are given in Annexure C. The proposed waterway would be developed in-line with the guidelines of Class V Waterways.

Table 84: Classification of Inland Waterways for rivers

S.No.	Class of Waterways	Minimum Depth (m)	Bottom Width (m)	Bend Radius (m)	Vertical Clearance (m)	Horizontal Clearance (m)
1.	Class I	1.2	30	300	4	30
2.	Class II	1.4	40	500	5	40
3.	Class III	1.7	50	700	7	50
4.	Class IV	2.0	50	800	10	50
5.	Class V	2.0	80	800	10	80
6.	Class VI	2.75	80	900	10	80
7.	Class VII	2.75	100	900	10	100

PIANC Guidelines

The Classification of European Inland Waterways are a set of standards for interoperability of large navigable waterways forming part of the Trans-European Inland Waterway network within Continental Europe and Russia. PIANC inland waterways are shown in the following table.

Table 85: PIANC Inland Waterways Classification

Classification	Tonnage (t)	Length (m)	Breadth (m)	Draught (m)	Air Draft (m)	Notes
RA		5.5	2.00	0.50	2.00	"Open boat"
RB		9.5	3.00	1.00	3.25	Cabin cruiser
RC		15.0	4.00	1.50	4.00	"Motor yacht"
RD		15.0	4.00	2.10	30.00	"Sailing boat"
I	250–400	38.5	5.05	1.80–2.20	3.70	"Péniche"
II	400–650	50.0–55.0	6.60	2.50	3.70–4.70	Euro-barge
III	650–1,000	67.0–80.0	8.20	2.50	4.70	"Gustav Koenigs"
IV	1,000–1,500	80.0–85.0	9.50	2.50	4.50; 6.70	"Johann Welker"
Va	1,500–3,000	95.0–110.0	11.40	2.50–4.50	4.95; 6.70; 8.80	"Large Rhine"
Vb	3,200–6,000	172.0–185.0	11.40	2.50–4.50	4.95; 6,70; 8,80	1×2 convoy
Via	3,200–6,000	95.0–110.0	22.80	2.50–4.50	6.70; 8.80	2×1 convoy
VIb	6,400–12,000	185.0–195.0	22.80	2.50–4.50	6.70; 8.80	2×2 convoy
Vic	9,600–18,000	270–280	22.80	2.50–4.50	8.80	2×3 convoy
	9,600–18,000	195–200	33.00–34.20	2.50–4.50	8.80	3×2 convoy
VII	14,500–27,000	285	33.00–34.20	2.50–4.50	8.80	3×3 convoy

The waterways would be designed with standards of Class V waterways as per PIANC guidelines.

10.1.2 Vertical Clearance

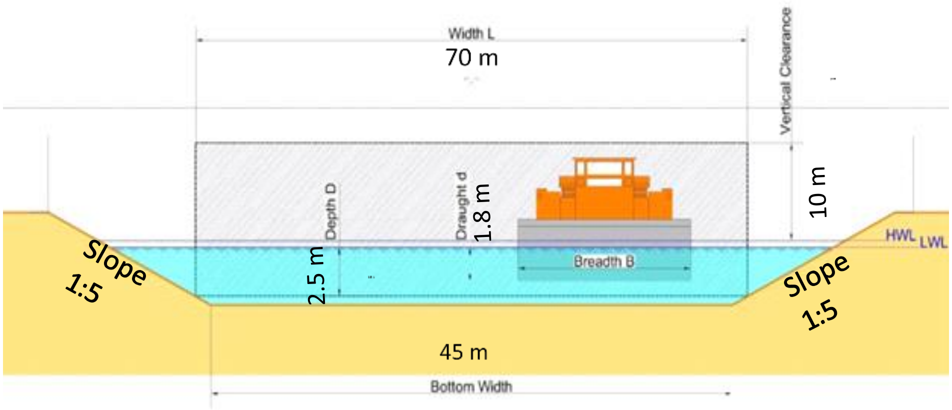
There are no cross structures across the waterway. So, vertical clearance is not an issue. Construction of new cross structures will be subject to obtaining of environmental clearances as the entire area around the waterways falls under CRZ-1. Currently barges up to 1,000 DWT are already plying on the route without any hindrance.

10.1.3 Proposed Navigation Channel

The proposed navigational channel would have the following specifications.

- Minimum water depth: 2.5 m
- Bottom width: 45 m
- Bend radius: 800 m
- Vertical clearance of 10 m and horizontal clearance of 80 m

Figure 54: Channel Specification



10.1.4 River Training

River training refers to the structural measures which are taken to improve a river and its banks, to ensure smooth and axial flow of water, to prevent the river from fall out from its normal course. The types of river training works are:

- Embankments
- Guide Banks or Bell Bunds
- Spurs or Groynes
- Impermeable Groynes
- Permeable Groynes
- Bed Pitching and Bank Revetment
- Dredging

Considering our study area, we propose to adopt two methods of river training works based on the conditions:

1. Dredging
2. Embankments

Any other river training method has not been proposed due to the ecological sensitivity of the Sunderbans region.

As Sunderbans is an eco-sensitive zone (CRZ 1 – details in Annexure E), apart from local municipal clearances for dredging and construction, clearances from Ministry of Environment and Forests would be required.

10.1.4.1 Dredging

Dredging is the removal of sediments and debris from the bottom, of freshwater or shallow sea's areas with the purpose of gathering up bottom sediments and disposing of them at a different location. This technique is often used to keep waterways navigable. Sedimentation - the natural process of sand and silt washing downstream—gradually fills channels and harbors.

Based on the technical investigation and site surveys, the following river training works have been proposed.

- For the surveyed sections, the dredging requirement is estimated to be 315,687.61 m^3 (considering the channel depth requirement of 2.5 m). For the entire stretch of the waterway ((from Thalweg survey of 0 chainage to 172 chainage), preliminary assessment based on Thalweg charts indicate a dredging requirement of 413,262.29 m^3
- The physiography of the delta region necessitates bank protection and sand traps to minimize sedimentation and shoal formation. Considering the ecological considerations, bank protection is recommended by utilizing natural materials.

The dredging requirements for various depths areas are shown in following table.

Table 86: Dredging Requirements (cu. m volume) – Survey Locations

Survey Location	Dredging Quantity in cu. m. (Channel Depth 2.5 m)
Chota Banshayamnagar	132,942.62
Lothian Island	43,085.3
Kumirmari	2,772.02
Bagnapara	7,968.77
Mollakhali	Depth more than 2.5m
Athrabanki	128,918.9
Total	**315,687.61**

The dredging requirements for the entire stretch of the waterway (from Thalweg survey of 0 chainage to 172 chainage) are shown in the following table.

Table 87: Dredging Requirements (cu. m volume) – Thalweg Survey

Survey Location	Chainage (m)		Dredging Quantity in cu. m. (Channel Depth 2.5 m)
	From	To	
	0	1200	5007.95
Atharabanki	**1200**	**2800**	**128918.9**
	2800	5000	2692.72
	5000	10000	0
	10000	15000	0
	15000	20000	0
	20000	25000	0
	25000	30000	0
	30000	35000	0
	35000	38130	0
Kumarimari	**38130**	**38530**	**2772.02**
	38530	40000	1350
	40000	41180	3153.85
Baghanpara	**41180**	**41490**	**7968.77**
	41490	45000	2612.6
	45000	50000	3689.5
	50000	55000	0
	55000	60000	0

Survey Location	Chainage (m)		Dredging Quantity in cu. m. (Channel Depth 2.5 m)
	From	To	
	60000	65000	0
	65000	70000	0
	70000	75000	0
	75000	80000	0
	80000	85000	0
	85000	90000	0
	90000	95000	0
	95000	100000	0
	100000	105000	0
	105000	110000	0
	110000	115000	0
	115000	120000	0
	120000	125000	0
	125000	130000	0
	130000	135000	4390.2
	135000	138440	19159.26
Choto Bhanshyam Nagar	**138440**	**139550**	**132942.62**
	139550	145000	2719.94
	145000	150000	0
	150000	155000	2570.9
	155000	155920	0
Lothian	**155920**	**156770**	**43085.3**
	156770	160000	830.79
	160000	165000	27105.47
	165000	170000	18588.9
	170000	175000	0
	175000	180000	0
	180000	185000	650.7
	185000	190000	1008.3
	190000	195000	0
	195000	197400	2043.6
Total			**413262.29**

10.1.4.2 Embankments

For stretches of the river where dredging requirement has been identified, river embankments protection needs to be provided on both sides of the river. Since, it is an eco-sensitive area, it is not prudent to take any hard construction measures. Thus, it is proposed to use eco-friendly material such as Geo-textile, Geo-membranes, Geo-grids, Geo-nets, etc. for protection of embankments. Given that the dredging is proposed along the survey stretch of 4.47 kms, the length where protection of embankment may be required will be around 9,000 meters.

10.1.5 Navigability

10.1.5.1 Type of Barges

As stated earlier, the navigation channel proposed is with a draught of 2.5 meters; bottom width of 45 meters with a slope of 1:5. This has been proposed keeping in view the capital investment required and the projected traffic.

Keeping the above in view, various types and sizes of vessels have been studied to find out the optimal size of barges that should ply on this route. The types of vessels that ply on waterways include self-propelled and towing barges. Towing barges cannot ply on this route because they can't negotiate the bends smoothly.

Also, currently, self-propelled barges with capacity up to 1,000 DWT are already plying on this waterway which are carrying mostly fly ash and sometimes food-grains, etc. Given the proposed draught and channel width, self-propelled barges up to 1,500 DWT should be able to ply comfortably. Plying these barges would be cost effective as compared to barges of 2,000 DWT which need a draft of 3.5 m and a relatively higher dredging requirement. The financial and economic feasibility has been carried out keeping in view 1,500 DWT self-propelled vessels.

The comparative analysis of the various self-propelled barges is shown in the following table.

Table 88: Comparative Analysis – Type of Self-Propelled Vessels

Vessel Type	LOA (m)	Beam (m)	Draught (m)	Cargo Carrying Capacity (Tonnes)	Bend Radius (m)	Dredging Quantity Required (cu. m.)
Less than 800 DWT	67-80	6.6	1.7	680	700	-
1,000-1,500 DWT	**80-85**	**8.2**	**2-2.5**	**1,275**	**800**	**0.413 million**
2,000-2,500 DWT	95-110	9.5	2.75-3.5	1,700	900	7 million

10.1.5.2 Navigation Aids

Adequate navigation aids (channel markings, navigation buoys and night navigation) should be ensured for safe and secure 24x7 navigation across the channel. There are existing navigation aids along the survey stretch.[78] However, as analysed from the Thalweg charts, there are 5 bends that do not have navigation aids. It is assumed that 2 buoys would be required for each bend (5 bends from Haldia to Athara Banki) and to mark navigation channel where dredging is undertaken. Thus, 10 navigation aids are proposed along the survey stretch. A total cost of INR 0.2 cr is estimated for the navigations aids.

The location of the bends where navigation buoys are proposed is shown in the following map.

Figure 55: Location of bends requiring navigation buoys

[78] Thalweg Data

These channel marker buoys would have the following specifications:

- Position – Start and end of bends
- Type – FRP
- Day Mark – Single Red, Cone type
- Radar Reflector – Fitted
- Light Characteristics – Fl R 3s 2m (portside buoys); LED 20W Halogen Lamps
- Power – Solar plus backup battery for optimum autonomy
- Anchoring Arrangement – with 32mm diameter chain and 3.0 tonnes anchor weight

10.1.6 Waterway CAPEX

The total capital expenditure that has been estimated for waterway infrastructure is ~ INR 12 cr. It is assumed that the cost of dredging is INR 250 per cu. m, that of bank protection is INR 2,000 per m and that of one navigation buoy is INR 20 lakhs. The total capex is as shown in the following table.

Table 89: CAPEX for Waterway Infrastructure

	Total (in INR cr)	Y 18	Y 19
Dredging	10	50%	50%
Bank Protection	2	50%	50%
Navigational Aids	0.2	-	100%
Total Capex	**12**		

10.2 Proposed Terminal Infrastructure

Terminal infrastructure has been proposed at 3 locations – Kolkata, Haldia and Hemnagar. The cost estimates are based on traffic phasing and suitable market benchmarks.

10.2.1 Kolkata

Currently, there are 3 operational berths at Kolkata which have been assumed to handle ~2 MTPA of Sunderbans waterways related general bulk cargo along with NW 1 traffic. This facility can be utilized in the initial years to promote traffic till infrastructure improvements in Haldia (as proposed in the next subsection) are undertaken. For storage, the existing storage area of ~22,300 sq m (including covered area storage of 1,200 sq m) would be utilized.

It is proposed that the following equipment should be procured for improvement in efficiency at the terminal.[79]

Table 90: Proposed loading / unloading and other equipment at Kolkata

Type of Equipment	Quantity (no.)	Unit Cost (in INR cr)	Capex (in INR cr)
Crane 60 T	2	20	40
Payloaders JCB 3.1 cum	3	0.37	1
Dumpers 20 MT	6	0.27	2
Total Capex			**43**

Additionally, the following facilities are proposed to be developed at Kolkata:

- Administrative and Operations Building: 500 sq m (@ INR 25,000 per sq m)
- Refurbishment of road within terminal area (@ INR 13,000 per m)
- Fencing wall for the site (@ INR 19,300 per m)

[79] This equipment is only envisaged for handling Sunderbans Waterways traffic and not traffic arising from NW 1

The consolidated capex for the development of suggested infrastructure is shown in the following table and is recommended to be incurred in Y 18.

Table 91: Total CAPEX at Kolkata

Head	Value (in INR cr)	Y 18
Equipment	43	100%
Administrative & Operations Building	1	100%
Road within backup area	1	100%
Fencing Wall	3	100%
Total Capex	**48**	

RECOMMENDATION

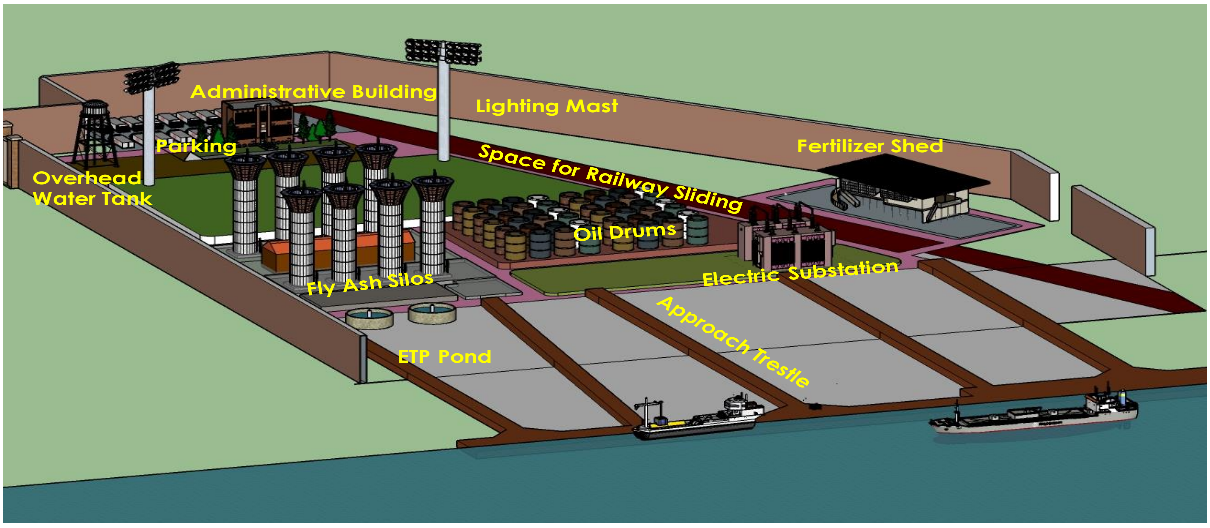
The total Sunderbans traffic is expected to be 10 MTPA by 2030, out of which, 2 MTPA would be handled at Kolkata and rest is expected to be handled at Haldia Multimodal IWT Terminal. IWAI has already floated a tender for procurement of one Mobile Harbour Crane for the terminal. Hence, apart from some equipment and ancillary facilities, no further upgradation has been proposed at Kolkata. Since capital expenditure is already being undertaken for NW 1, IWAI can improve the overall project feasibility and risk profile through integration of NW 1 and Sunderbans waterways.

10.2.2 Haldia

Presently, the EPC contract for construction of the Multimodal IWT Terminal at Haldia for handling NW 1 traffic is in the tender stage. It is expected to handle 16.36 million MT of NW 1 traffic by 2035.[80] The layout and facilities of this IWT Terminal are shown in the following figures.

Figure 56: Layout of existing Multimodal IWT Terminal at Haldia

[80] IWAI



As per inputs from IWAI, key highlights of the proposed infrastructure at terminal is as follows.

- 60 acres of land area
- Handling capacity envisaged in Phase 1: 3.8 MTPA
- 4 fixed berths (465 m) in Phase 1 and additional berth (150 m) in Phase 2
- 8 Fly ash silos

Currently, Haldia has 3 berths for handling fly ash. However, infrastructure improvements have been proposed to enable handling of general cargo and containers. The proposed infrastructure is as detailed below.

Berths

4 additional fixed berths (for general cargo and container) are proposed to handle ~6 MTPA of general cargo and ~1 lakh TEUs. Additionally, a floating pontoon (for fly-ash) is proposed along with refurbishment of the existing 3 floating pontoons to handle ~8 MTPA of fly-ash.

The unit cost of fixed berth is assumed to be INR15 cr and that of a floating berth is assumed to be INR 5 cr.

The phasing of the berths is shown in the following table.

Table 92: Berths

Berth	Y 19	Y 25
Fixed Berth	2	2
Floating Berth	-	1
Total	**2**	**3**

Equipment

The following equipment would be required for operations of the terminal.

Table 93: Equipment

Type of Equipment	Quantity	Unit Cost (in INR cr)	Capex (in INR cr)	Y 19	Y 25
Crane 60 T	5	20	100	3	2
Reach stackers	3	2.5	8	2	1
Pneumatic Handling Equipment	6	1	6	3	3

Dumpers 20 MT & Trailers	15	0.27	4	9	6
Payloaders JCB 3.1 cum	4	0.37	1	2	2
Weigh bridge 80 T	5	0.23	1	3	2
IT & Terminal Navigation Systems	-	-	2	100%	-
Total Capex			**123**		

Storage and Ancillary Facilities

To improve administrative and operational efficiency, the various facilities proposed include administrative building, utility block, open storage area, covered storage godowns, container yard and fencing wall, as detailed in the following table.

Table 94: Proposed Storage and Ancillary Buildings

Head	Area	Capex (in INR cr)	Y 19	Y 25
Administrative and Operations Building	1,000 sq m	3	100%	-
Utility Building	500 sq m	1	100%	-
Open Storage Area	25,200 sq m	4	10,100 sq m	15,100 sq m
Covered Storage Godowns	10,800 sq m	11	4,320 sq m	6,480 sq m
Container Yard	25,000 sq m	25	10,000 sq m	15,000 sq m
Silos	6 silos	18	3	3
Parking area	4000 sq m	0.5	100%	-
Road within backup area	3,000 m	4	100%	-
Fencing Wall	2,000 m	4	100%	-
Total Capex		**69**		

Storage Yard (General Cargo)

Total storage space covering an area of 36,000 sq m at the cost of INR 15 Cr is proposed based on the following assumptions.

Table 95: Bulk Yard Storage Capacity

Variables	Values
Annual Throughput	60,00,000 tonnes
Mean Weekly Throughput	1,15,385 tonnes
Cargo Dwell Time	20 days
Average Volume of Cargo in Storage	3,29,670 tonnes
Surge Factor	110%
Demand for Storage	3,62,637 tonnes
Stacking Ratio	10 sq m
Bulk Yard Area	36,000 sq m

Out of the required storage area, 10,800 sq m of covered storage is proposed primarily for foodgrains / food items. The unit cost of open storage area is assumed to be INR 1,500 per sq m and that of covered storage area is assumed to be INR 10,000 per sq m.

Container Yard

A container yard, covering an area of 25,000 sq m at the cost of INR 25 Cr is proposed based on the following assumptions.

Table 96: Container Yard Storage Capacity

Variables	Values
Cargo Handled p.a.	1,00,000 TEUs
Mean Stacking Height	3
Mean Dwell Time	12 days
Surge Factor	110%
TEU Static Capacity	3,616 TEUs
Required TGS	1,205
Area per TGS	15 sq m
Container Yard Area	25,000 sq m

The unit cost of container yard is assumed to be INR 10,000 per sq m.

Silos

Fly ash is the major commodity which is handled at Haldia Port and it can pose difficult storage and handling challenges due to its composition. Thus, 6 silos of 20,000 MT capacity are proposed for fly ash feeding, storage and transfer needs. The unit cost of silo is assumed to be INR 3 cr.

Truck Parking Area

Adequate parking area of ~4,000 sq m should be provided to facilitate smooth logistics operations. The unit cost is assumed to be INR 1,000 per sq m.

Last Mile Road Connectivity

As per the infrastructure assessment, the last mile road connectivity for Haldia port is poor and thus upgradation work for providing easy access to the hinterland is proposed to be carried out. A road requirement of 5 km is proposed.

The investment in last mile connectivity and bulk infrastructure would be undertaken in Y 19.

The consolidated capex for the development of suggested infrastructure is shown in the following table

Table 97: Total CAPEX at Haldia

Head	Capex (in INR cr)
Fixed Berth	60
Floating Berth	5
Refurbishment of Berths	3
Equipment	123
Storage & Ancillary Buildings	69
Last Mile Connectivity	13
Bulk Infra & Miscellaneous	20
Total Capex	**293**

Recommendation

The total Sunderbans traffic is expected to be 10 MTPA by 2030, out of which, 5 MTPA of fly ash would be handled at the existing facilities at Haldia. Out of the general cargo of 5 MTPA, 3 MTPA is expected to be handled at Haldia Multimodal IWT Terminal and 2 MTPA at Kolkata (with improvements as outlined in the previous section).

Post the completion of construction of Haldia Multimodal IWT Terminal, both the NW1 traffic and Sunderbans Waterways traffic could be handled at this terminal. The 2 fixed berths handling fly ash and 2 fixed berths handling general cargo along with addition of required equipment can be utilized for all cargo arising from Sunderbans Waterways and NW 1.

10.2.3 Hemnagar Terminal

The existing infrastructure at Hemnagar Terminal comprises of an administrative building which houses IWAI regional office and customs office. Besides the administrative building, the terminal has a mooring facility for ships carrying cargo in Bangladesh and a passenger jetty.

With the increased traffic (as projected) and number of barges plying on the route, it is proposed to add a floating steel Pontoon Barge connected to a floating Walkway and a Gangway. The administrative building (~200 sq m of built up space) is quite old and used very sparingly as and when the barges ply. Thus, the same facility with renovation and refurbishment could be used for first 5 years (up to Y 25). Beyond that, keeping in view increased movement of cargo, an expansion of this facility may be required. It is envisaged that a facility of ~500 sq m may be required in Y 25.

The Hemnagar terminal is mainly used for customs checking and does not require and have cargo handling facilities. The same usage of the terminal is expected in future as well.

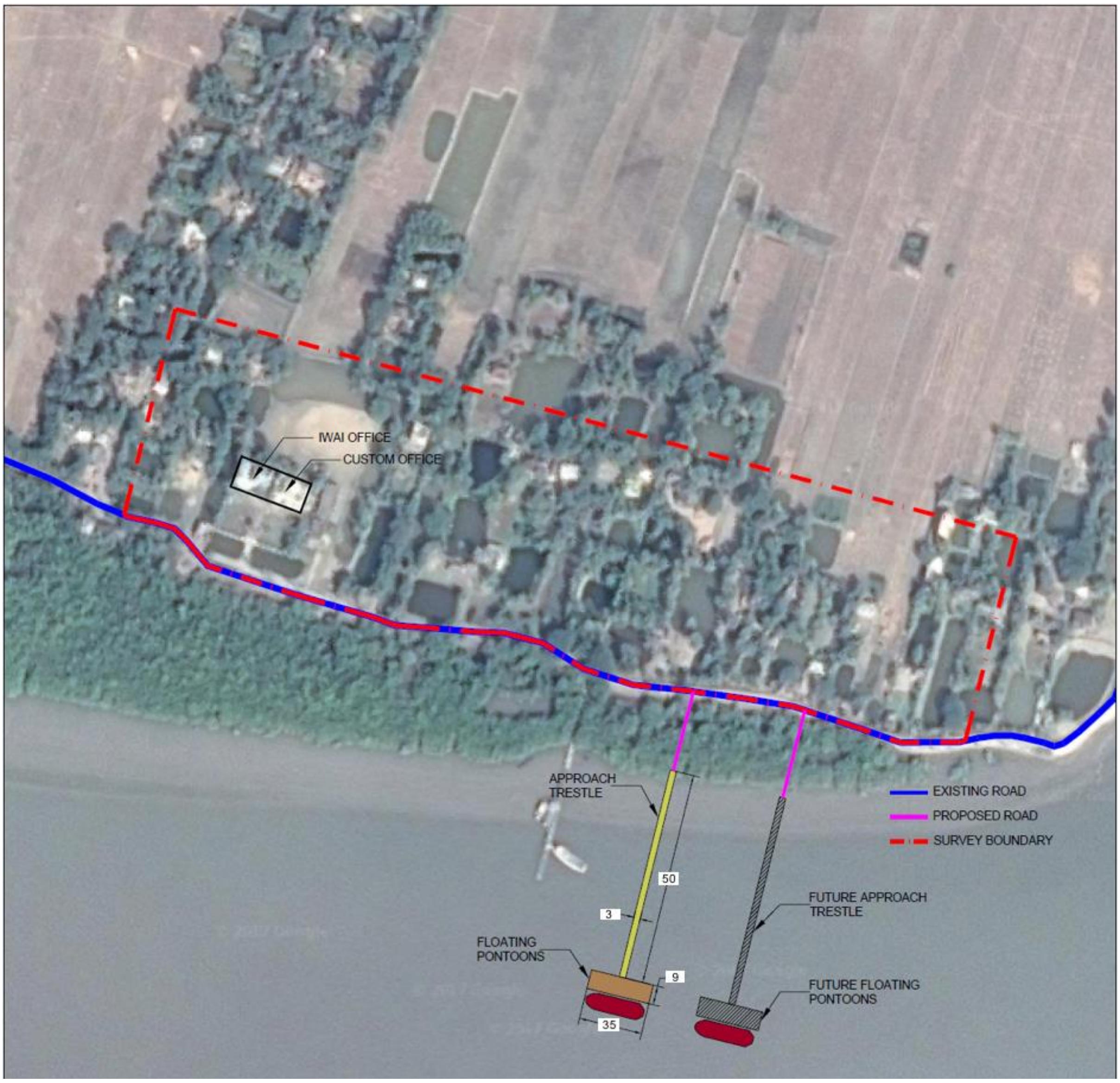
The suggested infrastructure improvements are proposed to be phased in Y 19 and Y 25 as detailed in the following table.

Table 98: Total CAPEX at Hemnagar Terminal

Head	Specifications	Scale	Capex (in INR cr)	Y 19	Y 25
Floating Terminal (Steel Pontoon)	35 m x 9 m	2 no.	2.40	50%	50%
Floating Walkway	50 m x 3 m	2 no.	1.80	50%	50%
Gangway	8 m x 3 m	2 no.	0.36	50%	50%
Transport, Installation and Contingencies			1.96	50%	50%
Administrative Building (Customs & Canteen)	500 sqm		1	-	100%
Road		80 m	0.1	50%	50%
Total Capex			**7.62**	**3.31**	**4.31**

The layout with existing and proposed facilities at Hemnagar Terminal is shown in the following figure.

Figure 57: Layout of Hemnagar Terminal



The preliminary engineering design including material and work specification for floating pontoon (Barge) along with the floating walkway and the gangway (approach) is provided in Annexure N to the report.

10.2.4 Other Facilities

No facilities at places apart from the above 3 locations is envisaged as major part of the Sunderbans Waterways would be trade / transit traffic and the OD of such traffic is not in the immediate catchment. **No major river-sea vessel traffic is envisaged for the Sunderbans Waterways.**

10.3 Capital Expenditure Summary

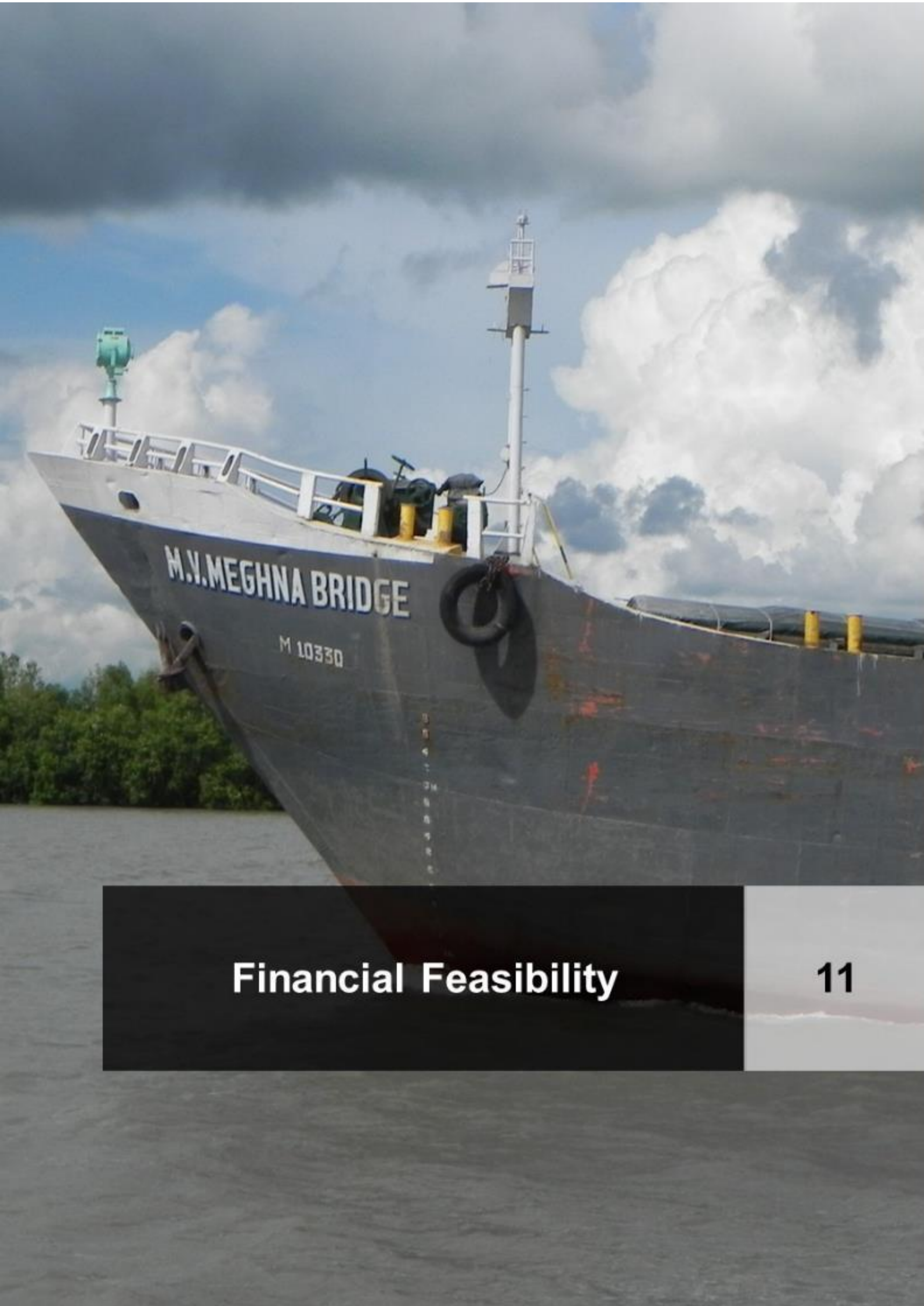
The total capital expenditure that has been estimated for the project is INR 19 Cr. However, no fresh capital expenditure is expected to be undertaken for Kolkata and Haldia terminals, since the infrastructure proposed by IWAI would be utilized. The capital expenditure for Hemnagar Terminal is ~INR 8 Cr, out of which INR 3.31 Cr would be required immediately for pontoons and ancillary infrastructure at the terminal.

10.4 Work and Time Schedule Summary

The phasing of the proposed infrastructure improvements for the development of Sunderbans Waterways is summarized in the following table.

Table 99: Work and Time Schedule

Head	Sub Head	Y 18	Y 19	Y 25
Waterway Infrastructure	Dredging	50%	50%	-
	Bank Protection	50%	50%	-
	Navigation Aids	-	100%	-
Hemnagar Terminal	Floating Terminal (Steel Pontoon)	-	50%	50%
	Floating Walkway	-	50%	50%
	Gangway	-	50%	50%
	Administrative Building (Customs & Canteen)	-	-	100%
	Road	-	50%	50%
Kolkata Terminal	Equipment	100%	-	-
	Administrative & Operations Building	100%	-	-
	Road within backup area	100%	-	-
	Fencing Wall	100%	-	-
Haldia Terminal	Fixed Berth	-	50%	50%
	Floating Berth	-	-	100%
	Crane 60 T	-	60%	40%
	Reach stackers	-	67%	33%
	Pneumatic Handling Equipment	-	50%	50%
	Dumpers 20 MT & Trailers	-	60%	40%
	Payloaders JCB 3.1 cum	-	50%	50%
	Weigh bridge 80 T	-	60%	40%
	IT & Terminal Navigation Systems	-	100%	-
	Road within backup area	-	100%	-
	Container Yard	-	40%	60%
	Open Storage Area	-	40%	60%
	Covered Storage Godowns	-	40%	60%
	Administrative & Operations Building	-	100%	-
	Utility Building	-	100%	-
	Fencing Wall	-	100%	-
	Bulk Infra & Miscellaneous	-	100%	-
	Last Mile Connectivity	-	100%	-



Financial Feasibility 11

11 Financial Feasibility

The financial feasibility for the project is analysed in this section. First, the survey stretch of ~170 km is considered for standalone feasibility and then the entire Sunderbans waterways has been considered based on two scenarios – Scenario 1: Current tariff structure and Scenario 2: Proposed tariff structure.

11.1 Financial Feasibility of the Survey Stretch

The survey stretch from Namkhana to Athara Banki (~170 km) has been considered for standalone feasibility. For the stretch, the capital expenditure would be for dredging and bank protection.

- Dredging requirement: 413,262.29 cu. m
- Bank Protection: ~9,000 m (on both sides of the bank in areas with sedimentation issues)

The revenues would constitute of only fairway charges (INR 0.02 per GRT per km) for the stretch km while O&M would constitute dredging and bank protection measures.

Based on these, the standalone financial projections for the study stretch are as follows.

Table 100: Financials for the Survey Stretch

Values in INR Cr	2018	2019	2020	2021	2022	2023	2024	2025	2030	2050
Revenues	-	-	2	2	3	4	4	5	9	79
Less: O&M Costs	-	-	2	2	2	2	2	2	3	7
Less: CAPEX	15	16	-	-	-	-	-	-	-	-
Dredging Costs	6	6	-	-	-	-	-	-	-	-
Bank Protection	9	10	-	-	-	-	-	-	-	-
	(15)	(16)	-	1	1	2	2	3	6	72

Based on the above analysis, we believe that the survey stretch should not be evaluated independently and should be evaluated in the context of the overall Indo-Bangladesh protocol route.

Thus, for establishing feasibility of the waterways, the entire 215-km stretch (Haldia to Athara Banki) has been analyzed in this report which includes terminal handling at Kolkata / Haldia.

11.2 Overall Feasibility – Indo Bangladesh Protocol Route

For assessment of feasibility of the waterways, two scenarios are considered based on tariff chargeable. The rationale for establishment of the scenarios is considered by taking the trade route from Kolkata to Dhaka as an example.

11.2.1 Overview of Value Chain

For cargo transport from Kolkata to Dhaka through road, major movement is through Petrapole land custom station. Due to infrastructure constraints, the typical detention time for any truck is 8-10 days. As Indian trucks are not allowed to ply in Bangladesh, there is transfer of goods from Indian trucks to warehouse and then on to the Bangladeshi trucks.

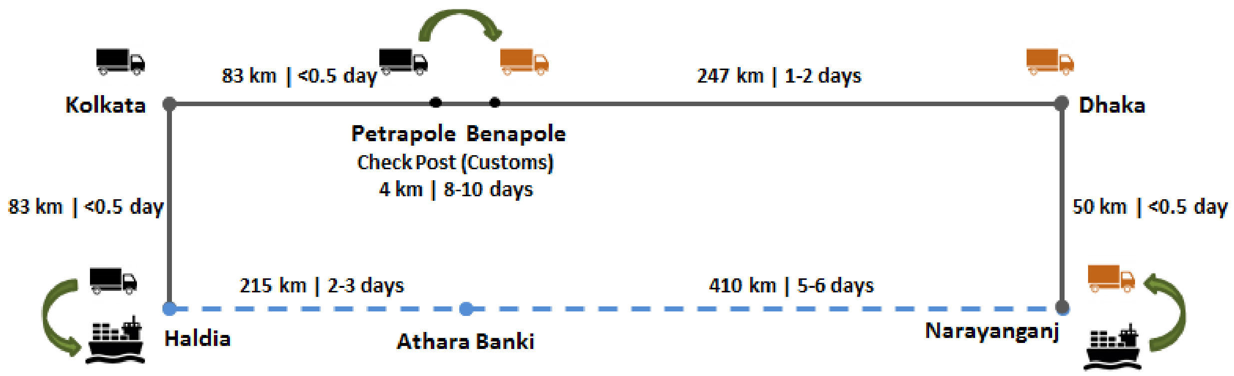
For the waterways, the following value chain for logistics transport of cargo from Kolkata to Dhaka is considered.

- **Truck Operators (India)** charge for the first mile connectivity from Kolkata to Haldia port via truck (including loading / unloading at the port)
- **IWAI** manages the terminal at Haldia and waterway in Indian territory (~215 km)
    - Fairway Charges – maintenance of waterway
    - Terminal Charges – operations and maintenance of Haldia terminal
        - Vessel related charges – berthing, towage and pilotage
        - Cargo related charges
        - Equipment hire charges

- **Private barge operators** ply their own fleet for the transportation of cargo through the waterways and charge based on turn-around time, distance and cargo volume.
- **Bangladesh Port Authority:** Terminal and Fairway charges
- **Truck Operators (Bangladesh)** charge for last mile connectivity from Narayanganj (Dhaka) to the industrial clusters via truck (including loading at port / unloading).

The transportation route for trade between Kolkata and Dhaka is summarized in the following figure.

Figure 58: Logistic Route (Kolkata – Dhaka)



11.2.2 Modal Cost Comparison (Current Tariff Structure)

Considering barge carrying 1500 tons (GRT of 2000 tons) and based on the current tariff structure of IWAI & BIWTA and existing barge hire charges, the break-down of the total transportation cost on the Kolkata-Dhaka route via waterways and road is shown in the following table.

Table 101: Modal Cost Comparison on Kolkata-Dhaka route under current tariff structure

Mode	Logistics Cost (INR / tonne)
Road	**6,000-7,000**
Waterways	**3,217**
First Mile Connectivity (INR 17,000 per truck till Haldia)[81]	**964**
IWAI	**17**
Fairway Charges (INR 0.02 per GRT per km)	13
Vessel related Charges (INR 1750 per barge)[82]	1
Cargo related Charges (INR 1 per ton)	1
Equipment Hire Charges (INR 2500 per crane for 8 hrs)	2
Barge Operators	**1800**
Bangladesh Port Authority (terminal)	**30**
Last Mile Connectivity (including handling)[83]	**406**

The present transportation cost via waterways is significantly low at ~40% of the transportation cost via road. There is immense scope of improvement in the tariffs and consequently the share of revenues to IWAI considering the investment envisaged in the waterways. Even, an improvement from INR 10 per ton to INR 40 per ton to IWAI would still have similar competitive logistics costs.

[81] For travel from Kolkata to Haldia port (~50 km) including loading / unloading at port
[82] Berthing Charges: INR 1000 for 24 hrs; Pilotage: INR 750 per pilot
[83] For travel from Narayanganj to Dhaka Industries (~30 km) including loading at port / unloading

Also, the charges by barge operators are based on current turn-around time and one-way traffic resulting in empty return journeys. It is expected that as the waterways become fully operational, the turn-around time would significantly reduce and logistic costs would further reduce.

11.2.3 Proposed Tariff Structure

The significant cost differential in waterways and possibility of further reduction due to efficiency, provides an opportunity for IWAI to improve tariffs and make each component of the waterway independently sustainable and feasible.

- Fairway charge: Doubling the fairway charges makes the fairway independently operational feasible. For the purposes of this study, the proposed fairway charges are 0.1 per GRT per ton.
- Terminal charge: There is scope for improving the terminal charges especially the cargo related charges. Based on benchmarking exercises as tabulated below, it is proposed that the cargo charges can be revised to ~INR 30 per ton.

Table 102: Proposed Tariff Structure and Benchmarking

Port Authority	Proposed IWAI Tariff	Current IWAI Tariff	Kolkata Port (for IWT vessels)	Bangladesh Inland Waterways
Dry Cargo (INR per ton)	**30**	1	24	29.5
Liquid Cargo (INR per ton)	**30**	1	38[84]	29.5
Container (INR per TEU)	**2,000**	50	1,865[85]	-

A comparison of the expected logistics cost for Kolkata-Dhaka route across the two modes based on the current and proposed tariff structures is shown in the following table.

Table 103: Modal Cost Comparison on Kolkata-Dhaka route under Proposed Tariff Structures

Mode	Proposed Tariff Logistic Costs (INR / ton)	Current Tariff Logistic Costs (INR / ton)
Road	**6,000-7,000**	
Waterways	**3,263**	**3,217**
First Mile Connectivity (INR 17,000 per truck till Haldia)[86]	**964**	**964**
IWAI	**63**	**17**
Fairway Charges (INR 0.1 per GRT per km)	30	13
Vessel related Charges (INR 1750 per barge)[87]	1	1
Cargo related Charges (INR 1 per ton)	30	1
Equipment Hire Charges (INR 2,500 per crane for 8 hrs)	2	2
Barge Operators	**1800**	**1800**
Bangladesh Port Authority (terminal)	**30**	**30**
Last Mile Connectivity (including loading)[88]	**406**	**406**

Under the proposed tariff structure, transportation cost via waterways is still significantly low than transportation cost via road. Further reduction in barge operator charges can be expected once the waterway is fully operational due to improved turn-around time and traffic. Hence, the above analysis

[84] IWT cargo loaded / unloaded at any berth / jetty meant for handling sea-going vessel – rate in INR / tonne at 50% of wharfage on foreign cargo landed / shipped within Kolkata Port Trust
[85] Composite box-rate for IWT container including Bangladesh moving through IWT mode covering wharfage and basic container handling services of ship to shore transfer, movement between berth and yard, lift-off at yard and subsequent lift on the delivery or vice-versa shall be levied
[86] For travel from Kolkata to Haldia port (~50 km) including loading / unloading at port
[87] Berthing Charges: INR 1000 for 24 hrs; Pilotage: INR 750 per pilot
[88] For travel from Narayanganj to Dhaka Industries (~30 km) including loading at port / unloading

indicates that even after increase in the terminal charges, transportation via waterways has advantageous cost economics.

11.2.4 Financial Scenarios

Thus, the financial assessment of the waterways would be undertaken based on the following two scenarios

- Scenario A – Financial assessment under current tariff structure
- Scenario B – Financial assessment under proposed tariff structure

11.2.5 Financial Assumptions

The following financial assumptions have been considered.

- Revenue escalation: 6%
- Cost inflation: 5%
- Corporate Tax Rate: 34.61%
- Cost of Debt: 10.5%
- Cost of Equity: 18%
- Weighted Average Cost of Capital: 11.3%
- Debt: Equity Ratio: 1.5
- Depreciation:
    - Civil Structures: 2%
    - Equipment: 3.3%
    - IT infra: 5%

11.2.6 Revenues

11.2.6.1 Revenue Projections under Scenario A

For estimating the revenues, the tariff structure provided by Inland Waterways Authority of India has been used. The tariff structure in INR is divided into the following heads.

Waterway Usage Charges: These charges are levied on the cargo vessel on a per km basis for using the Indo-Bangladesh waterways.

- Cargo vessel movement: 0.02 per GRT per km
  (Total length of waterway from Haldia to Athara Banki is 200 km)

Vessel Related Charges: These charges are dependent on the type and size of the vessel measured in the maximum amount of TEU (for container ships) and tonnage (for dry bulk vessels) or in Gross Tonnage (GT) of the vessel.

- Berth Hire – Tariff: 1,000 per vessel for 24 hours
- Towage – Tariff: 600 per vessel per hour
- Pilotage – Tariff: 750 per vessel

Cargo Charges: These mainly include cargo handling and wharfage charges. The charges are dependent upon the type of cargo being handled at the port.

- Dry Cargo Terminal Handling – Tariff: 1 per tonne
- Containerised Cargo: 50 per TEU

Storage Charges: Dependent upon the type of cargo being stored in the container and dry bulk storage yard certain grace period is provided to the consignee. The storage charges provided under the tariff structure are shown in the following table.

Table 104: Storage Charges

Storage Charges	INR per ton	Cargo Breakup
0-7 days	0.0	50%
7-21 days	2.5	30%
22-35 days	5.0	15%

Post 35 days	20.0	5%

Composite Charges: These charges are levied on movement of over dimensional cargo on the waterways.

- Movement of ODC (incl. waterway usage and vessel charges): 1.5 per ton per km

Major Equipment Hire Charges

- Crane (Bulk): 2,500 per shift of 8 hours
- Container Crane: 1,100 per hour

Miscellaneous Charges

- 5% of total revenues

Based on the above assumptions, the revenue projections for Scenario A is as follows.

Table 105: Revenue Projections under Scenario A

Values in INR Cr	2018	2019[89]	2020	2021	2022	2023	2024	2025	2030	2050
Waterway Usage Charges	-	-	1.6	2.4	3.0	3.8	4.4	5.0	9.1	78.5
Vessel Related Charges	-	-	0.7	1.1	1.4	1.7	2.0	2.2	4.1	35.6
Berthing	-	-	0.3	0.4	0.6	0.7	0.8	0.9	1.7	14.6
Towage	-	-	0.3	0.3	0.4	0.5	0.6	0.7	1.2	10.0
Pilotage	-	-	0.2	0.3	0.4	0.5	0.6	0.6	1.3	11.0
Cargo Related Terminal Charges	-	-	0.4	0.6	0.7	0.9	1.1	1.2	2.3	20.1
Storage Charges	-	-	1.0	1.5	1.9	2.4	2.7	3.0	5.5	47.5
Composite Charges	-	-	0.7	1.1	1.5	1.8	2.1	2.4	4.7	40.4
Equipment Hire Charges	-	-	0.7	1.1	1.4	1.8	2.1	2.4	4.3	37.3
Miscellaneous Charges	-	-	0.2	0.3	0.4	0.5	0.6	0.7	1.2	10.3
Total Revenue	**-**	**-**	**5.4**	**8.1**	**10.3**	**13.0**	**14.9**	**16.9**	**31.4**	**269.8**

11.2.6.2 Revenue Projections under Scenario B

As discussed in the previous section, the following tariff have been revised.

- Waterway Usage Charges: 0.1 per GRT per km
- Cargo related Charges
  - Dry / Liquid Bulk: INR 30 per ton
  - Container: INR 2,000 per TEU

The other charges and revenue assumptions have assumed to be similar. The following table shows revenue projections considering the revised tariff.

[89] The revenues for the initial two years when facilities are upgraded are assumed to be negligible.

Table 106: Revenue Projections under Scenario B

Values in INR Cr	2018	2019	2020	2021	2022	2023	2024	2025	2030	2050
Waterway Usage Charges	-	-	7.9	11.9	15.1	19.1	21.8	24.8	45.6	392.7
Vessel Related Charges	-	-	0.7	1.1	1.4	1.7	2.0	2.2	4.1	35.6
Berthing	-	-	0.3	0.4	0.6	0.7	0.8	0.9	1.7	14.6
Towage	-	-	0.2	0.3	0.4	0.5	0.6	0.6	1.2	10.0
Pilotage	-	-	0.2	0.3	0.4	0.5	0.6	0.7	1.3	11.0
Cargo Related Terminal Charges	-	-	11.2	17.0	21.9	28.3	33.6	39.2	74.2	639.2
Storage Charges	-	-	1.0	1.5	1.9	2.4	2.7	3.0	5.5	47.5
Composite Charges	-	-	0.7	1.1	1.5	1.8	2.1	2.4	4.7	40.4
Equipment Hire Charges	-	-	0.7	1.1	1.4	1.8	2.1	2.4	4.3	37.3
Miscellaneous Charges	-	-	1.3	2.0	2.5	3.2	3.8	4.6	8.4	72.2
Total Revenue	**-**	**-**	**23.6**	**35.7**	**45.7**	**58.4**	**68.1**	**78.6**	**146.9**	**1,265**

11.2.7 Operating and Maintenance Expenditure

The O&M cost for the development of Sunderbans Waterways has been divided into following components:

- Maintenance
  - Civil: 2% of Civil Capital Costs
  - Equipment: 3% of Equipment Capital Costs
  - IT infrastructure: 5% of IT Infrastructure Costs
  - Dredging Maintenance: 10% of Dredging Capital Cost (preliminary estimate which is subject to revision based on detailed model and sedimentation study)
- Power
  - Terminal Requirement: 1 kWH per ton
  - Power per unit cost: INR 6 per kWH
- Equipment Fuel
  - Fuel consumption of MHC: 38 litres per hour
  - Excavators: 15 litres per hour
  - Payloaders: 12 litres per hour
  - Fuel: INR 60 per litre
- Insurance Expenses: 0.2% of Gross Fixed Assets
- Overheads: 1% of Total Capital Costs
- Manpower Expenses: 4% of Total Revenues
- Other Expenses including general management and other costs: 2% of Total Revenues

Following table shows the year-on-year breakup of O&M costs.

Table 107: O&M Costs Projections

Values in INR Cr	2018	2019	2020	2021	2022	2023	2024	2025	2030	2050
Maintenance	-	-	**4.2**	**5.5**	**7.7**	**8.6**	**9.7**	**15.1**	**20.6**	**54.6**
Civil	-	-	1.7	2.2	2.8	3.6	4.4	5.6	8.4	22.3
Equipment	-	-	1.1	1.7	3.0	3.2	3.3	7.0	8.9	23.6
IT Infrastructure	-	-	0.1	0.2	0.4	0.4	0.4	0.9	1.2	3.2
Dredging Maintenance	-	-	1.3	1.3	1.4	1.5	1.6	1.6	2.1	5.5
Power	-	-	**1.6**	**2.5**	**4.4**	**4.6**	**4.8**	**10.1**	**12.9**	**34.3**

Values in INR Cr	2018	2019	2020	2021	2022	2023	2024	2025	2030	2050
Equipment Fuel	-	-	1.5	2.3	4.0	4.2	4.4	9.3	11.8	31.4
Insurance	-	-	0.3	0.4	0.5	0.6	0.8	1.0	1.5	3.9
Overheads	-	-	3.8	4.0	4.2	4.4	4.6	4.9	6.2	16.5
Manpower	-	-	0.2	0.3	0.4	0.5	0.6	0.7	1.3	11.1
Other Costs	-	-	0.1	0.2	0.2	0.3	0.3	0.3	0.6	5.5
Total O&M Costs	**-**	**-**	**11.7**	**15.1**	**21.4**	**23.3**	**25.3**	**41.4**	**55.0**	**157.3**

11.2.8 Capital Costs

The phasing of estimated capital costs has been undertaken based on traffic build-up assumed and considering the existing infrastructure.

Table 108: Phasing - Capital Expenditure

Head	Total (in INR cr)	2018	2019	2024
Berth	74	32	-	42
Construction of Floating Pontoons	19	5	-	14
Refurbishment of Berths	3	3	-	-
Equipment	182	-	84	99
Storage	71	9	24	38
Ancillary Infrastructure	39	39	-	-
Last Mile Connectivity	13	7	7	-
Dredging	12	6	6	-
Bank Protection	19	9	10	-
Navigational Aids	11	-	11	-
PMC / Contingency	22	6	7	10
Total Capital Expenditure	**467**	**116**	**148**	**203**

11.2.9 Project Cashflows

11.2.9.1 Project Cashflows under Scenario A

The cash flows for the project under current tariff structure are shown in the following table.

Table 109: Project Cashflows under Scenario A

Values in INR Cr	2018	2019	2020	2021	2022	2023	2024	2025	2030	2050
Revenues	-	-	5.4	8.1	10.3	13.0	14.9	16.9	31.4	269.8
Less: CAPEX	116	148	-	-	-	-	203	-	-	-
Less: O&M Costs	-	-	11.7	15.1	21.4	23.3	25.3	41.4	55.0	157.3
Pre-Tax Cash Flows	**(116)**	**(148)**	**(6)**	**(7)**	**(11)**	**(10)**	**(213)**	**(24)**	**(23)**	**115**

11.2.9.2 Project Cashflows under Scenario B

The cash flows for the project under proposed tariff structure are shown in the following table.

Table 110: Project Cashflows under Scenario B

Values in INR Cr	2018	2019	2020	2021	2022	2023	2024	2025	2030	2050
Revenues	-	-	23.6	35.7	45.7	58.4	68.1	78.6	146.9	1,265
Less: CAPEX	116	148	-	-	-	-	203	-	-	-
Less: O&M Costs	-	-	12.9	16.9	23.7	26.3	28.7	45.5	62.5	222.1
Pre-Tax Cash Flows	**(116)**	**(148)**	**11**	**19**	**22**	**33**	**(163)**	**34**	**86**	**1,050**

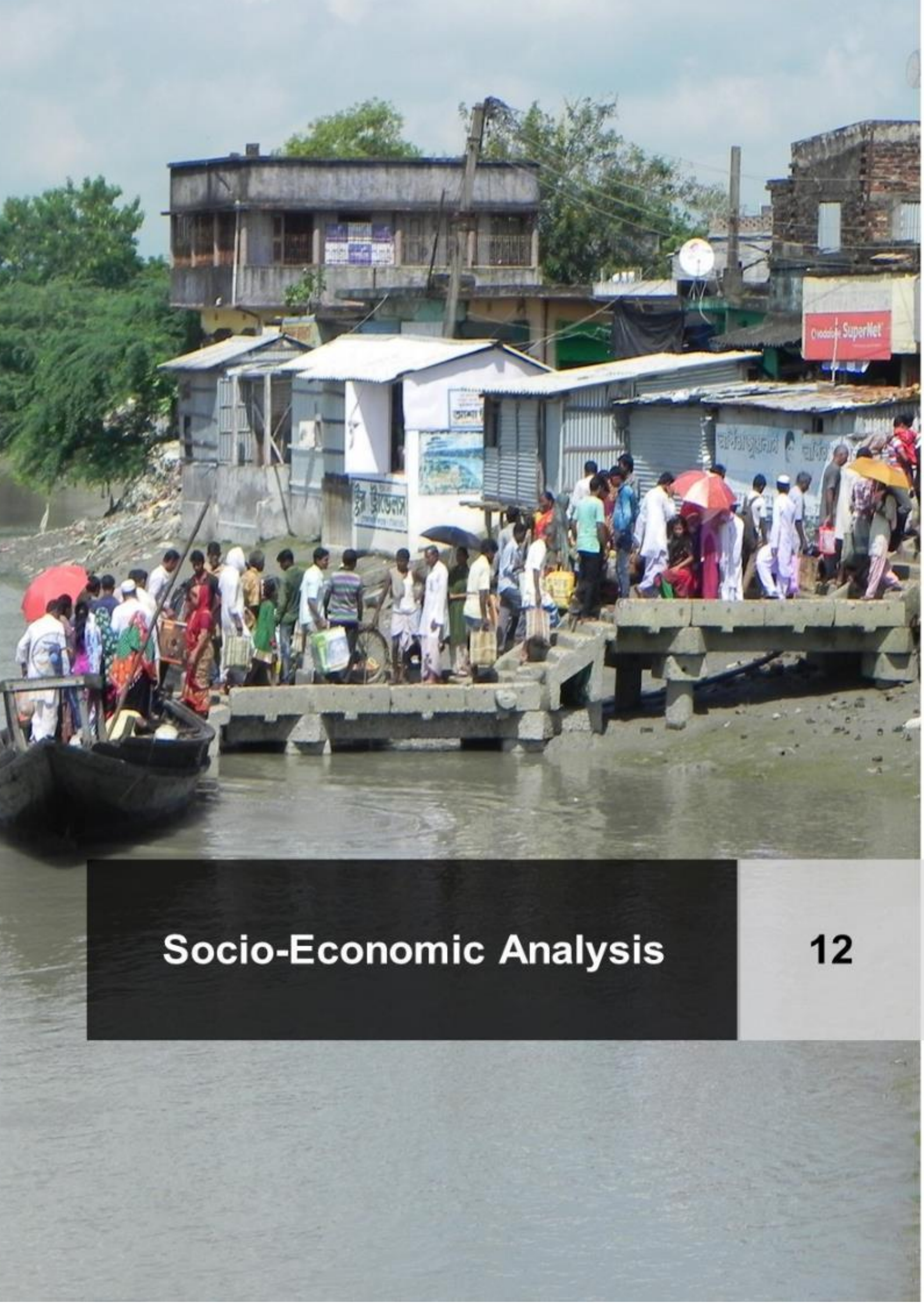
11.2.10 Project Returns

Considering the current tariff structure, IWAI has the capability to increase the tariff charges without jeopardizing the advantageous cost economics of transportation via waterways. Hence, financial feasibility was computed for the following two scenarios:

- Scenario A (assuming the current tariff structure) – Considering current tariff, the project has negative financial returns due to low tariffs and high O&M costs and is not financially viable
- Scenario B (assuming the proposed tariff structure) [90] – **With relevant revisions to terminal and fairway charges, the project has healthy returns with an IRR in the range of 17-18%.**

Given the potential traffic and significant integration benefits with the economy of North-East states of India and Bangladesh, the project is financial feasible with changes in the tariff structure.

[90] Current tariff for dry cargo is INR 1 per tonne and container is INR 50 per TEU and fairway usage charges: INR 0.02 per GRT per ton; Proposed tariff for dry cargo is INR 30 per tonne and container is INR 2,000 per TEU and fairway usage charges: INR 0.1 per GRT per ton



Socio-Economic Analysis 12

12 Socio-Economic Analysis

Inland waterways as a means of transportation has been harnessed worldwide in the face of expanding economies as it is considered as a preferred alternative due to its various direct and indirect benefits as mentioned in this section.

12.1 Direct Benefits

12.1.1 Employment Generation

Employment occurs both during the construction and operation phases of the transport infrastructure. Relevant studies show that investment of USD 100 million creates an employment effect of 1,250 man-years on an average for all kinds of transport infrastructure during the construction phase. More than 40% of this employment effect remains in the region of relevant project[91]. During the operation phase of the project, an investment of USD 50 million creates an average of 3,500 jobs for national highways, 1,500 for railways and 500 for waterways.

Inland waterways perform several non-transport related functions that can be easily considered as benefits of economic assessment. Its use to move goods and services was found to fuel the economic growth and rural development of the local communities especially where it is the only means of transport available. It would boost the economy of nearby districts by promoting all facets of agro and other businesses such as crop production, fishery, production of basic materials, processing of timber products etc.

12.1.2 Creation of Business Opportunity

Due to the proposed project, the local economy can be promoted through income from barge / boat hires, mooring and licensing fee, canoeing, wildlife watching and other recreational activities for further tourism development.

12.1.3 Vessel Operating Cost

Comparing the vessel operation cost of the three most common modes of cargo transfer, inland waterways turns out to be the cheapest mode of transport. Transport by road costs INR 2.58 per tonne-km and transport by rail costs INR 1.41 per tonne-km.[92] The cost for inland waterways is considerably cheaper at INR 1.06 per tonne-km.[93]

12.1.4 Environmental and Social Benefits

12.1.4.1 Carbon Saving

Estimating transport-related carbon savings depends on calculating the difference in emissions between the type of transport that is offset or equivalent vehicles that are offset.

Tyndall Centre for Climate Change Research has estimated that freight transport produces one-third of carbon emissions of road transport. Road freight transport produces 0.08 tons CO_2 per thousand tonne-km. The carbon emission through waterway transportation is 0.02 tons per thousand tonne-km. The saving in this regard is 0.06 tons of carbon per thousand tonne-km because 1 liter of fuel moves 24 tonne-km by road and 85 tonne-km by rail as compared to 105 tonne-km by waterways.[94]

The shadow price of carbon is used to estimate the value of carbon saving in many government projects. The methodology is based on a damage cost approach and provides values for a tonne of carbon in any given year and requires the costs to be inflated annual to account for increased damages over time. The benefits of carbon savings arising from renewable energy production should be valued at the market price of carbon. The carbon shadow price value of damages on society at large due to emissions is 20$ / ton. Reduction in carbon emission is a direct factor for damages on society which can be calculated based on this price.

12.1.4.2 Air / Noise pollution

Some of the most pervasive and intrusive sources of noise and air pollution are transportation systems. Air pollution comes from a wide variety of man-made and natural sources, with fossil fuel combustion as the largest contributor. Air pollution caused by transportation includes pollutants directly emitted by engines as well as secondary pollutants formed by chemical reactions. Road traffic is, by far, the greatest source of air emissions.

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[91] World Bank, http://www.worldbank.org/transport/ports/iwt_dev.htm
92 http://pib.nic.in/newsite/mbErel.aspx?relid=117695
93 http://pib.nic.in/newsite/mbErel.aspx?relid=1176335
94 http://pib.nic.in/newsite/mbErel.aspx?relid=117695

Water transport, conversely, causes far less air pollution than trucking, and less or comparable amounts, than rail. Cumulatively, it has a relatively minor effect on air quality, consumes much less energy (and thus, produces less air pollution) per tonne-km of freight carried than either rail or truck. For the most part, waterway operations are conducted away from population centers, which reduces the impact of its exhaust emissions. Little data exists on noise levels of barge operations, mainly because they are not considered a problem. Towboats operate well away from shore, with the sound of their engines muffled below the water line, and any noise levels are hardly audible beyond the immediate area of the town.

12.2 Indirect Benefits

12.2.1 Traffic Congestion Solution

The steady increase in highway traffic has outstripped any increase in infrastructure capacity, resulting in delays, safety problems, and congestion which costs the nation in crores annually. Other impacts of traffic congestion include accidents, increased energy consumption, environmental damage, increased commuting times, and greater social tension. Water transport is currently underutilized and optimizing the modal shift would reduce congestion problems in the country.

12.2.2 Economic Boost

Inland waterways can generate an economic benefit in the form of property premiums beyond the average rent or sale of residential and commercial property. The available studies show that proximity to waterway has effect of price of property. There is an average 8-20% increase in value of land and properties around waterways. There has been significant increase of property prices around NW1 and NW2[95]. The actual economic benefit is location specific and depends on the existing property prices and rental rates in the area.

12.2.3 Operational Safety

Transporting cargo safely is an important measure of environmental responsibility, and water transport has the fewest number of accidents, fatalities, and injuries as compared to road or rail. Shallow-draft water transportation has definite advantages over competitive modes. It generally involves less urban exposure than either road or rail, operates on a system that has few crossing junctures, and is relatively remote from population centres – all factors that reduce both the number and impact of waterway incidents. Truck and rail tank car spills occur more often than barge spills. Barges, because of their much larger capacity, require far fewer units than either road or rail to move an equivalent amount of cargo, and so the chance of a spill is less likely.

