Govt of Assam

Water Resources Department

Detailed Project Report

Name of the scheme:

Integrated Water Resources Management of Buridehing Basin (Vol-1)

ESTIMATED COST: RS. 7330473000

Submitted by:
Executive Engineer
Dibrugarh Water Resources Division

Dibrugarh Water Resources Division
Dibrugarh

JAN'2022

Contents

(Vol-1)

CHAPTER-I: FOREWORD

This DPR amounting to Rs. 733.0473 Cr **(SEVEN HUNDRED THIRTY THREE CRORES, FOUR LAKHS AND SEVENTY THREE THOUSANDS only)** has been prepared to show the cost of implementation of Buridehing basin project "Integrated Water Resources Management of Buridehing Basin". The project includes the flood and river bank erosion risk management work with structural intervention at selected priority reaches under Dibrugarh &Tinsukia Districts along the Buridehing River.

The Buridehing basin is situated in the North-Eastern part of Assam and lies between latitudes of 26°45′ North and 27°45′North and longitude 94°30′-96°45′ East. This basin is bounded by Dibru and Lohit basin on the north and the Desang on the west and hilly terrains of Burma on the south and east. The hilly terrains of the basin belong to Synphos range of Burma Border and Patkai ranges of Tirap District of Arunachal Pradesh.

The Buridehing basin forms one of the major sub-basins of the river Brahmaputra and it covers a catchment area of about 5447 Sq.Km, nearly 2.3% of Brahmaputra basin which exists within the periphery of the states of Assam and Arunachal Pradesh. Out of this total catchment area of 5447 Sq. Km the proportion of catchment area falling under the states of Assam and Arunachal Pradesh is 45:55 respectively.

The length of dyke system on both bank of river Buridehing is 219.24 Km (93.00Km LB + 126.24Km RB) and subsequently raising and strengthening was done in nineties. No major raising & strengthening work could be executed as per new design & specification due to lack of fund. Moreover, river Buridehing has meandering characteristics from foot hills to the outfall. The concave bends are chronically affected by erosion. The rate of erosion has become more severe at many concave reaches due to the formation of acute bend. From field observation it is observed that the erosion takes place during the flood season and the sloughing takes place during the draw down stage of the river. So, it was considered imperative to take up permanent anti-erosion measures to the existing embankment in the affected reaches.

The existing embankment system has been protecting a huge area of the river Buridehing basin from flood fury of river Buridehing since construction. But because of long wear & tear these embankment sections have become now inadequate to withstand the flood pressure. Therefore, raising and strengthening along with protection work at certain vulnerable reaches of the dyke in both banks is urgently necessary at present.

Provisions in under this flood & erosion risk management work of Buridehing basin are as follows

PART A : R/S works to Dehing bund right bank from Deochali hills to Sessamukh.
PART B: R/S works to Dehing bund left bank from Chippibasti to Joangaon.
PART C : Anti-erosion works at 51 most vulnerable reaches on both bank of Buridehing River.

The estimated cost comes out to be 850.214 Cr adopting the latest norms and rate. The phasing of the scheme is prepared on tentative basis and final phasing would be depending on the actual time of approval and implementation. However, for the present time, on realistic basis the work is targeted to be completed by 2024.

This is to be added that a Detailed Project Report amounting to Rs. 635.223 Cr was submitted earlier and was approved by different Directorates of CWC and was prepared for placing for getting techno- Economic Clearance.

However, this revised DPR was prepared for inclusion of additional length of anti-erosion work and increase in earthwork section to accommodate provision of paver block road. The memo of works with these provisions was present in the 82nd (Special) Meeting of State T.A.C. on dated 18th May'2021 and was recommended for onward submission. In the preparation of the project, the hydrology parameter & design specification are kept as per the earlier approval accorded by the Hydrology, B&CD, Gates and FM Dte. of CWC.

On completion of this project, an area of about 32800 Hectare of land comprising of cultivable as well as homestead and low lying land are expected to be benefited. Population of around 6,00,000 nos. would be benefitted & while the benefit cost ratio comes out as 2.28:1 which is found to be justified. The rates for the project have been adopted from APWD 2020-2021 (Rural Roads) & APWD 2018- 2019 (State Highway), WRD SR 2018-19 & WRD SR 2021-22(as per circular WR (ED) Tech/7728/2021/10 on Dt. 08/11/2021 & WR (ED) Tech/7728/2021/11 on Dt. 29/11/2021.

The Project will fit in with the overall structure of the Master plan for flood control pertaining to the River Basin prepared by the Brahmaputra Board. The flood and erosion protection measures to be taken up shall give positive results while providing a comprehensive and integrated approach to the flood and erosion management works Buridehing Basin. The scheme is considered technically feasible and economically viable and hence recommended for clearance.

Chief Engineer
Water Resources Department
Chandmari, Guwahati

CHAPTER 2: SALIENT FEATURES OF THE PROJECT

Salient Features for The Project

“Integrated Water Resources Management of Buridehing Basin”

SN	ITEMS	Remarks
1	Name of Work	**Integrated Water Resources Management Of Buridehing Basin**
2	Estimated cost & Price level	₹ Rs. 7330473000
3	Reference of State TAC clearance	*74th Meeting of T.A.C., dated 5th & 6th June/2018* *82nd (Special) Meeting of T.A.C., dated 18th May/2021*
4	Master Plan for the basin, fitment of the project and priority	*The Project will fit in with the overall structure of the Master plan for flood control pertaining to the River basin prepared by the Brahmaputra Board*
5	Name of State	Assam
6	Name of Districts	Dibrugarh & Tinsukia
7	Name of Basin/sub-basin	Buridehing
8	Name of rivers/tributaries	Buridehing and its tributaries namely Namchik, Namphuk, Tirap, Tipong, Namsang, Dirok, Tipling, Digboi, Tingrai, Disam & Sessa
9	Latitude & Longitude of the project	South-West Corner: 27°12'46.27"N, 94°41'9.62"E, North-East Corner: 27°26'39.59"N, 95°55'27.96"E
10	Nearest GD site & its latitude & longitude	Chenimari GDSQ site (94° 53' 4.000" E, 27° 18' 42.998" N)
11	Distance along with direction from nearby major district(HQ)/town	Dibrugarh: 12km Tinsukia: 17km
12	B.C. Ratio	2.28:1
13	Benefitted population in nos.	6,00,000 Nos (Approximately)
14	Benefitted area in ha	65,000 Hectare. (Approximately)
15	Details of proposed works along with reach length	Proposed works includes raising & strengthening of parts of existing embankments, Anti-erosion works with geo-bags apron & C.C. Blocks revetment at slopes and pro-siltation measures with porcupine screens at upstream and downstream of anti-erosion works, upgradation/restoration of existing sluice gates and installation of pavers block pavement.
	15.1) Flood Management Work **1) Earth work in Embankments**	**Propose upgradation/construction of Embankment with 6m crest width, 1.5m Free board over DHFL, Slopes of 2H:1V & 3H:1V at R/S & C/S respectively**

Sl. No	Code	Newly Proposed Embankments	Length
1	E-41	PROPOSED EMBANKMENT AT MAICHANG PATHAR	8.50km
2	E-40	EXTENSION OF T/DYKE ALONG THE L/B OF BURIDEHING RIVER FROM CHIPPIBASTI TO MOLONG GAON	2.10km
Sub-Total (New Embankment)			**10.60km**
Left Bank Embankments			

		3	E-39	T/DYKE ALONG THE L/B OF BURIDEHING RIVER FROM CHIPPIBASTI TO MOLONG GAON	2.70km
		4	E-31	T/DYKE ALONG THE L/B OF BURIDEHING RIVER FROM JOYPUR TO NAHARKATIA	7.20km
		5	E-17	EXTENSION OF SASSONI TINGKHONG BUND PH-II	5.50km
		6	E-16	EXTENSION OF SASSONI TINGKHONG BUND PH-I	12.00km
		7	E-22	TIE-BUND OF GELA DESAM	7.20km
		8	E-19	DEHING BUND 1ST SECTION FROM AGHUNIBARI TO SESSUGHAT (UNDER DIBRUGARH WEST WR SUB-DIVN)	25.20km
		9	E-12	DEHING BUND 1ST SECTION FROM AGHUNIBARI TO SESSUGHAT(UNDER DIBRUGARH EAST WR SUB-DIVN)	9.10km
		10	E-11	DEHING BUND OLD A.T. ROAD FROM SESSUGHAT TO JAGUNGAON	5.10km
		Sub-Total (R/S left bank)			**74.00 km**
		Right Bank Embankments			
		11	E-29	CONSTRUCTION OF AN EMBANKMENT ALONG THE R/B OF BURIDEHING RIVER FROM DEOCHALI HILL TO TIPLING GHAT PH-I (FAKIAL GRAZING)	8.25km
		12	E-30	CONSTRUCTION OF AN EMBANKMENT ALONG THE R/B OF BURIDEHING RIVER FROM DEOCHALI HILL TO TIPLING GHAT PH-II (FAKIAL GRAZING)	11.33km
		13	E-26	CONSTRUCTION OF T/DYKE ALONG THE R/B OF BURIDEHING RIVER FROM DEOCHALI TO TIPLING GHAT FROM NOWJAN TO RLY LINE - PH-III	1.50km
		14	E-25	TRIBUTARY DYKE FROM BHEKULAJAN TO TIPLING	13.30km
		15	E-14	EXTENSION OF TENGAKHAT BUND UPTO JOKAI R.F.	20.20km

		16	E-15	EXTENSION OF TENGAKHAT BUND FROM JOKAI R.F. TO A.T. ROAD	13.50km
		17	E-09	DEHING MARGINAL BUND FROM KOTOHA TO BHOGAMUR	8.40km
		18	E-10	EXTENSION OF DEHING BUND FROM BHOGAMUR TO SESSAMUKH	4.50km
		Sub-Total (R/S Right Bank)			**80.98 km**
		Tributary Embankments			
		13	E-28	CONSTRUCTION OF AN EMBANKMENT ALONG THE L/B OF TIPLING RIVER	4.00km
		14	E-27	CONSTRUCTION OF AN EMBANKMENT ALONG THE TIPLING BRIDGE TO TIPLING T.E.	3.80km
		17	E-24	TINGRAI L/B DYKE FROM BALIJAN TO TINGRAIMUKH	4.70km
		18	E-23	RECLAIMATION OF LOW-LYING AREA NEAR TINGRAIMUKH IN KHEREMIA MOUZA (R/B OF AMILGURI T.E. TO TINGRAIMUKH)	5.40km
		Sub-Total (Tributories)			**17.90km**
		Total length for earthwork in embankment			***183.48km***
	15.2 Sluice gates	**SLUICE GATES**			

1. Repairing/reconstruction of sluice gates (39 sluice gates).

a. Repairing works for 26 sluice gates.
b. Entire reconstruction for 13 nos. of sluice gates.

Sl. No	Sluice No.	Remarks
1	**E-09/1**	Damaged, to be newly constructed
2	**E-09/2**	
3	E-16/2	
4	E-24/4	
5	**E-27/2**	
6	**E-27/3**	
7	**E-27/4**	
8	**E-28/1**	
9	**E-12/1**	
10	**E-12/2**	
11	**E-12/3**	
12	E-16/1	
13	E-16/3	

14	E-15/4		
15	E-16/4		
16	E-13/2		
17	E-13/3		
18	E-23/1		
19	E-23/2		
20	E-24/1		
21	E-24/2		
22	E-24/3		
23	E-25/3		
24	E-13/1		
25	E-14/1		
26	E-14/4		
27	E-14/5		
28	E-15/3		
29	E-16/5		
30	E-25/1		
31	E-25/2		
32	E-14/3		
33	E-15/2		
34	E-15/1		
35	E-27/1		
36	E-14/2		
37	E-25/4		
38	E-25/5		
39	E-19/1		

Specification of existing structures are found to be adequate as per Design.
These Sluice gates are in working Condition, however Barrel length to be extended due to proposed widening of embankment as per new specifications by restructuring country side of structure.
Protection works are mostly detoriated and hence proposed to be completely rebuilt as per design specifications

15.3) Anti-erosion works

Proposed Anti-erosion works with Type-A G-bags in apron for a width of 16.5m & thickness of 0.60m, Bank pitching with cubical CC Blocks of size 0.3m

Sl. No.	Reach	Reach Length (m)
AE-1	MANMOW PATHAR	800
AE-2	MOULANG GAON	1000
AE-3	BORFAKIAL-A	600
AE-4	BORFAKIAL-B	1000
AE-5	BANSBARI	1000
AE-6	TANTIPATHAR MANIPURI BASTI A	300
AE-7	TANTIPATHAR MANIPURI BASTI B	200
AE-8	NOCTE GAON	700
AE-9	KONWARGAON A	600
AE-10	KONWARGAON B	500
AE-11	UTTAMMATI	650
AE-12	BAMUNGAON-1	280
AE-13	BAMUNGAON-2	340
AE-14	JAGUNGAON	600
AE-15	NAGAON 1	220
AE-16	NAGAON 2	595
AE-17	BORDOLOICHUK	700
AE-18	MOHMARI	500

		AE-19	AMGURI	700
		AE-20	PANCHUTI	650
		AE-21	TINGRAI NEPALIGAON A	450
		AE-22	TINGRAI NEPALIGAON B	90
		AE-23	TINGRAI NEPALIGAON C	410
		AE-24	KAIBARTAGAON	400
		AE-25	URIAMGURI	700
		AE-26	BAMUNIBEEL	300
		AE-27	KOLAGORA	400
		AE-28	SESSA NEPALI	600
		AE-29	DEHINGHOLLA	1000
		AE-30	AGHUNIBARI	300
		AE-31	SOLOGURI	500
		AE-32	TELPANI BONGAON	500
		AE-33	KORAIGURI	500
		AE-34	SINGIMARI	500
		AE-35	BHURBHURI-1	2150
		AE-36	BHURBHURI-2	515
		AE-37	BORBEEL A	525
		AE-38	BORBEEL B	400
		AE-39	CHARAIHABI KHAMTIGHAT	880
		AE-40	KOLOLUA DEORI GAON	1125
		AE-41	NATUNBOLAI	600
		AE-42	KOTOHA	675
		AE-43	BHOGAMUR A	600
		AE-44	BHOGAMUR B	300
		AE-45	PANIMIRI	450
		AE-46	JHANJIMUKH GAON	500
		AE-47	SESSUGHAT A	300
		AE-48	SESSUGHAT B	300
		AE-49	CHARAIBAHI	500
		AE-50	ITAKHULI	700
		AE-51	THANGAON	700
		Total reach length for Anti-erosion works		***29805m***
	15.4) PSC PORCUPINES SCREENS	**Proposed porcupine screens @ 60m intervals at U/S & D/S of proposed anti-erosion reaches. 6Nos of double layered screens at both U/S & D/S. Reach length for each protection reach.**		
	Part B: Road Component	**Providing interlocking concrete block pavement for 139.44 Km with a carriageway width of 4.00m.**		
16	Design	For this project, design discharge has been adopted as 2,994 cumecs for 50 years return period as provided by the Hydrology (NE) Directorate of CWC for the Chenimari G&D site. The different discharges at different reaches of the river are computed using the Dicken's formula		

		Mathematical modelling in HEC-RAS as per CWC guidelines had been conducted for the Buridehing River to compute the hydraulic parameters at the different worksites. For the CWC site of Chenimari the design HFL has been calculated analytically as 104.80m whereas from Mathematical modelling approach it has been found to be 104.88m. The Design H.F.L. of the river considered for design of the embankments have been considered from the flood profiling data obtained from mathematical modelling. The design of revetment and launching apron is as per IS code 8408:1994(Revised) and IS code 14262:1995. Sluice gates are designed considering hydrological parameters as per IS: 8835-1978.

Executive Engineer
Dibrugarh WR Division
Dibrugarh

CHAPTER 3: EXECUTIVE SUMMARY

3.1 INTRODUCTION:

This Detailed Project Report amounting to RS. 733.0473 Cr (Seven Hundred Thirty Three Crores, Four Lakhs and Seventy Three Thousands only) has been prepared to show the cost of raising and strengthening of Dehing embankments on both bank of Buridehing river at different reaches in Buridehing basin area including anti-erosion works at vulnerable locations under the nomenclature "Integrated water resources management of river Buridehing".

The Buridehing basin is situated in the North-Eastern part of Assam and lies between latitudes of 26°45′ North and 27°45′North and longitude 94°30′-96°45′ East. This basin is bounded by Dibru and Lohit basin on the north and the Desang on the west and hilly terrains of Burma on the south and east. The hilly terrains of the basin belong to Synphos range of Burma Border and Patkai ranges of Tirap District of Arunachal Pradesh.

The Buridehing basin forms one of the major sub-basins of the river Brahmaputra and it covers a catchment area of about 5447 Sq.Km, nearly 2.30% of Brahmaputra basin which exists within the periphery of the states of Assam and Arunachal Pradesh. Out of this total catchment area of 5447 Sq.Km the proportion of catchment area falling under the states of Assam and Arunachal Pradesh is 45:55 respectively.

The river Buridehing is one of the major tributaries of river Brahmaputra that originates from the hill ranges of Patkai in Arunachal Pradesh. It finally outfalls at the Brahmaputra at about 32 Km downstream of Dibrugarh town. The outfall is known as Dehingmukh. The total length of the river is 360 Km including that of the river Namchuk.

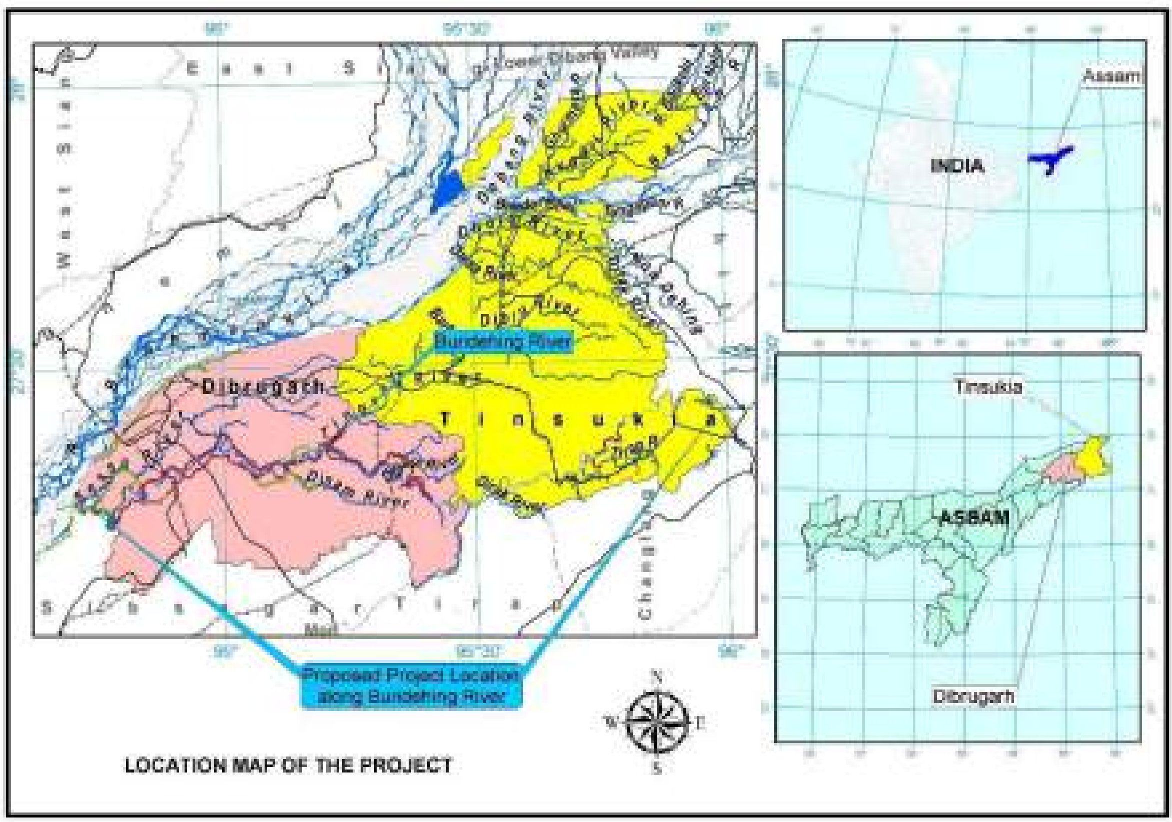
Almost the entire basin of the river Buridehing comprises of fertile land. It is suitable for all types of cultivation including tea. Besides these fertile lands of high agricultural productivity and intensity, the basin also contains tertiary rocks in its geomorphic structure suitable for occurrence of Natural Oil and Gases. The flood problem of the river Buridehing affects significantly the economic and social life of the inhabitants of this basin. Since early fifties the entire area of Buridehing basin is chronically flood affected due to inundation caused by bank spilling and bank erosion during flood season. Moreover, these areas fall under high intensive rainfall and therefore the surface runoff over catchment area is large enough to contribute large volume of discharge in the river.

