

Final Report on

Development of Digital Elevation Model (DEM) and delineation of
Catchment boundaries for Polders 43/2A,
Polder 43/2B, Polder 43/2D and Polder 43/2E of Blue Gold Program

Patuakhali O&M Division



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1. Introduction

1.1 Background of the Study

The coastal region of Bangladesh is regarded as a zone of multiple vulnerabilities. About 38% of the population in this region live below the poverty line and face high vulnerabilities in terms of insecurity of food, income, water and health. Water is the blessings as well as curse for the coastal population. Management of this natural resource is very crucial for achieving wellbeing of the coastal population. Participatory water resources management is successfully operating in coastal area of Bangladesh by BWDB, where Government of the Netherlands (GoN) participates as a development partner. Blue Gold is a collaboration program between the Government of the Netherlands (donor) and the Government of Bangladesh which is undertaken to uplift the socio-economic status of households living in coastal polders and its surroundings.

Blue gold is such a project of GoN and GoB which emphasizes active involvement of rural communities concerned and other stakeholders. Under the Blue Gold project the consultant Euroconsult Mott MacDonald assigned CEGIS to prepare Digital Elevation Model (DEM) and catchment boundaries for seven polders in Patuakhali and Khulna Districts. Under this project CEGIS has been assessed certain parameters, (topography, hydrology, drainage system, interventions and cropping practice) that usually govern overall drainage and hydrological dynamics within the polders.

1.2 Study area

The study areas of the project are situated in South-Central hydrological region of Bangladesh. The Polders under the South-Central region are Polder 43/2A, Polder 43/2B, Polder 43/2D and Polder 43/2E (Figure 1.1). The study area covers about 20.23 sq. km. Specific locations of the Polders, governing rivers and areas of the polders are mentioned in the following Table 1.1.

Table 1.1: Specific location of the Polders

SL	Polder Name	Location (union)	Major River/Khal	Area (ha)
01	Polder 43/2A	Choto Bighai, Bara Bighai, Madarbunia unions under Patuakhali Sadar Upazila.	Payra and Kala Nadi. The Kala Nadi meets the Payra river along the south and falls into the Bay of Bengal.	4,717
02	Polder 43/2B	Amkhola union of Galachipa upazila and Auliapur of Patuakhali sadar upazila.	Golkhali khal, Payra River (Buriswar), Lohalia, drainage and irrigation canals (khals) within the polder.	5,705
03	Polder 43/2D	Auliapur, Kalikapur, Madarbunia, Marichbunia and some portion of Jainkati union of Patuakhali Sadar upazila.	Gulishakhali, Gorai, Lohalia, Bahalgacia khal, Payra	8,136
04	Polder 43/2E	Half of Jainkati union of Patuakhali Sadar upazila.	Lohalia, Shuddurbaria khal and Naotana khal.	1,679

1.3 Objectives

The overall objective is to assess the existing condition of topography, hydrology, drainage system, interventions and existing cropping practice of selected polders coastal areas of Bangladesh.

Specific objectives:

The specific objectives of the study are:

- To identify detail topographic features, landforms and elevation;
- To assess the drainage pattern and tidal dynamics within the delineated catchment boundary;
- To identify the present condition of cropping pattern;

1.4 Scope of works

The scope of works as per the ToR is as follows:

- Digital Elevation Model development based on contour and point data from FINNMAP/BWDB Maps.
- Catchment area delineation including updated water management infrastructure layout along with roads and culverts/bridges.
- Tidal dynamics assessment around the polders and suggest drainage plans.

1.5 Deliverables and outcomes

As per the ToR and Scope of works a number of deliverables and outcomes identified. The major deliverables and outcomes are stated bellows:

- Inception Report
- DEM preparation & Elevation Mapping
- Catchment area delineation and detail mapping.
- Drainage pattern/direction maps
- Technical Report

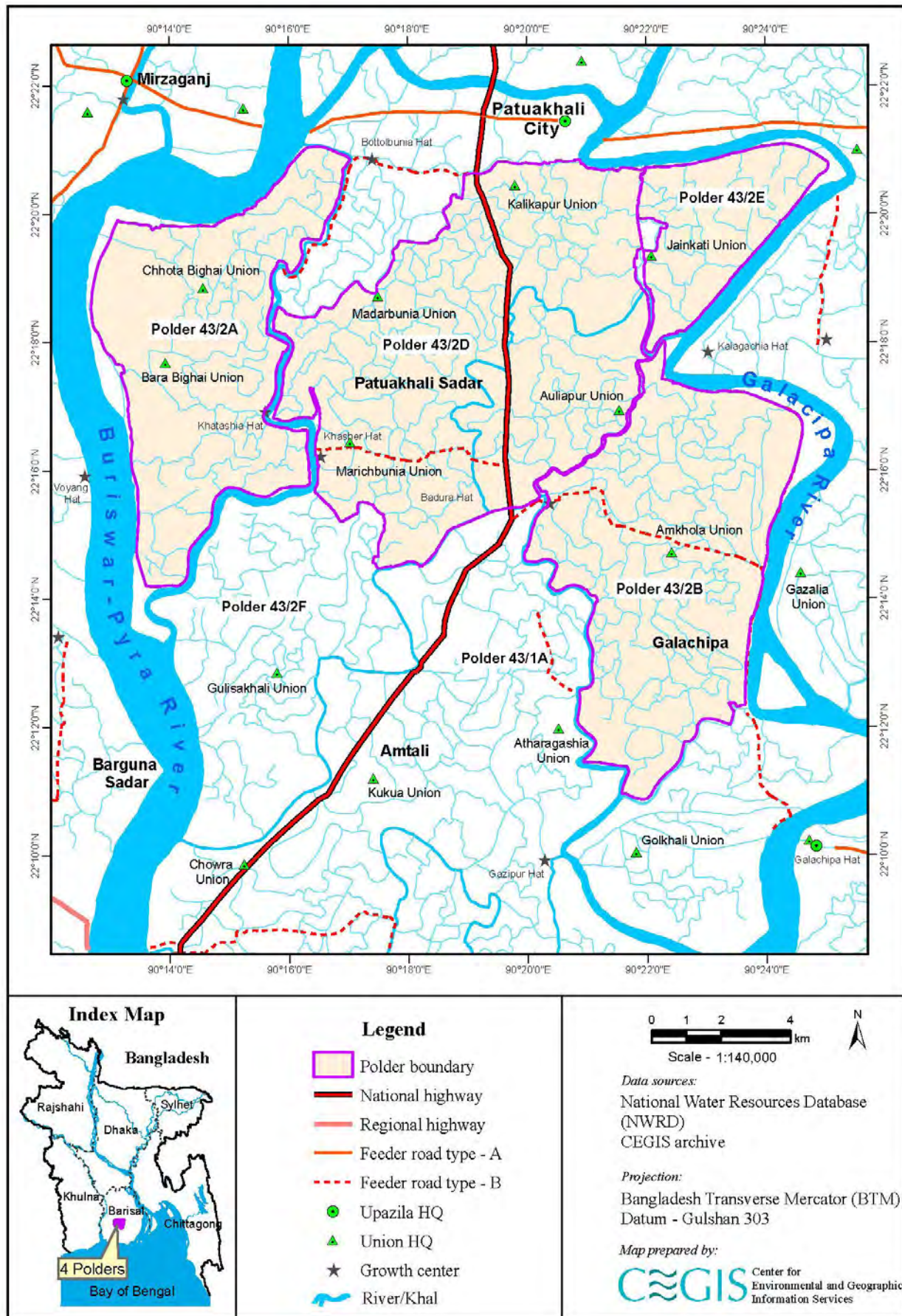


Figure 1.1: Study area of Polder 43/2A, Polder 43/2B, Polder 43/2D and Polder 43/2E

2. Approach and Methodology

2.1 Initial consultation meeting

At the inception phase all works have been identified and a step-by-step approach and methodology has been developed. The major activities are presented in Figure 2.1 and described in the following sections.

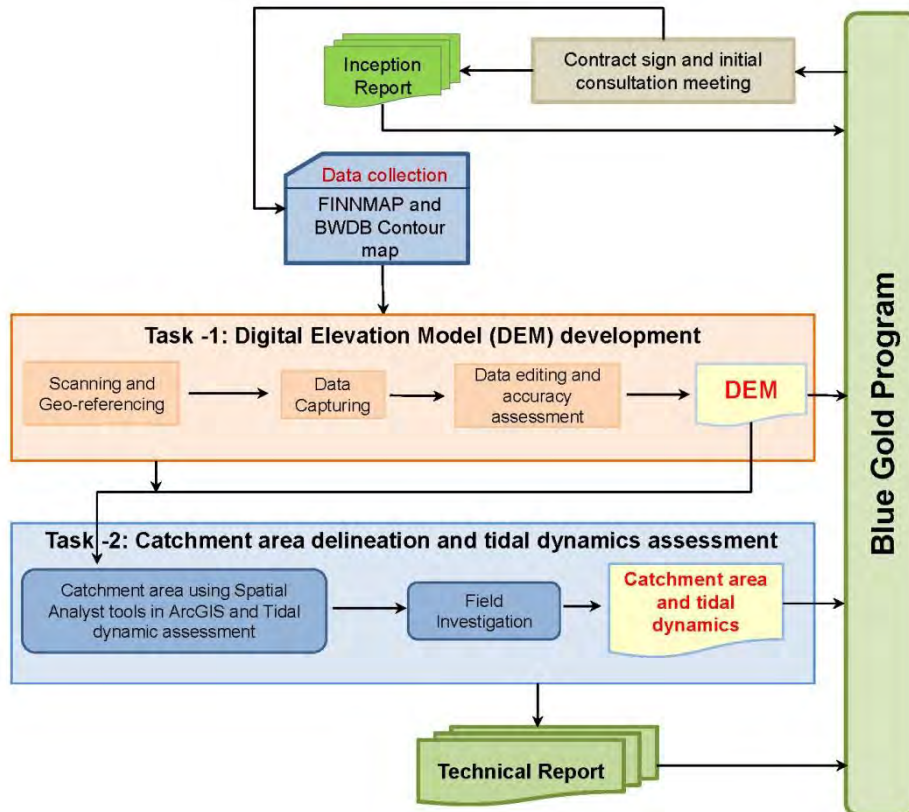


Figure 2.1: Overall methodology of the activities

2.2 Contract Signing

The contract was signed between Euroconsult Mott MacDonald and Center for Environmental and Geographic Information Services (CEGIS) on 27 March 2016. Mr. Guy Jones, Team Leader, Blue Gold Project and Engr. Md. Waji Ullah, Executive Director, CEGIS signed the contract.

2.3 Initial consultation meeting

After signing of the contact an initial consultation meeting was organized with the officials and relevant professionals of the client on 14 April 2016 to finalize the understanding of the requirements; identify the data sources, data format, spatial resolution, coordinate system, probable outcomes and priorities.

2.4 Inception Report

The Inception Report (this report) consists of detail activities, methodology, deliverables, and work plan for performing the project activities was prepared and submitted on 29 July 2016.

2.5 Data collection

The contours and spot elevations have been collected from FINNMAP. The FINNMAPs were published by Bangladesh Inland Water Transport Authority (BIWTA) in 1998 at 1:10000 scale. Twenty seven (27) numbers sheets have been collected under this study. The collected FINNMAPs are shown in Table 2.1.

Table 2.1: FINNMAP collection from BIWTA

SL No.	FINNMAP	Number of Sheet
1	2450 – 520, 525, 530, 535, 540	5
2	2455 – 520, 525, 530, 535, 540	5
3	2460 – 520, 525, 530, 535, 540	5
4	2465 – 520, 525, 530, 535, 540	5
5	2470 – 525, 530, 535, 540	4
6	2495 – 435, 440	2
7	2500 - 440	1
Total		27

The contour intervals of FINNMAP is 0.25 m. East-west spacing of spot elevation is about 300 m and spacing in north-south direction is about 100m. Sample of a FINNMAP is shown in Figure 2.2. Rivers and khal networks will be digitized from these maps.

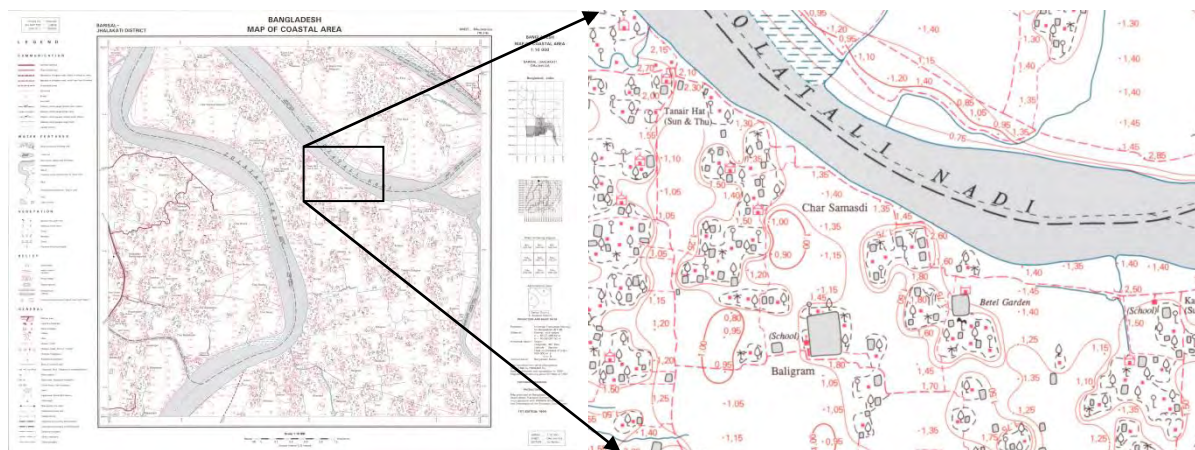


Figure 2.2 : Sample of BIWTA FINNMAP

2.6 Digital Elevation Model (DEM) development

2.6.1 Scanning and geo-referencing

All the collected FINNMAP sheets have been scanned using a high precision scanner at 300 dpi in JPG file format. The maps are scanned in such a way, that all the features are clearly visible and digitization done accurately. Geo-referencing are done using ArcGIS software.

Bangladesh Transverse Mercator (BTM) projection has been preferred by the client and used to geo-reference those images.

Projection parameters

Bangladesh Transverse Mercator (BTM) projection parameters will be used to geo-reference those images. The parameters of BTM projection are:

Projection Type	Transverse Mercator
Datum Name	Everest
Scale Factor at central meridian	0.99960000
Longitude of central meridian	90:00:00.000000E
Latitude of origin of projection	0:00:00.000000N
False easting	500000.000000 meters
False northing	-2000000.000000 meters

2.6.2 Data capturing

FINNMAP Maps are very reliable source for providing contour lines, spot height with fine details and accuracy. These data were captured from geo-referenced FINNMAP Maps. Settlement, detail roads network, rivers, khals, water bodies and water management infrastructure (Drainage and flushing regulators) were captured from these maps. The features were identified considering size, shape, pattern, texture and description available in the map.

2.6.3 Data editing and accuracy assessment

The good quality of the report was ensured from data accuracy, authentic source of information and inclusion of necessary parameters of accuracy. Data editing and accuracy assessment were carried out for quality output. The accuracy assessment was done through visual inspection and interpretation by comparing with the original FINNMAP maps. The contour values for each digitized map sheet were checked visually. GIS Expert and Quality Control Specialist were involved in accuracy assessment.

2.6.4 Develop Digital Elevation Map (DEM)

From the objectives it is clear that the study is deemed to be assessing topographic features, landforms, elevation, drainage patterns and tidal dynamics within the delineated catchment areas. The cropping patterns were assessed within all 7 polders. As per the undulating nature of the landform the drainage systems are governed. To get ideas about the landform variation within the study area appropriate Digital Elevation Maps were be prepared.

Original elevation of FINNMAP is in SoB datum, which is in Mean Sea Level (MSL). After capturing, the MSL values have been transferred to PWD datum. Roads and embankments are elevated based on the surrounding elevations and survey. The rivers, khals and other water bodies were lowered considering lowest elevation. Road were considered as dominant factor where khal are closed. Digital Terrain Model (DTM) were prepared using Spatial Analyst tool of ArcGIS. The DEM are prepared with 50m X 50m spatial resolution.

2.7 Field Investigation

After data capturing and initial assessment based on secondary data (FINNMAPs, Topo Sheet, Google Images and development of initial DEM) a field investigation were conducted to verify the collected ground information of flow pattern and structure with parameters. The field office of Blue Gold Project has identified consult to identify the available information and location of features in the field.

- Collection of detail information on Hydraulic structures (Drainage sluices, Outlets, Bridge and Culvert) in the study area.
- Flow direction and pattern assessment through visual inspection in stream and public consultation with local people for overland flow.
- Identify man made obstruction/barrier on the khal through visual inspection and satellite image
- Identify the location name, hat-bazars etc. through physical visit and public consultation.
- Considering all these collected information and knowledge gained from the BWDB officials, Blue Gold professionals, local people and direct field inspection were incorporated. These parameters are considered in DEM and catchment delineation.

Considering all these collected information and knowledge gained from the BWDB officials, Blue Gold professionals, local people and direct field inspection are incorporated. These parameter are considered in DEM and catchment delineation.

2.8 Catchment Area and tidal dynamics assessment

Catchment/watershed delineation is one of the most commonly performed activities in hydrologic analysis. A catchment of an outlet or pour point is the upslope area which drains its accumulated runoff through that point. Watershed delineation was performed with the Spatial Analyst Tools of ArcGIS using the Developed Digital Elevation Model (DEM) and rivers/khals network as inputs. All the watershed delineation steps such as filling sink, defining flow direction and accumulation will be done in ArcGIS using SWAT (Soil and Water Assessment Tool) hydrological model. Catchment wise drainage pattern and area elevation curves were derived from the DEM and watersheds.

CEGIS team installed ten (10) water level gauge stations to understand the tidal water level variations in and around the study area. Daily water level data at one (01) hour interval (from 6:00 AM to 6:00 PM) for 1 tide cycle (15 days) has been collected during monsoon. This water level data has been used to analyses the tidal dynamics.

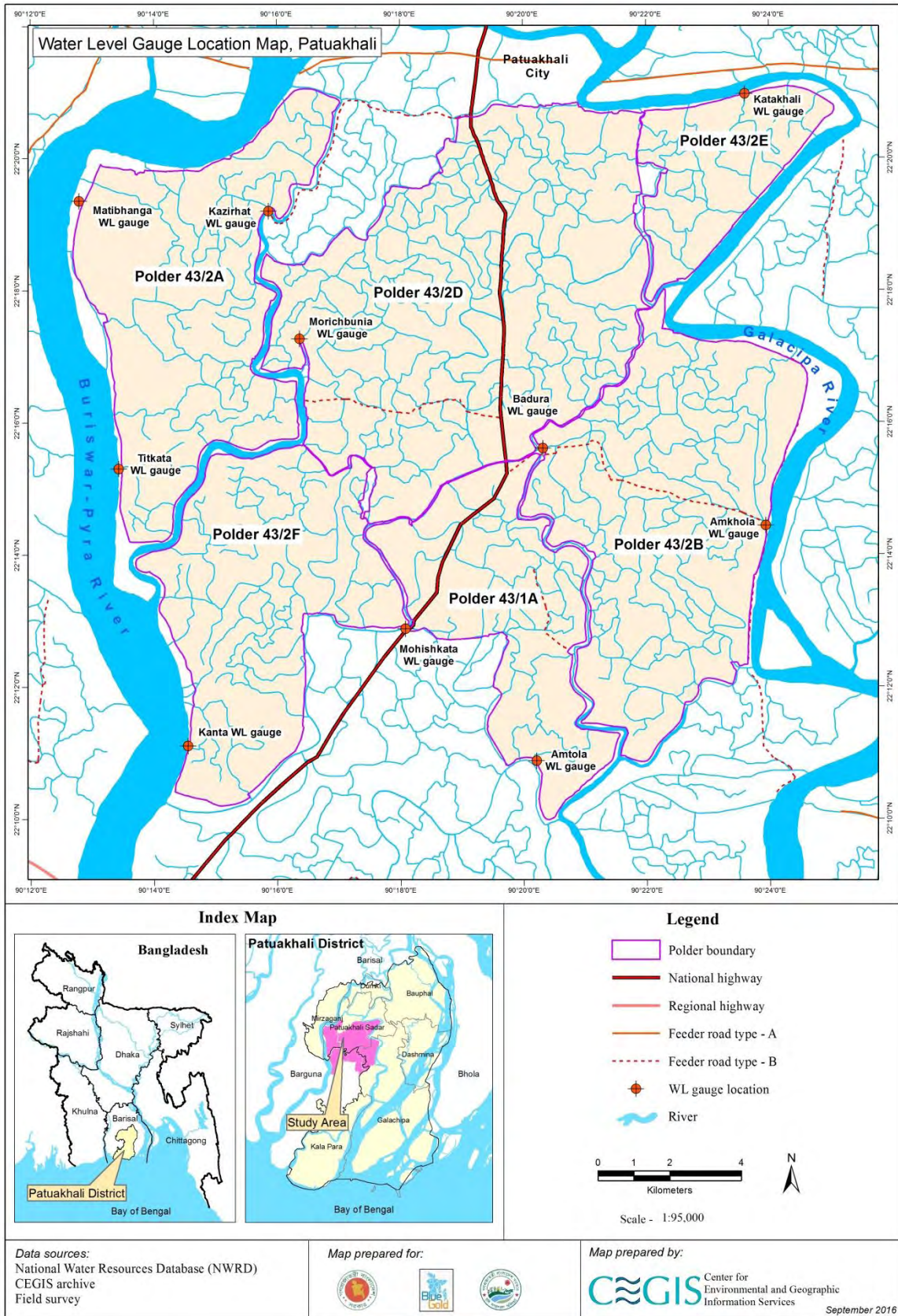


Figure 2.3: Water level gauge stations around the study area

2.9 Catchment of Polder 43/2A

In this study, for polder 43/2A, Catchment has been delineated for six (06) drainage outlets. The drainage outlets were selected at six (06) hydraulic structure locations. Figure 2.4, 2.5 and 2.6 shows the Base map, Intervention with catchment and Digital Elevation Model (DEM) map of Polder 43/2A. Area of each catchment boundary has been presented in Table 2.2. From the Figure 2.6 and Table 2.2 shows that catchment of Khatasia Sluice is the largest catchment which is about 1578 ha.