Also, design features of barges such as double-hulls and navigational aids help reduce accident frequency. Any hazardous liquid material shipped by water requires a comprehensive list of safeguards and controls that govern the design and construction of vessels and equipment, and personnel manning qualifications.

12.2.4 Land Usage and Social Impact

The impact of rail lines passing through urban areas, and trucking operations occurring near high-density population areas, can become a disturbing element to an otherwise reasonably calm environment in settled areas. By contrast, water transport has little impact on densely populated areas since shallow-draft vessels operate in mid-river, well away from shore, and because of the large tonnage moved at one time, tow passages are infrequent. Since most of the right-of-way for water transport is provided by nature, navigation is less likely than other transport forms to compete with non-transportation uses for land area, an important consideration in urban locations. Extensive land area can be taken up by new highways and railroad corridors, but apart from a few connections and waterside terminals, waterways pre-empt very little land.

12.3 Socio-Economic Returns

The following socio-economic impact is envisaged by the development of the waterways.

Parameter	Impact	Total Economic Impact (2030) INR cr	Total Economic Impact (2050) INR cr
Operation Efficiency (cost savings)	1.44 per ton km	147	396
Job Creation (monetary benefits)	1000 jobs per 100 mn USD	60	60
Total Economic Impact		**207**	**456**

95 http://www.indianchamber.org/wp-content/uploads/2015/06/Sector-Update-Logistics.pdf

Based on the socio-economic analysis, the project shows an economic return of ~20% across the long term.

Risk Analysis & Mitigation

13

13 Risk Analysis and Mitigation

The development and successful operation of the proposed inland waterway is contingent on assumptions and externalities. A few potential risk factors and measures that should be taken to mitigate them are discussed in this section.

13.1 Pre-Operative and Construction Risks

The potential pre-operative risks for the project before the beginning and during the construction period:

13.1.1 Conceptualisation Risks

The project comprises of berths, equipment and other components that requires designing to consider the capacities. Mismatch in the design and capacity can lead to underutilization of the inland waterway and terminals. There could also be delays in land acquisition for the proposed terminal and obtaining statutory approvals and environmental clearances (CRZ clearance, forest & wildlife clearance etc.).

Mitigation Strategy

The project should be designed with phased-out conservative estimate the capacities that are proposed to be handled by IWT movement. In addition, for the equipment optimal circulation area should also be incorporated in the design to minimize congestion and maintaining efficiencies.

13.1.2 Ecological Risks

The Sunderbans is a cluster of low-lying islands and estuarine areas which provides nursery grounds for many species of fish and invertebrates, including species such as tiger prawns and rich forest reserves.

The reclamation of land from the waterway and dredging of the sediments might affect the flora and fauna in the region and might affect the structural stability of the area. Also, highest order of design and technical specifications would be important for preserving the natural drainage, embankment etc. to reduce environmental impact.

Mitigation Strategy

A detailed study including sediment transport, siltation and environmental impact assessment needs to be carried out to confirm the available area for reclamation to minimize the impact on the ecological balance. In addition, gathering up natural and locally available sediments and disposing of them at a different location for dredging purposes should also be incorporated in the design to maintain ecological sensitivities and efficiencies.

13.1.3 Cost Overrun Risks

The region imports the construction material required for the construction activity. The availability and transportation cost of the equipment and construction material required for the project development would mainly lead to cost over-runs. In addition to this other factors such as availability of labour and project planning/implementation schedule also impact the construction cost of the project.

Mitigation Strategy

Since the project requires construction materials and equipment to be imported to the region for development so it is imperative to have a detailed project implementation schedule which would help in providing inputs for the type of equipment and construction material required during each phase of the development process. In addition, the cost of the project should be monitored over the course of development and a contingency provision should be built in the major cost heads of the project.

13.1.4 Financing Risks

The success of the project depends on the smooth and timely access to funds. With a high peak funding requirement, any delay in funds can lead to delay in the operations of the project leading to delay in revenues and thus reducing the expected cash flows.

Mitigation Strategy

The large format greenfield IWT infrastructure projects such as terminal development has significant funding requirement. Thus, IWAI can tap into Central Ministry funds or debt from multi-lateral institutions. Private participation to design, build, operate terminal can be considered.

13.1.5 Completion Delay Risks

The project may not be completed on time if the construction is not time bound and does not follow a schedule. It may lead to cost overruns, which would increase the cost of the project and thus impacts the project feasibility. Any major delay might change the dynamics of the market, which could lessen the potential for returns from the project.

The Project requires coordinated effort of multiple service providers, including third party ones, across the lifecycle, starting from conception to completion, and operations and maintenance. Delays and quality issues could come at multiple levels, impacting the project timelines / cost.

Mitigation Strategy

The private player would have to take the prerogative of setting up checks and systems in place to ensure the adherence of external contracts to stipulated quality and timelines. A project construction plan should be created and the schedules of development should be followed strictly. Time bound contracts should be followed with contractors or suppliers to minimize delays and cost overruns. Project reports detailing the progress of construction should be made.

13.1.6 Land Acquisition Risks

In case, IWAI decides to construct a new terminal at Haldia for handling Sunderbans traffic, 50-60 acres of land would be required.

Mitigation Strategy

It is expected that the additional land would be acquired at Haldia port on port land. As IWAI has already negotiated the land lease from Port for the new NW 1 terminal, it is expected that suitable cooperation would be extended for land acquisition for Sunderbans Waterways

13.2 Project Operations Risks

The potential risks that the project can face during operations period:

13.2.1 Maintenance Risks

Upon completion of the construction, there needs to be periodic maintenance of the terminal and dredging of waterway route to ensure proper functioning bulk infrastructure and equipment. In case of neglect, there would be decline in waterway efficiencies which might be negative feedback of the port in the region, which could dissuade potential shipping companies and other stakeholders.

Mitigation Strategy

India and Bangladesh can enter O&M agreements with contractors and agencies for proper functioning within area of jurisdiction. The agreement can specify certain minimum criteria for operations to ensure proper functioning of the terminal and waterway. Review of the terminal and waterway can be done on fixed time durations to ensure adherence to the conditions of agreement.

13.2.2 Market Risks

India and Bangladesh witnessing investments towards the development of terminals by major inland waterway operators. The upgradation of these terminals would cater to higher capacity freighters, competitive pricing, or service augmentation can drive traffic away from the proposed port. Moreover, development of new terminal in the region to address intercontinental trade may adversely influence the operations at Sunderbans Inland Waterway Movement.

Mitigation Strategy

To mitigate this risk, the following measures have been undertaken:

- Comprehensive analysis of regional and intercontinental trade and development of strategies based on conservative estimation of addressable market
- Suitable integration with the proposed port development to ensure operational efficiency and higher coordination
- Participation and involvement in creation of trade free zones can further enhance trade activity.

13.2.3 Safety, Security and Environmental Risks

In case of thefts and losses due to change in International boundaries and jurisdiction, operators diminishing confidence in the operations of the project leading to delay in revenues and thus reducing the expected trade movement. Potential risks might hold back operators from operating in the IWT infrastructure.
Additionally, there could be a risk of accidents due to collisions, grounding, overtaking, poor visibility, excessive gross tonnage and barging into permanent structures like bridges. The barges may also pose an environmental hazard risk such as oil spill, leakage of hazardous material etc.

Mitigation Strategy

The government and the private operators would have to take the prerogative of setting up checks and jurisdiction in place to ensure the adherence of external contracts to stipulated quality and timelines.

The environmental risk can be mitigated through safer navigation, safer loading and unloading operations and improved training of inland vessel operators

13.2.4 Ecosystem Risks

The project is expected to cater to the trade in Sunderbans and India's North-Eastern region. The success of the project is dependent upon the growth rate of the trade in the region. Any change in the trade patterns would have the direct impact on the project.

Mitigation Strategy

The implementation scheduling of the project should be done such that the products which have are shipped in containers and bulk cargo which significant demand prospects should be called at the terminal initially before moving towards other commodities.

13.3 Other Risks

Other Risks apart from the risks mentioned as above may include:

13.3.1 Political Risks

Unfavourable policy decisions by India and Bangladesh governments and changes in political scenario between India and Bangladesh during would directly impact while the changes in the Sunderbans region would indirectly impact investments in such mega projects. Thus, a stable political scenario ensures continued support for large scale project development.

The projects may be exposed to political risks because: the restrictions imposed on convertibility of currency and transfer, expropriation of the project assets by the government, and internal political stability causing physical damage to project or preventing its operation. The government may introduce changes in the law which provides the stable legal and regulatory environment for the project resulting in change in law risk.

Mitigation Strategy

India and Bangladesh has signed the Standard Operating Procedure (SOP) to operationalize the "Agreement on Coastal Shipping" to enhance bilateral trade between two countries. The project should be designed for the capacities that are proposed to be handled by the inland waterway. The agreement is based on the reciprocity of trade between the two countries without impairing the integrity and sovereignty of the Nations.

13.3.2 Stakeholder Risk

There could be challenges for reaching out to local industries in India and Bangladesh, logistics operators and community at large for promoting IWT.

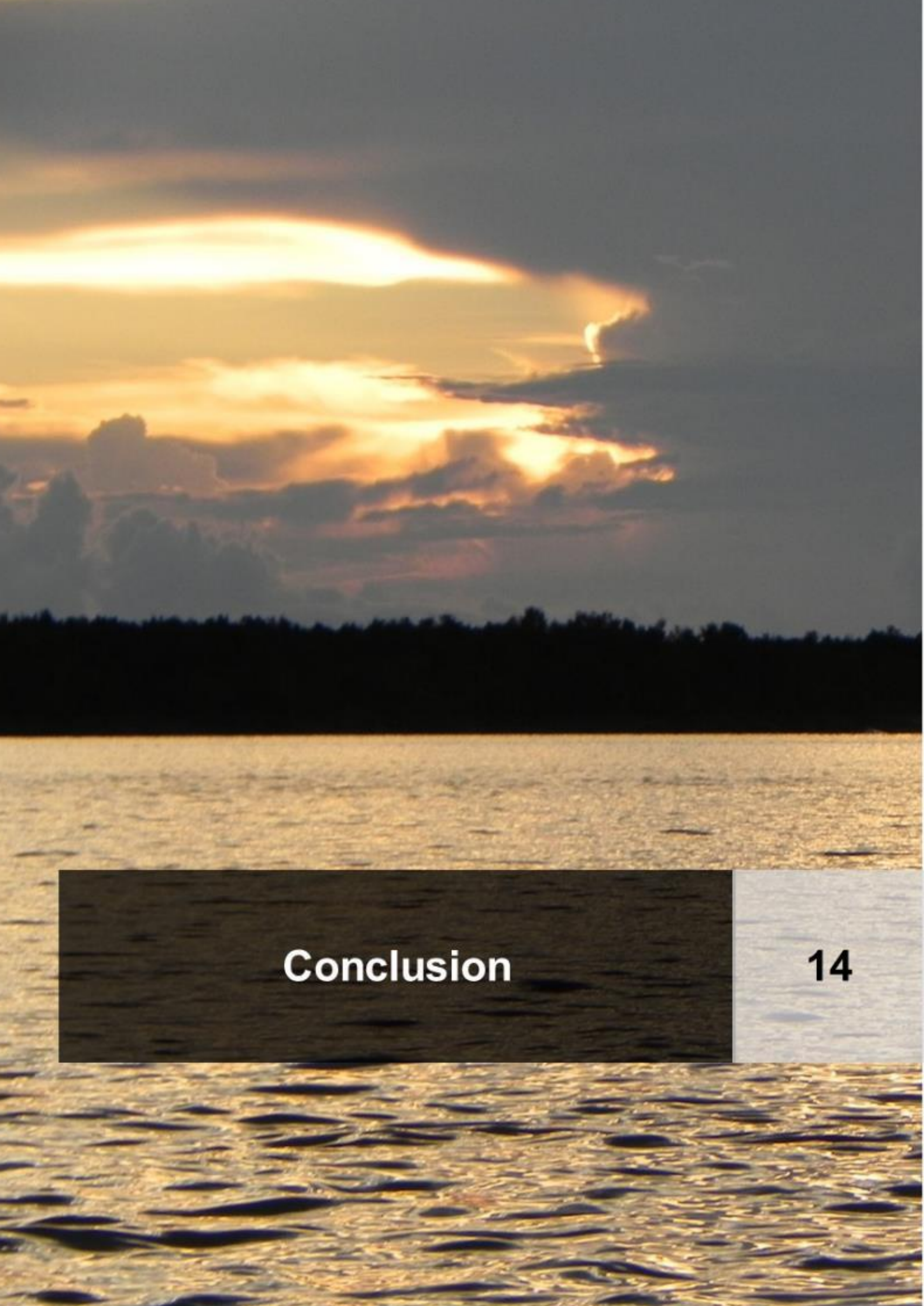
Mitigation Strategy

A suitable marketing plan should be devised to promote awareness and acceptability of waterways as a preferred mode of transport.

13.3.3 Force Majeure

There could be natural calamities or disasters such as earthquakes, floods, cyclones, famines, etc. beyond anyone's control. There could be large scale man-made disasters such as wars, protests, etc. These events can negatively impact the project.

Mitigation Strategy
Suitable insurance cover can be taken for incidents such as earthquakes to enable recovery from such disasters.



14 Conclusion

14 Conclusion

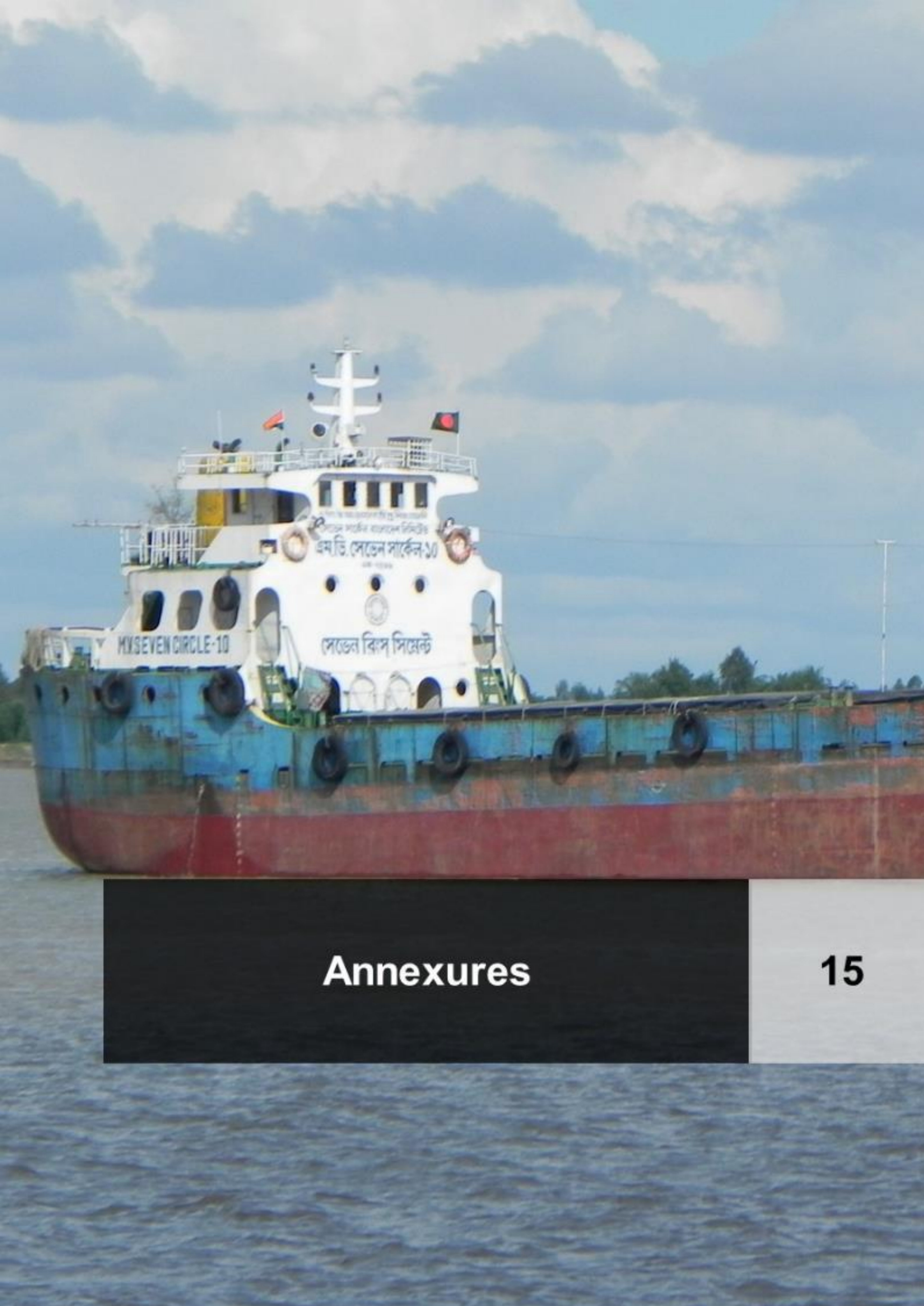
- **Sunderbans Waterways is an important route for development** as it provides the following essential connectivity options:
  - International connectivity to Bangladesh – improving trade relations with Bangladesh,
  - Transit to North-eastern states – providing shorter / cheaper transport options for cargo movement
  - Travel within Sunderbans – enhancing connectivity and economic development of the local populace.
- Dispersed urban settlements and low economic development in the region enhance the **need to tap the huge potential for adopting waterways as a preferred mode of transportation**.
- Technical assessment indicates **considerable shoal formation and sedimentation at the survey locations**. However, as there is significant tidal influence with minimal velocity, navigation through waterways is possible during high tide. The sedimentation analysis indicates significant proportion of fine particles (silt and clay).
- **Trade between India and Bangladesh involves issues such as infrastructure constraints, delays at Petrapole land port and administrative problems**. Analysis of cost economics of key routes indicates that waterways has immense potential due to its numerous benefits such as economic feasibility and time savings. Based on the trade traffic potential, trade with Bangladesh for commodities like cotton, ODC, iron & steel, food grains & spices, flyash, POL, electronics, processed food, raw jute, lead, zinc, rubber & leather products, readymade garments, chemicals and marine products can be diverted to the protocol route.
- **Cargo movement between India's North-eastern region and hinterland involves issues such as poor connectivity, inadequate infrastructure and severe topography of the North-eastern states**. Based on cost economics and infrastructure availability, the primary catchment for transit traffic through waterways has been identified as states of Southern Assam, Tripura, Meghalaya, Mizoram and Manipur. The transit commodities that can be diverted to the protocol route include rice, wheat & other food grains, sugar, iron & steel, ODC, limestone, tea, forest products and POL.
- The **waterway is proposed to be maintained with depth availability of 2.5 m throughout**. Thus, a navigation channel of 45 m wide is proposed. Given the proposed draught and channel width, self-propelled barges up to 1500 DWT should be able to ply comfortably. Additionally, with the technological improvements, flat bottom barges with cargo carrying capacity of 2,000 DWT could also ply on the waterways. For the surveyed sections, the dredging requirement is estimated to be 315,687.61 m^3 (for overall length, dredging of 413,262.29 m^3 is estimated based on preliminary analysis of the Thalweg charts). Considering, estimated bulk cargo traffic of ~15 MTPA and ~60,000 TEUs (2040), additional 5 berths (4 fixed and 1 floating) at Haldia, 2 floating pontoons at Hemnagar Terminal and adequate handling facilities are recommended.
- Based on the above analysis, we believe that the survey stretch should not be evaluated independently and should be evaluated in the context of the overall Indo-Bangladesh protocol route. Thus, for establishing feasibility of the waterways, the entire 215-km stretch (Haldia to Athara Banki) has been analyzed in this report which includes terminal handling at Kolkata / Haldia.
- Considering the current tariff structure, IWAI has the potential to increase the tariff charges without impacting the advantageous cost economics of transportation via waterways. Hence, financial feasibility was computed for the following two scenarios:
  - Scenario A (assuming the current tariff structure) – Considering current tariff, the project has negative financial returns due to low tariffs and high O&M costs and is not financially viable.
  - Scenario B (assuming the proposed tariff structure) [96] – **With relevant revisions to terminal and fairway charges, the project has healthy returns with an IRR in the range of 17-18%.**

Given the potential traffic and significant integration benefits with the economy of North-East states of India and Bangladesh, the project is financially feasible with changes in the tariff structure.

The total capital expenditure that has been estimated for the project is INR 23 Cr excluding the capital expenditure for Kolkata and Haldia terminals. As discussed earlier, no fresh capital expenditure is expected to be undertaken for Kolkata and Haldia terminals, since the infrastructure proposed by IWAI for NW 1

[96] Current tariff for dry cargo is INR 1 per tonne and container is INR 50 per TEU and fairway usage charges: INR 0.02 per GRT per ton; Proposed tariff for dry cargo is INR 30 per tonne and container is INR 2,000 per TEU and fairway usage charges: INR 0.1 per GRT per ton

would be utilized for Sunderbans Waterways. The capital expenditure for Hemnagar Terminal is INR 12 Cr, out of which INR 5.3 Cr would be required immediately for pontoons and ancillary infrastructure at the terminal.



Annexures

15

ANNEXURE A - Assessment of Demand Clusters

The relevant catchment includes Sunderbans, West Bengal, North-eastern states and Bangladesh. The mineral reserves and major industries in these regions are shown in the following maps.

Figure 59: Mineral Reserves in the Catchment

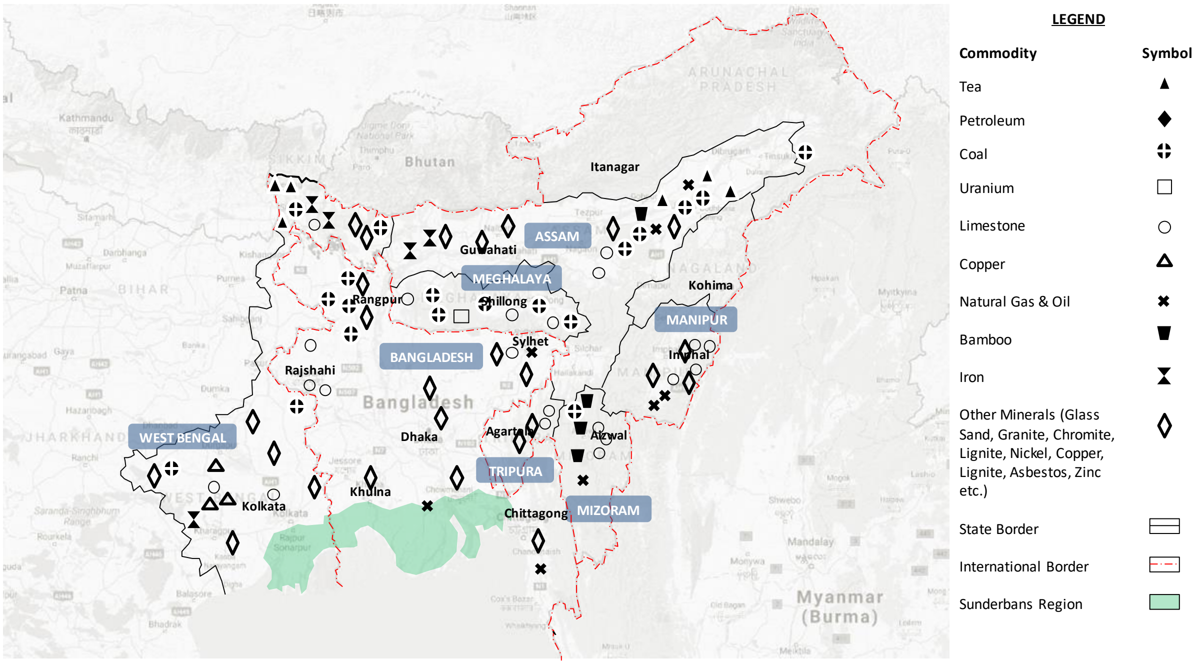
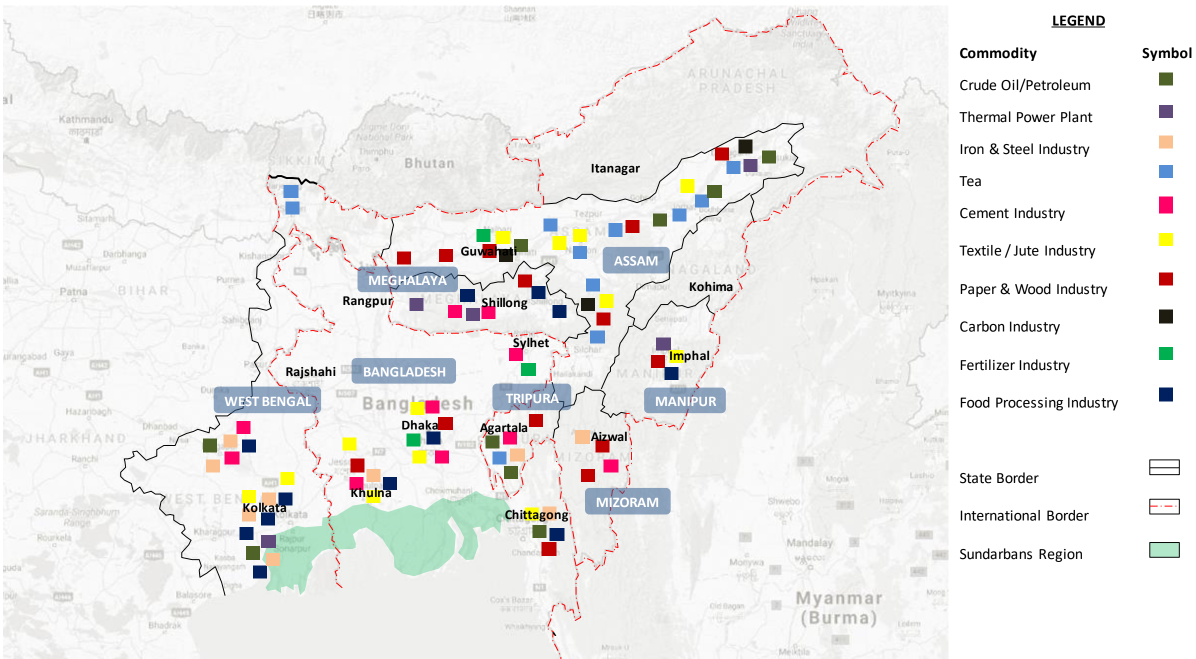


Figure 60: Major Industries in the Catchment



The following section explains the details of the mineral reserve deposits and concentration & type of industries in the catchment.

1) West Bengal

West Bengal is India's sixth largest economy and recorded a Gross State Domestic Product (GSDP) of US$ 132.86 billion in 2014-15. The state's GSDP expanded at a CAGR of 11.06% from 2004-05 to 2014-15. As of January 2015, West Bengal had a total installed power generation capacity of 10,063 MW. Agriculture is the chief occupation in the state and contributed 18.8 % to the GSDP in 2014-15[97].

The state is the largest producer of rice in India with a total production of 15.4 million tons in FY 15. It is also the largest fish producing state and second largest producer of tea and potato in India. During 2014-15, it produced 329.3 million kg of tea, accounting for 27.8% of India's total tea production and is home to the globally acclaimed Darjeeling tea variety[98].

Kolkata is the prime centre for India's jute industry. During 2014-15, West Bengal accounted for 79.6% of India's total jute production. It is also a leading exporter of leather and has ~500 tanneries, accounting for 55% of India's leather goods exports. About 22-25% of India's tanning activity is undertaken in Kolkata. West Bengal has abundant natural resources of minerals and suitable agro-climatic conditions for agriculture, horticulture and fisheries[99].

The state has also made a beginning in information technology (IT) sector. By 2015-16, 8 IT parks are expected to start operating in the state. Additionally, 7 new IT parks are expected to start in the state over next five years.

Mineral Reserves

The state contributes ~one-fifth to the total production of minerals in the country. Coal constitutes 99% of the minerals extracted in West Bengal. Fireclay, china, clay, limestone, copper, iron, wolfram, manganese and dolomite are mined in small quantities. The details of mineral reserves in the state are shown in the following table.

Table 111: Mineral Reserves in West Bengal[100]

Mineral	Reserves	District	Related Major Industry
Copper	0.2 million tons	Tamakhun, Manbazar, Purulia	Power, Construction, Handicrafts, Transportation, Telecom, Electrical Appliances
Baryte	66 tons	Kashipur, Purulia	Paint, Plastic, Ceramic, Chemicals, Paper, Glass
Clay	8.57 million tons	Mahatomara, Bandaluhar, Taldih, Purulia, Khariduara. Hankasara, Katachua, Midnapur. Kashipur, Bankura, Birbhum	Ceramic, Glass
Dolomite	1.05 million tons	Boch, Manbazar, , Purulia	Iron & Steel, Glass, Fertilizer
Quartz	2.23 million tons	Janipur, Purulia, Gobindapur, Barrabazar, Midnapur	Gemstone, Glass, Petroleum
Tungsten	0.17 million tons	Thanpahar, Cheradungri, Purnapani	Jewellery, Steel, Chemical

The key districts in the catchment of Sunderbans are South 24 Parganas, North 24 Parganas, Howrah, Hooghly, and Purba Midnapur. Key industries in West Bengal are tea, petroleum and petrochemicals, leather, iron and steel, information technology, mineral resources, automobile and auto components, biotechnology, fisheries, jute products and textiles etc.

Industrial Snapshot

The major districts and industries across the catchment are summarised in the following table.

[97] IBEF West Bengal Report; (2015); New Delhi
[98] IBEF West Bengal Report; (2015); New Delhi
[99] IBEF West Bengal Report; (2015); New Delhi
[100] Directorate of Mines & Minerals, Government of West Bengal

Table 112: Major Industries in West Bengal

Area	Commodity	Major Industries
Budge Budge	Edible Oil	Budge Budge Refineries Limited
Banganagar	Edible Oil	Rasoi Limited
Naihati	Diversified Jute Products	Hukumchand Jute Mill
Khardaha	D1 Pipes. CI Pipes, TMT MBF, Coal Sinter	Electrosteel Castings Limited
Howrah	Iron & Steel products	Jindal, BMW Industries, Kamini Steels
	Cement	Ambuja Cement Eastern Limited
	Edible Oil	Swastik Refinery Private Limited
Hooghly	Iron & Steel products	Manab Ispat, Utkarsha Galva, Indvac Metals & Forge
	Jute	Ganges Jute Private Limited
Haldia	Iron & Steel products	Hindusthan Seals, Chariat Exim
	Cement	Sanghi Industries
	Edible Oil	Akalmar Oils & Fats, MP Glychem Industries, Haldia Vegetable Oils & Foods, Ambo Agro Products
	Petrochemical & Oil based	Indian Oil Corporation Refinery, Hindustan Lever Chemical, Petro Carbon & Chemical

District-wise Industrial Profile

South Twenty Four Parganas has presence of humble number of large, medium and some small scale industries in the Sunderbans. Major exportable items are jute diversified products, hosiery and garments, leather products, plastic products, machinery and parts except electrical products. The relevant major industries in South Twenty Four Parganas district in the Sunderbans catchment are mentioned in the following table.

Table 113: Major Industries in South 24 Parganas in Sunderbans Catchment

Location	Major Industries	Product	Turnover (in INR Cr)	Direct Employment
Budge Budge	Budge Budge Refineries Ltd.	Edible Oil	65	150
Banganagar	Rasoi Ltd.	Edible Oil	50	100
Bishnupur	Century Plywood (I) Ltd.	Laminates, adhesives, formaldehyde	28	75

North Twenty Four Parganas has a modest number of large, medium and some small scale industries in the Sunderbans. Major exportable items are engineering goods, plastic based items, jute and jute diversified products, food and beverages, tobacco, basic metal products etc. The relevant major industries in North Twenty Four Parganas district in the Sunderbans catchment are mentioned in the following table.

Table 114: Major Industries in North 24 Parganas in Sunderbans Catchment

Location	Major Industries	Product	Turnover (in INR Cr)	Direct Employment
Naihati	Hukumchand Jute Mill	Diversified Jute Products	30	4,500
Khardaha	Electrosteel Castings Ltd.	D1 Pipes. CI Pipes, TMT MBF, Coal Sinter	225	650

The district of Howrah has a large industrial population and it plays a vital role in the economy of West Bengal. The major exportable items are engineering, chemical based articles, edible oil and food processing products. The relevant major industries in Howrah district in the Sunderbans catchment are mentioned in the following table.

Table 115: Major Industries in Howrah District in Sunderbans Catchment

Location	Major Industries	Product	Turnover (In INR Cr)	Direct Employment
Jangalpur Howrah	Jindal India Pvt. Ltd.	CR strips, GP IGC sheets	42	150
Jangalpur Howrah	Jindal India Pvt. Ltd.	ERW steel pipes	100	200
Howrah	BMW Industries Ltd.	GP/GC sheets	200	250
Howrah	Kamini Steels Ltd.	Pig Iron, Coke	35	150
Angadpur	Shivam India Pvt. Ltd.	MS Billet, SS Billet	28	95
Bagnan	Bishan Dayal Goel & Sons Pvt. Ltd.	Pig Iron	62	200
Howrah	Zindal India Ltd.	CR coils, JP1GC sheets	100	150
Howrah	Ambuja Cement Eastern Ltd.	Cement	33	30
Jangalpur Howrah	Swastik Refinery Pvt. Ltd.	Edible Oil	28	50
Howrah	Frito Lay India Ltd.	Potato chips	105	200

The district of Hooghly has people engaged in both agricultural and industrial activities. At present, multi-national companies are showing interest in setting up industries in the district. The major exportable items are specially engineering goods, jute goods, metal goods etc. The relevant major industries in Hooghly district in the Sunderbans catchment are mentioned in the following table.

Table 116: Major Industries in Hooghly District in Sunderbans Catchment

Location	Major Industries	Product	Turnover (In Cr. Rs.)	Direct Employment
Serampore	Manab Ispat Pvt. Ltd.	Rolled Products, ERW Pipes, Black & Galvanised, Alloy Steel, Non Alloy Steel Ingots	35	150
Hooghly	Indvac Metals & Forge Pvt. Ltd.	Foundry Products	38	300
Hooghly	Utkarsha Galva Ltd.	Cold Rolling Mill	100	250
Bansberia	Ganges Jute Pvt. Ltd.	Jute Goods	30	3000

The district of Purba Midnapur has presence of several large scale industries and also public sector undertakings. Presence of Haldia Port is the best choice for eastern gateway of India. Haldia port remains one of the pioneering and most promising ports of India. The relevant major industries in Purba Midnapur district in the Sunderbans catchment are mentioned in the following table.

Table 117: Major Industries in Purba Midnapur District (Haldia) in Sunderbans Catchment

Major Industries	Industry	Turnover (In INR Cr)	Direct Employment
Aluminium Products, Steel CR Plant, Galvanising Sheets	Hindusthan Seals Ltd.	313	220
Pig Iron, DI pipe, Ductile Iron	Chariat Exim Ltd.	70	500
Coke, Sponge Iron, Captive Power Plant (18 MW)	Electrosteel Castings Ltd.	160	600
Cement	Sanghi Industries Ltd.	100	200
Edible Oil	Akalmar Oils & Fats Ltd.	70	120

Major Industries	Industry	Turnover (In INR Cr)	Direct Employment
Edible Oil	MP Glychem Industries Ltd.	150	150
Edible Oil	Haldia Vegetable Oils & Foods (Ruchi Soya (I) Ltd.	130	130
Edible Oil	Ambo Agro Products Ltd.	40	170
Speciality Solvent	Teej Impex Pvt. Ltd.	30	40
Plastic Packaging Film	Mirage Impex Pvt. Ltd.	50	37
Specialised Vehicle	Ural India Ltd.	525	500
Petrochemical & oil based products	Indian Oil Corporation Refinery	-	-
Chemical Products	Hindusthan Lever Chemical Ltd.	-	-
Metallurgical Coke	Haldia Met. Coke & Power Ltd.	-	-
Petrochemical products	Petro Carbon & Chemical Ltd.	-	-

2) <u>Assam</u>

Assam is India's gateway to Northeast India and acts as a vital link for trade with Southeast Asian countries. The GSDP of Assam was US$ 30.5 billion in 2014-15 while the average annual GSDP growth rate from 2004-05 to 2014-15 was 9.9%.

The state is rich in water resources and has vast tracts of fertile land. It is also the third-largest producer of petroleum and natural gas in the country and has ample reserves of limestone. With its 5 national parks and 18 wildlife sanctuaries, the state is a biodiversity hotspot. Other potential areas of investment include power and energy, mineral-based industries, tourism and crude oil refining.

It is known for its tea, petroleum resources, muga silk and bio-diversity. It is also becoming an increasingly popular destination for wildlife tourism. Agriculture, Fisheries and Sericulture are the important economic sectors of the state.

Mineral Reserves

Assam is rich in mineral resources coal, granite, limestone, china clay, glass sand, iron ore and sillimanite The details of mineral reserves are shown in the following table.

Table 118: Mineral Reserves in Assam

Mineral	Reserves	District	Related Major Industry
Coal	~ 1200 million tons	Tinsukia, Dibrugarh, Karbi Anglong, North Cachar	-
Granite	~ 950 million cubic metres	Nagaon, Karbi Anglong, Kamrup, Goalpara	Road making, Railway ballast
Limestone	~ 670 million tons	North Cachar, Karbi Anglong	Cement, iron-steel production, chemical industries raw material
China clay	-	Karbi Anglong	Ceramic
Glass sand	~ 10.5 million tons	Nagaon, Karbi Anglong	Glass
Iron ore	-	Dhubri, Goalpara	Iron & steel
Sillimanite	-	Karbi Anglong	Glass
Oil & Natural Gas	-	Jorhat, Dibrugarh	POL

Industrial Snapshot

The key districts in the catch of Brahmaputra in Assam are Dhubri, Barpata, Goalpara, Kamrup, Darrang, Morigaon, Nagaon, Sonitpur, Golaghat, Jorhat, Lakhimpur, Dhemaji, Sivasagar, Dibrugarh, Tinsukhia, Cachar and Bongaigaon. The major industries are across sectors such as tea processing, oil refineries & petrochemicals, cement and asbestos, chemicals and fertilizers, pulp and paper, food processing, beverage and confectionary, jute based herbal medicine and cosmetics, silk, plastic processing, polyester and acrylic yarn, induction furnace, steel re-rolling mills, iron pipes, metallurgical coke, calcinated petroleum coke and engineering goods based.

The major districts and industries across the catchment are summarised in the following table.

Table 119: Major Industries in Assam

Area	Commodity	Major Industries
Dhubri	Safety Matches	Wimco Limited
Guwahati	POL	Indian Oil Corporation
	Carbon	India Carbon, Assam Carbon
	Fertilizers	Fertichem, Assam State Fertilizers & Chemicals Ltd. (ASFC)
	Yarn	Goenka Woollen Mills
Darrang	Tea	Tata Tea, George Williamson, AFT Industries, Tezpore Tea Corporation, Goodricke Tea
	Yarn	Prag Bosini Synthetics
	Food Processing	Sunanda Ram Food, SRD Nutrients, Trinity Fructa
Morigaon	Textiles	Assam Spun Silk Mills, Assam Polytex
Nagaon	Tea	Tata Tea, Assam Corporation, Jayshree Tea & Industries
	Jute	Assam Co-operative Jute Mills
Sonitpur	Tea	McLeod Russell India
	Paper	Star Paper & Board Mills, Brahmaputra Paper
Numaligarh	POL	Numaligarh Oil Refinery
Jorhat	Tea	Assam Corporation, B & A Plantations & Industries, Jayashree Tea
Lakhmipur	Tea	Bengal Tea & Fabrics
Sivasagar	Tea	Tata Tea, McLeod Russell India, Assam Corporation, Dhunseri Tea & Industries,
	POL	ONGC
Dibrugarh	Tea	Brooke Bond Lipton Tea, Tata Tea, George Williamson, Bishnauth Tea, AFT Industries, Andrew & Yule
	POL	Oil India, Assam Gas Company
	Power	NEEPCO, Namrup Thermal Power Station
Tinsukhia	POL	IOCL
Cachar	Tea	Dhunseri Tea & Industries, Bengal Tea, Jayashree Tea

District-wise Industrial Profile

Dubri District is situated in west south corner of Assam with area of 1,664 sq km. It has no large scale industries / public sector undertakings in the district available. Medium and small scale enterprises are also not available in the district. There are no exportable items. The relevant industries in Dhubri district are mentioned in the following table.

Table 120: Major Industries in Dhubri District, Assam

Location	Major Industries	Product	Turnover (In INR Cr)
Dhubri	Wimco Ltd.	Safety Matches	46.2

Kamrup District is situated in western side of Assam with Guwahati as headquarters. Kamrup district agro-climatically falls in Lower Brahmaputra valley zone with area of 4,345 sq km. It has large scale industries/public sector undertakings in the district available. Medium and small scale enterprises are available in the district. The major exportable items are tea, silk and handloom. The relevant industries in Kamrup district are mentioned in the following table.

Table 121: Major Industries in Kamrup District, Assam

Location	Major Industries	Product
Guwahati	Indian Oil Corporation Ltd.	Petroleum/Petrochemical
Duliajan	Oil India Ltd.	Petroleum/Petrochemical
Guwahati	India Carbon Ltd.	Carbon
Guwahati	Assam Carbon Ltd.	Carbon
Guwahati	Fertichem Ltd.	Fertilizers
Guwahati	Assam State Fertilizers & Chemicals Ltd. (ASFC)	Fertilizers
Chandrapur	National Textiles Corporation	Textiles
Guwahati	STAFED	Vanaspati Ghee
Rangia	Assam Polyster Co-op. Society	PV Yarn
Guwahati	Goenka Woollen Mills	Woollen Yarn

Darrang District is situated in central part of Assam with an area of 1,851 sq km. It has presence of large scale industries tea processing units in the district. There is presence of medium and small scale enterprises in the district. There are no exportable items. The relevant industries in Darrang district are mentioned in the following table.

Table 122: Major Industries in Darrang District, Assam

Major Industries	Product	Turnover (In INR Cr)
Tata Tea	Tea	24
George Williamson	Tea	13.2
AFT Industries	Tea	84
Tezpore Tea Corp.	Tea	37.8
Goodricke Tea	Tea	19.7
Goodricke Tea	Tea	17.6
Prag Bosini Synthetics	PF Yarn	46.2
Assam Cotton Mills	Textiles	-
Sunanda Ram Food Pvt. Ltd.	Food Processing Units	-
SRD Nutrients Pvt. Ltd.	Food Processing Units	-
Trinity Fructa Ltd.	Food Processing Units	-

Morigaon District is bounded by the mighty Brahmaputra with area of 1,450 sq km. It has presence of large scale industries / public sector undertakings in the district. Medium and small scale enterprises are also available in the district. There are no major exportable items. The relevant industries in Morigaon district are mentioned in the following table.

Table 123: Major Industries in Morigaon District, Assam

Major Industries	Product	Turnover (In INR Cr)
Hindustan Paper Corp.	Paper	386
Assam Spun Silk Mills	Textiles	-
Assam Polytex Ltd.	PV Yarn	-

Nagaon District is situated in the very heartland of Assam with area of 3,993 sq km. It has presence of large scale industries / public sector undertakings in the district. Medium and small scale enterprises are also present in the district. The major exportable items are jute and tea. The relevant industries in Nagaon district are mentioned in the following table.

Table 124: Major Industries in Nagaon District, Asam

Major Industries	Product	Turnover (In INR Cr)
Tata Tea	Tea	24
Assam Corp.	Tea	117.6
Jayshree Tea & Industries	Tea	121.8
Assam Co-operative Jute Mills Ltd.	Jute	-

Sonitpur District is spread on northern bank of the river Brahmaputra of Assam with area of 5,324 sq km. It has no large scale industries / public sector undertakings in the district available. Medium and small scale enterprises are also present in the district. There are minor exportable items like tea and paper. The relevant industries in Sonitpur district are mentioned in the following table.

Table 125: Major Industries in Sonitpur District, Assam

Location	Major Industries	Product	Turnover (In INR Cr)
Sonitpur	McLeod Russell India	Tea	168
Tinmila	Star Paper & Board Mills	Paper	-
Kaliabhomora	Brahmaputra Paper Pvt. Ltd.	Paper	-

Golaghat District is surrounded by the river Brahmaputra of Assam with area of 3,502 sq km. It has a large scale industries/public sector undertaking in the district available. Medium and small scale enterprises are also present in the district. There are major exportable item is Tea. The relevant industries in Golaghat district are mentioned in the following table.

Table 126: Major Industries in Golaghat District, Assam

Location	Major Industries	Product
Numaligarh	Numaligarh Oil Refinery	Petroleum/Petrochemical

Jorhat District is located between the river Brahmaputra on the North and Nagaland on the South with an area of 2,851 sq km. It has large scale industries / public sector undertakings in the district available. Medium and small scale enterprises are also present in the district. The major exportable item is tea. The relevant industries in Jorhat district are mentioned in the following table.

Table 127: Major Industries in Jorhat District, Assam

Major Industries	Product	Turnover (In INR Cr)
Assam Corp.	Tea	117.6
B&A Plantations & Industries	Tea	23.5
Jayashree Tea & Industries	Tea & Plywood, Boards	121.8

Lakhimpur District is located on east of Assam, with an area of 2,277 sq km. It has no large scale industries / public sector undertakings in the district available. Medium and small scale enterprises are also present in the district. The minor exportable item is tea. The relevant industries in Lakhimpur district are mentioned in the following table.

Table 128: Major Industries in Lakhmipur District, Assam

Major Industries	Product	Turnover (In INR Cr)
Bengal Tea & Fabrics	Tea	26.9

Sivasagar District is located on the east of Assam with an area of 2,668 sq km. It has large scale industries / public sector undertakings in the district available. Medium and small scale enterprises are also present in the district. The minor exportable item is Tea. The relevant industries in Sivasagar district are mentioned in the following table.

Table 129: Major Industries in Sivasagar District, Assam

Major Industries	Product	Turnover (In INR Cr)
Tata Tea	Tea	24
McLeod Russell India	Tea	168
Assam Corp.	Tea	117.6
Dhunseri Tea & Industries	Tea	42
Bengal Tea & Fabrics	Tea	26.9
Jayashree Tea & Industries	Tea	121.8
Oil & Natural Gas Corp. (ONGC)	Petroleum/Petrochemical	1399
Jayashree Tea & Industries	Plywood & Boards	121.8

Dibrugarh District is from the North Bank of the mighty Brahmaputra with an area of 3,381 sq km. It has large scale industries / public sector undertakings in the district available. Medium and small scale enterprises are also present in the district. Dibrugarh District has major deposits of Petroleum (Crude), Coal and Natural Gas. The minor exportable item is tea. The relevant industries in Dibrugarh district are mentioned in the following table.

Table 130: Major Industries in Dibrugarh District, Assam

Major Industries	Product	Turnover (In INR Cr)
Brooke Bond Lipton Tea	Tea	462

Major Industries	Product	Turnover (In INR Cr)
Tata Tea	Tea	24
George Williamson	Tea	13.2
Bishnauth Tea Corp.	Tea	12
AFT Industries	Tea	84
Jayashree Tea & Industries	Tea	121.8
Oil India Ltd.	Petroleum / Petrochemical	-
Assam Petrochemicals Ltd.	Methanol, Formalin	50
Sarada Plywood	Plywood & Boards	-
Hindustan Fertiliser Corp.	Fertilisers	71.4
Brahmaputra Gas Cracker & Polymer Ltd.	PF Yarn	-
Brahmaputra Valley Fertiliser Ltd.	Fertilisers	-
Assam Gas Company Ltd.	Petroleum / Petrochemical	-
Andrew & Yule Ltd.	Tea	-
North Eastern Electrical Power Corp. Ltd.	Power	-
Namrup Thermal Power Station	Power	-

Tinsukhia District is located on east of Assam with an area of 3,790 sq km. It has a large scale industries / public sector undertakings in the district available. Medium and small scale enterprises are not present in the district. The relevant industries in Tinsukhia district are mentioned in the following table.

Table 131: Major Industries in Tinsukhia District, Assam

Major Industries	Product	Turnover (In INR Cr)
Indian Oil Corp. Ltd. (IOCL)	Petroleum/Petrochemical	2520

Cachar District is located on south of Assam with an area of 3,786 sq km. It has no large scale industries / public sector undertaking in the district available. Medium and small scale enterprises are present in the district. The major exportable item is tea. The relevant industries in Cachar district are mentioned in the following table.

Table 132: Major Industries in Cachar District, Assam

Major Industries	Product	Turnover (In INR Cr)
Dhunseri Tea & Industries	Tea	42
Bengal Tea & Fabrics	Tea	26.9
Jayashree Tea & Industries	Tea, Plywood & Boards	121.8
Hindustan Paper Corp.	Paper	386

Bongaigaon District is located in lower-western parts of Assam with an area of 1,725 sq km. It has no large scale industries/public sector undertaking in the district available. Medium and small scale enterprises are present in the district. The major exportable item is Calcinated Petroleum Coke (CPC). The relevant industries in Bongaigaon district are mentioned in the following table.

Table 133: Major Industries in Bongaigaon District, Assam

Major Industries	Product
Ashok Paper Milll	Paper
Brahmaputra Carbon Ltd.	Carbon

3) Tripura

Mineral Reserves

Tripura is rich in mineral resources such as hard rock, limestone, clay and glass sand. The details of mineral reserves are shown in the following table.

Table 134: Mineral Reserves in Tripura[101]

Mineral	Reserves	Area	Related Major Industry
Hard Rock	-	Jampui Hills, Longatari Hill	Road making, Railway ballast
Limestone	9,90,000 tons	Sakhan & Jampui Range, Manpui	Cement, iron-steel production, chemical industries raw material
Clay	1.73 million tons	Mohanpur, Kamalghat, Bisramganj, Champamura, Kumarghat, Sonamura	Ceramic
Glass sand	3,62,832 tons	Bisramganj, Jogendranagar, Sekerkota, Dasharambar, Mohanpur	Glass

Industrial Snapshot

The major industries in Tripura are concentrated in Agartala and Palatana. The key industries in these regions are as provided in the following table.

Table 135: Major Industries in Tripura

Area	Commodity	Major Industries
Agartala	Oil & Natural Gas	GAIL, Tripura Natural Gas Company Limited
	Coal	North Eastern Electric Power Corporation Limited (NEEPCO)
	Tea	Tripura Tea Development Corporation Limited
	Cement	Camellia Group, Star Cement, ICORE Super Cement Pvt. Ltd.
	Steel	Baba Steel, DS Group, Tripura ISPAT
Palatana	Natural Gas	ONGC

4) Meghalaya

Mineral Reserves

Meghalaya is rich in mineral resources such as limestone, coal, clay, iron ore and uranium. The details of mineral reserves are shown in the following table.

[101] Tripura State Pollution Control Board

Table 136: Mineral Reserves in Meghalaya[102]

Mineral	Reserves	Area	Related Major Industry
Limestone	15,100 million tons	Cherrapunjee, Mawlong, Ishamati,Shella, Komorrah, Borsora, Bagli in Khasi Hills District, Lakadong, Lumshonong, Nongkhlieh in Jaintia Hills District, Darrang Era-Aning, Siju and Chokpot in Garo Hills District	Cement, iron-steel production, chemical industries raw material
Coal	576.5 million tons	Langrin and East Darrangiri in Khasi Hills District, Bapung in Jaintia Hills District and West Darranggiri in Garo Hills District	Power
Clay	97 million tons	Cherrapunjee and Mahadek in Khasi Hills District, Tongseng in Jaintia Hills District, Nangwalbibra and Rongrenggiri in Garo Hills District	Ceramic
Iron Ore	3.6 million tons	West Khasi Hills and East Garo Hills District	Iron & steel
Uranium	9 million tons	Domiasiat village in West Khasi Hills	Nuclear

Industrial Snapshot

The major industries in Meghalaya are concentrated in Garo Hills, Jantia Hills, Khasi Hills and Byrnihat. The key industries in these regions are as provided in the following table.

Table 137: Major Industries in Meghalaya[103]

Area	Commodity	Major Industries
Garo Hills, Jantia Hills	Thermal Power Plant	DS Group, NEEPCO, Adhunik Cement Limited, Jud Cements Private Limited, Meghalaya Power Limited
Jantia Hills	Cement	Adhunik Cement Limited, Jud Cements Private Limited, Cement Manufacturing Company Limited, Green Valley Industries Limited, Meghalaya Cements Limited, Hills Cement, Star Cement
Khasi Hills	Ferro Alloy	Meghalaya Ferrous Limited
Byrnihat	Iron & Steel	Greystone Ispat, Maithan Smelters, Byrnihat Ispat, Gita Ferro Alloys, Adhunik Meghalaya Steels, Commercial Iron & Steel, Meghalaya Steels

5) Mizoram

Mineral Reserves

Mizoram is rich in mineral resources such as coal, limestone, building material, gas & oil, clay and bamboo. The details of mineral reserves are shown in the following table.

Table 138: Mineral Reserves in Mizoram[104]

Mineral	Area	Related Major Industry
Coal	Chubel village	Power
Limestone	Muthi village, Kwarte Thanwveng, Sesawang village, Nghrum Lui, Laipui Tlang	Cement
Building Material	Dhaleswari river bed, Hnathial, Theiriat, Lunglai, Rulkual, Thingfal, Vanhni, Mante	Construction
Gas and Oil	Sabual village	
Clay	Borai village, Plura village	Ceramic
Bamboo	Tlawng, Tut, Teirei, Lang-kaih, Barak rivers	Furniture

[102] Government of Meghalaya, Department of Mining & Geology; Centre for Science and Environment
[103] Meghalaya State Pollution Control Board, Meghalaya Directorate of Industries
[104] NEDFi Databank, Natural Resources Atlas of Mizoram

Industrial Snapshot

The major industries in Mizoram are concentrated in Mendipur, Aizawl and Shillong. The key industries in these regions are as provided in the following table.

Table 139: Major Industries in Mizoram

Area	Major Industrial Zone	Product
Mendipur HFO	Thermal Power Plant	Power (24 MW Capacity)
Aizawl	Iron & Steel	Mizoram ISPAT, UBC Precision Bearing Manufacturing
Shillong	Cement	Star Cement

6) Manipur

Mineral Reserves

Manipur is rich in mineral resources such as limestone, chromite, lignite, asbestos, chromites, copper, nickel and salt. The details of mineral reserves are shown in the following table.

Table 140: Mineral Reserves in Manipur[105]

Mineral	Area	Related Major Industry
Limestone	Ukhrul, Hungdung, Khangoi, Lambui, New Paoyi, Narum, Shokvao	Cement
Chromite	Ukhrul, Gamnom, Moreh	Metal
Lignite	Kangvai, Kanvai village	Petrochemical & Chemical
Asbestos	Nepali basti, Kwatha, Moreh	Construction
Chromites	Shiroi Hill, Ukhrul, Napali Basti	Metal
Copper	Nigthi, Kwatha, Humie	Metal
Nickel	Manbashi, Kwatha	Electronics
Salt	Waikhong, Sikhong, Chandrakhong, Keithel Manbi	Food Processing

Industrial Snapshot

The major industries in Manipur are concentrated in Nilakuthi, Moreh, Khunuta Chingjin Lamlai Napet and Leimakhong The key industries in these regions are as provided in the following table.

Table 141: Major Industries in Manipur

Area	Major Industrial Zone	Product
Nilakuthi	Nilakuthi Food Park	Food processing Industry
Moreh	Integrated Infrastructural Development Project (IID), Trade Centres	-
Khunuta Chingjin	Export Promotion Industrial Park (EPIP)	-
Lamlai Napet	Industrial Growth Centre	-
Leimakhong	Thermal Power Plant	Power (18 MW Capacity)

7) Bangladesh

[105] Department of Commerce and Industries, Government of Manipur; State Profile of Manipur, Development Commissioner (MSME)

People's Republic of Bangladesh shares large borders with India and a southern strip with Myanmar. Bangladesh is home to the Ganges, the Brahmaputra and the Meghna rivers and networks of smaller rivers and canals. A total population of ~ 155 million and land area of 1,47,570 sq km, much of the economy is rural and agricultural based. Bangladesh's alluvial soil is highly fertile but vulnerable to flood and draught.

Table 142: Geographical Characteristics of Bangladesh

Total area (sq km)	1,43,998
Land area (sq km)	1,30,168
Water area (sq km)	13,830
Land boundaries (km)	4,413
Coastline length (km)	580

The rivers of Bangladesh mark both the physiography of the nation and the life of the people. ~700 in number, these rivers generally flow south. The larger rivers serve as the main source of water for cultivation and as the principal arteries of commercial transportation. Rivers also provide fish, an important source of protein. Flooding of the rivers during the monsoon season causes enormous hardship and hinders development, but fresh deposits of rich silt replenish the fertile but overworked soil. The rivers also drain excess monsoon rainfall into the Bay of Bengal.

Mineral Reserves

Bangladesh is rich in natural gas, coal, limestone, hardrock, gravel, boulder, glass sand etc. Primary crops are rice, jute, maize and vegetables. The details of mineral reserves in Bangladesh are shown in the following table.

Table 143: Mineral Reserves in Bangladesh

Mineral	Reserves	Administrative Division	Related Major Industry
Natural Gas	~ 21.05 trillion cubic feet	Barisal, Sylhet, Chittagong	Power sector, Fertilizer,
Coal	1882 million tons	Barisal, Rangpur	Power sector, Brickfields
Limestone	~ 100 million tons	Nagaon, Karbi Anglong, Kamrup, Goalpara, Rajshahi	-
Hardrock	-	Rangpur	Construction Materials
Peat	170 million tons	Khulna, Dhaka	Brickfields, Boilers, Domestic purposes
Metallic Minerals, Construction Sand	-	Chittagong, Barisal	Construction Industry
Gravel	~ 10 million cubic metre	-	-
Glass Sand	~ 109 million tons	Sylhet, Rangpur	Glass Industry

Industrial Snapshot

The major industries in Bangladesh are concentrated in Gazipur, Dhaka (Narayanganj district) and Khulna cluster. The key industries in these regions are as provided in the following table.

Table 144: Major Industries in Bangladesh

Area	Commodity	Major Industries
Gazipur	Cement	Seven Circle (Bangaldesh)
	Ceramics	Standard Ceramic Industries
	Textile	Fortuna Group, Starlight Sweaters, Viyellatex Group
Dhaka	Cement	Akij Cement Factory, Holcim Cement Bangladesh, Lafarge Surma Cement, Premier Cement
	Ceramics	Peoples Ceramic Industries

Area	Commodity	Major Industries
	Textile	R,K.Group of industries, Suad Garments Industries, Modele De Capital Industries
	Urea, Fertilizers	Urea Fertilizer Factory, Polash Urea Fertilizer Factory, Karnaphuli Fertilizer Company Ltd. (KAFCO)
Khulna	Cement	Akij Cement Factory, Holcim Cement Bangladesh, Meghna Cement Mills
	Steel	Koreshi Steel Industries
	Textile	Peoples Jute Mills, Star Jute Mills
	Boards, Arts & Crafts Business	Khulna Hard Board Mills
Sylhet	Cement	Chhatak Cement Company Ltd. (Assam Bengal Cement Company)
	Fertilizer	Natural Gas Fertilizer Factory Limited

According to the Total Transport System Study Report (2014) by erstwhile Planning Commission of India, the modal split of the transit traffic movement for each commodity is shown in the following table.

Table 145: Modal Split of commodities for transit movement

Commodity	Arunachal Pradesh		Assam		Manipur		Meghalaya		Mizoram		Nagaland		Tripura	
	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road
Rice	0%	100%	64%	36%	0%	100%	0%	100%	7%	93%	46%	54%	48%	52%
Wheat & Other Foodgrains	0%	100%	68%	32%	0%	100%	0%	100%	10%	90%	71%	29%	76%	24%
Sugar	0%	100%	58%	42%	0%	100%	0%	100%	100%	0%	55%	45%	73%	27%
Iron & Steel	0%	100%	20%	80%	0%	100%	0%	100%	0%	100%	0%	100%	0%	100%
ODC	0%	100%	0%	100%	0%	100%	0%	100%	0%	100%	0%	100%	0%	100%
Limestone	0%	100%	15%	85%			0%	100%					35%	65%
Tea	0%	100%												
Forest Products	0%	100%												

Annexure B – Site Images

KOLKATA PORT

HALDIA PORT

SONAKHALI, SUNDERBANS (passenger & commodity movement)

GODKHALI, SUNDERBANS (passenger & commodity movement)

HEMNAGAR TERMINAL

SURVEY LOCATIONS, SUNDERBANS WATERWAYS

ANNEXURE C – Classification of Waterways

The Inland waterways in India are classified into seven categories for rivers as well as canals as per the 'The Inland Waterways Authority of India Act, 1985' for safe plying of self-propelled vessels upto 2,000 dead weight tonnage(DWT) and tug-barge formation in push-tow units of carrying capacity upto 8,000 tons. The classification of waterways is discussed in the following table.

Table 146: Classification of Inland Waterways for rivers

S.No.	Class of Waterways	Minimum Depth (m)	Bottom Width (m)	Bend Radius (m)	Vertical Clearance (m)	Horizontal Clearance (m)
1.	Class I	1.2	30	300	4	30
2.	Class II	1.4	40	500	5	40
3.	Class III	1.7	50	700	7	50
4.	Class IV	2.0	50	800	10	50
5.	Class V	2.0	80	800	10	80
6.	Class VI	2.75	80	900	10	80
7.	Class VII	2.75	100	900	10	100

This classification shall be effective only if:

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.
c) Reference level for vertical clearance in different types of channel shall be:
   i. For rivers, over Navigational High Flood Level (NHFL), which is the highest flood level at a frequency of 5% in any year over a period of last twenty years.
   ii. For tidal canals, over the highest high water level.
   iii. For other canals, over designed full supply level.

Type of vessels that can be used in different classes of waterways as per 'The Inland Waterways Authority of India Act, 1985' is shown in the following table.

Table 147: Types of vessels to be used in different Class waterways

Class of Waterways	Self-propelled Vessel	Tug with barges
Class I	Carrying capacity -100DWT (Size - 32m LOA, 5m moulded breadth and 1m loaded draft)	1 Tug + 2 barges – 200DWT (Size – 80m LOA, 5m moulded breadth and 1m loaded draft)
Class II	Carrying capacity -300DWT (Size - 45m LOA, 8m moulded breadth and 1.2m loaded draft)	1 Tug + 2 barges – 600DWT (Size – 110m LOA, 8m moulded breadth and 1.2m loaded draft)
Class III	Carrying capacity -500DWT (Size - 58m LOA, 9m moulded breadth and 1.5m loaded draft)	1 Tug + 2 barges – 1000DWT (Size – 141m LOA, 9m moulded breadth and 1.5m loaded draft)
Class IV	Carrying capacity -1000DWT (Size - 70m LOA, 12m moulded breadth and 1.8m loaded draft)	1 Tug + 2 barges – 2000DWT (Size – 170m LOA, 12m moulded breadth and 1.8m loaded draft)
Class V	Carrying capacity -1000DWT (Size - 70m LOA, 12m moulded breadth and 1.8m loaded draft)	1 Tug + 4 barges – 4000DWT (Size – 170m LOA, 24m moulded breadth and 1.8m loaded draft)
Class VI	Carrying capacity -2000DWT	1 Tug + 2 barges – 4000DWT

Class VII	(Size - 86m LOA, 14m moulded breadth and 2.5m loaded draft) Carrying capacity -2000DWT (Size - 86m LOA, 14m moulded breadth and 2.5m loaded draft)	(Size – 210m LOA, 14m moulded breadth and 2.5m loaded draft) 1 Tug + 4 barges – 8000DWT and above (Size – 210m LOA, 28m moulded breadth and 2.5m loaded draft or with higher dimensions)

All new structures to be constructed across the national waterways classified under these regulations shall confirm to the respective criteria of horizontal and vertical clearances of the appropriate class of waterway as provided.