3.2 LOCATION OF THE PROJECT

Satellite image of River Buridehing

The river Buridehing originates from a tributary called Namphuk from the hilly terrain of Patkai ranges in the Arunachal Pradesh. The channel Namphuk after traversing for a couple of kilometer over the hilly track in a westerly direction combines with another activated channel called Namchik. The river Noadehing which also originates from the Patkai ranges in the Arunachal Pradesh flows in the westerly direction in the hilly regions until it bifurcated into two distinct channels near Miao. The northern channel is known as Noadehing and the Southern Channel is known as Khoikee and then Maganton. This channel after traversing a few kilometers in the westerly direction joins Namphuk Namchik channel and from this confluence point the channel is known as Buridehing river. After traversing about 75Km, another tributary Tirap joins the Buridehing river just upstream of Ledo on the left bank.

The Buridehing river starts meandering acutely below Margharita towards its downstream to its confluence and there are three major loops towards the left bank and similar nos. of such bends towards the right bank. After travelling through the plain areas of Tinisukia, Dibrugarh and Sivasagar Districts, it outfalls at river Brahmaputra at Dehingmukh about 32Km down stream of Dibrugarh Town. The total length of the river is 360Km including the length of Namphuk which is considered to be the origin of Buridehing river.



Project location map

On the basis of topography, river gradient and the confluence/bifurcations of tributaries, the entire length of river Buridehing may be divided into three major reaches. These reaches are :

i) The reaches from the source of Namphuk in Arunachal Pradesh to joining point of flood plains at interstate border of Assam and Arunachal Pradesh which has a steep gradient of about 1 in 85.

ii) The reach within the flood plains of Assam from the interstate border to Jeypore with a gradient of about 1 in 2600. This reach can be further sub-divided into two parts as follows

   a) The first part of reach from the interstate border to about 46km downstream upto Dehing-Patkai Wildlife Sanctuary where the soil characteristics is of alluvial nature. Here the river tends to meander, thereby causing erosion at several concave bends. Most of the banks are high and bank spillage during high stages is insignificant except for a few reaches. In this stretch of the river, the locations proposed for various works are Manmow Pathar, Moulang, Borfakial, Bansbari & Maichang Pathar which are thickly populated, besides the area being highly industrialized with tea-estates and coal mines.

   b) The second part of reach from Dehing Patkai Wild life Sanctuary to Jeypore where the soil characteristics is of rocky nature. In this reach the river has been observed to be very stable and no works have been proposed.

iii) The reach from Jeypore to the out fall at Buridehing into river Brahmaputra with an average gradient of about 1 in 6000.

Here the river flows through alluvial soil and severe meandering has been observed since the past decades from satellite imageries. Most of the banks at this stretch of river are overtopped by flood water during high stage and thus both the banks of the river in this stretch are fortified with embankments for flood protection to the adjacent areas. The river is very problematic here due to the meandering tendency, which causes severe erosion and eventually erodes away parts of embankments. Most of the project sites are located in this stretch which includes up gradation of the embankment system and bank stabilization of erosion prone reach at locations with high significance of population, industries, agricultural land and tea-estates, oil mining areas etc. Important areas like Naharkatia, Duliajan, Jagun, Tengakhat, Sassoni, Khowang etc are located within this stretch of the river.

3.3 Problems

The river system of Buridehing originates and initially traverse through the hilly terrain of geologically wound mountain ranges which predominantly consists of origillatous sand stones with thick forest cover. The catchment area also experiences heavy shower during monsoon (ranging from 2000mm to 4000mm) and located at seismically most unstable zone. Heavy shower lashing on the steep hill slopes causes a great deal of soil erosion. The eroded soils along with the debris of landslides pour into the river during rains when the river carries not only the enormous discharge but also the excessive silt loads. Under these circumstances, the river tries to build steeper bed slope resulting in widening of the river bed and braiding of the channel. The widening of the subsequently erodes its banks. This process of bank erosion has been going on for a long time and still continues in the basin of river Buridehing.

Of the total length of 360 Km of the Buridehing river, 160 Km falls in the hilly region of Arunachal Pradesh and the rest in the plain zone of Assam. In the hilly areas, there is no such problem of flood inundation, bank erosion and drainage congestion etc. The 200 kms stretch of the river which lies in the floodplains of Assam faces problems of erosions and overflowing of riverbanks at different reaches.

3.3.1 FLOODING

Since time immemorial, the floods have been responsible for loss of crops, property and causing human misery in different basin of Assam and the Buridehing basin is no exception. The earliest great floods in the basin occurred in 1946 as a result of heavy rainfall. Subsequently, heavy floods were recorded in the year 1954, necessitating construction of embankment.

Occurrence of flood/ flood havoc in Buridehing river became a natural phenomenon particularly after great earthquake of 1950. Prior to 1950, except for flooding along its course, there was hardly any flood problem in the basin due to spilling. The earthquake of 1950 has completely disturbed the regime of the river and as a result of which the basin experiences devastating flood almost every year incurring losses of human life, livestock, crops and public and private properties worth of crores of rupees.

The earthquake of 1950 completely disturbed the regime of the river and as a result experienced flood devastation every year incurring losses to human life, livestock, crops and public and private properties worth crores of rupees.

Moreover, due to natural wear and tear of the embankment section and lack of major raising and strengthening works to these embankment sections, they are in dilapidated condition. The embankment section has been reduced to a great extent and few sections are critically vulnerable for breach. Considerable lengths of the embankment are experiencing the overtopping during high stage of flood and make it very vulnerable for probable breach.

During flood of 2007, one breach occurred at 13th Km of the right bank dyke “Extension of Tengakhat bund from Bhogamur to Sessamukh” near Thangaon (Ch 12900M to Ch 12955M), due to overtopping on 1/08/07.

Similarly, during the flood of 2010, 2014, the embankment system of Buridehing both bank were critically vulnerable for breach by overtopping at Bamunibeel, Uriumguri, Than Gaon, Panimiri, Kotoha, Bhogamur, Aghunibari, Sessughatetc along the both bank of Buridehing river. Most of the dyke section on the both bank of river Buridehing are in dilapidated and in reduced section and are most vulnerable for probable breach, Therefore, raising and strengthening of the Dehing bund on both bank of Buridehing considering the entire Buridehing basis is urgently required to protect the vast areas along the river.

However, during flood of 2015, the flood level of river Buridehing crossed all the previous record (fig.-3.1) by reaching the highest recorded level of 104.15M on 2nd September 2015 at Chenimai gauge site crossing the previously recorded highest Flood Level of 103.93M in 25th August 1988.

As a result, during the high stage of flood of August and September 2015, the condition of the Buridehing embankment was very critical at almost entire reaches due to their inadequate sections and crest height and were most vulnerable to withstand this increased water level. In most of the areas the flood level reached up to the crest of the embankments and were almost overtopped, however, due to the round the clock emergency works executed by the WR Department by way of construction of dowel bund etc. the situation was saved from any eventualities. The over topping was prevented by construction of dowel bund with earth filled cement bags constructed along the critical reaches with all round the clock vigilance. Along entire embankment reaches seepage, boiling, leakages took places which were prevented by construction of pressure well by cement bags, bamboo palisading, cement bag pitching. Therefore, considering the critical situations and the existing structural condition of the dyke, it is felt that there is an urgent need for taking permanent solution to flood problem at the Buridehing basin and therefore, the existing embankment system on both bank of Buridehing river which has been affectively preventing flood overspill since its construction in last 1966's, are to be upgraded to present design requirement and specification. This memo includes provision for upgradation of the existing dyke which has been proposed after detail survey and analysis, and studying its historical tendencies, migrations etc.

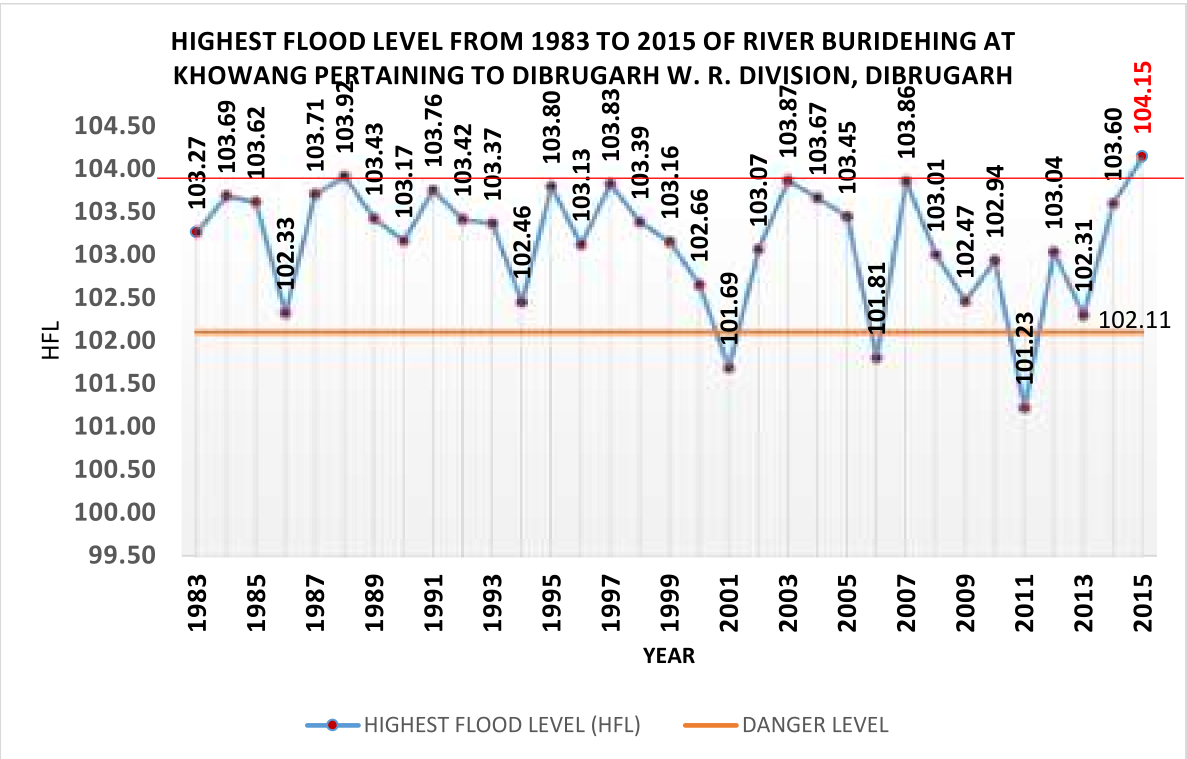


Fig.-3.1

Moreover, the embankment system also serves as the heart-line of surface communication to these highly-developed areas of agricultural activity. Any breach of embankment would create flood devastation and disaster to large areas of the Tingkhong, Moran, Tengakhat & Naharkatia Revenue Circles under Dibrugarh District. Many Prosperous villages like *Thangaon, Bordoibam, Majgaon, Moinamirigaon, Dighaliagaon, Chakoipather, Gohaigaon, Itakhuligaon, RongagoraMishinggaon, Bharatchukgaon, Panimirigaon, Jajimukhgaon, Kolakhowa, Bhabanigaon, Gojaigaon, KolakhowaCharialigaon, Bam Kolakhowa, Charaihabigaonetc.*of these flood prone areas such as will be affected if breaches occurs at the dyke "Extension of Tengakhat band from*Bhogamur to Sessamukh*". *The villages like Kutuha, Bhogamur, Baligaon, KotuhaBarbeel, KutuhaHalmari, Naojan, Baruahgaon, Panigaon, Rongagoraetc are protected by the "Extension of Tengakhat Bund from* Kutuha to Bhogamur*". Dalnikur, Goroimari, Barbeel, Mainamirigaon, Haldhibarichetiagaon, Joangaonetc are benefited by the "Extension of*

Tengakhat bund fronAgunibari to Sessughat". Many villages like Namphakial, Tingraigaon, Tingrai Nepali gaon,Kolagora, Bantona, Pandhuwaghat, Bamunibeel, Uriumguri, Kolagora, NatunBharali, NatunBolai, HologuriDeurigaon, Hingari, Thangaon, Bhogmur, ,etc situated at different reaches along both bank of Buridehing are benefited by the existing dyke system.

Therefore, to tackle the problem of flooding due to over topping of the Dehing bund along on the both bank of river Buridehing, upgradation of the dyke by raising and strengthening works are urgently to be carried out at the most vulnerable locations. Almost entire length of the Dehing bund which is in dilapidated condition requires immediate upgradation and the provision are made in this Detailed Project Report.

The following photographs illustrates the severity of its vulnerability and critical condition of the dyke.

Photographs-1, Overtopping and damaged section of dyke

Overtopping and seepage, boiling leakage etc.

Overtopping of Dyke of Buridehing river


Overtopping and seepage, boiling, leakage etc.




Overtopping of the dyke


Damages due to sudden slump down of dyke structure die to seepage, leakage etc.

3.3.2 BANK EROSION

The migration of the river Buridehing i.e. by comparing of satellite imageries of 1954, 1977 and 2015 have shown that the river had been migrating considerably at both its banks

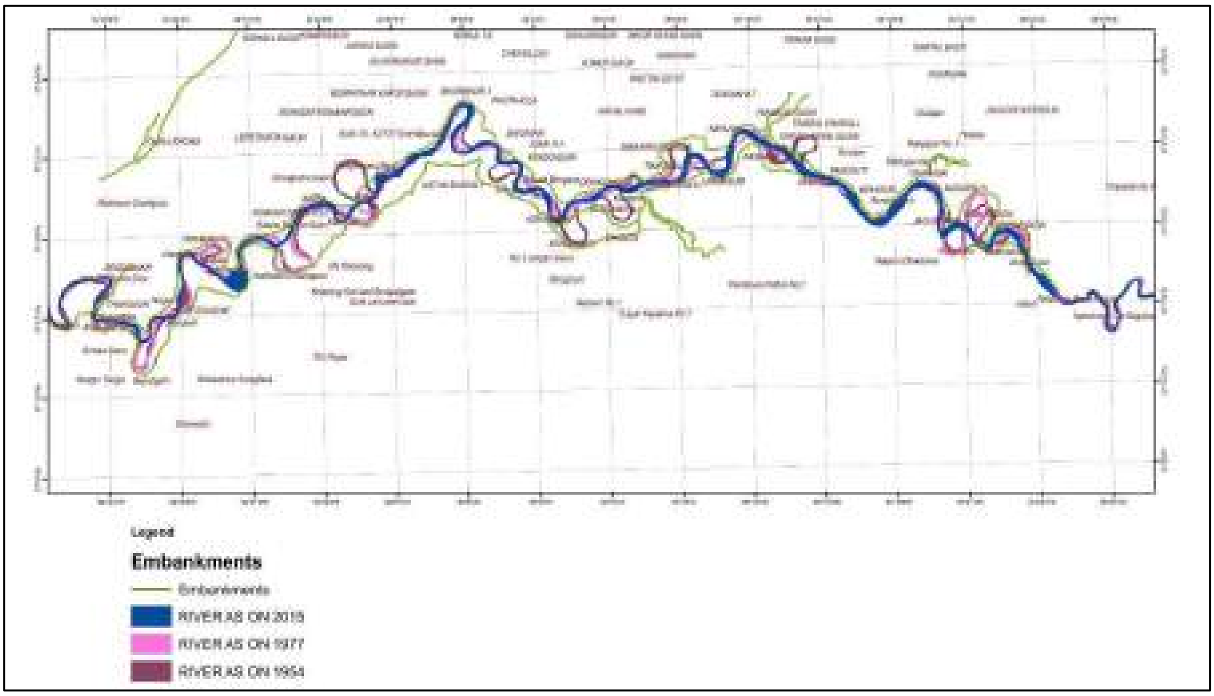


Fig-3, Map showing the migration of river in 1954, 1977 and 2015 derived from past satellite imageries.

The shift of the river from the center line of the river as in 1954 has also been calculated which shows the magnitude of erosion problem

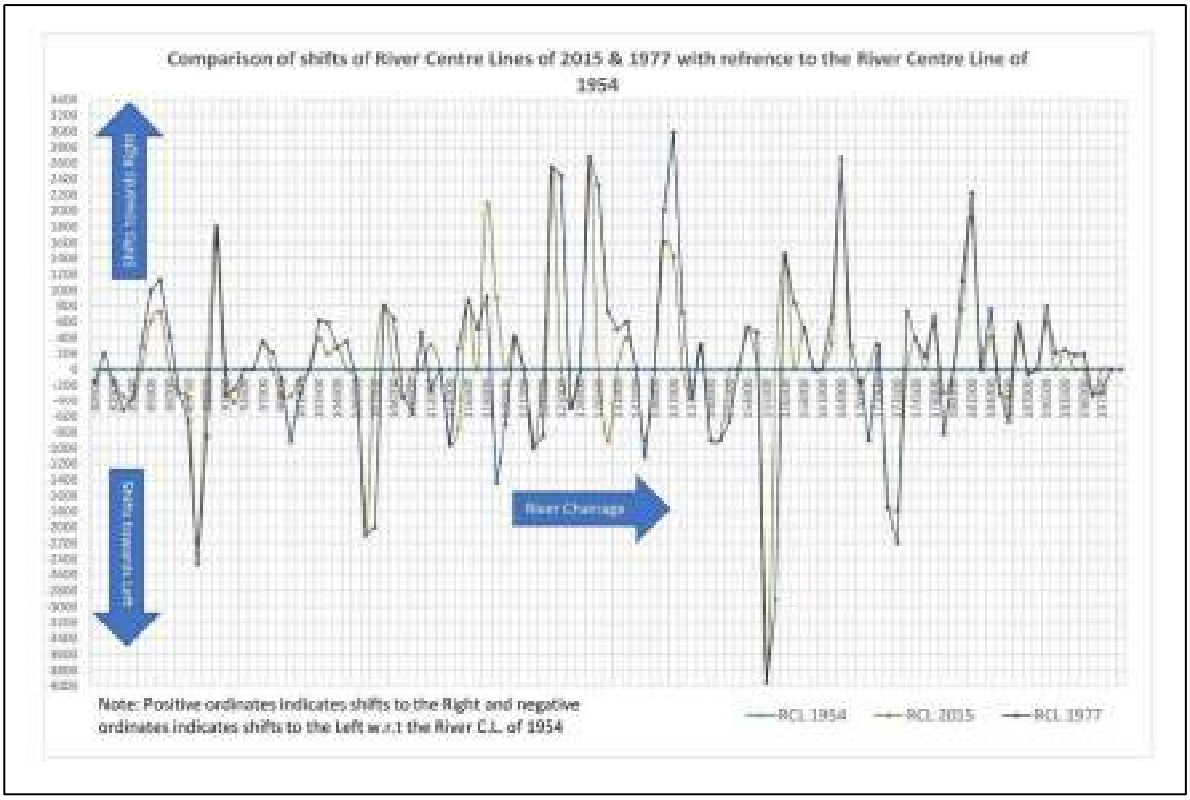


Diagram showing the shift of river from center line as in 1954 to that of 1977 and 2015

As already explained above that the Buridehing river is a meandering river. Moreover, there exists several locations where the meandering bend of the river Buridehing have reached up to of the embankment which are to be protected with necessary anti erosion works. Accordingly, the anti-erosion work at most vulnerable locations are also incorporated at this Detailed Project Report.

The land of this area is highly fertile for any agricultural activity. The socio-economic activity of this area mostly revolves round the Land. The ongoing bank erosion has already engulfed huge chunks of valuable agricultural land and homestead land. The alarming rate of bank erosion towards the embankment has led to the apprehension about the breach of embankment. A breach of embankment in these reaches will create untold miseries to the people and will cause huge loss of life and property in these areas.