Table 2.2: Drainage outlet/ hydraulic Structure wise drainage catchment for polder 43/2A

Description of Catchment 01

Catchment Name	Cat -1 (Titkata catchment)
Location	Northern part of Titkata (423 ha) and southern part of Dakshin Bighai (108 ha) mauza of Bara Bighai union
Catchment area (ha)	531
Drainage Outlet	Titkata sluice, DS-1 at Ch. 3.847 km (1V- 1.5m X 1.8m)
Main Drainage Canal	Titkata Khal (Average Top width: about 20m to 25m)
Land elevation of Catchment (m PWD)	Max: 3.35 Min: 1.31
Length of Stream within catchment (Km)	9.63
Drainage Density (m/ha)	18.15
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Payra river • Condition: Active ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Partially silted up • Branch Khal: <i>Latiatala Khal</i> and <i>Sidamgain Khal</i> are silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Minor (usually takes 2-3 days to properly drain out rain water) • Permanent Water logging: Not found ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Minor • Water Scarcity: Not found ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Partially functional (Vertical lift gate is corroded)





Figure: C/S of Titkata Sluice



Figure: Outfall of Titkata Catchment (Payra River)



Description of Catchment 02

Catchment Name	Cat-02 (Katakhali catchment)
Location	Part of Chhota Bighai (223 ha) mauza of Chhota Bighai union
Catchment area (ha)	223
Drainage Outlet	Katakhali sluice, DS-2 at Ch. 9.650 km (1V- 0.9m X 1.2m)
Main Drainage Canal	Katakhali Khal (Average Top width: about 14m to 18m)
Land elevation of Catchment (m PWD)	Max: 2.96 Min: 1.35
Length of Stream within catchment (Km)	2.19
Drainage Density (m/ha)	9.81
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Payra river • Condition: Partially Active ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Highly silted up • Branch Khal: <i>Nayankhali Khal</i> and <i>Bilair Khal</i> are moderately silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • <u>Problem</u>: Severe, usually takes 6-7 days to properly drain out rain water • Due to sedimentation, the outfall bed level (C/S portion adjacent to the regulator) of Katakhali khal is comparatively higher than the upstream. As such, during ebbing water cannot drain out properly. Moreover, encroachment (several cross bundh on Katakhali khal) made by the local people interrupts the natural drainage system.

	<ul style="list-style-type: none"> • Re-excavation of Katakhalı khal (about 1 Km) and removing encroachments may reduce drainage congestion. • Permanent Water logging: Not observed ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Major due to drainage congestion (mainly affects Lt Aman and HYV Aman during seed bed preparation). • Re-excavation of Katakhalı khal may reduce the crop damage. • Water Scarcity: Partially found ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Partially functional • Loose Apron both R/S and C/S is damaged.
	
<p>Figure: C/S of Katakhalı Sluice</p>	<p>Figure: Outfall of Katakhalı catchment</p>





Description of Catchment 03

Catchment Name	Cat- 03 (Matibhanga Catchment)
Location	Southern part of Matibhanga (257 ha) and northern part of Chhota Bighai (242 ha) mauza of Chhota Bighai union
Catchment area (ha)	499
Drainage Outlet	Matibhanga Sluice, DS-3 at Ch. 11.910 km (1V- 1.2m X1.2m)
Main Drainage Canal	Matibhanga khal (Average Top width: about 14m to 16m)
Land elevation of Catchment (m PWD)	Max: 3.19 Min: 1.08
Length of Stream within catchment (Km)	10.17
Drainage Density (m/ha)	20.42

<p>Catchment Description</p>	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Payra river • Condition: Active ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Moderately silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • <u>Problem</u>: Moderate, usually takes 3-4 days to properly drain out rain water. • Vent size of Matibhanga Sluice is inadequate for efficient drainage. • Construction of new drainage outlet at Dhanger khal may reduce drainage congestion. • Permanent Water logging: Not found. ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Moderate • Water Scarcity: Observed (Mainly affects Rabi crops and HYV Aman during seed bed preparation) ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Partially functional (Loose Apron damaged both R/S and C/S) • Capacity of sluice is inadequate
	
<p>Figure: C/S of Matibhanga Sluice</p>	<p>Figure: Outfall of Matibhanga catchment</p>

Description of Catchment 04

Catchment Name	Cat 04 (Matherbunia catchment)
Location	Nandipara (256 ha) and northern part of Madarbunia (27 ha) mauza of Madarbunia union; eastern part of Bhajna (59 ha) and Tushkhali (36 ha) of Chhota Bighai union
Catchment area (ha)	378
Drainage Outlet	Matherbunia sluice, DS -04 at Ch. 22+983 km (1V- 1.2m X 1.5m)
Main Drainage Canal	Matherbunia Khal (Average Top width: 8m to 10m)
Land elevation of Catchment (m PWD)	Max: 2.89 Min: 1.40
Length of Stream within catchment (Km)	7.26
Drainage Density (m/ha)	19.18
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Gulishakhali River • Condition: Active ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Highly Silted up (Ch. 0.00 to 0.5 km of Matherbunia khal is active; rest portion about (1.70 km) is fully silted up) ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • <u>Problem</u>: Severe, usually takes 6-7 days to properly drain out rain water. Nandipara khal and Matherbunia khal is silted up. Moreover, a closer dam was constructed on Matherbunia khal at Ch. 2+200 km near Tushkhali School which causes severe drainage congestion. • Re-excavation of Matherbunia khal & Nandipara khal and removing encroachments (closer dam) may reduce drainage congestion. • Permanent Water logging: Not found. ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Major (Mainly affects Lt Aman and HYV Aman for drainage congestion) • Water Scarcity: Not found ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Damaged <ul style="list-style-type: none"> ▪ Loose apron are damaged both C/S and R/S. ▪ Gates are corroded ▪ Barrel wall is damaged and holes are formed on top of the barrel.

	<ul style="list-style-type: none"> • Major repairing/reconstruction is required. <p>➤ <i>Erosion</i></p> <ul style="list-style-type: none"> • Around 3.0 km embankment from Bhajna primary school to Nandipara is vulnerable to river bank erosion.
	
<p>Figure: C/S of Matherbunia sluice</p>	<p>Figure: Damaged barrel at Matherbunia sluice</p>
	
<p>Figure: Embankment erosion at Matibhanga and Nandipara of polder 43/2A</p>	

Description of Catchment 05

Catchment Name	Cat -5 (Kazirhat Catchment)
Location	Part of Bara Bighai (158 ha) mauza of Bara Bighai union, part of Chhota Bighai (384 ha), Tushkhali (286 ha), Haritakibaria (448 ha), Matibhanga (214 ha) mauza of Chhota Bighai union and part of Madarbunia (17 ha) mauza of Madarbunia union
Catchment area (ha)	1507
Drainage Outlet	Kazirhat sluice, DS – 5 at Ch. 25.804 km (3V- 1.5m X 1.8m)
Main Drainage Canal	Kaliar Khal (Average Top width: about 30m to 35m)
Land elevation of Catchment (m PWD)	Max: 3.31 Min: 1.20
Length of Stream within	44.67

catchment (Km)	
Drainage Density (m/ha)	29.64
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Gulishakhali River • Condition: Active ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Moderately Silted up • Branch khal: <i>Gazaria (Hortokiabaria) Khal</i> is highly silted up and <i>Tushkhali Khal</i> are moderately silted up. ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: minor (usually takes 2-3 days to properly drain out rain water) • Permanent Water logging: Not found. ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Minor • Water Scarcity: Minor (Mainly affects Rabi crops and HYV Aman during seed bed preparation) ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Partially functional <ul style="list-style-type: none"> ▪ R/S flap gate is corroded and rubber seals are damaged ▪ Hoisting arrangement of vertical lift gate is damaged ➤ <i>Erosion</i> <ul style="list-style-type: none"> • Around 220m embankment at Haritakibaria mauza is vulnerable to river bank erosion.



Figure: R/S of Kazirhat sluice



Figure: C/S of Kazirhat sluice (Kaliar Khal)



Figure: R/S of Bashtola outlet



Figure: Erosion near Bashtola Outlet

Description of Catchment 06

Catchment Name	Cat-6 (Khatasia Catchment)
Location	Paschim Kewabania (610 ha), Pasaribunia (190 ha) part of Bara Bighai (390 ha), Dakshin Bighai (367 ha), Titkata (22 ha) mauza of Bara Bighai union
Catchment area (ha)	1579
Drainage Outlet	Khatasia sluice, DS-6 at Ch 30.940 km (3V- 1.5m X 1.8m)
Main Drainage Canal	Khatasia Khal (Average Top width: about 18m to 25m)
Land elevation of Catchment (m PWD)	Max: 3.27 Min: 1.27
Length of Stream within catchment (Km)	40.62
Drainage Density (m/ha)	25.73
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Gulishakhali River • Condition: Active ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Functional • Branch khal: <i>Kewabunia Khal, Dhopar Khal</i> are Partially silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Minor (usually takes 2-3 days to properly drain out rain water) • Permanent Water logging: Moderate; about 120 ha area at Paschim Kewabania mauza remains waterlogged from September to November. • A flushing cum drainage sluice is required at Hapuar khal to reduce water logging.

	<ul style="list-style-type: none"> ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Moderate (mainly affects Lt Aman and Rabi crops) • Water Scarcity: Observed, Northern part of Dakshin Bighai mauza is affected by irrigation scarcity during winter season (mainly affects Robi crops) • Re-excavation of Karamjatala khal and Zintola khal with water retention provision will ensure water availability for irrigation. ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Damaged <ul style="list-style-type: none"> ▪ Main structure is partially tilted and settled down ▪ Gates are corroded and rubber seals are damaged which caused leakage. • Similar capacity (3V- 1.5 m X 1.8 m) new Sluice is required. ➤ <i>Erosion</i> <ul style="list-style-type: none"> • Around 600m embankment at Paschim Kewabania mauza is partially eroded. (Retired embankment is completed).
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Figure: C/S of Khatasia sluice



Figure: Embankment erosion at Paschim Kewabania mauza

2.10 Tidal dynamics assessment

CEGIS team installed four (04) water level gauge stations outside the polder 43/2A (shown in Figure 2.11) to understand the tidal water level variations. Daily water level data at one (01) hour interval (from 6:00 AM to 6:00 PM) for 1 tide cycle (15 days) from 20st August 2016 to 03rd September 2016 has been collected presented in Table 2.3. All water level data was collected in mPWD datum.

Daily water level data were collected on an hourly basis. Water level hydrographs were plotted as water level versus time. The water level hydrograph at Mativanga, Titkata, Kazirhat and Morichbunia stations are shown in Figure 2.7 to 2.10 respectively. The highest water level is found to be about +3.0 m PWD and the lowest water level to be about +0.3 m PWD. During spring tide, maximum tidal variation is about 3 meters while it is about 2 meters during neap tide.

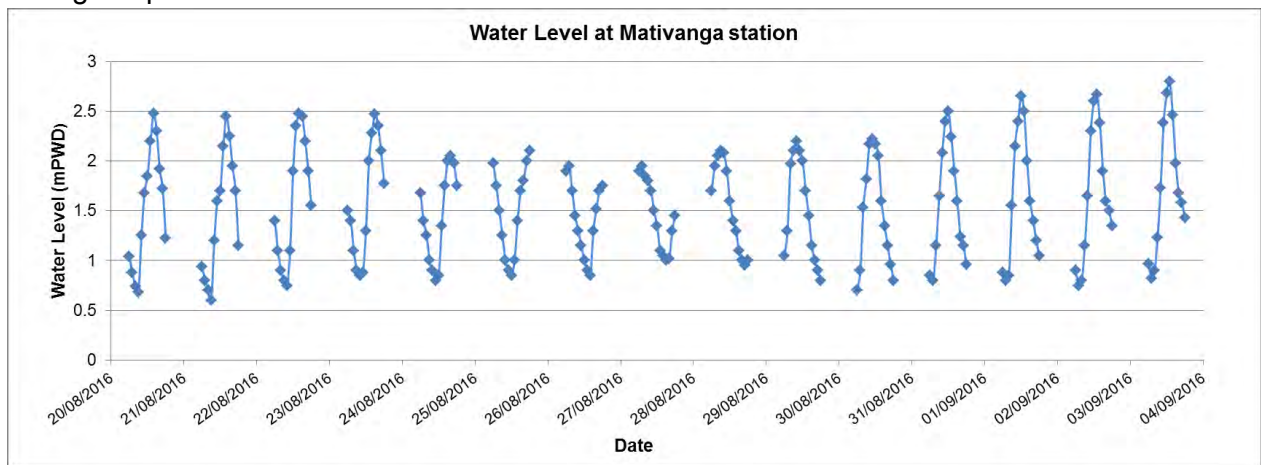


Figure 2.7: Water level analysis at Mativanga station

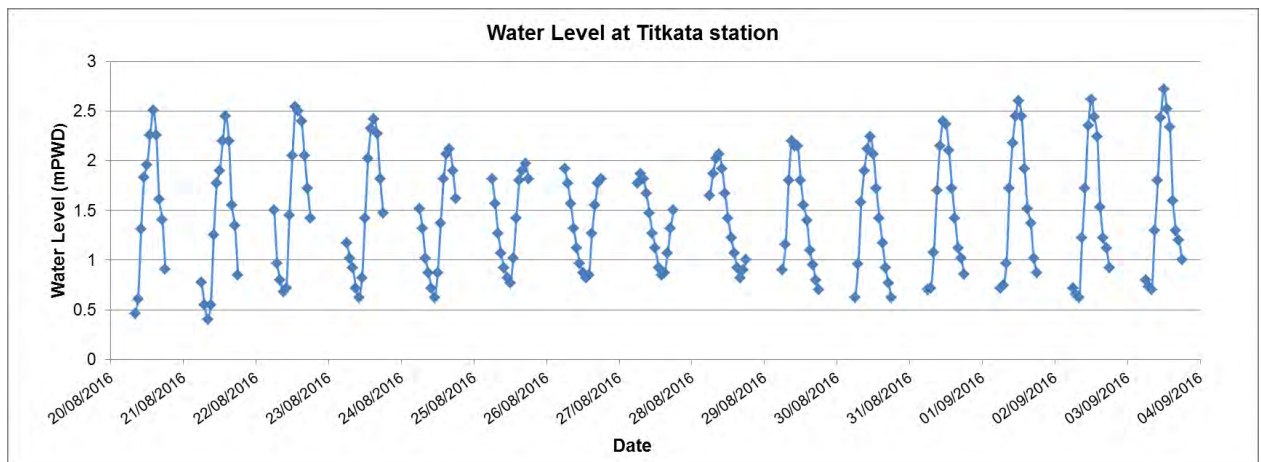


Figure 2.8: Water level analysis at Titkata station

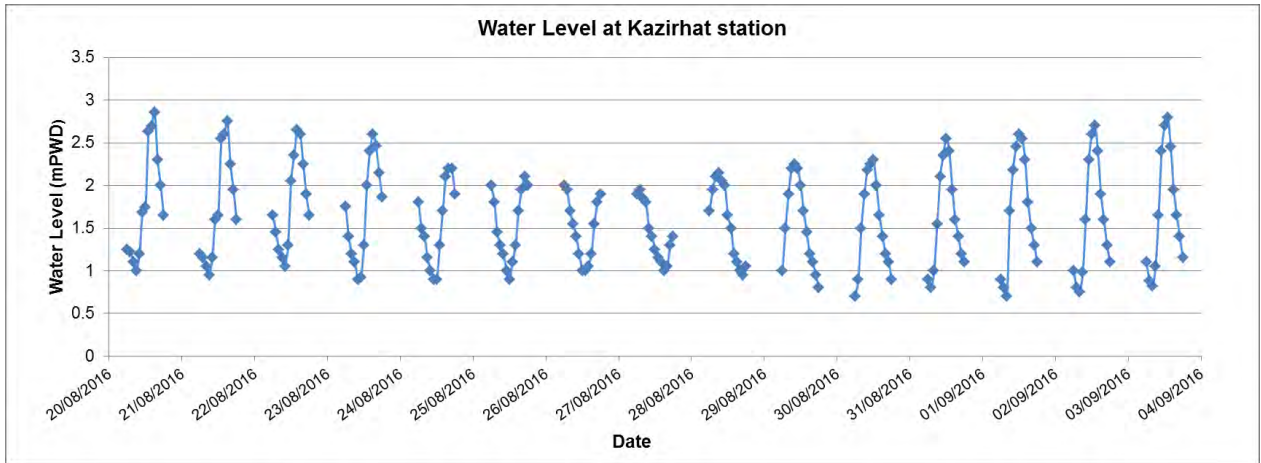


Figure 2.9: Water level analysis at Kazirhat station

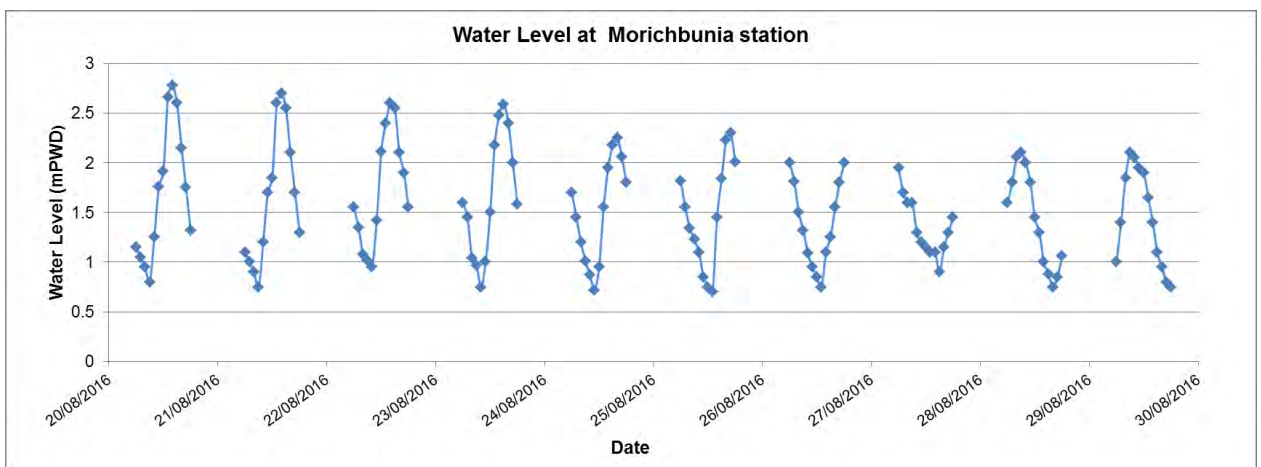
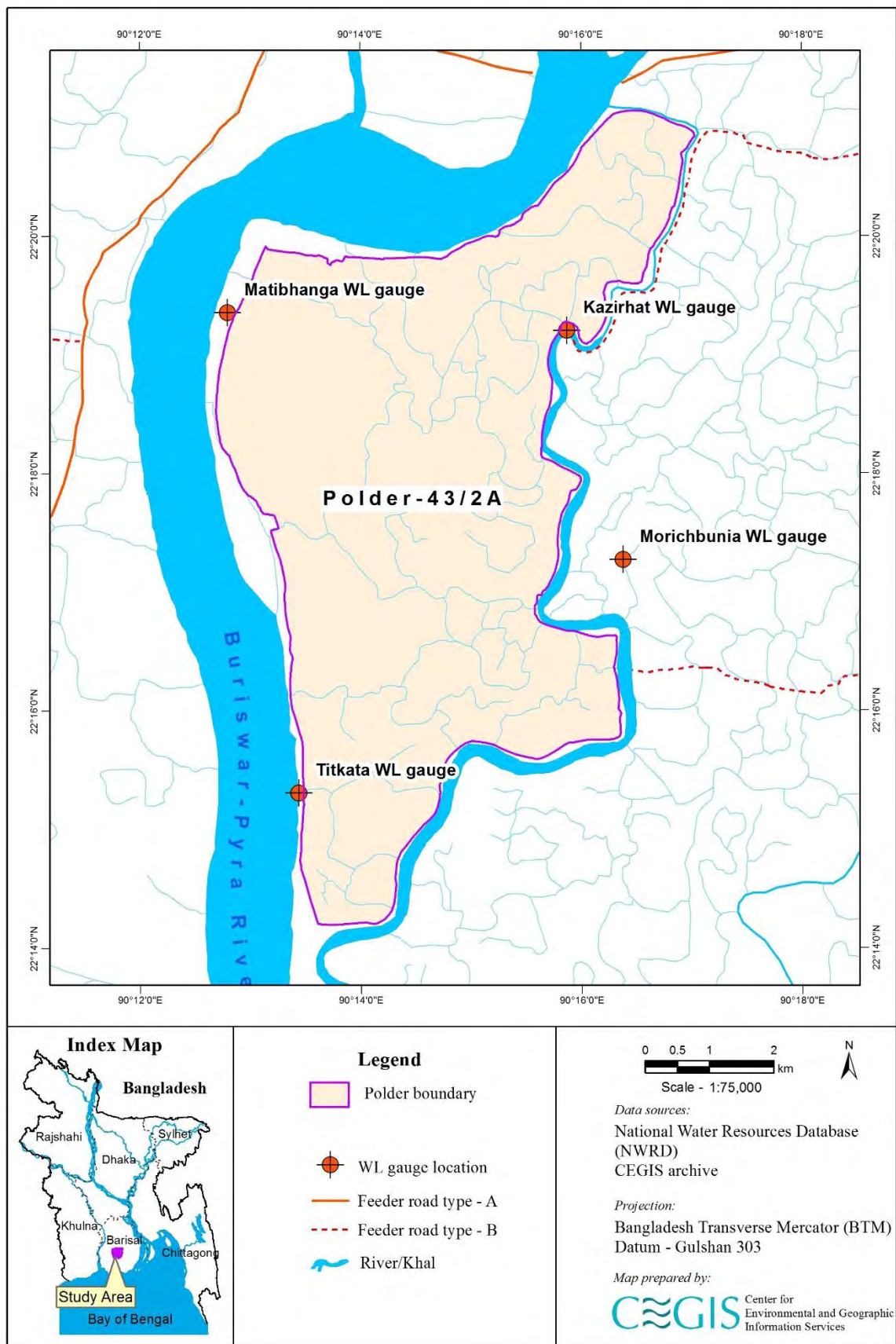