PIANC Guidelines

The Classification of European Inland Waterways are a set of standards for interoperability of large navigable waterways forming part of the Trans-European Inland Waterway network within Continental Europe and Russia. PIANC inland waterways are shown in the following table.

Table 148: PIANC Inland Waterways Classification

Classification	Tonnage (t)	Length (m)	Breadth (m)	Draught (m)	Air Draft (m)	Notes
RA		5.5	2.00	0.50	2.00	"Open boat"
RB		9.5	3.00	1.00	3.25	Cabin cruiser
RC		15.0	4.00	1.50	4.00	"Motor yacht"
RD		15.0	4.00	2.10	30.00	"Sailing boat"
I	250–400	38.5	5.05	1.80–2.20	3.70	"Péniche"
II	400–650	50.0–55.0	6.60	2.50	3.70–4.70	Euro-barge
III	650–1,000	67.0–80.0	8.20	2.50	4.70	"Gustav Koenigs"
IV	1,000–1,500	80.0–85.0	9.50	2.50	4.50; 6.70	"Johann Welker"
Va	1,500–3,000	95.0–110.0	11.40	2.50–4.50	4.95; 6.70; 8.80	"Large Rhine"
Vb	3,200–6,000	172.0–185.0	11.40	2.50–4.50	4.95; 6,70; 8,80	1×2 convoy
Via	3,200–6,000	95.0–110.0	22.80	2.50–4.50	6.70; 8.80	2×1 convoy
VIb	6,400–12,000	185.0–195.0	22.80	2.50–4.50	6.70; 8.80	2×2 convoy
Vic	9,600–18,000	270–280	22.80	2.50–4.50	8.80	2×3 convoy
	9,600–18,000	195–200	33.00–34.20	2.50–4.50	8.80	3×2 convoy
VII	14,500–27,000	285	33.00–34.20	2.50–4.50	8.80	3×3 convoy

The standards were extended with four smaller sizes RA–RD covering recreational craft, which had originally been developed and proposed via PIANC.

ANNEXURE D – BIWTA Tariff Sheet and Barge Economics

Schedule-1			
S. no.	**Description**	**Measurement unit**	**Rates**
01 (Pg 1)	**Conservancy charge**		
	All Barge/ Dump Ferry/Flat	Annual Per Gross ton(Regn.)	34.50
	All Self-Propelled Vessel (Cargo/ Bulk Head/ Fishing Boat/ Fishing Trolled/ Ro Ro Ferry	Annual Per Gross ton(Regn.)	45.00
	All Tug	Annual Per Gross ton(Regn.)	51.75
	Dredger (Sand Excavation and Removal)	Annual Per Gross ton(Regn.)	57.50
	All Passenger Ship / Launch	Annual Per Passenger	100.00
	All Passenger Ship and operated troller (Applicable only for Mawa and Charjanajat Port)	Annual Per Passenger	115.00
	Speed Boat	Annual Per Passenger	414.00
	Towards Foreign Flag Bering ship		
	1) Tug/ Barge/ Cargo Vessels (Under Navy Protocol tariff following Bilateral/ Trilateral agreement)	Annual Per Gross ton(Regn.)	172.50
	2) Passenger Vessels (Under Navy Protocol tariff following Bilateral/ Trilateral agreement)	Annual Per Passenger(Regn.)	172.50
02 (Pg 1)	**Pilotage Fees: (Under Navy Protocol tariff following Bilateral/ Trilateral agreement)**	**Per cycle every time (Per 8 hrs or part thereafter is one bit)**	**400.00**
03 (Pg 2)	**Applicable fee in Port area**		
	1) Terminal Building Ticket	Terminal Building Entry Per head each time Dhaka (Entry Fee 3.00 Taka Passenger welfare fund 2.00 Taka)	5.00
		Barisal, Chandpur, Khulna, Narayan Ganj, Narsingdi and Pataua kahli river Ports	5.00
	2) Bhawan Class or Temporary Tin shed building Terminal	Terminal Building Entry Per head (Aricha, Mawa, Ashuganj, Bhairab Bazar, Daulatdia, Nogorbari, Tokhi, Bhola , Borguna, Cox's bazaar, Charjanajat, Meghnaghat, Mirkadim, Chhatak, Ghorashal, Faridpur and other river ports	4.00
	3) Eco Park A) Whichever Eco park not having Rides facilities	Terminal Building Entry Per head each time	6.00
	B) Whichever Eco park having Rides facilities	Terminal Building Entry Per head each time	20.00
	4) Pagla VIP Jetty	Terminal Building Entry Per head each time	5.00
04 (Pg 2)	**Landing and Shipping Charge along with Throughput charge**	**Cargo Loading/ unloading in port area for (incoming and outgoing) purpose every MT or part thereafter each time**	**34.50**
05 (Pg 2)	**Berthing charge:**		
A)	**Domestic Vessels**		
1)	Cargo Hauling capacity upto 50 maund/ 1.866 ton	Berthing each time not exceeding one day (Berthing time as per port authority regulations)	11.50

2)	Cargo Hauling capacity between 50 maund upto 100 maund/ 1.866 ton upto 3.732 ton	-do-	17.25
3)	Cargo Hauling capacity between 100 maund upto 200 maund/ 3.732 ton upto 7.464 ton	-do-	28.75
4)	Cargo Hauling capacity between 200 maund upto 500 maund/ 7.464 ton upto 18.660 ton	-do-	34.50
5)	Cargo Hauling capacity between 500 maund upto 1000 maund/ 18.660 ton upto 37.320 ton	-do-	46.00
6)	Cargo Hauling capacity greater than 1000 maund/37.320 ton	-do-	57.00
B)	Passenger Vessels (Launch/ Steamer)		
1)	Dhaka and Barishal River Port	Every 50-passenger vehicle capacity or thereafter. For Each time berthing, provided not more than a day, berthing charges applicable after commencement of trip (Berthing time as per port authority regulations)	14.00
2	Chandpur River Port	-do-	14.00
3	Pataua kahli River Port	-do-	13.00
4	Khulna River Port	-do-	13.00
5	Narayanganj River Port	-do-	13.00
6	Aricha River Port	-do-	13.00
7	Daulatdia, Nogorbari, Narshingdi, Baghabadi, Ghorashal, Faridpur and other river Ports	-do-	13.00
8	Mawa-charanajat River Port a) Launch/ Steamer	Every 50-passenger vehicle capacity or thereafter. One berthing charge applicable for one terminal from 1-24 hrs. Provided not more than a day, berthing charges applicable after commencement of trip (Berthing time as per port authority regulations)	13.00
	b) Speed Boat	Every 15-passenger vehicle capacity or thereafter. Berthing charges applicable on every departure. Berthing time as per port authority regulations	75.00
	c) Engine controlled Troller	Every 15-passenger vehicle capacity or thereafter. Berthing charges applicable on every departure. Berthing time as per port authority regulations	20.00
C)	**Cargo Vessels (Barge, Flat, Coasters, Tanker or ferry etc.**	**Provided not more than a day, berthing charges applicable after commencement of trip (Berthing time as per port authority regulations)**	
1	Cargo Hauling Capacity upto 50 ton	-do-	125.00
2	Cargo Hauling Capacity 51- 100 ton	-do-	150.00
3	Cargo Hauling Capacity 101- 250 ton	-do-	175.00
4	Cargo Hauling Capacity 251- 500 ton	-do-	200.00
5	Cargo Hauling Capacity 501- 750 ton	-do-	240.00
6	Cargo Hauling Capacity 751- 1000 ton	-do-	315.00
7	Cargo Hauling Capacity 1001- 1500 ton	-do-	400.00
8	Cargo Hauling Capacity 1501- 2000 ton	-do-	565.00
9	Cargo Hauling Capacity 2001- 2500 ton	-do-	850.00
10	Cargo Hauling Capacity 2501- 3000 ton	-do-	1125.00
11	Cargo Hauling Capacity greater than 3001 ton	-do-	1690.00
06 (Pg 4)	**Storage Charge: (Coast/ Foreshore/ Port area goods storage.) Dhaka, Narayan Ganj, Taki and Ghorachal river port**		
a)	Covered	Every sqm or thereafter or every day or part thereafter.	5.75
	Uncovered		3.45
b)	Terminal building area rent	Every sqm or thereafter or every month.	172.50
c)	Go down rent	-do-	86.25

d)	Floating(for Pontoon) rent	-do-	115.00
07 (Pg 4)	**Storage Charge: Coast/ Foreshore/ Port area goods storage.) All other river ports.**		
a)	Covered	Every sqm or thereafter or every day or part thereafter.	4.60
	Uncovered		2.30
b)	Terminal building area rent	Every sqm or thereafter or every month.	92.00
c)	Go down rent	-do-	57.50
d)	Floating (for Pontoon) rent	-do-	86.25
08 (Pg 5)	**Applicable charges in Ferry Terminal**		
a)	Bus, Truck, Mini Truck, Covered Van, Troller, Tank lorry, Mini Bus, Micro Bus (Greater than 10 seaters.)	For every entry (For every terminal entry for one can stay for a minimum of 24 hrs, overstay shall pay the same amount)	58.00
b)	Microbus (Less than 10 seat),Station wagon, Jeep, Car etc.	For every entry (For every terminal entry for one can stay for a minimum of 24 hrs, overstay shall pay the same amount)	30.00
c)	Tempo/CNG operated Auto and Autobike etc.	-do-	23.00
d)	Van, Motorcycle etc.	-do-	12.00
09 (Pg 5)	**Driver Rest Area charges (Aricha, Nogorbadi, Daulatdia and other river port)**	**Per seat per day (24 hrs and thereafter**	**23.00**
10 (Pg 5)	**Road Charge (Applicable for every river port)**		
a)	5 ton and above carrying capacity Truck, bus, covered van, troller, trailer or lorry.	Port road usage every time within area	
	Loaded	-do-	46.00
	Empty	-do-	23.00
b)	Below 5 ton carrying capacity Truck, microbus and covered van.		
	Loaded	-do-	35.00
	Empty	-do-	12.00
c)	Minibus, car, Jeep, Pickup, Station Wagon, three-wheeler, and other motorable cargo vehicles	-do-	12.00
d)	Cart		
	Loaded	Port road usage every time within area	12.00
	Empty	-do-	6.00
11 (Pg 5)	**Train, forklift usage charges**		
a)	Train (Excluding Maintanence and operation cost	Every hour or part thereafter	287.50
b)	Forklift (Excluding Maintanence and operation cost	-do-	184.00
	Schedule- 2		
3 (Pg 12)	**Landing and Shipping Charges**		
a)	Goat and Sheep	Per item every time	7.00
b)	Cattle	-do-	17.00
c)	Rest of animals	-do-	17.00
d)	Birds	-do-	2.00
e)	Truck, Bus, Mini Bus, Station Wagon, Covered Van	-do-	35.00
f)	Car, jeep, Pickup, Microbus	-do-	17.00
g)	Tempo, Baby taxi(CNG), Motor Cycle	-do-	10.00
h)	Cycle	-do-	2.00
i)	All Substance whose measurement is fixed as Sqft and Sqm	Per Sqft / Sqm or part thereafter	0.25 per Sqft 8.92 per Sqm
04 (Pg 12)	**Coolie/ labour charges for Goods Loading/ unloading Sadarghat Terminal Bhawan area**		
a.)	All type of Luggage/ baggage from Road upto launch/ Steamer or from launch/ Steamer to road on back, on head, hand applicable per coolie/ labour/Porter	Not Exceeding 10 kg	12.00
		Not Exceeding 20 kg	23.00
		Not Exceeding 30 kg	35.00
		Not Exceeding 40 kg	35.00

		(1 bag)	
		Not Exceeding 40kg (2bag)	46.00
		Not Exceeding 60kg (1 bag)	46.00
		Not Exceeding 60kg (2 bag)	58.00
b)	Steel/ Wooden Almirah	Per (Maximum weight 100 kg)	115.00
c)	Cloth Bundle	a) Per 50 kg	58.00
		b) Above 50 kg per 20 kg	12.00
d)	Wood/ Steel Bed	per	115.00
e)	Wood/ Steel/bamboo table/ chair	per	23.00
f)	Fridge(All make)	per	58.00
g)	TV(All make)	per	58.00
h)	Hardware Goods/ other goods(Cartoon/ Packet/basket)	Applicable for Cartoon/ Packet/basket) for every 50 kg	46.00
i)	Motorcycle	per	29.00
j)	Bicycle	per	23.00
k)	Ceiling fan/ table fan/ other items	per	23.00
l)	Computer (all make)	per	35.00
7.	**Wayside Launch Station and coastal offshore Ghat/terminal/ jetty**		
3.(Pg 17)	**Berthing Charge (Wayside launch Ghat and coastal/ offshore island etc.)**		
a)	**Domestic Boats**		
1	Cargo Hauling Capacity upto 5 ton	**Berthing charges Each time Provided not more than a day, applicable (Berthing time as per port authority regulations)**	5.00
2	Cargo Hauling Capacity 5- 10 ton	-do-	6.00
3	Cargo Hauling Capacity 10- 25 ton	-do-	10.00
4	Cargo Hauling Capacity 25- 50 ton	-do-	20.00
5	Cargo Hauling Capacity greater than 50 ton	-do-	30.00
b)	Passenger Boats (Launch/ Steamer)	Every 50-passenger vehicle capacity or thereafter. Berthing charges applicable on every departure. (Berthing time as per port authority regulations)	10.00
c)	Cargo Vessels (Barge, Flat, Coasters, Tanker etc.	Applicable every 50 ton or part thereafter, Berthing charges applicable after each time, provided not more than a day (Berthing time as per port authority regulations)	15.00

Annexure E – Environmental Screening

The Indian Sunderbans Delta (ISD) is part of the delta of the Ganga-Brahmaputra-Meghna basin in Asia. The Sunderbans is a natural region comprising southern Bangladesh and a part in the Indian state of West Bengal. It is the largest single block of tidal halophytic mangrove forest in the world encompassing ~10,000 sq km. The Sunderbans is a national park, tiger Reserve, and a biosphere reserve in West Bengal and is situated in the Sunderbans mangrove forests on the Ganga delta.

Development activities in the Sunderbans Bio reserve area falls under the jurisdiction of Sundarban Affair Department (SAD). Constituted in 1994, SAD promotes social, economic, and cultural advancement of people residing in the Sunderbans area of the districts of North & South 24 Parganas, co-ordinates development schemes and projects in the area, provides infrastructural facilities through improvement of rural communication, water resources, preservation of ecological balance, provides facilities for the development of the agriculture including minor irrigation and drainage system and allied matters. The Sundarban Development Board (SDB) is the executing arm of SAD and implements development activities.

Coastal Regulation Zone

The Ministry of Environment and Forests (MoEF) issued the Coastal Regulation Zone (CRZ) in 1991 under the Environment (Protection) Act, 1986, with the aim to provide comprehensive measures for the protection and conservation of our coastal environment. In 2011, a new CRZ Notification was issued to include CRZ-IV, which includes the water areas upto the territorial waters and the tidal influenced water bodies.

Costal Regulation Zone applies to the land area from High Tide Line (HTL) to 500 m on the landward side along the sea front. The entire water area which includes 12 nautical miles in the sea and the entire water area of a tidal water body such as creek, river, estuary will be regulated by the Notification. With the aim of conserving the coastal areas and marine waters, the CRZ in India has been classified into 4 categories, viz., CRZ-I, CRZ-II, CRZ-III, CRZ-IV and Special Category.

CRZ-I: Ecologically sensitive areas like mangroves, corals, sand dunes etc. and the areas between Low Tide Line (LTL) and High Tide Line (HTL)
CRZ-II: Built up area (areas that have been developed upto or close to the shoreline)
CRZ-III: Rural Area (areas that are relatively undisturbed and those do not belong to either CRZ-I or II)
CRZ-IV: Water Area (water area from the Low Tide Line to twelve nautical miles on the seaward side)
Special Category: Critically Vulnerable Coastal Areas (CVCA)[106] and CRZ areas of Greater Mumbai, Kerala and Goa

The details of the CRZ classification are as follows:

CRZ-I

I. The areas that are ecologically sensitive and the geomorphological features which play a role in the maintaining the integrity of the coast
   - Mangroves, in case mangrove area is more than 1000 sq mts, a buffer of 50 meters along the mangroves shall be provided
   - Corals and coral reefs and associated biodiversity
   - Sand Dunes
   - Mudflats which are biologically active
   - National parks, marine parks, sanctuaries, reserve forests, wildlife habitats and other protected areas under the provisions of Wild Life (Protection) Act, 1972 (53 of 1972), the Forest (Conservation) Act, 1980 (69 of 1980) or Environment (Protection) Act, 1986 (29 of 1986) including
     - Biosphere Reserves
     - Salt Marshes
     - Turtle nesting grounds
     - Horse shoe crabs habitats
     - Sea grass beds

[106] Areas requiring special consideration for protecting the critical coastal environment and difficulties faced by local communities

- Nesting grounds of birds
- Areas or structures of archaeological importance and heritage sites

II. The area between Low Tide Line and High Tide Line;

CRZ-II
The areas that have been developed upto or close to the shoreline.
Developed area is referred to as that area within the existing municipal limits or in other existing legally designated urban areas which are substantially built-up and has been provided with drainage and approach roads and other infrastructural facilities, such as water supply and sewerage mains.

CRZ-III
Areas that are relatively undisturbed and those do not belong to either CRZ-I or II which include coastal zone in the rural areas (developed and undeveloped) and areas within municipal limits or in other legally designated urban areas, which are not substantially built up.

CRZ-IV

I. The water area from the Low Tide Line to twelve nautical miles on the seaward side
II. It shall include the water area of the tidal influenced water body from the mouth of the water body at the sea upto the influence of tide which is measured as five parts per thousand during the driest season of the year.

Special Category
Areas requiring special consideration for protecting the critical coastal environment and difficulties faced by local communities. These are:

I. CRZ area falling within municipal limits of Greater Mumbai
II. CRZ areas of Kerala including the backwaters and backwater islands
III. CRZ areas of Goa
IV. Critically Vulnerable Coastal Areas (CVCA) such as Sunderbans region of West Bengal and other ecologically sensitive areas identified as under Environment (Protection) Act, 1986 and managed with the involvement of coastal communities including fisher folk

Sunderbans: CRZ-I Category
To protect, conserve and regulate development in Sunderbans region of West Bengal, this region is included in CRZ-I category as it is the mangrove forest in the world. The development or construction activities in Sunderbans region of CRZ-I are regulated by the West Bengal Coastal Zone Management Authority (CZMA) in accordance with the CZR norm. Since, the area of Sunderbans is more than 1,000 sq m, a buffer of 50 m along the mangroves shall be provided as per the CRZ-I norm.

Coastal Zone Management Plan (CZMP) map of Sunderbans
The entire intertidal zone of Suderbans from Kakdwip on west to Barishat on east is subdivided into 3 zones from east to west. Thezse zone are:

- **Eastern Zone**: From mouth of Harinbhanga river to mouth of river Hooghly is the Suderbans delta along the sea. Intertidal zone covers 9,630 sq. km of which 2100 sq. km is mangrove and 4,264 sq.km area has been declared as reserved. Sandy coast are – Halliday, Frazergunge, Bakkhali and Sagar group of tidal shoals with dunes and runnels
- **Central Zone**: River Hooghly has a tidal excursion of 200 kms upstream with 30 sq km Nayachar Island at the mouth of Haldi river. Khejuri and Nijkasba have mangrove patches
- **Western Zone**: This zone has coastal plain with 3 rows of dunes – One from Subernarekha to Junput with beaches of Digha and Shankarpur. From Orissa border Jatranal is the zone of accretion Digha proper is the zone of erosion, east of Mohana to Chandpur village end is a zone of accretion which again is followed by a zone of erosion on the east.
- Gangasagar Island , the Dunes/Runnels, Fraserganj and Digha/Shankarpur area - the portion upto sand dunes in CRZ areas are classified as CRZ-I

Permissible Activities
The activities permissible under CRZ-I are:

1. No new construction shall be permitted in CRZ-I except the following:

- Construction of trans harbour sea link and without affecting the tidal flow of water between LTL and HTL
- Projects relating to Department of Atomic Energy
- Pipelines, conveying systems including transmission lines
- Facilities that are essential for activities permissible under CRZ-I
- Installation of weather radar for monitoring of cyclones movement and prediction by Indian Meteorological Department
- Development of green field airport already approved at only Navi Mumbai

2. Areas between LTL and HTL which are not ecologically sensitive, necessary safety measures will be incorporated while permitting the following:
   - Construction of trans harbour sea links, roads on stilts or pillars without affecting the tidal flow of water
   - Storage of non-hazardous cargo such as edible oil, fertilizers and food grain within notified ports
   - Exploration and extraction of natural gas
   - Construction of dispensaries, schools, public rainshelter, community toilets, bridges, roads, jetties, water supply, drainage, sewerage which are required for traditional inhabitants living within the biosphere reserves after obtaining approval from concerned CZMA
   - Necessary safety measure shall be incorporated while permitting such developmental activities in the area falling in the hazard zone
   - Salt harvesting by solar evaporation of seawater
   - Desalination plants

Sunderbans region has also been declared as a Critically Vulnerable Coastal Areas (CVCA) under the under Environment (Protection) Act, 1986. For the conservation and management of mangroves, needs of local communities an Integrated Management Plans (IMPs) are prepared by the CZMA.

Pollution Control

The CRZ 2011 Notification has listed the following measures to control pollution in coastal areas / coastal waters.

- The disposal of wastes and effluents into coastal waters is a prohibited activity
- The existing practice of discharging untreated waste and effluents to be phased out within a period not exceeding two years
- Dumping of solid waste to be phased out within one year from the commencement of the Notification
- An Action Plan is to prepared for dealing with pollution in coastal areas and waters in a time bound manner
- The Action Plan to be submitted to MoEF which will provide technical and financial assistance

Clearance Procedure

The procedure of obtaining CRZ clearance is as follows:

1. The project authorities shall submit the proposal to the concerned West Bengal CZMA along with the following documents/reports:
   - Form-1 (Annexure-IV of the Notification)
   - Rapid Environment Impact Assessment (EIA) Report including marine and terrestrial EIA. Comprehensive EIA and cumulative studies for port and foreshore projects shall be as per guidelines issued by MoEF from time to time
   - Disaster Management Report and Risk Management Report
   - CRZ map indicating HTL and LTL demarcated by an authorized agency (1:4000 scale)
   - Project layout to be superimposed on the CRZ map
   - The CRZ map to indicate a 7 km radius around the project site
   - The CRZ map to indicate the CRZ-I, II, III and IV areas
   - Mandatory No Objection Certificate (NOC) to be obtained from the concerned Pollution Control Boards or Committees for the projects which envisage discharge of effluents, solid wastes, sewage etc.
2. The CZMA shall examine the above documents in accordance with the approved CZMP and CRZ Notification and make recommendations within a period of 60 days from date of receipt of above document to
   - SEAC or EAC in case of the project attracting EIA Notification, 2006
   - MoEF or West Bengal Government for the project attracting CRZ Notification

3. MoEF or West Bengal Government shall consider such projects based on the recommendations of the concerned CZMA within a period of 60 days
4. The clearance shall be valid for the period of 5 years from the date of issue of such clearance

Post Clearance Mechanism

The post clearance monitoring mechanism is as follows:

- Mandatory submission of half-yearly compliance reports in respect of the terms and conditions stipulated for granting environmental clearance in hard and soft copies to the concerned regulatory authority, on 1st June and 31st December of each calendar year
- All such compliance reports submitted by the project management shall be public documents
- Copies of the same shall be given to any person on application to the concerned regulatory authority

The latest compliance report shall also be displayed on the website of the concerned regulatory authority and shall be valid for the period of 5 years from the date of issue of clearance

ANNEXURE F – Baseline Processing Report

Project information	**Coordinate System**	
Name:	Name:	UTM
Size:	Datum:	WGS 1984
Modified:	Zone:	45 North (87E)
Time zone:	Geoid:	EGM96 (Global)
Reference number:	Vertical datum:	
Description:		

Baseline Processing Report

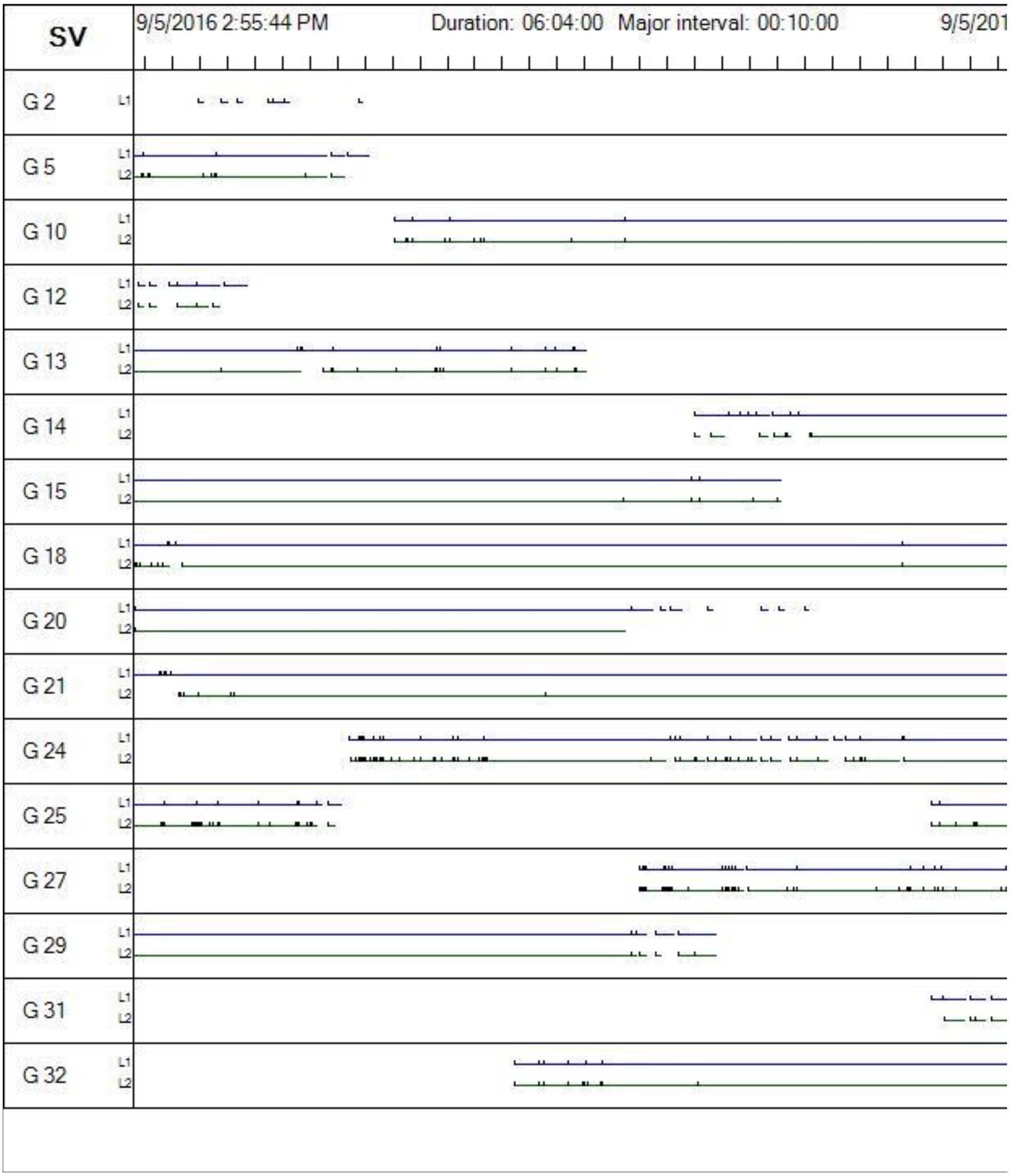
Processing Summary

Observation	From	To	Solution Type	H. Prec. (Meter)	V. Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	Δ Height (Meter)
TBM 1 --- TBM 2	TBM 1 Hemnagar	TBM 2 Choto Bhanshyamnagar	Fixed	0.088	0.085	232° 50'00"	76751.017	-1.375

Acceptance Summary

Processed	Passed	Flag	Fail
1	1	0	0

Tracking Summary



Processing style

Elevation mask:	10.0 deg
Auto start processing:	Yes
Start automatic ID numbering:	AUTO0001
Continuous vectors:	No
Generate residuals:	Yes
Antenna model:	Automatic
Ephemeris type:	Automatic
Frequency:	Multiple Frequencies
Processing Interval:	Use all data
Force float:	No

Acceptance Criteria

Vector Component	Flag	Fail
Horizontal Precision >	0.050 m + 1.000 ppm	0.100 m + 1.000 ppm
Vertical Precision >	0.100 m + 1.000 ppm	0.200 m + 1.000 ppm

1/13/2017 11:08:25 AM		Spectra Precision Survey Office

Project information		Coordinate System	
Name:	C:¥Users¥Admin¥Documents¥Spectra Precision Survey Office¥SUNDERBANS.vce	Name:	UTM
Size:	199 KB	Datum:	WGS 1984
Modified:	1/10/2017 4:16:18 PM (UTC:5)	Zone:	45 North (87E)
Time zone:	India Standard Time	Geoid:	EGM96 (Global)
Reference number:		Vertical datum:	
Description:			

Baseline Processing Report

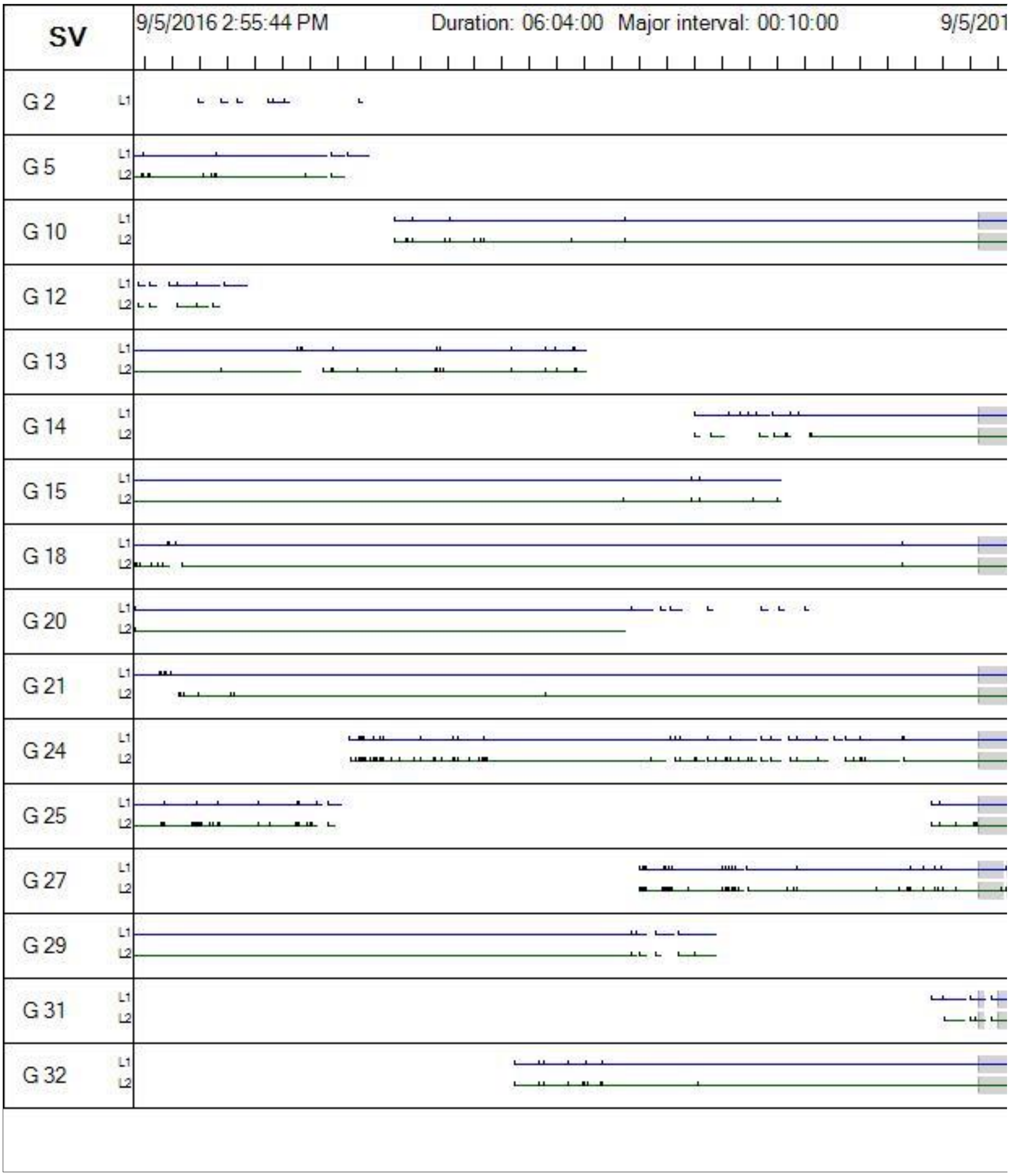
Processing Summary

Observation	From	To	Solution Type	H. Prec. (Meter)	V. Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	Δ Height (Meter)
TBM1 --- TBM2	TBM1-Hemnagar	TBM2-Chota Bhanshyam Nagar	Fixed	0.067	0.127	232° 50'00"	76751.000	-1.449

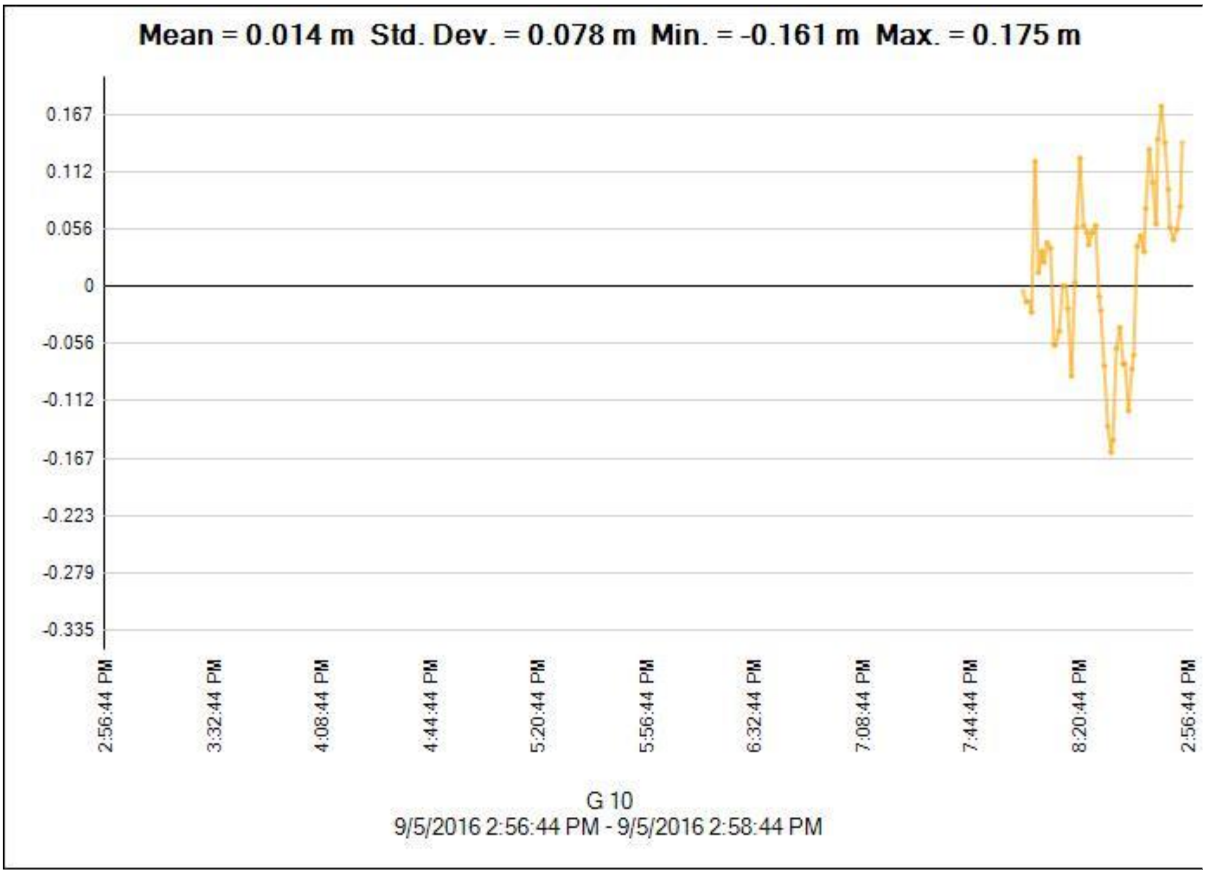
Acceptance Summary

Processed	Passed	Flag	Fail
1	1	0	0

Tracking Summary



Residuals



Mean = 0.014 m Std. Dev. = 0.078 m Min. = -0.161 m Max. = 0.175 m
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0.112
0.056
0
-0.056
-0.112
-0.167
-0.223
-0.279
-0.335
2:56:44 PM
3:32:44 PM
4:08:44 PM
4:44:44 PM
5:20:44 PM
5:56:44 PM
6:32:44 PM
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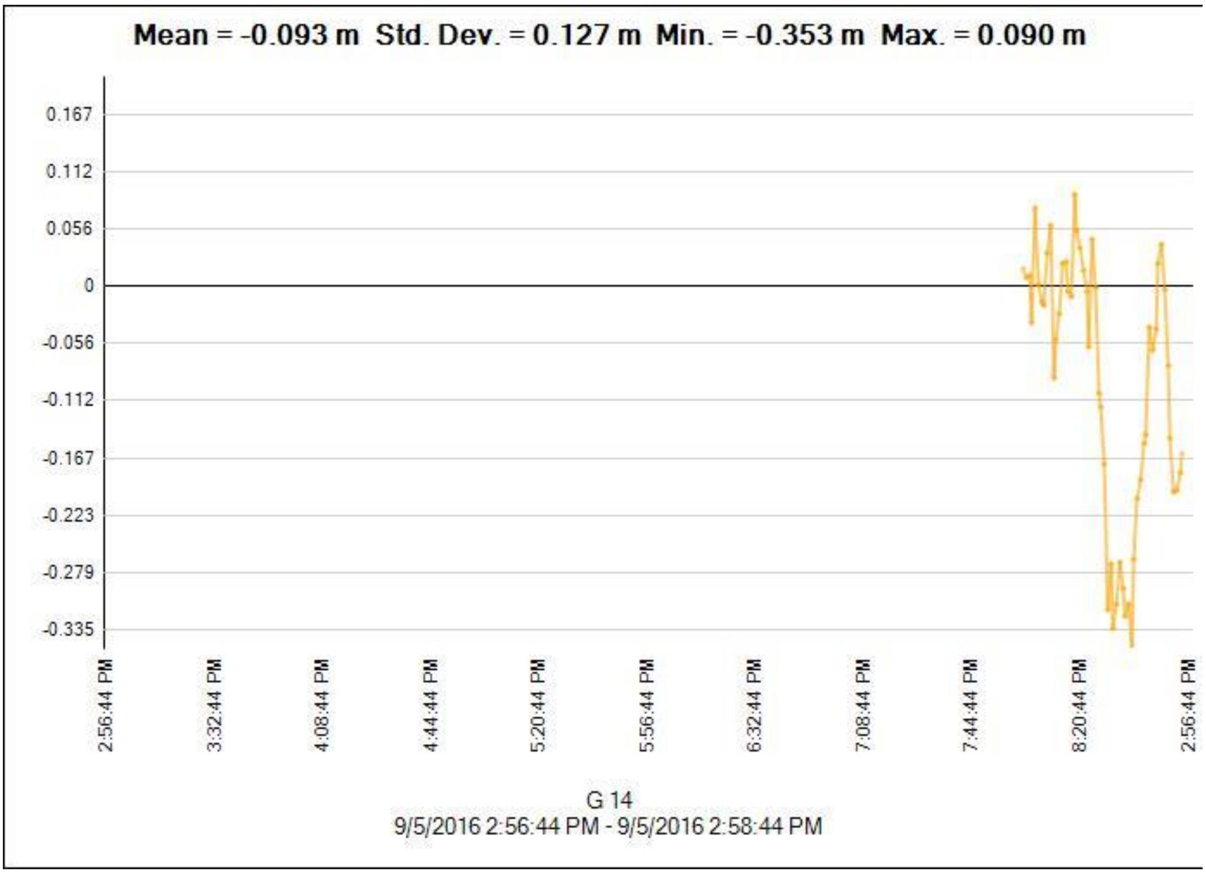
G 10
9/5/2016 2:56:44 PM - 9/5/2016 2:58:44 PM



Mean = -0.093 m Std. Dev. = 0.127 m Min. = -0.353 m Max. = 0.090 m
0.167
0.112
0.056
0
-0.056
-0.112
-0.167
-0.223
-0.279
-0.335
2:56:44 PM
3:32:44 PM
4:08:44 PM
4:44:44 PM
5:20:44 PM
5:56:44 PM
6:32:44 PM
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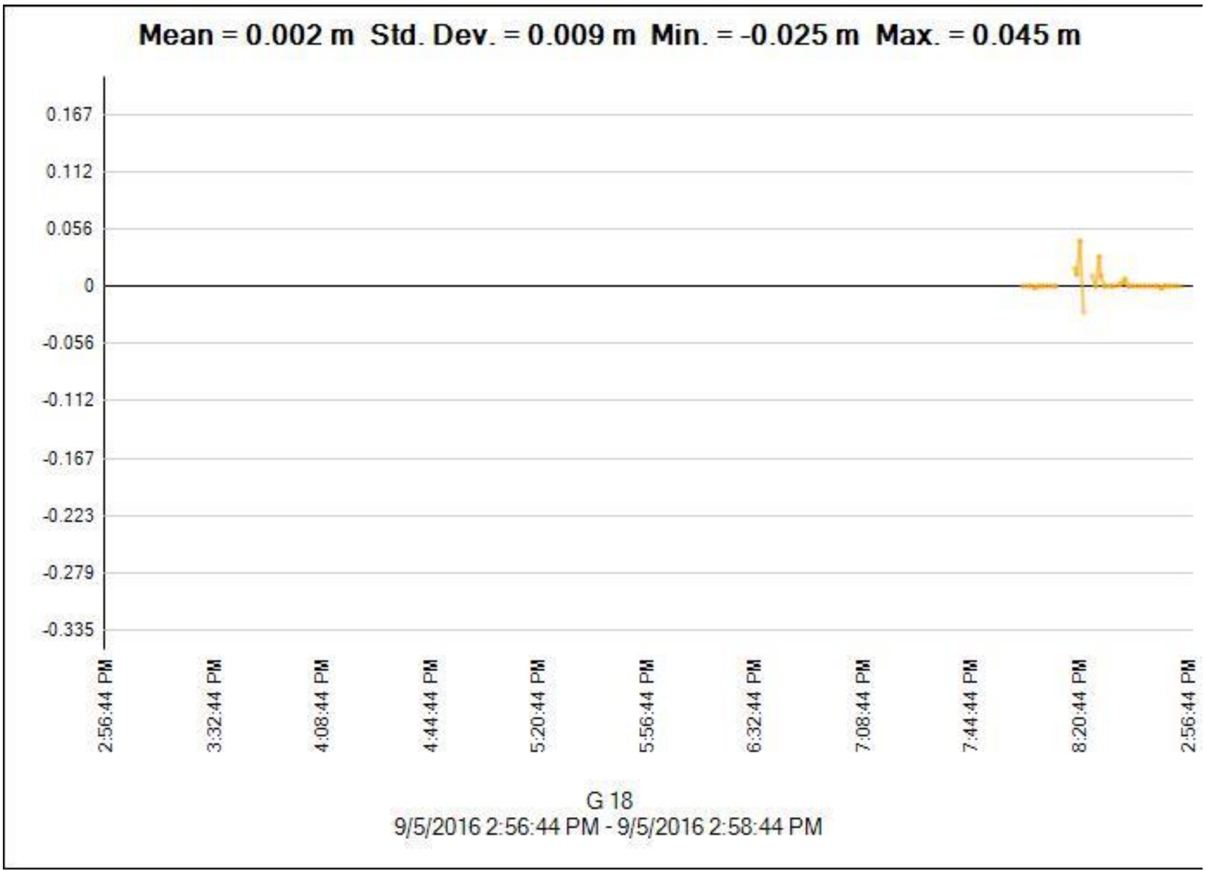
G 14
9/5/2016 2:56:44 PM - 9/5/2016 2:58:44 PM


Mean = 0.002 m Std. Dev. = 0.009 m Min. = -0.025 m Max. = 0.045 m
0.167
0.112
0.056
0
-0.056
-0.112
-0.167
-0.223
-0.279
-0.335
2:56:44 PM
3:32:44 PM
4:08:44 PM
4:44:44 PM
5:20:44 PM
5:56:44 PM
6:32:44 PM
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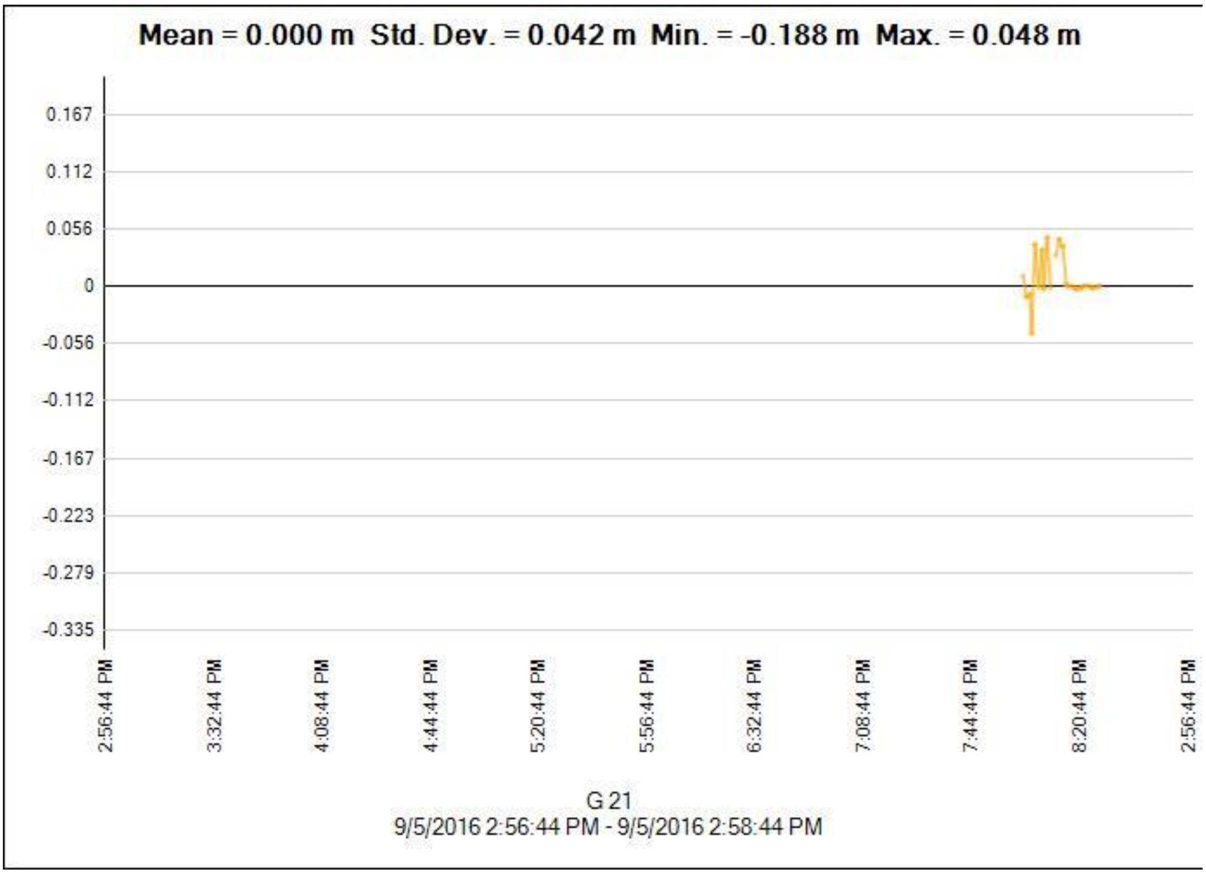
G 18
9/5/2016 2:56:44 PM - 9/5/2016 2:58:44 PM


Mean = 0.000 m Std. Dev. = 0.042 m Min. = -0.188 m Max. = 0.048 m
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0.112
0.056
0
-0.056
-0.112
-0.167
-0.223
-0.279
-0.335
2:56:44 PM
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4:44:44 PM
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6:32:44 PM
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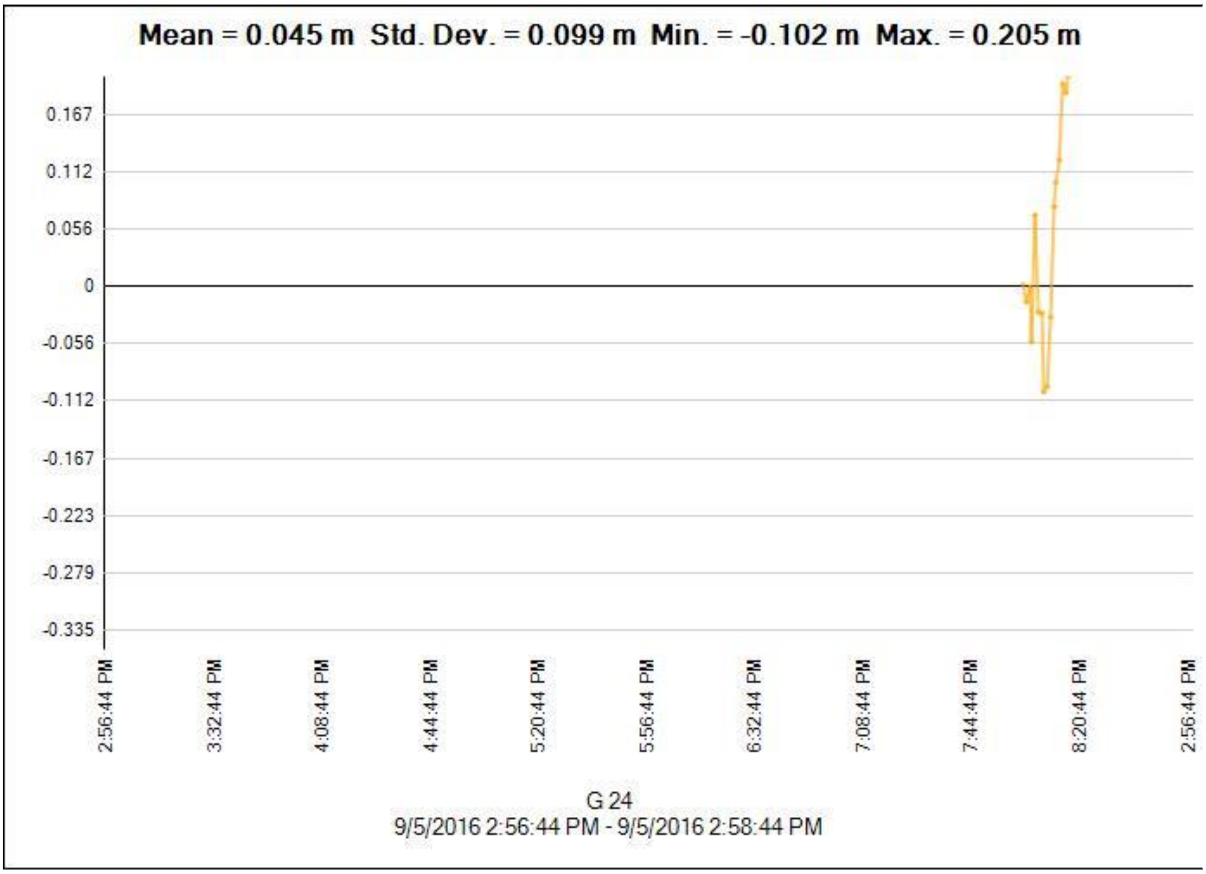
G 21
9/5/2016 2:56:44 PM - 9/5/2016 2:58:44 PM


Mean = 0.045 m Std. Dev. = 0.099 m Min. = -0.102 m Max. = 0.205 m
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0.112
0.056
0
-0.056
-0.112
-0.167
-0.223
-0.279
-0.335
2:56:44 PM
3:32:44 PM
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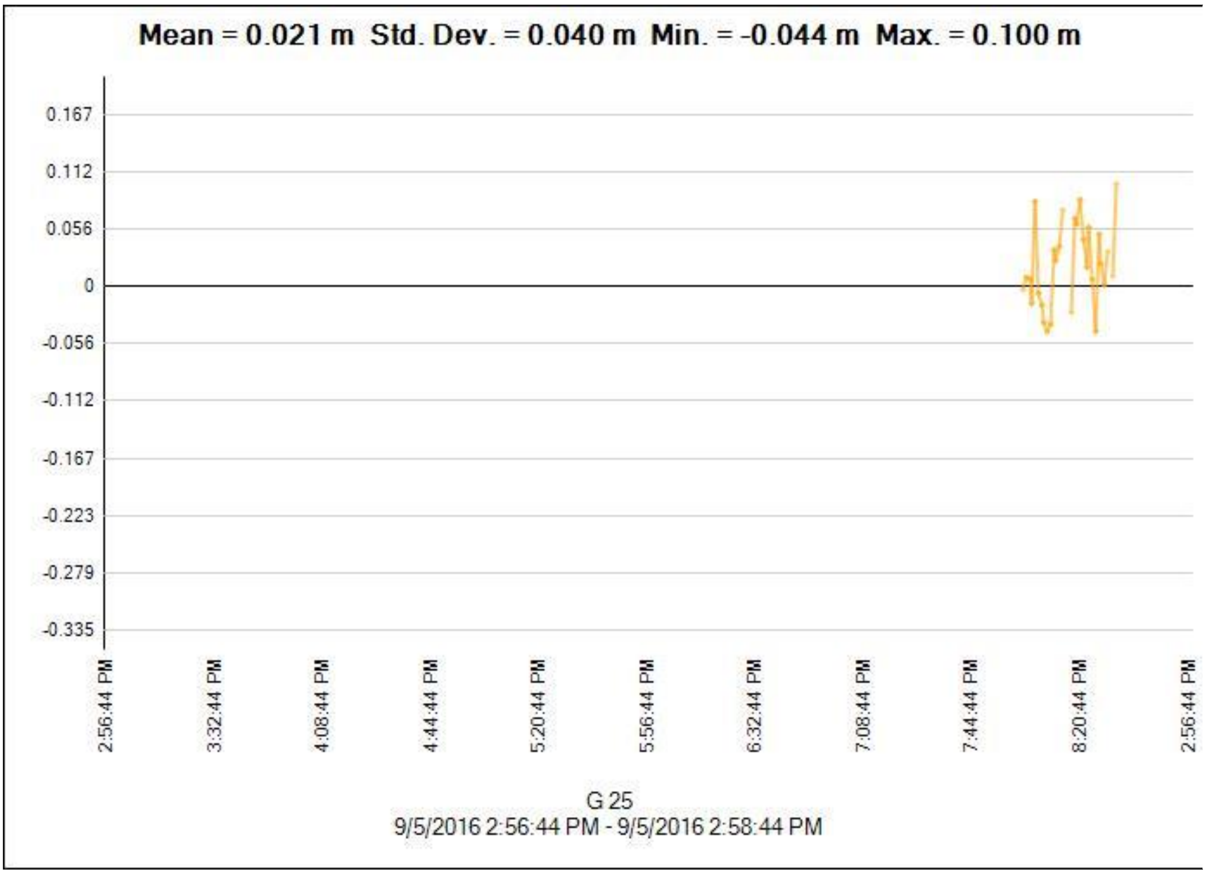
G 24
9/5/2016 2:56:44 PM - 9/5/2016 2:58:44 PM


Mean = 0.021 m Std. Dev. = 0.040 m Min. = -0.044 m Max. = 0.100 m
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0.112
0.056
0
-0.056
-0.112
-0.167
-0.223
-0.279
-0.335
2:56:44 PM
3:32:44 PM
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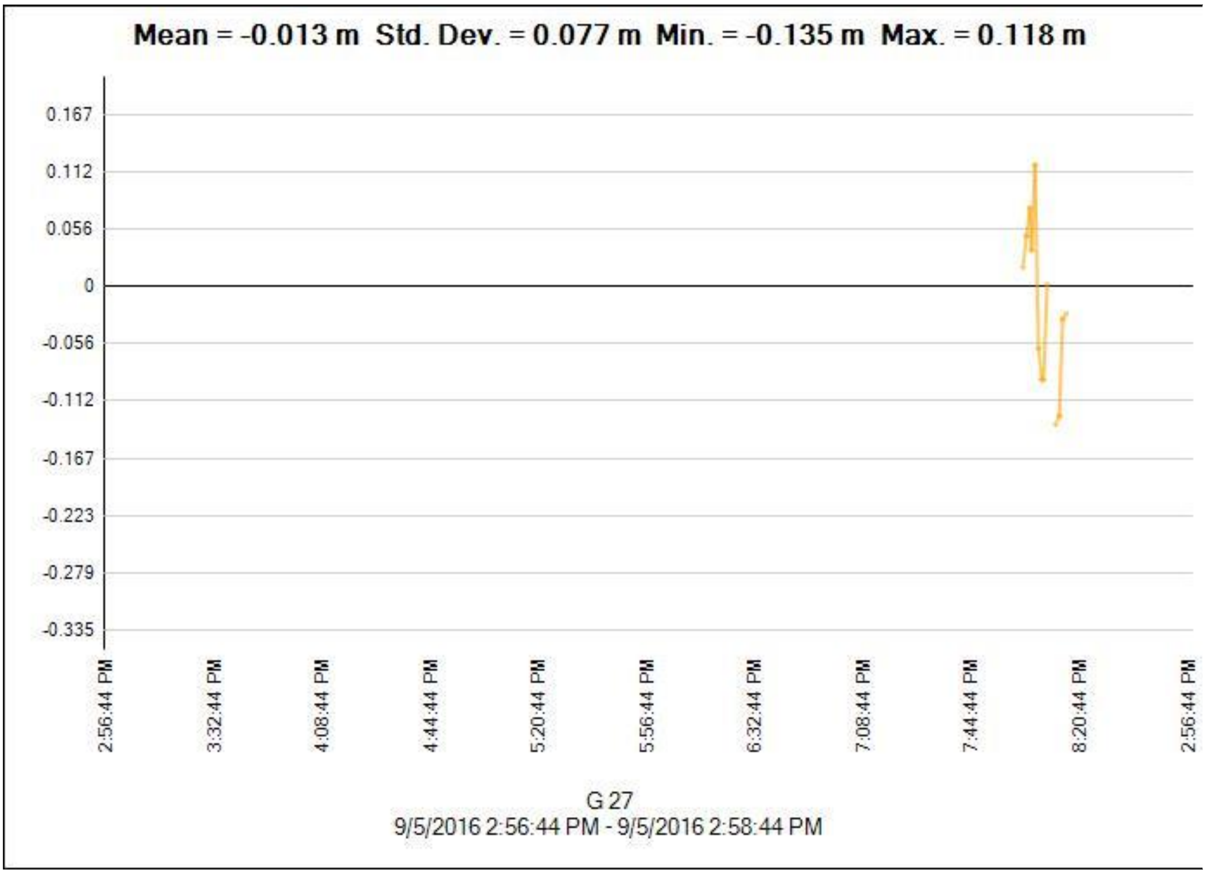
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0.167
0.112
0.056
0
-0.056
-0.112
-0.167
-0.223
-0.279
-0.335
2:56:44 PM
3:32:44 PM
4:08:44 PM
4:44:44 PM
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6:32:44 PM
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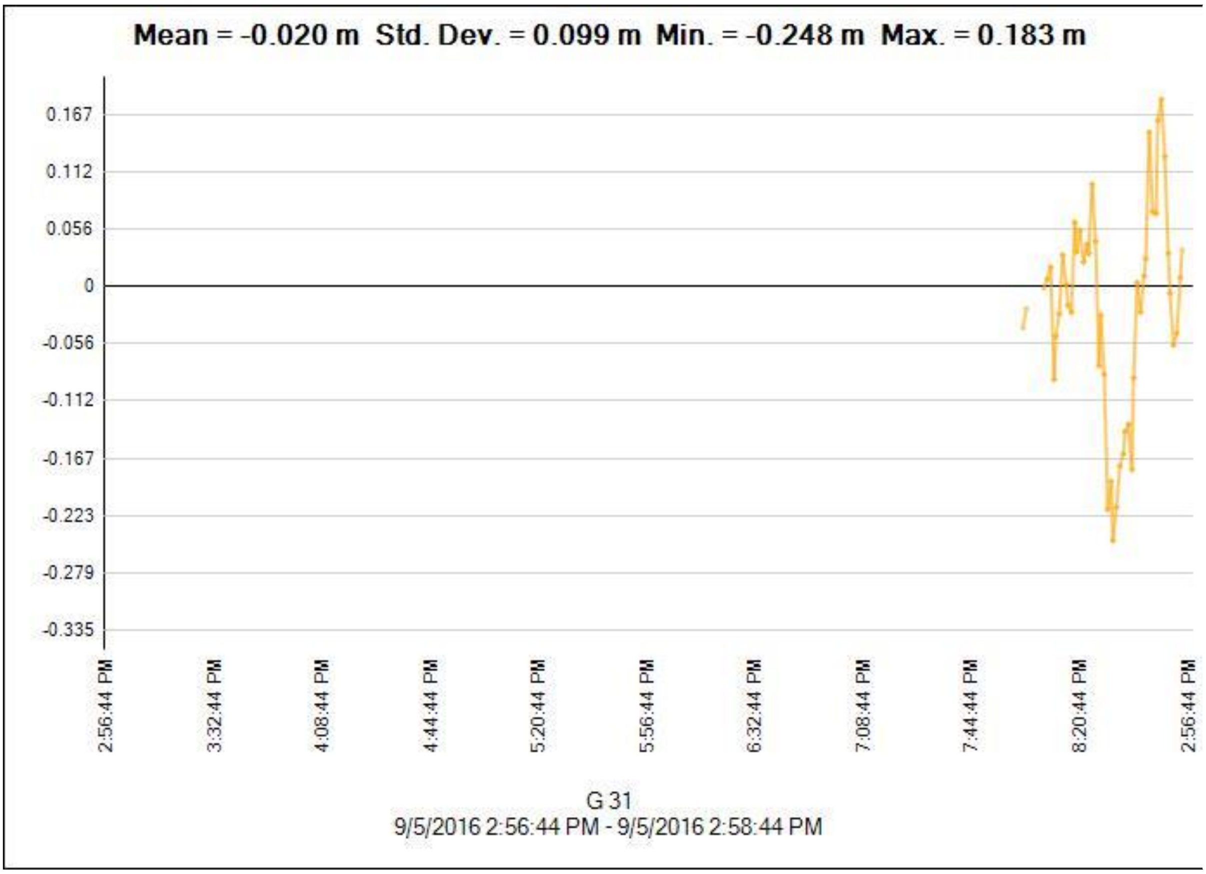
G 27
9/5/2016 2:56:44 PM - 9/5/2016 2:58:44 PM