The bank erosion of river Buridehing is active particularly during flood period at many reaches on bank of the river. At some reaches, the erosion is very severe, especially on its concave bend of the meanders and is fast approaching towards the embankments at an alarming rate threatening the dyke from probable breach. Severe erosion continued at the concave bend of the river at Moulonggaon, Basbari, TatipatherManipuribasti,Noctegaon, Konwergaon, Bamungaon, Jagungaon, Nagaon, Boedoloichuk, Mohmari, PanchutiTingraigaon, Tingrai Nepali gaon, Amguri, Kaibortagaon, Uriumguri, Bamunibeel, Kolagora, SessaNepaligaon, Dehingholla, Aghunibari, Sologuri, Tenpanibongaon, Kordoiguri, Singimari, Bhurbhuri-I, Bhurbhuri-II, Borbeel, Natunbolai, Kololowa, Kotoha, HaldhibariChetiagaon, Baligaon, Joangaon, Panigaon, Rongagora on the both bank of river Buridehing. The bare minimum side berm available at these reaches making these affected reaches and at few locations like Jagungaon, Konwergaon, Bamuninbeel, Bhogamur, Kotoha etc, the erosion has already eaten away the half of the embankment making these locations very vulnerable for breach of embankment and subsequent flood devastation.

The following photographs illustrates the severity of its vulnerability and critical condition of the dyke.

Photographs-2, Showing bank erosion along Buridehing river

Kowargaon

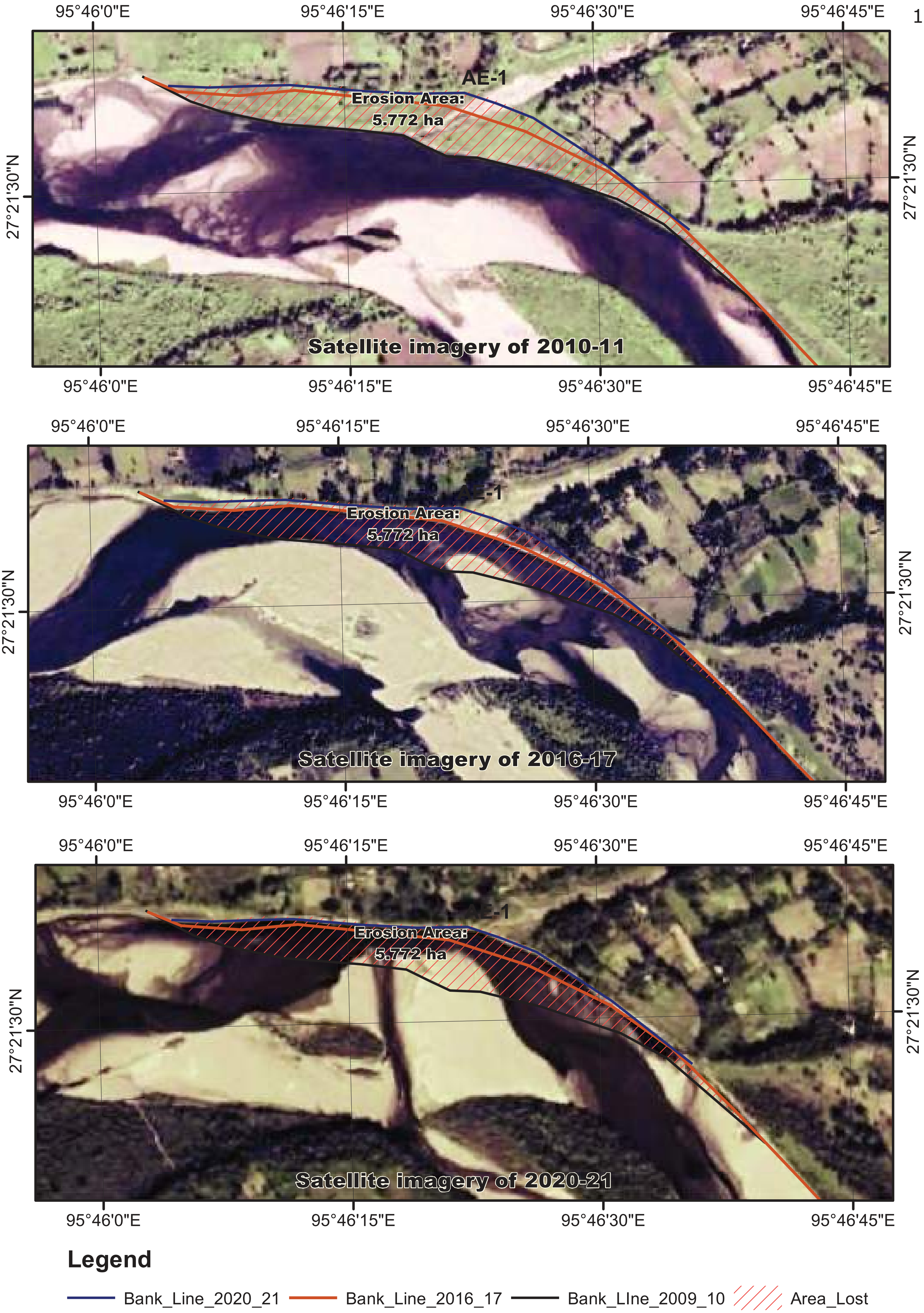
Sessughat

Jhanjigaon Jagungaon

3.3.3 Summary of Right Bank: For the first 17km of the river along the right bank within the flood plains of Assam, there isn't any significant flooding of its banks due to the high banks. However from about 17th km to about 8.5km downstream at Manmow Pathar to Maichang Pathar area, due to the relatively lower bank level, flooding of the area occurs during high spate of flow due to the absence of any embankment. Further downstream upto Deochali Hills at about 79km from Assam-Arunachal Pradesh border, with the exception of a few erosion reaches at the concave bends of the river, there are not any significant flooding or erosion problems. The right bank of the river from Deochali Hills to its outfall at Brahmaputra river is completely fortified with embankments to prevent flooding of the areas which mostly comprises of thickly populated villages, towns, agricultural areas, tea estates and oil exploration industries, however most of the embankments are in poor shape due to its deterioration by age and non-maintenance and several stretches of the embankment are overtopped by flood water during high stages. Also most of the concave bends of the river lying within the stretch of Deochali Hills to its outfall are severely affected by erosion which in turn is causing a threat to the existence of the embankments.

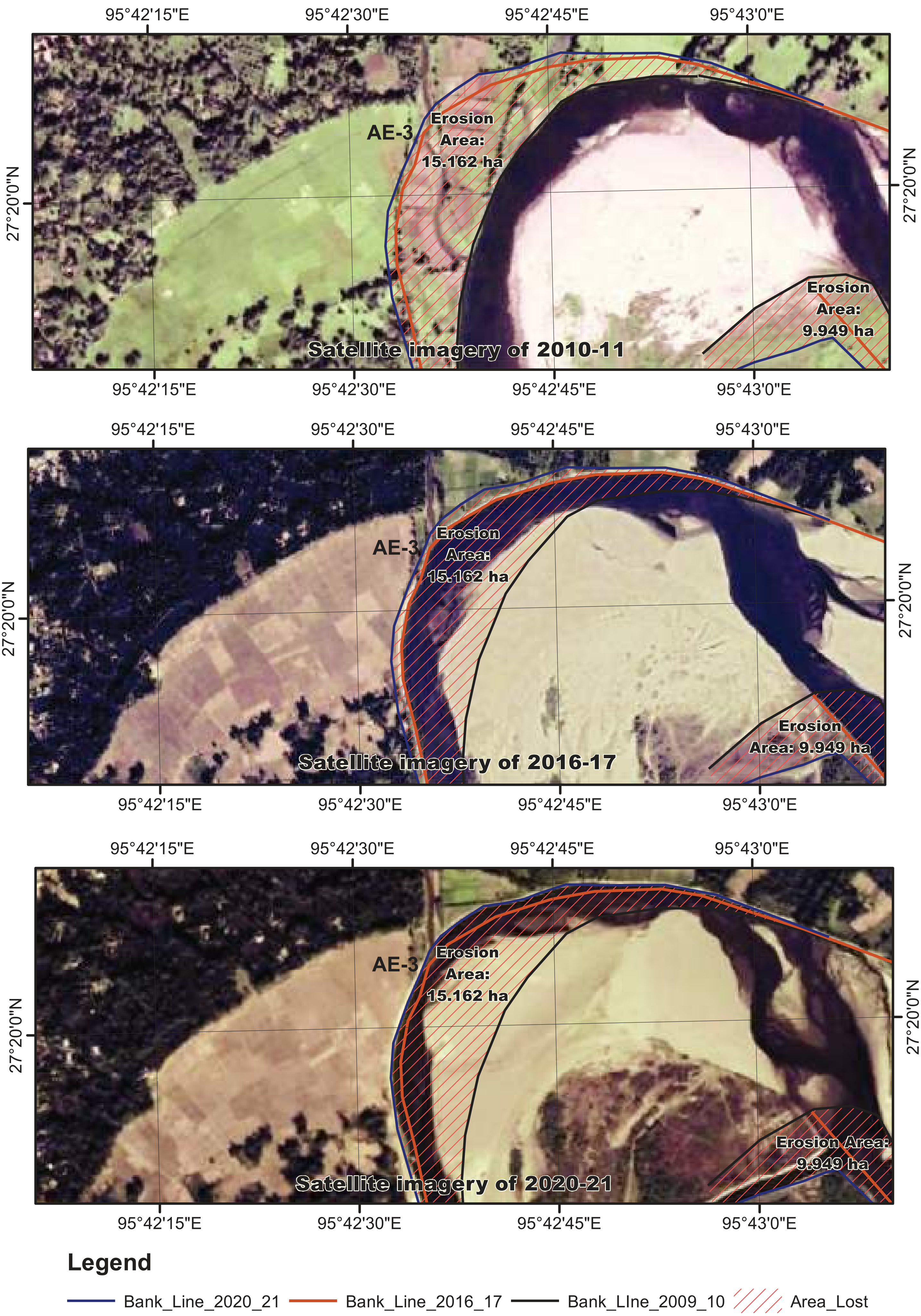
3.3.4 Summary of Left Bank: The left bank of the River Buridehing within the floodplains of Assam from the interstate border of Assam-Arunachal Pradesh to Joypur area at about 80km downstream is mostly highland except for the reach at Moulang near Ledo, where bank is relatively low and flooding occurs during high stage of the river as the originally constructed embankment at Moulang is also non-existent as it had been eroded by the river. Eventhough most of the concave bends of the river shows signs of erosion, significant erosion has been occurring at a few reaches like Moulang & Bansbari within the first 80km stretch of the river upto Joypur. Further downstream from Joypur to its outfall at Brahmaputra, the left bank of the river is mostly of lower height causing banks spillage during high stages and embankments has already been constructed along all the affected reaches comprising of thickly populated areas and productive agricultural land, however the embankments are in a bad shape due to deterioration by ages and non-maintenance. Several stretches of these embankments are also overtopped by the flood water during high stages. Also most of the concave bends of the river along the left bank from downstream of Joypur to its outfall has been affected by erosions and at several locations the existing embankments are now vulnerable to been washed off due to erosion

3.3.5 Satellite imageries of past years showing erosions of prominent reaches are on the continuing pages



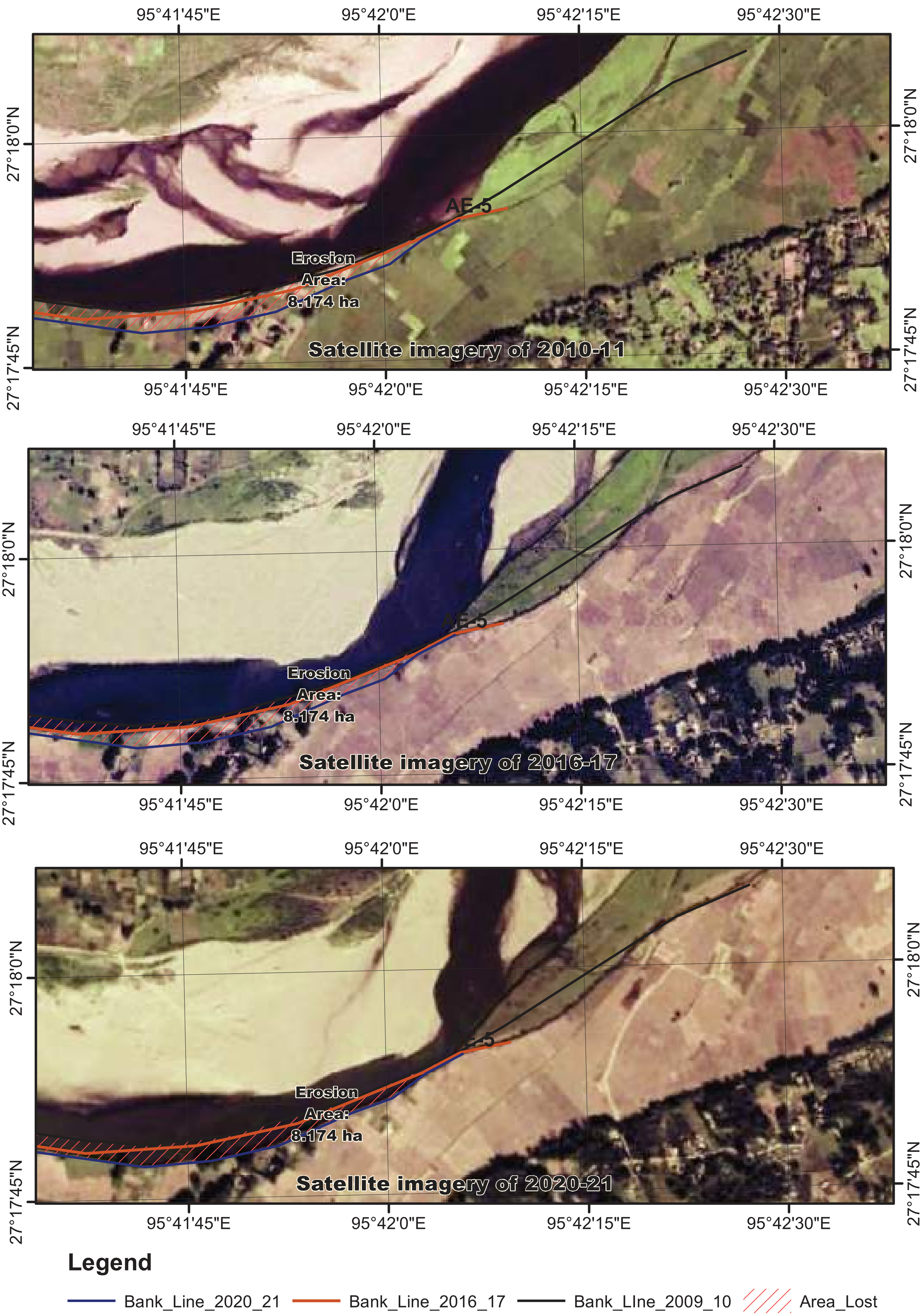
Satellite Imageries of Site AE-1 showing erosion since past years

Satellite Imageries of Site AE-2 showing erosion since past years



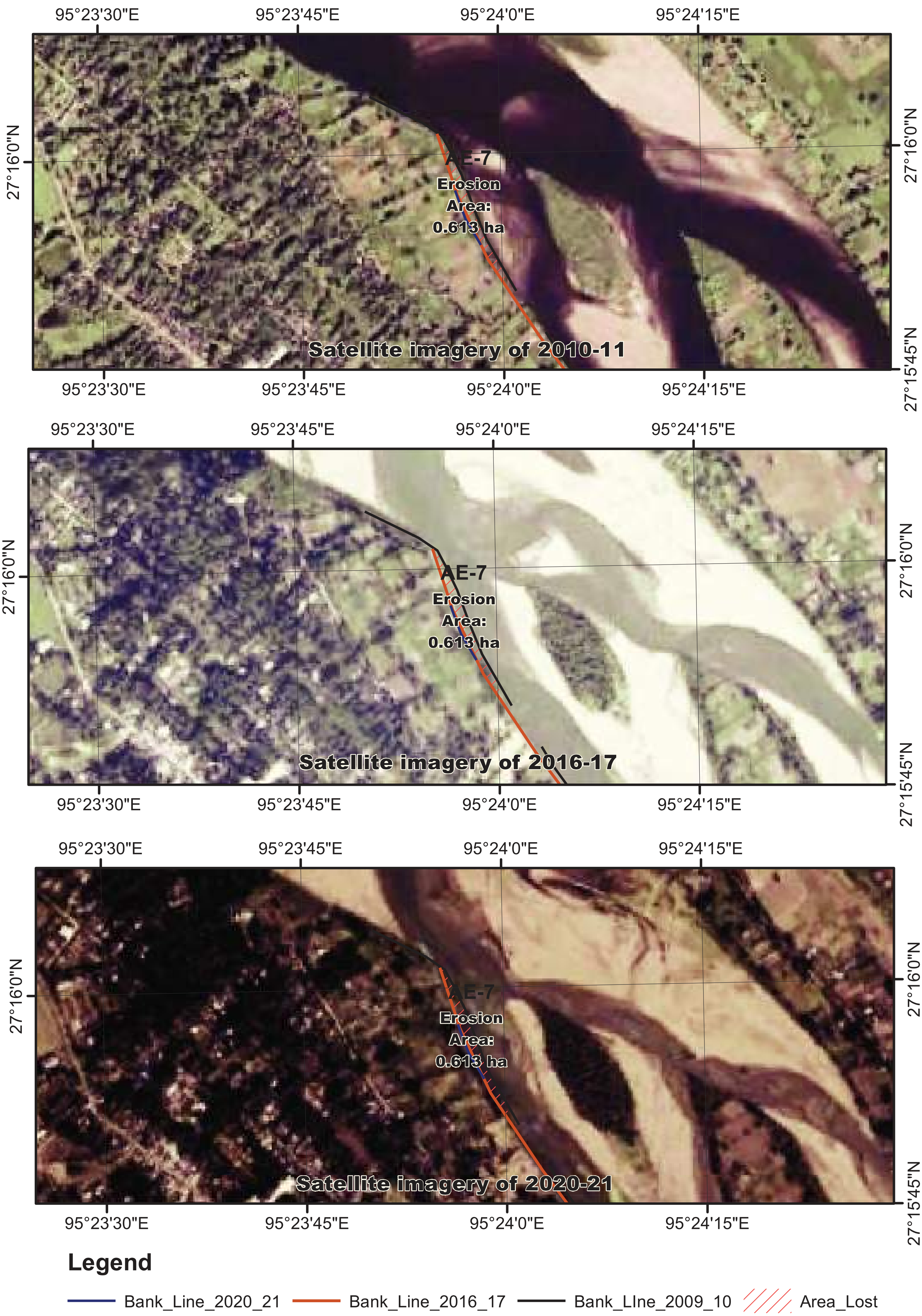
Satellite Imageries of Site AE-3 showing erosion since past years