Figure 2.10: Water level analysis at Morichbunia station



June 2016

Figure 2.11: CEGIS installed gauge location at Polder 43/2A

Table 2.3: Water level gauge data from 20/08/2016 to 03/09/2016

Date	Time	Matibhanga	Titkata	Kazirhat	Morichbunia
20/08/2016	6:00	1.04	0.88	1.25	1.15
	7:00	0.88	0.61	1.22	1.05
	8:00	0.74	0.46(LTL)	1.10	0.95
	9:00	0.68 (LTL)	0.61	1(LTL)	0.8(LTL)
	10:00	1.25	1.31	1.20	1.25
	11:00	1.68	1.83	1.68	1.76
	12:00	1.85	1.96	1.74	1.91
	13:00	2.20	2.26	2.63	2.66
	14:00	2.48 (HTL)	2.51 (HTL)	2.69	2.78 (HTL)
	15:00	2.30	2.26	2.86 (HTL)	2.60
	16:00	1.92	1.61	2.30	2.15
	17:00	1.72	1.41	2.00	1.75
	18:00	1.22	0.91	1.65	1.32

Date	Time	Matibhanga	Titkata	Kazirhat	Morichbunia
21/08/2016	6:00	0.94	0.78	1.20	1.10
	7:00	0.80	0.55	1.15	1.00
	8:00	0.70	0.4 (LTL)	1.05	0.90
	9:00	0.6 (LTL)	0.55	0.95 (LTL)	0.75 (LTL)
	10:00	1.20	1.25	1.15	1.20
	11:00	1.60	1.77	1.60	1.70
	12:00	1.70	1.90	1.65	1.85
	13:00	2.15	2.20	2.55	2.60
	14:00	2.45 (HTL)	2.45 (HTL)	2.60	2.7 (HTL)
	15:00	2.25	2.20	2.75 (HTL)	2.55
	16:00	1.95	1.55	2.25	2.10
	17:00	1.70	1.35	1.95	1.70
	18:00	1.15	0.85	1.60	1.30

Date	Time	Matibhanga	Titkata	Kazirhat	Morichbunia
22/08/2016	6:00	1.40	1.50	1.65	1.55
	7:00	1.10	0.97	1.45	1.35
	8:00	0.90	0.80	1.25	1.08
	9:00	0.80	0.68 (LTL)	1.15	1.02
	10:00	0.75 (LTL)	0.72	1.05 (LTL)	0.95 (LTL)
	11:00	1.10	1.45	1.30	1.42
	12:00	1.90	2.05	2.05	2.11
	13:00	2.35	2.54 (HTL)	2.35	2.40
	14:00	2.48 (HTL)	2.50	2.65 (HTL)	2.6 (HTL)
	15:00	2.45	2.40	2.60	2.55
	16:00	2.20	2.05	2.25	2.10
	17:00	1.90	1.72	1.90	1.90
	18:00	1.55	1.42	1.65	1.55

Date	Time	Matibhanga	Titkata	Kazirhat	Morichbunia
23/08/2016	6:00	1.50	1.17	1.75	1.60
	7:00	1.40	1.02	1.40	1.45
	8:00	1.10	0.92	1.20	1.04
	9:00	0.90	0.72	1.10	0.97
	10:00	0.85 (LTL)	0.62 (LTL)	0.9 (LTL)	0.75 (LTL)
	11:00	0.88	0.82	0.92	1.00
	12:00	1.30	1.42	1.30	1.50
	13:00	2.00	2.02	2.00	2.18
	14:00	2.28	2.32	2.40	2.48
	15:00	2.47 (HTL)	2.42 (HTL)	2.6 (HTL)	2.59 (HTL)
	16:00	2.35	2.27	2.46	2.40
	17:00	2.10	1.82	2.15	2.00
	18:00	1.77	1.47	1.86	1.58

Date	Time	Matibhanga	Titkata	Kazirhat	Morichbunia
24/08/2016	6:00	1.68	1.52	1.80	1.70
	7:00	1.40	1.32	1.50	1.45
	8:00	1.25	1.02	1.40	1.20
	9:00	1.00	0.87	1.15	1.01
	10:00	0.90	0.72	1.00	0.87
	11:00	0.8 (LTL)	0.62 (LTL)	0.9 (LTL)	0.72 (LTL)
	12:00	0.85	0.87	0.90	0.95
	13:00	1.35	1.37	1.30	1.55
	14:00	1.75	1.82	1.70	1.95
	15:00	2.00	2.07	2.10	2.18
	16:00	2.05 (HTL)	2.12 (HTL)	2.20	2.25 (HTL)
	17:00	1.98	1.90	2.2 (HTL)	2.06
	18:00	1.75	1.62	1.90	1.80

Date	Time	Matibhanga	Titkata	Kazirhat	Morichbunia
25/08/2016	6:00	1.98	1.82	2.00	1.82
	7:00	1.75	1.57	1.80	1.55
	8:00	1.50	1.27	1.45	1.34
	9:00	1.25	1.07	1.30	1.23
	10:00	1.00	0.92	1.20	1.10
	11:00	0.90	0.82	1.00	0.85
	12:00	0.85 (LTL)	0.77 (LTL)	0.9 (LTL)	0.75
	13:00	1.00	1.02	1.10	0.7 (LTL)
	14:00	1.40	1.42	1.30	1.45
	15:00	1.70	1.80	1.70	1.84
	16:00	1.80	1.90	1.95	2.23
	17:00	2.00	1.97 (HTL)	2.1 (HTL)	2.3 (HTL)
	18:00	2.1 (HTL)	1.82	2.00	2.01

Date	Time	Matibhanga	Titkata	Kazirhat	Morichbunia
26/08/2016	6:00	1.90	1.92 (HTL)	2 (HTL)	2 (HTL)
	7:00	1.95 (HTL)	1.77	1.95	1.81
	8:00	1.70	1.57	1.70	1.50
	9:00	1.45	1.32	1.55	1.32
	10:00	1.30	1.12	1.40	1.09
	11:00	1.15	0.97	1.20	0.95
	12:00	1.00	0.87	1 (LTL)	0.85
	13:00	0.90	0.82 (LTL)	1.00	0.75 (LTL)
	14:00	0.85 (LTL)	0.85	1.05	1.10
	15:00	1.30	1.27	1.20	1.25
	16:00	1.52	1.55	1.55	1.55
	17:00	1.70	1.77	1.80	1.80
	18:00	1.75	1.82	1.90	2.00

Date	Time	Matibhanga	Titkata	Kazirhat	Morichbunia
27/08/2016	6:00	1.90	1.77	1.90	1.95 (HTL)
	7:00	1.95 (HTL)	1.87 (HTL)	1.95 (HTL)	1.70
	8:00	1.85	1.82	1.85	1.60
	9:00	1.80	1.67	1.80	1.60
	10:00	1.70	1.47	1.50	1.30
	11:00	1.50	1.27	1.40	1.20
	12:00	1.35	1.12	1.25	1.15
	13:00	1.10	0.92	1.15	1.10
	14:00	1.05	0.85 (LTL)	1.10	1.10
	15:00	1 (LTL)	0.87	1 (LTL)	0.9 (LTL)
	16:00	1.02	1.07	1.05	1.15
	17:00	1.30	1.32	1.30	1.30
	18:00	1.45	1.50	1.40	1.45

Date	Time	Matibhanga	Titkata	Kazirhat	Morichbunia
28/08/2016	6:00	1.70	1.65	1.70	1.60
	7:00	1.95	1.87	1.95	1.80
	8:00	2.05	2.02	2.10	2.06
	9:00	2.1 (HTL)	2.07 (HTL)	2.15 (HTL)	2.1 (HTL)
	10:00	2.08	1.92	2.05	2.00
	11:00	1.90	1.67	2.00	1.80
	12:00	1.60	1.42	1.65	1.45
	13:00	1.40	1.22	1.50	1.30
	14:00	1.30	1.07	1.20	1.00
	15:00	1.10	0.92	1.10	0.88
	16:00	1.00	0.82 (LTL)	1.00	0.75 (LTL)
	17:00	0.95 (LTL)	0.90	0.95 (LTL)	0.85
	18:00	1.00	1.00	1.05	1.06

Date	Time	Matibhanga	Titkata	Kazirhat	Morichbunia
29/08/2016	6:00	1.05	0.90	1.00	1.00
	7:00	1.30	1.16	1.50	1.40
	8:00	1.97	1.80	1.90	1.85
	9:00	2.10	2.2 (HTL)	2.20	2.1 (HTL)
	10:00	2.2 (HTL)	2.15	2.25 (HTL)	2.05
	11:00	2.10	2.15	2.20	1.95
	12:00	2.00	1.80	2.00	1.90
	13:00	1.70	1.55	1.70	1.65
	14:00	1.45	1.40	1.45	1.40
	15:00	1.15	1.10	1.20	1.10
	16:00	1.00	0.95	1.10	0.95
	17:00	0.90	0.80	0.95	0.80
18:00	0.80	0.70	0.80	0.75	

Date	Time	Matibhanga	Titkata	Kazirhat	Morichbunia
30/08/2016	6:00	0.7 (LTL)	0.62 (LTL)	0.7 (LTL)	0.65 (LTL)
	7:00	0.90	0.96	0.90	1.05
	8:00	1.53	1.58	1.50	1.50
	9:00	1.82	1.90	1.90	1.92
	10:00	2.17	2.12	2.18	2.22
	11:00	2.22 (HTL)	2.24 (HTL)	2.25	2.25 (HTL)
	12:00	2.17	2.07	2.3 (HTL)	2.10
	13:00	2.05	1.72	2.00	1.88
	14:00	1.60	1.42	1.65	1.50
	15:00	1.35	1.17	1.40	1.20
	16:00	1.15	0.92	1.20	0.92
	17:00	0.96	0.77	1.10	0.85
18:00	0.80	0.62	0.90	0.68	

Date	Time	Matibhanga	Titkata	Kazirhat	Morichbunia
01/09/2016	6:00	0.88	0.72 (LTL)	0.90	0.88
	7:00	0.8 (LTL)	0.75	0.80	0.8 (LTL)
	8:00	0.85	0.97	0.7 (LTL)	0.95
	9:00	1.55	1.72	1.70	1.75
	10:00	2.15	2.18	2.18	2.20
	11:00	2.40	2.45	2.45	2.50
	12:00	2.65 (HTL)	2.6 (HTL)	2.6 (HTL)	2.6 (HTL)
	13:00	2.50	2.45	2.55	2.50
	14:00	2.00	1.92	2.30	2.15
	15:00	1.60	1.52	1.80	1.70
	16:00	1.40	1.37	1.50	1.40
	17:00	1.20	1.02	1.30	1.25
18:00	1.05	0.87	1.10	1.00	

Date	Time	Matibhanga	Titkata	Kazirhat	Morichbunia
02/09/2016	6:00	0.90	0.72	1.00	1.00
	7:00	0.75 (LTL)	0.65	0.80	0.75
	8:00	0.80	0.62 (LTL)	0.75 (LTL)	0.7 (LTL)
	9:00	1.15	1.22	0.98	1.10
	10:00	1.65	1.72	1.60	1.85
	11:00	2.30	2.35	2.30	2.35
	12:00	2.60	2.62 (HTL)	2.60	2.65 (HTL)
	13:00	2.67 (HTL)	2.44	2.7 (HTL)	2.62
	14:00	2.38	2.24	2.40	2.30
	15:00	1.90	1.53	1.90	1.80
	16:00	1.60	1.22	1.60	1.35
	17:00	1.50	1.12	1.30	1.25
	18:00	1.35	0.92	1.10	1.10

Date	Time	Matibhanga	Titkata	Kazirhat	Morichbunia
03/09/2016	6:00	0.97	0.80	1.10	1.04
	7:00	0.82 (LTL)	0.73	0.88	0.82
	8:00	0.90	0.7 (LTL)	0.82 (LTL)	0.78 (LTL)
	9:00	1.23	1.30	1.05	1.15
	10:00	1.73	1.80	1.65	1.93
	11:00	2.38	2.43	2.40	2.43
	12:00	2.68	2.72 (HTL)	2.70	2.68
	13:00	2.8 (HTL)	2.52	2.8 (HTL)	2.73 (HTL)
	14:00	2.46	2.34	2.45	2.38
	15:00	1.98	1.60	1.95	1.88
	16:00	1.68	1.30	1.65	1.43
	17:00	1.58	1.20	1.40	1.33
	18:00	1.43	1.00	1.15	1.18

2.11 Catchment of Polder 43/2B

In this study, for polder 43/2B, Catchment has been delineated for six (06) drainage outlets. The drainage outlets were selected at six (06) hydraulic structure locations. Figure 2.12, 2.13 and 2.14 shows the Base map, Intervention with catchment and Digital Elevation Model (DEM) map of Polder 43/2B. Area of each catchment boundary has been presented in Table 2.4. From the Figure 2.13 and Table 2.4 shows that catchment of Musurikati Sluice is the largest catchment which is about 1347 ha.

Table 2.4: Drainage outlet/ hydraulic Structure wise drainage catchment for polder 43/2B

Description of Catchment 01

Catchment Name	Cat – 1 (Musurikati Catchment)
Location	Algi Taflabaria (224 ha), Musurikathi (128 ha), Nijshahati (69 ha), part of Bhangra (264 ha), Bauria Chariani (66 ha), eastern part of Bauria Kismat (235 ha) and Ramananda (47 ha), southern part of Banshbunia (137 ha), Amkhola (107 ha) and Chhailabunia (10 ha) mauza of Amkhola union and western part of Suhari (60ha) mauza of Golkhali union of Galachipa Upazila.
Catchment area (ha)	1347 ha
Drainage Outlet	Musurikati Sluice, DS - 1 at Ch. 0.00 km (2V – 1.5m X 1.8 m)
Main Drainage Canal	Vodrar Khal (Average top width: about 35m to 50m)
Land elevation of Catchment (m PWD)	Max: 3.47 Min: 1.12
Length of Stream within catchment (Km)	37.40
Drainage Density (m/ha)	27.80
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Galachipa River • Condition: Active ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Moderately silted up (about 2.0 km from outfall of Vodrer khal is fully silted up) • Branch khal: <i>Tulabaria Khal, Mushurikata Khal, Beeler Khal</i> are Moderately silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • <u>Problem</u>: Moderate, usually takes 4-5 days to properly drain out rain water • Main drainage and connecting branch khal is silted up which lead slow drainage. • Re-excavation of Vodrer khal will reduce drainage congestion • Permanent Water logging: Observed; about 50

	<p>ha area at Algi-Taflabaria mauza remains waterlogged from October to November.</p> <ul style="list-style-type: none"> • Re-excavation of Beeler khal and Tulabaria khal will reduce the water logging issue. <p>➤ <i>Agricultural condition</i></p> <ul style="list-style-type: none"> • Crop damage: Moderate (mainly damage Lt Aman and Rabi crops) • Water Scarcity: Not found <p>➤ <i>Hydraulic structure condition</i></p> <ul style="list-style-type: none"> • Damaged <ul style="list-style-type: none"> ▪ Main structure is partially tilted and settled down ▪ Gates are corroded and rubber seals are damaged which caused leakage ▪ Vertical lift gate are collapsed • New Sluice with adequate vent size is required.
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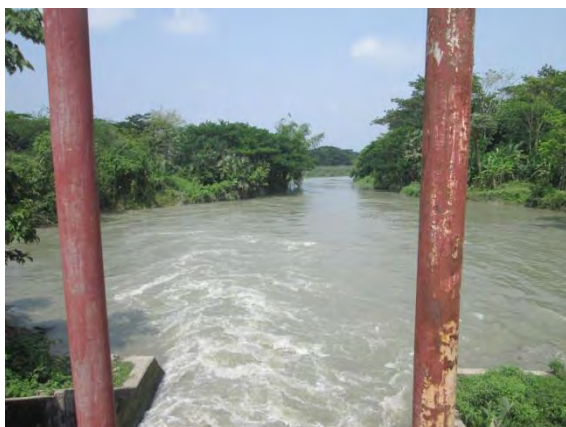


Figure: R/S of Musurikati Sluice



Figure: Collapsed vertical lift gate

Description of Catchment 02

Catchment Name	Cat-2 (Bauria Catchment)
Location	Kanchanbaria (88 ha), Khantakhali (51 ha), southern part of Ramananda (87 ha), eastern part of Bauria kismat (142 ha) and Bauria Chariani (24 ha) mauza of Amkhola union and Chalitabunia (90 ha), western part of Gerabunia (150 ha) and Sonakhali (236) mauza of Atharagashia union.
Catchment area (ha)	868
Drainage Outlet	Bauria Sluice, DS - 2 at Ch. 4.15 km (2V – 1.5m X 1.8 m)
Main Drainage Canal	Bauria khal (Average top width: about 25m to 30m)
Land elevation of Catchment (m PWD)	Max: 3.27 Min: 1.17

Length of Stream within catchment (Km)	23.20
Drainage Density (m/ha)	26.70
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Tabalbaria khal • Condition: Active ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Moderately silted up (about 4.0 km khal is proposed for re-excavation under Bluegold program) • Branch khal: <i>Chalitabunia Khal, Bastala Khal, Shener Khal and Khuntakhali Khal</i> are Moderately silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Moderate (usually takes 3-4 days to properly drain out rain water) • Re-excavation of Bauria khal will reduce drainage congestion • Permanent Water logging: Observed; about 20 ha area at Ramananda and Chalitabunia mauza remains waterlogged from October to mid-November. • Re-excavation of Kakrabunia and its connecting branch khal will reduce the water logging issue. ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Moderate (mainly damage Lt Aman and Rabi crops) • Water Scarcity: Sonakhali, Khantakhali and Kanchanbaria areas are affected by water scarcity (mainly affects Rabi crops and Lt & HYV Aman during seed bed preparation) • Re-excavation of Bastala khal with water retention provision will ensure water availability for irrigation ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Damaged <ul style="list-style-type: none"> ▪ Main structure is inclined ▪ Gates are corroded and rubber seals are damaged which caused leakage • Major repairing/construction of new Sluice with adequate vent size is required