Mean = -0.020 m Std. Dev. = 0.099 m Min. = -0.248 m Max. = 0.183 m
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0.112
0.056
0
-0.056
-0.112
-0.167
-0.223
-0.279
-0.335
2:56:44 PM
3:32:44 PM
4:08:44 PM
4:44:44 PM
5:20:44 PM
5:56:44 PM
6:32:44 PM
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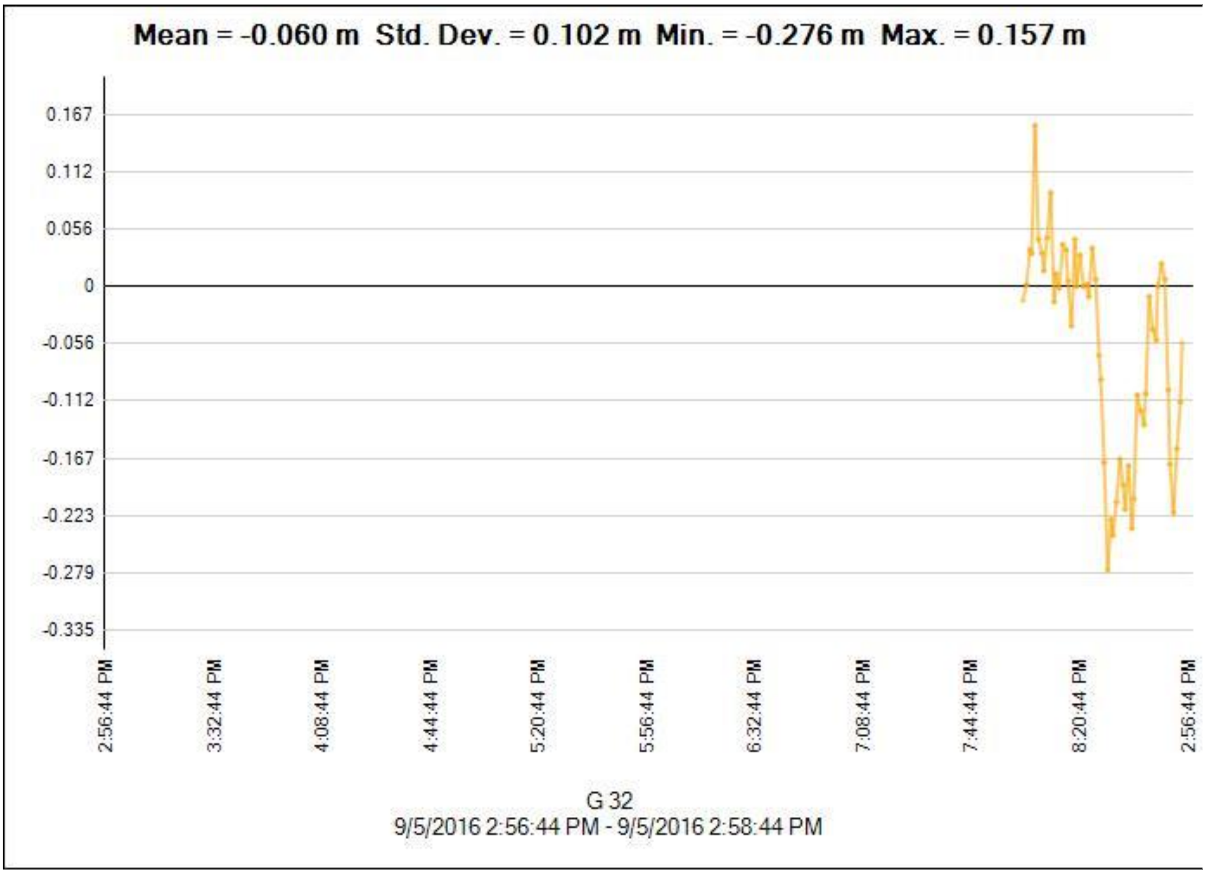
G 31
9/5/2016 2:56:44 PM - 9/5/2016 2:58:44 PM


Mean = -0.060 m Std. Dev. = 0.102 m Min. = -0.276 m Max. = 0.157 m
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0.112
0.056
0
-0.056
-0.112
-0.167
-0.223
-0.279
-0.335
2:56:44 PM
3:32:44 PM
4:08:44 PM
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6:32:44 PM
7:08:44 PM
7:44:44 PM
8:20:44 PM
2:56:44 PM
G 32
9/5/2016 2:56:44 PM - 9/5/2016 2:58:44 PM

Processing style

Elevation mask:	10.0 deg
Auto start processing:	Yes
Start automatic ID numbering:	AUTO0001
Continuous vectors:	No
Generate residuals:	Yes
Antenna model:	Automatic
Ephemeris type:	Automatic
Frequency:	Multiple Frequencies
Processing Interval:	Use all data
Force float:	No

Acceptance Criteria

Vector Component	Flag	Fail
Horizontal Precision >	0.050 m + 1.000 ppm	0.100 m + 1.000 ppm
Vertical Precision >	0.100 m + 1.000 ppm	0.200 m + 1.000 ppm

1/10/2017 3:41:30 PM		Spectra Precision Survey Office

Project information		Coordinate System	
Name:	C:¥Users¥Admin¥Documents¥Spectra Precision Survey Office¥SUNDERBANS.vce	Name:	UTM
		Datum:	WGS 1984
		Zone:	45 North (87E)
Size:	199 KB	Geoid:	EGM96 (Global)
Modified:	1/10/2017 4:16:18 PM (UTC:5)	Vertical datum:	
Time zone:	India Standard Time		
Reference number:			
Description:			

Baseline Processing Report

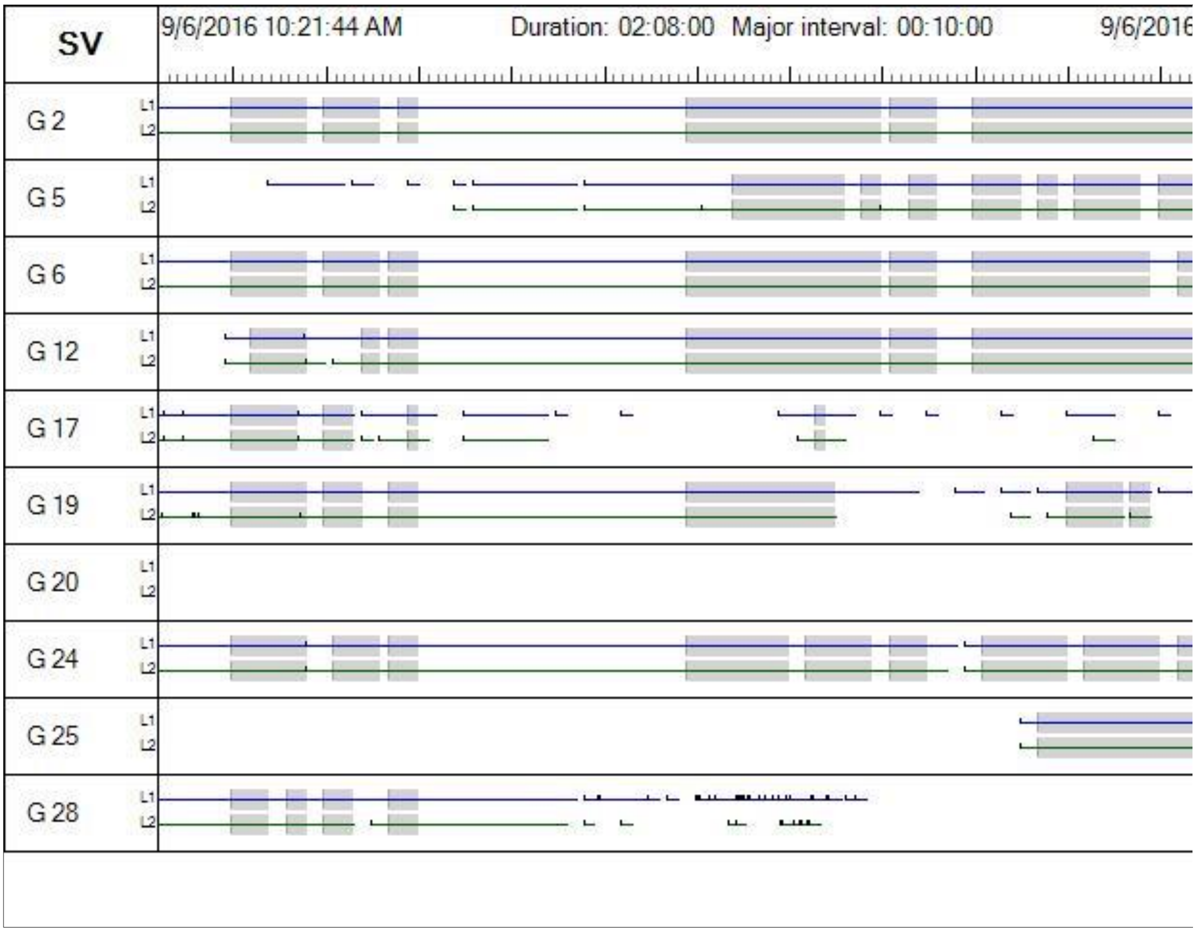
Processing Summary

Observation	From	To	Solution Type	H. Prec. (Meter)	V. Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	Δ Height (Meter)
TBM 3 --- TBM2 (B3)	TBM2	TBM 3	Fixed	0.033	0.119	231° 19'41"	14209.367	-0.822

Acceptance Summary

Processed	Passed	Flag	Fail
1	1	0	0

Tracking Summary



Processing style

Elevation mask:	10.0 deg
Auto start processing:	Yes
Start automatic ID numbering:	AUTO0001
Continuous vectors:	No
Generate residuals:	Yes
Antenna model:	Automatic
Ephemeris type:	Automatic
Frequency:	Multiple Frequencies
Processing Interval:	Use all data
Force float:	No

Acceptance Criteria

Vector Component	Flag	Fail
Horizontal Precision >	0.050 m + 1.000 ppm	0.100 m + 1.000 ppm
Vertical Precision >	0.150 m + 1.000 ppm	0.200 m + 1.000 ppm

1/10/2017 3:52:55 PM		Spectra Precision Survey Office

Project information		Coordinate System	
Name:		Name:	UTM
Size:		Datum:	WGS 1984
Modified:		Zone:	45 North (87E)
Time zone:		Geoid:	EGM96 (Global)
Reference number:		Vertical datum:	
Description:			

Baseline Processing Report

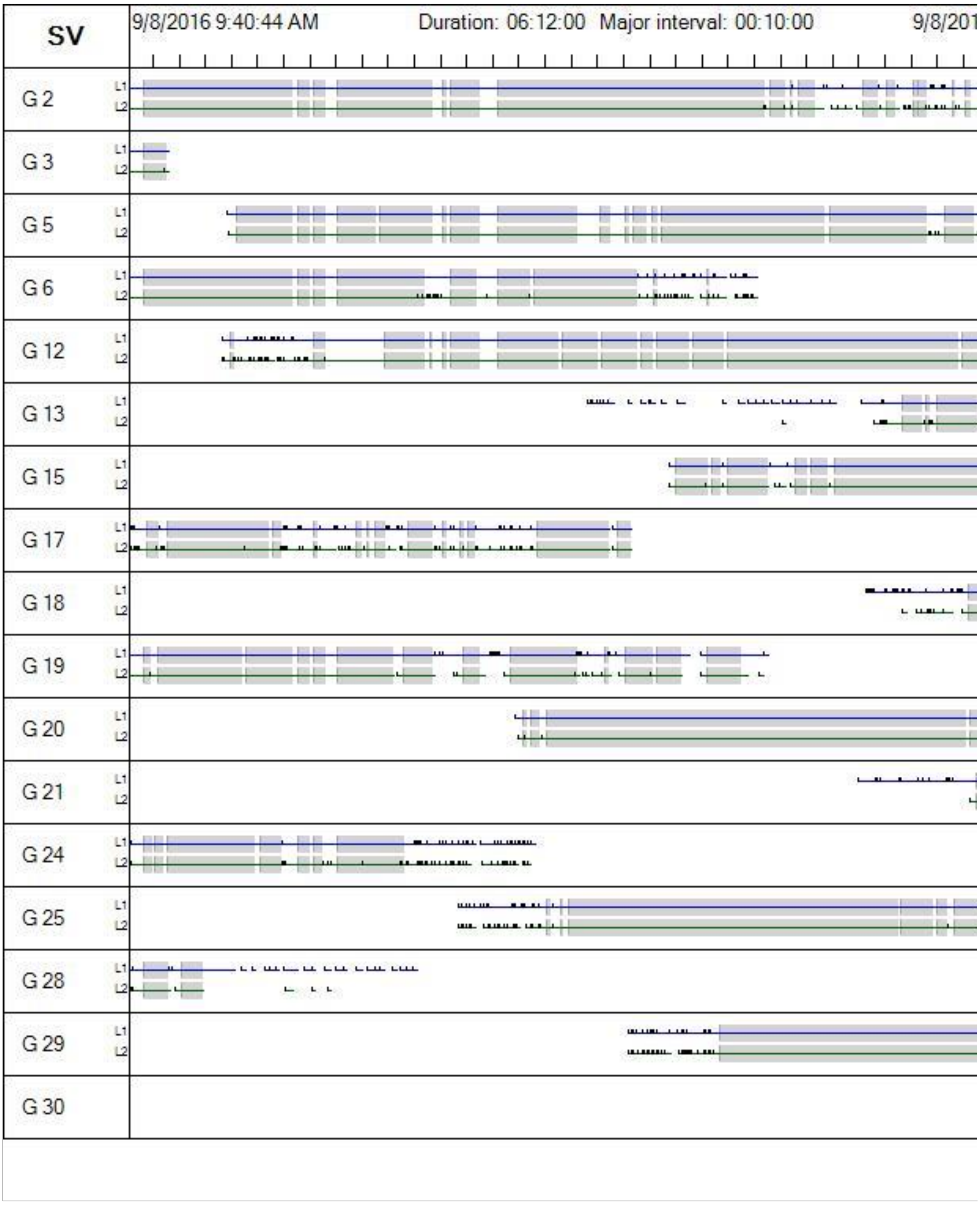
Processing Summary

Observation	From	To	Solution Type	H. Prec. (Meter)	V. Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	Δ Height (Meter)
TBM 1 --- TBM 4 (B4)	TBM 1	TBM 4	Fixed	0.019	0.049	243° 54'34"	3691.297	-0.177

Acceptance Summary

Processed	Passed	Flag	Fail
1	1	0	0

Tracking Summary



Processing style

Elevation mask: 10.0 deg

Auto start processing: Yes

Start automatic ID numbering: AUTO0001

Continuous vectors: No

Generate residuals: Yes

Antenna model: Automatic

Ephemeris type: Automatic

Frequency: Multiple Frequencies

Processing Interval: Use all data

Force float: No

Acceptance Criteria

Vector Component	Flag	Fail
Horizontal Precision >	0.050 m + 1.000 ppm	0.100 m + 1.000 ppm
Vertical Precision >	0.150 m + 1.000 ppm	0.200 m + 1.000 ppm

Project information		Coordinate System	
Name:	C:¥Users¥Admin¥Documents¥Spectra Precision Survey Office¥SUNDERBANS.vce	Name:	UTM
Size:	199 KB	Datum:	WGS 1984
Modified:	1/10/2017 4:16:18 PM (UTC:5)	Zone:	45 North (87E)
Time zone:	India Standard Time	Geoid:	EGM96 (Global)
Reference number:		Vertical datum:	
Description:			

Baseline Processing Report

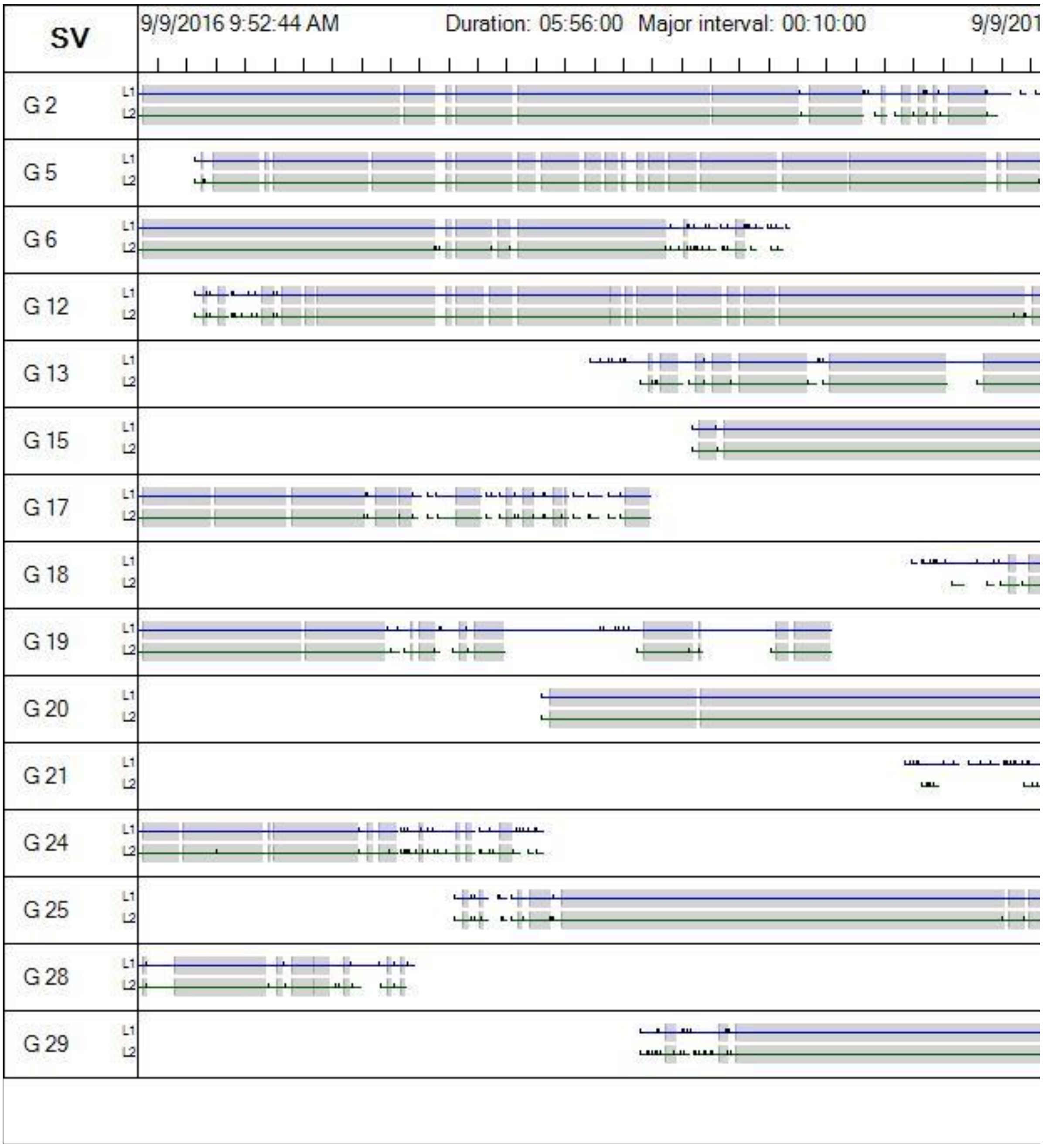
Processing Summary

Observation	From	To	Solution Type	H. Prec. (Meter)	V. Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	ΔHeight (Meter)
TBM1 --- TBM 5 (B1)	TBM1	TBM 5	Fixed	0.018	0.050	241° 17'26"	5450.602	-0.090

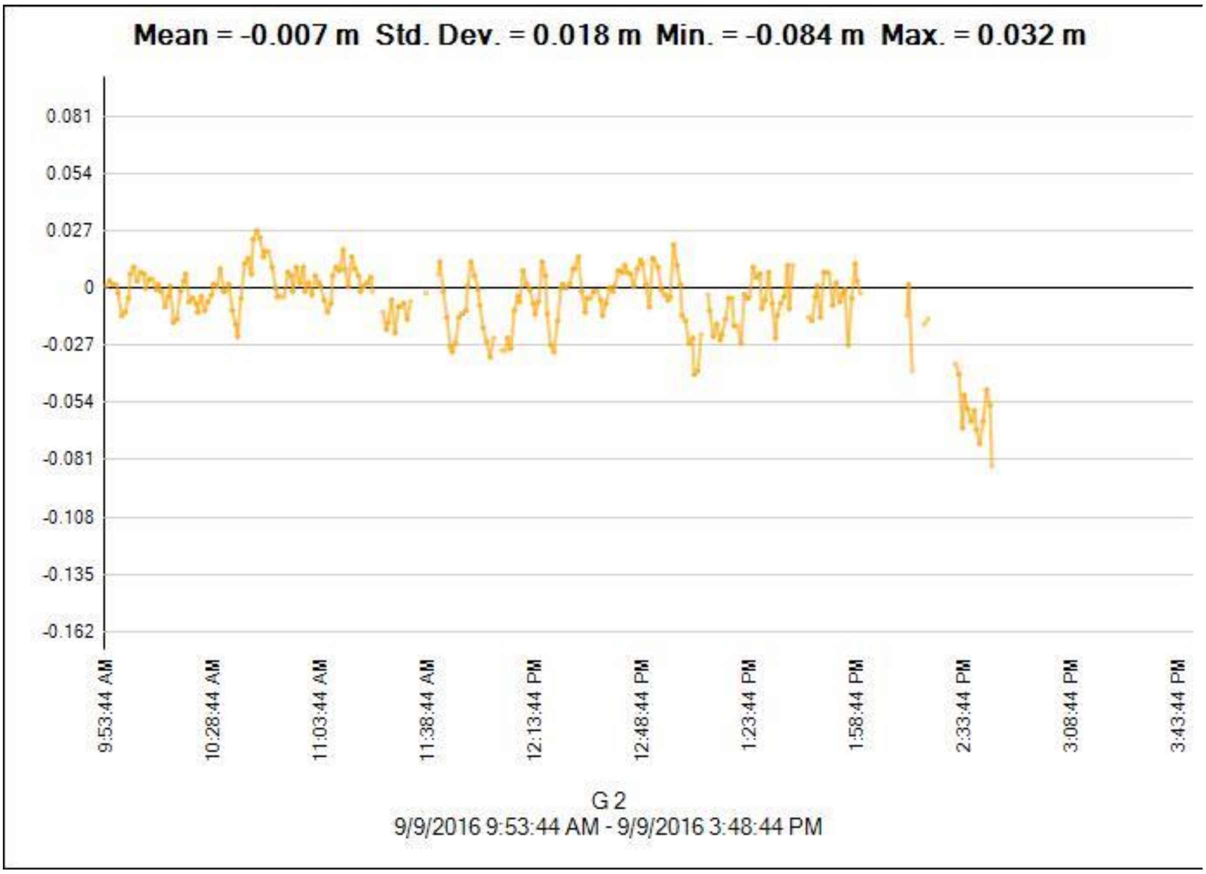
Acceptance Summary

Processed	Passed	Flag	Fail
1	1	0	0

Tracking Summary



Residuals


Mean = -0.007 m Std. Dev. = 0.018 m Min. = -0.084 m Max. = 0.032 m
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0.027
0
-0.027
-0.054
-0.081
-0.108
-0.135
-0.162
9:53:44 AM
10:28:44 AM
11:03:44 AM
11:38:44 AM
12:13:44 PM
12:48:44 PM
1:23:44 PM
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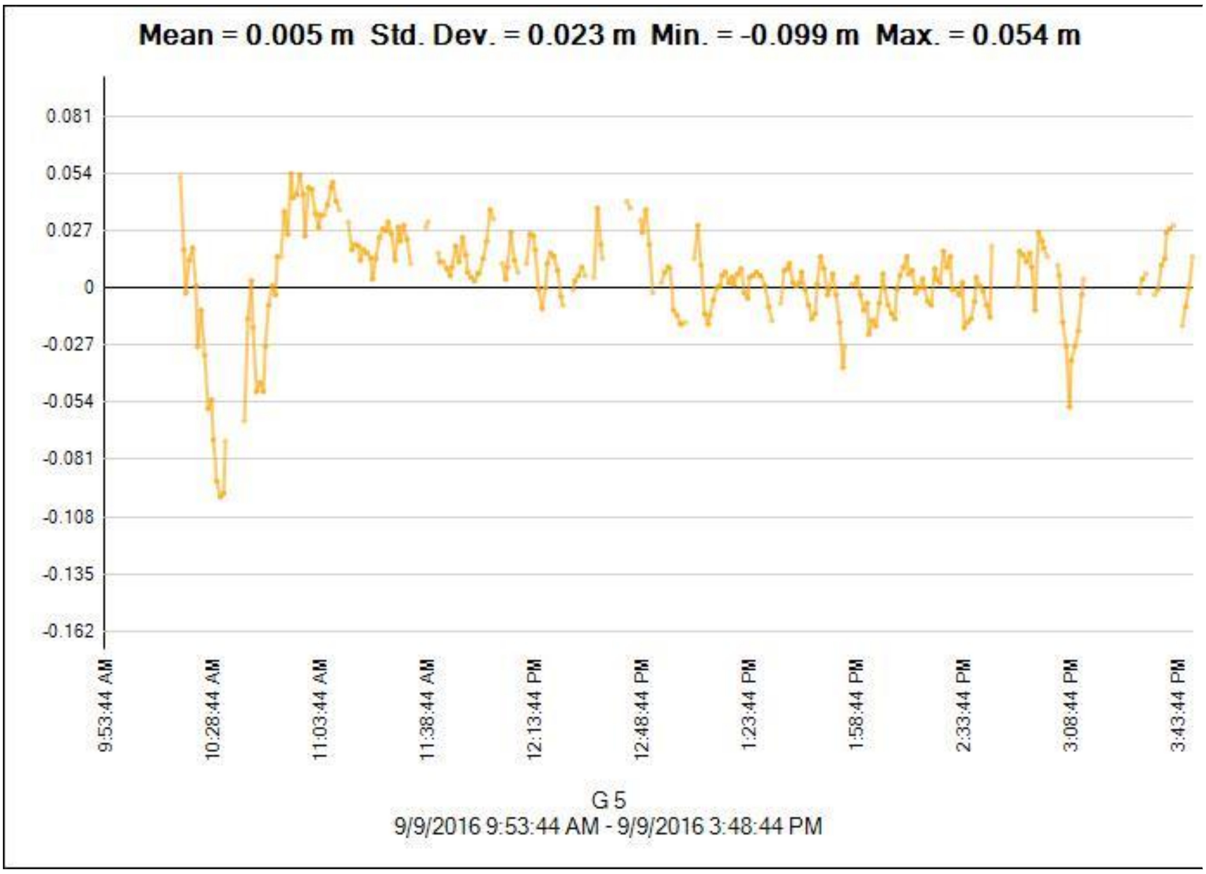
3:08:44 PM
3:43:44 PM
G 2
9/9/2016 9:53:44 AM - 9/9/2016 3:48:44 PM


Mean = 0.005 m Std. Dev. = 0.023 m Min. = -0.099 m Max. = 0.054 m
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0.054
0.027
0
-0.027
-0.054
-0.081
-0.108
-0.135
-0.162
9:53:44 AM
10:28:44 AM
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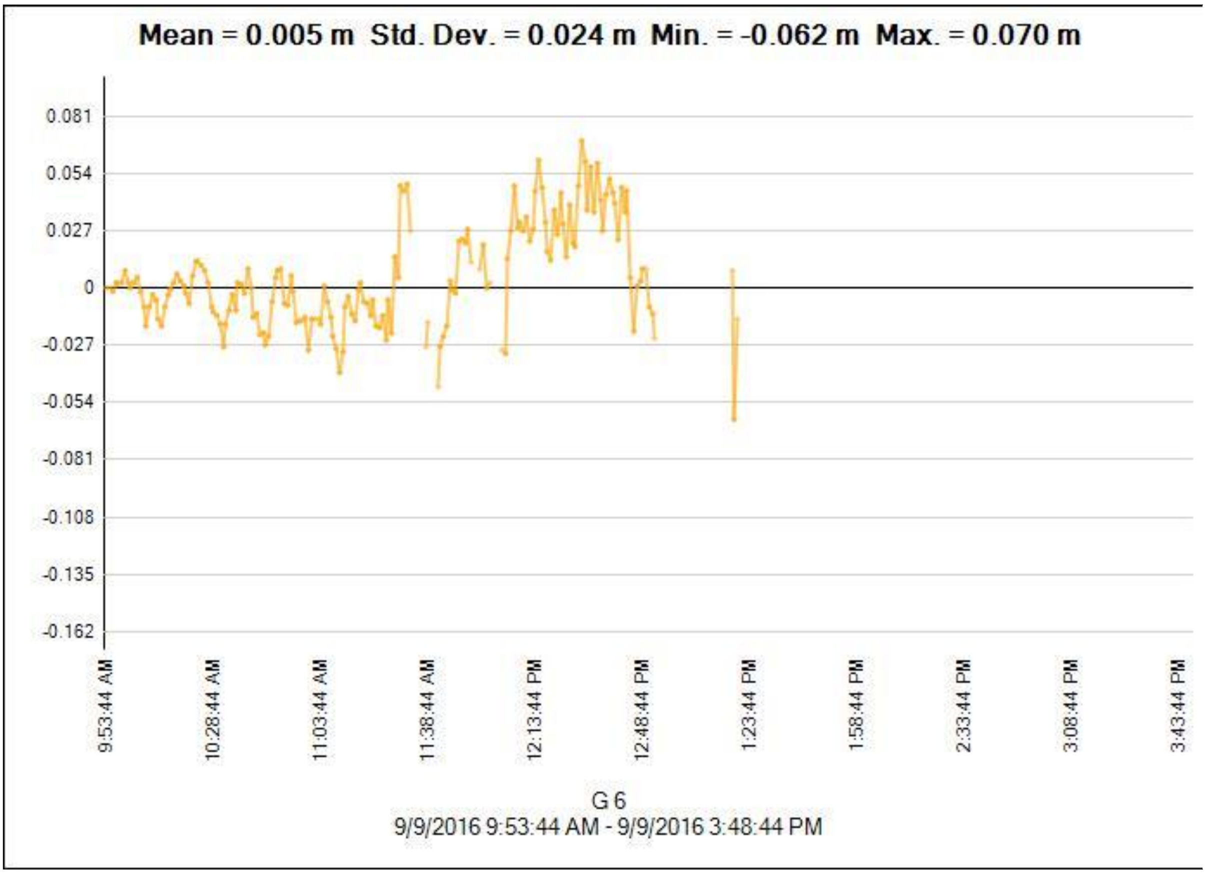
3:08:44 PM
3:43:44 PM
G 5
9/9/2016 9:53:44 AM - 9/9/2016 3:48:44 PM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0.054
0.027
0
-0.027
-0.054
-0.081
-0.108
-0.135
-0.162
9:53:44 AM
10:28:44 AM
11:03:44 AM
11:38:44 AM
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1:23:44 PM
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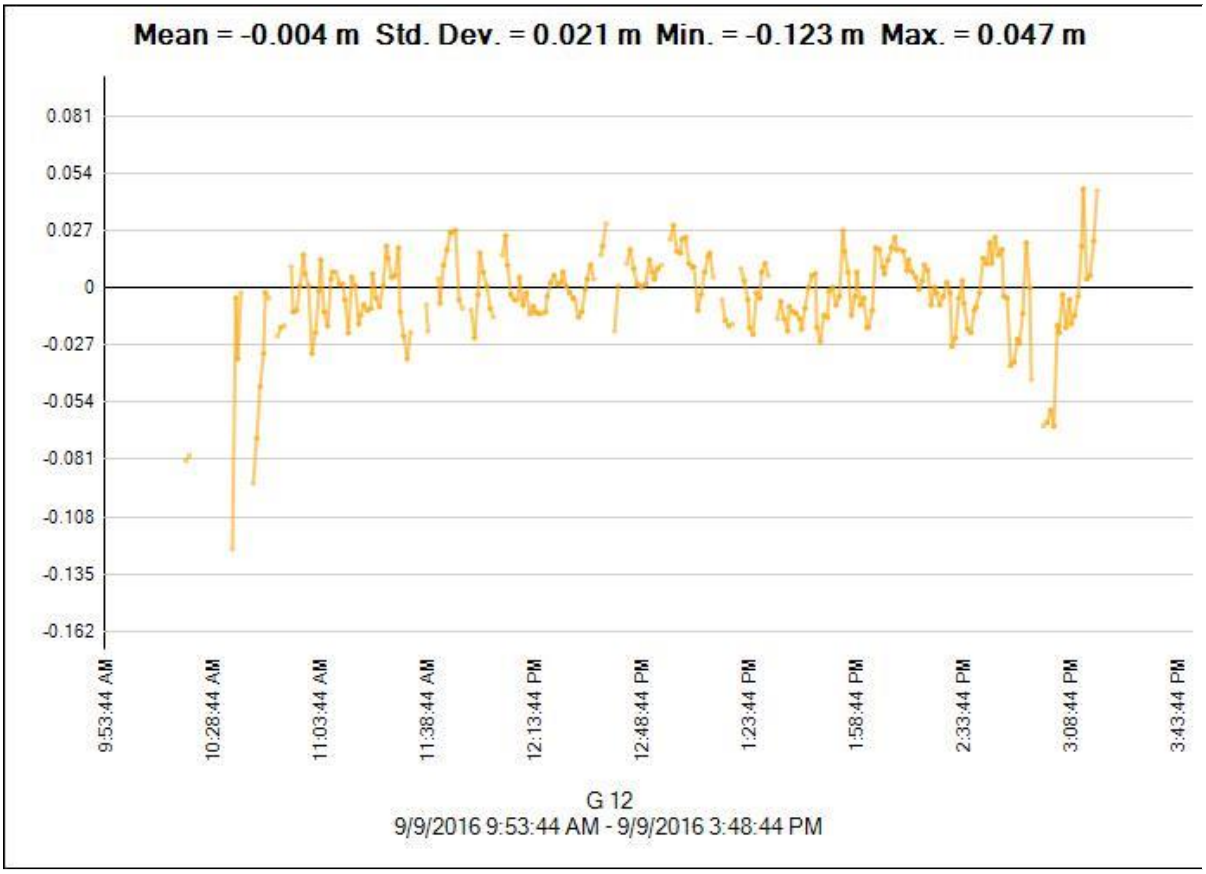
3:08:44 PM
3:43:44 PM
G 6
9/9/2016 9:53:44 AM - 9/9/2016 3:48:44 PM


Mean = -0.004 m Std. Dev. = 0.021 m Min. = -0.123 m Max. = 0.047 m
0.081
0.054
0.027
0
-0.027
-0.054
-0.081
-0.108
-0.135
-0.162
9:53:44 AM
10:28:44 AM
11:03:44 AM
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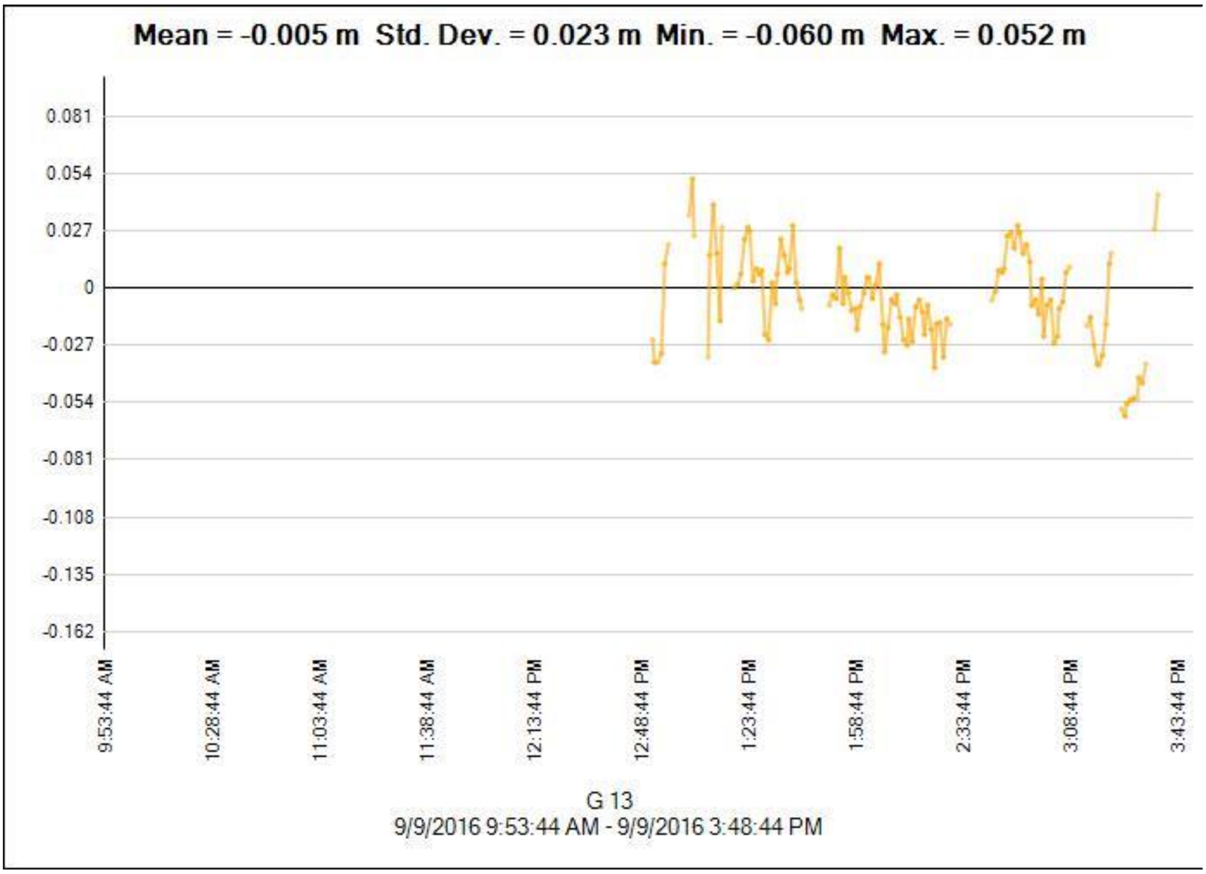
3:08:44 PM
3:43:44 PM
G 12
9/9/2016 9:53:44 AM - 9/9/2016 3:48:44 PM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0.081
0.054
0.027
0
-0.027
-0.054
-0.081
-0.108
-0.135
-0.162
9:53:44 AM
10:28:44 AM
11:03:44 AM
11:38:44 AM
12:13:44 PM
12:48:44 PM
1:23:44 PM
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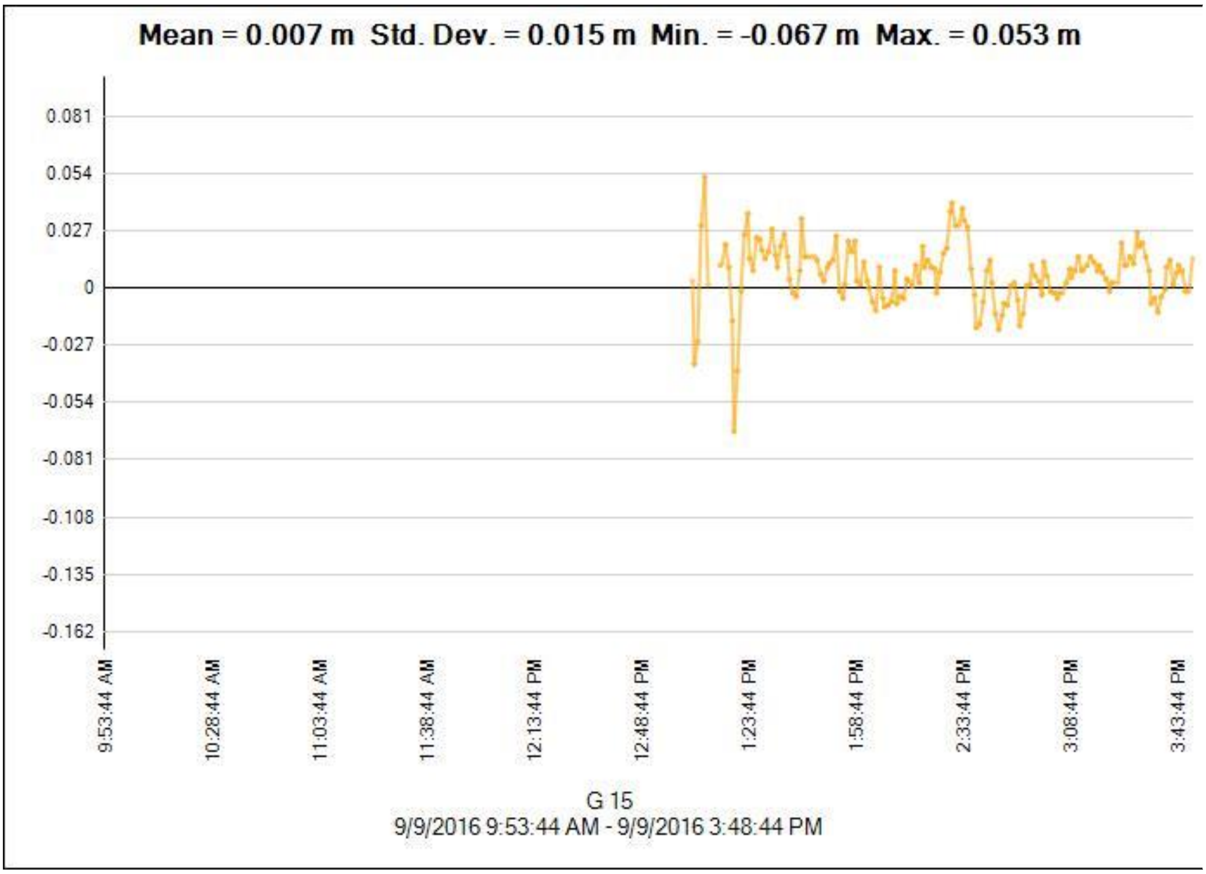
3:08:44 PM
3:43:44 PM
G 13
9/9/2016 9:53:44 AM - 9/9/2016 3:48:44 PM


Mean = 0.007 m Std. Dev. = 0.015 m Min. = -0.067 m Max. = 0.053 m
0.081
0.054
0.027
0
-0.027
-0.054
-0.081
-0.108
-0.135
-0.162
9:53:44 AM
10:28:44 AM
11:03:44 AM
11:38:44 AM
12:13:44 PM
12:48:44 PM
1:23:44 PM
1:58:44 PM
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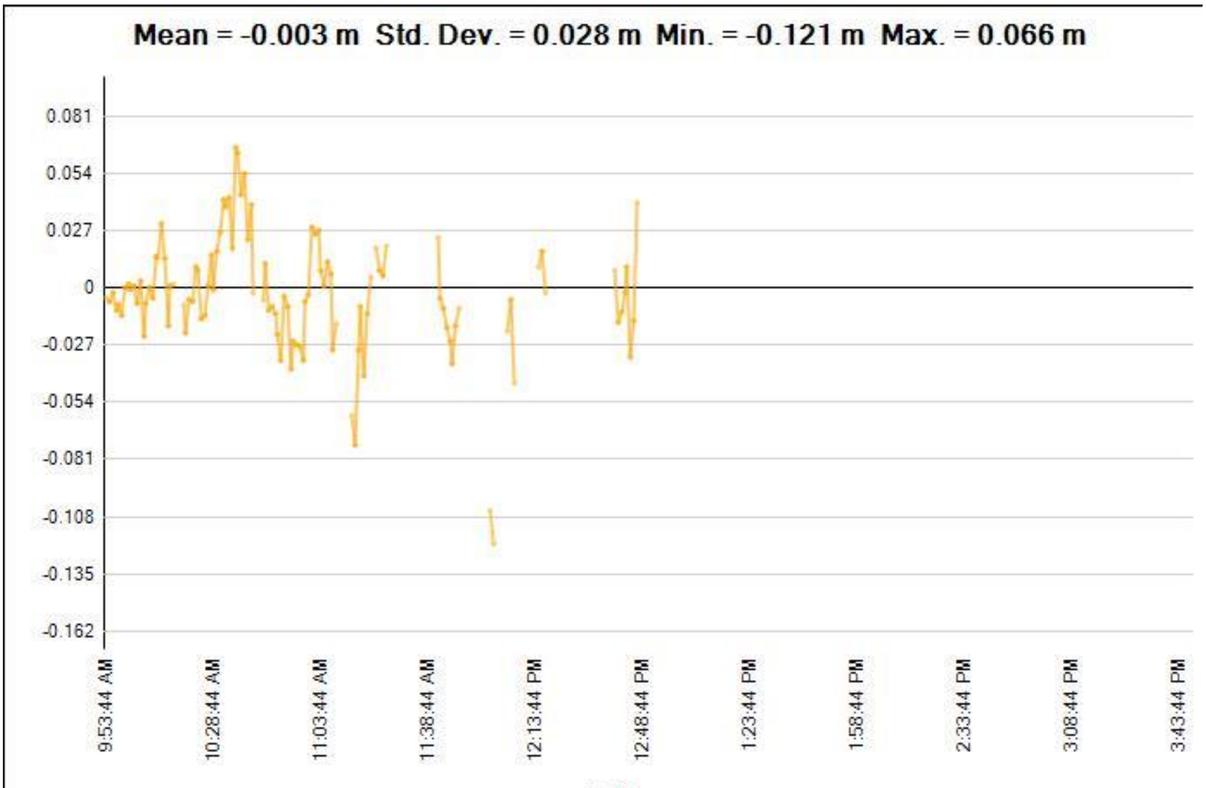
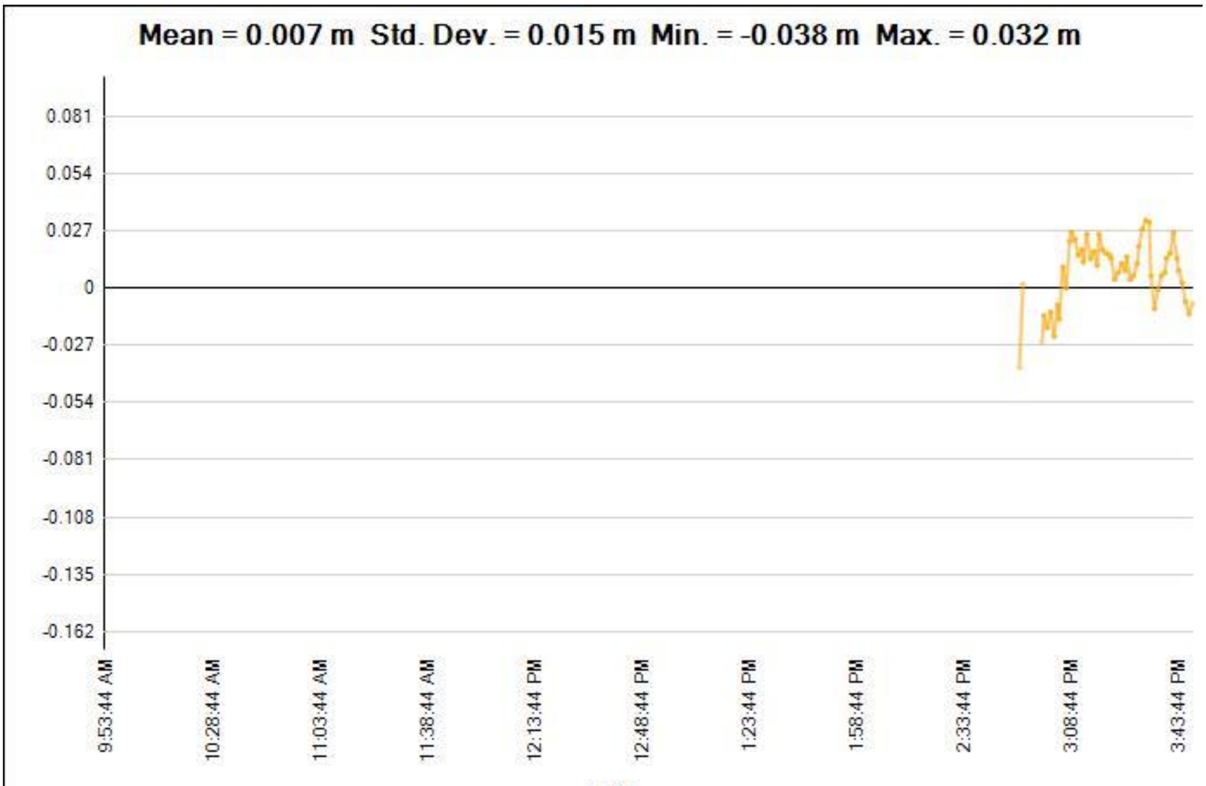
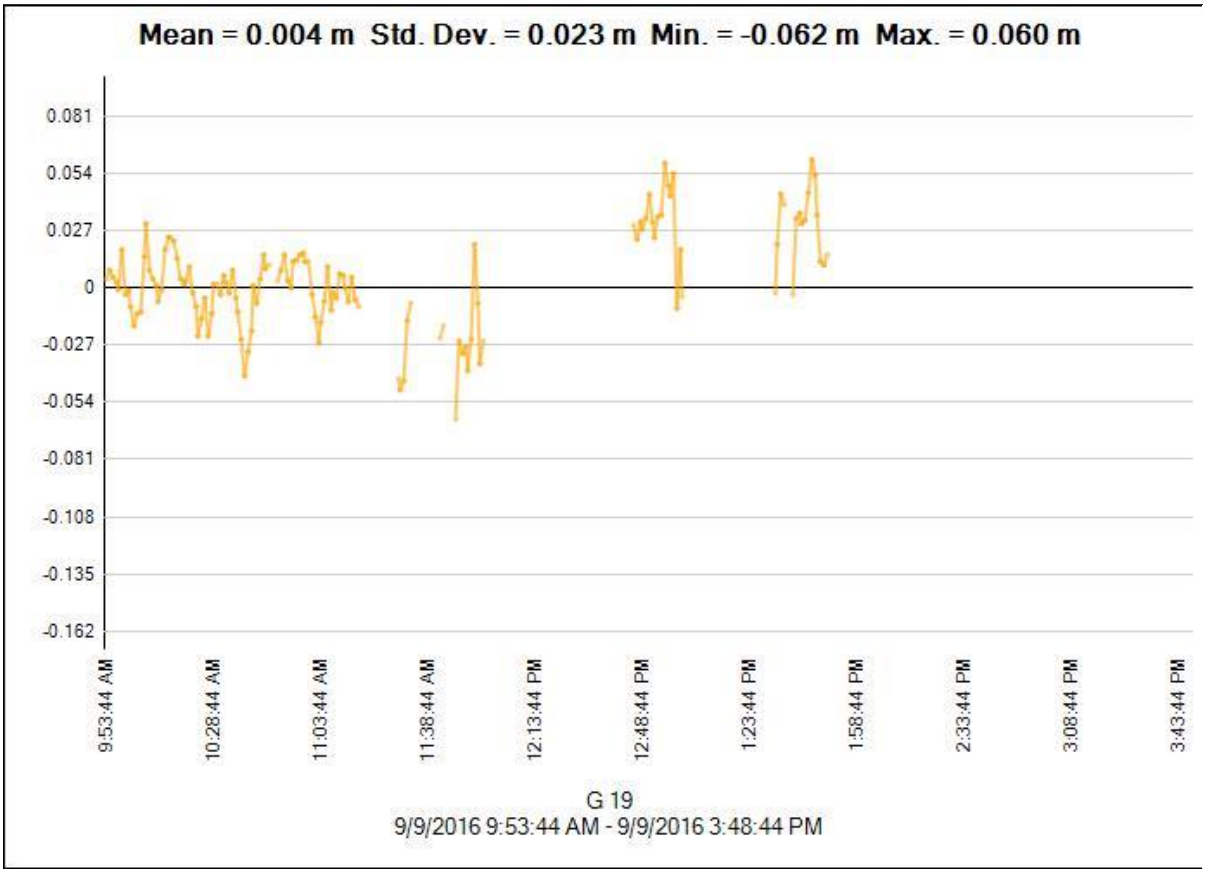
3:08:44 PM
3:43:44 PM
G 15
9/9/2016 9:53:44 AM - 9/9/2016 3:48:44 PM



G 17
9/9/2016 9:53:44 AM - 9/9/2016 3:48:44 PM



G 18
9/9/2016 9:53:44 AM - 9/9/2016 3:48:44 PM


Mean = 0.004 m Std. Dev. = 0.023 m Min. = -0.062 m Max. = 0.060 m
0.081
0.054
0.027
0
-0.027
-0.054
-0.081
-0.108
-0.135
-0.162
9:53:44 AM
10:28:44 AM
11:03:44 AM
11:38:44 AM
12:13:44 PM
12:48:44 PM
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3:08:44 PM
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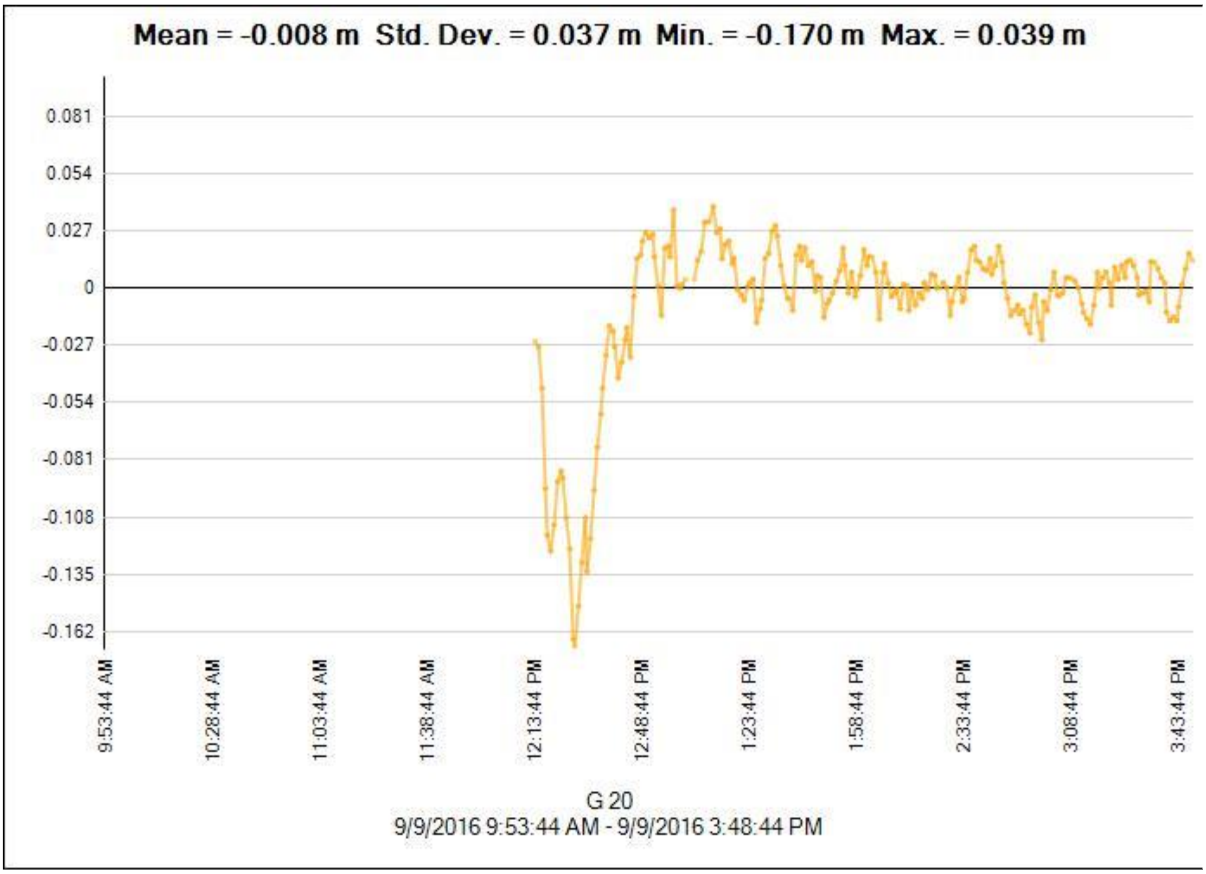
G 19
9/9/2016 9:53:44 AM - 9/9/2016 3:48:44 PM


Mean = -0.008 m Std. Dev. = 0.037 m Min. = -0.170 m Max. = 0.039 m
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0.054
0.027
0
-0.027
-0.054
-0.081
-0.108
-0.135
-0.162
9:53:44 AM
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11:03:44 AM
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12:48:44 PM
1:23:44 PM
1:58:44 PM
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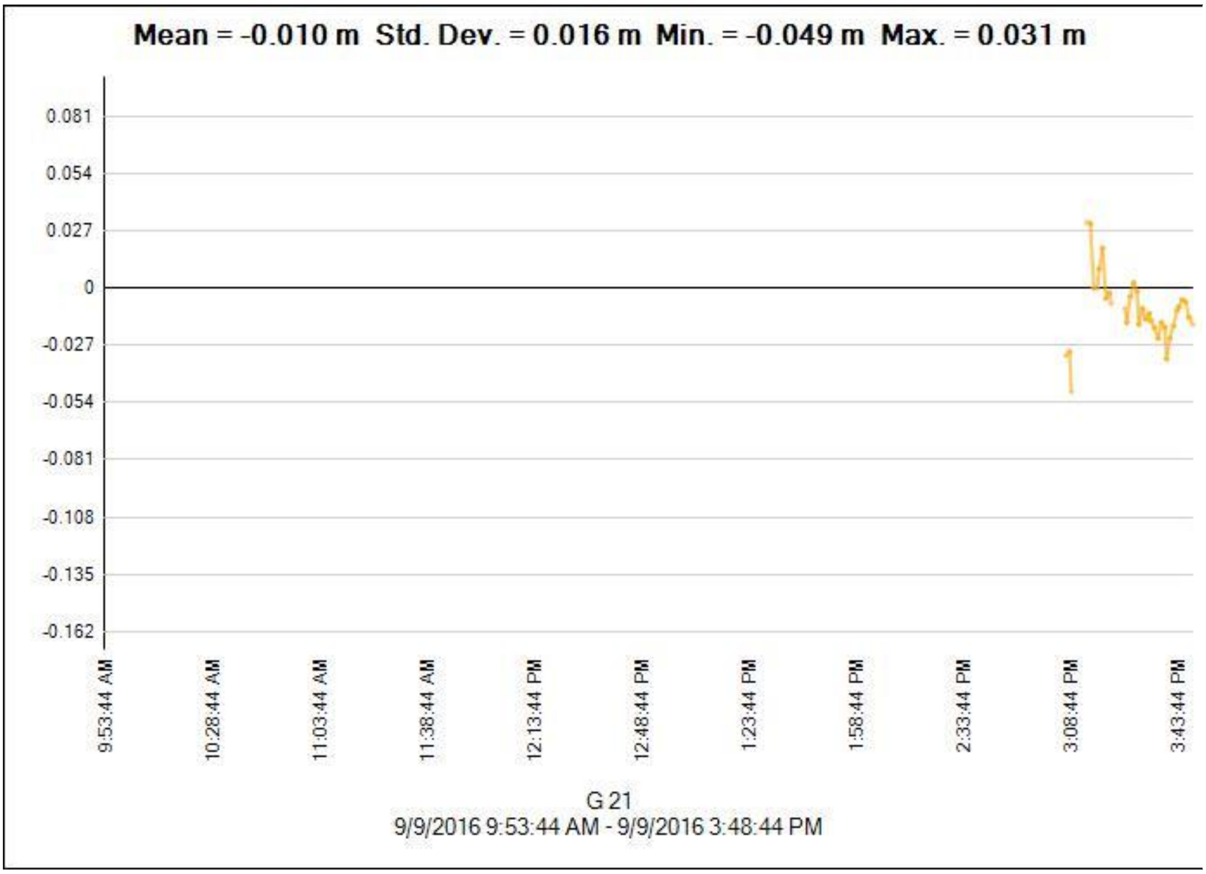
3:08:44 PM
3:43:44 PM
G 20
9/9/2016 9:53:44 AM - 9/9/2016 3:48:44 PM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0.054
0.027
0
-0.027
-0.054
-0.081
-0.108
-0.135
-0.162
9:53:44 AM
10:28:44 AM
11:03:44 AM
11:38:44 AM
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12:48:44 PM
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3:43:44 PM
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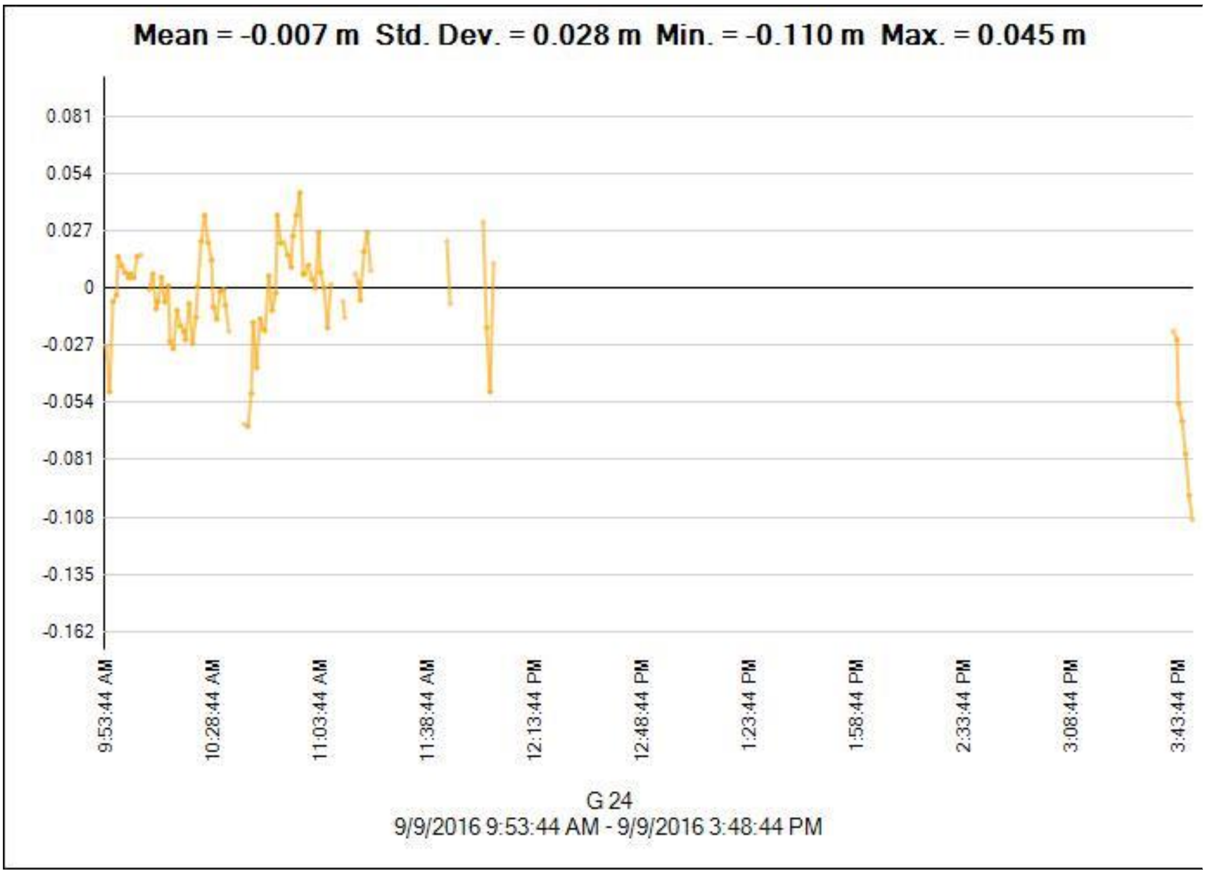
9/9/2016 9:53:44 AM - 9/9/2016 3:48:44 PM