Satellite Imageries of Site AE-4 showing erosion since past years

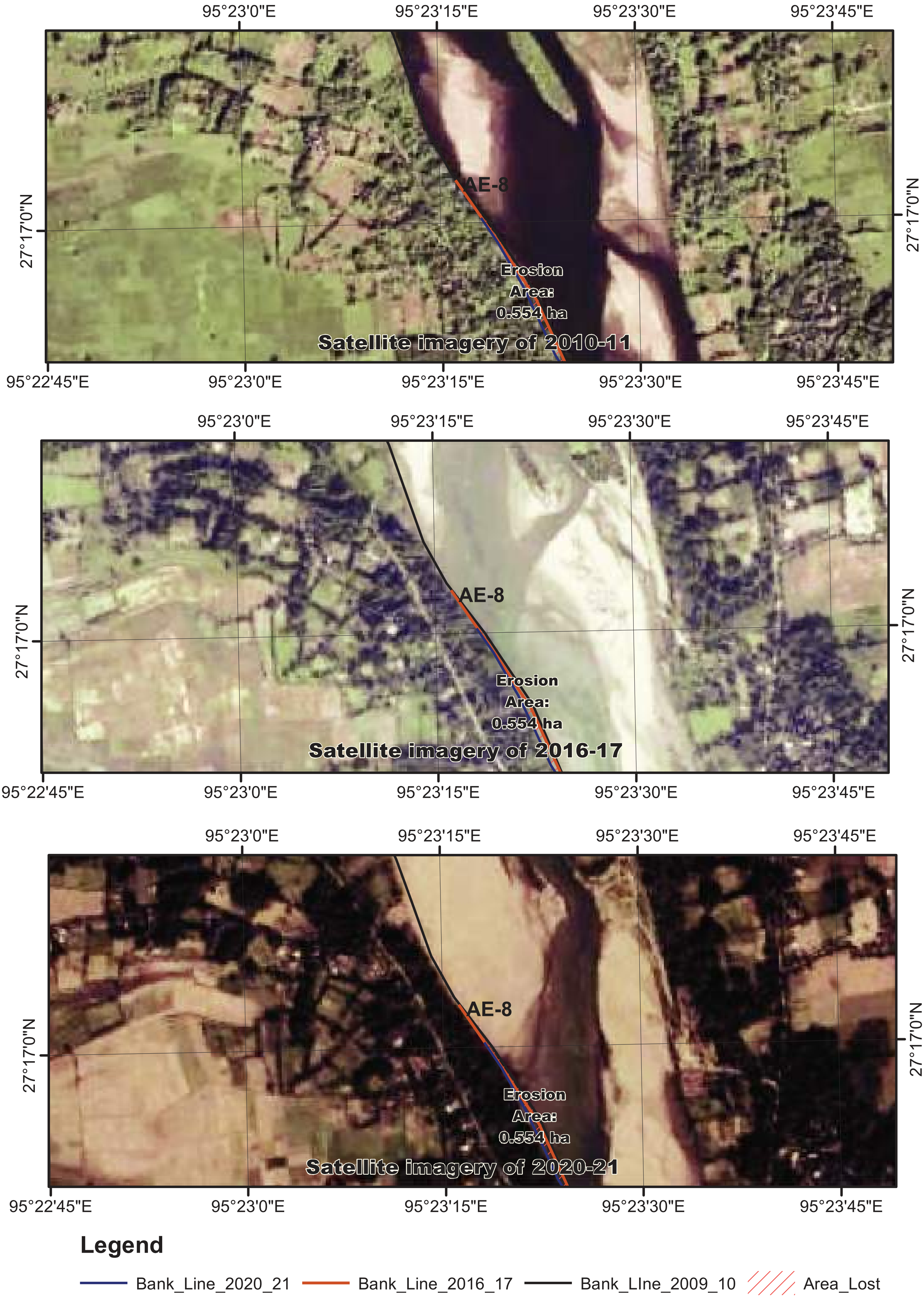


Satellite Imageries of Site AE-5 showing erosion since past years

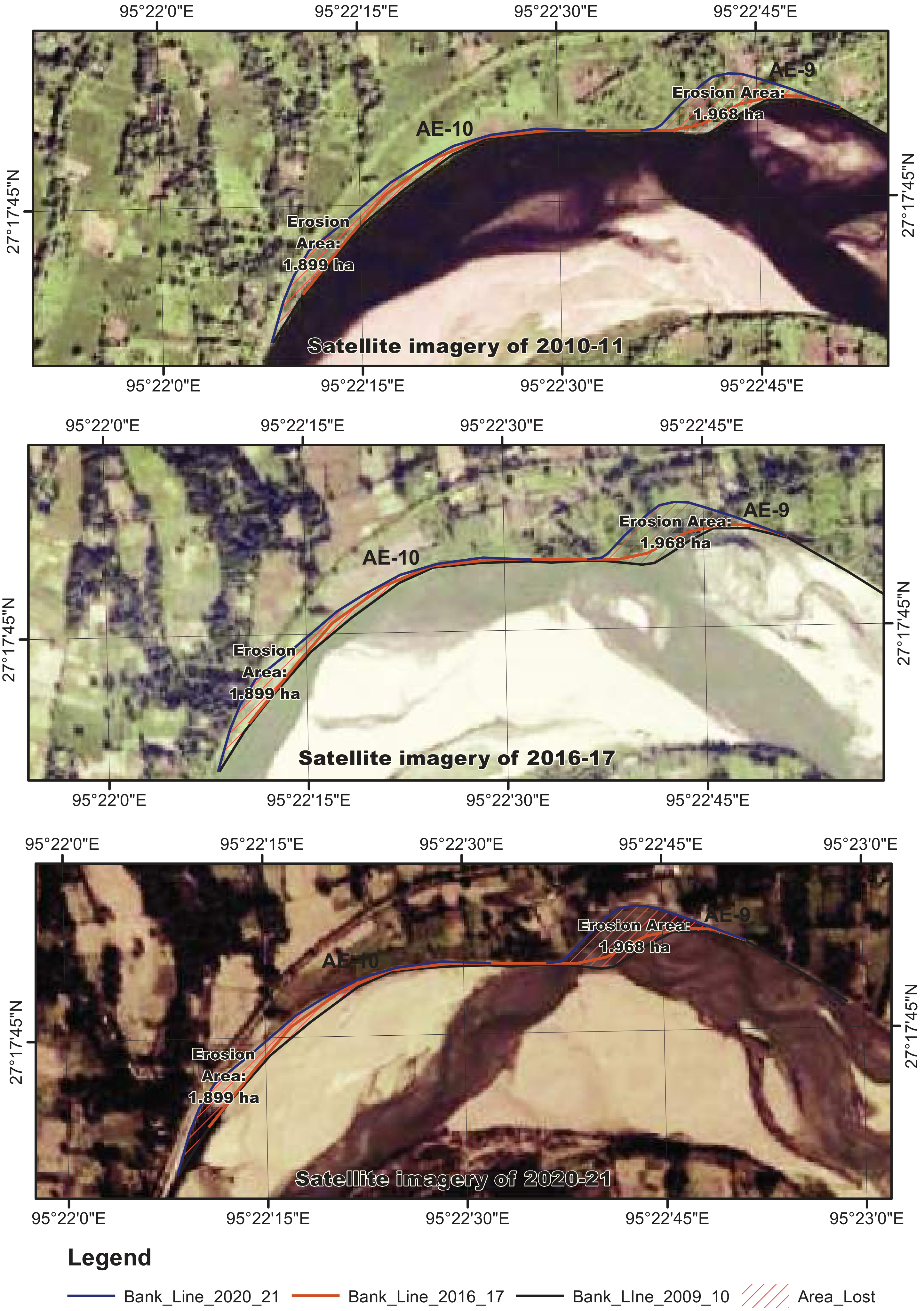
Satellite Imageries of Site AE-6 showing erosion since past years



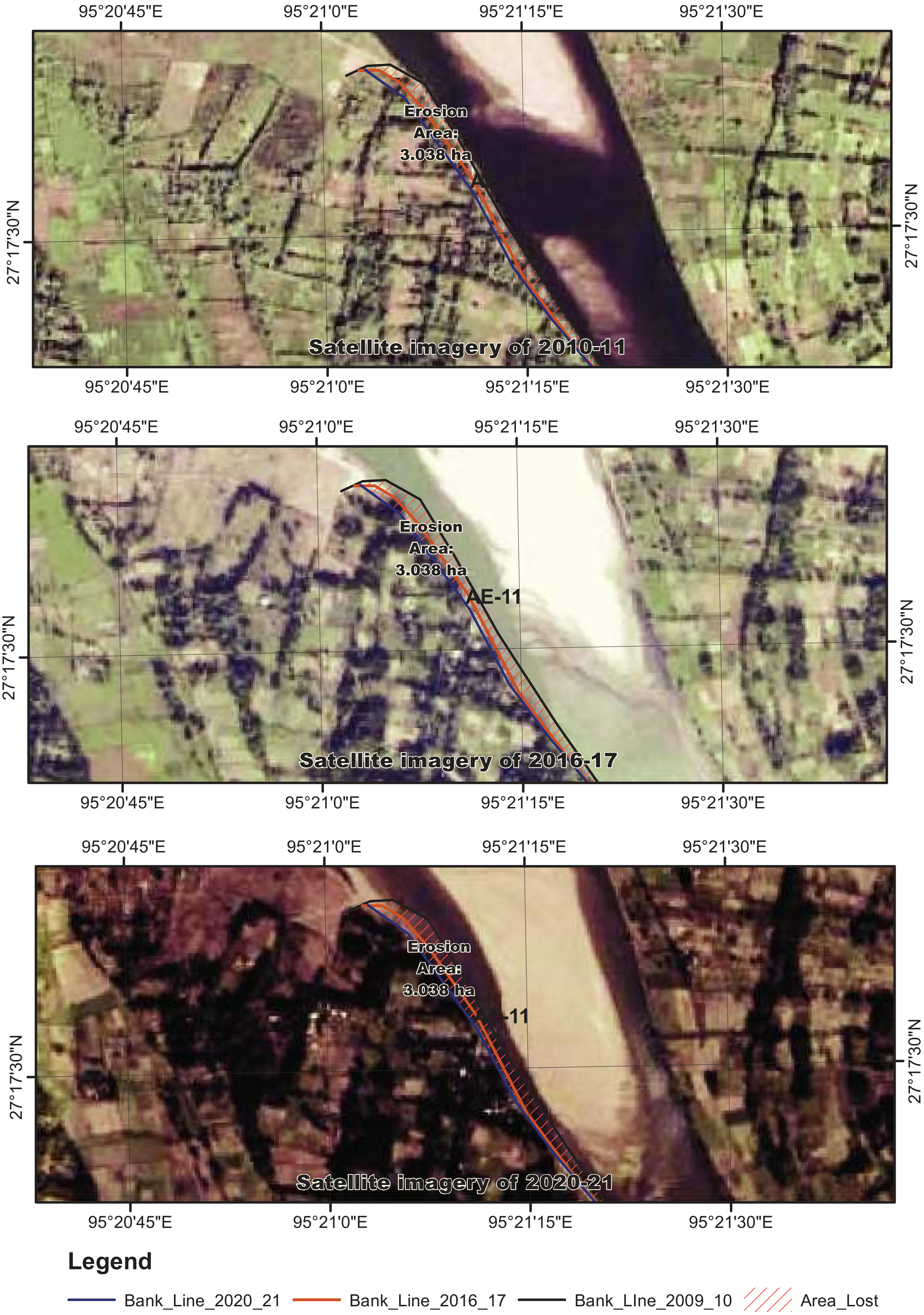
Satellite Imageries of Site AE-7 showing erosion since past years



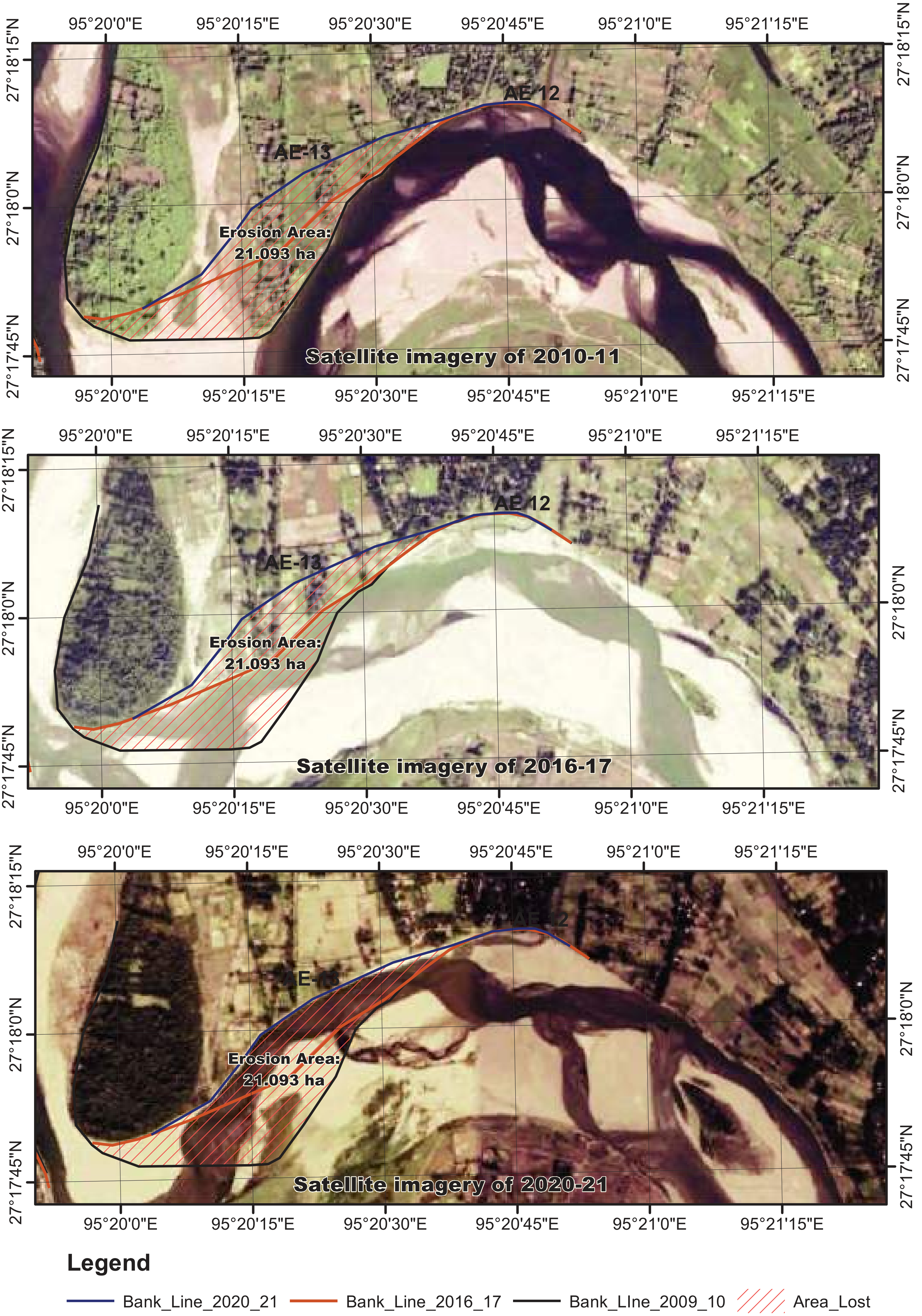
Satellite Imageries of Site AE-8 showing erosion since past years



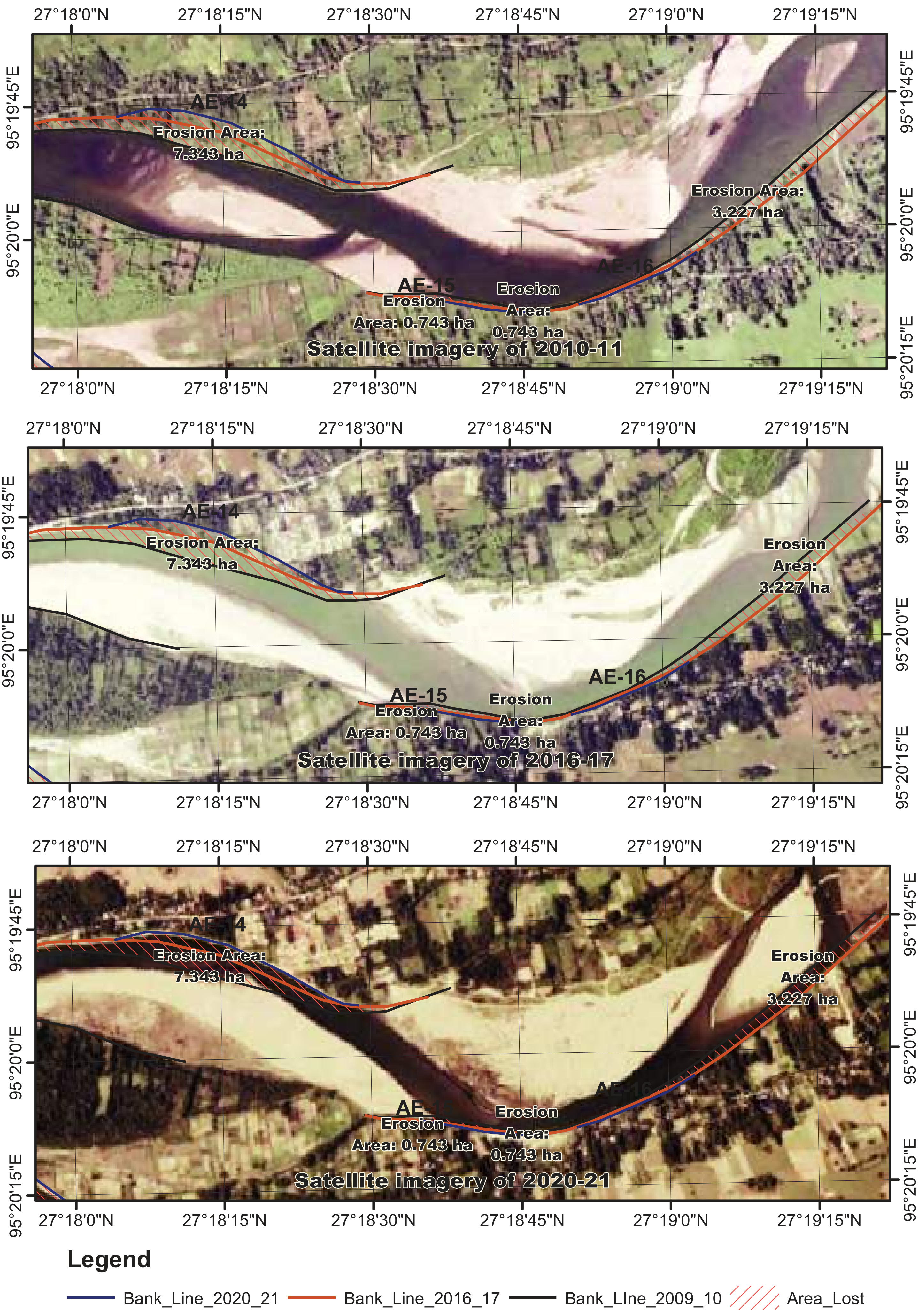
Satellite Imageries of Sites AE-9 & AE-10 showing erosion since past years



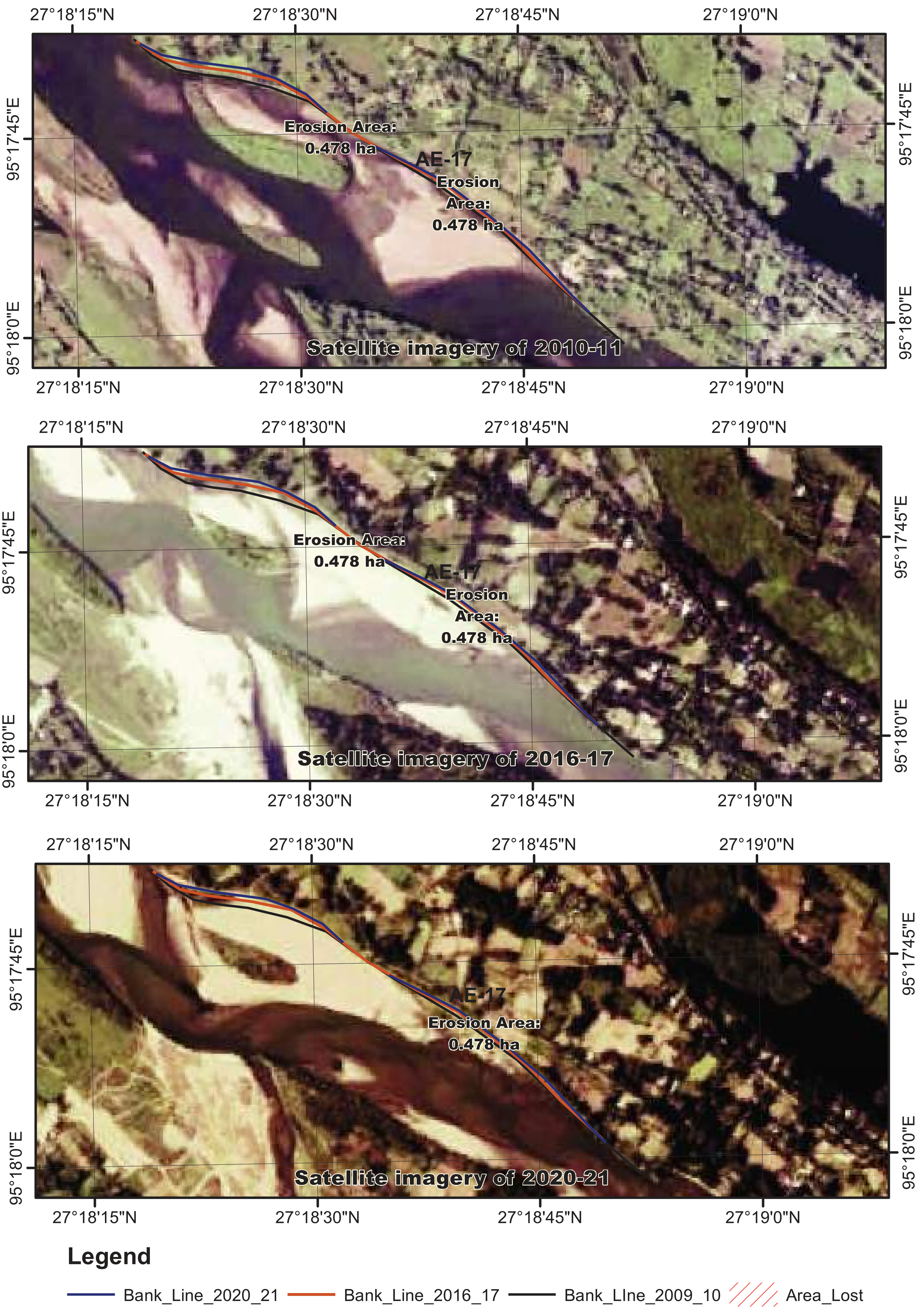
Satellite Imageries of Sites AE-11 showing erosion since past years