Figure: R/S of Bauria Sluice (under construction)



Figure: Outfall of Bauria Catchment

Description of Catchment 03

Catchment Name	Cat-3 (Nosaishing catchment)
Location	Chhailabunia (359 ha), southern part of Banshbunia (258 ha) and Amkhola (44 ha) mauza of Amkhola union and northern part of Gerabunia (227 ha) mauza of Atharagashia union
Catchment area (ha)	888
Drainage Outlet	Nosaishing Sluice, DS - 3 at Ch. 14.895 km (2V – 1.5m X 1.8 m)
Main Drainage Canal	Nosaishing khal (Average top width: about 18m to 22m)
Land elevation of Catchment (m PWD)	Max: 3.30 Min: 1.22
Length of Stream within catchment (Km)	29.90
Drainage Density (m/ha)	33.6
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Talbaria khal • Condition: Active ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Functional • Branch khal: Sobaram Khal, kalaikoshor khal is Moderately silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Minor (usually takes 2-3 days to properly drain out rain water) • Permanent Water logging: Not found ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Minor

	<ul style="list-style-type: none"> • Water Scarcity: Banshbunia areas adjacent the Sobaram Khal are affected by water scarcity (mainly affects Rabi crops) • Re-excavation of Sobaram khal with water retention provision will ensure water availability for irrigation <p>➤ <i>Hydraulic structure condition</i></p> <ul style="list-style-type: none"> • Partially functional <ul style="list-style-type: none"> ▪ Flap gates and vertical lift gates are corroded and collapsed • Gate replacement is required
 <p>Figure: R/S of Nosaishing Sluice</p>	

Description of Catchment 04

Catchment Name	Cat-04 (Badura Catchment)
Location	Southern part of Uttar Badura (473 ha) mauza of Auliapur union, western part of Banshbunia (456 ha), Chhailabunia (31 ha) and Amkhola (32 ha) mauza of Amkhola union
Catchment area (ha)	992
Drainage Outlet	Badura Sluice, DS - 4 at Ch. 20.045 km (2V – 1.5m X 1.8 m)
Main Drainage Canal	Badura khal (Average top width: about 20m to 25m)
Land elevation of Catchment (m PWD)	Max: 3.36 Min: 1.13
Length of Stream within catchment (Km)	31.4
Drainage Density (m/ha)	31.6

Catchment Description

- *Outfall*
 - Outfall Khal: **Kukua River**
 - Condition: **Highly silted up**
- *Condition of Drainage Khal*
 - Main drainage Khal: **Moderately** Silted up ((about 3.0 km khal is proposed for re-excavation under Bluegold program)
 - Branch khal: *Nomor Khal, Badura Ramdula Khal and Lebutala Khal* are **moderately** silted up.
- *Drainage Congestion*
 - Drainage congestion problem: **Minor** (usually takes 2-3 days to properly drain out rain water)
 - Permanent Water logging: **Not found**
- *Agricultural condition*
 - Crop damage: **Minor**
 - Water Scarcity: Western part of Banshgunia and Uttar Badura areas are affected by water scarcity during February to April (mainly affects Rabi crops and HYV & Lt Aman during seed bed preparation)
 - Re-excavation of Masuakhlai and Mongoler khal with water retention provision will ensure water availability for irrigation
- *Hydraulic structure condition*
 - **Partially functional**
 - Gates are corroded and rubber seals are damaged
 - Gates and its hoisting arrangement repairing is required



Figure: C/S of Badura Sluice



Figure: C/S of Badura Khal

Description of Catchment 05

Catchment Name	Cat-05 (Masuakhali Catchment)
Location	Northern part of Uttar Badura (296 ha) and southern part of Balaikati (116 ha) mauza of Auliapur union and small portion of Dakshin Balaikati (4 ha) mauza of Amkhola union
Catchment area (ha)	416
Drainage Outlet	Masuakhali Sluice, DS - 5 at Ch. 25.098 km (1V – 1.5m X 1.8 m)
Main Drainage Canal	Masuakhali khal (Average top width: about 16m to 24m)
Land elevation of Catchment (m PWD)	Max: 3.42 Min: 1.17
Length of Stream within catchment (Km)	8.0
Drainage Density (m/ha)	24.7
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Gorai River • Condition: Highly silted up ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Moderately Silted up (about 5.0 km khal needs re-excavation) • Branch khal: <i>Boloikathi Khal</i> and <i>Mredhabarir Khal</i> are Moderately silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Minor (usually takes 2-3 days to properly drain out rain water) • Permanent Water logging: Not found ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Minor • Water Scarcity: Southern part of Uttar Badura are affected by water scarcity during February to April (mainly affects Rabi crops) ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Functional ➤ <i>Erosion</i> <ul style="list-style-type: none"> • A breach of about 300 m was found (27+500 km to Ch. 27+800 km) at the north-east corner along Galachipa River. About 300 m (Ch. 29+200 km to 29+500 km) at southern part of Balaikati Mauza is affected by river bank erosion. Therefore, about 100 ha area at northern part of this catchment is open which allow tidal water inside the polder and eventually may cause severe river erosion in near future.



Figure: R/S of Masuakhali Sluice



Figure: Outfall of Masuakhali Sluice



Figure: Embankment erosion at Dari Baherchar (Boloikati Village)

Description of Catchment 06

Catchment Name	Cat-6 (Amkhola Catchment)
Location	Dakshin Balaikati (88 ha), Amkhola (576 ha), western part of Dari Baherchar (383 ha), southern part of Chingaria (50 ha) and Char Amkhola (26 ha), northern part of Balaikati (18 ha), Bhangra (17 ha) and Banshbunia (31 ha) mauza of Amkhola union
Catchment area (ha)	1195
Drainage Outlet	Amkhola Sluice, DS - 6 at Ch. 36.91 km (2V – 1.5m X 1.8 m)
Main Drainage Canal	Amkhola khal (Average top width: about 18m to 24m)
Land elevation of Catchment (m PWD)	Max: 3.68 Min: 1.08
Length of Stream within catchment (Km)	34.0
Drainage Density (m/ha)	28.5

<p>Catchment Description</p>	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Galachipa River • Condition: Active ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Moderately Silted up • Branch khal: <i>Daribaheerchar Khal, Chinguria Khal, Nandir khal and Aichar Khal</i> are moderately silted up. ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: minor (usually takes 2-3 days to properly drain out rain water) • Permanent Water logging: Not observed ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Minor • Water Scarcity: Amkhola and Dari Baheerchar areas have water scarcity during February to April (mainly affects Rabi crops) • Repairing and proper maintenance of irrigation inlets will ensure available irrigation water ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Partially functional <ul style="list-style-type: none"> ▪ Gates are corroded and collapsed • Repairing of Gates and its hoisting arrangement is required
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Figure: R/S of Amkhola Sluice



Figure: Broken flap gate of Amkhola sluice

2.12 Tidal dynamics assessment

CEGIS team installed three (03) water level gauge stations (**Badura, Amkhola and Amtola**) outside the polder 43/2B (shown in Figure 2.18) to understand the tidal water level variations. Daily water level data at one (01) hour interval (from 6:00 AM to 6:00 PM) for 1 tide cycle (15 days) from 20st August 2016 to 03rd September 2016 has been collected presented in Table 2.5. All water level data was collected in mPWD datum.

Daily water level data were collected on an hourly basis. Water level hydrographs were plotted as water level versus time. The water level hydrograph at Badura, Amkhola and Amtola stations are shown in Figure 2.15 to 2.17 respectively.

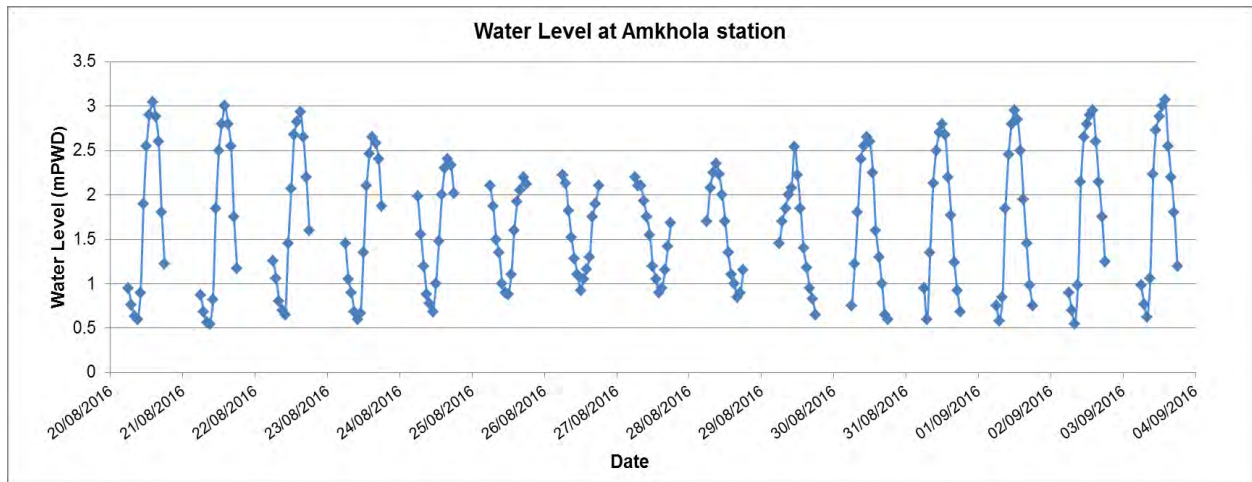


Figure 2.15: Water level analysis at Amkhola station

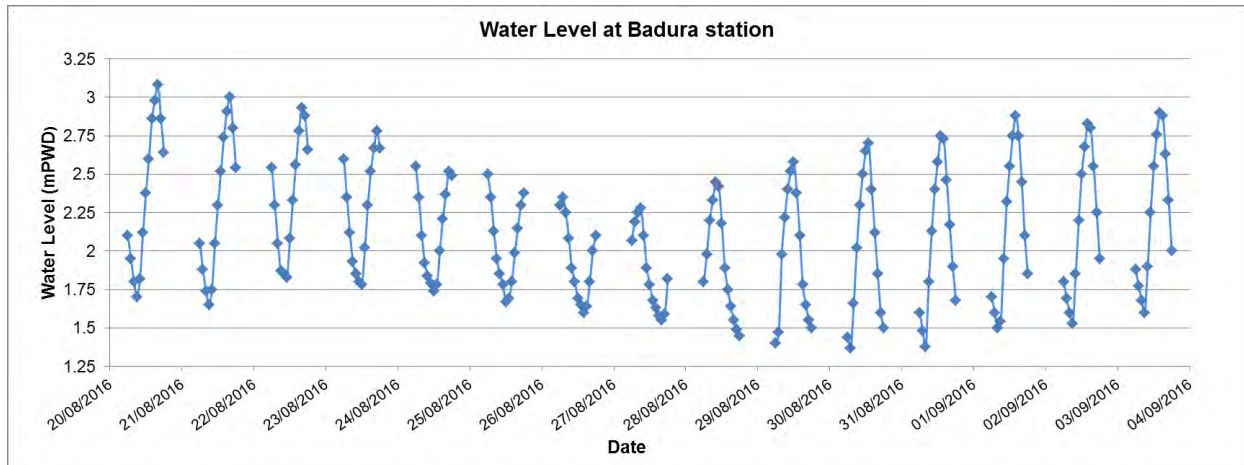


Figure 2.16: Water level analysis at Badura station

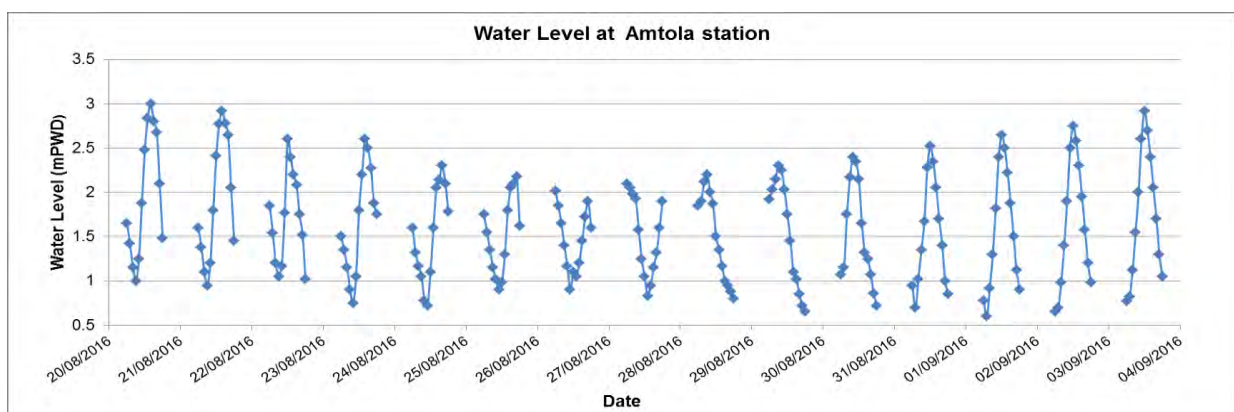


Figure 2.17: Water level analysis at Amtola station

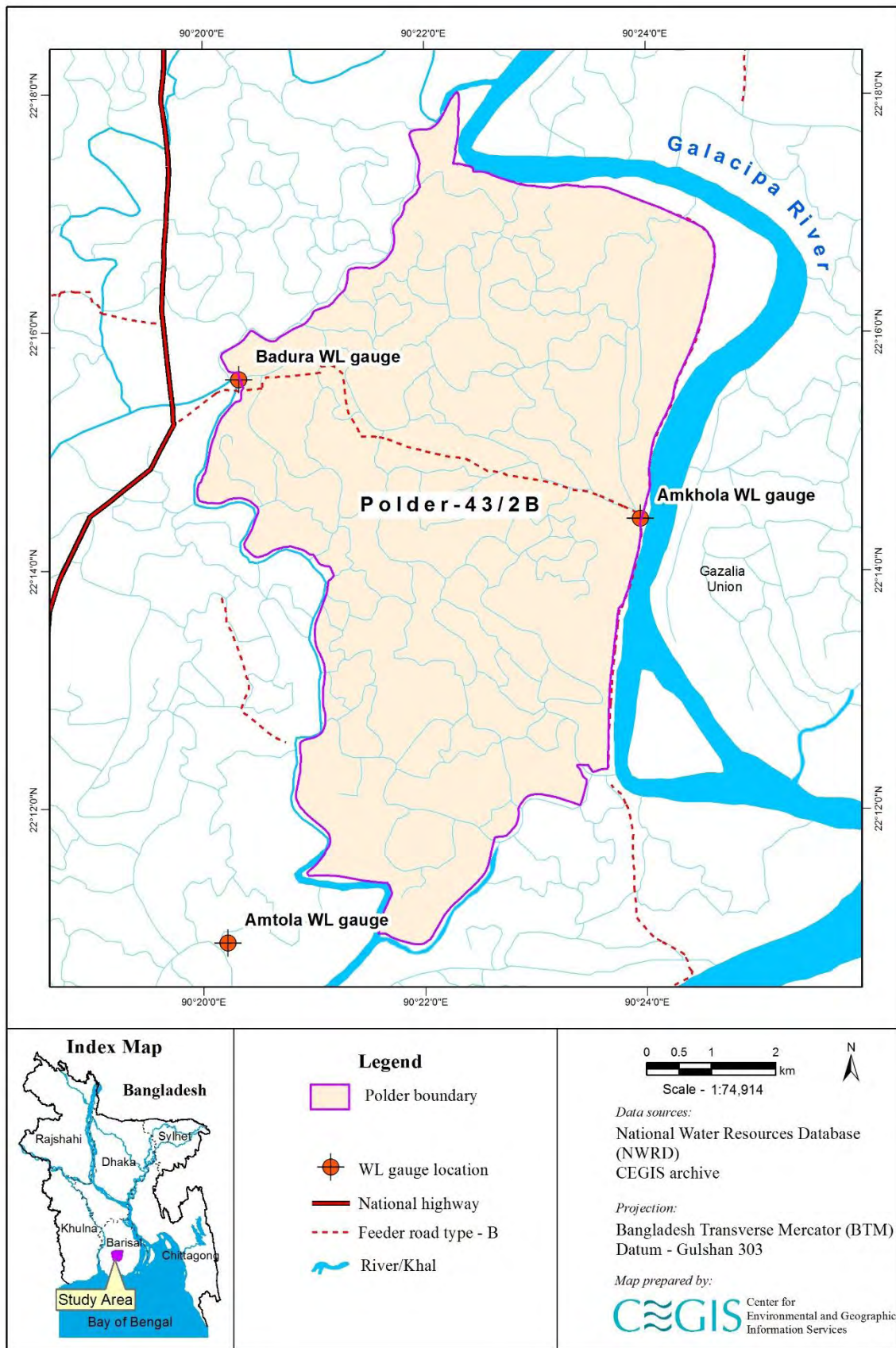


Figure 2.18: CEGIS installed gauge location at Polder 43/2B

Table 2.5: Water level gauge data from 20/08/2016 to 03/09/2016

Date	Time	Amkhola	Badura	Amtola
20/08/2016	6:00	0.95	2.10	1.65
	7:00	0.76	1.95	1.42
	8:00	0.63	1.80	1.15
	9:00	0.6(LTL)	1.7(LTL)	1(LTL)
	10:00	0.90	1.82	1.25
	11:00	1.90	2.12	1.88
	12:00	2.55	2.38	2.48
	13:00	2.90	2.60	2.84
	14:00	3.04 (HTL)	2.86	3 (HTL)
	15:00	2.88	2.98	2.80
	16:00	2.60	3.08 (HTL)	2.68
	17:00	1.80	2.86	2.10
	18:00	1.22	2.64	1.48

Date	Time	Amkhola	Badura	Amtola
21/08/2016	6:00	0.87	2.05	1.60
	7:00	0.68	1.88	1.38
	8:00	0.56	1.74	1.10
	9:00	0.55 (LTL)	1.65 (LTL)	0.95 (LTL)
	10:00	0.82	1.75	1.20
	11:00	1.85	2.05	1.80
	12:00	2.50	2.30	2.41
	13:00	2.80	2.52	2.77
	14:00	3 (HTL)	2.74	2.92 (HTL)
	15:00	2.80	2.91	2.78
	16:00	2.55	3 (HTL)	2.65
	17:00	1.75	2.80	2.05
	18:00	1.17	2.54	1.45

Date	Time	Amkhola	Badura	Amtola
22/08/2016	6:00	1.26	2.54	1.85
	7:00	1.06	2.30	1.54
	8:00	0.80	2.05	1.20
	9:00	0.70	1.87	1.05 (LTL)
	10:00	0.65 (LTL)	1.85	1.17
	11:00	1.45	1.83 (LTL)	1.77
	12:00	2.07	2.08	2.6 (HTL)
	13:00	2.68	2.33	2.40
	14:00	2.82	2.56	2.20
	15:00	2.93 (HTL)	2.78	2.08
	16:00	2.65	2.93 (HTL)	1.75
	17:00	2.20	2.88	1.52
	18:00	1.60	2.66	1.02

Date	Time	Amkhola	Badura	Amtola
23/08/2016	6:00	1.45	2.60	1.50
	7:00	1.05	2.35	1.35
	8:00	0.90	2.12	1.15
	9:00	0.68	1.93	0.90
	10:00	0.6 (LTL)	1.85	0.75 (LTL)
	11:00	0.67	1.80	1.05
	12:00	1.35	1.78 (LTL)	1.80
	13:00	2.10	2.02	2.20
	14:00	2.46	2.30	2.6 (HTL)
	15:00	2.65 (HTL)	2.52	2.50
	16:00	2.58	2.67	2.27
	17:00	2.40	2.78 (HTL)	1.88
	18:00	1.87	2.67	1.75

Date	Time	Amkhola	Badura	Amtola
24/08/2016	6:00	1.98	2.55	1.60
	7:00	1.56	2.35	1.32
	8:00	1.20	2.10	1.17
	9:00	0.88	1.92	1.05
	10:00	0.78	1.84	0.78
	11:00	0.68 (LTL)	1.79	0.72 (LTL)
	12:00	1.00	1.74 (LTL)	1.10
	13:00	1.48	1.78	1.60
	14:00	2.00	2.00	2.05
	15:00	2.30	2.21	2.14
	16:00	2.4 (HTL)	2.37	2.3 (HTL)
	17:00	2.33	2.52 (HTL)	2.10
	18:00	2.02	2.49	1.78