Mean = -0.007 m Std. Dev. = 0.028 m Min. = -0.110 m Max. = 0.045 m
0.081
0.054
0.027
0
-0.027
-0.054
-0.081
-0.108
-0.135
-0.162
9:53:44 AM
10:28:44 AM
11:03:44 AM
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12:13:44 PM
12:48:44 PM
1:23:44 PM
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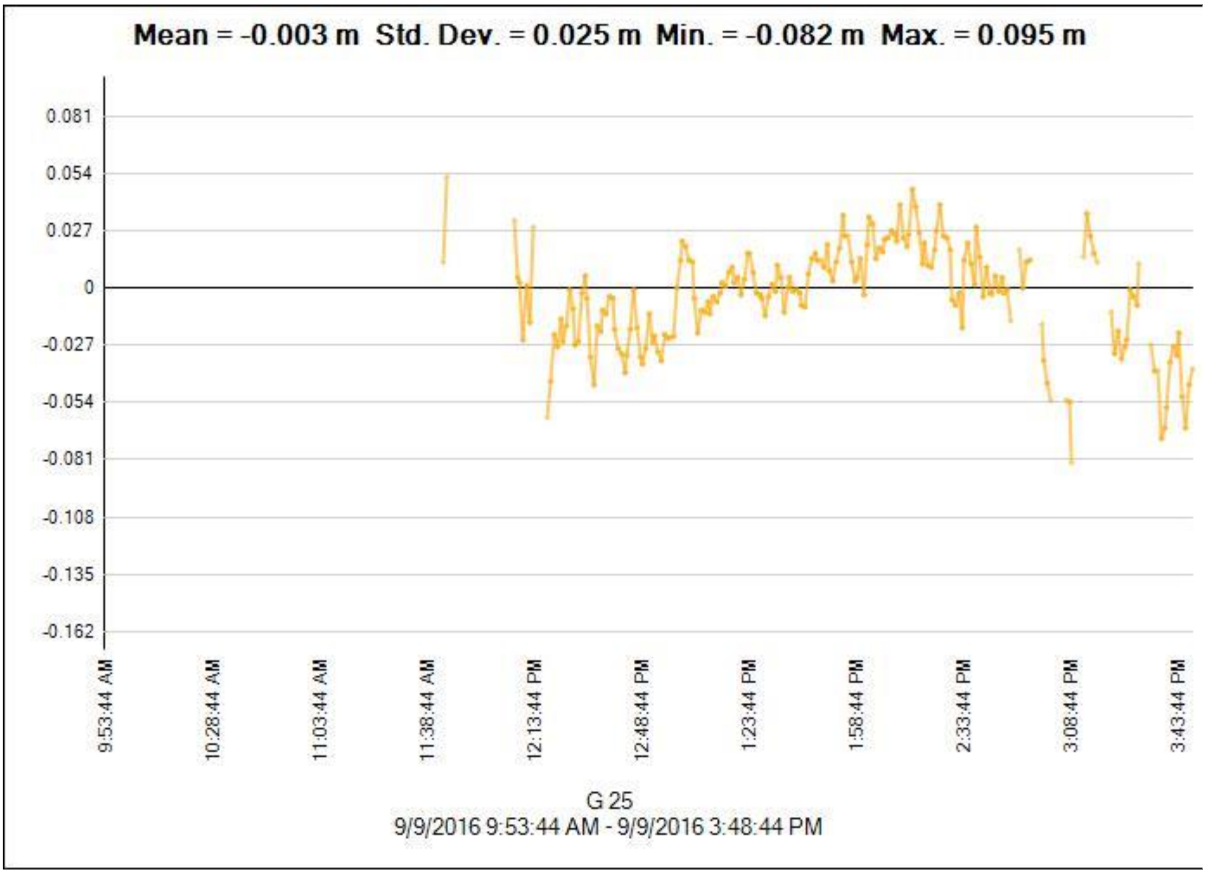
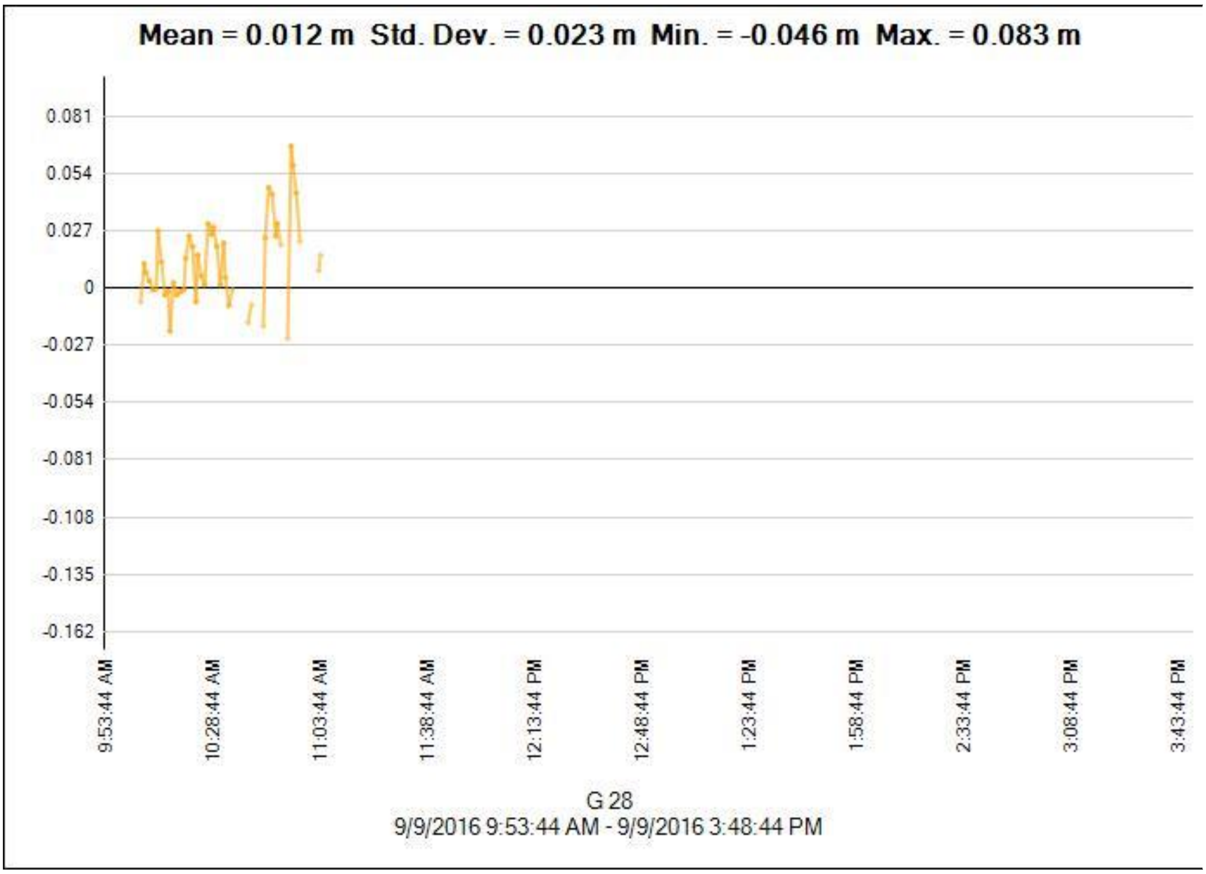
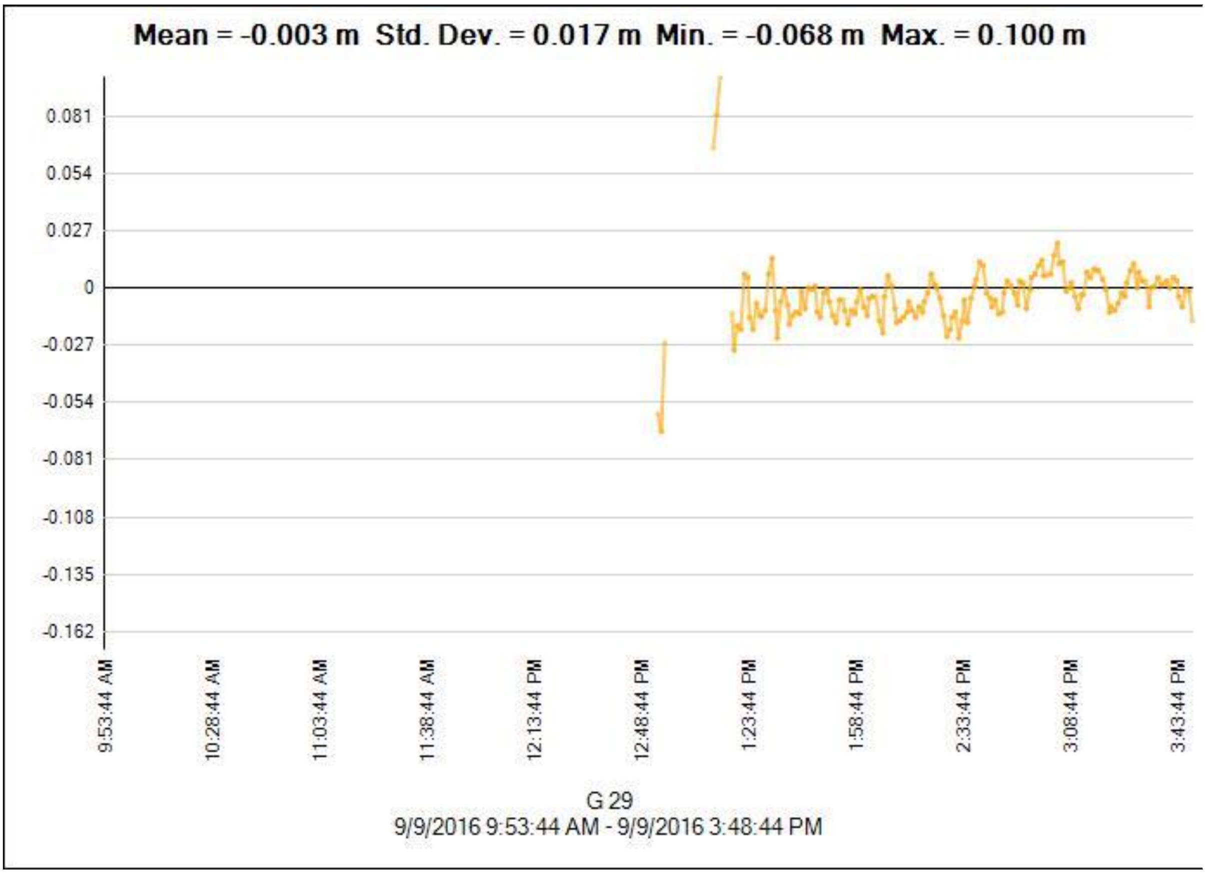
G 24
9/9/2016 9:53:44 AM - 9/9/2016 3:48:44 PM



Mean = -0.003 m Std. Dev. = 0.025 m Min. = -0.082 m Max. = 0.095 m
0.081
0.054
0.027
0
-0.027
-0.054
-0.081
-0.108
-0.135
-0.162
9:53:44 AM
10:28:44 AM
11:03:44 AM
11:38:44 AM
12:13:44 PM
12:48:44 PM
1:23:44 PM
1:58:44 PM
2:33:44 PM
3:08:44 PM
3:43:44 PM
G 25
9/9/2016 9:53:44 AM - 9/9/2016 3:48:44 PM



Mean = 0.012 m Std. Dev. = 0.023 m Min. = -0.046 m Max. = 0.083 m
0.081
0.054
0.027
0
-0.027
-0.054
-0.081
-0.108
-0.135
-0.162
9:53:44 AM
10:28:44 AM
11:03:44 AM
11:38:44 AM
12:13:44 PM
12:48:44 PM
1:23:44 PM
1:58:44 PM
2:33:44 PM
3:08:44 PM
3:43:44 PM
G 28
9/9/2016 9:53:44 AM - 9/9/2016 3:48:44 PM


Mean = -0.003 m Std. Dev. = 0.017 m Min. = -0.068 m Max. = 0.100 m
0.081
0.054
0.027
0
-0.027
-0.054
-0.081
-0.108
-0.135
-0.162
9:53:44 AM
10:28:44 AM
11:03:44 AM
11:38:44 AM
12:13:44 PM
12:48:44 PM
1:23:44 PM
1:58:44 PM
2:33:44 PM
3:08:44 PM
3:43:44 PM
G 29
9/9/2016 9:53:44 AM - 9/9/2016 3:48:44 PM

Processing style

Elevation mask:	10.0 deg
Auto start processing:	Yes
Start automatic ID numbering:	AUTO0001
Continuous vectors:	No
Generate residuals:	Yes
Antenna model:	Automatic
Ephemeris type:	Automatic
Frequency:	Multiple Frequencies
Processing Interval:	Use all data
Force float:	No

Acceptance Criteria

Vector Component	Flag	Fail
Horizontal Precision >	0.050 m + 1.000 ppm	0.100 m + 1.000 ppm
Vertical Precision >	0.100 m + 1.000 ppm	0.200 m + 1.000 ppm

Project information		Coordinate System	
Name:	C:¥Users¥Admin¥Documents¥Spectra Precision Survey Office¥SUNDERBANS.vce	Name:	UTM
Size:	199 KB	Datum:	WGS 1984
Modified:	1/10/2017 4:16:18 PM (UTC:5)	Zone:	45 North (87E)
Time zone:	India Standard Time	Geoid:	EGM96 (Global)
Reference number:		Vertical datum:	
Description:			

Baseline Processing Report

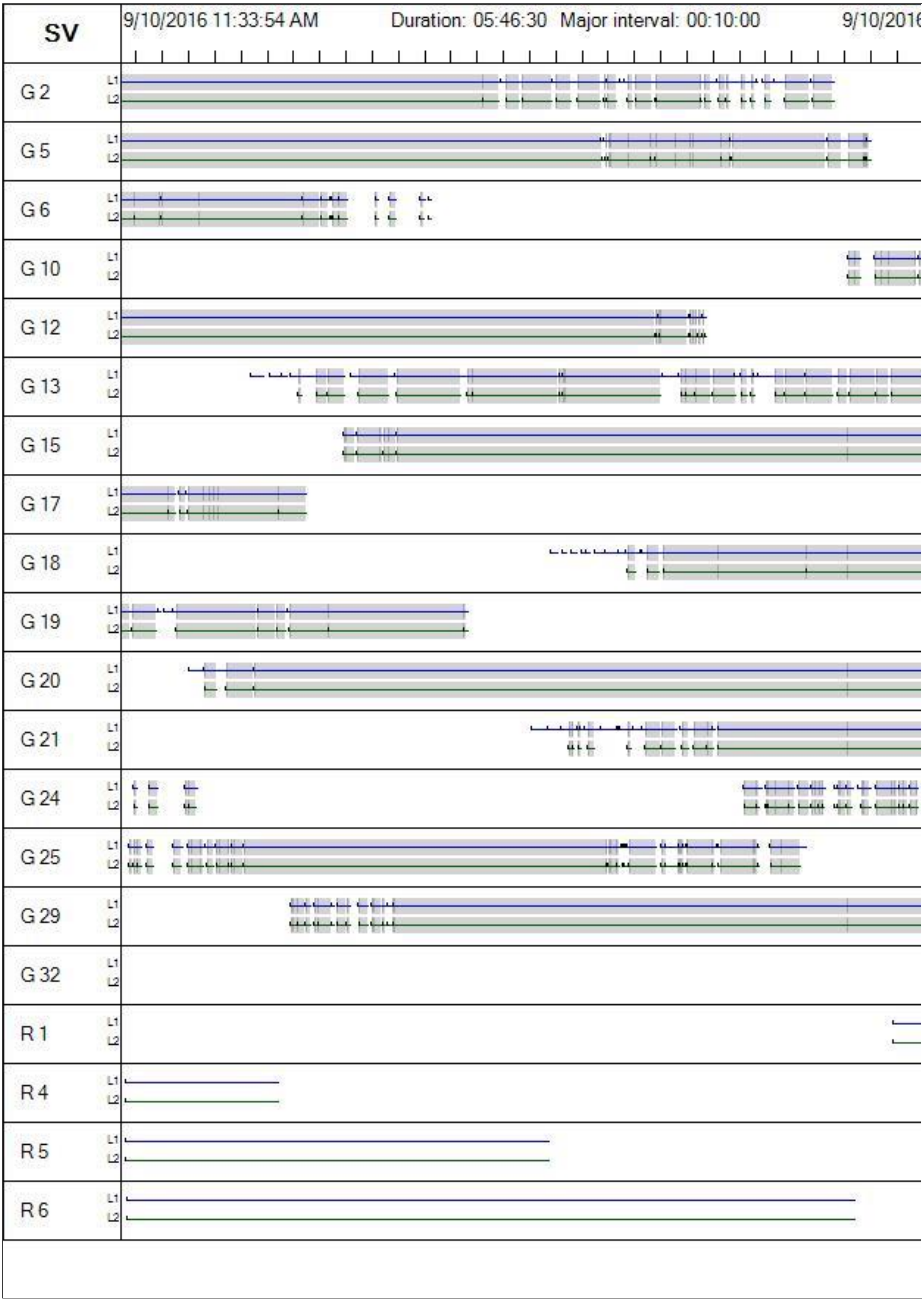
Processing Summary

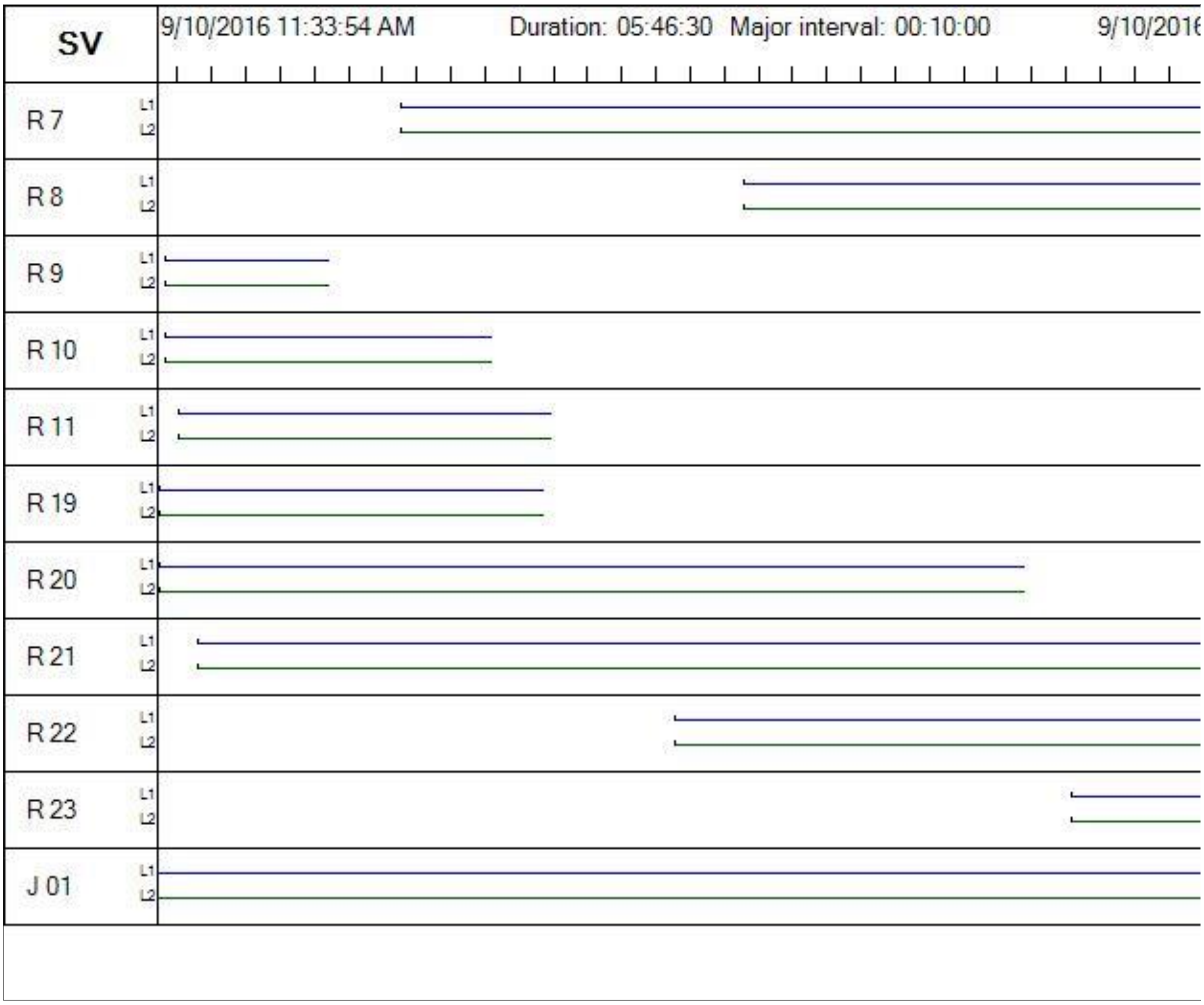
Observation	From	To	Solution Type	H. Prec. (Meter)	V. Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	Δ Height (Meter)
TBM1 --- TBM 6 (B2)	TBM1	TBM 6	Fixed	0.010	0.027	250° 34'17"	10115.893	-0.319

Acceptance Summary

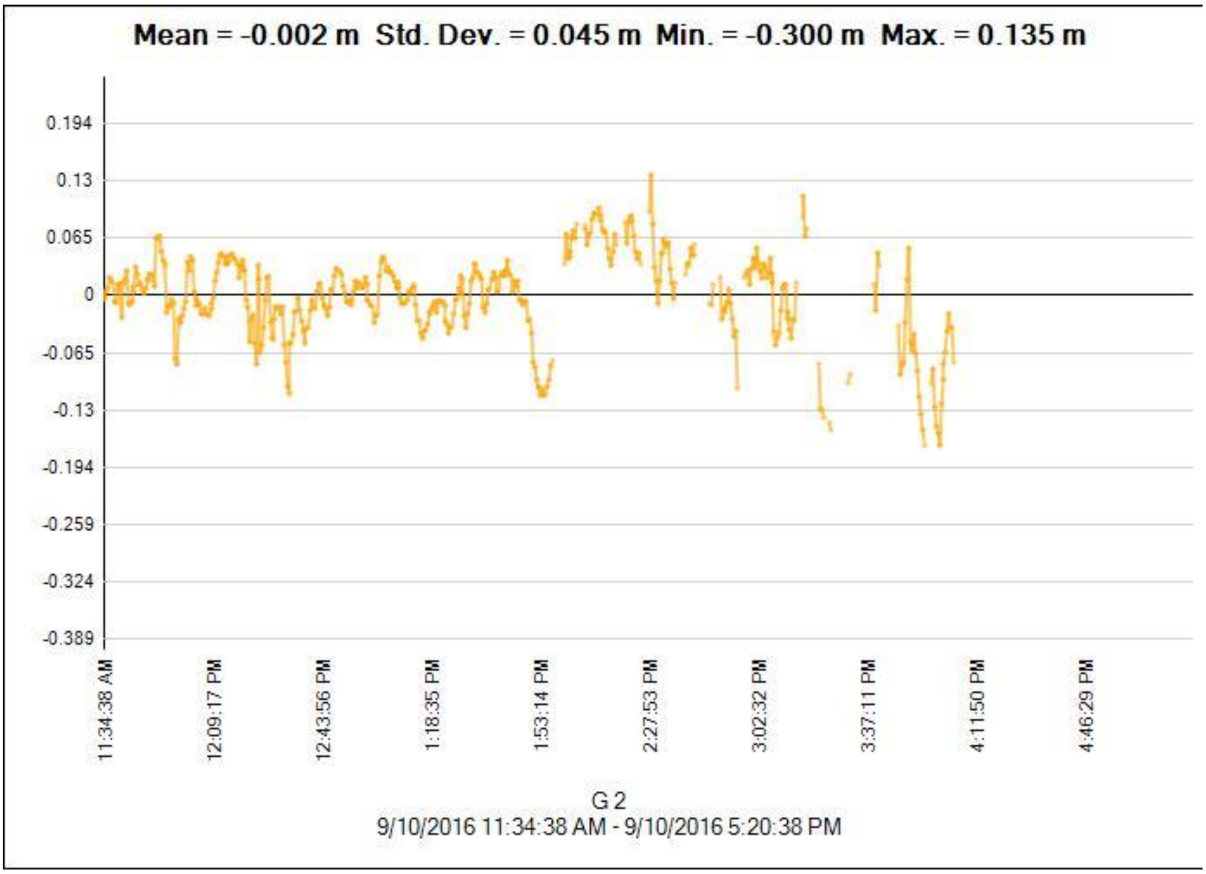
Processed	Passed	Flag	Fail
1	1	0	0

Tracking Summary

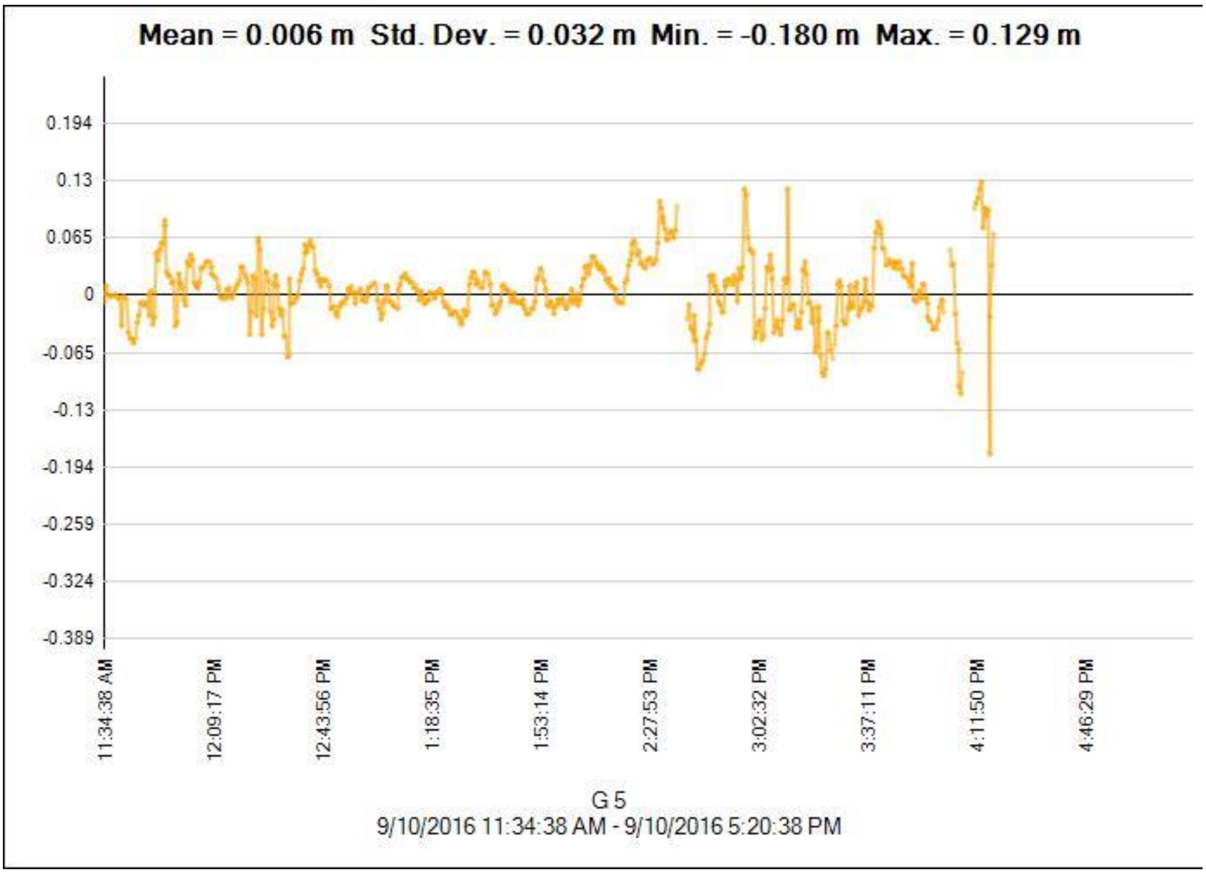



SV
9/10/2016 11:33:54 AM
Duration: 05:46:30 Major interval: 00:10:00
R 7
R 8
R 9
R 10
R 11
R 19
R 20
R 21
R 22
R 23
J 01

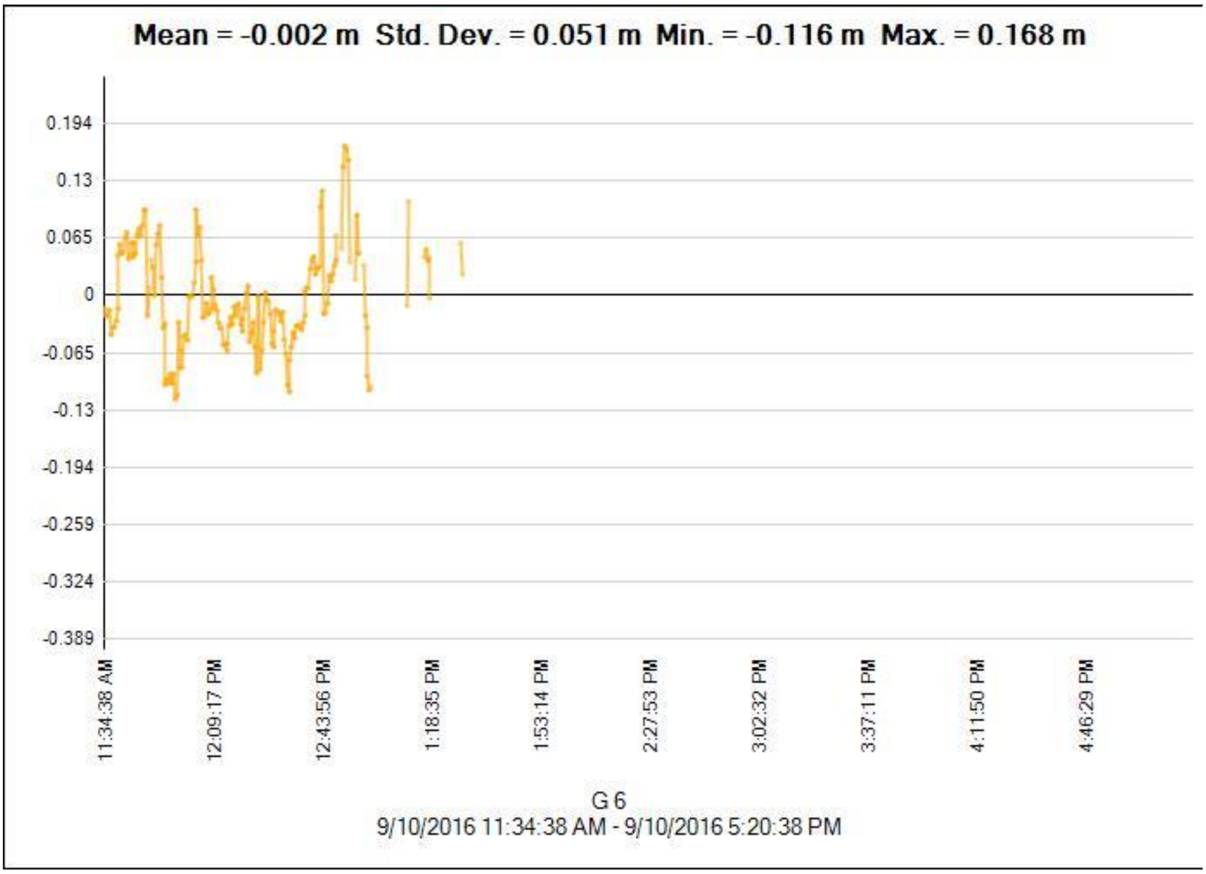
Residuals

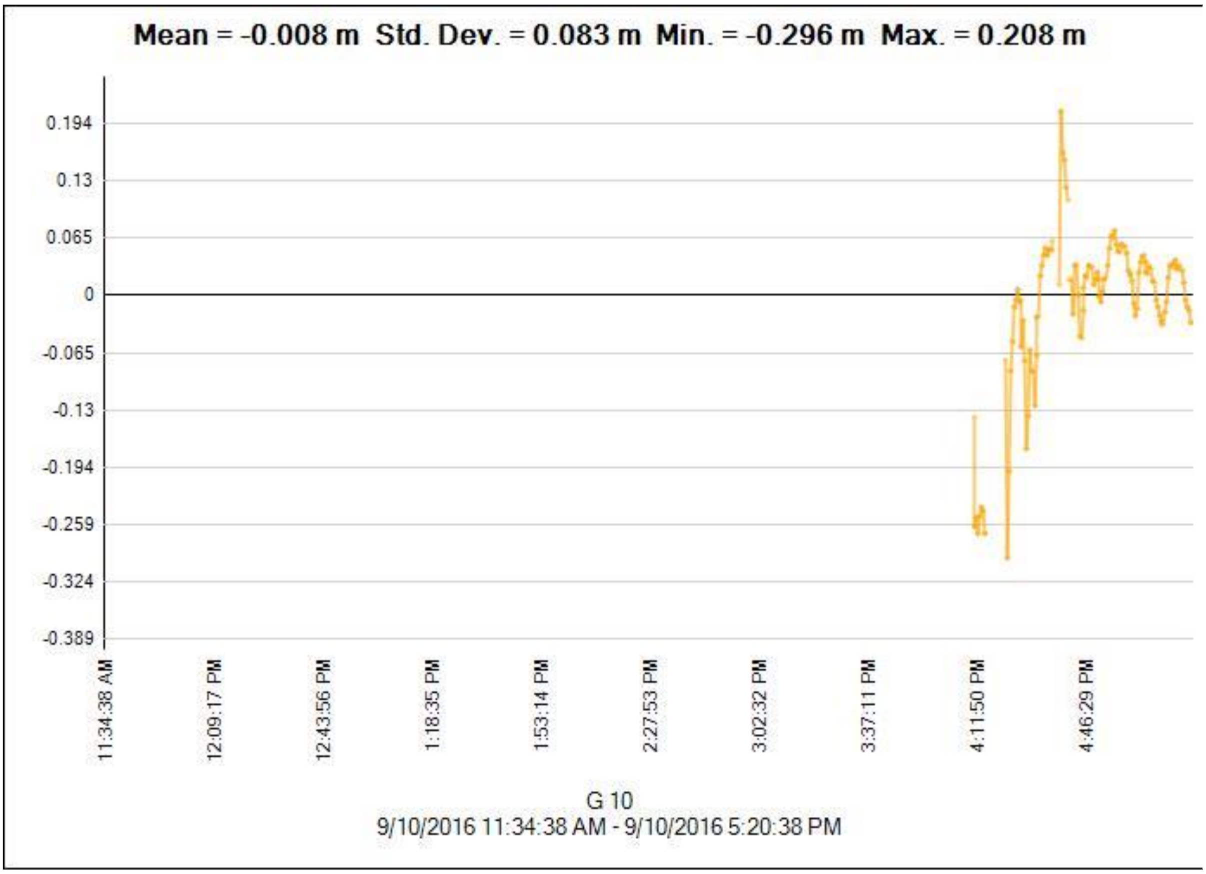


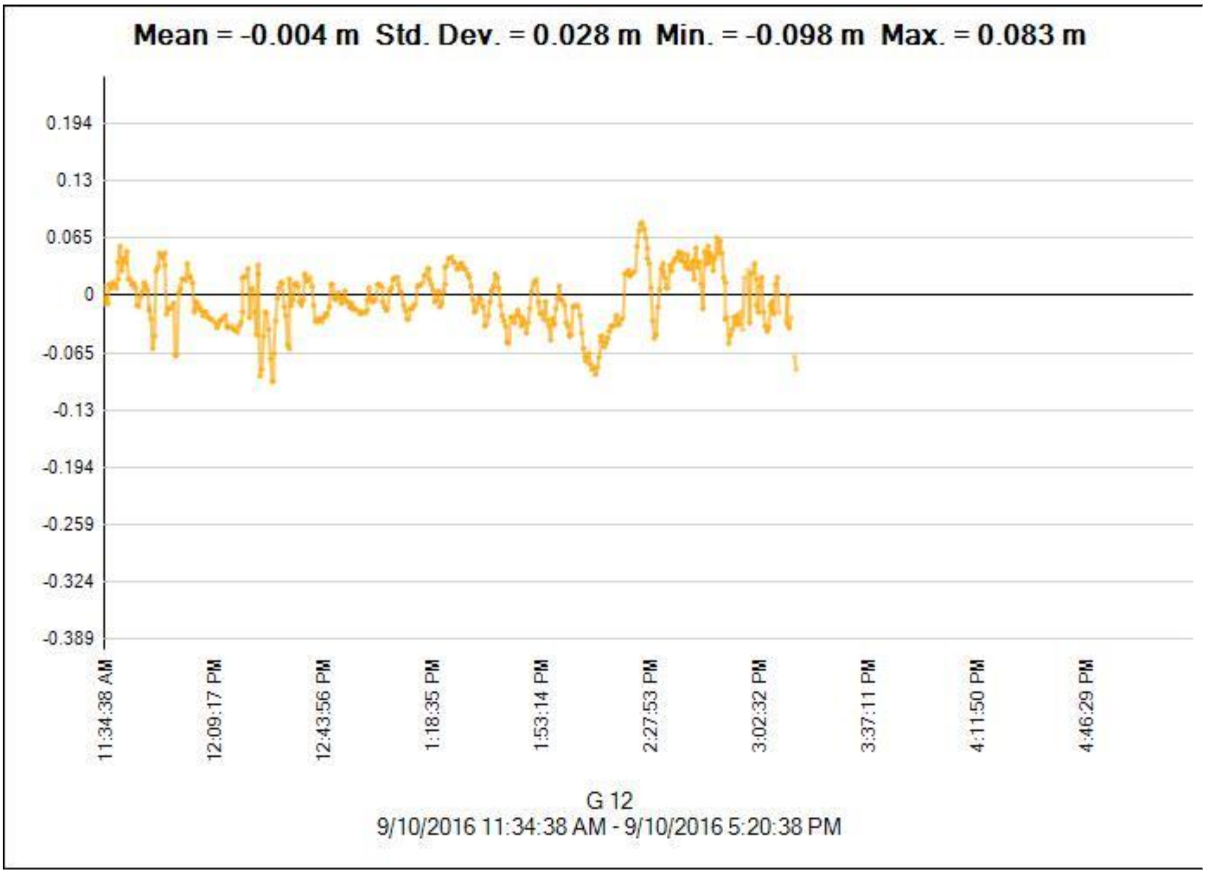
Mean = -0.002 m Std. Dev. = 0.045 m Min. = -0.300 m Max. = 0.135 m
0.194
0.13
0.065
0
-0.065
-0.13
-0.194
-0.259
-0.324
-0.389
11:34:38 AM
12:09:17 PM
12:43:56 PM
1:18:35 PM
1:53:14 PM
2:27:53 PM
3:02:32 PM
3:37:11 PM
4:11:50 PM
4:46:29 PM
G 2
9/10/2016 11:34:38 AM - 9/10/2016 5:20:38 PM

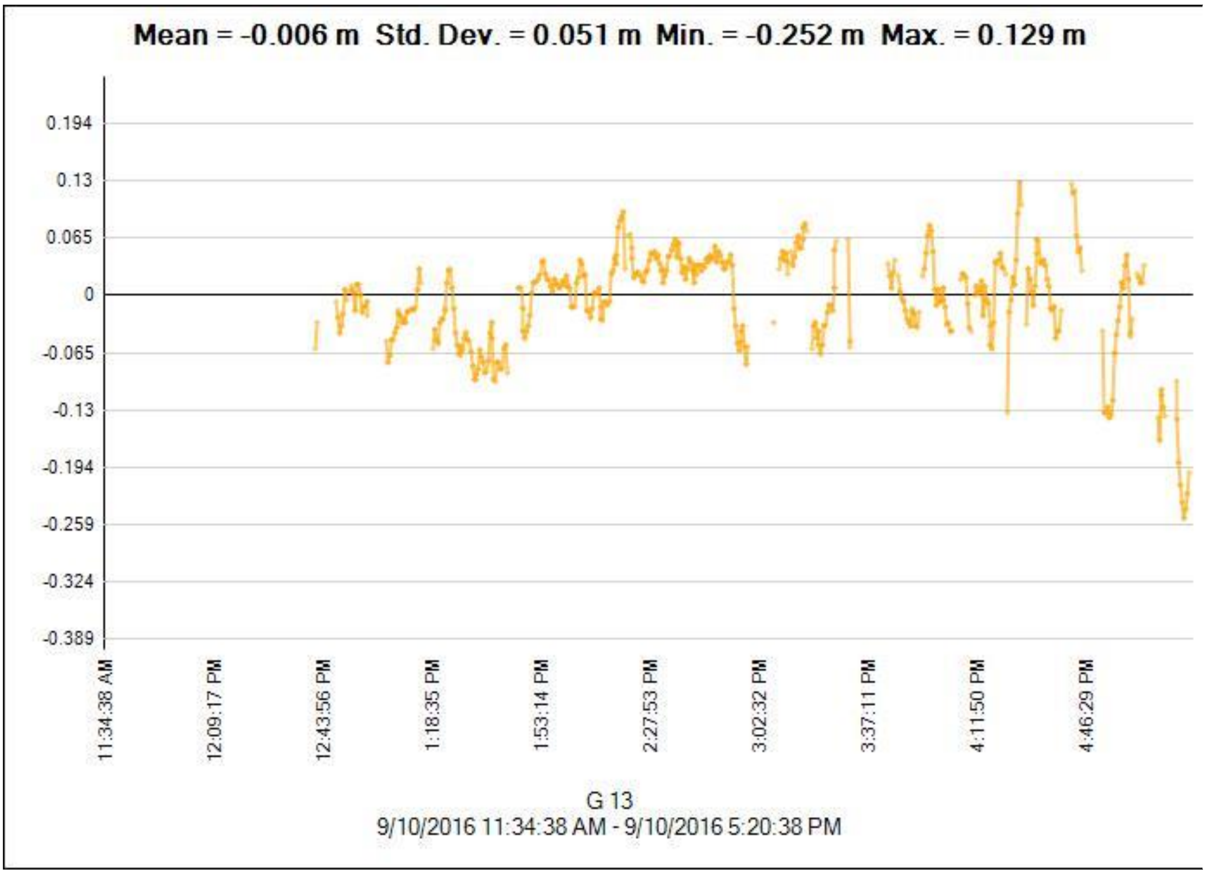


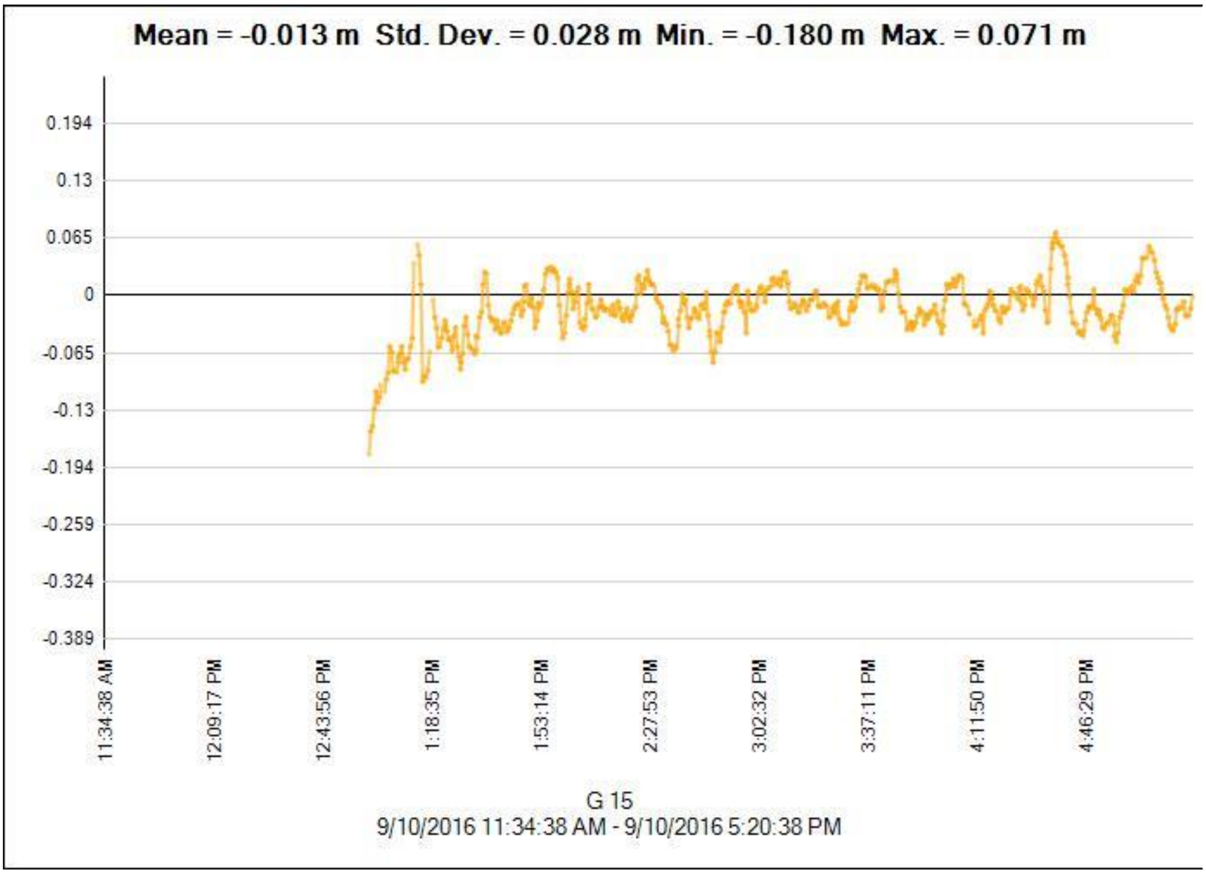
Mean = 0.006 m Std. Dev. = 0.032 m Min. = -0.180 m Max. = 0.129 m
0.194
0.13
0.065
0
-0.065
-0.13
-0.194
-0.259
-0.324
-0.389
11:34:38 AM
12:09:17 PM
12:43:56 PM
1:18:35 PM
1:53:14 PM
2:27:53 PM
3:02:32 PM
3:37:11 PM
4:11:50 PM
4:46:29 PM
G 5
9/10/2016 11:34:38 AM - 9/10/2016 5:20:38 PM

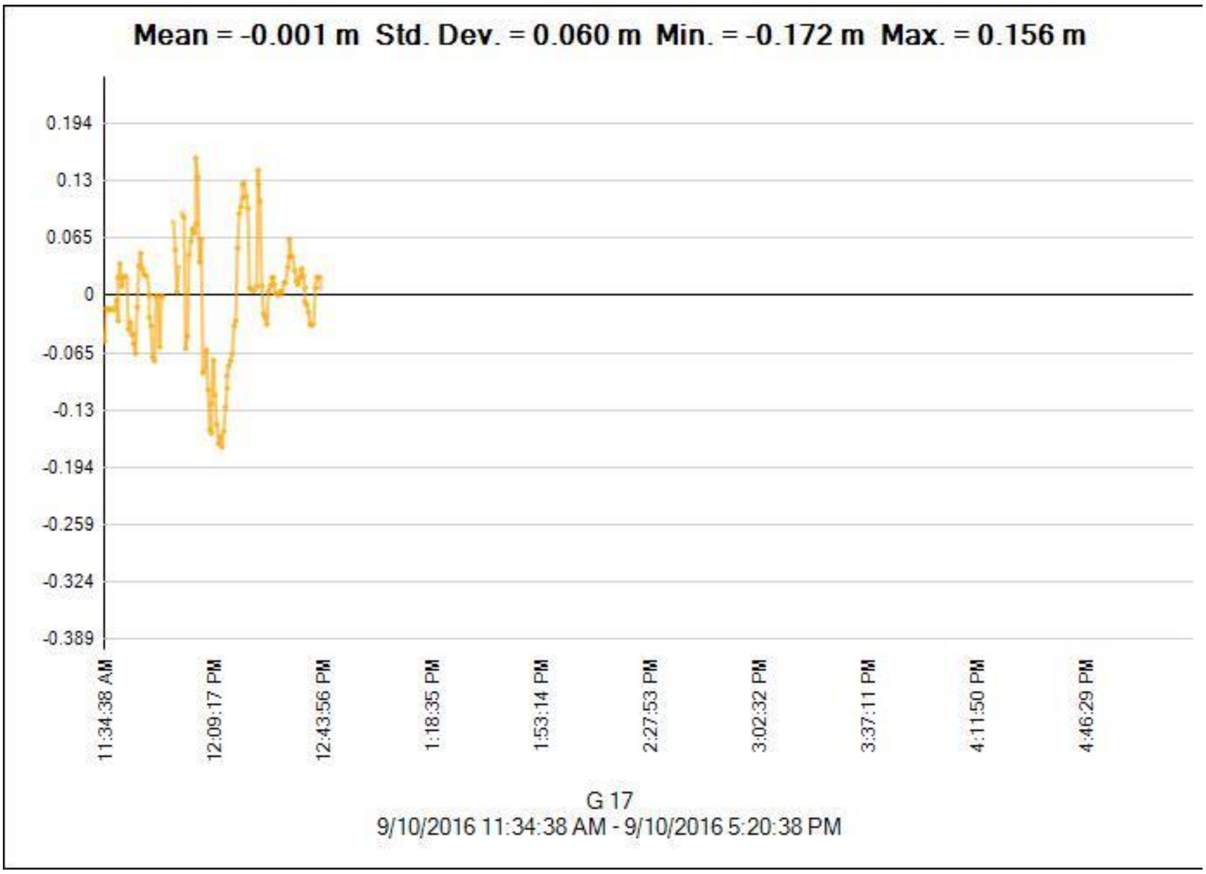

Mean = -0.002 m Std. Dev. = 0.051 m Min. = -0.116 m Max. = 0.168 m
0.194
0.13
0.065
0
-0.065
-0.13
-0.194
-0.259
-0.324
-0.389
11:34:38 AM
12:09:17 PM
12:43:56 PM
1:18:35 PM
1:53:14 PM
2:27:53 PM
3:02:32 PM
3:37:11 PM
4:11:50 PM
4:46:29 PM
G 6
9/10/2016 11:34:38 AM - 9/10/2016 5:20:38 PM

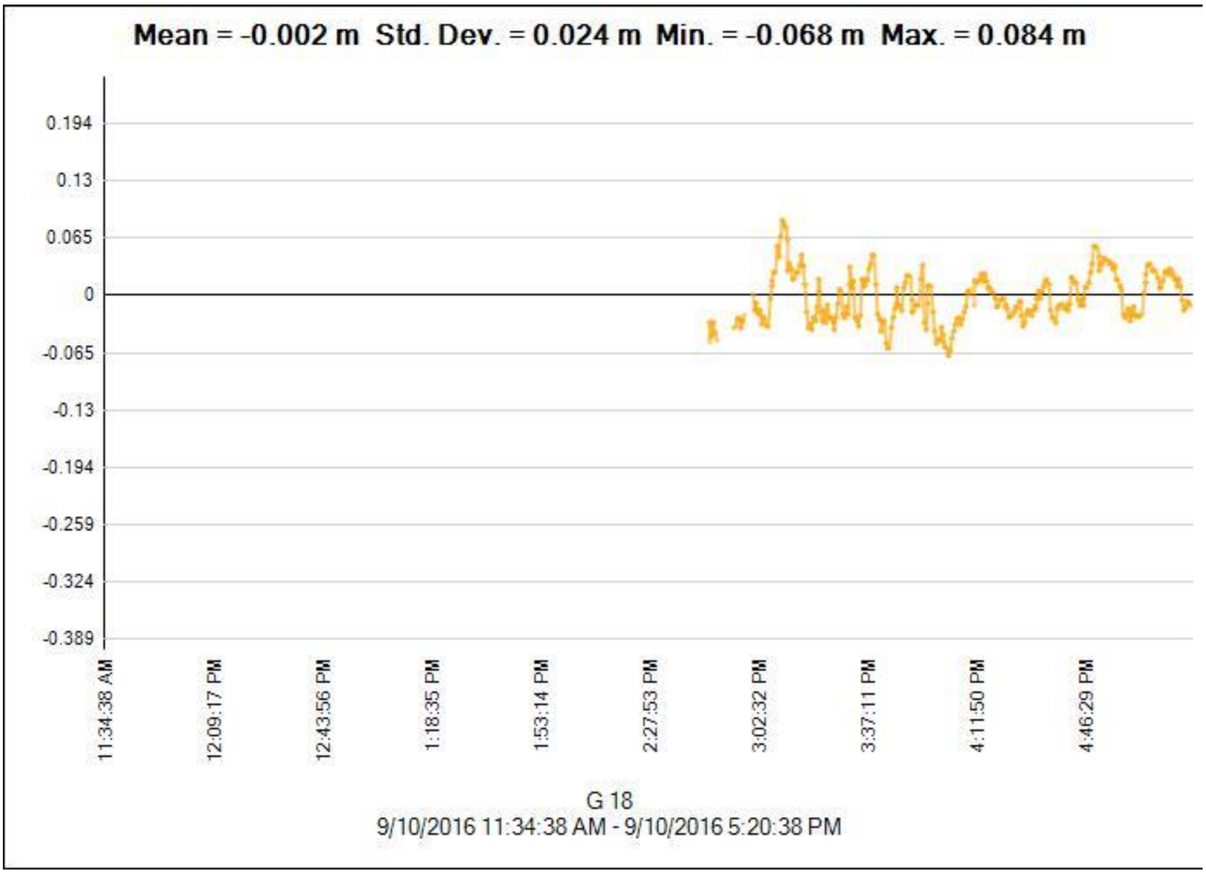

Mean = -0.008 m Std. Dev. = 0.083 m Min. = -0.296 m Max. = 0.208 m
0.194
0.13
0.065
0
-0.065
-0.13
-0.194
-0.259
-0.324
-0.389
11:34:38 AM
12:09:17 PM
12:43:56 PM
1:18:35 PM
1:53:14 PM
2:27:53 PM
3:02:32 PM
3:37:11 PM
4:11:50 PM
4:46:29 PM
G 10
9/10/2016 11:34:38 AM - 9/10/2016 5:20:38 PM

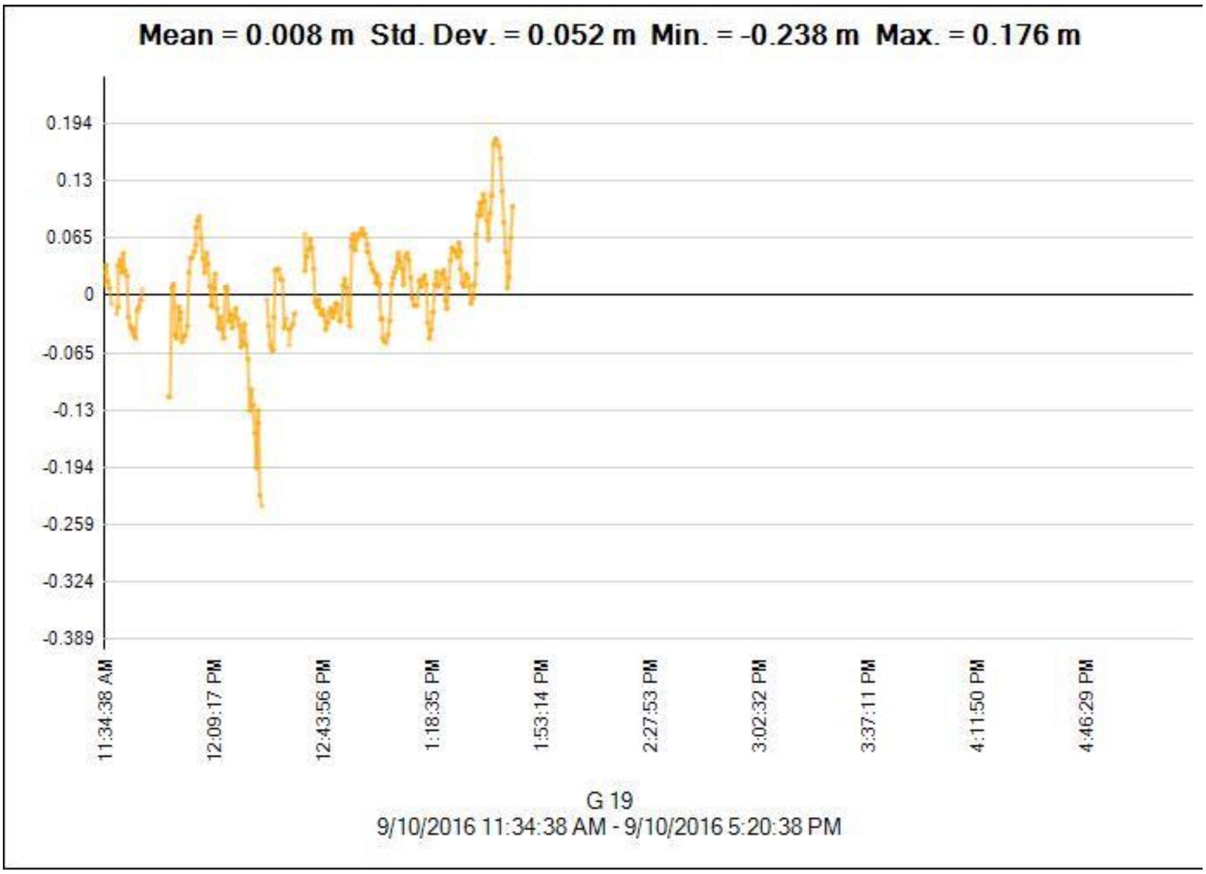

Mean = -0.004 m Std. Dev. = 0.028 m Min. = -0.098 m Max. = 0.083 m
0.194
0.13
0.065
0
-0.065
-0.13
-0.194
-0.259
-0.324
-0.389
11:34:38 AM
12:09:17 PM
12:43:56 PM
1:18:35 PM
1:53:14 PM
2:27:53 PM
3:02:32 PM
3:37:11 PM
4:11:50 PM
4:46:29 PM
G 12
9/10/2016 11:34:38 AM - 9/10/2016 5:20:38 PM

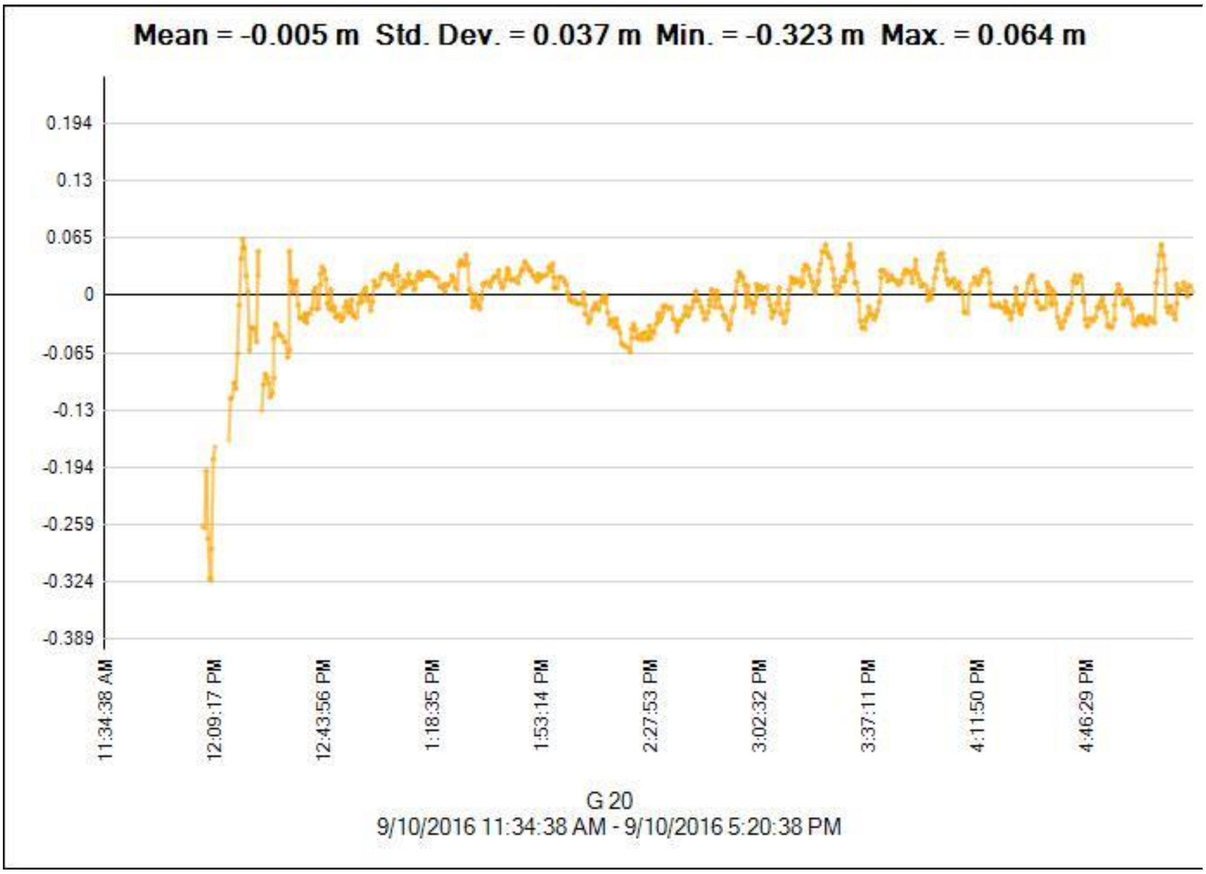

Mean = -0.006 m Std. Dev. = 0.051 m Min. = -0.252 m Max. = 0.129 m
0.194
0.13
0.065
0
-0.065
-0.13
-0.194
-0.259
-0.324
-0.389
11:34:38 AM
12:09:17 PM
12:43:56 PM
1:18:35 PM
1:53:14 PM
2:27:53 PM
3:02:32 PM
3:37:11 PM
4:11:50 PM
4:46:29 PM
G 13
9/10/2016 11:34:38 AM - 9/10/2016 5:20:38 PM