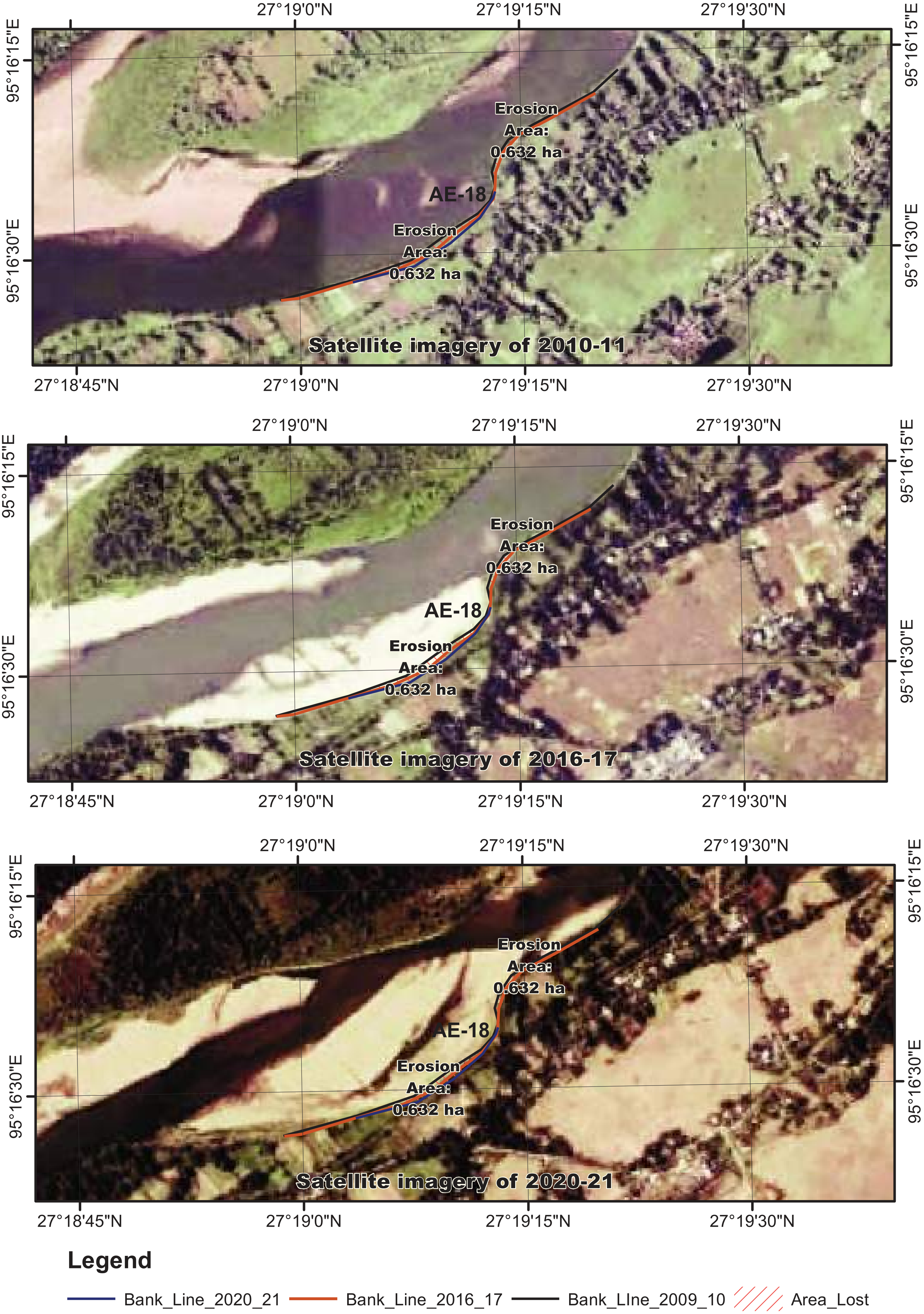
Satellite Imageries of Sites AE-12 & AE-13 showing erosion since past years



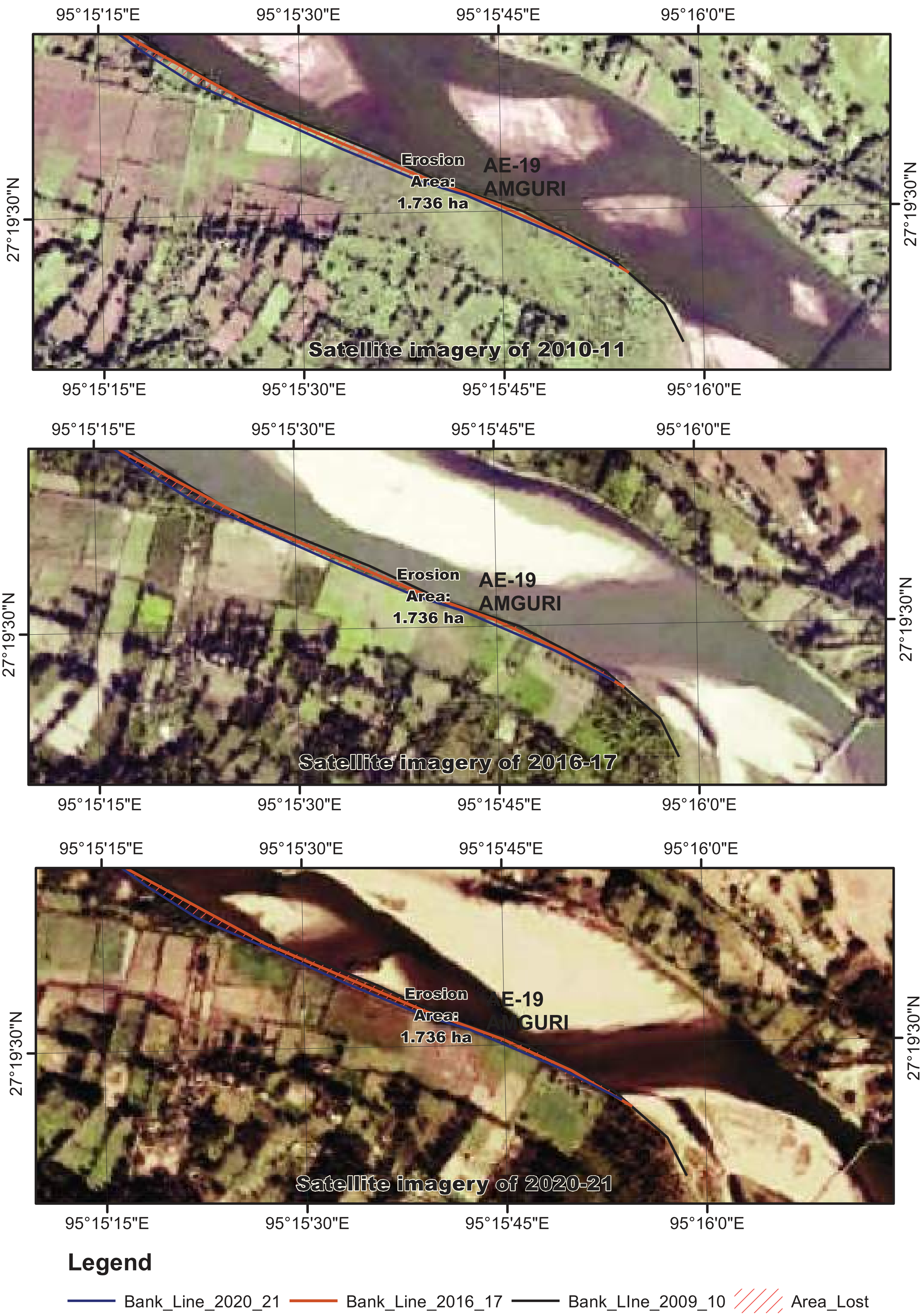
Satellite Imageries of Sites AE-14,AE-15 & AE-16 showing erosion since past years



Satellite Imageries of Sites AE-17 showing erosion since past years

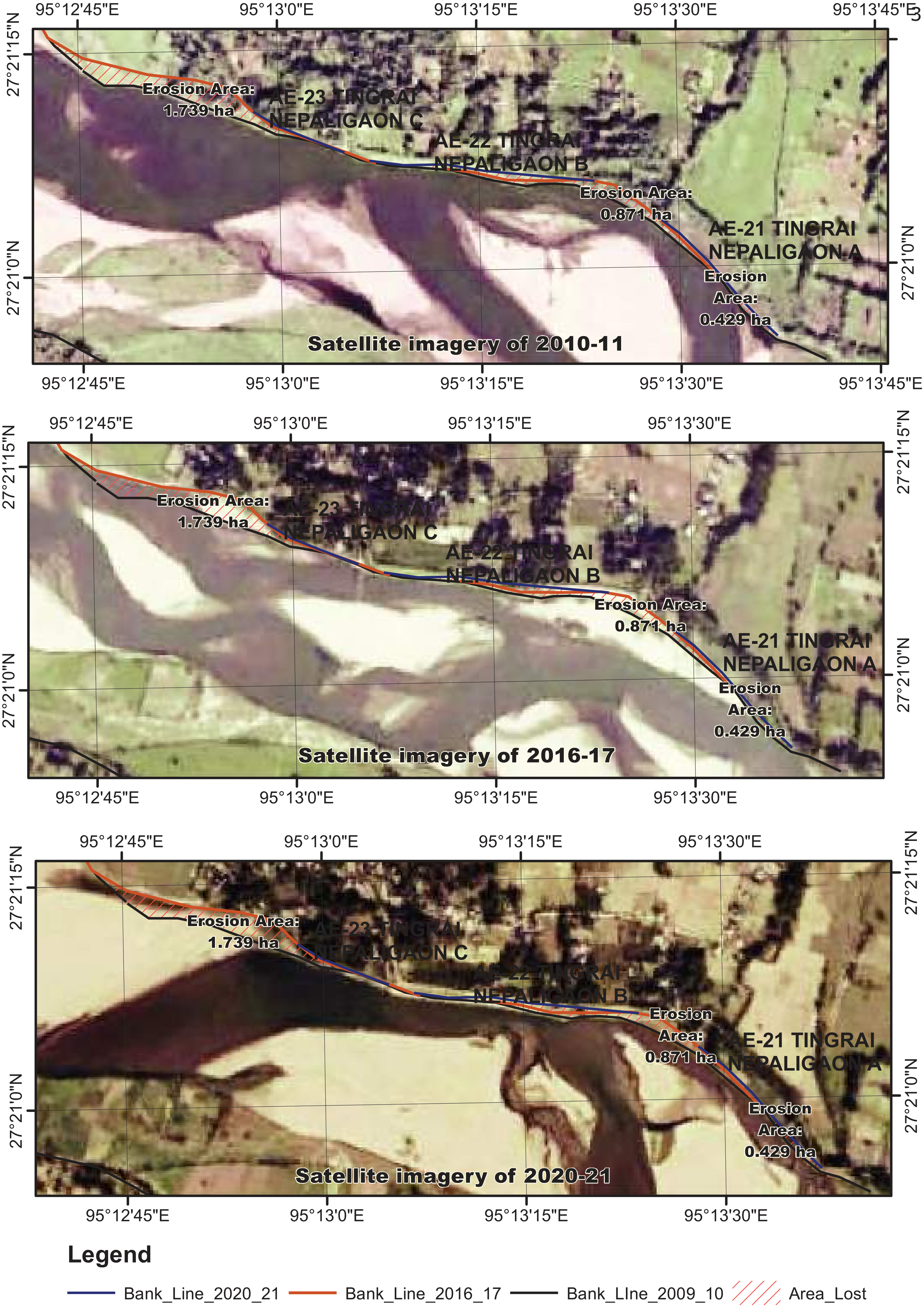


Satellite Imageries of Sites AE-18 showing erosion since past years

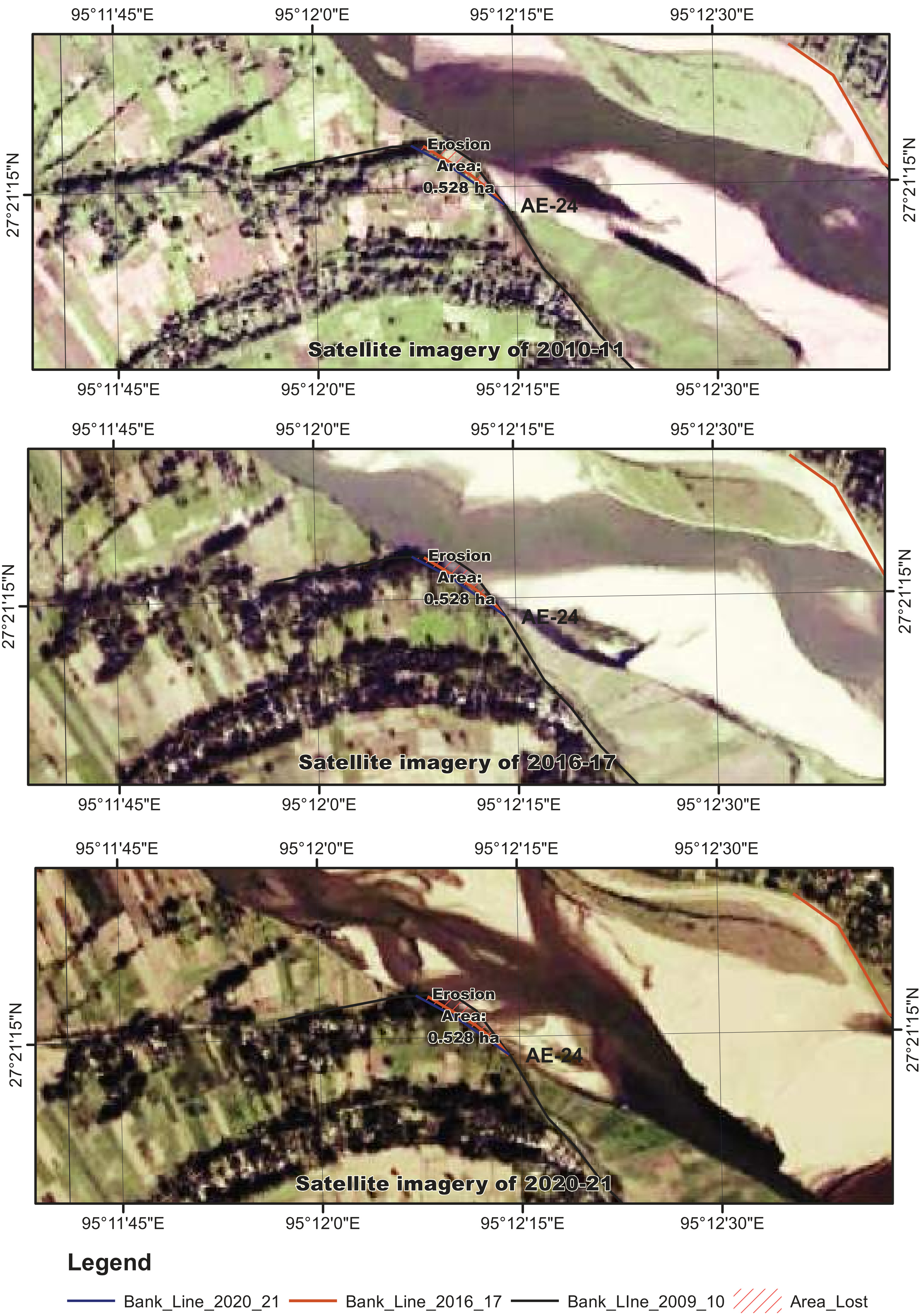


Satellite Imageries of Sites AE-19 showing erosion since past years

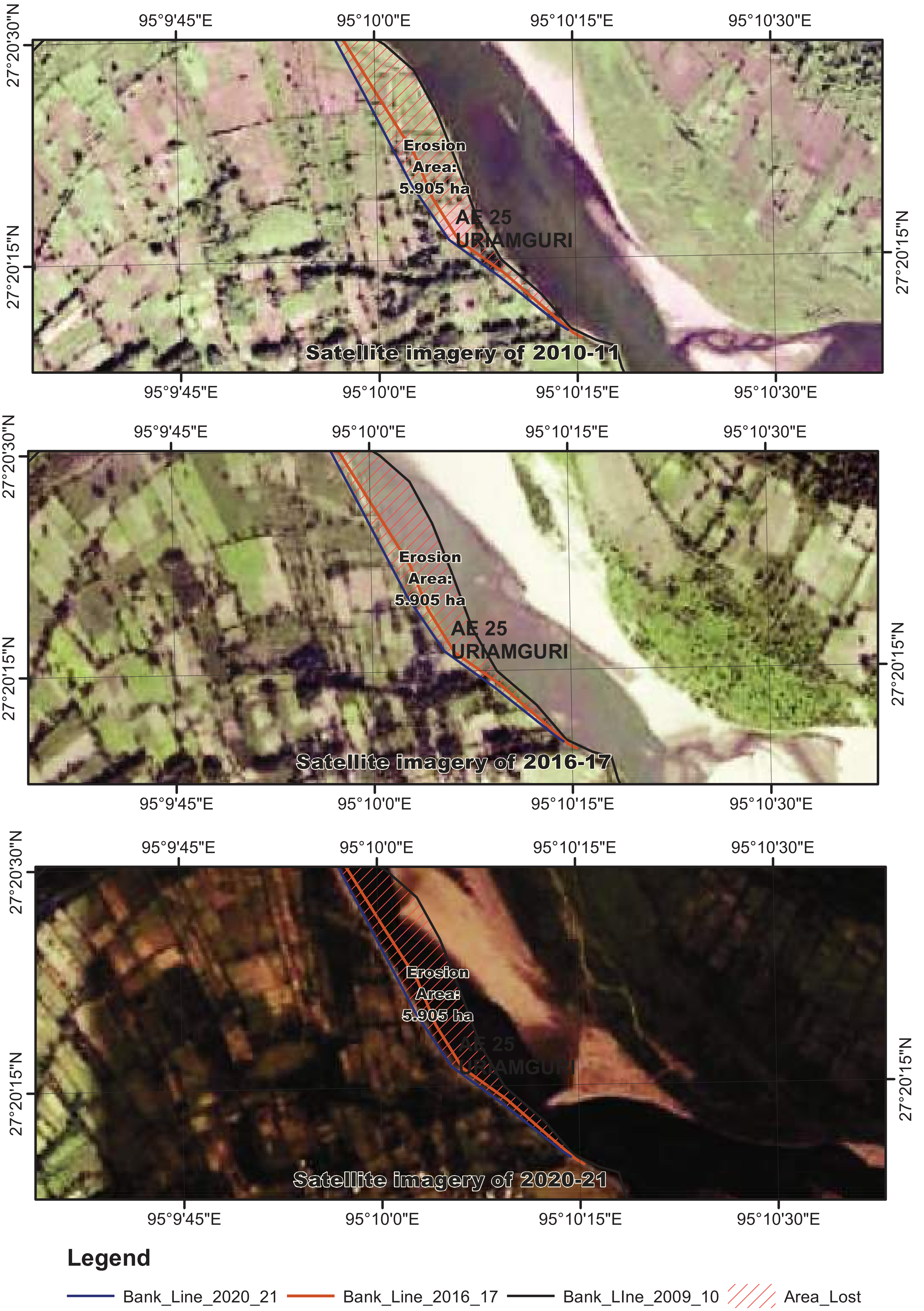
Satellite Imageries of Sites AE-20 showing erosion since past years