Date	Time	Amkhola	Badura	Amtola
25/08/2016	6:00	2.10	2.50	1.75
	7:00	1.87	2.35	1.55
	8:00	1.50	2.13	1.35
	9:00	1.35	1.95	1.15
	10:00	1.00	1.85	1.02
	11:00	0.90	1.78	0.9 (LTL)
	12:00	0.88 (LTL)	1.67 (LTL)	0.98
	13:00	1.10	1.69	1.30
	14:00	1.60	1.80	1.80
	15:00	1.92	1.99	2.05
	16:00	2.05	2.15	2.10
	17:00	2.2 (HTL)	2.30	2.18 (HTL)
	18:00	2.12	2.38 (HTL)	1.62

Date	Time	Amkhola	Badura	Amtola
26/08/2016	6:00	2.22 (HTL)	2.30	2.02 (HTL)
	7:00	2.13	2.35 (HTL)	1.85
	8:00	1.82	2.25	1.65
	9:00	1.52	2.08	1.40
	10:00	1.28	1.89	1.17
	11:00	1.10	1.80	0.9 (LTL)
	12:00	0.92 (LTL)	1.69	1.10
	13:00	1.05	1.65	1.05
	14:00	1.16	1.6 (LTL)	1.20
	15:00	1.30	1.64	1.45
	16:00	1.75	1.80	1.72
	17:00	1.90	2.00	1.90
	18:00	2.10	2.10	1.60

Date	Time	Amkhola	Badura	Amtola
27/08/2016	6:00	2.2 (HTL)	2.07	2.1 (HTL)
	7:00	2.10	2.19	2.05
	8:00	2.10	2.25	1.98
	9:00	1.93	2.28 (HTL)	1.93
	10:00	1.75	2.10	1.58
	11:00	1.55	1.89	1.25
	12:00	1.20	1.78	1.05
	13:00	1.05	1.68	0.83 (LTL)
	14:00	0.9 (LTL)	1.63	0.95
	15:00	0.95	1.58	1.15
	16:00	1.15	1.55 (LTL)	1.32
	17:00	1.42	1.59	1.60
	18:00	1.68	1.82	1.90

Date	Time	Amkhola	Badura	Amtola
28/08/2016	6:00	1.70	1.80	1.85
	7:00	2.08	1.98	1.90
	8:00	2.25	2.20	2.12
	9:00	2.35 (HTL)	2.33	2.2 (HTL)
	10:00	2.23	2.45 (HTL)	2.00
	11:00	2.00	2.42	1.87
	12:00	1.70	2.18	1.50
	13:00	1.35	1.89	1.35
	14:00	1.10	1.75	1.17
	15:00	1.00	1.64	1.00
	16:00	0.85 (LTL)	1.55	0.95
	17:00	0.90	1.49	0.88
	18:00	1.15	1.45 (LTL)	0.8 (LTL)

Date	Time	Amkhola	Badura	Amtola
29/08/2016	6:00	1.45	1.4 (LTL)	1.92
	7:00	1.70	1.47	2.03
	8:00	1.85	1.98	2.15
	9:00	2.00	2.22	2.3 (HTL)
	10:00	2.08	2.40	2.25
	11:00	2.54 (HTL)	2.52	2.03
	12:00	2.22	2.58 (HTL)	1.75
	13:00	1.85	2.38	1.45
	14:00	1.40	2.10	1.10
	15:00	1.18	1.78	1.02
	16:00	0.95	1.65	0.85
	17:00	0.83	1.55	0.72
	18:00	0.65	1.50	0.65

Date	Time	Amkhola	Badura	Amtola
30/08/2016	6:00	0.75 (LTL)	1.44	1.07 (LTL)
	7:00	1.22	1.37 (LTL)	1.15
	8:00	1.80	1.66	1.75
	9:00	2.40	2.02	2.17
	10:00	2.55	2.30	2.4 (HTL)
	11:00	2.65 (HTL)	2.50	2.35
	12:00	2.60	2.65	2.15
	13:00	2.25	2.7 (HTL)	1.65
	14:00	1.60	2.40	1.32
	15:00	1.30	2.12	1.25
	16:00	1.00	1.85	1.07
	17:00	0.65	1.60	0.86
	18:00	0.60	1.50	0.72

Date	Time	Amkhola	Badura	Amtola
31/08/2016	6:00	0.95	1.60	0.95
	7:00	0.6 (LTL)	1.48	0.7 (LTL)
	8:00	1.35	1.38 (LTL)	1.02
	9:00	2.13	1.80	1.35
	10:00	2.50	2.13	1.67
	11:00	2.70	2.40	2.28
	12:00	2.8 (HTL)	2.58	2.52 (HTL)
	13:00	2.68	2.75 (HTL)	2.35
	14:00	2.20	2.73	2.05
	15:00	1.77	2.46	1.70
	16:00	1.24	2.17	1.40
	17:00	0.92	1.90	1.00
	18:00	0.68	1.68	0.85

Date	Time	Amkhola	Badura	Amtola
01/09/2016	6:00	0.75	1.70	0.78
	7:00	0.58 (LTL)	1.60	0.6 (LTL)
	8:00	0.85	1.5 (LTL)	0.92
	9:00	1.85	1.54	1.30
	10:00	2.45	1.95	1.82
	11:00	2.80	2.32	2.40
	12:00	2.95 (HTL)	2.55	2.65 (HTL)
	13:00	2.85	2.75	2.50
	14:00	2.50	2.88 (HTL)	2.22
	15:00	1.95	2.75	1.88
	16:00	1.45	2.45	1.50
	17:00	0.98	2.10	1.12
	18:00	0.75	1.85	0.90

Date	Time	Amkhola	Badura	Amtola
02/09/2016	6:00	0.90	1.80	0.65 (LTL)
	7:00	0.70	1.69	0.70
	8:00	0.55 (LTL)	1.60	0.98
	9:00	0.98	1.53 (LTL)	1.40
	10:00	2.15	1.85	1.90
	11:00	2.65	2.20	2.50
	12:00	2.80	2.50	2.75 (HTL)
	13:00	2.90	2.68	2.58
	14:00	2.95 (HTL)	2.83 (HTL)	2.30
	15:00	2.60	2.80	1.95
	16:00	2.15	2.55	1.58
	17:00	1.75	2.25	1.20
	18:00	1.25	1.95	0.98

Date	Time	Amkhola	Badura	Amtola
03/09/2016	6:00	0.98	1.88	0.77 (LTL)
	7:00	0.77	1.77	0.82
	8:00	0.62 (LTL)	1.68	1.12
	9:00	1.06	1.6 (LTL)	1.55
	10:00	2.23	1.90	2.00
	11:00	2.73	2.25	2.60
	12:00	2.88	2.55	2.92 (HTL)
	13:00	3.00	2.76	2.70
	14:00	3.07 (HTL)	2.9 (HTL)	2.40
	15:00	2.55	2.88	2.05
	16:00	2.20	2.63	1.70
	17:00	1.80	2.33	1.30
	18:00	1.20	2.00	1.05

2.13 Catchment of Polder 43/2D

In this study, for polder 43/2D, Catchment has been delineated for seventeen (17) drainage outlets. The drainage outlets were selected at seventeen (17) hydraulic structure locations. Figure 2.19, 2.20 and 2.21 shows the Base map, Intervention with catchment and Digital Elevation Model (DEM) map of Polder 43/2D. Area of each catchment boundary has been presented in Table 2.6. From the Figure 2.20 and Table 2.6 shows that catchment of Marichbunia Sluice is the largest catchment which is about 1738 ha.

Table 2.6: Drainage outlet/ hydraulic Structure wise drainage catchment for polder 43/2D

Description of Catchment 01

Catchment Name	Cat-01 (Hatalia catchment)
Location	Major part of Dibupura (80ha), eastern part of Purba Hatalia (135 ha), southern part of Ballabhpur (30 ha) and Pasairbunia (45 ha) mauza of Kalikapur union
Catchment area (ha)	290
Drainage Outlet	Hatalia Sluice at Ch. 1.03 km (2V- 1.5m X 1.8m)
Main Drainage Canal	Narikeltola Khal
Land elevation of Catchment (m PWD)	Max: 2.91 Min: 1.20
Length of Stream within catchment (Km)	7.22
Drainage Density (m/ha)	24.89
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Narikeltala khal • Condition: Silted up ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Functional ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: minor (usually takes 2-3 days to properly drain out rain water) • Permanent Water logging: Not Observed ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Minor • Water Scarcity: Not found ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Functional





Figure: C/S of Hatalia Sluice



Figure: Outfall of Hatalia catchment

Description of Catchment 02

Catchment Name	Charabunia
Location	Northern part of Purba Hatalia (35), Ballabhpur (212 ha), Charabunia (104), western part of Sankarpur (6 ha) and eastern part of Purba Sarikkhali (14 ha).
Catchment area (ha)	371
Drainage Outlet	Chara Bunia Sluice at 2.373 km (1V-1.5mX1.8m)
Main Drainage Canal	Bettala Khal
Land elevation of Catchment (m PWD)	Max: 2.91 Min: 1.26
Length of Stream within catchment (Km)	11.74
Drainage Density (m/ha)	31.64
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Narikelatala khal • Condition: Partially Silted up ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Highly silted up (BADC will re-excavated this khal) • Branch khal: Partially silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Moderate (usually takes 3-4 days to properly drain out rain water as the) • Re-excavation of Bettala khal and Charabunia khal will reduce drainage congestion • Permanent Water logging: Not Observed ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Moderate (Mainly affects Lt Aman)

	<p>and HYV Aman)</p> <ul style="list-style-type: none"> • Water Scarcity: Not found <p>➤ <i>Hydraulic structure condition</i></p> <ul style="list-style-type: none"> • Partially functional <ul style="list-style-type: none"> ▪ Gates are corroded and collapsed ▪ Rubber seals are damaged which caused leakage • Repairing/replacement of Gates and its hoisting arrangement is required
 <p>Figure: C/S of Charabunia Sluice</p>	 <p>Figure: Charabunia khal</p>

Description of Catchment 03

Catchment Name	Cat-3 (Batgachia catchment)
Location	Eastern part of Charabunia (30 ha), major part of Sankarpur (150 ha) and southern part of Chalitabunia (73 ha) mauza.
Catchment area (ha)	253
Drainage Outlet	Batgachia Sluice at Ch. 4.53 km (2V-0.90 mX1.20m).
Main Drainage Canal	Botgachia Khal
Land elevation of Catchment (m PWD)	Max: 2.74 Min: 1.31
Length of Stream within catchment (Km)	9.44
Drainage Density (m/ha)	37.32
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Narikeltala khal • Condition: Partially Silted up ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Partially silted up • Branch khal: Partially silted up ➤ <i>Drainage Congestion</i>

	<ul style="list-style-type: none"> • Drainage congestion problem: Moderate (usually takes 3-4 days to properly drain out rain water) • Re-excavation of Batgachia Khal will reduce drainage congestion • Permanent Water logging: Not found <p>➤ <i>Agricultural condition</i></p> <ul style="list-style-type: none"> • Crop damage: Moderate (Mainly affects Lt Aman and HYV Aman) • Water Scarcity: Not found <p>➤ <i>Hydraulic structure condition</i></p> <ul style="list-style-type: none"> • Functional
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Figure: R/S of Batgachia Sluice



Figure: Batgachia Khal

Description of Catchment 04

Catchment Name	Kanaidanga catchment
Location	Major part of Dakshin Hazikhali (125 ha) and Southern part of Hajikhali Abad (7 ha) mauza
Catchment area (ha)	132
Drainage Outlet	Kanaidanga Sluice at Ch. 5.71 km (1V-0.90 mX1.20m).
Main Drainage Canal	Kanaidanga khal
Land elevation of Catchment (m PWD)	Max: 2.76 Min: 1.28
Length of Stream within catchment (Km)	2.88
Drainage Density (m/ha)	21.80

Catchment Description

- *Outfall*
 - Outfall Khal: **Narikeltala khal**
 - Condition: **Active**
- *Condition of Drainage Khal*
 - Main drainage Khal: **Highly silted up**
 - Branch khal: **Moderately silted up**
- *Drainage Congestion*
 - Drainage congestion problem: **Severe** (usually takes 5-6 days to properly drain out rain water)
 - Re-excavation of Kanaidanga khal and removing encroachments (closer dam) may reduce drainage congestion.
 - Permanent Water logging: **Not found**
- *Agricultural condition*
 - Crop damage: **Major** (Mainly affects Lt Aman and HYV Aman during July to August for drainage congestion)
 - Water Scarcity: **Not found**
- *Hydraulic structure condition*
 - **Functional**



Figure: C/S of Kanaidanga Sluice



Figure: Kanaidanga Khal

Description of Catchment 05

Catchment Name	Cat -05 (Hajikhali catchment)
Location	Western part of Dakshin Hazikhali (18 ha), Guabaria (36 ha) and Northern part of Barunbaria (75 ha) Mouza.
Catchment area (ha)	129
Drainage Outlet	Hajikhali Sluice at Ch. 8.23 km (1V-0.90 mX1.20m).
Main Drainage Canal	Hajikhali khal
Land elevation of Catchment (m PWD)	Max: 2.98 Min: 1.51
Length of Stream within catchment (Km)	2.12
Drainage Density (m/ha)	16.4
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Narikeltala khal • Condition: Active ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Partially silted up • Branch khal: Moderately silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: minor (usually takes 2-3 days to properly drain out rain water) • Permanent Water logging: Not found ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Minor • Water Scarcity: Dakshin Hazikhali and Guabaria area are affected by water scarcity during February to April (mainly affects Rabi crops) ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Functional



Figure: R/S of Hajikhali Sluice



Figure: Outfall of Hajikhali catchment

Description of Catchment 06

Catchment Name	Cat-06 (Baktaria Catchment)
Location	Western major part of Barunbaria (260 ha) and eastern major part of Tafalbaria (86 ha) mauza.
Catchment area (ha)	346
Drainage Outlet	Baktaria Sluice at Ch. 12.1 km (1V-1.5m X 1.80m)
Main Drainage Canal	Baktaria khal
Land elevation of Catchment (m PWD)	Max: 3.18 Min: 1.26
Length of Stream within catchment (Km)	9.12
Drainage Density (m/ha)	26.37
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Gulishakhali khal • Condition: Active ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Functional • Branch khal: Moderately silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Moderate (usually takes 3-4 days to properly drain out rain water) • Re-excavation of Baktaria khal, will reduce drainage congestion. • Permanent Water logging: Not found ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Moderate (Mainly affects Lt Aman and HYV Aman during July to August for drainage congestion) • Water Scarcity: Not found ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Functional



Figure: R/S of Baktaria Sluice



Figure: Outfall of Baktaria catchment

Description of Catchment 07

Catchment Name	Cat -07 (Marichbunia catchment)
Location	Eastern part of Purba Sarikkhali (40 ha), northern part of Chalitabunia (160 ha), eastern part of Pakshia (230 ha), major part of Gerakhali (555 ha), western part of Hajikhali Abad (65 ha), western part of Barunbaria (42 ha), western part of Tafalbaria (160 ha), western part of Pacha Koralia (242 ha), major part of Marichbunia (70 ha), southern part of Arazi Gerakhali Kismat (60 ha) and southern part of Patuakhali (114 ha).
Catchment area (ha)	1,738
Drainage Outlet	Marichbunia Sluice at Ch. 15.1 km (2V-1.5 mX1.80m).
Main Drainage Canal	Guabarir Khal
Land elevation of Catchment (m PWD)	Max: 3.07 Min: 1.21
Length of Stream within catchment (Km)	55.32
Drainage Density (m/ha)	32.48
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Gulishakhali khal • Condition: Active ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Functional • Branch khal: Moderately silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Severe (usually takes 6-7 days to properly drain out rain water as the vent size of Marichbunia Sluice is inadequate) • Re-excavation of Batgachia khal, Pakshia Gerakhali khal and its connecting branches with

	<p>adequate slope towards Batgachia catchment should reduce the drainage congestion at northern part of Marichbunai catchment.</p> <ul style="list-style-type: none"> • Drainage at western part of Marichbunia catchment can be diverted towards Baktaria catchment by re-excavating Bakataria khal, Aktaria Chota khal and its connecting branches maintaining proper slope. • Permanent Water logging: About 18 ha area at Gerakhali mauza remains waterlogged from October to November. <p>➤ <i>Agricultural condition</i></p> <ul style="list-style-type: none"> • Crop damage: Major (Mainly affects Lt Aman and HYV Aman during July to August for drainage congestion) • Water Scarcity: Gerakhali and Tafalbaria area are affected by water scarcity during February to April (mainly affects Rabi crops) <p>➤ <i>Hydraulic structure condition</i></p> <ul style="list-style-type: none"> • Functional
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Figure: R/S of Marichbunia Sluice



Figure: Outfall of Marichbunia catchment

Description of Catchment 08

Catchment Name	Cat-08 (Rajabaria khal catchment)
Location	Major part of Rajabaria mauza
Catchment area (ha)	407
Drainage Outlet	Rajabaria khal at Ch. 18.6 km Sluice (1V-1.5mX1.8m)
Main Drainage Canal	Rajabaria khal
Land elevation of Catchment (m PWD)	Max: 3.23 Min: 1.31
Length of Stream within catchment (Km)	7.88

<p>Drainage Density (m/ha)</p>	<p>19.35</p>
<p>Catchment Description</p>	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Gulishakhali khal • Condition: Active ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Functional • Branch khal: Partially silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: minor (usually takes 2-3 days to properly drain out rain water) • Permanent Water logging: Not found ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Minor • Water Scarcity: Not found ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Functional ➤ <i>Erosion</i> <ul style="list-style-type: none"> • About 200m embankment at the southern corner along Gulishakhali khal is affected by river bank erosion.



Figure: R/S of Rajabaria khal Sluice



Figure: Rajabaria khal Sluice



Figure: Start of River bank erosion (22° 15' 53.0" N, 90° 16' 20.3" E)



Figure: End of River bank erosion (22° 15' 48.1" N, 90° 16' 17.9" E)

Description of Catchment 09

Catchment Name	Cat-09 (Nilkhola Catchment)
Location	Eastern part of Marichbunia (360 ha)
Catchment area (ha)	360
Drainage Outlet	Nilkhola sluice at Ch. 20.5 km (1V-1.5mX1.8m)
Main Drainage Canal	Nilkhola khal
Land elevation of Catchment (m PWD)	Max: 2.79 Min: 1.21
Length of Stream within catchment (Km)	9.23
Drainage Density (m/ha)	25.65
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Kukua River • Condition: Highly silted up ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Functional • Branch khal: Moderately silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Moderate (usually takes 3-4 days to properly drain out rain water) • Permanent Water logging: Not found ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Minor • Water Scarcity: Eastern part of Marichbunia area is affected by water scarcity during February to April. ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Functional



Figure: C/S of Nilkhoal Sluice



Figure: Outfall of Nilkhola catchment

Description of Catchment 10

Catchment Name	Cat – 10 (Chatua Catchment)
Location	Southern part of Marichbunia (196 ha), Major part of Bazarghona (480 ha) mauza
Catchment area (ha)	676
Drainage Outlet	Chatua sluice at Ch. 21.0 km (2V-1.5mX1.8m)
Main Drainage Canal	Chatua khal
Land elevation of Catchment (m PWD)	Max: 3.29 Min: 1.26
Length of Stream within catchment (Km)	18.7
Drainage Density (m/ha)	26.75
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Kukua River • Condition: Highly silted up ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Functional • Branch khal: Partially silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Minor (usually takes 2-3 days to properly drain out rain water) • Permanent Water logging: Not found ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Minor • Water Scarcity: Not found ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Functional



Figure: R/S of Chatua Sluice



Figure: Outfall of Chatua catchment

Description of Catchment 11

Catchment Name	Cat-11 (Jhapukhali Catchment)
Location	Major part of Patuakhali (252 ha).
Catchment area (ha)	252
Drainage Outlet	Jhapukhali sluice at Ch. 26.6 km (1V- 0.9m X 1.2m)
Main Drainage Canal	Jhapukhali khal
Land elevation of Catchment (m PWD)	Max: 2.69 Min: 1.27
Length of Stream within catchment (Km)	5.60
Drainage Density (m/ha)	22.22
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Kukua River • Condition: Highly silted up ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Moderately Silted up • Branch khal: Partially silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Moderate (usually takes 3-4 days to properly drain out rain water) • Permanent Water logging: About 25 ha area at Patukhali mauza remains waterlogged from October to mid-November. • Re-excavation of Jhapukhali khal will reduce the water logging issue ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Moderate (Mainly affects Lt Aman and Rabi crops) • Water Scarcity: Not found ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Functional