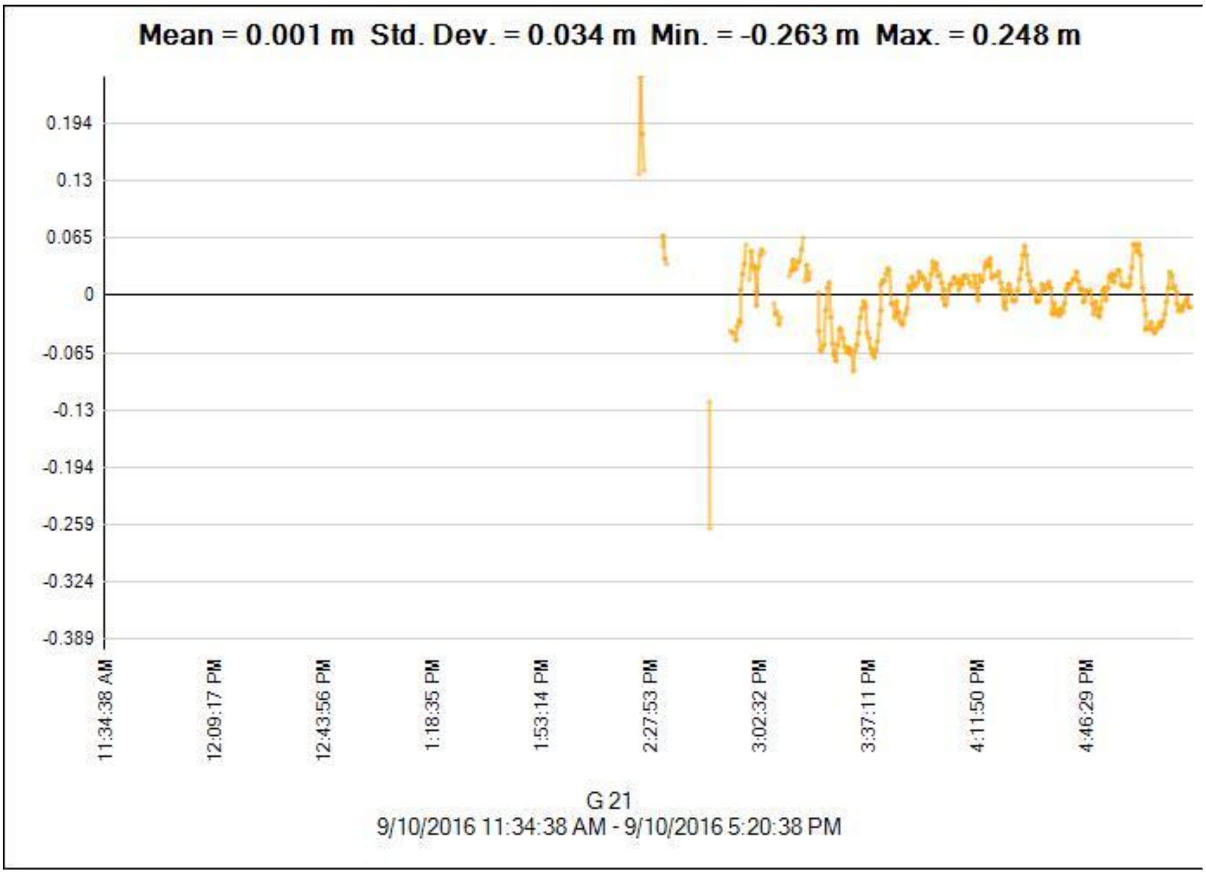

Mean = -0.013 m Std. Dev. = 0.028 m Min. = -0.180 m Max. = 0.071 m
0.194
0.13
0.065
0
-0.065
-0.13
-0.194
-0.259
-0.324
-0.389
11:34:38 AM
12:09:17 PM
12:43:56 PM
1:18:35 PM
1:53:14 PM
2:27:53 PM
3:02:32 PM
3:37:11 PM
4:11:50 PM
4:46:29 PM
G 15
9/10/2016 11:34:38 AM - 9/10/2016 5:20:38 PM


Mean = -0.001 m Std. Dev. = 0.060 m Min. = -0.172 m Max. = 0.156 m
0.194
0.13
0.065
0
-0.065
-0.13
-0.194
-0.259
-0.324
-0.389
11:34:38 AM
12:09:17 PM
12:43:56 PM
1:18:35 PM
1:53:14 PM
2:27:53 PM
3:02:32 PM
3:37:11 PM
4:11:50 PM
4:46:29 PM
G 17
9/10/2016 11:34:38 AM - 9/10/2016 5:20:38 PM


Mean = -0.002 m Std. Dev. = 0.024 m Min. = -0.068 m Max. = 0.084 m
0.194
0.13
0.065
0
-0.065
-0.13
-0.194
-0.259
-0.324
-0.389
11:34:38 AM
12:09:17 PM
12:43:56 PM
1:18:35 PM
1:53:14 PM
2:27:53 PM
3:02:32 PM
3:37:11 PM
4:11:50 PM
4:46:29 PM
G 18
9/10/2016 11:34:38 AM - 9/10/2016 5:20:38 PM


Mean = 0.008 m Std. Dev. = 0.052 m Min. = -0.238 m Max. = 0.176 m
0.194
0.13
0.065
0
-0.065
-0.13
-0.194
-0.259
-0.324
-0.389
11:34:38 AM
12:09:17 PM
12:43:56 PM
1:18:35 PM
1:53:14 PM
2:27:53 PM
3:02:32 PM
3:37:11 PM
4:11:50 PM
4:46:29 PM
G 19
9/10/2016 11:34:38 AM - 9/10/2016 5:20:38 PM


Mean = -0.005 m Std. Dev. = 0.037 m Min. = -0.323 m Max. = 0.064 m
0.194
0.13
0.065
0
-0.065
-0.13
-0.194
-0.259
-0.324
-0.389
11:34:38 AM
12:09:17 PM
12:43:56 PM
1:18:35 PM
1:53:14 PM
2:27:53 PM
3:02:32 PM
3:37:11 PM
4:11:50 PM
4:46:29 PM
G 20
9/10/2016 11:34:38 AM - 9/10/2016 5:20:38 PM


Mean = 0.001 m Std. Dev. = 0.034 m Min. = -0.263 m Max. = 0.248 m
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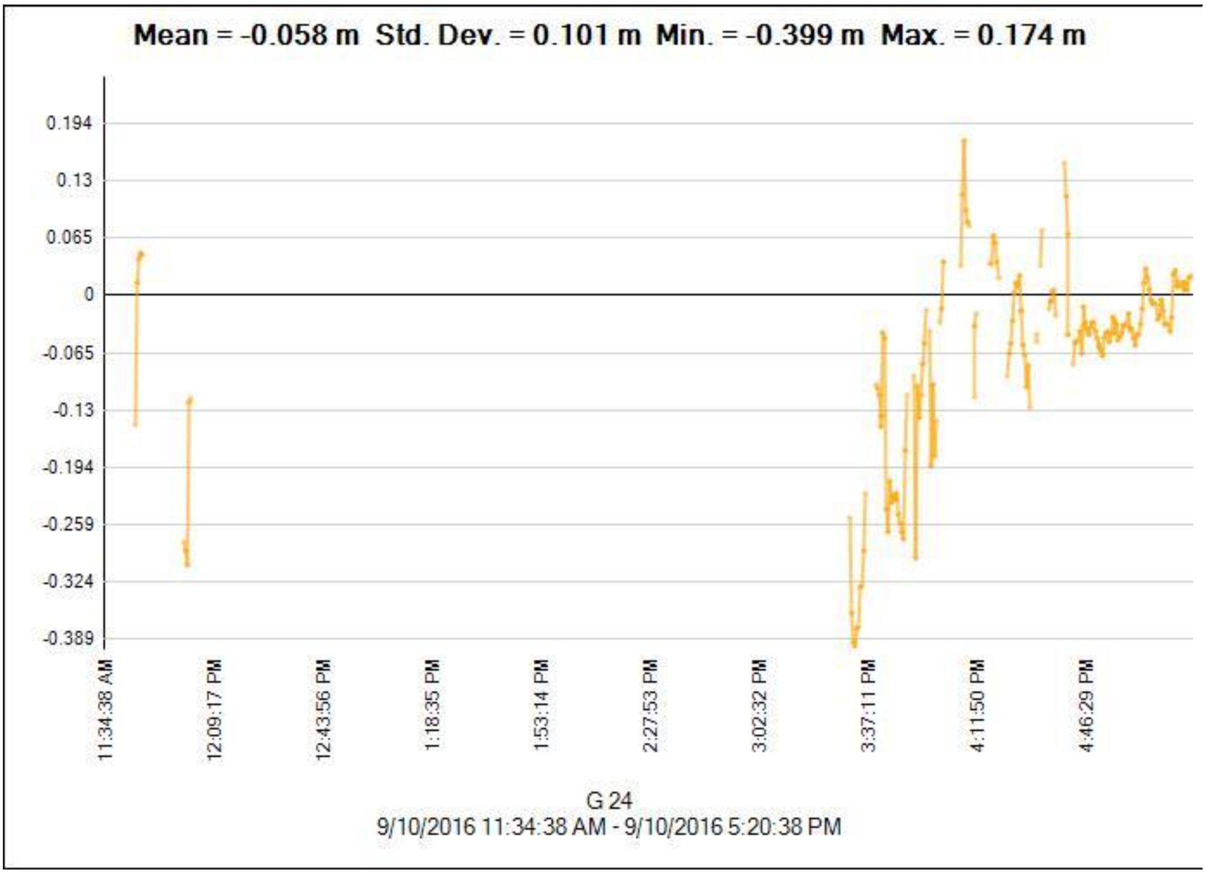
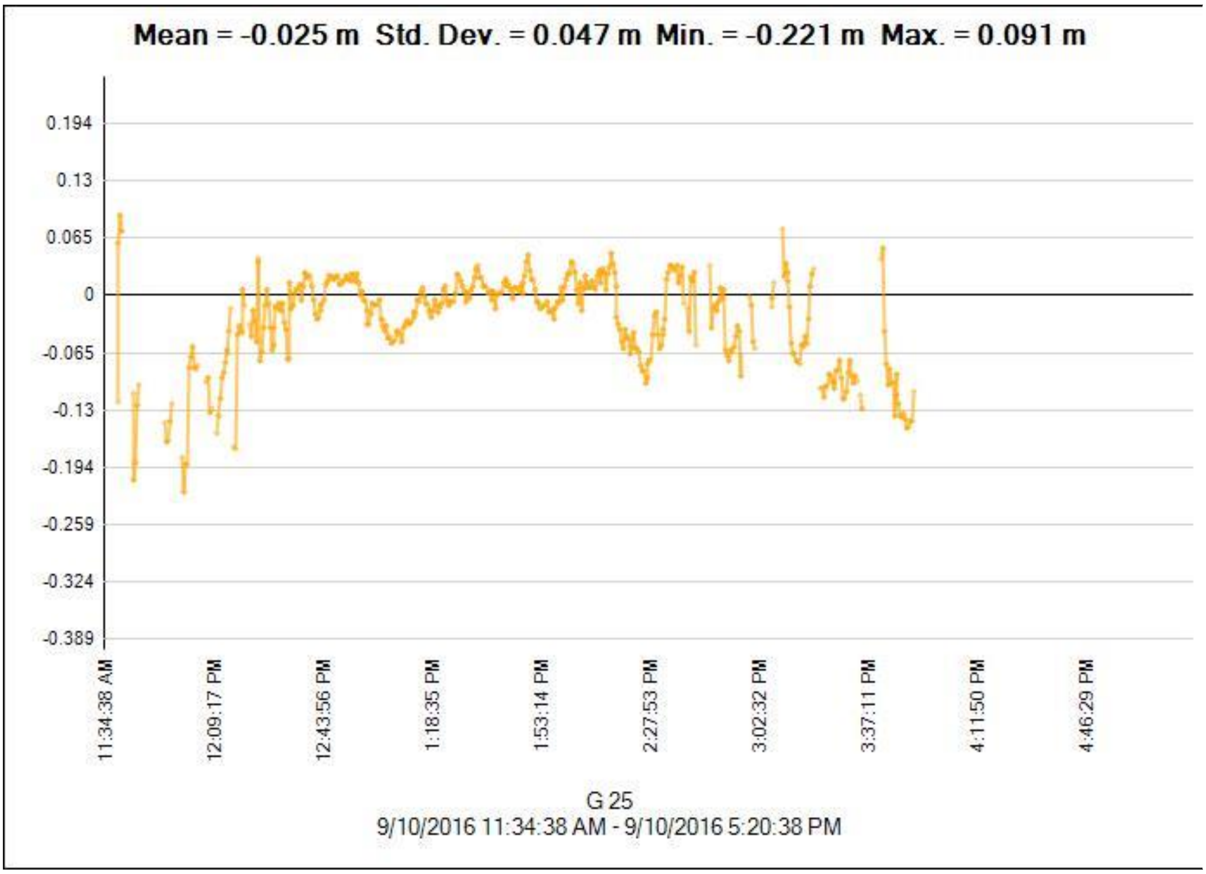
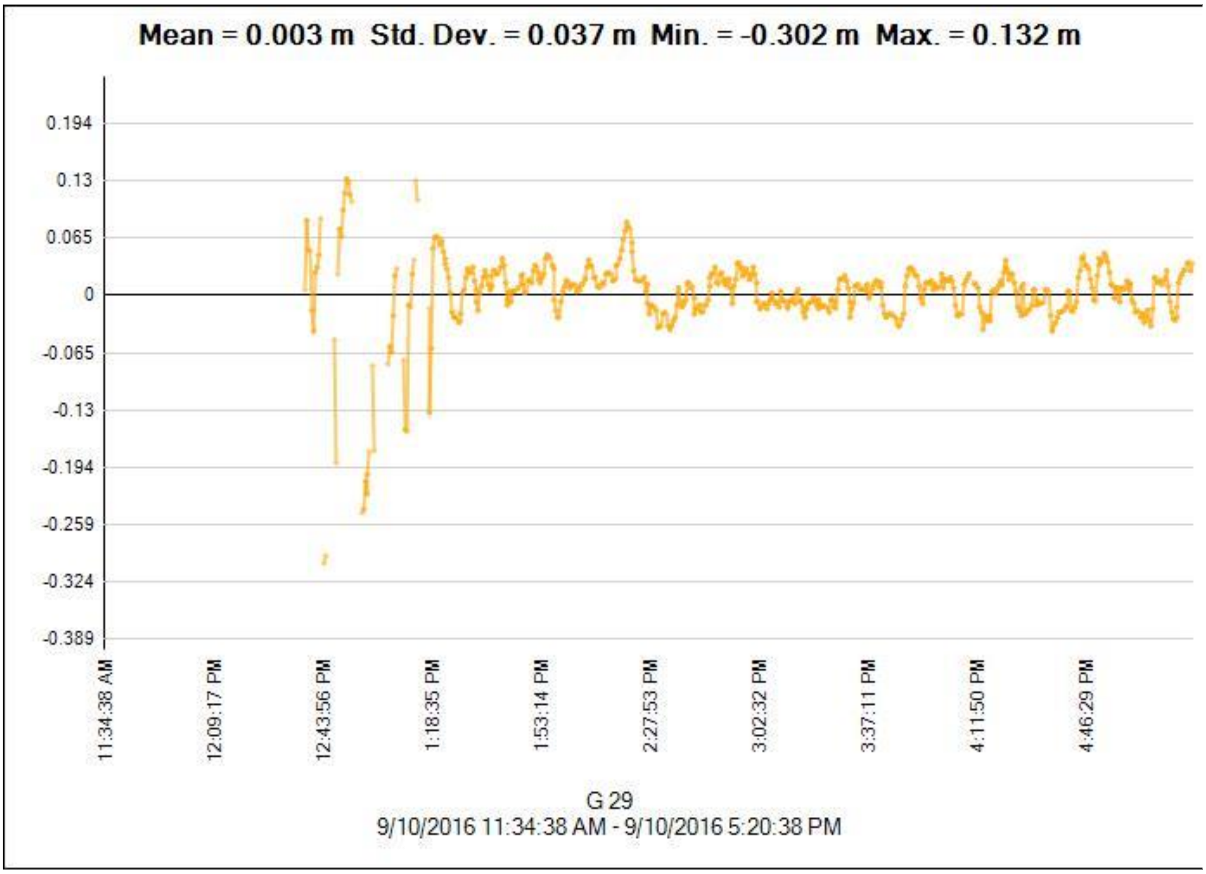
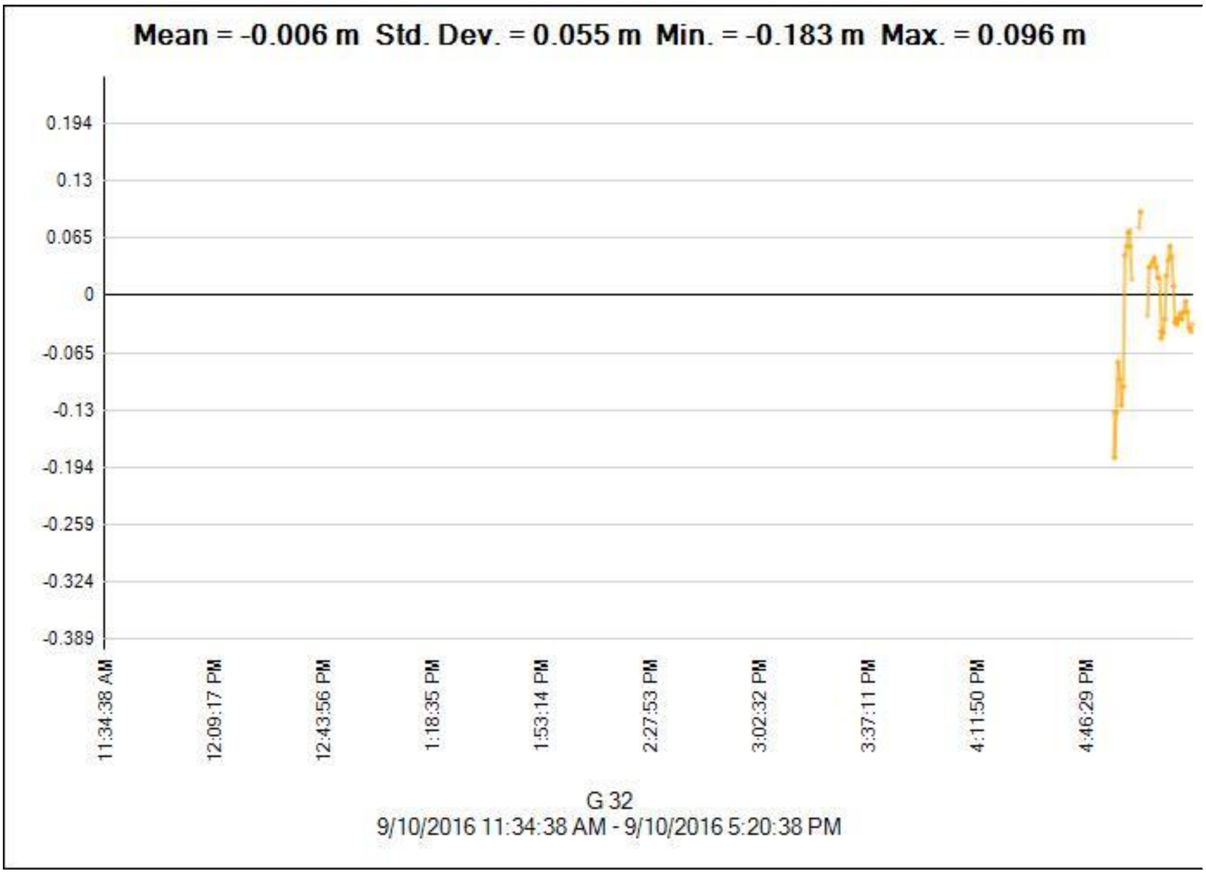
0.13
0.065
0
-0.065
-0.13
-0.194
-0.259
-0.324
-0.389
11:34:38 AM
12:09:17 PM
12:43:56 PM
1:18:35 PM
1:53:14 PM
2:27:53 PM
3:02:32 PM
3:37:11 PM
4:11:50 PM
4:46:29 PM
G 21
9/10/2016 11:34:38 AM - 9/10/2016 5:20:38 PM


Mean = -0.058 m Std. Dev. = 0.101 m Min. = -0.399 m Max. = 0.174 m
0.194
0.13
0.065
0
-0.065
-0.13
-0.194
-0.259
-0.324
-0.389
11:34:38 AM
12:09:17 PM
12:43:56 PM
1:18:35 PM
1:53:14 PM
2:27:53 PM
3:02:32 PM
3:37:11 PM
4:11:50 PM
4:46:29 PM
G 24
9/10/2016 11:34:38 AM - 9/10/2016 5:20:38 PM


Mean = -0.025 m Std. Dev. = 0.047 m Min. = -0.221 m Max. = 0.091 m
0.194
0.13
0.065
0
-0.065
-0.13
-0.194
-0.259
-0.324
-0.389
11:34:38 AM
12:09:17 PM
12:43:56 PM
1:18:35 PM
1:53:14 PM
2:27:53 PM
3:02:32 PM
3:37:11 PM
4:11:50 PM
4:46:29 PM
G 25
9/10/2016 11:34:38 AM - 9/10/2016 5:20:38 PM


Mean = 0.003 m Std. Dev. = 0.037 m Min. = -0.302 m Max. = 0.132 m
0.194
0.13
0.065
0
-0.065
-0.13
-0.194
-0.259
-0.324
-0.389
11:34:38 AM
12:09:17 PM
12:43:56 PM
1:18:35 PM
1:53:14 PM
2:27:53 PM
3:02:32 PM
3:37:11 PM
4:11:50 PM
4:46:29 PM
G 29
9/10/2016 11:34:38 AM - 9/10/2016 5:20:38 PM


Mean = -0.006 m Std. Dev. = 0.055 m Min. = -0.183 m Max. = 0.096 m
0.194
0.13
0.065
0
-0.065
-0.13
-0.194
-0.259
-0.324
-0.389
11:34:38 AM
12:09:17 PM
12:43:56 PM
1:18:35 PM
1:53:14 PM
2:27:53 PM
3:02:32 PM
3:37:11 PM
4:11:50 PM
4:46:29 PM
G 32
9/10/2016 11:34:38 AM - 9/10/2016 5:20:38 PM

Processing style

Elevation mask:	10.0 deg
Auto start processing:	Yes
Start automatic ID numbering:	AUTO0001
Continuous vectors:	No
Generate residuals:	Yes
Antenna model:	Automatic
Ephemeris type:	Automatic
Frequency:	Multiple Frequencies
Processing Interval:	Use all data
Force float:	No

Acceptance Criteria

Vector Component	Flag	Fail
Horizontal Precision >	0.050 m + 1.000 ppm	0.100 m + 1.000 ppm
Vertical Precision >	0.100 m + 1.000 ppm	0.200 m + 1.000 ppm

ANNEXURE G – LEVELING REPORT FROM BENCH MARK TO TIDE POLE

LOCATION	CHOTA BANSHYAM NAGAR
TBM VALUE	**6.703**
TBM	**TBM 2**
ZERO OF GAUGE W.R.T. SD	**+1.270M**
TIME	**14:40 HRS TO 17:40 HRS**
DATE	**9/5/2016**
OBSERVER	**JIBIN LAL**

TBM 2 TO TIDE POLE				
BS	FS	HI	RL	REMARK
0.088		6.791	6.703	TMB 2
	5.521		1.27	TIDE POLE

TIDE POLE TO TBM 2				
BS	FS	HI	RL	REMARK
5.519		6.789	1.27	TIDE POLE
	0.086		6.703	TBM 2

LOCATION	LOTHIAN (UTTAR CHANDANPIDI)
TBM VALUE	**5.537**
TBM	**TBM 3**
DATE	**9/6/2016**
TIME	**10:00 TO 13:50**
ZERO OF TIDE POLE	**5.537 m**
OBERVER	**VAIBHAV**

TBM 3 TO TIDE POLE				
BS	FS	HI	RL	REMARK
1.286		6.823	5.537	TBM 3
	4.363		2.46	TIDE POLE

TIDE POLE TO TBM 3				
BS	FS	HI	RL	REMARK
4.352		6.812	2.46	TIDE POLE
	1.275		5.537	TBM 3

LOCATION	BAGNAPARA
TBM VALUE	6.867
TBM	TBM 5
ZERO OF GAUGE W.R.T. SD	+1.457 M
TIME	10:00 HRS TO 12:00HRS
DATE	9/9/2016
OBSERVER	JIBIN LAL

LOCATION	MOLLAKHALI
TBM VALUE	6.294
AT TBM	TBM 6
ZERO OF GAUGE W.R.T. SD	**+2.681 M**
TIME	11:35 HRS TO 14:15HRS
DATE	10/9/2016
OBSERVER	AMAL

TBM 5 TO TIDE POLE				
BS	FS	HI	RL	REMARK
0.334		7.201	6.867	TMB 5
	5.744		1.457	TIDE POLE

TIDE POLE TO TBM 5				
BS	FS	HI	RL	REMARK
5.611		7.068	6.867	TIDE POLE
	0.201		1.457	TBM 5

LOCATION	KUMIR MARI
BM VALUE	6.784
AT TBM	TBM 4
ZERO OF GAUGE W.R.T. SD	**+2.03 M**
TIME	10:00 HRS TO 13:00HRS
DATE	9/8/2016
OBSERVER	JIBIN LAL

TBM 4 TO TIDE POLE

BS	FS	HI	RL	REMARK
0.054		6.838	6.784	TMB 4
	4.808		2.03	TIDE POLE

TIDE POLE TO TBM 4

BS	FS	HI	RL	REMARK
4.857		6.887	2.03	TIDE POLE
	0.103		6.784	TBM 4

TBM 6 TO TIDE POLE

BS	FS	HI	RL	REMARK
0.811		7.105	6.294	TMB 2
	4.424		2.681	TIDE POLE

TIDE POLE TO TBM 6

BS	FS	HI	RL	REMARK
4.443		7.124	2.681	TIDE POLE
	0.83		6.294	TBM 2

LOCATION	HEMNAGAR
TBM VALUE	6.934
TBM	TBM 1
ZERO OF GAUGE W.R.T. SD	**+1.696 M**
TIME	7:20 HRS TO 17:20HRS
DATE	13/9/2016
OBSERVER	AMAL

TBM 1 TO TIDE POLE

BS	FS	HI	RL	REMARK
0.114		7.048	6.934	TMB 1
	5.352		1.696	TIDE POLE

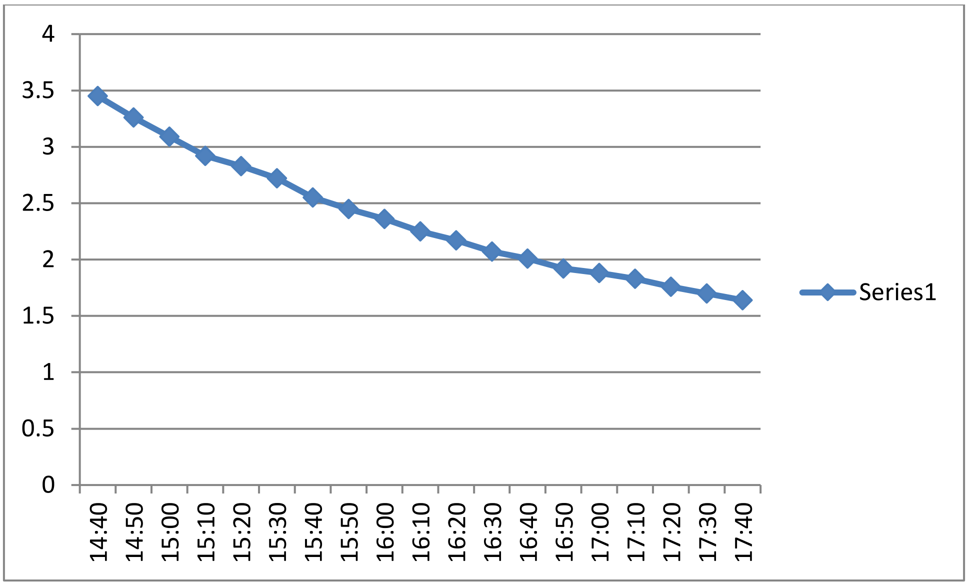
TIDE POLE TO TBM 1

BS	FS	HI	RL	REMARK
5.342		7.038	1.696	TIDE POLE
	0.104		6.934	TBM 1

ANNEXURE H – TIDE OBSERVATIONS

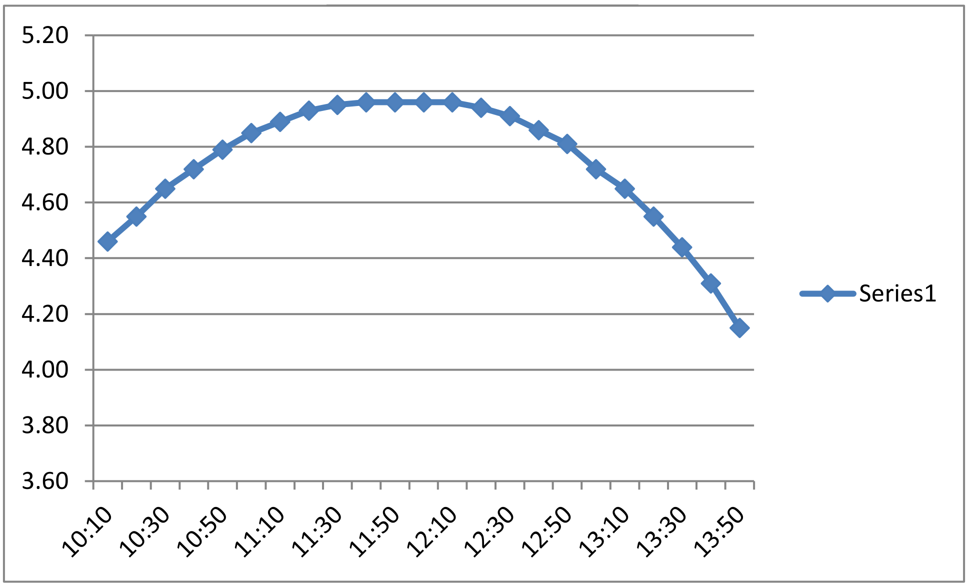
LOCATION	CHOTA BANSHYAM NAGAR
TBM VALUE	6.703
TBM	TBM 2
TIME	14:40 HRS TO 17:40 HRS
DATE	9/5/2016
OBSERVER	JIBIN LAL

TIME	CORRECTED TIDE
14:40	3.45
14:50	3.26
15:00	3.09
15:10	2.92
15:20	2.83
15:30	2.72
15:40	2.55
15:50	2.45
16:00	2.36
16:10	2.25
16:20	2.17
16:30	2.07
16:40	2.01
16:50	1.92
17:00	1.88
17:10	1.83
17:20	1.76
17:30	1.7
17:40	1.64



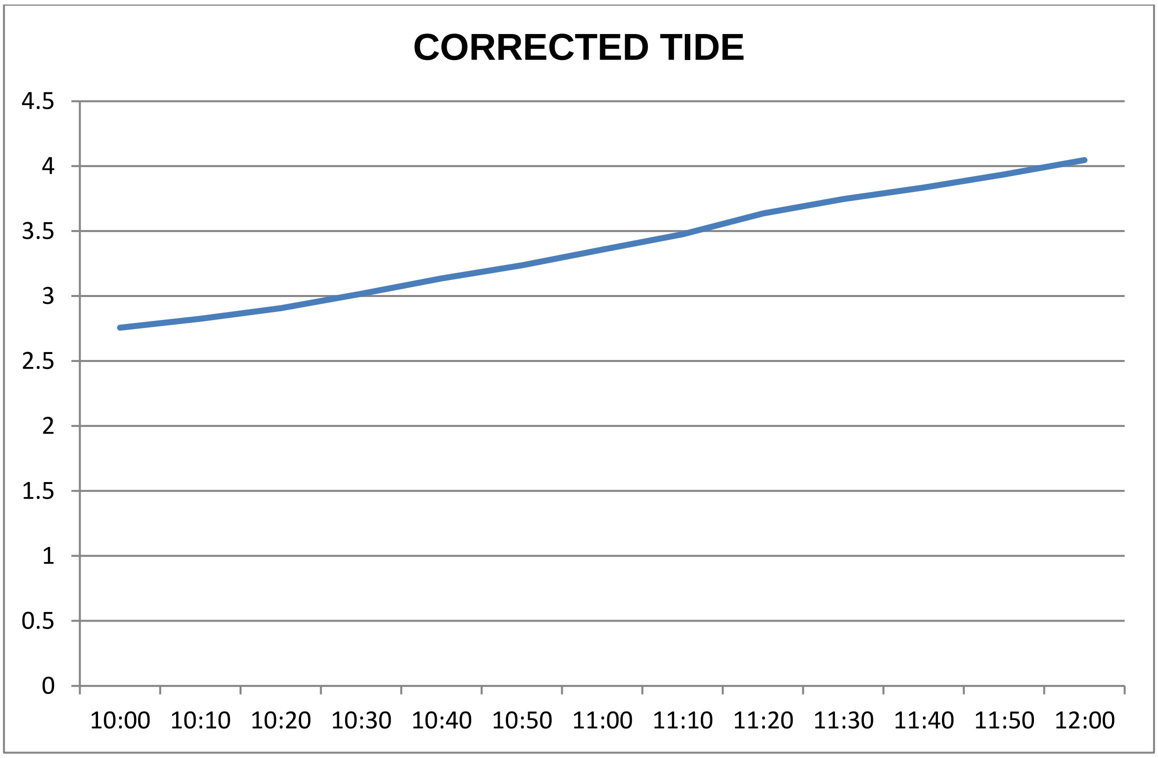
LOCATION	LOTHIAN (UTTAR CHANDANPIDI)
TBM 3 VALUE	5.537
DATE	9/6/2016
TIME	10:00 TO 13:50
ZERO OF TIDE POLE	3.484
OBERVER	VAIBHAV

TIME	CORRECTED TIDE
10:00	4.46
10:10	4.55
10:20	4.65
10:30	4.72
10:40	4.79
10:50	4.85
11:00	4.89
11:10	4.93
11:20	4.95
11:30	4.96
11:40	4.96
11:50	4.96
12:00	4.96
12:10	4.94
12:20	4.91
12:30	4.86
12:40	4.81
12:50	4.72
13:00	4.65



LOCATION	BAGNAPARA
TBM VALUE	6.867
TBM	TBM 5
TIME	10:00 HRS TO 12:00HRS
DATE	9/9/2016
OBSERVER	JIBIN LAL

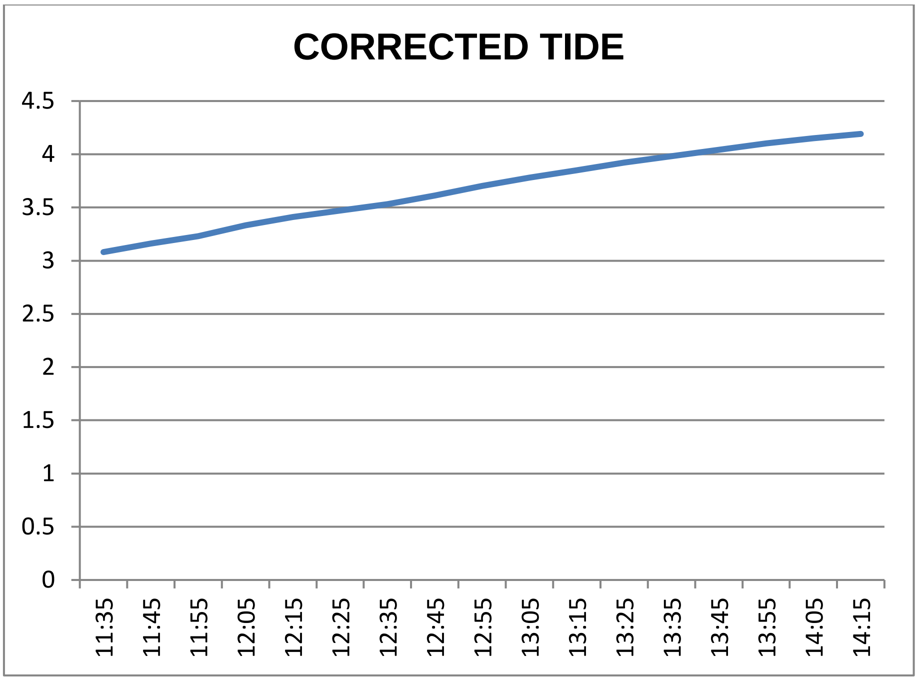
TIME	CORRECTED TIDE
10:00	2.757
10:10	2.827
10:20	2.907
10:30	3.017
10:40	3.137
10:50	3.237
11:00	3.357
11:10	3.477
11:20	3.637
11:30	3.747
11:40	3.837
11:50	3.937
12:00	4.047



LOCATION	MOLLAKHALI
TBM VALUE	6.294
AT TBM	TBM 6
TIME	11:35 HRS TO 14:15HRS
DATE	10/9/2016
OBSERVER	AMAL

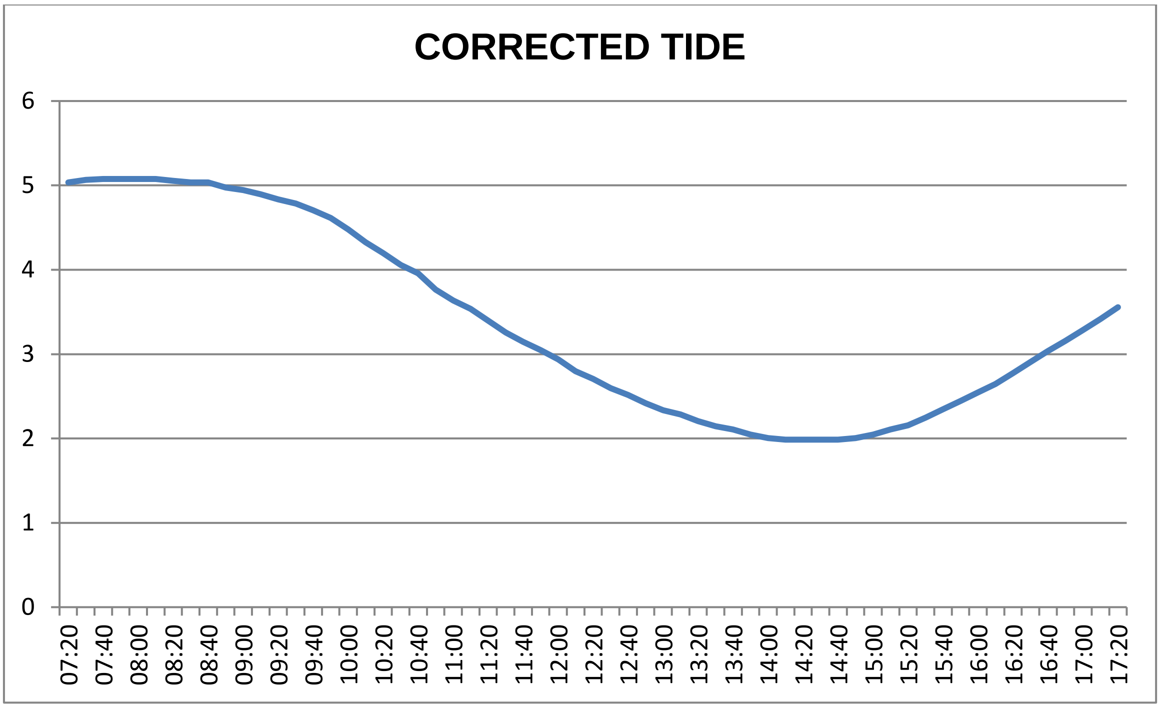
TIME	**CORRECTED TIDE**
11:35	3.081
11:45	3.161
11:55	3.231
12:05	3.331
12:15	3.411
12:25	3.471
12:35	3.531
12:45	3.611
12:55	3.701
13:05	3.781
13:15	3.851
13:25	3.921
13:35	3.981
13:45	4.041
13:55	4.101
14:05	4.151
14:15	4.191

LOCATION	HEMNAGAR
TBM VALUE	6.934
TBM	TBM 1
TIME	7:20 HRS TO 17:20HRS
DATE	13/9/2016
OBSERVER	AMAL



TIME	CORRECTED TIDE
7:20	5.036
7:30	5.066
7:40	5.076
7:50	5.076
8:00	5.076
8:10	5.076
8:20	5.056
8:30	5.036
8:40	5.036
8:50	4.976
9:00	4.946
9:10	4.896
9:20	4.836
9:30	4.786
9:40	4.706
9:50	4.616
10:00	4.476
10:10	4.326
10:20	4.196
10:30	4.056
10:40	3.956
10:50	3.766
11:00	3.636

11:10	3.536
11:20	3.396
11:30	3.256
11:40	3.146
11:50	3.046
12:00	2.936
12:10	2.796
12:20	2.706
12:30	2.596
12:40	2.516
12:50	2.416
13:00	2.336
13:10	2.286
13:20	2.206
13:30	2.146
13:40	2.106
13:50	2.046
14:00	2.006
14:10	1.986
14:20	1.986
14:30	1.986
14:40	1.986
14:50	2.006
15:00	2.046
15:10	2.106
15:20	2.156
15:30	2.246
15:40	2.346
15:50	2.446
16:00	2.546
16:10	2.646
16:20	2.776
16:30	2.906
16:40	3.036
16:50	3.156
17:00	3.286
17:10	3.416
17:20	3.556


CORRECTED TIDE
0
1
2
3
4
5
6
07:20
07:40
08:00
08:20
08:40
09:00
09:20
09:40
10:00
10:20
10:40
11:00
11:20
11:40
12:00
12:20
12:40
13:00
13:20
13:40
14:00
14:20
14:40
15:00
15:20
15:40
16:00
16:20
16:40
17:00
17:20

ANNEXURE I – Water and Bottom Sample Report

WATER SAMPLE REPORT

JPCL

JUBILANT PHARMA & CHEMICAL LAB

THE QUALITY & COMMITMENT YOU TRUST

Accreditation: NABL for Chemical & Biology (T-2790 & T-2971 Certification: FDA for Chemical, Instrumentation & Biology (MH/101584 & TL/Ayu/01-16), ISO9001:2008, ISO14001:2004, ISO18001:2007

TEST REPORT

Report No.	C/16/1528-1551	Report Date	01.10.2016

Name of Customer: **GEOSERVICES MARITIME PVT. LTD**	
Customer Address: Plot No. D-14 & 15, Sector-6 , New Panvel (E) Navi Mumbai, India – 410 206	
Telephone No.:- NM	Fax No. : 022 - 27490588
Email ID:- **operations@geoservicesmaritime.com**	

Name of Sample: **Water Sample - 24 (Liquid)**	Batch no./vehicle No:- NM
Sample Collected By: Customer	
Date of Manufacturing : NM	Date of Expiry: NM
Sample Reference Number: QA/ *C/16/1528-1551*	Sample Received Date: 24/09/2016
Date of Analysis Started: 24/09/2016	Date of Analysis Completed: 01/10/2016

Results of Analysis & protocols of Tests Applied

		Parameters		
Ref. No.	**Name of Sample**	**pH**	**Specific Gravity**	**Sediment Concentration % by Mass**
C/16/1528	Banashyamnagar-1	7.25	0.9919	0.000084
C/16/1529	Banashyamnagar-2	7.11	1.0293	0.000247
C/16/1530	Banashyamnagar-3	7.15	0.9924	0.000236
C/16/1531	Banashyamnagar-4	7.32	1.0291	0.000397
C/16/1532	Lothian-1	7.15	1.0164	0.000156
C/16/1533	Lothian-2	7.28	1.0112	0.00016
C/16/1534	Lothian-3	7.41	1.0159	0.000198
C/16/1535	Lothian-4	7.32	1.00909	0.000182
C/16/1536	Kumir Mari-1	7.15	0.9907	0.000086
C/16/1537	Kumir Mari-2	7.38	1.0263	0.000161
C/16/1538	Kumir Mari-3	7.31	0.9885	0.000172
C/16/1539	Kumir Mari-4	7.35	1.02619	0.000124
C/16/1540	Baganapara -1	7.28	0.9863	0.00006
C/16/1541	Baganapara -2	7.21	0.9915	0.000079
C/16/1542	Baganapara -3	7.40	1.01779	0.000061
C/16/1543	Baganapara -4	7.39	1.023463	0.000069
C/16/1544	Mollakhali-1	7.36	0.9905	0.000059
C/16/1545	Mollakhali-2	7.40	1.026855	0.000126

Surya Gayathri CHS. Ltd., Shop No. 10 to 15, Plot No. D-14/15, Sector no. 6, New Panvel (E), Navi Mumbai - 410 206
Con. No.: 022 - 65233936 / 65133332 / 65643936 / 27450686 / 9819659434 / 9167400988
Email: jubilant.pharmalab@gmail.com / madhuri.deshmukh66@gmail.com

C/16/1546	Mollakhali-3	7.41	0.98995	0.000098
C/16/1547	Mollakhali-4	7.38	1.02733	0.000097
C/16/1548	Atharabanki-1	7.26	0.9898	0.000187
C/16/1549	Atharabanki-2	7.29	1.026358	0.000187
C/16/1550	Atharabanki-3	7.38	0.9903	0.000198
C/16/1551	Atharabanki-4	7.41	1.02635	0.000166

END OF REPORT

NOTE: This Certificate refers only to the sample tested.
This Certificate may not reproduce in part, without the permission of this laboratory.
Any correction is invalidates in this Certificate.

Analyzed By — 1/10/16 — Ms. Renuka Jadhav (Chemist)

Checked By — 1/10/16 — Ms. Ashwini D Mule (QC-Incharge)

Approved By — 1/10/16 (TSR) — Mr. T.S. Rawat (Lab-Manager)

JUBILANT PHARMA CHEMICAL LAB

SOIL SAMPLE REPORT

JUBILANT PHARMA & CHEMICAL LAB

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JPCL

Accreditation: NABL for Chemical & Biology (T-2790 & T-2971 Certification: FDA for Chemical, Instrumentation & Biology (MH/101584 & TL/Ayu/01-16), ISO9001:2008, ISO14001:2004, ISO18001:2007

TEST REPORT

Report No. C/16/1552-1557 Report Date 01.10.2016

Name of Customer: **GEOSERVICES MARITIME PVT. LTD**

Customer Address: Plot No. D-14 & 15, Sector-6, New Panvel (E) Navi Mumbai, India – 410 206

Telephone No.:- NM Fax No. : 022 - 27490588

Email ID:- **operations@geoservicesmaritime.com**

Name of Sample: **Soil Sample – 6 (Soild)** Batch no./vehicle No:- NM

Sample Collected By: Customer

Date of Manufacturing : NM Date of Expiry: NM

Sample Reference Number: QA/ *C/16/1552-1557* Sample Received Date: 24/09/2016

Date of Analysis Started: 24/09/2016 Date of Analysis Completed: 01/10/2016

Ref. No.	Name of Sample	pH	Specific Gravity	Grain size Distribution			Uniformity Coefficient (Cu)	Coefficient of Curvature (Cc)
				Gravel %	Sand %	Fine (Slit +Clay)%		
C/16/1552	Cholo Banashyamnagar(Clay)	6.81	1.51	1.54	21.17	77.29	1.72	1.03
C/16/1553	Lothian Island(Clay)	6.89	1.39	1.6	27.86	70.54	3.40	0.94
C/16/1554	Kumir Mari(Clay)	6.75	1.54	1.7	25.06	73.24	1.83	0.72
C/16/1555	Baganapara (Clay)	6.71	1.50	3.25	13.05	83.7	3.49	1.09
C/16/1556	Mollakhali (Clay)	7.1	1.52	1.0	2.0	79.0	2.10	0.25
C/16/1557	Atharabank (Clay)	7.21	1.75	3.0	38.34	58.65	3.23	0.48

END OF REPORT

NOTE: This Certificate refers only to the sample tested.
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JUBILANT Pharma & Chemical Lab

Analyzed By **Checked By** **Approved By**

01/10/16 ADM 01/10/16 01/10/16 (TSR)

Ms. Renuka Jadhav (Chemist)

Ms. Ashwini D Mule (QC-Incharge)

Mr. T.S. Rawat (Lab-Manager)

JUBILANT PHARMA CHEMICAL LAB

Surya Gayathri CHS. Ltd., Shop No. 10 to 15, Plot No. D-14/15, Sector no. 6, New Panvel (E), Navi Mumbai - 410 206
Con. No.: 022 - 65233936 / 65133332 / 65643936 / 27450046 / 9819659434 / 9167400988
Email: jubilant.pharmalab@gmail.com / madhuri.deshmukh66@gmail.com

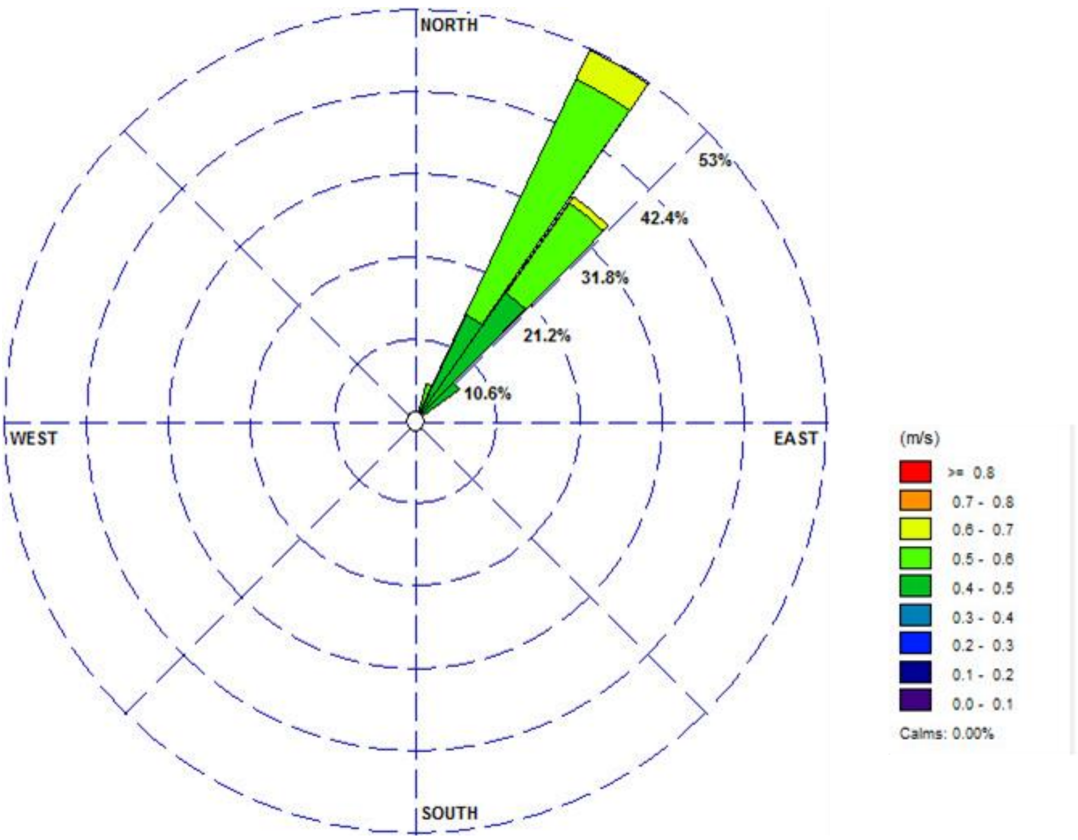
ANNEXURE J – CURRENT METER OBSERVATION

The velocity of flow at any point in the open channel can be most accurately and conveniently determined by means of a mechanical device called current meter. The following table and figures depict the current velocities observed at the 6 survey locations.

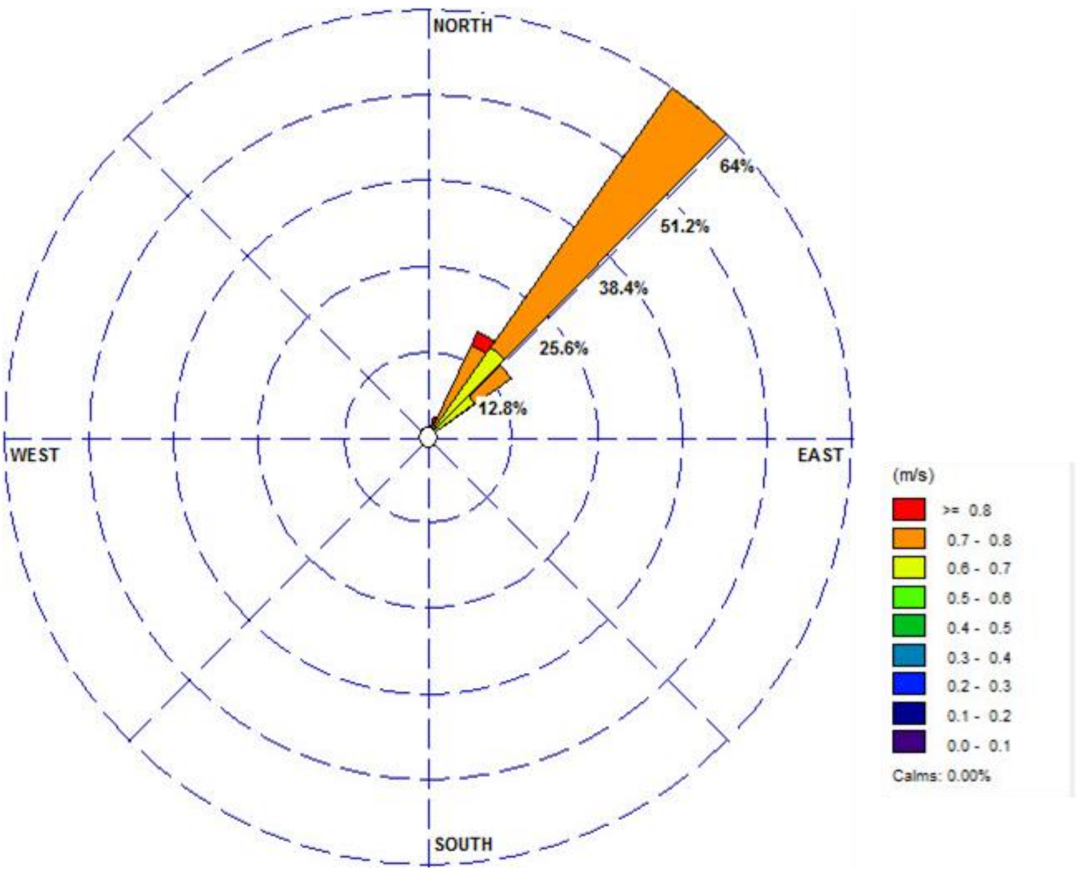
Current Meter Observation					
Date	Location	Time	Position		Depth
			Easting	Northing	
5/9/2016	Choto Banashyamnagar	7.28 pm to 7.45 pm	644153.81	2410933.69	7 m
		7.50 pm to 8.15 pm	644159.63	2410939.46	3.5 m
		8.09 pm to 8.26 pm	644165.24	2410942.58	2.2 m
		8.27 pm to 8.44 pm	644169.35	2410946.68	Surface
6/9/2016	Lothian Island	12.05 pm to 12.20 pm	634558.68	2400862.48	7 m
		12.39 pm to 12.55 pm	634561.74	2400868.45	3.5 m
		1.21 pm to 1.38 pm	634566.85	2400874.35	2.2 m
		1.39 pm to 1.57 pm	634571.35	2400880.36	Surface
8/9/2016	Kumir mari	12.26 pm to 12.42 pm	700912.92	2455199.17	5 m
		12.52 pm to 1.07 pm	700917.54	2455204.21	2.5 m
		3.08 pm to 3.23 pm	700922.68	2455209.08	1.5 m
		3.53 pm to 4.09 pm	700927.17	2455215.08	Surface
9/9/2016	Baganapara	11.58 am to 12.14 pm	699578.02	2454192.96	12 m
		12.16 pm to 12.33 pm	699575.25	2454195.36	6 m
		3.51 pm to 4.07 pm	699580.23	2454201.47	3.6 m
		4.11 pm to 4.28 pm	699583.78	2454207.28	Surface
10/9/2016	Mollakhali	12.12pm to 12.29 pm	696155.33	2453363.65	8 m
		12.35 pm to 12.51 pm	696161.55	2453355.38	4 m
		04.26 pm to 4.43 pm	696150.82	2453371.25	2.4 m
		4.45 pm to 05.01 pm	696145.94	2453359.65	Surface
13/9/2016	Atharabanki	02.18 pm to 02.33 pm	715508.86	2431530.86	20 m
		02.35 pm to 02.50 pm	715511.06	2431532.94	10 m
		03.52 pm to 03.09 pm	715514.35	2431536.38	6 m
		03.10 pm to 03.26 pm	715517.69	2431541.98	Surface

In the following figures, the side vertical bar represents the velocity in m / s with the colours depicting different velocity ranges.

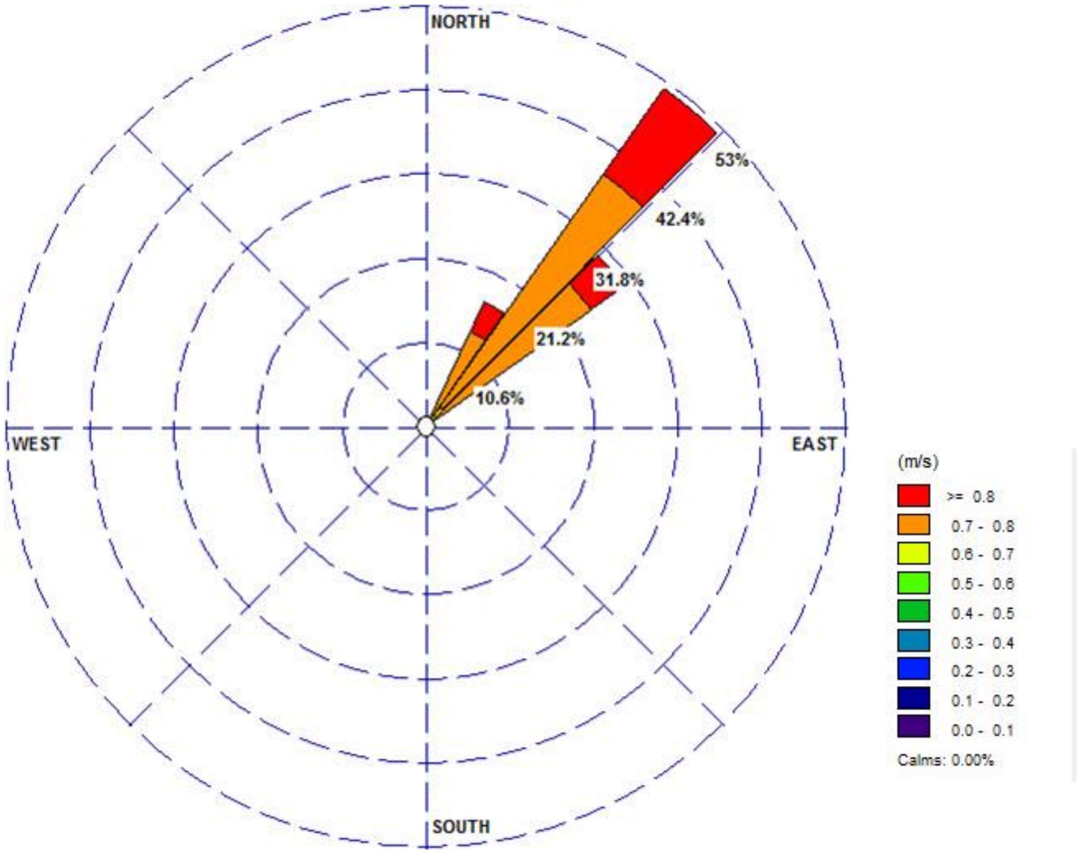
The current is flowing in the North-East direction in Choto Banashyamnagar, South-West direction in Lothian Island, South-East & North-West direction in Kumirmari, North-East, South-West & North-West direction in Bagnapara, South-East and North-West direction in Mollakhali and South-West & North-East direction in Atharabanki.