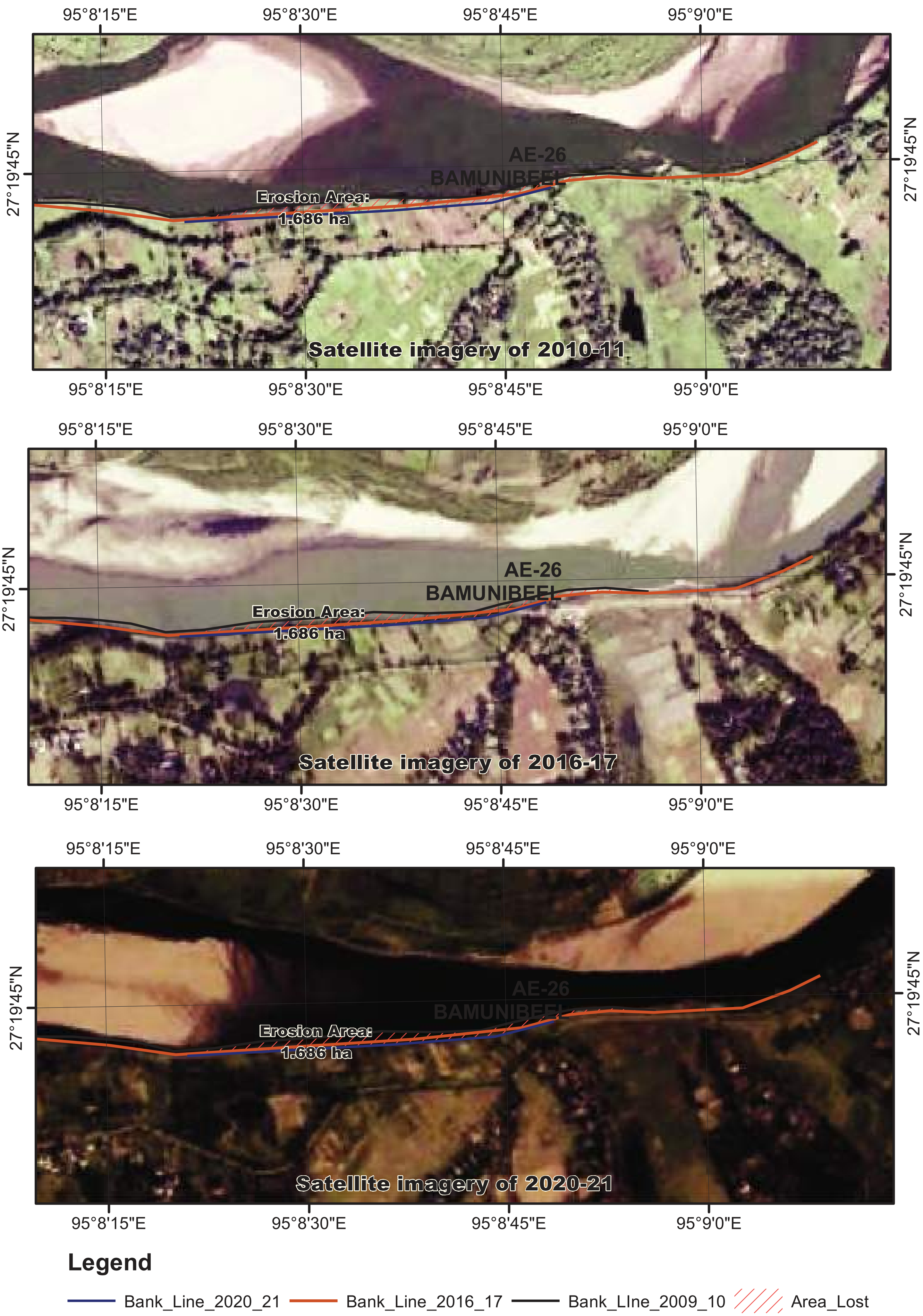
Satellite Imageries of Sites AE-21, AE-22 & AE-23 showing erosion since past years



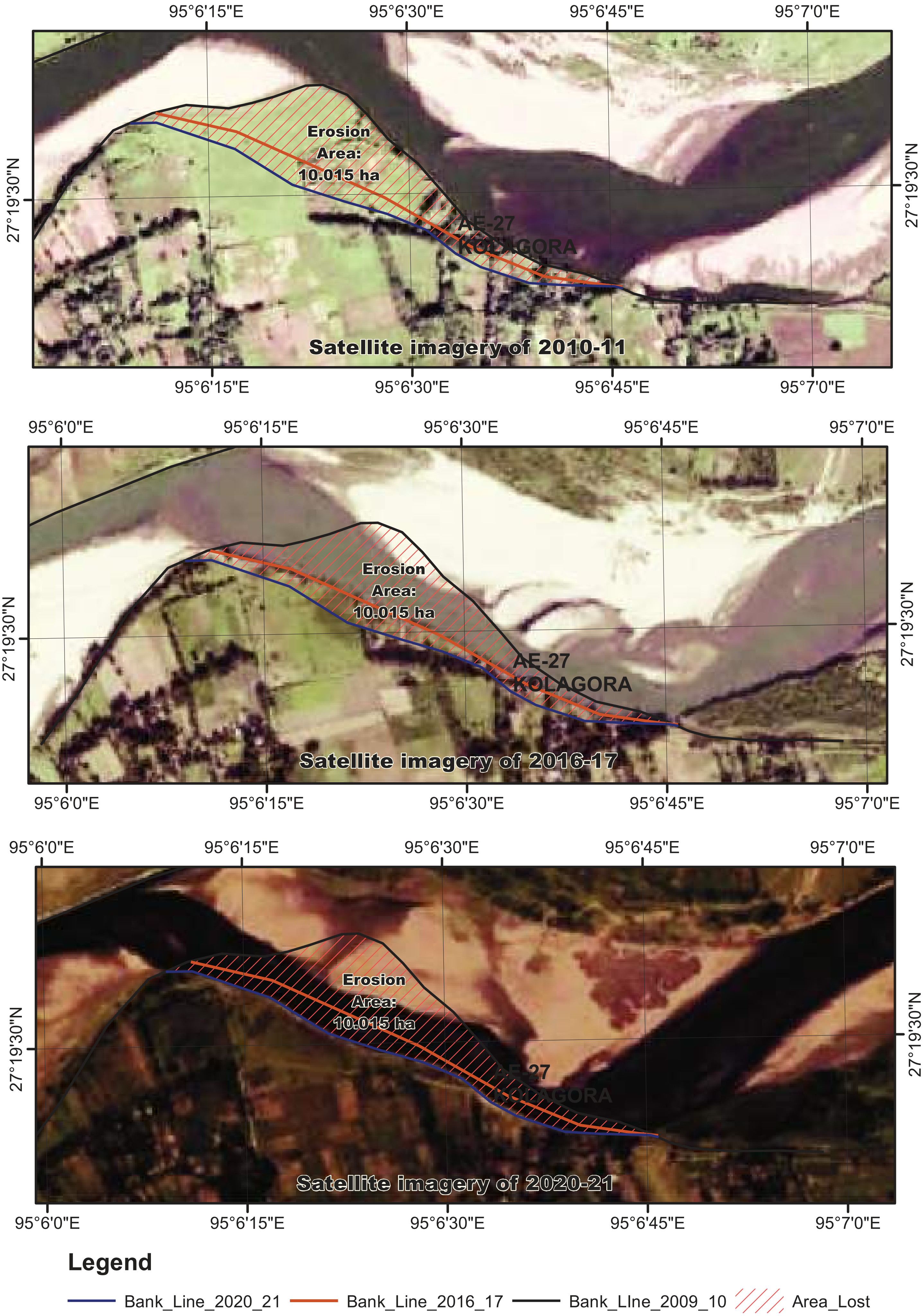
Satellite Imageries of Sites AE-24 showing erosion since past years



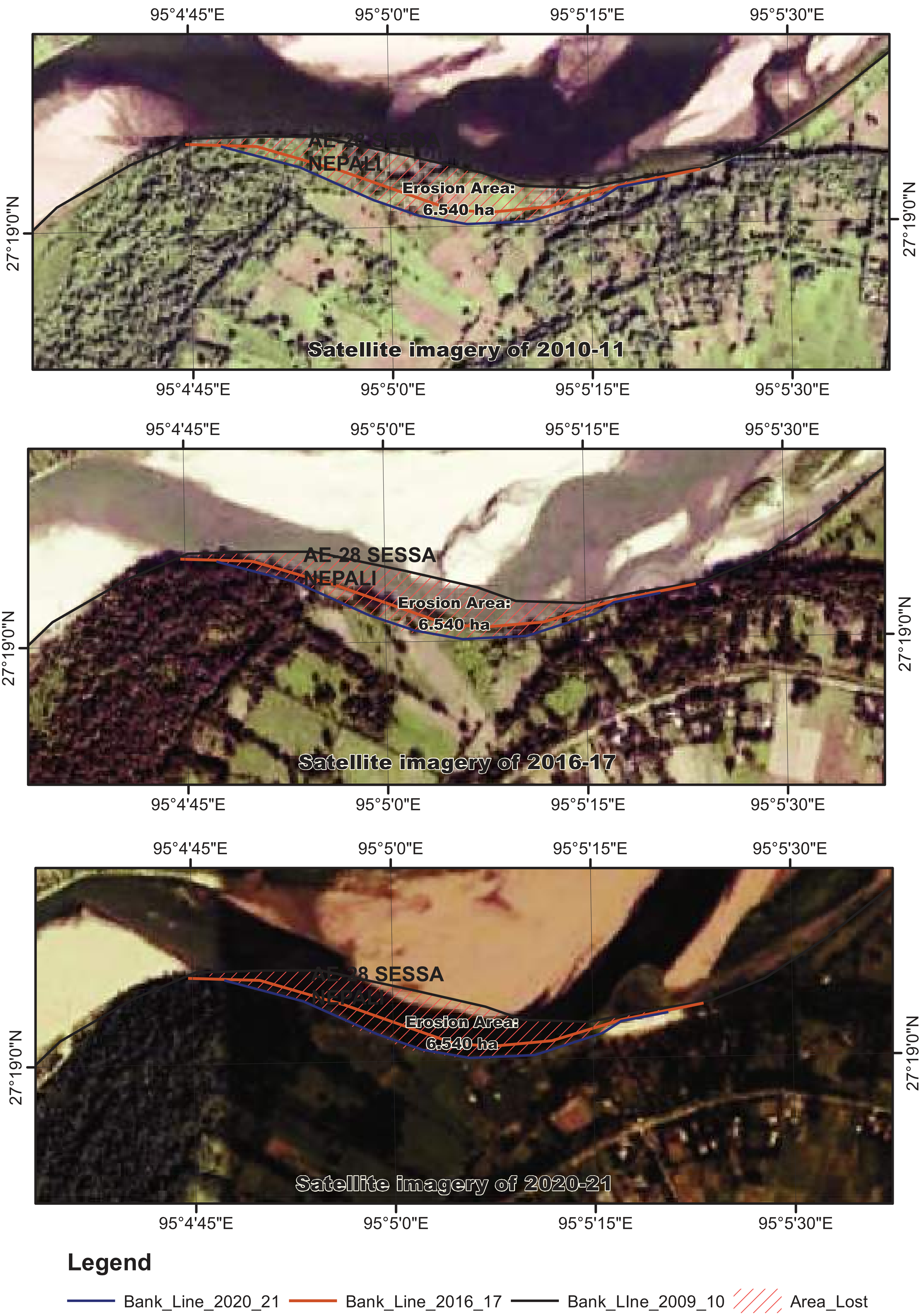
Satellite Imageries of Sites AE-25 showing erosion since past years



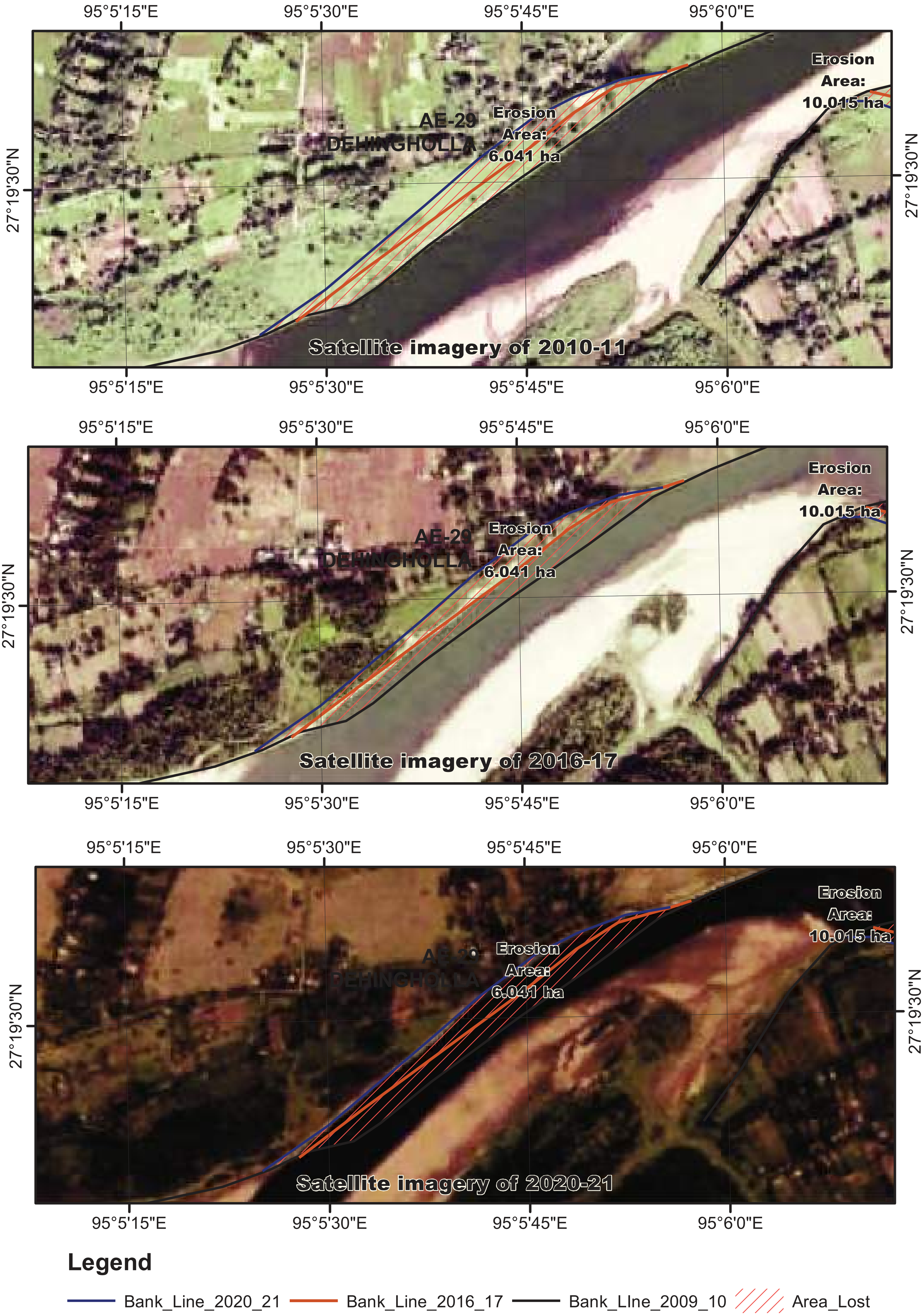
Satellite Imageries of Sites AE-26 showing erosion since past years



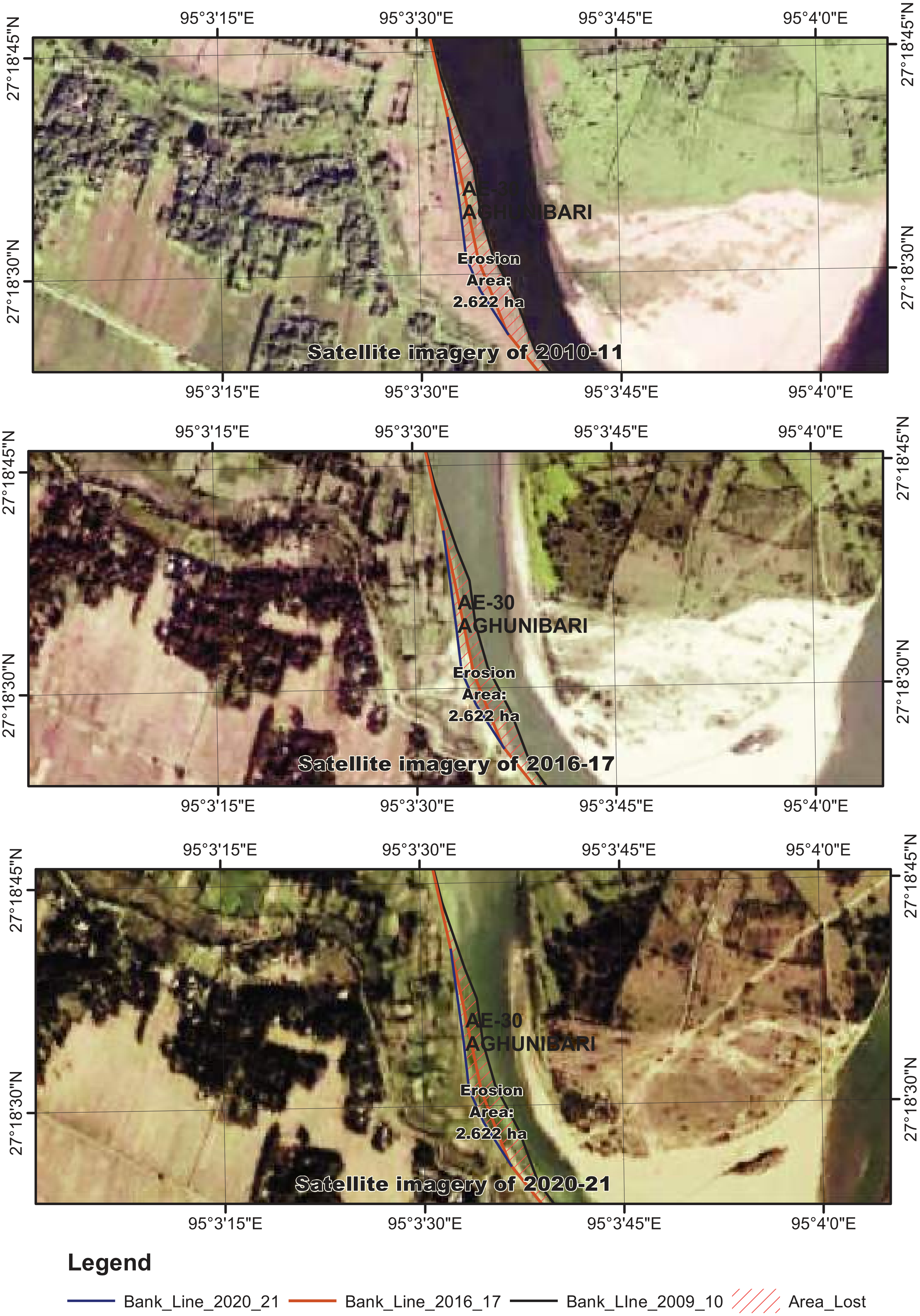
Satellite Imageries of Site AE-27 showing erosion since past years