Figure: C/S of Jhapukhali Sluice



Figure: Outfall of Jhapukhali catchment

Description of Catchment 12

Catchment Name	Cat – 12 (Patukhali Catchment)
Location	Southern part of Pacha Koralia mauza
Catchment area (ha)	198
Drainage Outlet	Patukhali sluice at Ch. 27.9 km (1V- 0.9m X 1.2m)
Main Drainage Canal	Patukhali khal
Land elevation of Catchment (m PWD)	Max: 2.59 Min: 1.26
Length of Stream within catchment (Km)	4.31
Drainage Density (m/ha)	21.76
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Kukua River • Condition: Highly silted up ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Moderately Silted up • Branch khal: Danger khal is Highly silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Moderate (usually takes 3-4 days to properly drain out rain water) • Permanent Water logging: Not found ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Moderate • Water Scarcity: Eastern part of Patukhali mauza near dungar khal area affected by water scarcity during winter season (mainly affects Rabi crops) • Re-excavation of Patukhali khal its connecting branches with water retention provision will ensure

- water availability for irrigation
- *Hydraulic structure condition*
 - **Functional**



Figure: R/S of Patukhali Sluice



Figure: Outfall of Patukhali catchment

Description of Catchment 13

Catchment Name	Cat – 13 (Taktakhali Catchment)
Location	Western part of Chotto Auliapur (167 ha) and eastern part of Pacha Koralia (157).
Catchment area (ha)	324
Drainage Outlet	Taktakhali sluice at Ch. 30.6 km (1V- 0.9m X 1.2m)
Main Drainage Canal	Taktakhali Khal
Land elevation of Catchment (m PWD)	Max: 2.70 Min: 1.24
Length of Stream within catchment (Km)	8.89
Drainage Density (m/ha)	27.43
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Gorai River • Condition: Moderately silted up ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Highly Silted up • Branch khal: Moderately silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Moderate (usually takes 3-4 days to properly drain out rain water) • Permanent Water logging: Not found ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Moderate (affects Lt Aman and HYV Aman during seed bed preparation) • Water Scarcity: Not found ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Functional



Figure: C/S of Taktakhali Sluice



Figure: Outfall of Taktakhali catchment

Description of Catchment 14

Catchment Name	Cat – 14 (Taltola Catchment)
Location	Major part of Chotto Auliapur and Purba Auliapur mauza
Catchment area (ha)	399
Drainage Outlet	Taltola sluice at Ch. 33.3 km (1V-0.9mX1.2m)
Main Drainage Canal	Narikeltola khal
Land elevation of Catchment (m PWD)	Max: 2.55 Min: 1.28
Length of Stream within catchment (Km)	9.20
Drainage Density (m/ha)	23.05
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Gorai River • Condition: Moderately silted up ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Moderately Silted up • Branch khal: Partially silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Moderate (usually takes 3-4 days to properly drain out rain water) • Permanent Water logging: Not found ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Moderate (affects Lt Aman and HYV Aman during seed bed preparation) • Water Scarcity: Not found ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Functional



Figure: Taltola Sluice



Figure: Outfall of Taltola catchment

Description of Catchment 15

Catchment Name	Cat – 15 (Katakhali Catchment)
Location	Eastern part of Bohalgachhia (part) (91 ha), western part of Keshabpur (213 ha), major part of Purba Sarikkhali (273 ha), major part of Bara Auliapur (375 ha), eastern part of Purba Auliapur (78 ha), western part of Chotto Auliapur (93 ha) and Pacha Koralia (251 ha).
Catchment area (ha)	1,374
Drainage Outlet	Katakhali sluice at Ch. 36.4 (3V- 1.5m X 1.8m)
Main Drainage Canal	Katakhali khal
Land elevation of Catchment (m PWD)	Max: 3.12 Min: 1.17
Length of Stream within catchment (Km)	44.54
Drainage Density (m/ha)	27.58
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Chandanbaria khal • Condition: Moderately silted up ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Moderately Silted up (About 2.5 km from Katakhali khal needs re-excavation) • Branch khal: Moderately silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Moderate (usually takes 3-4 days to properly drain out rain water) • Permanent Water logging: About 45 ha area at Pacha Koralia mauza remains waterlogged from October to mid-December. • Re-excavation of Katakhali khal (about 2.5 km from outfall) will reduce the drainage congestion and water logging issue ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Moderate (Lt Aman and HYV Aman seed bed affected by drainage congestion) • Water Scarcity: Bara Auliapur mauza near Nakshakhali khal area affected by water scarcity during winter season (mainly affects Rabi crops) ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Functional



Figure: Katakhal Sluice



Figure: Outfall of Katakhal catchment

Description of Catchment 16

Catchment Name	Cat – 16 (Koyer Khal Catchment)
Location	Major part of Koyer Khal (138 ha).
Catchment area (ha)	138
Drainage Outlet	Koyer Khal Sluice (1V-1.5mX1.8m)
Main Drainage Canal	Koyer khal
Land elevation of Catchment (m PWD)	Max: 2.48 Min: 1.14
Length of Stream within catchment (Km)	4.69
Drainage Density (m/ha)	28.75
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Chandanbaria khal Condition: Highly Silted up ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Functional (Recently BADC re-excavated this khal) • Branch khal: Partially silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Moderate (usually takes 3-4 days to properly drain out rain water) • Permanent Water logging: Not found ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Minor • Water Scarcity: Not found ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Functional



Figure: Koyer khal Sluice



Figure: Outfall of Koyer khal catchment

Description of Catchment 17

Catchment Name	Cat – 17 (Fultola catchment)
Location	Eastern part of Bohalgachhia (Part) (90 ha), major part of Town Zainkati (205 ha), Northern part of Keshabpur (part) (34 ha) and eastern part of Town Bahalgachhia (50 ha).
Catchment area (ha)	379
Drainage Outlet	Fultola Sluice (1V-1.5mX1.8m)
Main Drainage Canal	Fultola khal
Land elevation of Catchment (m PWD)	Max: 2.78 Min: 1.18
Length of Stream within catchment (Km)	11.14
Drainage Density (m/ha)	29.39
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Chandanbaria khal • Condition: Highly silted up ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Partially Silted up • Branch khal: Partially silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Moderate (usually takes 3-4 days to properly drain out rain water) • Permanent Water logging: Not found ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Moderate • Water Scarcity: Not observed ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Functional



Figure: Fultola Sluice



Figure: Fultola khal

2.14 Tidal dynamics assessment

CEGIS team installed four (04) water level gauge stations (**Kazirhat, Morichbunia, Badura and Katakali**) outside the polder 43/2D (shown in Figure 2.26) to understand the tidal water level variations. Daily water level data at one (01) hour interval (from 6:00 AM to 6:00 PM) for 1 tide cycle (15 days) from 20st August 2016 to 03rd September 2016 has been collected presented in Table 2.7. All water level data was collected in mPWD datum.

Daily water level data were collected on an hourly basis. Water level hydrographs were plotted as water level versus time. The water level hydrograph at Kazirhat, Morichbunia, Badura and Katakali stations are shown in Figure 2.22 to 2.25 respectively.

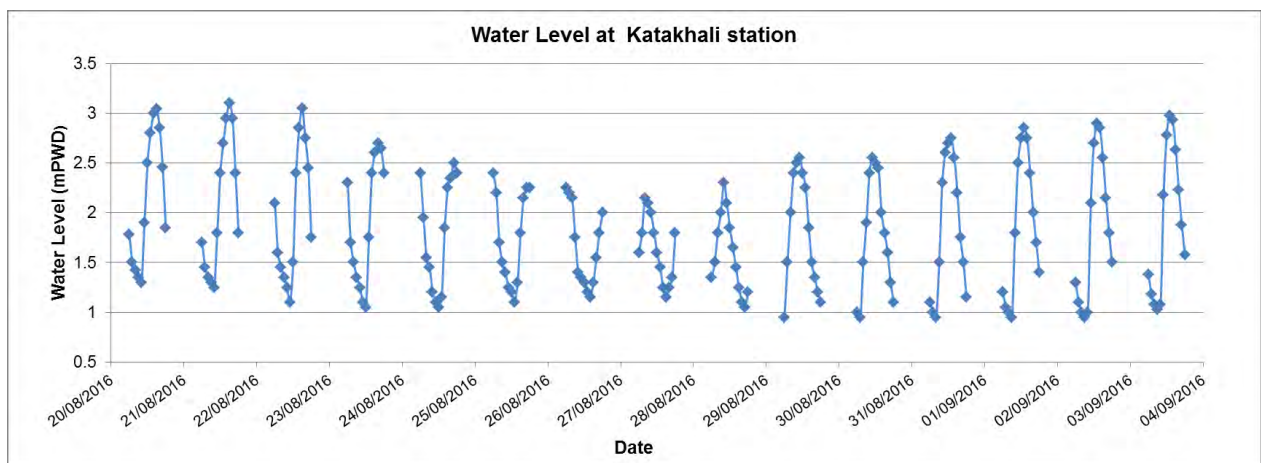


Figure 2.22: Water level analysis at katakhali station

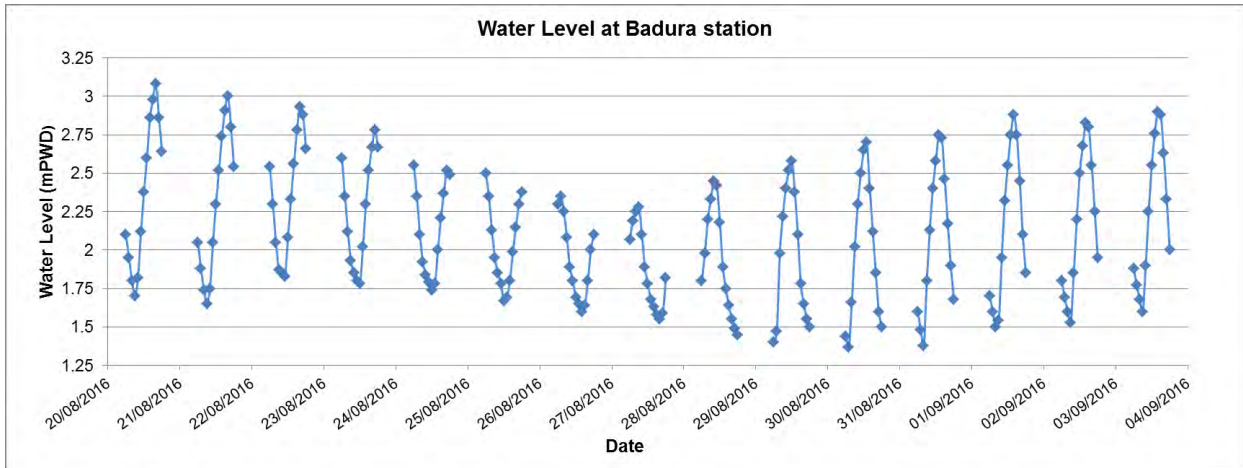


Figure 2.23: Water level analysis at Badura station

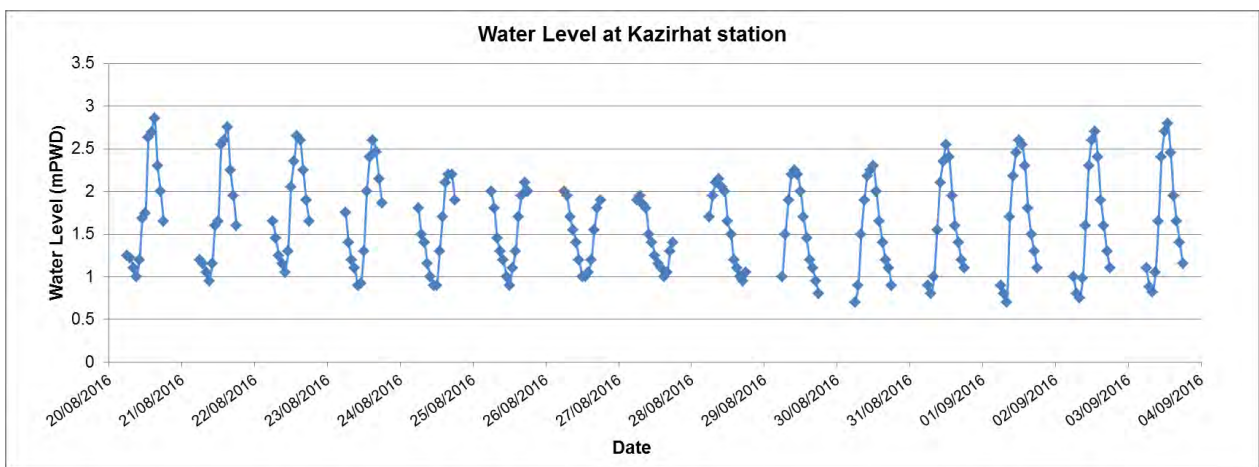


Figure 2.24: Water level analysis at Kazirhat station

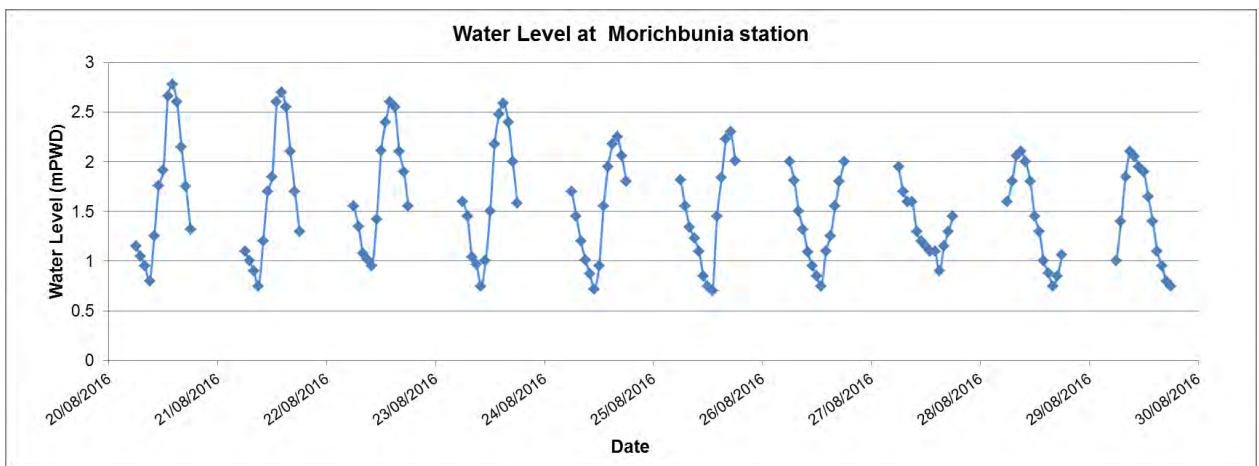
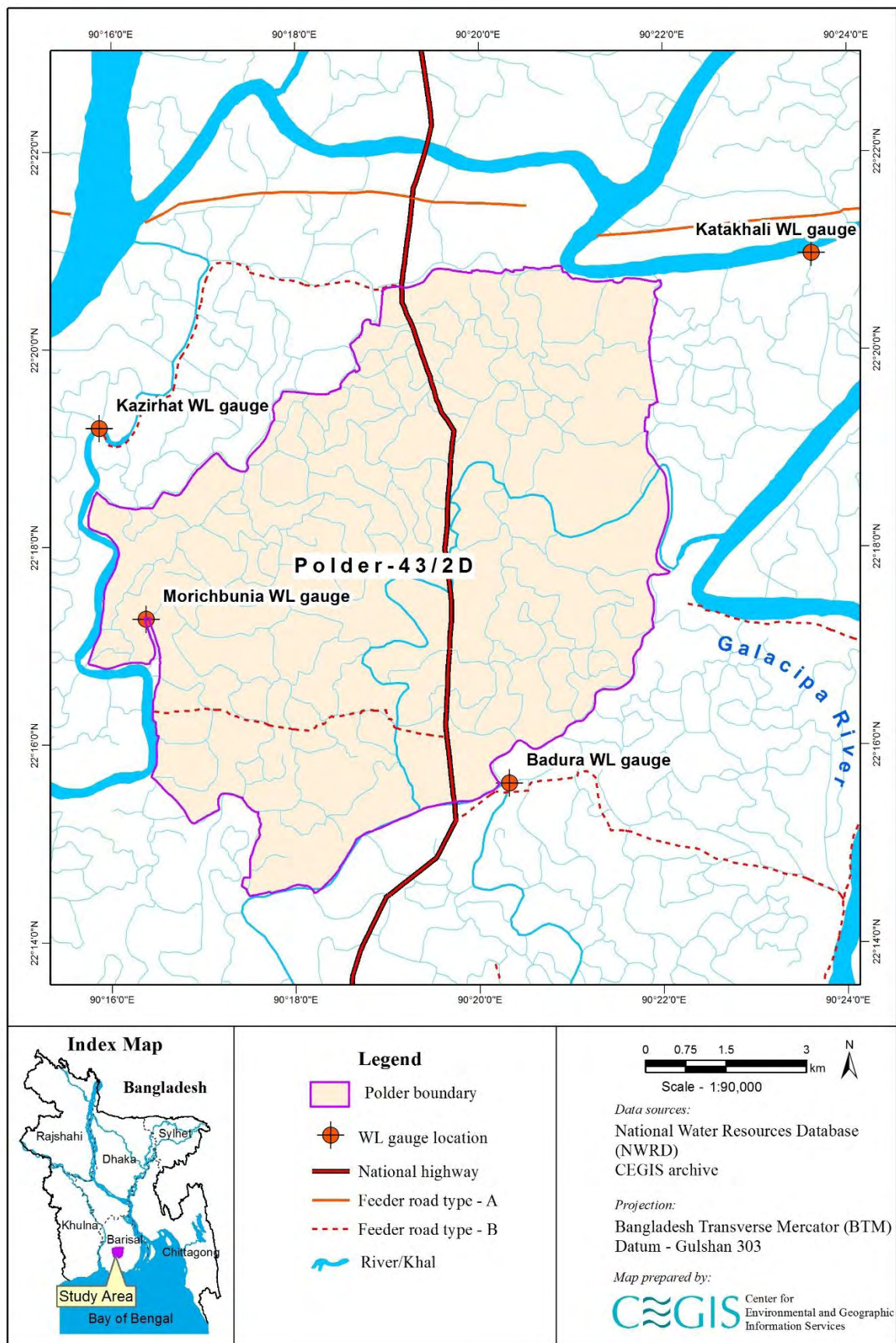


Figure 2.25: Water level analysis at Morichbunia station



June 2016

Figure 2.26: CEGIS installed gauge location at polder 43/2D

Table 2.7: Water level gauge data from 20/08/2016 to 03/09/2016

Date	Time	Kazirhat	Morichbunia	katakhal	Badura
20/08/2016	6:00	1.25	1.15	1.78	2.10
	7:00	1.22	1.05	1.50	1.95
	8:00	1.10	0.95	1.42	1.80
	9:00	1(LTL)	0.8(LTL)	1.35	1.7(LTL)
	10:00	1.20	1.25	1.3(LTL)	1.82
	11:00	1.68	1.76	1.90	2.12
	12:00	1.74	1.91	2.50	2.38
	13:00	2.63	2.66	2.80	2.60
	14:00	2.69	2.78 (HTL)	3.00	2.86
	15:00	2.86 (HTL)	2.60	3.04 (HTL)	2.98
	16:00	2.30	2.15	2.85	3.08 (HTL)
	17:00	2.00	1.75	2.46	2.86
18:00	1.65	1.32	1.85	2.64	

Date	Time	Kazirhat	Morichbunia	katakhal	Badura
21/08/2016	6:00	1.20	1.10	1.70	2.05
	7:00	1.15	1.00	1.45	1.88
	8:00	1.05	0.90	1.35	1.74
	9:00	0.95 (LTL)	0.75 (LTL)	1.30	1.65 (LTL)
	10:00	1.15	1.20	1.25 (LTL)	1.75
	11:00	1.60	1.70	1.80	2.05
	12:00	1.65	1.85	2.40	2.30
	13:00	2.55	2.60	2.70	2.52
	14:00	2.60	2.7 (HTL)	2.95	2.74
	15:00	2.75 (HTL)	2.55	3.1 (HTL)	2.91
	16:00	2.25	2.10	2.95	3 (HTL)
	17:00	1.95	1.70	2.40	2.80
18:00	1.60	1.30	1.80	2.54	

Date	Time	Kazirhat	Morichbunia	katakhal	Badura
22/08/2016	6:00	1.65	1.55	2.10	2.54
	7:00	1.45	1.35	1.60	2.30
	8:00	1.25	1.08	1.45	2.05
	9:00	1.15	1.02	1.35	1.87
	10:00	1.05 (LTL)	0.95 (LTL)	1.25	1.85
	11:00	1.30	1.42	1.1 (LTL)	1.83 (LTL)
	12:00	2.05	2.11	1.50	2.08
	13:00	2.35	2.40	2.40	2.33
	14:00	2.65 (HTL)	2.6 (HTL)	2.85	2.56
	15:00	2.60	2.55	3.05 (HTL)	2.78
	16:00	2.25	2.10	2.75	2.93 (HTL)
	17:00	1.90	1.90	2.45	2.88
18:00	1.65	1.55	1.75	2.66	