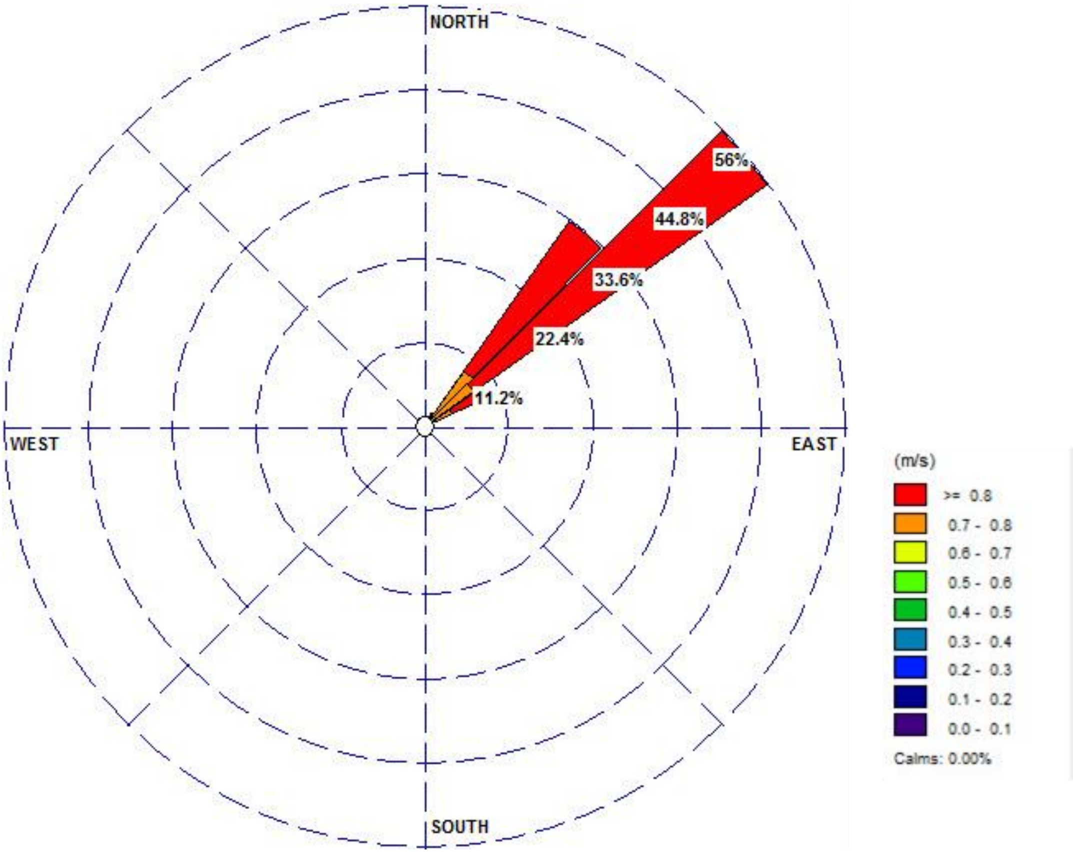
Choto Banashyamnagar
Depth : 5.5 m



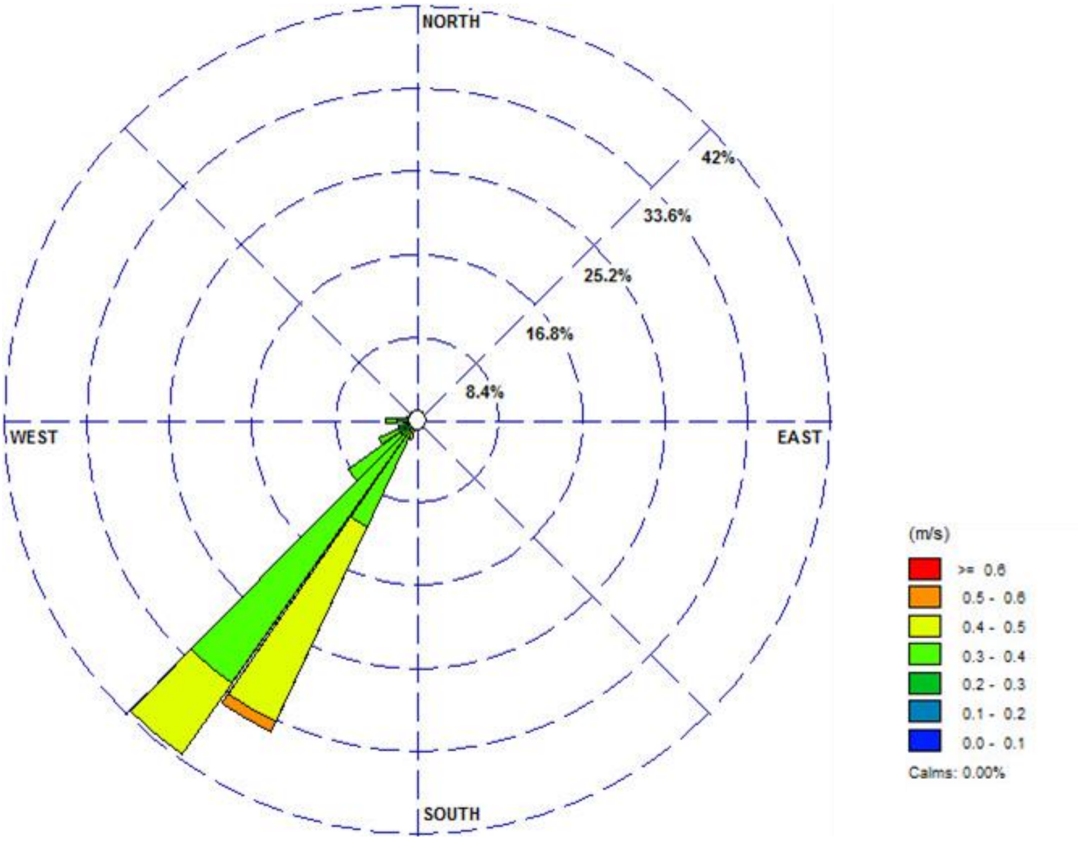
Choto Banashyamnagar
Depth : 2.2 m



Choto Banashyamnagar
Depth : 1.5m

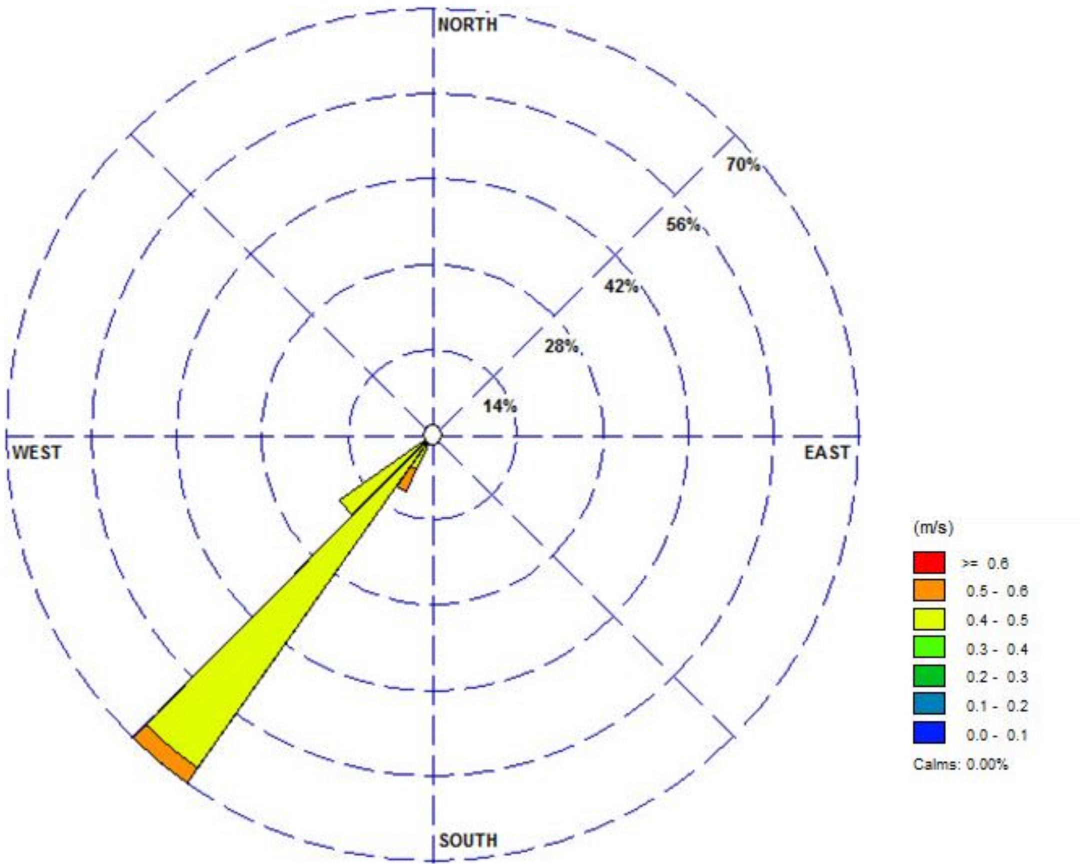


Choto Banashyamnagar
Surface



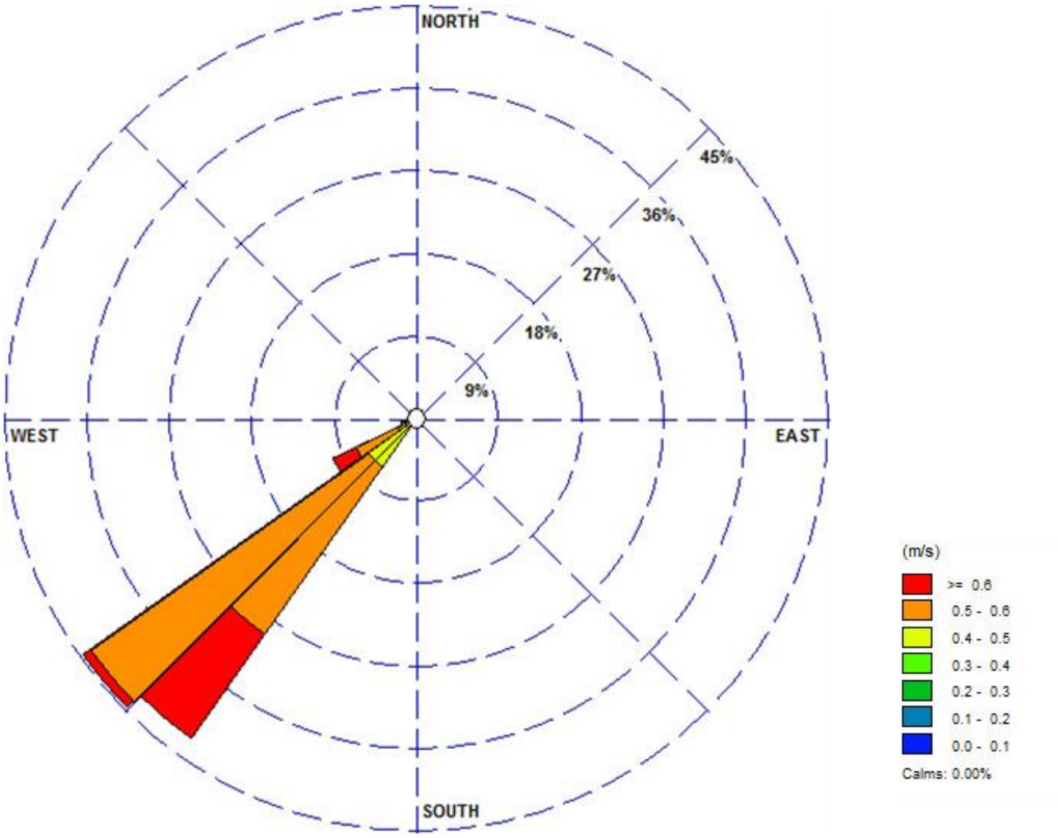
Lothian Island

Depth: 6 m



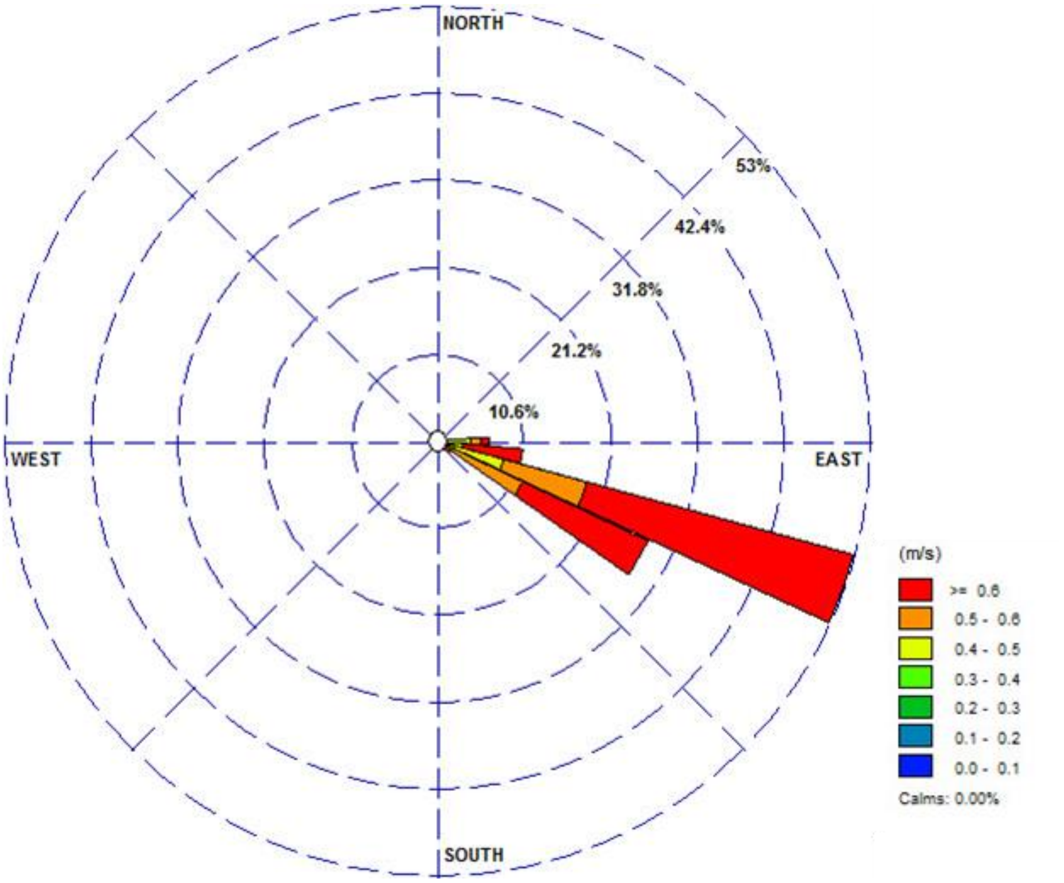
Lothian Island

Depth: 3 m

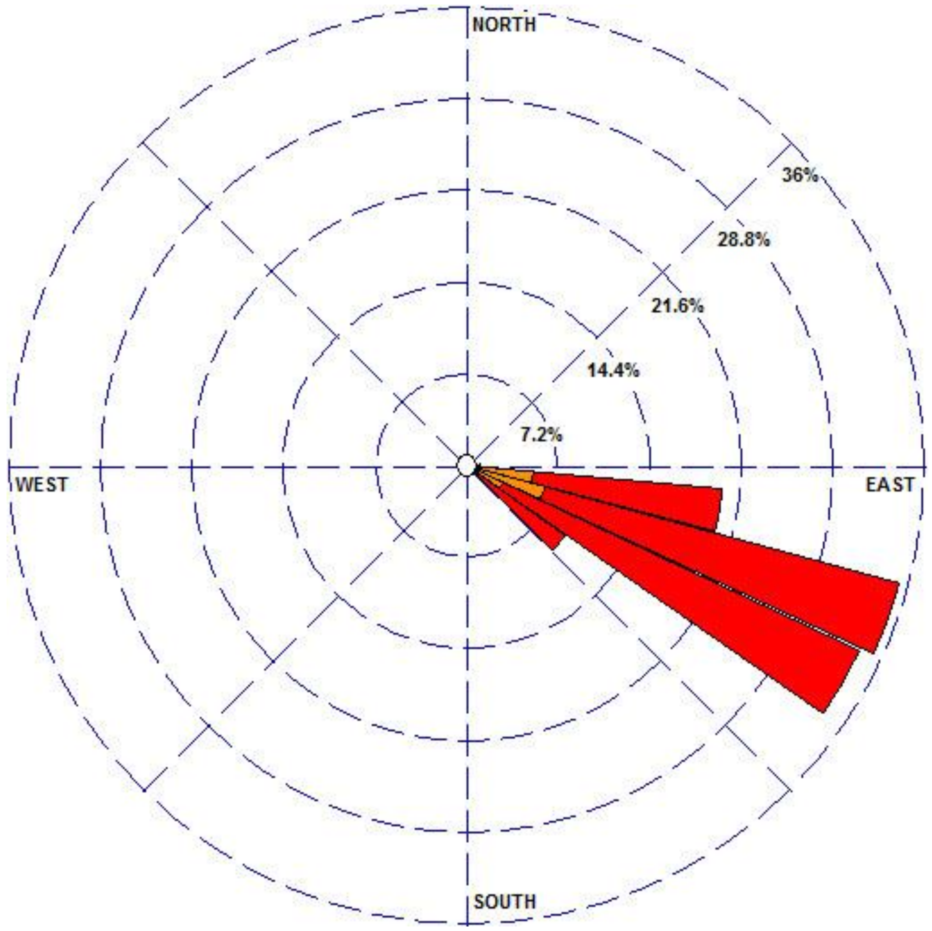


Lothian Island

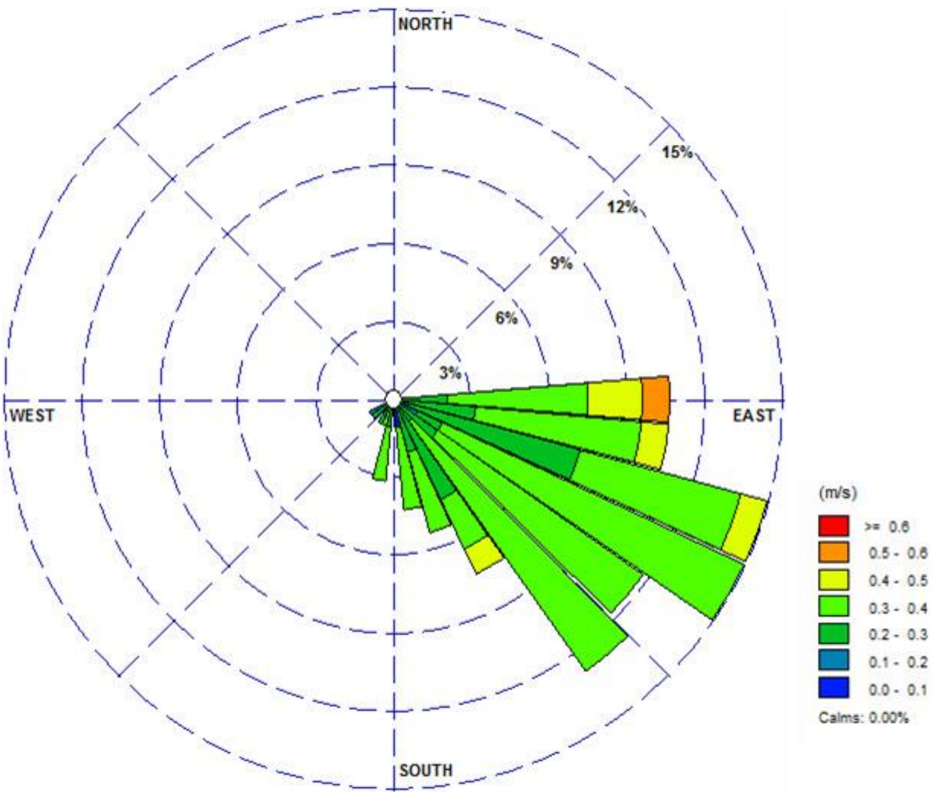
Surface



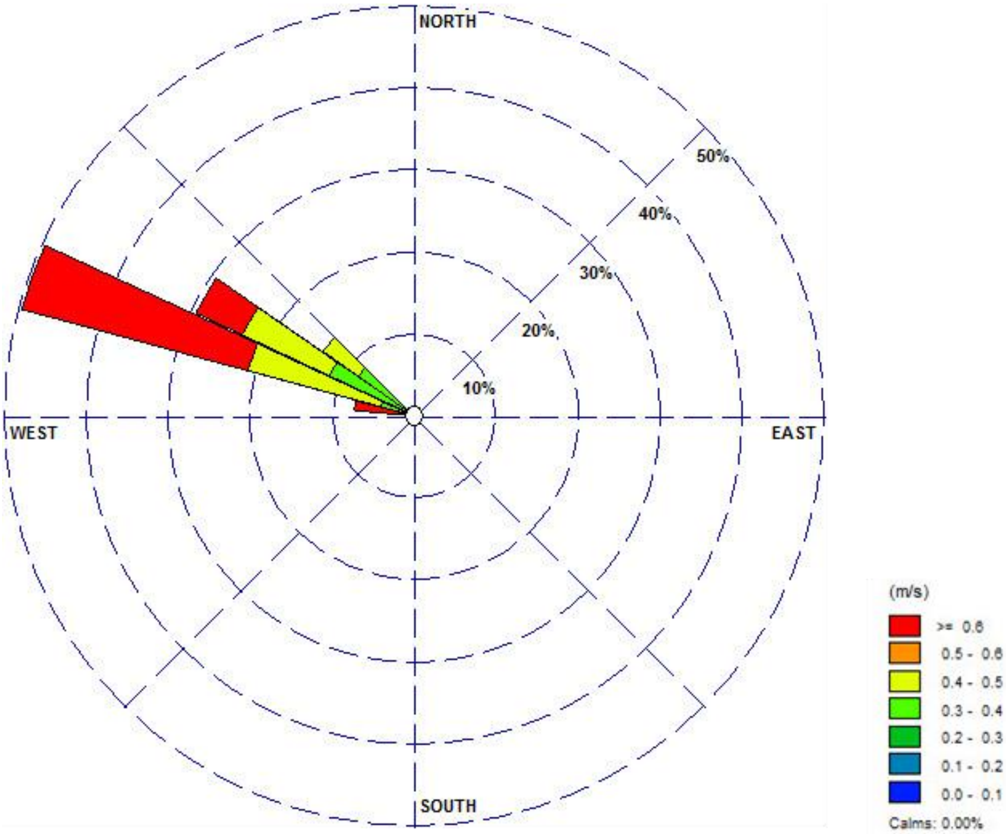
Kumir mari
5 mtr



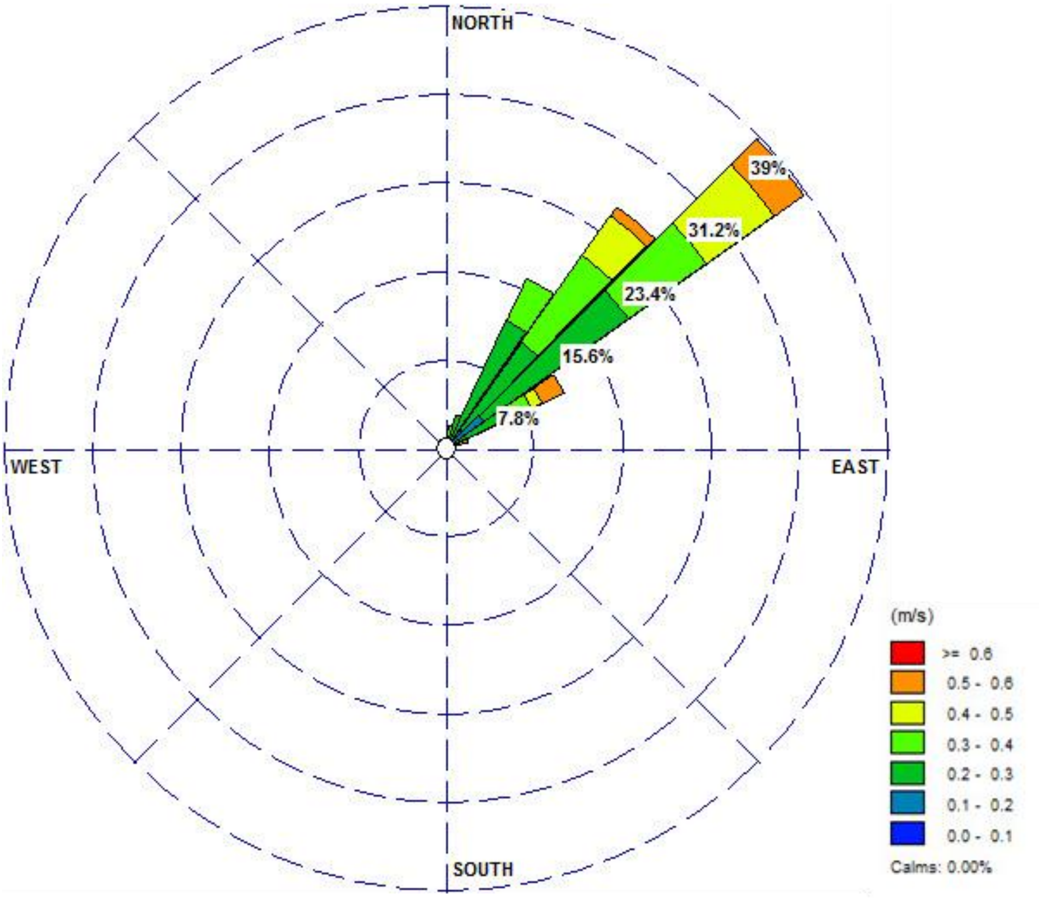
Kumir mari
2.5 mtr



Kumir mari
1.5 mtr

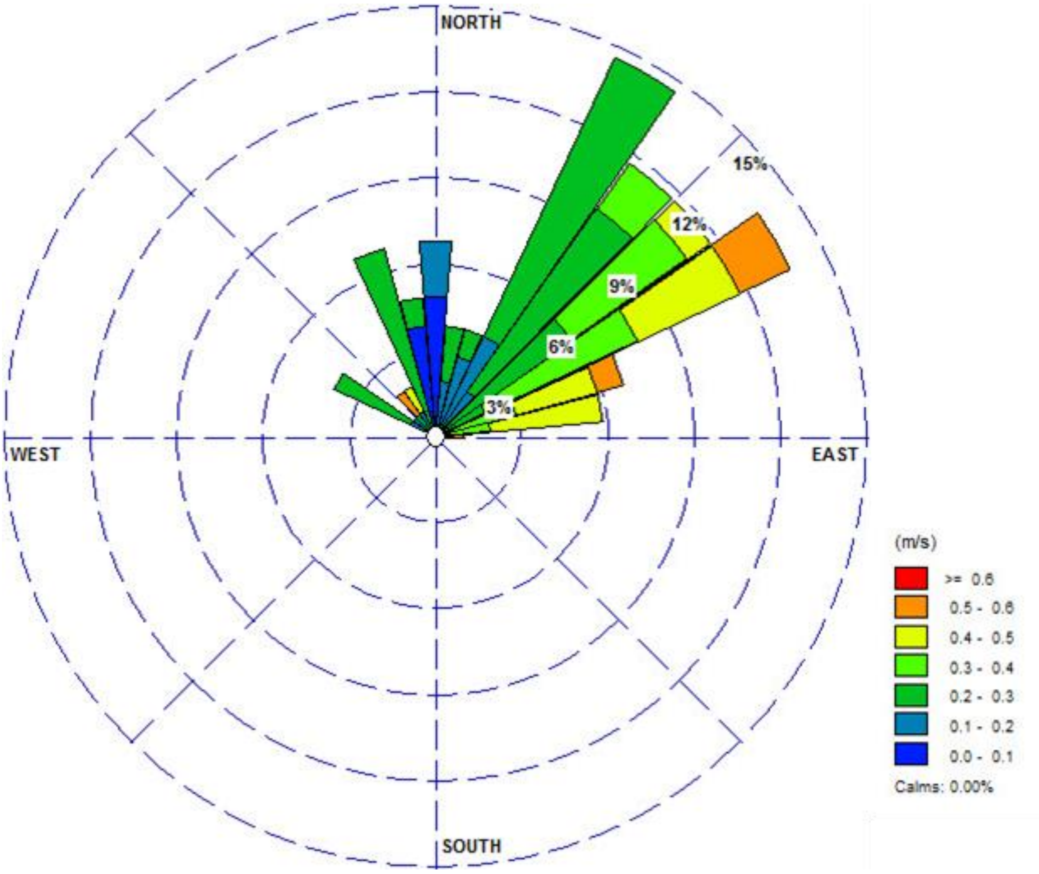


Kumir mari
Surface

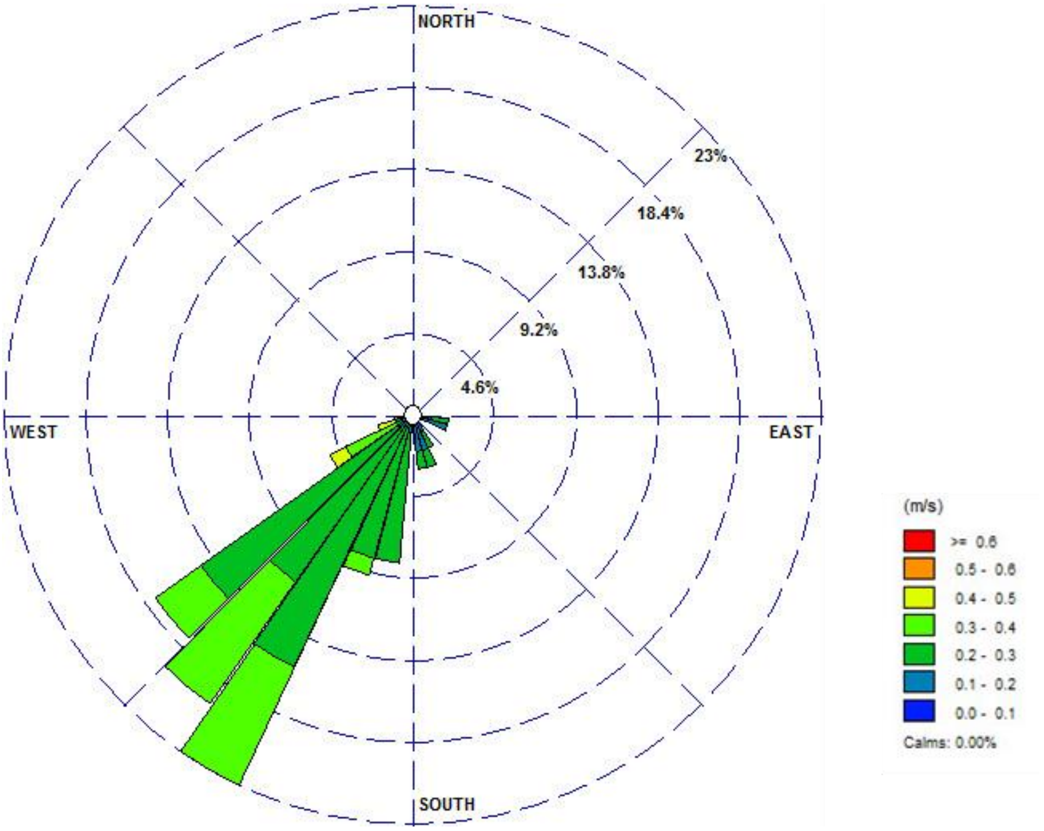


<u>Baganapara</u>

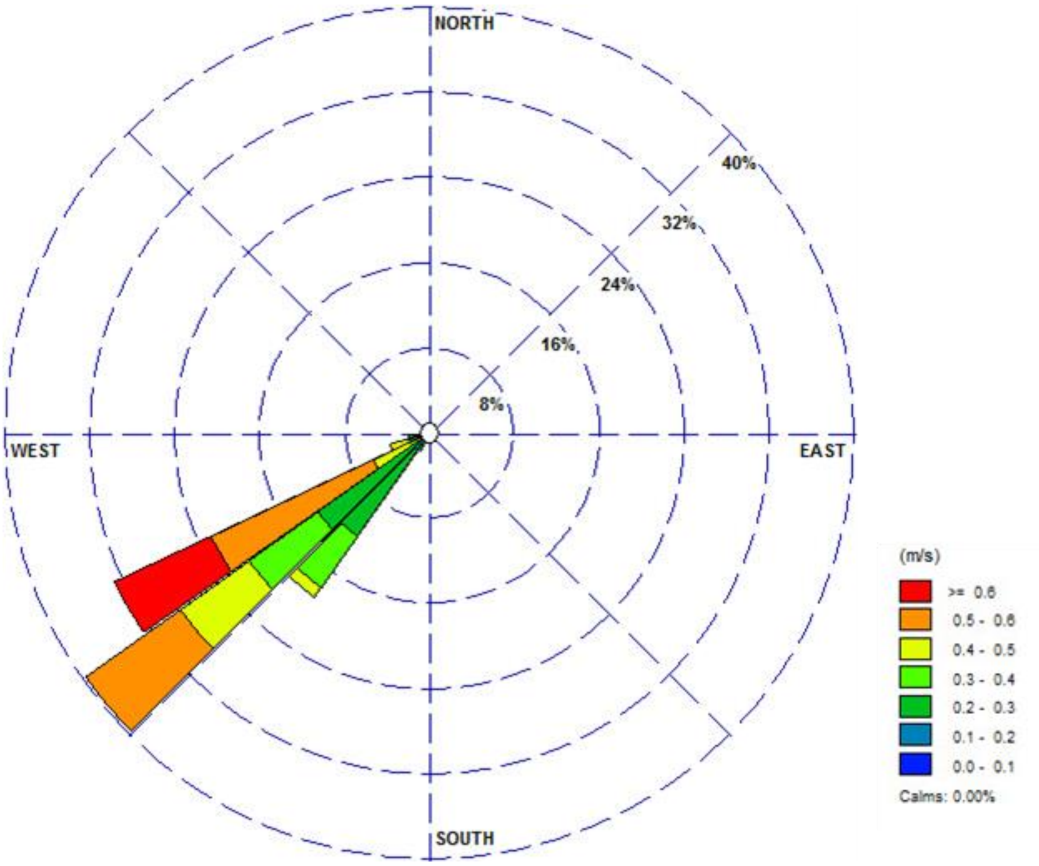
<u>12 mtr</u>



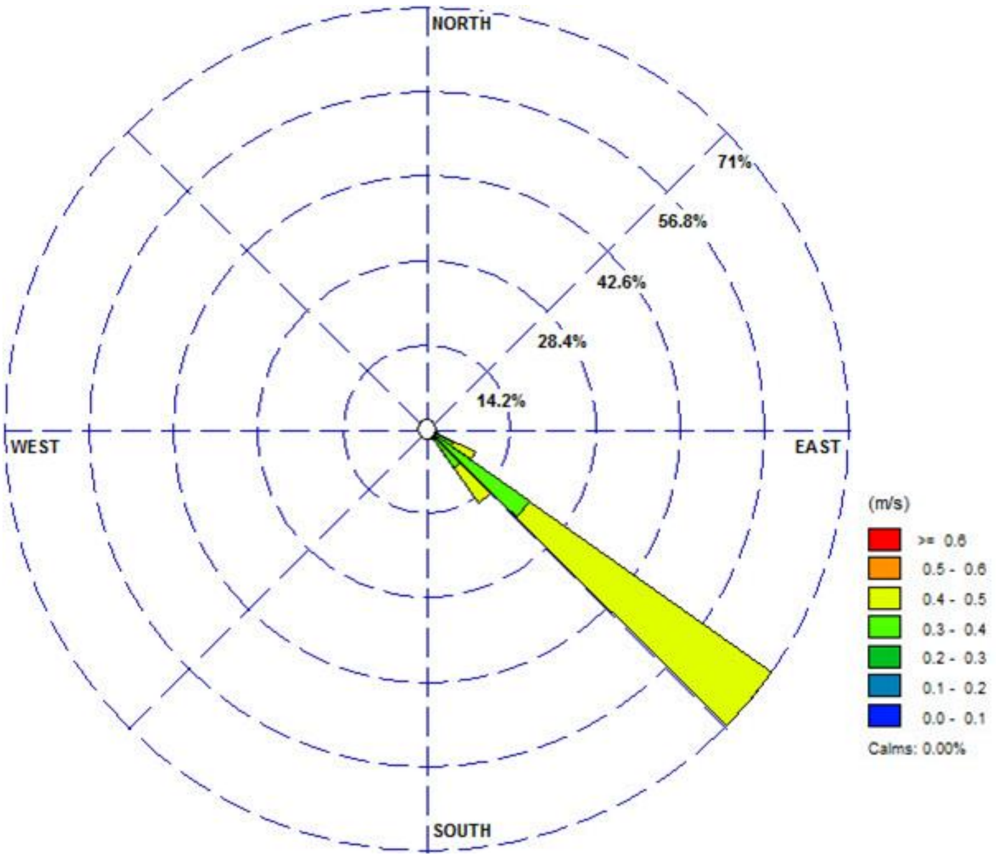
Baganapara
6 mtr



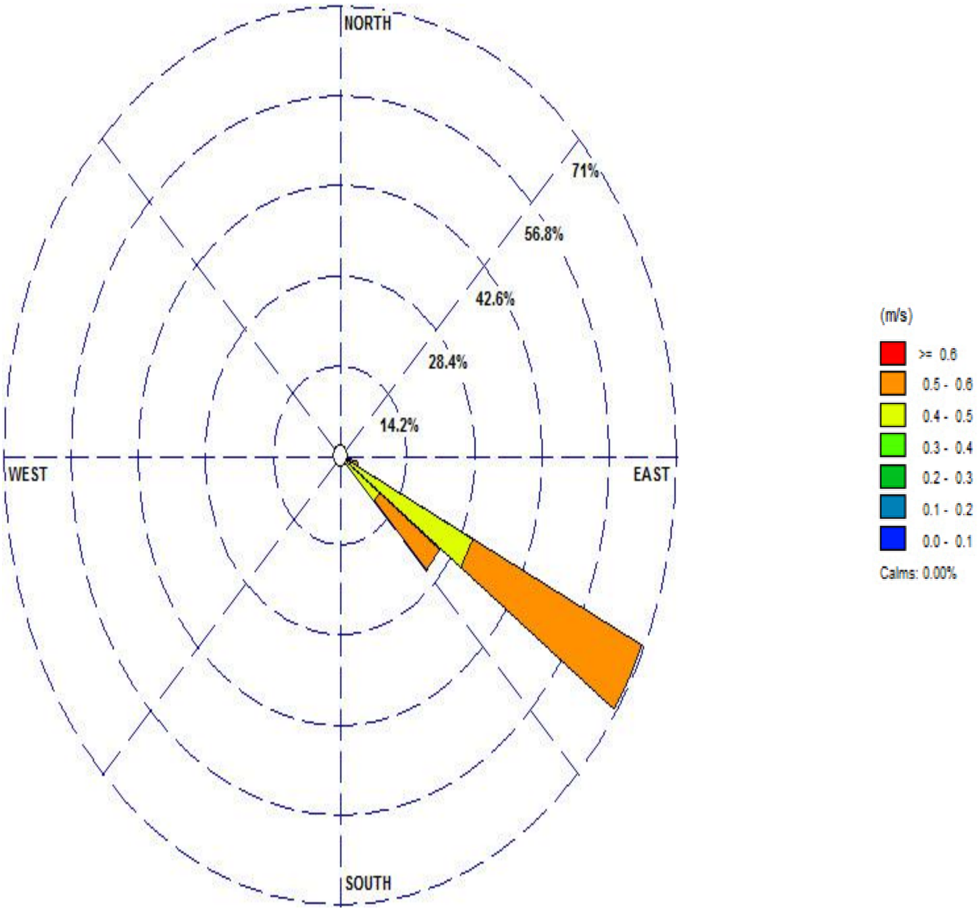
Baganapara
3.6 mtr



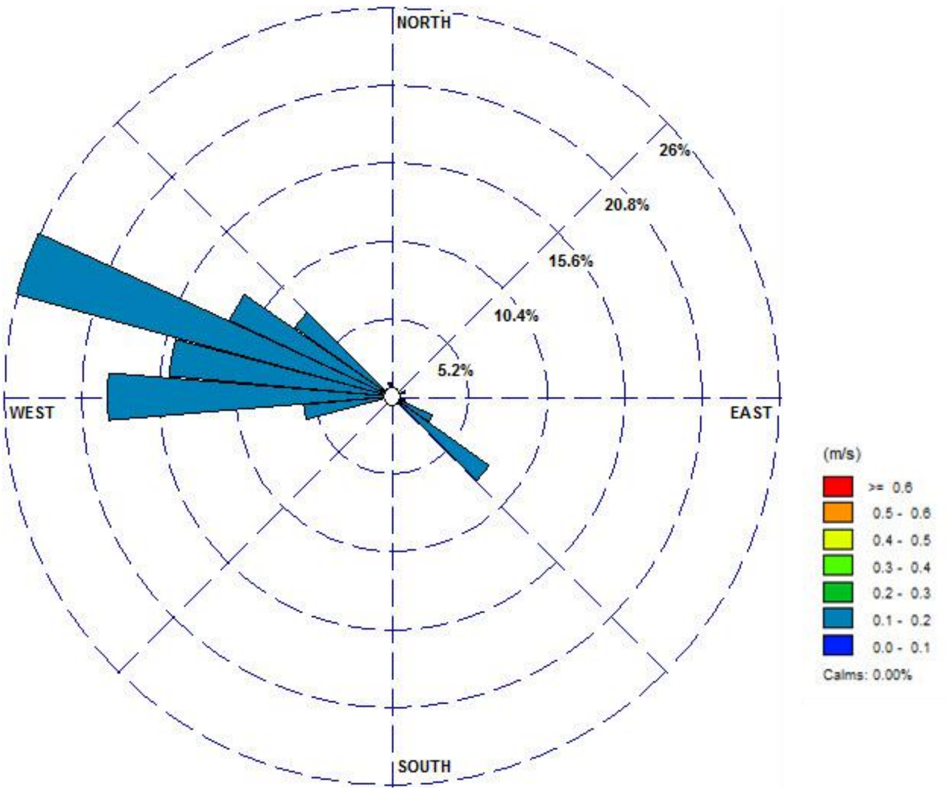
Baganapara
Surface



Mollakhali
8mtr

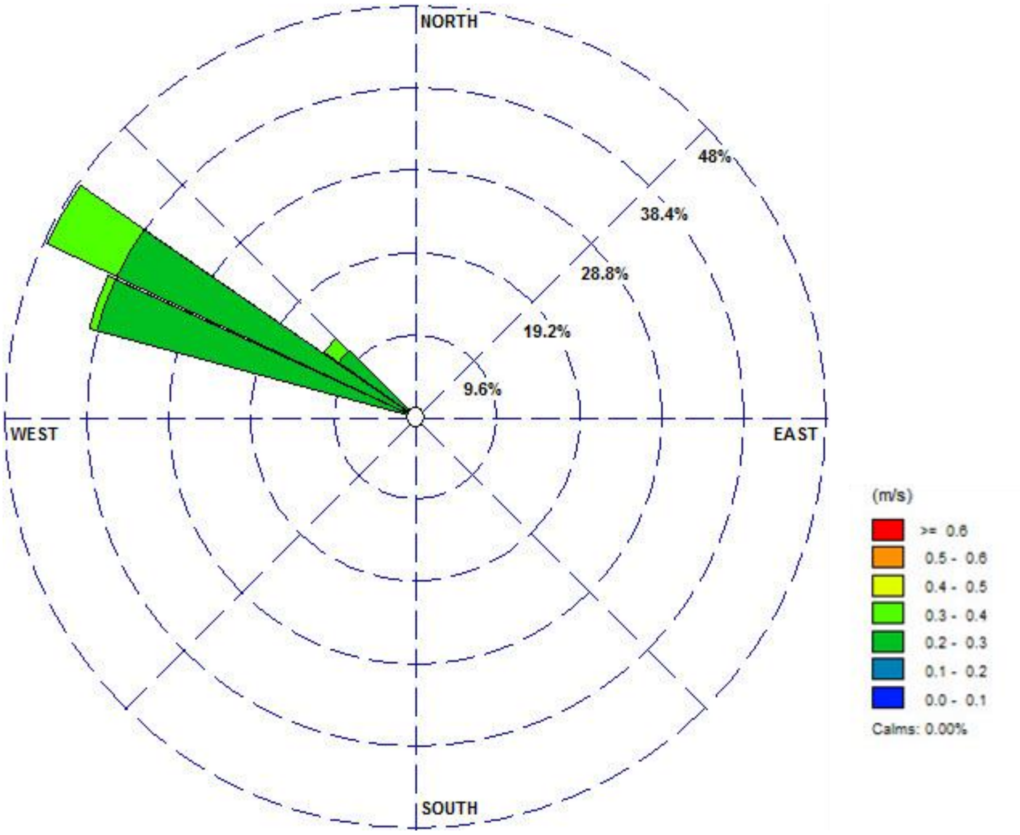


Mollakhali
4mtr

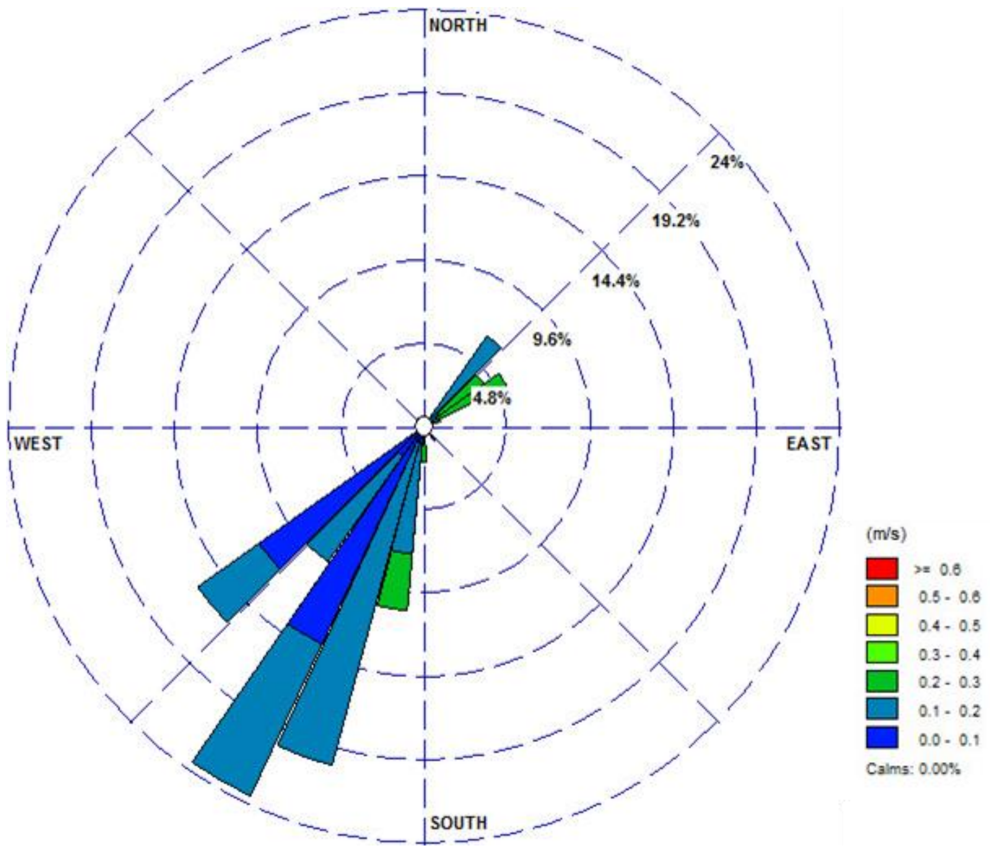


Mollakhali

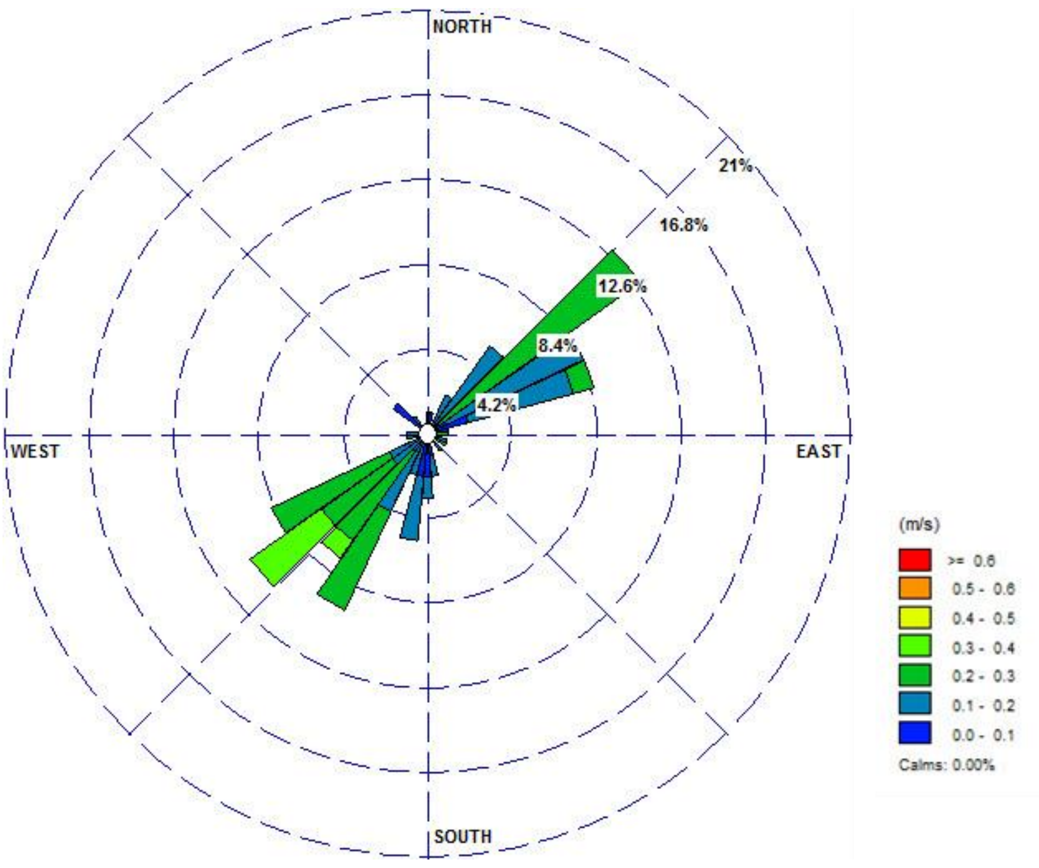
2.4mtr



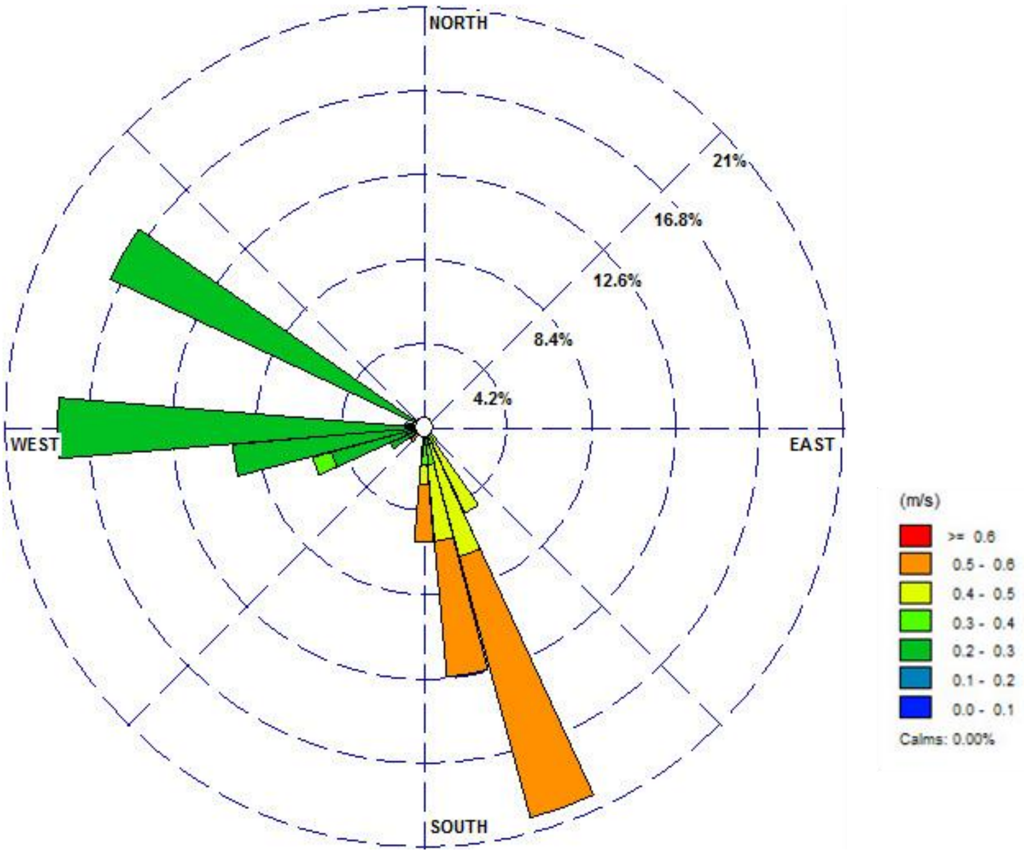
Mollakhali
Surface



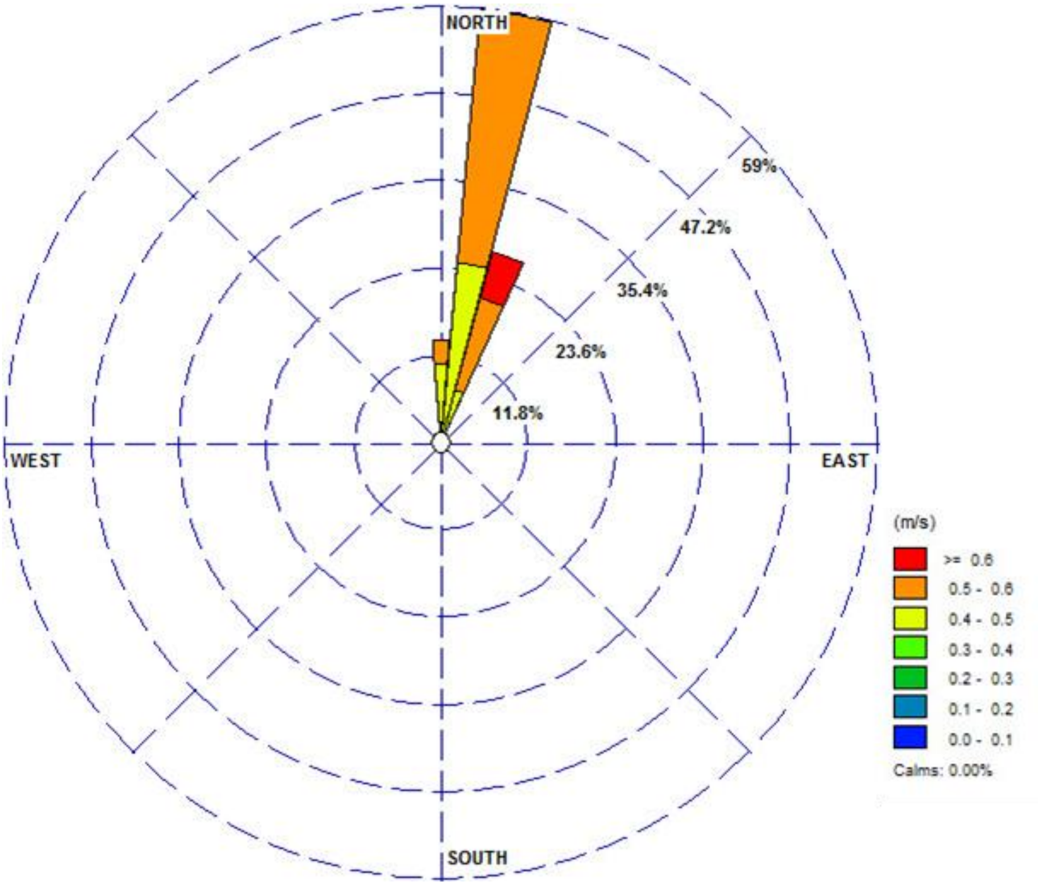
Atharabanki
20 mtr



Atharabanki
20 mtr



Atharabanki
6 mtr



Atharabanki
Surface

ANNEXURE K – Geotechnical Investigations and Lab Reports

BORE LOG DATA SHEET

BORE LOG DATA SHEET				JOB NO.	P-SUR-008-Feedback
Site	Hemnagar, 24- Pgs.	**Location**	Hemnagar Jeti Ghat	**BH No.** 1	**Client** Feedback Infra
Date of Commencement :	10.09.16	**Date of Completion :**	11.09.16	**BH Depth (m)**	25.95
Soil Boring Method	Shell & Auger	**Size**	150 mm	**Co-ordinate**	N: 2456956.949, E: 704451.301
Rock Drilling Method	-	**Size**	-	**Reduced Level (m)** 97.726	**Sheet No.**1

SAMPLE & INSITU TESTS				N - Value	Strata Depth (m)	DESCRIPTION
Depth (m) From	Depth (m) To	Type	No.			
					0.00	
						Top river transported soil deposit of silty clay
					0.30	
0.50		D	1	-		Very soft to soft, bluish grey silty clay with traces of mica and decomposed wood.
1.00		D	2	-		
1.50	1.95	P	1	2		
2.00		D	3	-		
3.00		D	4	-		
3.00	3.45	U	1	-		
4.00		D	5	-		
4.50	4.95	P	2	1		
5.00		D	6	-		
6.00		D	7	-		
6.00	6.45	U	2	-		
7.00		D	8	-		
7.50	7.95	P	3	1		
8.00		D	9	-		
9.00		D	10	-		
9.00	9.45	U	3	-		
10.00		D	11	-		
					10.40	
10.50	10.95	P	4	3		Soft , bluish grey silty clay with traces of mica .
11.00		D	12	-		
12.00		D	13	-		
12.00	12.45	U	4	-		
12.50	12.95	P	5	4		
13.00		D	14	-		
					13.20	

Remarks – .	**Water Struck at (b.g.l)**
	At EGL

D – Disturbed Sample; **B** – Bulk Sample; **W** – Water Sample; **U** – Undisturbed Sample; **P** – Standard Penetration Test; **V** – Vane Shear Test

BORE LOG DATA SHEET								JOB NO.	P-SUR-008-Feedback
Site	Hemnagar, 24- Pgs.	**Location**	Hemnagar Jeti Ghat		**BH No.**	1		**Client**	Feedback Infra
Date of Commencement :		10.09.16	**Date of Completion :**		11.09.16			**BH Depth (m)**	25.95
Soil Boring Method		Shell & Auger	**Size**	150 mm	**Co-ordinate**			N: 2456956.949, E: 704451.301	
Rock Drilling Method		-	**Size**	-	**Reduced Level (m)**			97.726	**Sheet No.**2
SAMPLE & INSITU TESTS				**N - Value**	**Strata Depth (m)**	**DESCRIPTION**			
Depth (m)		**Type**	**No.**						
From	To								
					13.20				
13.50	13.95	P	6	11		Medium stiff to stiff, bluish grey silty clay with traces of mica and decomposed wood.			
14.00		D	15	-					
15.00		D	16	-					
15.00	15.45	P	7	12					
16.00		D	17	-					
16.50	16.95	P	8	6					
17.00		D	18	-					
18.00		D	19	-					
18.00	18.45	P	9	10					
19.00		D	20	-					
					19.30				
19.50	19.95	P	10	54		Dense to very dense, bluish grey silty fine sand with traces of mica and clay as binder .			
20.00		D	21	-					
21.00		D	22	-					
21.00	21.45	P	11	47					
22.00		D	23	-					
					22.10				
22.50	22.95	P	12	8		Medium stiff to very stiff, bluish grey silty clay with traces of mica and sand.			
23.00		D	24	-					
24.00		D	25	-					
24.00	24.45	P	13	18					
25.00		D	26	-					
25.50	25.95	P	14	23					
					25.00				
Remarks – Borehole is terminated at 25.95 m below existing ground level.								**Water Struck at (b.g.l)** At EGL	
D – Disturbed Sample; **B** – Bulk Sample; **W** – Water Sample; **U** – Undisturbed Sample; **P** – Standard Penetration Test; **V** – Vane Shear Test									

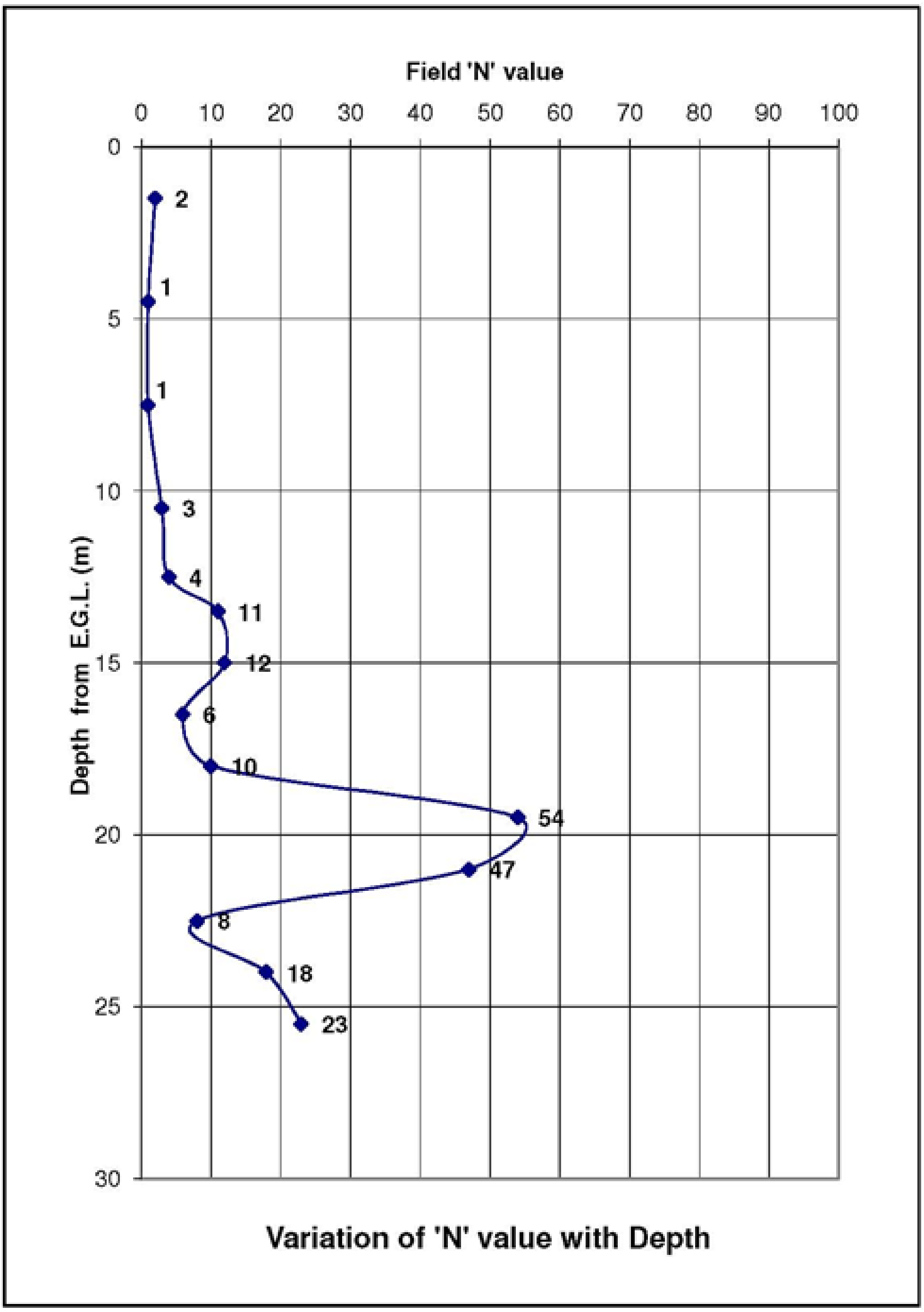
<table>
<tr><th colspan="8">BORE LOG DATA SHEET</th><th>JOB NO.</th><th>P-SUR-008-Feedback</th></tr>
<tr><td>Site</td><td colspan="2">Hemnagar, 24- Pgs.</td><td>Location</td><td colspan="2">Hemnagar Jeti Ghat</td><td>BH No.</td><td>2</td><td>Client</td><td>Feedback Infra</td></tr>
<tr><td colspan="3">Date of Commencement :</td><td>12.09.16</td><td colspan="2">Date of Completion :</td><td colspan="2">13.09.16</td><td>BH Depth (m)</td><td>25.95</td></tr>
<tr><td colspan="2">Soil Boring Method</td><td colspan="2">Shell & Auger</td><td>Size</td><td>150 mm</td><td colspan="2">Co-ordinate</td><td colspan="2">N: 2456957.004, E: 704471.031</td></tr>
<tr><td colspan="2">Rock Drilling Method</td><td colspan="2">-</td><td>Size</td><td>-</td><td colspan="2">Reduced Level (m)</td><td>97.891</td><td>Sheet No.1</td></tr>
<tr><th colspan="4">SAMPLE & INSITU TESTS</th><th rowspan="3">N - Value</th><th rowspan="3">Strata Depth (m)</th><th colspan="4" rowspan="3">DESCRIPTION</th></tr>
<tr><th colspan="2">Depth (m)</th><th rowspan="2">Type</th><th rowspan="2">No.</th></tr>
<tr><th>From</th><th>To</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>0.00</td><td colspan="4"></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Top river transported soil deposit of silty clay</td></tr>
<tr><td colspan="2"></td><td></td><td></td><td></td><td>0.30</td><td colspan="4"></td></tr>
<tr><td colspan="2">0.50</td><td>D</td><td>1</td><td>-</td><td></td><td colspan="4" rowspan="18">Very soft to soft, bluish grey silty clay with traces of mica and decomposed wood.</td></tr>
<tr><td colspan="2">1.00</td><td>D</td><td>2</td><td>-</td><td></td></tr>
<tr><td>1.50</td><td>1.95</td><td>U</td><td>1</td><td>-</td><td></td></tr>
<tr><td colspan="2">2.00</td><td>D</td><td>3</td><td>-</td><td></td></tr>
<tr><td colspan="2">3.00</td><td>D</td><td>4</td><td>-</td><td></td></tr>
<tr><td>3.00</td><td>3.45</td><td>P</td><td>1</td><td>2</td><td></td></tr>
<tr><td colspan="2">4.00</td><td>D</td><td>5</td><td>-</td><td></td></tr>
<tr><td>4.50</td><td>4.95</td><td>U</td><td>2</td><td>-</td><td></td></tr>
<tr><td colspan="2">5.00</td><td>D</td><td>6</td><td>-</td><td></td></tr>
<tr><td colspan="2">6.00</td><td>D</td><td>7</td><td>-</td><td></td></tr>
<tr><td>6.00</td><td>6.45</td><td>P</td><td>2</td><td>2</td><td></td></tr>
<tr><td colspan="2">7.00</td><td>D</td><td>8</td><td></td><td></td></tr>
<tr><td>7.50</td><td>7.95</td><td>P</td><td>3</td><td>3</td><td></td></tr>
<tr><td colspan="2">8.00</td><td>D</td><td>9</td><td>-</td><td></td></tr>
<tr><td colspan="2">9.00</td><td>D</td><td>10</td><td>-</td><td></td></tr>
<tr><td>9.00</td><td>9.45</td><td>P</td><td>4</td><td>2</td><td></td></tr>
<tr><td colspan="2">10.00</td><td>D</td><td>11</td><td>-</td><td></td></tr>
<tr><td>10.50</td><td>10.95</td><td>U</td><td>3</td><td>-</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>11.00</td><td colspan="4"></td></tr>
<tr><td>11.00</td><td>11.45</td><td>P</td><td>5</td><td>3</td><td></td><td colspan="4" rowspan="8">Soft, bluish grey silty clay with traces of mica .</td></tr>
<tr><td colspan="2">12.00</td><td>D</td><td>12</td><td>-</td><td></td></tr>
<tr><td>12.00</td><td>12.45</td><td>P</td><td>6</td><td>3</td><td></td></tr>
<tr><td colspan="2">13.00</td><td>D</td><td>13</td><td>-</td><td></td></tr>
<tr><td>13.50</td><td>13.95</td><td>P</td><td>7</td><td>3</td><td></td></tr>
<tr><td colspan="2">14.00</td><td>D</td><td>14</td><td>-</td><td></td></tr>
<tr><td colspan="2">15.00</td><td>D</td><td>15</td><td>-</td><td></td></tr>
<tr><td>15.00</td><td>15.45</td><td>P</td><td>8</td><td>4</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>15.60</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="8" rowspan="2">Remarks – .</td><td colspan="2">Water Struck at (b.g.l)</td></tr>
<tr><td colspan="2">At EGL</td></tr>
<tr><td colspan="10">D – Disturbed Sample; B – Bulk Sample; W – Water Sample; U – Undisturbed Sample; P – Standard Penetration Test; V – Vane Shear Test</td></tr>
</table>