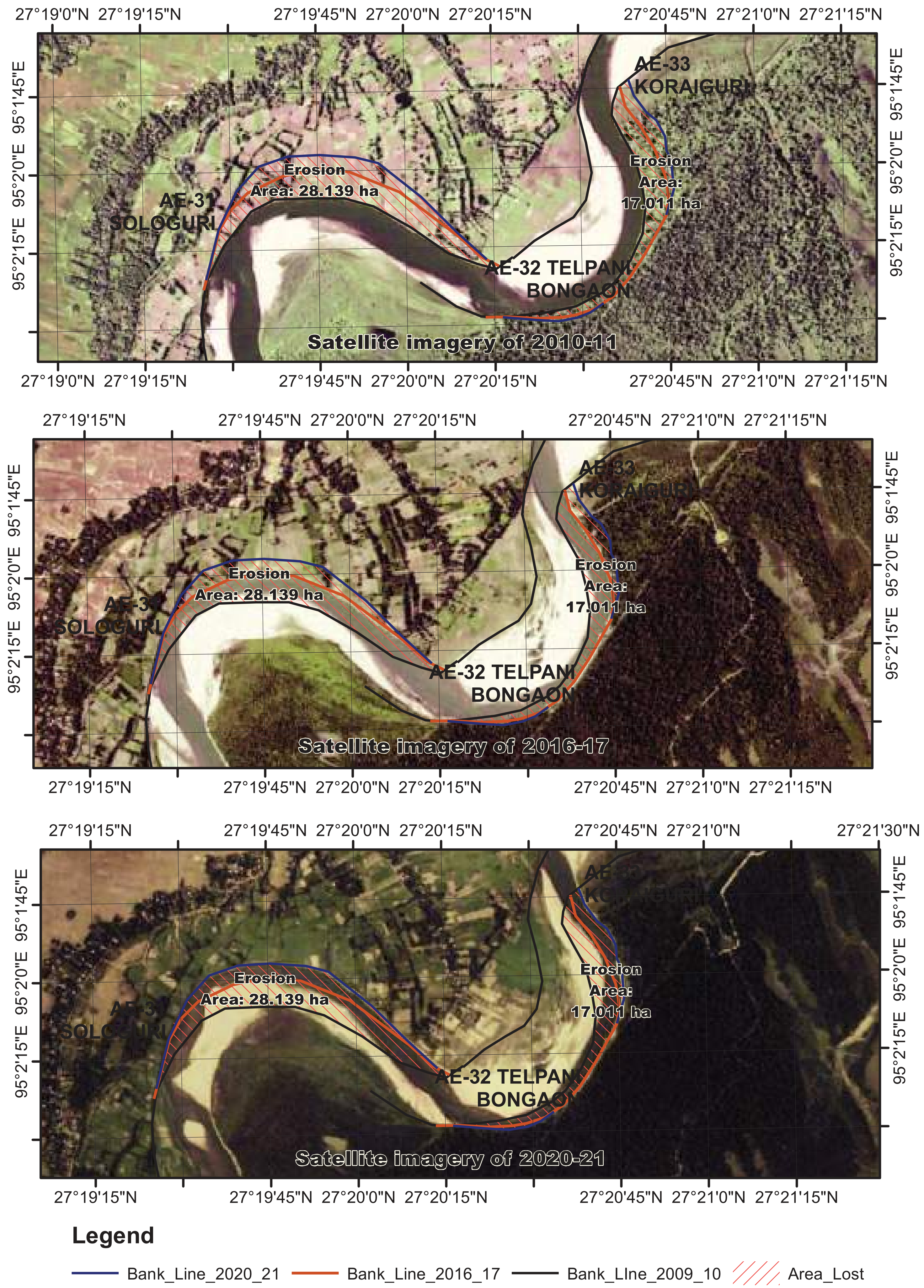
Satellite Imageries of Site AE-28 showing erosion since past years



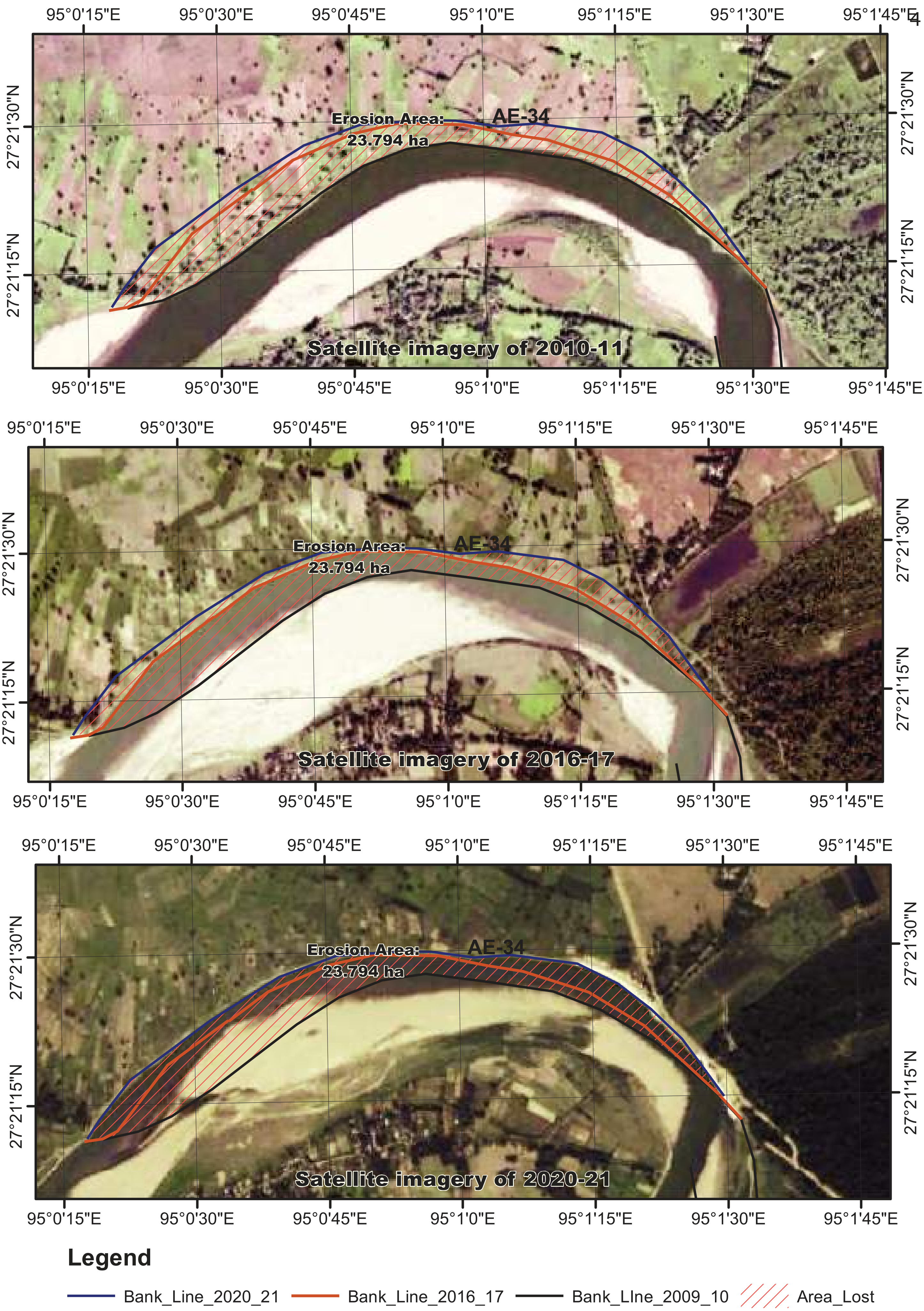
Satellite Imageries of Site AE-29 showing erosion since past years



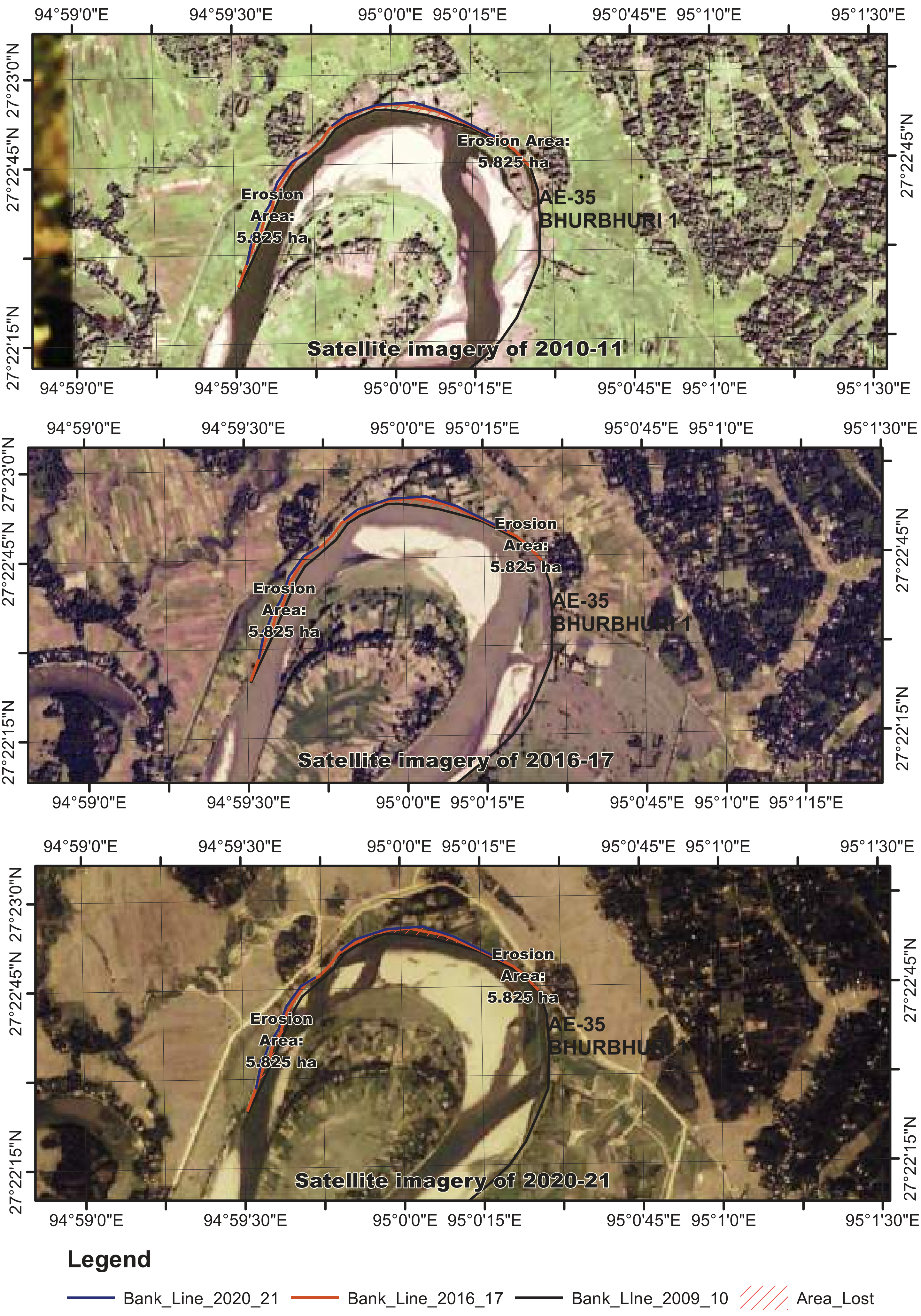
Satellite Imageries of Site AE-30 showing erosion since past years



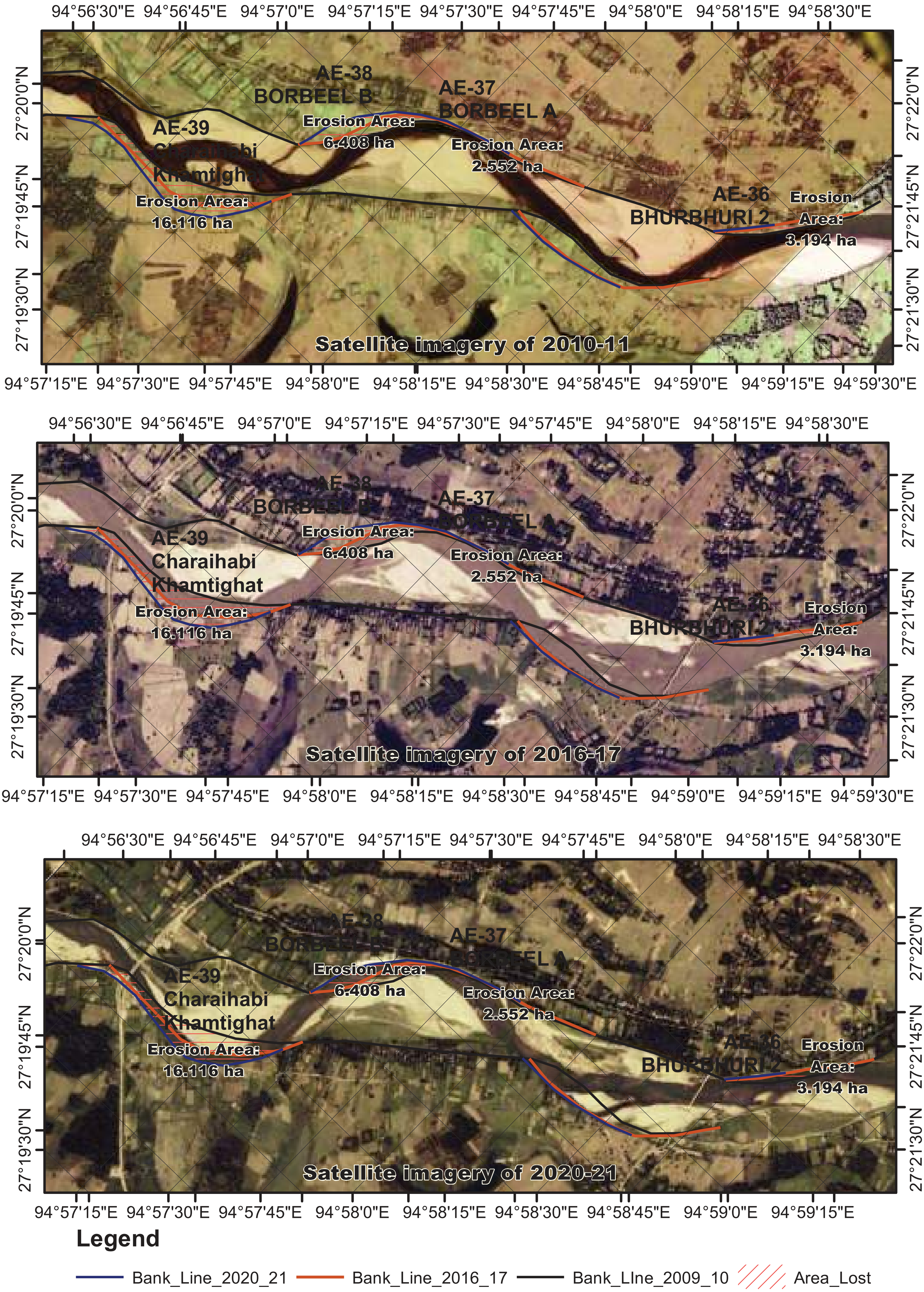
Satellite Imageries of Sites AE-31, AE-32 & AE-33 showing erosion since past years



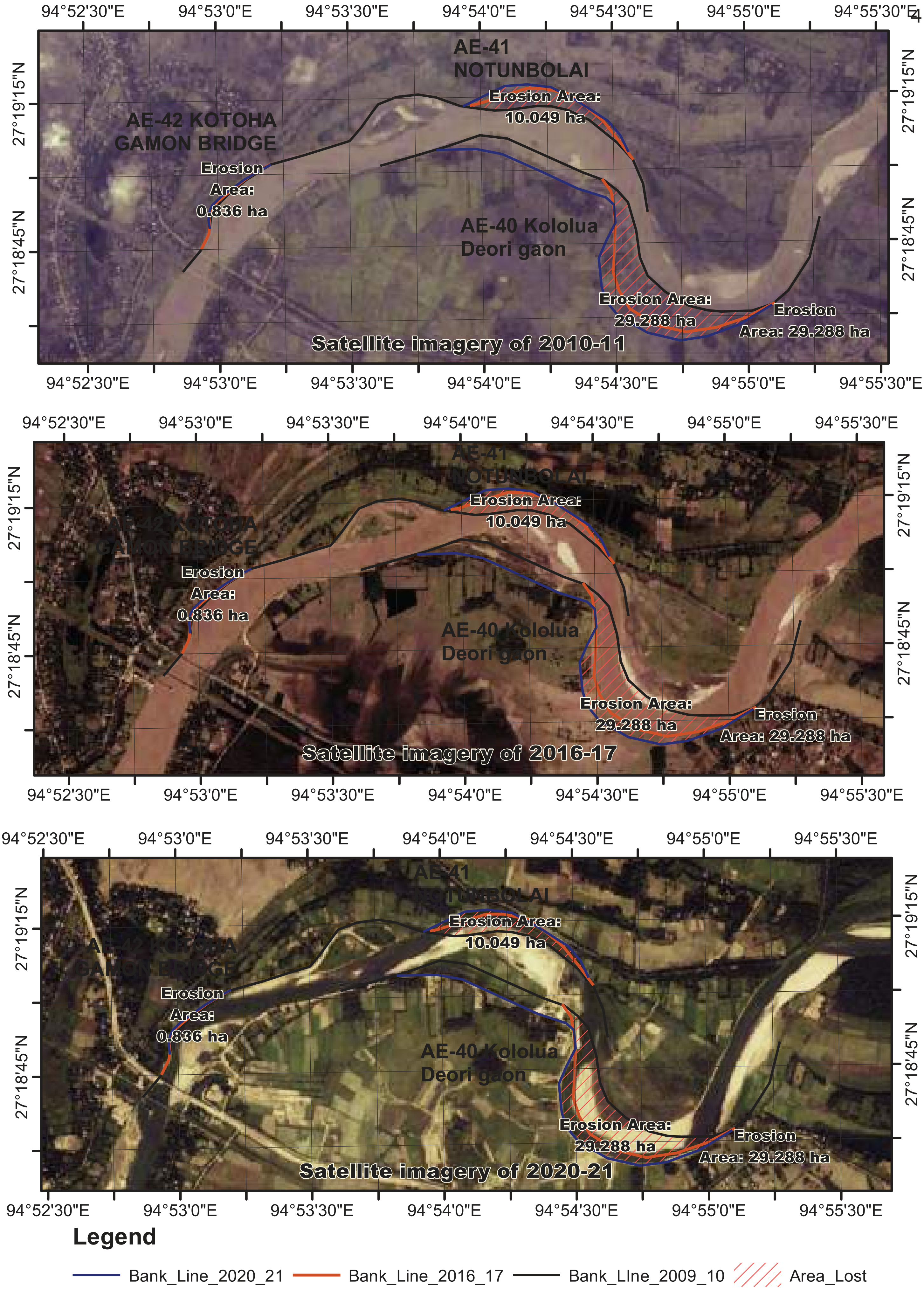
Satellite Imageries of Site AE-34 showing erosion since past years



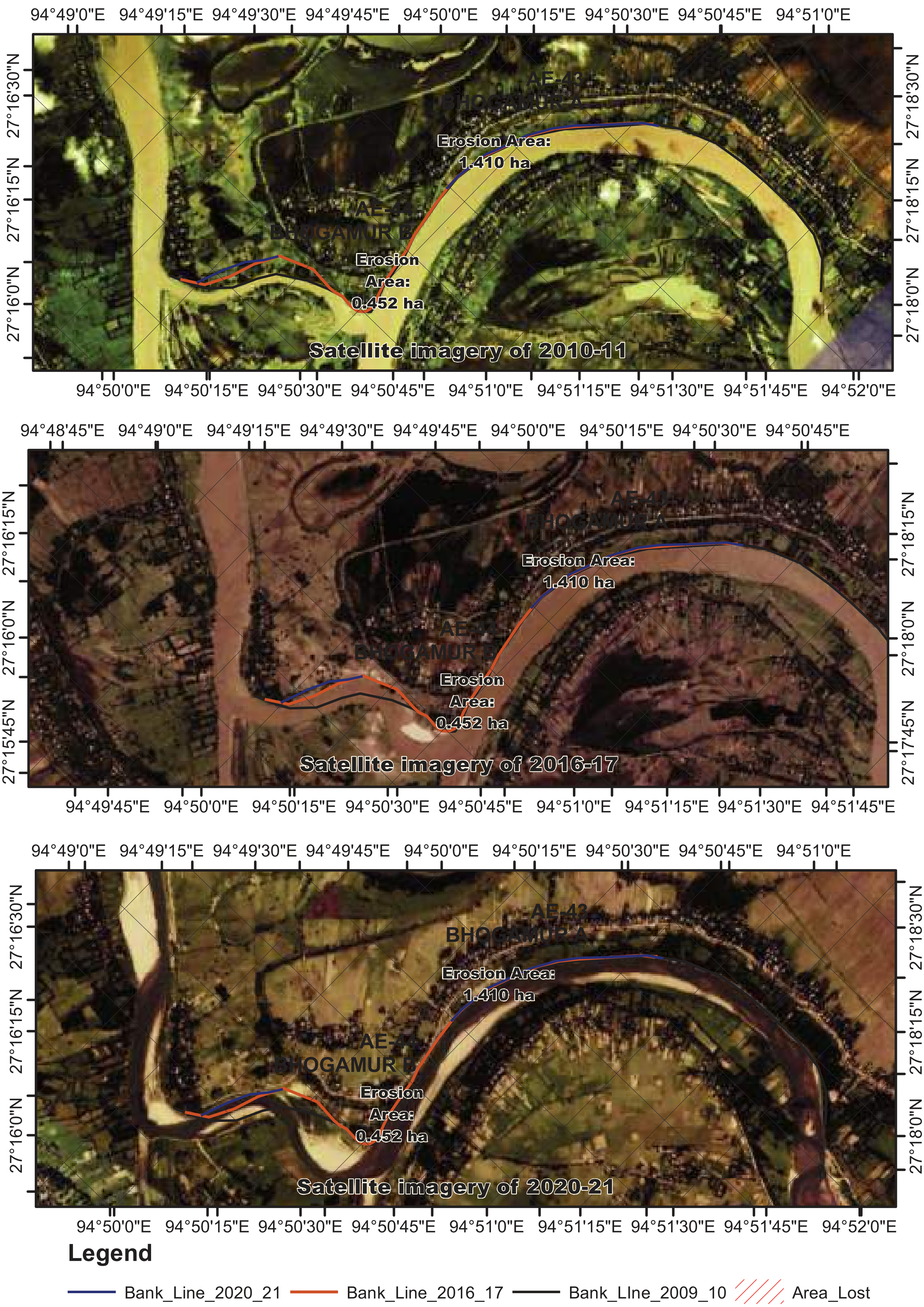
Satellite Imageries of Site AE-35 showing erosion since past years