Date	Time	Kazirhat	Morichbunia	katakhali	Badura
23/08/2016	6:00	1.75	1.60	2.30	2.60
	7:00	1.40	1.45	1.70	2.35
	8:00	1.20	1.04	1.50	2.12
	9:00	1.10	0.97	1.35	1.93
	10:00	0.9 (LTL)	0.75 (LTL)	1.25	1.85
	11:00	0.92	1.00	1.10	1.80
	12:00	1.30	1.50	1.05 (LTL)	1.78 (LTL)
	13:00	2.00	2.18	1.75	2.02
	14:00	2.40	2.48	2.40	2.30
	15:00	2.6 (HTL)	2.59 (HTL)	2.60	2.52
	16:00	2.46	2.40	2.7 (HTL)	2.67
	17:00	2.15	2.00	2.65	2.78 (HTL)
18:00	1.86	1.58	2.40	2.67	

Date	Time	Kazirhat	Morichbunia	katakhali	Badura
24/08/2016	6:00	1.80	1.70	2.40	2.55
	7:00	1.50	1.45	1.95	2.35
	8:00	1.40	1.20	1.55	2.10
	9:00	1.15	1.01	1.45	1.92
	10:00	1.00	0.87	1.20	1.84
	11:00	0.9 (LTL)	0.72 (LTL)	1.10	1.79
	12:00	0.90	0.95	1.05 (LTL)	1.74 (LTL)
	13:00	1.30	1.55	1.15	1.78
	14:00	1.70	1.95	1.85	2.00
	15:00	2.10	2.18	2.25	2.21
	16:00	2.20	2.25 (HTL)	2.35	2.37
	17:00	2.2 (HTL)	2.06	2.5 (HTL)	2.52 (HTL)
18:00	1.90	1.80	2.40	2.49	

Date	Time	Kazirhat	Morichbunia	katakhali	Badura
25/08/2016	6:00	2.00	1.82	2.4 (HTL)	2.50
	7:00	1.80	1.55	2.20	2.35
	8:00	1.45	1.34	1.70	2.13
	9:00	1.30	1.23	1.50	1.95
	10:00	1.20	1.10	1.40	1.85
	11:00	1.00	0.85	1.25	1.78
	12:00	0.9 (LTL)	0.75	1.20	1.67 (LTL)
	13:00	1.10	0.7 (LTL)	1.1 (LTL)	1.69
	14:00	1.30	1.45	1.30	1.80
	15:00	1.70	1.84	1.80	1.99
	16:00	1.95	2.23	2.15	2.15
	17:00	2.1 (HTL)	2.3 (HTL)	2.25 (HTL)	2.30
18:00	2.00	2.01	2.25	2.38 (HTL)	

Date	Time	Kazirhat	Morichbunia	katakhali	Badura
26/08/2016	6:00	2 (HTL)	2 (HTL)	2.25 (HTL)	2.30
	7:00	1.95	1.81	2.20	2.35 (HTL)
	8:00	1.70	1.50	2.15	2.25
	9:00	1.55	1.32	1.75	2.08
	10:00	1.40	1.09	1.40	1.89
	11:00	1.20	0.95	1.35	1.80
	12:00	1 (LTL)	0.85	1.30	1.69
	13:00	1.00	0.75 (LTL)	1.20	1.65
	14:00	1.05	1.10	1.15 (LTL)	1.6 (LTL)
	15:00	1.20	1.25	1.30	1.64
	16:00	1.55	1.55	1.55	1.80
	17:00	1.80	1.80	1.80	2.00
	18:00	1.90	2.00	2.00	2.10

Date	Time	Kazirhat	Morichbunia	katakhali	Badura
27/08/2016	6:00	1.90	1.95 (HTL)	1.60	2.07
	7:00	1.95 (HTL)	1.70	1.80	2.19
	8:00	1.85	1.60	2.15 (HTL)	2.25
	9:00	1.80	1.60	2.10	2.28 (HTL)
	10:00	1.50	1.30	2.00	2.10
	11:00	1.40	1.20	1.80	1.89
	12:00	1.25	1.15	1.60	1.78
	13:00	1.15	1.10	1.45	1.68
	14:00	1.10	1.10	1.25	1.63
	15:00	1 (LTL)	0.9 (LTL)	1.15 (LTL)	1.58
	16:00	1.05	1.15	1.25	1.55 (LTL)
	17:00	1.30	1.30	1.35	1.59
	18:00	1.40	1.45	1.80	1.82

Date	Time	Kazirhat	Morichbunia	katakhali	Badura
28/08/2016	6:00	1.70	1.60	1.35	1.80
	7:00	1.95	1.80	1.50	1.98
	8:00	2.10	2.06	1.80	2.20
	9:00	2.15 (HTL)	2.1 (HTL)	2.00	2.33
	10:00	2.05	2.00	2.3 (HTL)	2.45 (HTL)
	11:00	2.00	1.80	2.10	2.42
	12:00	1.65	1.45	1.85	2.18
	13:00	1.50	1.30	1.65	1.89
	14:00	1.20	1.00	1.45	1.75
	15:00	1.10	0.88	1.25	1.64
	16:00	1.00	0.75 (LTL)	1.10	1.55
	17:00	0.95 (LTL)	0.85	1.05 (LTL)	1.49
	18:00	1.05	1.06	1.20	1.45 (LTL)

Date	Time	Kazirhat	Morichbunia	katakhali	Badura
29/08/2016	6:00	1.00	1.00	0.95 (LTL)	1.4 (LTL)
	7:00	1.50	1.40	1.50	1.47
	8:00	1.90	1.85	2.00	1.98
	9:00	2.20	2.1 (HTL)	2.40	2.22
	10:00	2.25 (HTL)	2.05	2.50	2.40
	11:00	2.20	1.95	2.55 (HTL)	2.52
	12:00	2.00	1.90	2.40	2.58 (HTL)
	13:00	1.70	1.65	2.25	2.38
	14:00	1.45	1.40	1.85	2.10
	15:00	1.20	1.10	1.50	1.78
	16:00	1.10	0.95	1.35	1.65
	17:00	0.95	0.80	1.20	1.55
18:00	0.80	0.75	1.10	1.50	

Date	Time	Kazirhat	Morichbunia	katakhali	Badura
30/08/2016	6:00	0.7 (LTL)	0.65 (LTL)	1.00	1.44
	7:00	0.90	1.05	0.95 (LTL)	1.37 (LTL)
	8:00	1.50	1.50	1.50	1.66
	9:00	1.90	1.92	1.90	2.02
	10:00	2.18	2.22	2.40	2.30
	11:00	2.25	2.25 (HTL)	2.55 (HTL)	2.50
	12:00	2.3 (HTL)	2.10	2.50	2.65
	13:00	2.00	1.88	2.45	2.7 (HTL)
	14:00	1.65	1.50	2.00	2.40
	15:00	1.40	1.20	1.80	2.12
	16:00	1.20	0.92	1.60	1.85
	17:00	1.10	0.85	1.30	1.60
18:00	0.90	0.68	1.10	1.50	

Date	Time	Kazirhat	Morichbunia	katakhali	Badura
31/08/2016	6:00	0.90	0.90	1.10	1.60
	7:00	0.8 (LTL)	0.88 (LTL)	1.00	1.48
	8:00	1.00	1.00	0.95 (LTL)	1.38 (LTL)
	9:00	1.55	1.60	1.50	1.80
	10:00	2.10	2.10	2.30	2.13
	11:00	2.35	2.40	2.60	2.40
	12:00	2.55 (HTL)	2.5 (HTL)	2.70	2.58
	13:00	2.40	2.30	2.75 (HTL)	2.75 (HTL)
	14:00	1.95	1.85	2.55	2.73
	15:00	1.60	1.55	2.20	2.46
	16:00	1.40	1.10	1.75	2.17
	17:00	1.20	1.00	1.50	1.90
18:00	1.10	0.92	1.15	1.68	

Date	Time	Kazirhat	Morichbunia	katakhali	Badura
01/09/2016	6:00	0.90	0.88	1.20	1.70
	7:00	0.80	0.8 (LTL)	1.05	1.60
	8:00	0.7 (LTL)	0.95	1.00	1.5 (LTL)
	9:00	1.70	1.75	0.95 (LTL)	1.54
	10:00	2.18	2.20	1.80	1.95
	11:00	2.45	2.50	2.50	2.32
	12:00	2.6 (HTL)	2.6 (HTL)	2.75	2.55
	13:00	2.55	2.50	2.85 (HTL)	2.75
	14:00	2.30	2.15	2.75	2.88 (HTL)
	15:00	1.80	1.70	2.40	2.75
	16:00	1.50	1.40	2.00	2.45
	17:00	1.30	1.25	1.70	2.10
18:00	1.10	1.00	1.40	1.85	

Date	Time	Kazirhat	Morichbunia	katakhali	Badura
02/09/2016	6:00	1.00	1.00	1.30	1.80
	7:00	0.80	0.75	1.10	1.69
	8:00	0.75 (LTL)	0.7 (LTL)	1.00	1.60
	9:00	0.98	1.10	0.95 (LTL)	1.53 (LTL)
	10:00	1.60	1.85	1.00	1.85
	11:00	2.30	2.35	2.10	2.20
	12:00	2.60	2.65 (HTL)	2.70	2.50
	13:00	2.7 (HTL)	2.62	2.9 (HTL)	2.68
	14:00	2.40	2.30	2.85	2.83 (HTL)
	15:00	1.90	1.80	2.55	2.80
	16:00	1.60	1.35	2.15	2.55
	17:00	1.30	1.25	1.80	2.25
18:00	1.10	1.10	1.50	1.95	

Date	Time	Kazirhat	Morichbunia	katakhali	Badura
03/09/2016	6:00	1.10	1.04	1.38	1.88
	7:00	0.88	0.82	1.18	1.77
	8:00	0.82 (LTL)	0.78 (LTL)	1.08	1.68
	9:00	1.05	1.15	1.03 (LTL)	1.6 (LTL)
	10:00	1.65	1.93	1.08	1.90
	11:00	2.40	2.43	2.18	2.25
	12:00	2.70	2.68	2.78	2.55
	13:00	2.8 (HTL)	2.73 (HTL)	2.98 (HTL)	2.76
	14:00	2.45	2.38	2.93	2.9 (HTL)
	15:00	1.95	1.88	2.63	2.88
	16:00	1.65	1.43	2.23	2.63
	17:00	1.40	1.33	1.88	2.33
18:00	1.15	1.18	1.58	2.00	



2.15 Catchment of Polder 43/2E

In this study, for polder 43/2E, Catchment has been delineated for seven (07) drainage outlets. The drainage outlets were selected at seven (7) hydraulic structure locations. Figure 2.27, 2.28 and 2.29 shows the Base map, Intervention with catchment and Digital Elevation Model (DEM) map of Polder 43/2E. Area of each catchment boundary has been presented in Table 2.8. From the Figure 2.28 and Table 2.8 shows that catchment of Dholkhali Sluice is the largest catchment which is about 350 ha.

Table 2.8: Drainage outlet/ hydraulic Structure wise drainage catchment for polder 43/2E

Description of Catchment 1

Catchment Name	Cat – 1 (Naotana Catchment)
Location	Northern part of Purba Jaiakati (64 ha), western part of Keshabpur (144 ha) and Sehakati (65 ha)
Catchment area (ha)	273 ha
Drainage Outlet	Naotana Sluice at Ch. 1+080 km (1V- 0.9 m X1.2 m)
Main Drainage Canal	Naotana khal
Land elevation of Catchment (m PWD)	Max: 3.37 Min: 1.31
Length of Stream within catchment (Km)	6.47
Drainage Density (m/ha)	23.69
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Lohalia River Condition: Active ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Moderately silted up (proposed for re-excavation under Bluegold program) • Branch khal: Moderately silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Moderate (usually takes 3-4 days to properly drain out rain water) • Permanent Water logging: About 15 ha area at southern part of Sehakati mauza remains waterlogged from October to mid-November. • Re-excavation of Naotana khal and Bahaitala khal reduce the drainage congestion and water logging issue ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Moderate (Lt Aman and HYV Aman Seed bed affected by drainage congestion) • Water Scarcity: Talbaria village at Chowdhury

	<p><i>Beel/kola</i> affected by water scarcity during winter season (mainly affects Rabi crops)</p> <ul style="list-style-type: none"> ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Functional
	
Figure: C/S of Naotana Sluice	Figure: Outfall of Naotana catchment

Description of Catchment 2

Catchment Name	Cat – 2 (Katakhali Catchment)
Location	Purba Jainkati (283 ha) and northern part of Char Jainkati (62 ha)
Catchment area (ha)	345 ha
Drainage Outlet	Katakhali Sluice at Ch. 2+610 km (1V- 0.9 m X1.2 m)
Main Drainage Canal	Katakhali khal
Land elevation of Catchment (m PWD)	Max: 3.20 Min: 1.27
Length of Stream within catchment (Km)	8.11
Drainage Density (m/ha)	23.50
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Lohalia River Condition: Active ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Moderately silted up (proposed for re-excavation under Bluegold program) • Branch khal: Moderately silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Moderate (usually takes 3-4 days to properly drain out rain water) • Permanent Water logging: About 22 ha area adjacent the Durlabkhalir khal at Char Jainkati mauza remains waterlogged from October to mid-

	<p>December.</p> <ul style="list-style-type: none"> • Construction of new drainage cum flashing regulator and re-excavation of Durlab khal (about 1.7 km) with removing all encroachments will reduce the water logging and drainage congestion issue. <p>➤ <i>Agricultural condition</i></p> <ul style="list-style-type: none"> • Crop damage: Moderate (Seed bed of HYV Aman affected by drainage congestion) • Water Scarcity: Not found <p>➤ <i>Hydraulic structure condition</i></p> <ul style="list-style-type: none"> • Functional
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Figure: C/S of Katakhal Sluice



Figure: R/S of Katakhal Sluice

Description of Catchment 3

Catchment Name	Cat – 3 (Gogonkhali Catchment)
Location	Eastern part of Purba Jainkati (72 ha) and Char Jainkati (105 ha) mauza
Catchment area (ha)	177 ha
Drainage Outlet	Gogonkhali Sluice at Ch. 6+700 km (1V- 0.9 m X1.2 m)
Main Drainage Canal	Gogonkhali khal
Land elevation of Catchment (m PWD)	Max: 2.27 Min: 1.32
Length of Stream within catchment (Km)	2.94
Drainage Density (m/ha)	16.61
	<p>➤ <i>Outfall</i></p> <ul style="list-style-type: none"> • Outfall Khal: Galachipa River Condition: Active <p>➤ <i>Condition of Drainage Khal</i></p> <ul style="list-style-type: none"> • Main drainage Khal: Moderately silted up

Catchment Description	<p>(proposed for re-excavation under Bluegold program)</p> <ul style="list-style-type: none"> • Branch khal: Moderately silted up <p>➤ <i>Drainage Congestion</i></p> <ul style="list-style-type: none"> • Drainage congestion problem: Minor (usually takes 2-3 days to properly drain out rain water) • Permanent Water logging: About 8 ha area adjacent the Durlabkhalir khal at Char Jainkati mauza remains waterlogged from October to mid-December. • Re-excavation of Durlab khal will reduce the water logging issue. <p>➤ <i>Agricultural condition</i></p> <ul style="list-style-type: none"> • Crop damage: Minor • Water Scarcity: Not found <p>➤ <i>Hydraulic structure condition</i></p> <ul style="list-style-type: none"> • Functional
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Figure: C/S of Gogonkhali Sluice



Figure: R/S of Gogonkhali Sluice

Description of Catchment 4

Catchment Name	Cat – 4 (Dholkhali Catchment)
Location	Purba Jainkati mauza (350 ha)
Catchment area (ha)	350 ha
Drainage Outlet	Dholkhali Sluice at Ch. 8+900 km (1V- 1.5 m X1.8 m)
Main Drainage Canal	Dholkhali khal
Land elevation of Catchment (m PWD)	Max: 2.96 Min: 1.28
Length of Stream within catchment (Km)	8.80
Drainage Density (m/ha)	25.14

<p>Catchment Description</p>	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Galachipa River Condition: Active ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Moderately silted up <i>(proposed for re-excavation under Bluegold program)</i> • Branch khal: Moderately silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Minor (usually takes 2-3 days to properly drain out rain water) • Permanent Water logging: Not found ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Minor • Water Scarcity: Dhooper khal and Katura Taluk north branch khal are silted-up, for which water cannot reach at the tail end during flooding. Therefore, kathuriar Taluk area undergoes crisis of irrigation water for Rabi crops (February to April) • Re-excavation of Dhooper khal and its connecting branches with water retention provision will ensure water availability for irrigation ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Functional
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Figure: R/S of Dholkhali Sluice



Figure: Dholkhali Khal

Description of Catchment 5

Catchment Name	Cat – 5 (Shuddhurbari Catchment)
Location	Purba Jainkati (70ha), Sehakati (145 ha), Fedainagar (41 ha) and Purba Auliapur (8 ha)
Catchment area (ha)	264 ha
Drainage Outlet	Shuddhurbari Sluice at Ch. 11+550 km (1V- 0.9 m X1.2 m)
Main Drainage Canal	Shuddhurbari khal
Land elevation of Catchment (m PWD)	Max: 2.92 Min: 1.34
Length of Stream within catchment (Km)	6.25
Drainage Density (m/ha)	23.67
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Galachipa River Condition: Partially active ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Highly silted up (<i>proposed for re-excavation under Bluegold program</i>) • Branch khal: Highly silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Minor, usually takes 2-3 days to properly drain out rain water. However, about 35 ha area at southern part near Sehakati bazar is affected by severe (6-7 days) drainage congestion and damaged Aman crop. • The culvert on Dangar khal is insufficient to carry storm water due to uplift of its sill level. In addition, Suddurbarir khal and Dangar khal are silted up which lead slow drainage. • Permanent Water logging: Not found ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Minor • Water Scarcity: Not found ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Functional





Figure: Shuddhurbari khal Sluice



Figure: C/S of Shuddhurbari Sluice

Description of Catchment 6

Catchment Name	Cat – 6 (Maubaria Catchment)
Location	Sehakati mauza (121 ha)
Catchment area (ha)	121 ha
Drainage Outlet	Maubaria Sluice at Ch. 15+970 km (1V- 0.9 m X1.2 m)
Main Drainage Canal	Maubaria Khal
Land elevation of Catchment (m PWD)	Max: 2.85 Min: 1.32
Length of Stream within catchment (Km)	3.45
Drainage Density (m/ha)	28.51
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Chandanbaria Khal Condition: Highly silted up ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Moderately silted up (proposed for re-excavation under Bluegold program) • Branch khal: Moderately silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Minor (usually takes 2-3 days to properly drain out rain water) • Permanent Water logging: Not found ➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> • Crop damage: Minor • Water Scarcity: Area nearby the Borigher Khal is affected by water scarcity during winter season (mainly affects Rabi crops) • Re-excavation of Maubaria khal and its connecting

	<p>branches with water retention provision will ensure water availability for irrigation</p> <ul style="list-style-type: none"> ➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> • Functional
 <p>Figure: C/S of Maubaria Sluice</p>	 <p>Figure: C/S of Maubaria Sluice</p>

Description of Catchment 7

Catchment Name	Cat – 7 (Natar Catchment)
Location	Purba Jainkati (29 ha) and Sehakati mauza (118 ha)
Catchment area (ha)	148 ha
Drainage Outlet	Natar khal pipe sluice at Ch. 17+500 km (1V- 0.9 m dia)
Main Drainage Canal	Natar khal
Land elevation of Catchment (m PWD)	Max: 2.72 Min: 1.25
Length of Stream within catchment (Km)	3.92
Drainage Density (m/ha)	26.48
Catchment Description	<ul style="list-style-type: none"> ➤ <i>Outfall</i> <ul style="list-style-type: none"> • Outfall Khal: Chandanbaria Khal Condition: Highly silted up ➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> • Main drainage Khal: Moderately silted up (proposed for re-excavation under Bluegold program) • Branch khal: Moderately silted up ➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> • Drainage congestion problem: Severe as the outfall khal Chandanbaria is highly silted up and takes 5-6 days to properly drain out rain water. • Permanent Water logging: About 11 ha area

	<p>northern part of Natuar khal remains waterlogged for 1 month.</p> <ul style="list-style-type: none"> • Re-excavation of Natuar khal and Chandanbaria Khal (outside khal) will reduce the drainage congestion and water logging issue. <p>➤ <i>Agricultural condition</i></p> <ul style="list-style-type: none"> • Crop damage: High (HYV Aman affected by drainage congestion) • Water Scarcity: Not found <p>➤ <i>Hydraulic structure condition</i></p> <ul style="list-style-type: none"> • Partially functional (R/S and C/S flap gate is damaged)
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Figure: Natuar khal Sluice



Figure: Outfall of Natuar khal catchment

2.16 Tidal dynamics assessment

CEGIS team installed three (03) water level gauge stations (**Katakali, Badura and Amkhola**) outside the polder 43/2E (shown in Figure 2.33) to understand the tidal water level variations. Daily water level data at one (01) hour interval (from 6:00 AM to 6:00 PM) for 1 tide cycle (15 days) from 20st August 2016 to 03rd September 2016 has been collected presented in Table 2.9. All water level data was collected in mPWD datum.