<table>
<tr><th colspan="8">BORE LOG DATA SHEET</th><th>JOB NO.</th><th>P-SUR-008-Feedback</th></tr>
<tr><td>Site</td><td colspan="2">Hemnagar, 24- Pgs.</td><td>Location</td><td colspan="2">Hemnagar Jetty Ghat</td><td>BH No.</td><td>2</td><td>Client</td><td>Feedback Infra</td></tr>
<tr><td colspan="3">Date of Commencement :</td><td>12.09.16</td><td colspan="2">Date of Completion :</td><td colspan="2">13.09.16</td><td>BH Depth (m)</td><td>25.95</td></tr>
<tr><td colspan="2">Soil Boring Method</td><td colspan="2">Shell & Auger</td><td>Size</td><td>150 mm</td><td colspan="2">Co-ordinate</td><td colspan="2">N: 2456957.004, E: 704471.031</td></tr>
<tr><td colspan="2">Rock Drilling Method</td><td colspan="2">-</td><td>Size</td><td>-</td><td colspan="2">Reduced Level (m)</td><td>97.891</td><td>Sheet No.2</td></tr>
<tr><th colspan="4">SAMPLE & INSITU TESTS</th><th rowspan="3">N - Value</th><th rowspan="3">Strata Depth (m)</th><th colspan="4" rowspan="3">DESCRIPTION</th></tr>
<tr><th colspan="2">Depth (m)</th><th rowspan="2">Type</th><th rowspan="2">No.</th></tr>
<tr><th>From</th><th>To</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>15.60</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">16.00</td><td>D</td><td>16</td><td>-</td><td></td><td colspan="4" rowspan="5">Medium stiff , bluish grey silty clay with traces of mica and decomposed wood.</td></tr>
<tr><td>16.50</td><td>16.95</td><td>P</td><td>9</td><td>8</td><td></td></tr>
<tr><td colspan="2">17.00</td><td>D</td><td>17</td><td>-</td><td></td></tr>
<tr><td colspan="2">18.00</td><td>D</td><td>17</td><td>-</td><td></td></tr>
<tr><td>18.00</td><td>18.45</td><td>P</td><td>10</td><td>6</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>18.80</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">21.00</td><td>D</td><td>21</td><td>-</td><td></td><td colspan="4" rowspan="2">Medium dense, bluish grey silty fine sand with traces of mica and clay as binder .</td></tr>
<tr><td>21.00</td><td>21.45</td><td>P</td><td>12</td><td>16</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>21.70</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">22.00</td><td>D</td><td>22</td><td>-</td><td></td><td colspan="4" rowspan="7">Stiff to very stiff, bluish grey silty clay with traces of mica and sand.</td></tr>
<tr><td>22.50</td><td>22.95</td><td>P</td><td>13</td><td>11</td><td></td></tr>
<tr><td colspan="2">23.00</td><td>D</td><td>23</td><td>-</td><td></td></tr>
<tr><td colspan="2">24.00</td><td>D</td><td>24</td><td>-</td><td></td></tr>
<tr><td>24.00</td><td>24.45</td><td>P</td><td>14</td><td>23</td><td></td></tr>
<tr><td colspan="2">25.00</td><td>D</td><td>25</td><td>-</td><td></td></tr>
<tr><td>25.50</td><td>25.95</td><td>P</td><td>15</td><td>28</td><td></td></tr>
<tr><td colspan="2"></td><td></td><td></td><td></td><td>25.95</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="8">Remarks – .</td><td colspan="2">Water Struck at</td></tr>
<tr><td colspan="8" rowspan="2">Borehole is terminated at 25.95 m below existing ground level.</td><td colspan="2">(b.g.l)</td></tr>
<tr><td colspan="2">At EGL</td></tr>
<tr><td colspan="10">D – Disturbed Sample; B – Bulk Sample; W – Water Sample; U – Undisturbed Sample; P – Standard Penetration Test; V – Vane Shear Test</td></tr>
</table>

‘N’ VALUE CURVE

Borehole No. : 1 Ground R.L. 97.726 m

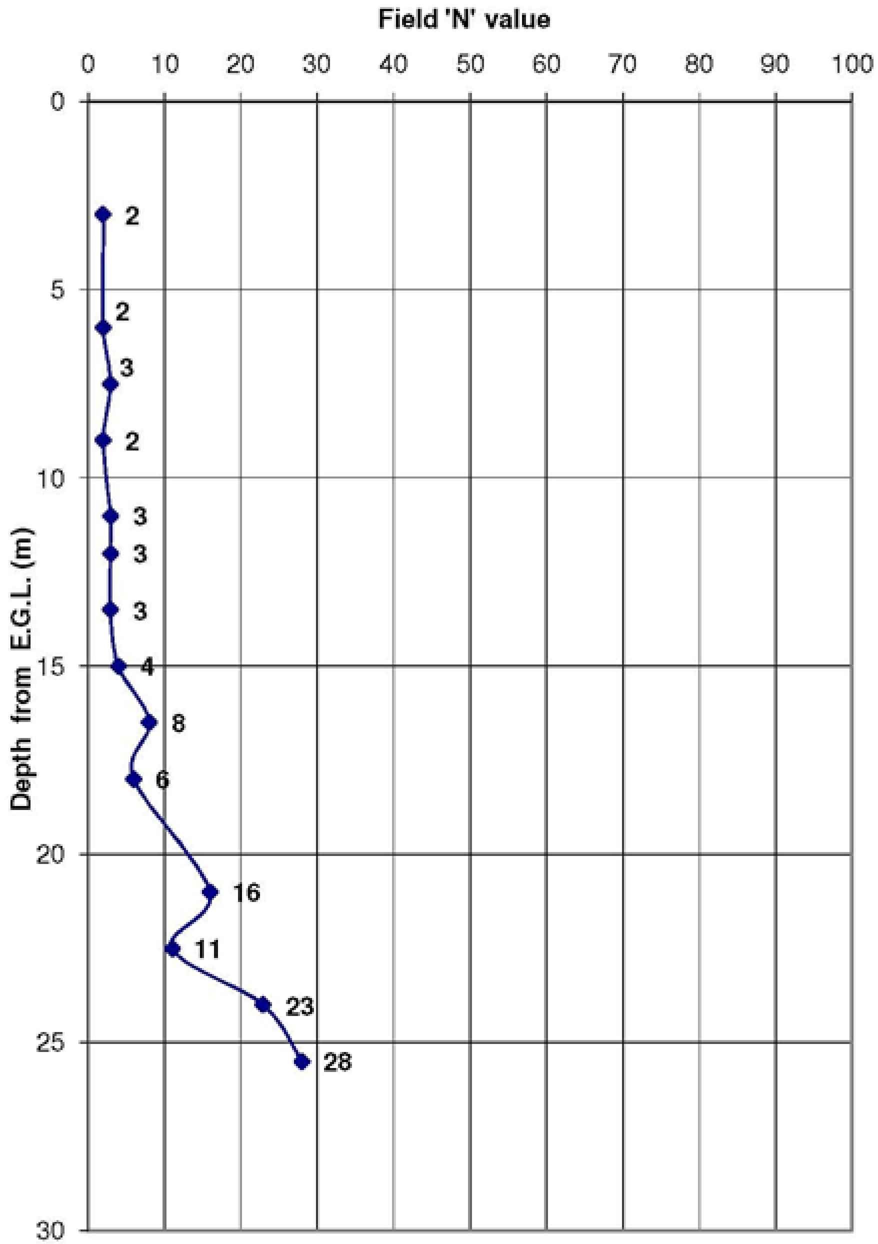
Termination : 25.00 m from EGL



Geoservices Maritime Pvt. Ltd.	N Value Curve	Job No. : P-SUR-008
		Fig No. : 1

Borehole No. : **2** Ground R.L. 97.891 m

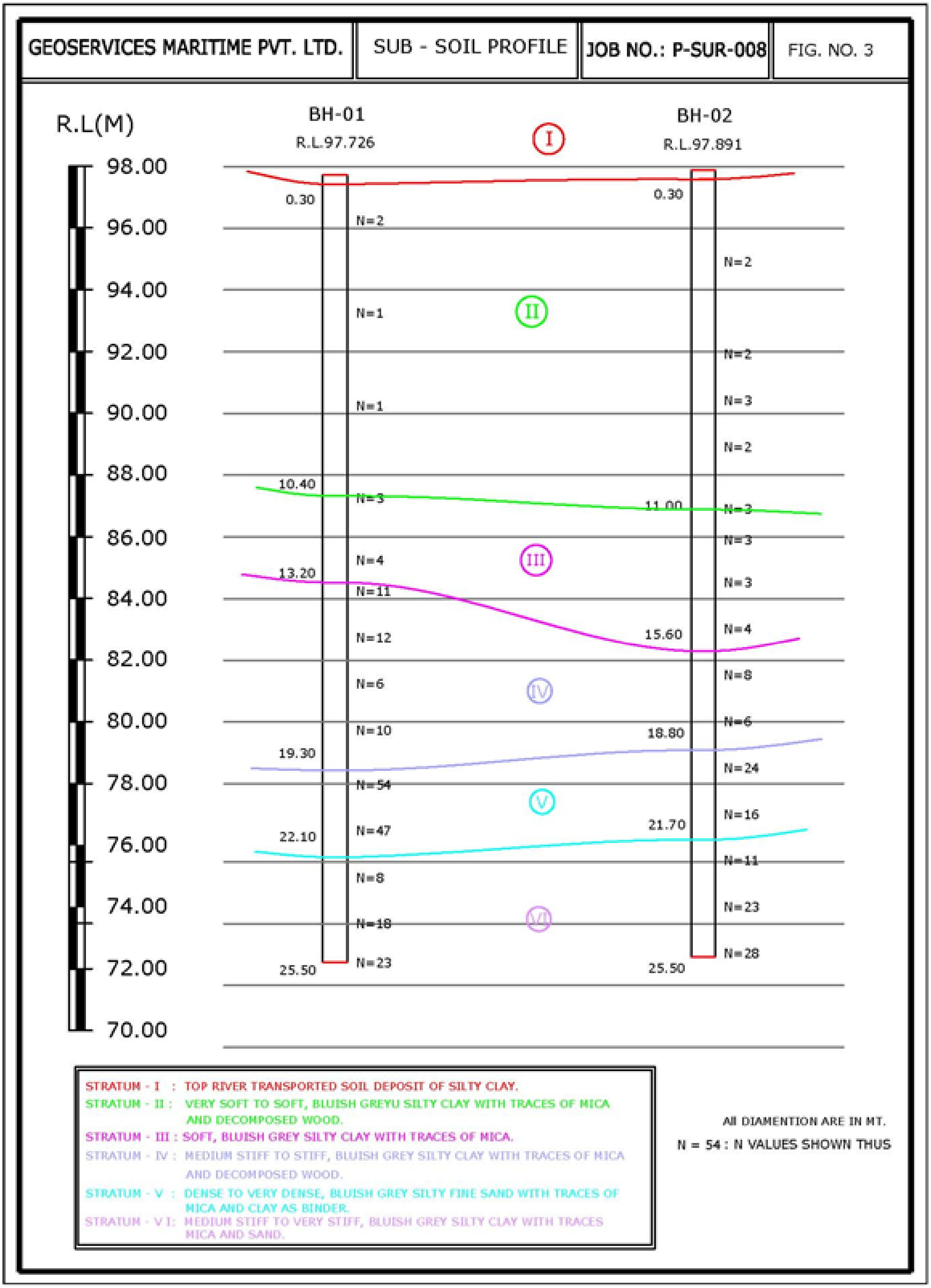
Termination : 25.00 m from EGL



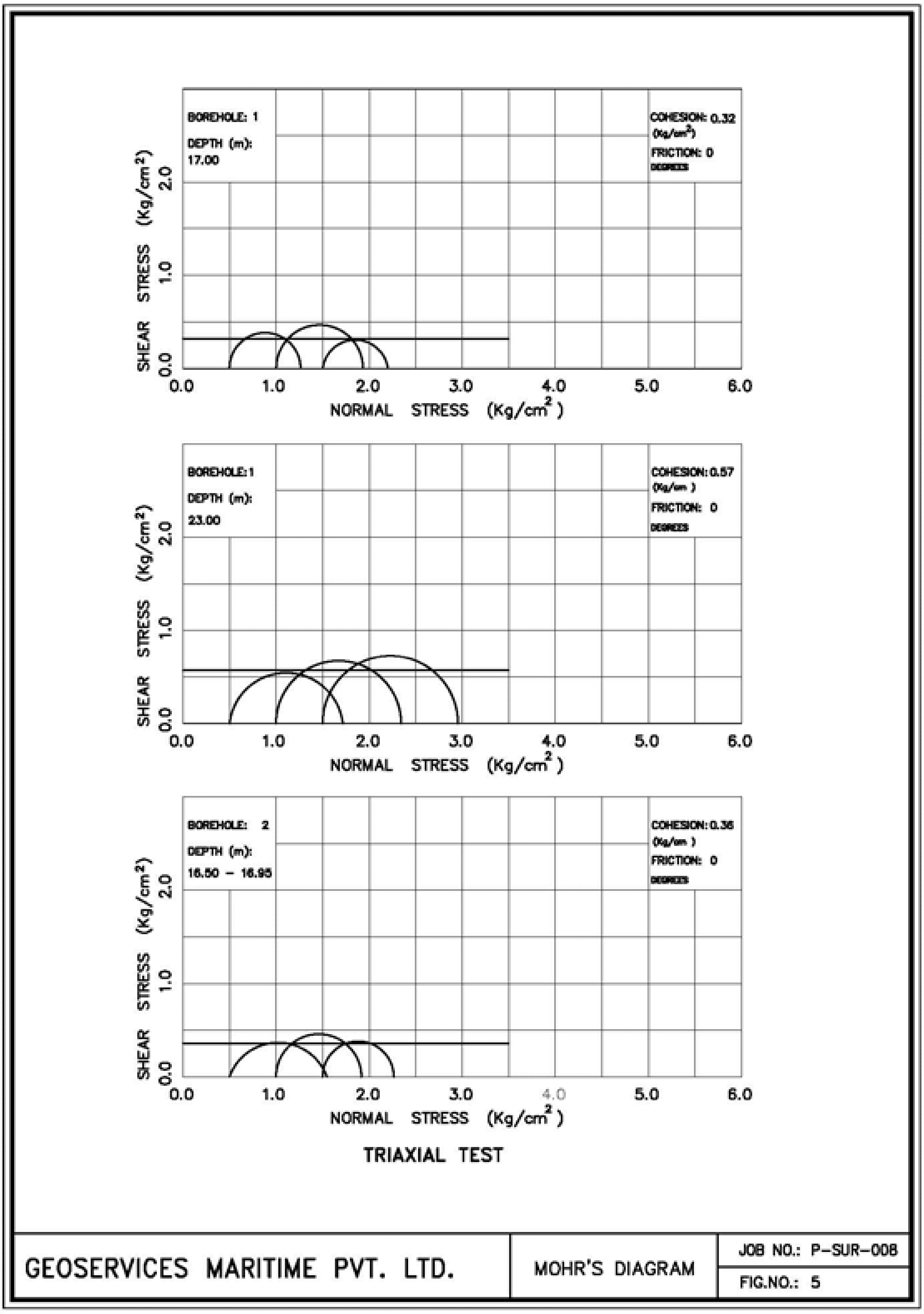
Variation of 'N' value with Depth

Geoservices Maritime Pvt. Ltd.	**N Value Curve**	**Job No. :** P-SUR-008
		Fig No. : 2

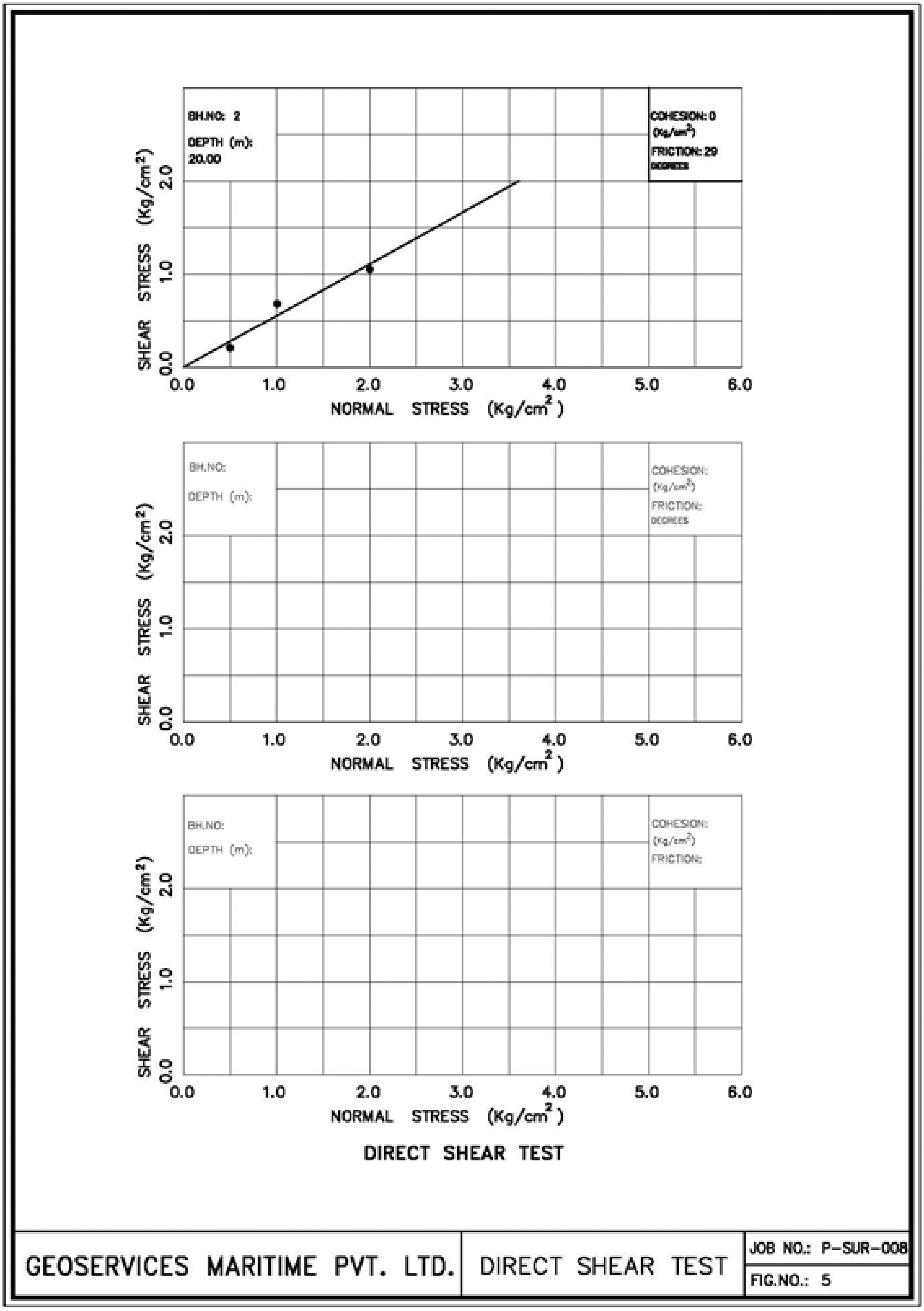
SUB SOIL PROFILE



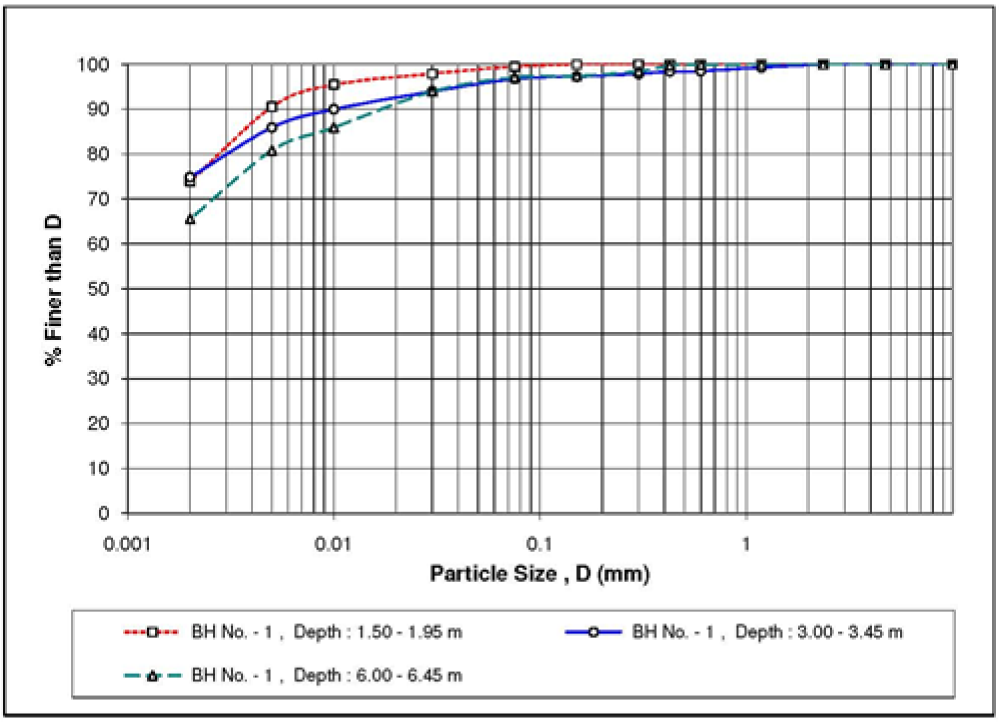
MOHR'S DIAGRAM

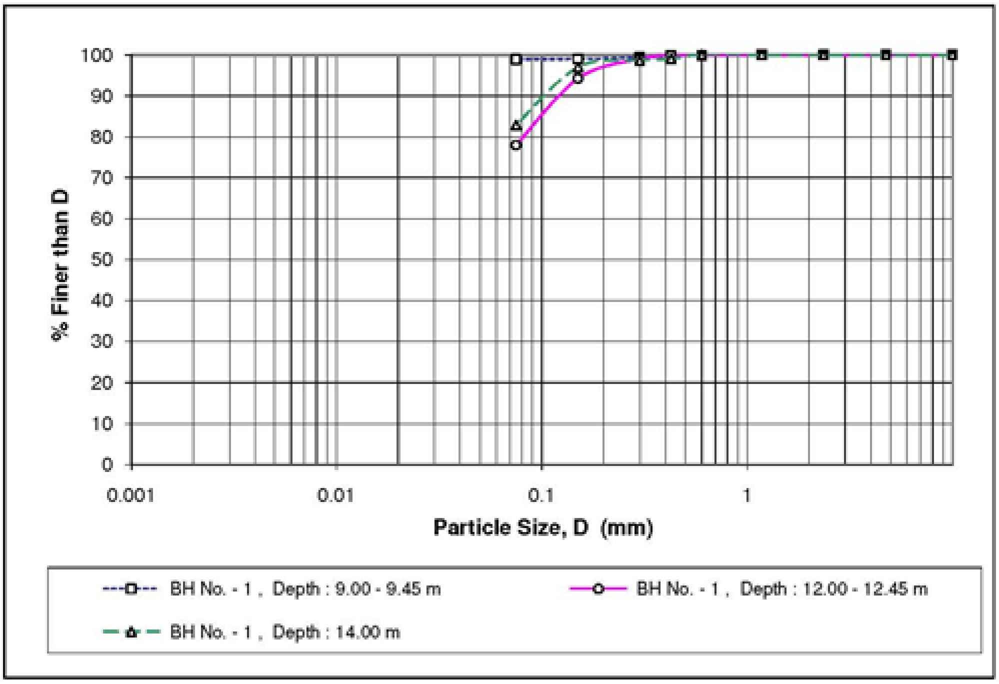


DIRECT SHEAR TEST

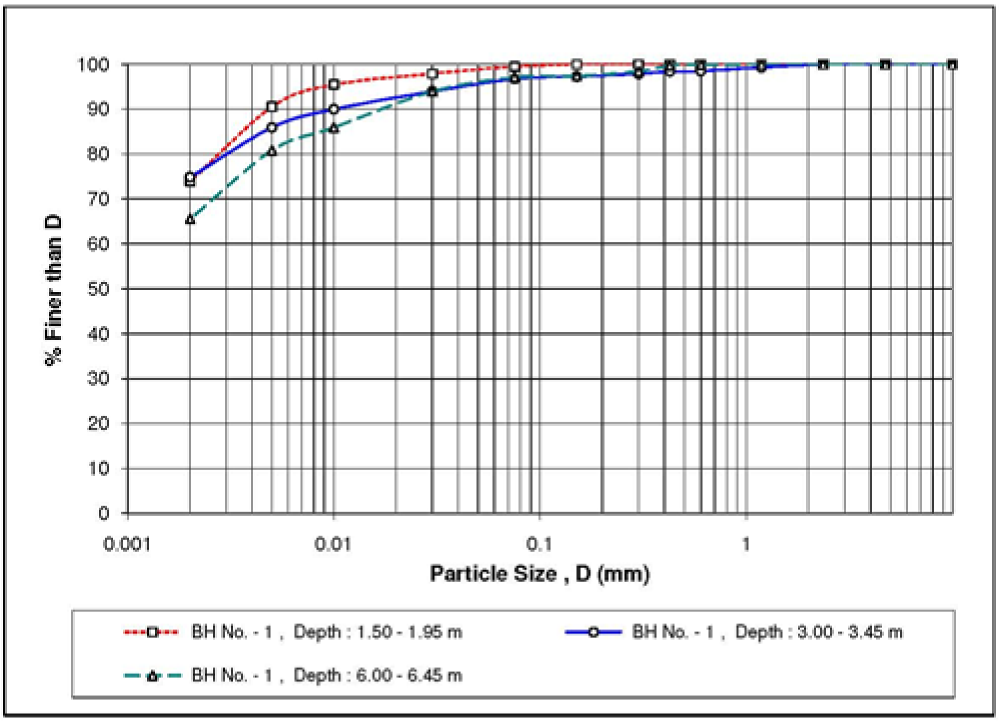


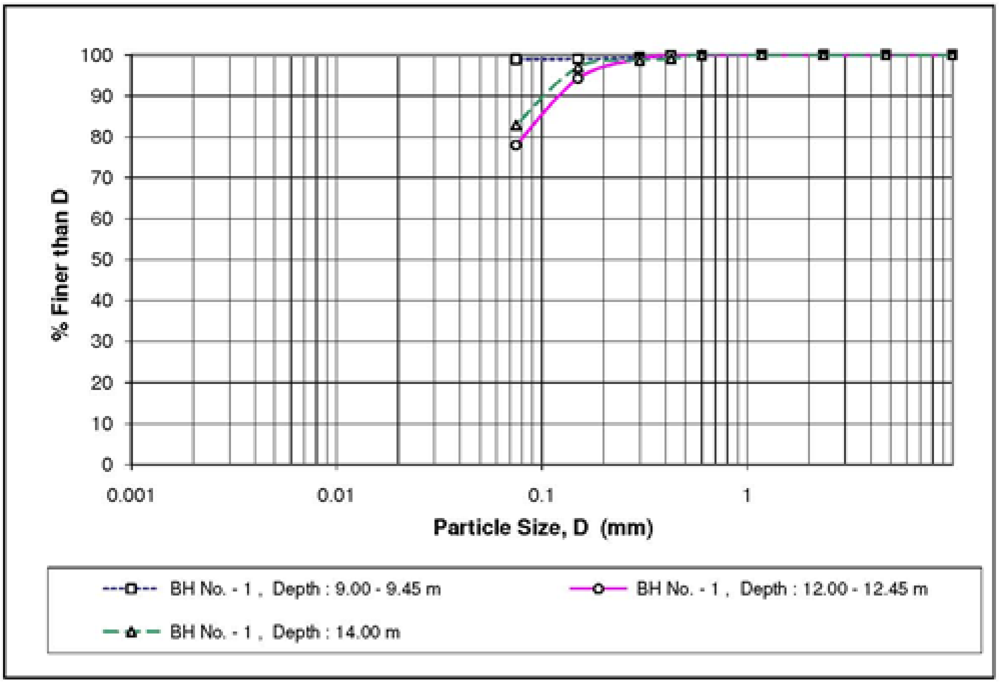
PARTICLE SIZE DISTRIBUTION CURVE



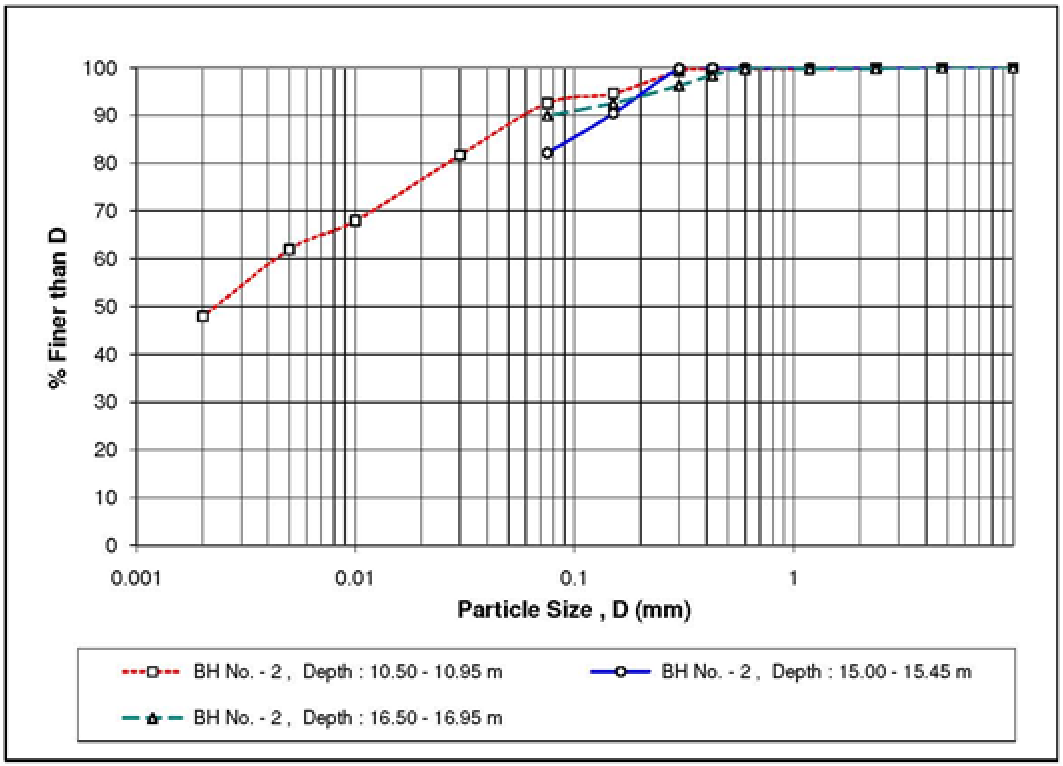


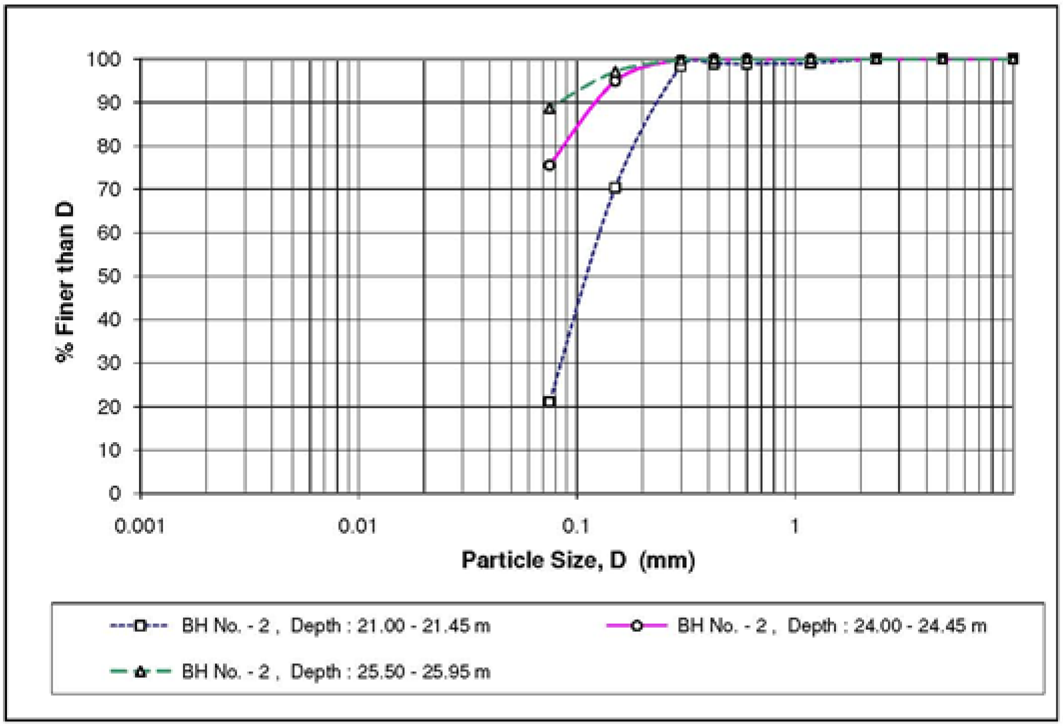
Geoservices Maritime Pvt. Ltd.	Particle Size Distribution Curve	Job No. : P-SUR-008
		Fig. No. : 6





Geoservices Maritime Pvt. Ltd.	**Particle Size Distribution Curve**	**Job No. :** P-SUR-008
		Fig. No. : 6





Geoservices Maritime Pvt. Ltd.	**Particle Size Distribution Curve**	**Job No. :**P-SUR-008
		Fig. No. : 8

ANNEXURE L – Laboratory Test Results on Soil Samples

LABORATORY TEST RESULTS ON SOIL SAMPLES																			Table No. :	
cal Invèstigation at Hemnagar̀, Sundarban.										Location :		Hemnagar, Sundarban, 24 Pgs(N), W.B.							Job No. :	
(m)	Grain Size Analysis				Liquid Limit (%)	Plastic Limit (%)	NMC (%)	Bulk Density (gm/cc)	Specific Gravity	Shear Strength			Consolidation Test: Co-efficient of volume compressibility, m_v in cm^2/kg (for different pressure ranges)					Standard Proctor Compaction Test	
	Gravel (%)	Sand (%)	Silt (%)	Clay (%)						Type of test	Cohesion (Kg/cm^2)	Angle of internal Friction (Degree)	(0.25 - 0.5) kg/cm^2	(0.50 - 1.0) kg/cm^2	(1.0 - 2.0) kg/cm^2	(2.0 - 4.0) kg/cm^2	(4.0 - 8.0) kg/cm^2	OMC (%)	MDD (gm/cc)
1.95	0	1	26	74	84	41	33.70	1.48	2.47	VS	0.08	0	-	-	-	-	-	-	-
3.45	0	3	22	75	81	46	40.08	1.52	-	VS	0.11	0	-	-	-	-	-	-	-
6.45	0	3	32	65	80	37	37.17	1.51	2.51	VS	0.09	0	-	-	-	-	-	-	-
9.45	0	1	99		71	33	22.46	1.52	-	VS	0.14	0	-	-	-	-	-	-	-
12.45	0	22	78		54	26	18.41	1.55	-	UC	0.21	0	0.0665	0.0492	0.0287	0.0244	0.0183	-	-
0	0	17	83		43	21	-	-	2.53	-	-	-	-	-	-	-	-	-	-
0	0	15	85		41	19	-	1.65	-	UU®	0.32	0	0.0357	0.0308	0.0194	0.0162	0.0121	-	-
0	0	85	15		NP	NP	-	1.75	2.65	DS®	0	29	-	-	-	-	-	-	-
0	0	19	81		-	-	-	1.72	-	UU®	0.57	0	0.0223	0.0202	0.0178	0.0139	0.0114	-	-
1.95	0	2	98		72	34	34.28	1.53	-	VS	0.13	0	-	-	-	-	-	-	-
4.95	0	6	21	73	64	28	29.73	1.57	2.55	UC	0.17	0	-	-	-	-	-	-	-
7.95	0	9	91		50	29	-	-	-	-	-	-	-	-	-	-	-	-	-

TUU : Triaxial Unconsolidated Undrained, TCU : Triaxial Consolidated Undrained, TCD : Triaxial Consolidated Drained, DS : Direct Shear, UC : Unconfined
: Undisturbed sample, D : Disturbed sample, P : SPT sample

LABORATORY TEST RESULTS ON SOIL SAMPLES																			Table No. :	
nical Investigation at Hemnagar, Sundarban.									Location:		Hemnagar, Sundarban, 24 Pgs(N), W.B.								Job No. :	P-
th (m)	Grain Size Analysis				Liquid Limit (%)	Plastic Limit (%)	NMC (%)	Bulk Density (gm/cc)	Specific Gravity	Shear Strength			Consolidation Test: Co-efficient of volume compressibility, m_v in cm^2/kg (for different pressure ranges)					Standard Proctor Compaction Test		
	Gravel (%)	Sand (%)	Silt (%)	Clay (%)						Type of test	Cohesion (Kg/cm^2)	Angle of internal Friction (Degree)	(0.25 - 0.5) kg/cm^2	(0.50 - 1.0) kg/cm^2	(1.0 - 2.0) kg/cm^2	(2.0 - 4.0) kg/cm^2	(4.0 - 8.0) kg/cm^2	OMC (%)	MDD (gm/cc)	
- 10.95	0	7	45	48	59	24	15.81	1.59	2.53	UC	0.19	0	-	-	-	-	-	-	-	
- 15.45	0	18	82		48	27	-	-	-	-	-	-	-	-	-	-	-	-	-	
- 16.95	0	10	90		42	18	-	1.69	-	UU®	0.36	0	-	-	-	-	-	-	-	
- 21.45	0	79	21		NP	NP	-	-	2.66	-	-	-	-	-	-	-	-	-	-	
- 24.45	0	25	75		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
- 25.95	0	11	89		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

: TUU : Triaxial Unconsolidated Undrained, TCU : Triaxial Consolidated Undrained, TCD : Triaxial Consolidated Drained, DS : Direct Shear, UC : Unconfined
U : Undisturbed sample, D : Disturbed sample, P : SPT sample

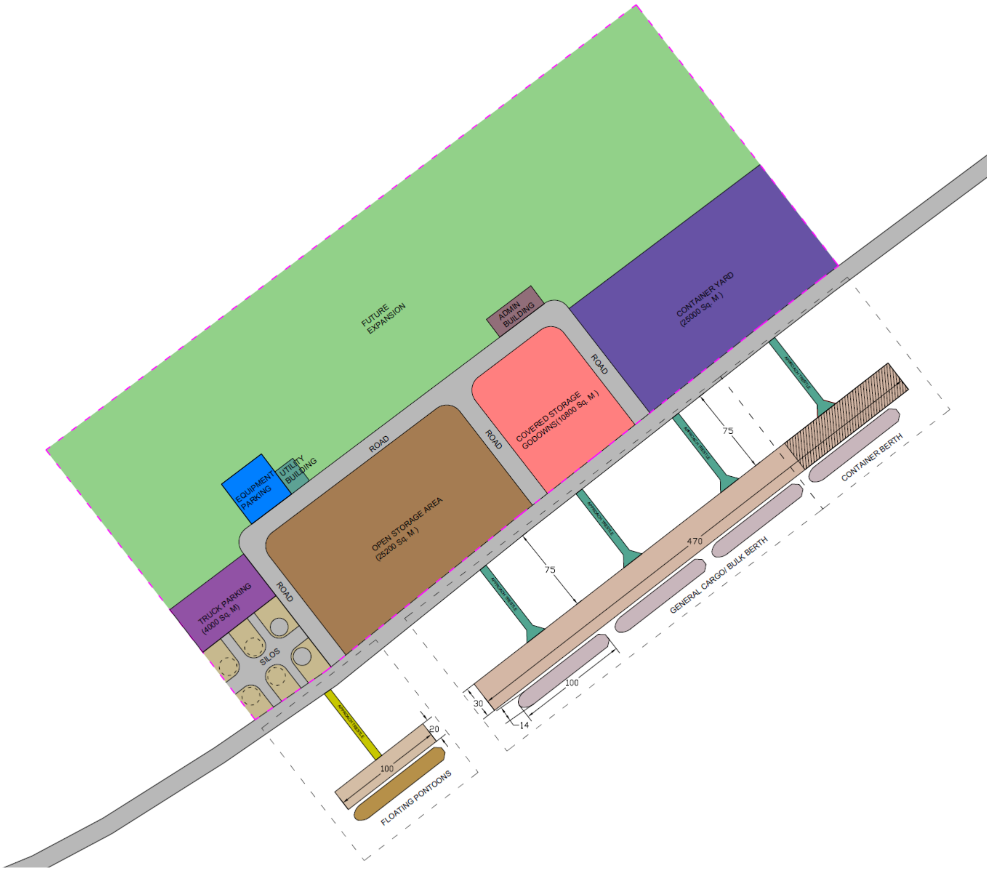
ANNEXURE M – Proposed Terminal Layout and Location

An integrated IWT terminal is planned by IWAI at Haldia and it would be prudent to also operate Sunderbans traffic from this terminal till it achieves its peak capacity. Post built-up of traffic, an alternate land parcel can be identified for future expansion of the terminal.

An alternative option is development of new integrated terminal at Haldia for handling Sunderbans traffic. The total area that would be required to handle the traffic potential of fly ash, containers and general cargo is ~60 acres.

The infrastructure requirement is as detailed out in section 10.2.2 and the indicative terminal layout and facilities are as shown in the following figure. The existing floating pontoons would be refurbished and utilized for handling fly ash. These pontoons can be integrated with the proposed new terminal at Haldia if adequate waterfront is available.

Figure 61: Layout of New Terminal at Haldia



Two indicative land parcels have been identified for development of the new terminal in Haldia. However, land parcels would have to be decided post discussions of IWAI with relevant stakeholders including Haldia Port Trust and State Government.

Figure 62: Preliminary Identification of Land Parcels for Development of New Terminal at Haldia

ANNEXURE N – Preliminary Engineering Design (Hemnagar Terminal)

Introduction

This Annexure provides the preliminary engineering design concept of a floating pontoon and its approach from the shore for the terminal proposed at Hemnagar.

Hemnagar (22012'52.70" N& 88058'55.15" E) is situated on the left bank of the River Raimangal at the Indo-Bangladesh Border in the region of Sundarbans. It falls in the Indo-Bangladesh Protocol Route followed by the inland cargo pontoons of Bangladesh and the Indian pontoons transiting through Bangladesh to Assam.

The Hemnagar Terminal is proposed as a Customs check-point. Hence, no loading or unloading of material/cargo is envisaged at the terminal. The design has been prepared in accordance of the required infrastructure.

Meteorology & Hydrographic Conditions

The Project is located within the tidal region of Sundarbans. The average tidal range observed at Hemnagar is in the order of about 3 m and is semidiurnal in nature.

The region is prone to severe cyclonic storms, particularly in the months of April & May. In May 2009, a devastating cyclonic storm named Aila, had hit this area with colossal loss of lives and property. The hydrographic, bathymetric and tidal information has already been provided in the Report and the same has been applied in designing the various project related marine components.

Description of the Project

Keeping in view the shallowness of the river from the navigation channel towards the bank, the following configuration of the project components have been considered:

The main floating pontoon of steel (35 meter * 9 meter) would be placed near the main shipping channel so as to dock and un-dock cargo barges up to 1500 DWT capacity.
This will be connected to a 50 meter long and 3 meter wide floating steel walkway leading to the shore.
Finally, the walkway would be linked with an 8 meter long and 3 meter wide steel gangway connected to the shore with flexibility to rise and fall with tidal variation.

All the above marine installations are proposed to be properly anchored for safety.

Project Components

Floating Pontoon

It is suggested to construct the steel Pontoon of size 35 m in length, 9 m width and 1.5 m depth considering good stability and efficient working conditions in the Project location. The pontoon will be designed to support and anchor vessels up to 1500 DWT. Scantlings & mooring arrangement can be done as per IRS/IWT Rules.

Floating Walkway

A floating steel walkway of size 50 m in length and 3 m in width is planned, connecting to the berthing Jetty and leading to the shore shall float horizontally at all levels of the tide (with a maximum range of 3 m as reported) keeping the same level with the Deck of the pontoon jetty for safe movement of people from/to the Jetty and the shore. As such, the other end of the Walkway cannot be connected rigidly with the shore itself which may be about half a meter at least above the HHWL of the tide. This will prevent the free horizontal rise and fall of the Walkway with tide. For this a Gangway flexibly connected with the shore and the Walkway to absorb the tidal rise and fall of the Walkway keeping it floating at all stages of the tide with varying its slope is planned.

The steel walkway will have to be secured on the jetty at one end with yoke, roller, pin. A Doubler plate to be used at the edge of the berthing pontoon, where the end of the steel walkway will be connected, the same shall cover an area of 3 m x 3.5 m for additional strengthening. The floating Walkway may be buoyed at each support by a pair of 1000mm dia. steel cylinder 3 m long placed along the current direction. Each floating support may be placed at an interval of 8 m. A pair may be connected by welding with suitable I sections to fix the bottom of the Walkway with a suitable clamping system in such a manner that the steel floaters may be disengaged from the Walkway for repairs & maintenance as and when required. The other end is to be secured by wire ropes and sinkers.

Steel Gangway

A steel gangway of size 8 m in length and 3 m in width will be hinged at the shore on a steel plate grouted to the bank, and supported by roller & pin arrangement at the other end on the floating walkway. Gangway should be flexibly connected with the shore and the floating walkway as to absorb the tidal rise and fall of the walkway keeping it floating at all stages of the tide by varying its slope is planned.

Drawings

The design drawings of the proposed infrastructure are attached with this note. The following drawings are provided herewith:

i. GA Layout For 35 M Long Pontoon, 50 Meter long floating walkway and 8 meter long floating gangway to be used for docking vessels up to 1500 DWT Capacity.
ii. Design Details for 35 M Long Pontoon
iii. Anchoring Details for 35 M Long Pontoon
iv. Design Details for 50 m Long Steel Floating Walkway connecting to the Floating Pontoon – 1
v. Design Details for 50 m Long Steel Floating Walkway connecting to the Floating Pontoon – 2
vi. Design Details for 8 m Long Steel Gangway connecting to the Floating Walkway

Design Specifications to be included in the Tender Document

We understand that the construction of the above marine structure could be tendered out by IWAI for construction. The design specifications for the above marine structures therefore, have been provided in the form of design specifications which could be included in the Tender Document.

Description &Technical Specifications of the Project Components

Steel Pontoon (Barge)

The Pontoon including all its material, equipment, piping, machinery, workmanship, etc., shall be in accordance with this specification and to the requirement of the classification Society and regulatory bodies, and shall be fully documented as required by these bodies.

The Pontoon is to be constructed for inland waters and as such classified by class with IRS (Indian Register of Shipping) or any other Classification Society who is Member of IACS (International Association of Classification Society). The building is to be carried out under the survey of this Classification Society having the class notation for the hull.

All materials, equipment and machinery required for the construction of the Pontoon shall be of high quality and suitable for marine use and for the prescribed services. All workmanship entering construction and finishing of the work shall be of first class standard in accordance with good shipbuilding practice, suitable for the purpose intended and to the satisfaction of the Classification Society.

All tests and trials required for the pontoon and ancillary equipment shall be performed in compliance with the Statutory/Classification/Owner's requirements.

The Builder shall prepare and submit a detailed programme of the relevant trials to the Owner and Classification Society for approval.

Any defect/shortfall pointed out by the Surveyors/Owner during the tests and trials shall be rectified by the builder at no extra cost.

All costs involved in conducting the trials shall be borne by the Builder. The costs of the tests and trials are for account of the Contractor, including those for additional measuring devices and means.

If during tests or trials any part of the pontoon fails to fulfil adequately the specified requirements, the faulty parts shall be altered, removed or replaced and the test shall be repeated at the Contractor's expense.

Factory/Yard Tests

Testing of water tightness of steel constructions to be carried out in accordance with the requirements of the Classification Society. Testing of welds for steel constructions is to be in accordance with the Class requirements.

Installation Trials

When the pontoon is completely equipped to the satisfaction of both the Owners the Classification Society, the installation trials shall be carried out (at or near to the Contractor's shipyard). The Pontoon with all installations to be tested by the Contractor to prove their good working, capacities and characteristics, separately as well as simultaneously working with other installations.

These trials are to include an inclining test for determination of weight, draught, trim, center of gravity etc.

Welding

The pontoon shall be of all welded steel construction. All openings and holes in the structure shall be made with the consent of the Classification Society and shall be suitably compensated for strength.

Welding shall be of high quality and shall be performed by skilled and Classification Society approved personnel. Necessary precautions shall be taken to eliminate deformations. All surfaces shall be cleaned from rust and grease before welding. Approved manual, semi-automatic or automatic welding techniques shall be adopted for the construction using coated electrodes of approved make. A regular x-ray testing asper Classification Society rules shall be carried out to test the standard of welds. Builder shall submit inspection and testing plan to the owner for approval.

Tank Testing

All tanks and watertight compartments shall be tested in the presence of the Surveyor and Owner’s representative and shall comply with the rule requirements. The tests shall be carried out after completion of the construction and prior to commencement of painting. At the time of testing all welds at boundary surfaces shall be clean and free from primer/paint/oil etc. Immediately after testing these entire weld surfaces, which are cleared of any defects, shall be coated with primer/paint.

Inclining Test

Before the trials and with the pontoon in a condition as complete as possible, an inclining test shall be conducted to ascertain the lightship displacement and center of gravity in the presence of Owner’s representative, Classification Society and IWT surveyor. The inclining test report approved by Classification Society and IWT surveyor shall be made available to the Owner’s representative.

Delivery

The pontoon shall be delivered and accepted at Hemnagar in the District of South 24 Paraganas, West Bengal. After the trials and the approval of Owner and Classification Society of these trials with reports etc. the pontoon shall be handed over to the Owner in a proper and clean condition. The costs of transportation, additional painting, checking trials and handing over and with the stores specified above shall be to the account of the Builder. All relevant documents, certificates, tools, inventories, spare parts etc. shall be on board at the time of handing over.

Photographs

The Builder shall take photographs of the pontoon at various stages of construction and shall submit them along with the monthly progress report and bills for stage payment to the Owner. On completion of the pontoon, additional photographs shall be taken for framing purposes.

Hull Structure

Introduction

The scantling of the structural members shall comply with the Rules and Regulations of the Classification Society as far as no higher requirements are stipulated.

Good continuity of structural members in basic hull structure shall be maintained. Care shall be taken to obtain proper alignment of important structural members. Where members are discontinuous, the continuity shall be provided by means of suitable tapers, overlaps and/or brackets.

Materials

All materials used to be of excellent quality. The hull will be constructed out of shipbuilding quality steel conforming to the rules & requirements of the Classification Society and BIS (Bureau of Indian Standards0. Structural steel of hull construction shall be of Classification Society Grade ‘B’/Equivalent. The steel will be procured from primary steel producers like SAIL or TATA Steel or their authorized dealers. The Contractor must guarantee that only approved materials will be used in the construction of the Pontoon.

All structural steel shall be free from rust, pitting, cracks, laminations and similar defects. In case of any such defects being noticed, the plates etc. shall be renewed for the extent necessary to the approved quality/standards.

Large size steel plates shall be used for the construction of hull as far as practicable.

As required by the Class, samples of materials are to be submitted for approval. If any material is used which has defects, or which is not considered suitable for the purpose intended, it must be replaced without loss of time and without any compensation of cost for carrying out these replacements.

Rolled Steel
Hull materials and further all rolled steel, to be tested to the rules of the Class, of which certificates should be submitted. The steel must have good welding qualities and should have a carbon percentage not exceeding 0.2%.

Before the material is employed in the construction, rust and mill scale must be removed by means of steel grit or sand blasting according to Class Standard. Immediately after the blasting, one coat of approved shop primer with a thickness of approx. 20 microns is to be applied as a temporary protection.

Cast Steel
Steel castings only of first-class approved foundry and of approved design, properly annealed is to be used. Quality and testing will be in accordance with the rules of the Class. Castings must be free from blowholes or other defects.

All materials including casting and forging shall be of qualities complying with the requirements of the Classification Society.

Bolts and Nuts
All bolts and nuts are to be of approved standard. Throughout the construction metric thread is to be used.

Preparation of Materials and Welding
When steel plates are deformed during transport, these are to be flattened by rolling before use. Flanging of plates and brackets is generally not allowed. For bolts and rivet holes only drilling is allowed.

Doublings will not be allowed, and where necessary, locally inserted thicker plates with well rounded corners are to be adapted.

Plates and rolled sections are to be cleaned and preserved as described above.
The sub-division into blocks and panels and the sequence of the execution of the welding shall be fixed according to the Class requirement.

A drawing of the constructional sub-division in sections and panels is to be submitted by the Contractor for approval. The blocks and panels shall only be placed on the berth after inspection and approval by the Class.
Holes in the construction for pipes, cables, trunk passages or other passing are to be determined according to the Class requirement.

All tanks, watertight or oil tight compartments (if any) and other constructions as considered necessary, are to be pressure tested in accordance with the requirements of the Class and to the satisfaction of the IRS.
The testing must be carried out after the construction work has been finished and approved. A tank testing plan to be timely submitted for approval.

During building the correct line of the bottom centre is to be inspected regularly, to determine any deformation of the hull.

Welding
All welding is to be of excellent quality. During the welding operations, all necessary precautions are to be taken, so that welds of high standards are obtained. All surfaces are to be well cleaned and free from rust, paint etc. before welding has commenced. Plate edges are to be flame-cut mechanically as much as possible. Where

possible, plates and sections are to be interconnected by automatic welding methods. Overhead welding is to be avoided as far as possible and therefore necessary provisions are to be taken for underhand welding where practical.

Manual, semi-automatic or automatic welding procedures for welding specific parts of respective steps in the process of assembling the structural blocks of the hull shall be selected in consultation with the Classification Society.

A complete welding list is to be submitted for approval of the Class. In this list, particulars are to be given, such as shape of welded joints, the manner of preliminary treatments, the dimensions of the weld and the type of electrodes to be used.

Hull

Layout

The layout of the hull shall be:

- aft peak
- store
- fore peak.

All compartments shall be bordered by watertight bulkheads. The complete hull shall be built of steel according the transverse framing system with the Frame spacing of 500 mm.

Bottom construction

The pontoon shall have single bottom construction. The thickness of the bottom plating shall be as determined by the rules and requirement of Class. The keel to be of a flat plate-type with a thickness of 8 mm. A sufficient number of drain and air holes to be provided in floors and girders. Bottom plating, floors, girders and brackets in way of the foundation/pillars of the cranes of increased thickness and arranged in such a way that a sturdy construction will be obtained.

Shell plating and framing

The scantlings of the shell plating to be determined as per the rules and requirement of Class and the thickness of shell plating to be at least 7 mm. Web frames shall be provided with a maximum spacing of 2 m if required as per class.

Stem and Stern

The thickness of the stem and stern plating will be equal to the thickness of the shell plating. Adequate stiffening is to be provided. Plating of increased thickness shall be provided in way of pusher stools.

Deck and Beams

The main deck shall be stiffened according the transverse system, with beams/brackets every 500 mm distance. The beams shall be supported by longitudinal girders, which are place in line with the bottom longitudinal.
Local reinforcements shall be integrated in way of anchor winch, bollards, etc. The deck shall be locally strengthened adequately in way of deck fittings or deck machinery.

The construction, materials, arrangement and fittings in the accommodation spaces shall comply with the statutory requirements applicable to this class of pontoon.

Pillars and Girders

Girders shall be provided under the deck if required from the view points of the design of the Pontoon. Reinforcement pillars shall be fitted in combination with, and at the same positions as the web frames.

Pillars shall be arranged such as to minimize obstruction to passage inside the engine-room.

Bulkheads

The pontoon shall have transverse watertight bulkheads and the scantlings to be determined as per the rules and requirements of the Class. All bulkheads shall be vertically stiffened. Where pipes etc., are carried through the watertight bulkhead they shall be provided with necessary arrangements to the approval of classification surveyors.

Hull openings

Hull openings if any including hawse pipes may be made as per the Class requirement.

Miscellaneous

Manholes

Each compartment shall be provided with as much (but at least two) manhole covers as needed to provide a good accessibility. The covers shall be placed in such a way that with opened covers good ventilation will be obtained.

The covers shall have dimensions of at least 400 x 450 mm or as per Class requirements. Thickness of the cover 12 mm or as required and fixed on a welded coming ring with tap bolts and nuts of stainless steel. Two thread holes for press bolts shall be provided in each cover. Vertical covers to be provided with handgrips. All covers shall be provided with oil resistant packing.

Hatches

The hatches shall be fitted for the store with required scantlings etc.

All hatches in watertight execution with rubber seal and hinged clamping bolts of stainless steel with brass butterfly nuts if applicable.

The hatch above the store shall be provided with hoisting eyes for removing by crane.

Hawse Pipes

The hawse pipes on the centre line of both stem & stern are to be installed to facilitate suitable mooring system. Same from the shell to the deck is to be made of seamless steel tube with appropriate thickness and a diameter suitable for the anchor shaft.

Collars of 30 mm solid round bar to be welded at both ends of the hawse pipe.

A chain pipe from the anchor winch to the chain locker to be led through the main deck and to be provided at both sides with conical ends with solid round edges. The pipe is to be extended adequately below the top of the locker.

Chain Locker

A totally closed chain locker shall be arranged in the aft and forepeak. The locker of sufficient capacity to contain the anchor chains. On the bottom of the locker galvanized and perforated steel plate to be laid, under this floor plate a mud box to be provided. For drainage of the box a self-closing valve with drain to the bilge of the fore peak to be installed.

On the top of the chain locker a safety device is to be installed for fixing the last link of the anchor chain.

In the wall near the top of the locker a manhole with hinged cover to be made for access to the locker.

Bollards

Adequate double bollards to be provided on the main deck distributed on the port and starboard side for effective mooring. The bollards placed in heavy foundations with a height of about 200 mm. Total height of the bollards 500 mm. Deck construction in way of bollards shall be reinforced with increased plating thickness and extra stiffeners.

Name and Draught Marks

Pontoon’s name and Port of Registry

The Pontoon’s name shall be marked forward port and starboard sides and transom.

The Port of registry shall also be marked below the Pontoon’s name on the transom.

Draft marks

The draft mark shall be marked in meter and decimetres by welded 6 mm thick steel plate figures at forward and aft perpendiculars and amidships on both sides.

Fenders
Half round steel pipe fenders shall be provided at the main deck level on the side shell. The front flat part of the tug shall be provided with suitable neoprene rubber fenders for efficient push towing.

Hull preservation
General
Painting specification giving details of painting and method of application shall be submitted to the owner for approval.

The colours of finish coats shall be in accordance with the Owner's colour scheme and those of primer coats shall be in accordance with the manufacturer's recommendations. Alternate coatings shall be of different colours for easy identification. Pipelines shall be marked with a colour code system approved by the Owner.

Equipment, which the builder shall purchase, shall be painted according to each manufacturer's standard and the damaged part, after installation shall be touched up with one coat of finish paint of compatible kind.

Surface Preparation
Surfaces of all structural steel plates and sections to be used for fabrication shall be sand or grit blasted to Sa 2.5 and immediately primed with inorganic zinc silicate type shop primer according to the Builder's standard.
Dry film thickness of shop primer shall be approximately 20 microns.

The steel surface of fittings such as pipe supports, grating supports, auxiliary machinery seats, etc. shall be sand blasted to Sa2.5 or pickling treated.

Pipes of over 250 mm diameter shall be blasted to Sa2.5 and pipes with 250 mm diameter and below, small pieces of pipes, seats etc. shall be power cleaned with wire brush or disc sander to St 3 or pickling.

Prior to the application of main system, all weld spatters, rust grease and other contaminants shall be removed by wire brushing from the surface.

Equipment and Outfit
General
This paragraph of the Specification contains the descriptions of equipment and outfit of the pontoon.

All requirements laid down in other paragraphs are also valid in this paragraph as far as applicable. The requirements regarding painting are also valid for the constructions and equipment.

Anchor and Mooring Arrangement & Equipment
The pontoon deployed on the river is to encounter heavy current of maximum 4m/sec during flood & cyclones with water level variation of 5m. Therefore, suitable mooring arrangements along with high powered anchors are to be provided for sustaining the above adverse conditions. Detail design and calculation in this regard to be prepared and same to be approved by owner & IRS before installation. The winches, anchor chain, mooring ropes, shackles etc. shall be as per the class requirement. The requirement of mooring at shore with appropriate arrangement through steel wire rope of adequate dia shall also be provided.

Anchor Winches
Electrically operated anchor winch to be installed on both sides of required size shall be provided. Winch also suitable for manual operation. The anchor winch to have one chain pulley/sprocket and one warping head. Lined brakes and couplings to be provided for independent operation of the pulley and the warping head.

Floating Walkway
The floating Walkway will be all steel construction as per IWT rules and scantlings as approved by Class with the following dimension:
Length: 50 m
Width: 03 m

The cargo vessels are expected to berth alongside the Pontoon for Customs Inspection within the main navigation channel itself since no loading or unloading of cargo is proposed. As per data provided in the topographic charts

and bathymetric details of the region, a length of 50 m from the shore is proposed for docking of barges handling 1000-1500 DWT.
As and where applicable the same technical specifications for the Pontoon (Barge) will hold good for the Floating Walkway.

Steel Gangway
The Steel Gangway will have the following dimensions:
Length: 08 m
Width: 03 m

As and where applicable the same technical specifications for the Pontoon (Barge) will hold good for the Steel Gangway.

Cost of the Project
Cost of the components of the Project is given in the following table.

(The cost is based on budgetary quotations received Kolkata Shipyards on 17thApril 2017.)

S. No.	Items	Quantity (No.)	Cost (in INR)
1.	35 m LOA, 9 m moulded breadth & 1.50 m depth floating pontoon with all accessories	One	1,20,00,000
2.	50 m long & 3 m wide steel floating Steel Walkway including yoke, roller, pins supported on at least 6 nos. of steel floaters with supply of necessary wire ropes & sinkers all complete	One	90,00,000
3.	8 m long and 3m wide steel gangway	One	18,00,000
4.	Transportation of Pontoon and Gangway/Walkways from the Shipyard to Hemnagar site including installation with mooring gears i.e. 10 lengths of 44 mm dia chains, 4 nos. approx. 3 Tonnes each Stockless anchors etc. (old and used) at site	One	70,00,000
5.	Contingencies (10%)		29,80,000
	Total		**3,27,80,000**

Conclusion
Preliminary design drawings of various marine components as described above have been attached with this Note. Based on a final inspection of the Project location, the drawings may have to be adjusted a little bit to suit to the actual site conditions.

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