Daily water level data were collected on an hourly basis. Water level hydrographs were plotted as water level versus time. The water level hydrograph at Katakali, Badura and Amkhola stations are shown in Figure 2.30 to 2.32 respectively.

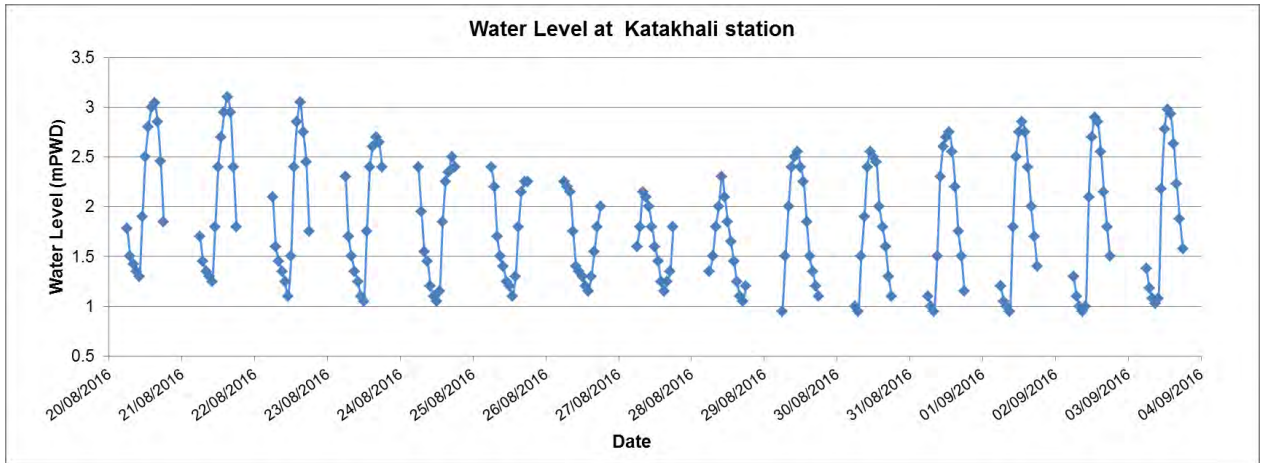


Figure 2.30: Water level analysis at katakhali station

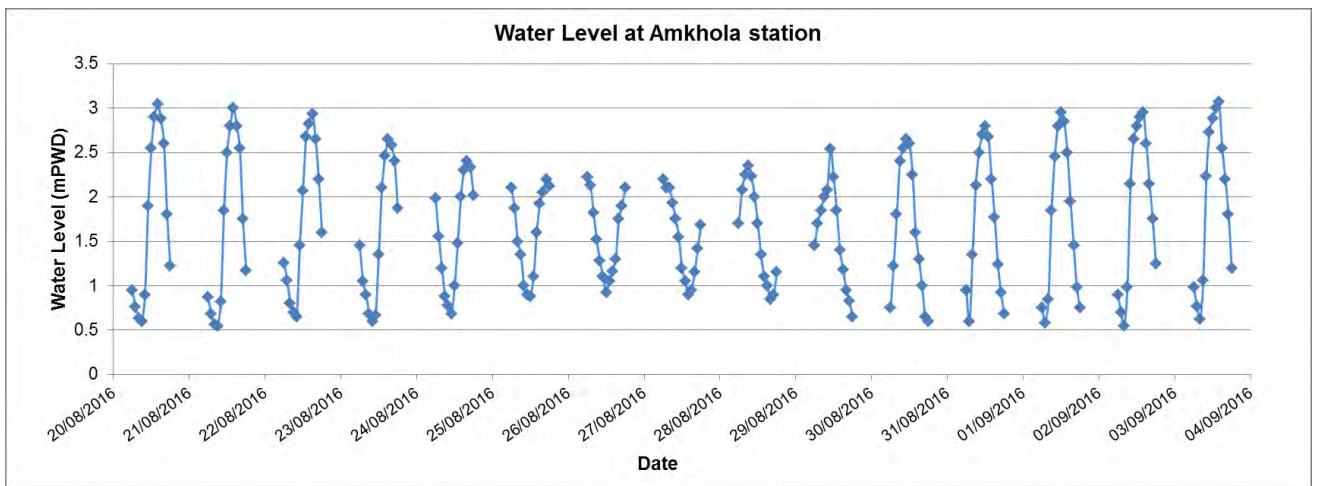


Figure 2.31: Water level analysis at Amkhola station

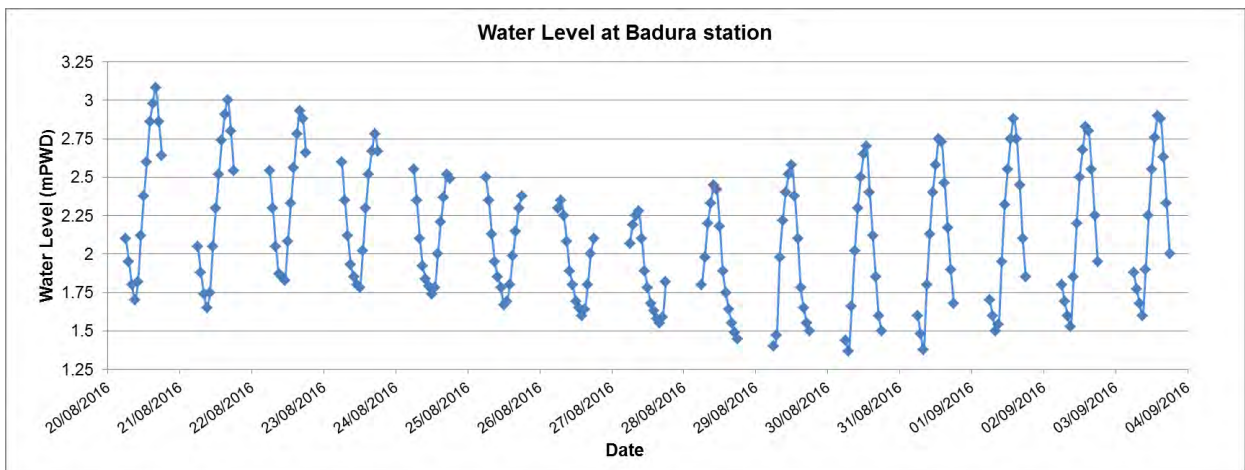


Figure 2.32: Water level analysis at Badura station

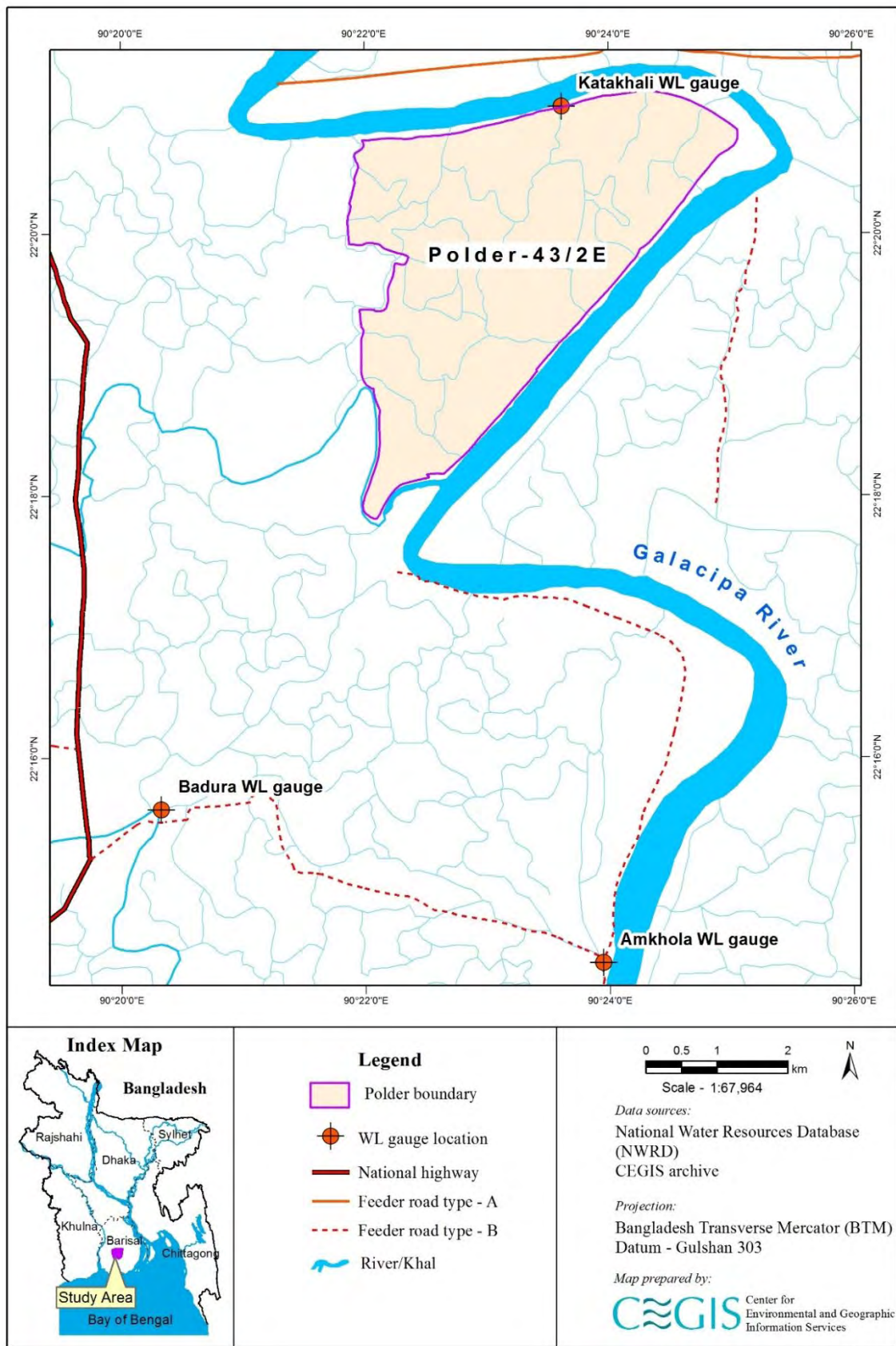


Figure 2.33: CEGIS installed gauge location map at Polder 43/2E

Table 2.9: Water level gauge data from 20/08/2016 to 03/09/2016

Date	Time	katakhali	Amkhola	Badura
20/08/2016	6:00	1.78	0.95	2.10
	7:00	1.50	0.76	1.95
	8:00	1.42	0.63	1.80
	9:00	1.35	0.6(LTL)	1.7(LTL)
	10:00	1.3(LTL)	0.90	1.82
	11:00	1.90	1.90	2.12
	12:00	2.50	2.55	2.38
	13:00	2.80	2.90	2.60
	14:00	3.00	3.04 (HTL)	2.86
	15:00	3.04 (HTL)	2.88	2.98
	16:00	2.85	2.60	3.08 (HTL)
	17:00	2.46	1.80	2.86
	18:00	1.85	1.22	2.64

Date	Time	katakhali	Amkhola	Badura
21/08/2016	6:00	1.70	0.87	2.05
	7:00	1.45	0.68	1.88
	8:00	1.35	0.56	1.74
	9:00	1.30	0.55 (LTL)	1.65 (LTL)
	10:00	1.25 (LTL)	0.82	1.75
	11:00	1.80	1.85	2.05
	12:00	2.40	2.50	2.30
	13:00	2.70	2.80	2.52
	14:00	2.95	3 (HTL)	2.74
	15:00	3.1 (HTL)	2.80	2.91
	16:00	2.95	2.55	3 (HTL)
	17:00	2.40	1.75	2.80
	18:00	1.80	1.17	2.54

Date	Time	katakhali	Amkhola	Badura
22/08/2016	6:00	2.10	1.26	2.54
	7:00	1.60	1.06	2.30
	8:00	1.45	0.80	2.05
	9:00	1.35	0.70	1.87
	10:00	1.25	0.65 (LTL)	1.85
	11:00	1.1 (LTL)	1.45	1.83 (LTL)
	12:00	1.50	2.07	2.08
	13:00	2.40	2.68	2.33
	14:00	2.85	2.82	2.56
	15:00	3.05 (HTL)	2.93 (HTL)	2.78
	16:00	2.75	2.65	2.93 (HTL)
	17:00	2.45	2.20	2.88
	18:00	1.75	1.60	2.66

Date	Time	katakhali	Amkhola	Badura
23/08/2016	6:00	2.30	1.45	2.60
	7:00	1.70	1.05	2.35
	8:00	1.50	0.90	2.12
	9:00	1.35	0.68	1.93
	10:00	1.25	0.6 (LTL)	1.85
	11:00	1.10	0.67	1.80
	12:00	1.05 (LTL)	1.35	1.78 (LTL)
	13:00	1.75	2.10	2.02
	14:00	2.40	2.46	2.30
	15:00	2.60	2.65 (HTL)	2.52
	16:00	2.7 (HTL)	2.58	2.67
	17:00	2.65	2.40	2.78 (HTL)
	18:00	2.40	1.87	2.67

Date	Time	katakhali	Amkhola	Badura
24/08/2016	6:00	2.40	1.98	2.55
	7:00	1.95	1.56	2.35
	8:00	1.55	1.20	2.10
	9:00	1.45	0.88	1.92
	10:00	1.20	0.78	1.84
	11:00	1.10	0.68 (LTL)	1.79
	12:00	1.05 (LTL)	1.00	1.74 (LTL)
	13:00	1.15	1.48	1.78
	14:00	1.85	2.00	2.00
	15:00	2.25	2.30	2.21
	16:00	2.35	2.4 (HTL)	2.37
	17:00	2.5 (HTL)	2.33	2.52 (HTL)
	18:00	2.40	2.02	2.49

Date	Time	katakhali	Amkhola	Badura
25/08/2016	6:00	2.4 (HTL)	2.10	2.50
	7:00	2.20	1.87	2.35
	8:00	1.70	1.50	2.13
	9:00	1.50	1.35	1.95
	10:00	1.40	1.00	1.85
	11:00	1.25	0.90	1.78
	12:00	1.20	0.88 (LTL)	1.67 (LTL)
	13:00	1.1 (LTL)	1.10	1.69
	14:00	1.30	1.60	1.80
	15:00	1.80	1.92	1.99
	16:00	2.15	2.05	2.15
	17:00	2.25 (HTL)	2.2 (HTL)	2.30
	18:00	2.25	2.12	2.38 (HTL)

Date	Time	katakhali	Amkhola	Badura
26/08/2016	6:00	2.25 (HTL)	2.22 (HTL)	2.30
	7:00	2.20	2.13	2.35 (HTL)
	8:00	2.15	1.82	2.25
	9:00	1.75	1.52	2.08
	10:00	1.40	1.28	1.89
	11:00	1.35	1.10	1.80
	12:00	1.30	0.92 (LTL)	1.69
	13:00	1.20	1.05	1.65
	14:00	1.15 (LTL)	1.16	1.6 (LTL)
	15:00	1.30	1.30	1.64
	16:00	1.55	1.75	1.80
	17:00	1.80	1.90	2.00
	18:00	2.00	2.10	2.10

Date	Time	katakhali	Amkhola	Badura
27/08/2016	6:00	1.60	2.2 (HTL)	2.07
	7:00	1.80	2.10	2.19
	8:00	2.15 (HTL)	2.10	2.25
	9:00	2.10	1.93	2.28 (HTL)
	10:00	2.00	1.75	2.10
	11:00	1.80	1.55	1.89
	12:00	1.60	1.20	1.78
	13:00	1.45	1.05	1.68
	14:00	1.25	0.9 (LTL)	1.63
	15:00	1.15 (LTL)	0.95	1.58
	16:00	1.25	1.15	1.55 (LTL)
	17:00	1.35	1.42	1.59
	18:00	1.80	1.68	1.82

Date	Time	katakhali	Amkhola	Badura
28/08/2016	6:00	1.35	1.70	1.80
	7:00	1.50	2.08	1.98
	8:00	1.80	2.25	2.20
	9:00	2.00	2.35 (HTL)	2.33
	10:00	2.3 (HTL)	2.23	2.45 (HTL)
	11:00	2.10	2.00	2.42
	12:00	1.85	1.70	2.18
	13:00	1.65	1.35	1.89
	14:00	1.45	1.10	1.75
	15:00	1.25	1.00	1.64
	16:00	1.10	0.85 (LTL)	1.55
	17:00	1.05 (LTL)	0.90	1.49
	18:00	1.20	1.15	1.45 (LTL)

Date	Time	katakhali	Amkhola	Badura
29/08/2016	6:00	0.95 (LTL)	1.45	1.4 (LTL)
	7:00	1.50	1.70	1.47
	8:00	2.00	1.85	1.98
	9:00	2.40	2.00	2.22
	10:00	2.50	2.08	2.40
	11:00	2.55 (HTL)	2.54 (HTL)	2.52
	12:00	2.40	2.22	2.58 (HTL)
	13:00	2.25	1.85	2.38
	14:00	1.85	1.40	2.10
	15:00	1.50	1.18	1.78
	16:00	1.35	0.95	1.65
	17:00	1.20	0.83	1.55
	18:00	1.10	0.65	1.50

Date	Time	katakhali	Amkhola	Badura
30/08/2016	6:00	1.00	0.75 (LTL)	1.44
	7:00	0.95 (LTL)	1.22	1.37 (LTL)
	8:00	1.50	1.80	1.66
	9:00	1.90	2.40	2.02
	10:00	2.40	2.55	2.30
	11:00	2.55 (HTL)	2.65 (HTL)	2.50
	12:00	2.50	2.60	2.65
	13:00	2.45	2.25	2.7 (HTL)
	14:00	2.00	1.60	2.40
	15:00	1.80	1.30	2.12
	16:00	1.60	1.00	1.85
	17:00	1.30	0.65	1.60
	18:00	1.10	0.60	1.50

Date	Time	katakhali	Amkhola	Badura
31/08/2016	6:00	1.10	0.95	1.60
	7:00	1.00	0.6 (LTL)	1.48
	8:00	0.95 (LTL)	1.35	1.38 (LTL)
	9:00	1.50	2.13	1.80
	10:00	2.30	2.50	2.13
	11:00	2.60	2.70	2.40
	12:00	2.70	2.8 (HTL)	2.58
	13:00	2.75 (HTL)	2.68	2.75 (HTL)
	14:00	2.55	2.20	2.73
	15:00	2.20	1.77	2.46
	16:00	1.75	1.24	2.17
	17:00	1.50	0.92	1.90
	18:00	1.15	0.68	1.68

Date	Time	katakhali	Amkhola	Badura
01/09/2016	6:00	1.20	0.75	1.70
	7:00	1.05	0.58 (LTL)	1.60
	8:00	1.00	0.85	1.5 (LTL)
	9:00	0.95 (LTL)	1.85	1.54
	10:00	1.80	2.45	1.95
	11:00	2.50	2.80	2.32
	12:00	2.75	2.95 (HTL)	2.55
	13:00	2.85 (HTL)	2.85	2.75
	14:00	2.75	2.50	2.88 (HTL)
	15:00	2.40	1.95	2.75
	16:00	2.00	1.45	2.45
	17:00	1.70	0.98	2.10
	18:00	1.40	0.75	1.85

Date	Time	katakhali	Amkhola	Badura
02/09/2016	6:00	1.30	0.90	1.80
	7:00	1.10	0.70	1.69
	8:00	1.00	0.55 (LTL)	1.60
	9:00	0.95 (LTL)	0.98	1.53 (LTL)
	10:00	1.00	2.15	1.85
	11:00	2.10	2.65	2.20
	12:00	2.70	2.80	2.50
	13:00	2.9 (HTL)	2.90	2.68
	14:00	2.85	2.95 (HTL)	2.83 (HTL)
	15:00	2.55	2.60	2.80
	16:00	2.15	2.15	2.55
	17:00	1.80	1.75	2.25
	18:00	1.50	1.25	1.95

Date	Time	katakhali	Amkhola	Badura
03/09/2016	6:00	1.38	0.98	1.88
	7:00	1.18	0.77	1.77
	8:00	1.08	0.62 (LTL)	1.68
	9:00	1.03 (LTL)	1.06	1.6 (LTL)
	10:00	1.08	2.23	1.90
	11:00	2.18	2.73	2.25
	12:00	2.78	2.88	2.55
	13:00	2.98 (HTL)	3.00	2.76
	14:00	2.93	3.07 (HTL)	2.9 (HTL)
	15:00	2.63	2.55	2.88
	16:00	2.23	2.20	2.63
	17:00	1.88	1.80	2.33
	18:00	1.58	1.20	2.00