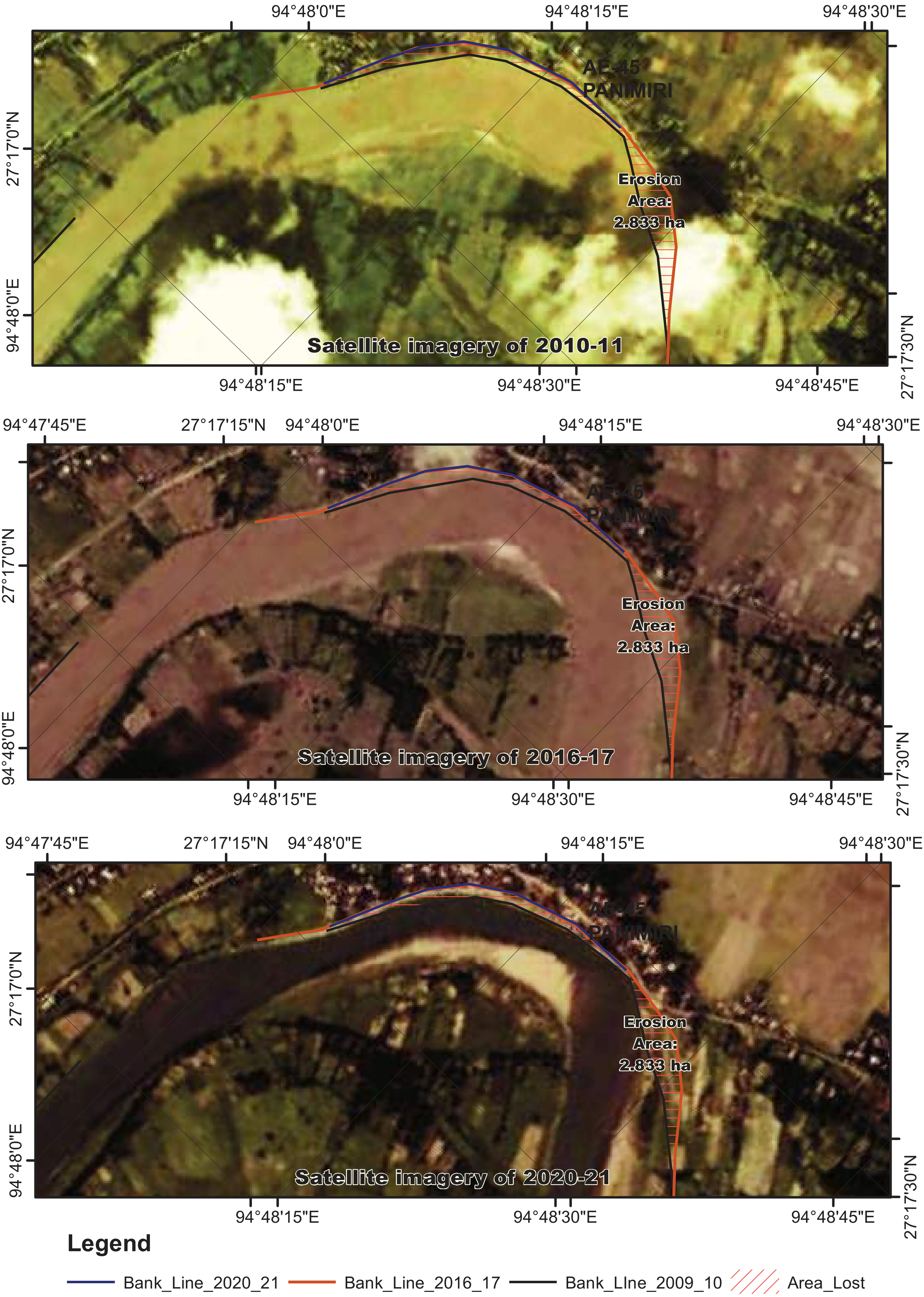
Satellite Imageries of Sites AE-36, AE-37, AE-38 7 AE-39 showing erosion since past years



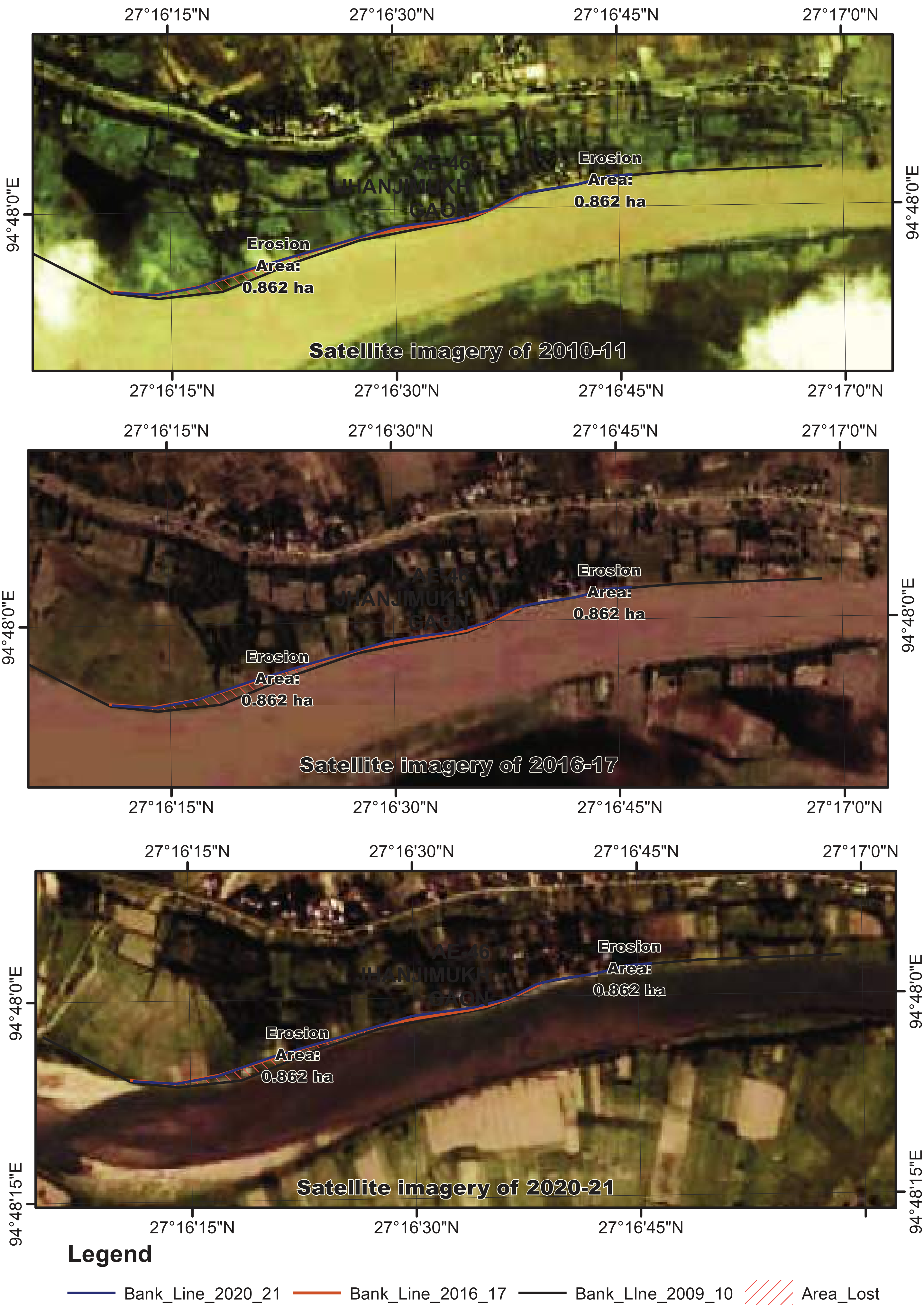
Satellite Imageries of Sites AE-40, AE-41& AE-42 showing erosion since past years



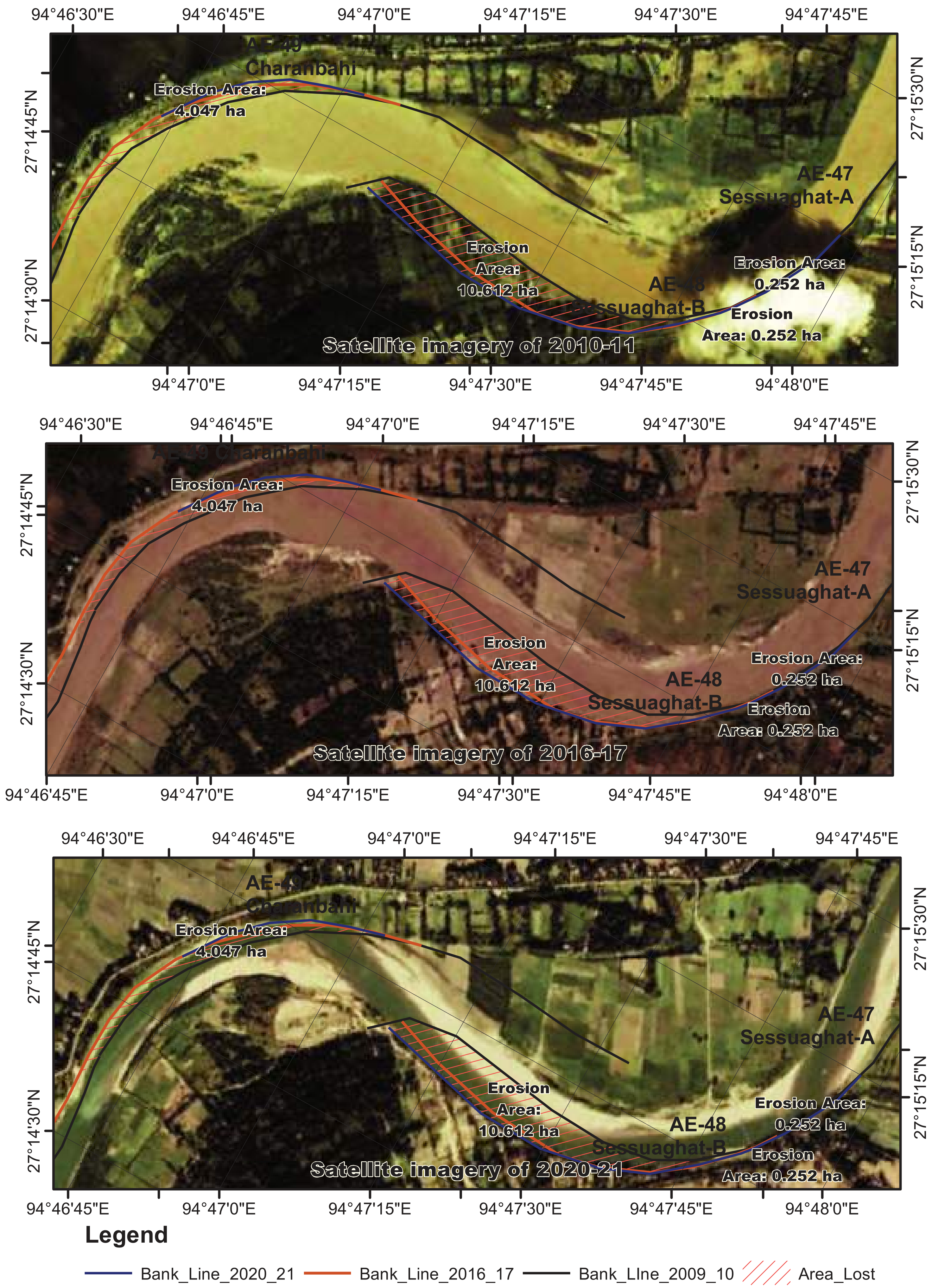
Satellite Imageries of Sites AE-43, AE-44 showing erosion since past years



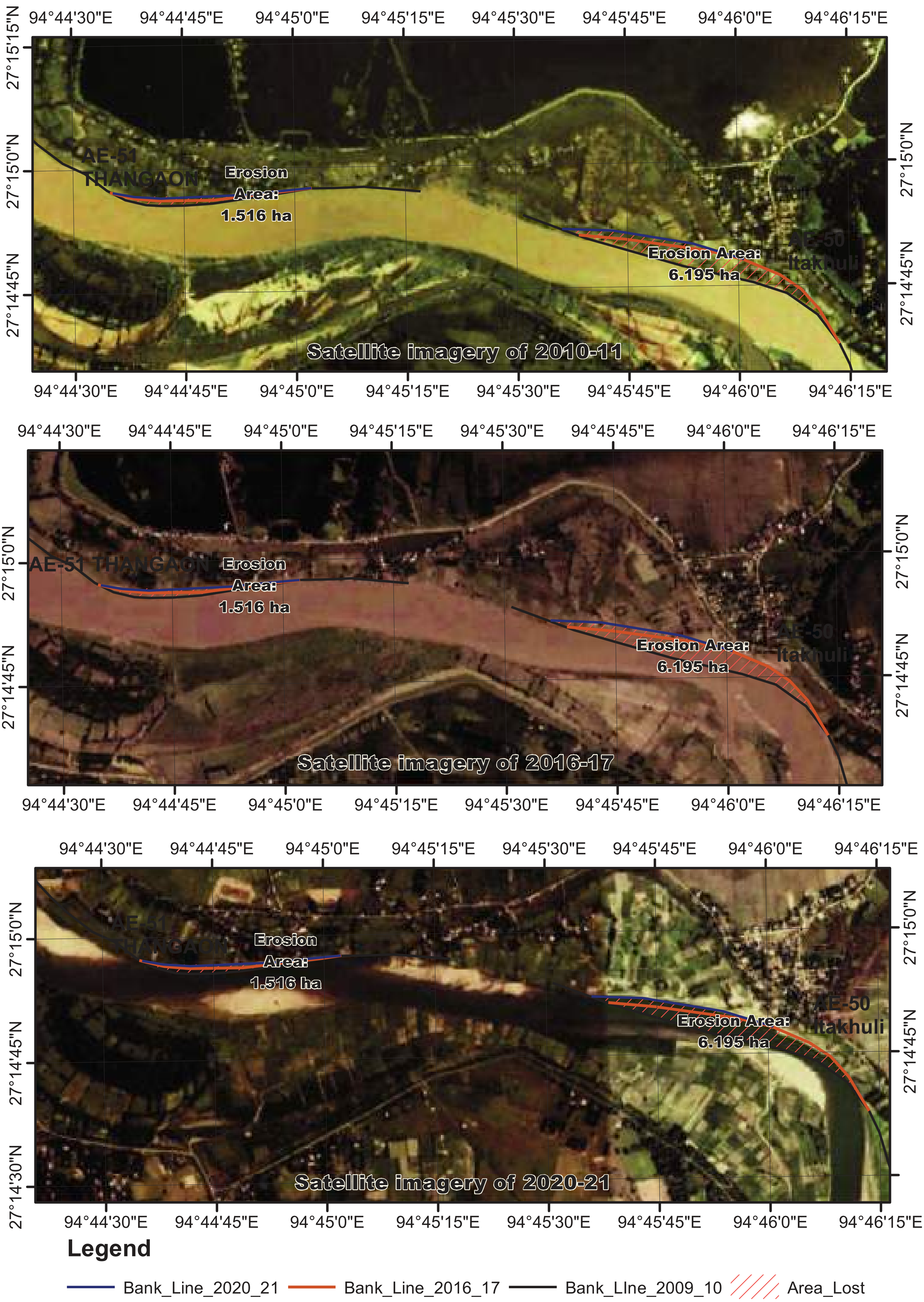
Satellite Imageries of Sites AE-45 showing erosion since past years



Satellite Imageries of Sites AE-46 showing erosion since past years



Satellite Imageries of Sites AE-47, AE-48 & AE-49 showing erosion since past years



Satellite Imageries of Sites AE-50 & AE-51 showing erosion since past years

3.4 Details of earlier executed/ongoing works

Table-1 Showing left bank embankment of the Buridehing river

Sl No.	Index No.	Name of Embankment	Length in Km	Type of Work	Year of Start	Year of Comp
1	E-39	T/Dyke along L/B of Buridehing river from Chippibsti to Mollong	2.7	Original	1956	1956
2	E-40	Extension of T/Dyke along L/B of Buridehing river from Chippibsti to Mollong	2			
3	E-31	T/Dyke from Joypur to Naharkatia	7.2	Original	1983	1984
4	E-19	Dehing bund 1st section from Aghunibari to Sessughat (WEST)	25.2	Original	1959	1960
				1st R/S	1962	1964
				2nd R/S	1972	1973
				3rd R/S	1979	1980
				4th R/S	1980	1981
5	E-12	Dehing bund 1st section from Aghunibari to Sessughat (EAST)	9.1	original	1959	1960
6	E-16	Extension of SassoniTingkhong Bund Ph - I	12.8	Original	1954	1956
7	E-17	Extension of SassoniTingkhong Bund Ph - II	15.3	Original	1955	1957
				1st R/S	1990	1992
8	E-18	Flood Protection at SassoniTingkhongMouza	7	Original	1953	1954
				1st R/S	1962	1964
9	E-11	Dehing bund old AT road Sessughat to Joan gaon	5.1	Original	1954	1955
				1st R/S	1969	1970
				2nd R/S	1961	1982
10	E-22	Tie bund of Gela Desam	7.2		1953	1954

Table-2 Showing right bank embankment of the Buridehing river

Sl No.	Index No.	Name of Embankment	Length in Km	Type of Work	Year of Start	Year of Comp
1	E-9	Dehing Marginal bund from Kotuha to Bhogamur	8.4	Original	1955	1958
2	E-10	Extension of Tengakhat Bund from Bhogamur to Sessamukh	18.6	Original	1955	1958
				1ST R/S (3.2km to 15.2km)	2012	2013
3	E-30	Closing spill channel from Deochalli hills to Tiplingghat Ph - I	8.25	Original	1961	1963
				1st R/S	1977	1980
4	E-29	Construction of embankment from Deochali Hills to TiplingGhatPh - II (Fakia grazing)	11.33	Original	1963	1965
5	E-26	Construction of T/Dyke from Deochali hills to TiplingghatPh - III	1.5	Original	1984	1985
6	E-25	T/Dyke from Bhekulajan to Tipling river	13.3	Original	1956	1960
				1st R/S	1977	1980
7	E-24	Tingrai left bank dyke from Balijan to Tingraimukh	4.7	Original	1953	1954

8	E-23	Reclamamtion of low laying areas of near TingraimukhinKheremiaMouza	5.4	Original		
9	E-27	Construction of emabankment along the Tipling Bgidge to Tipling TE	3.8	Original		
10	E-28	Construction of emabankment along left bank of Tipling river	4	Original		
11	E-13	Flood Protection of TengakhatMouza	13.7	Original	1953	1955
				1st R/S	1962	1963
				2ND R/S	2011	2013
12	E-14	Extension of Tengakhat bund upto Jokai R.F.	19.96	Original	1954	1956
				1st R/S	1966	1968
13	E-15	Extension of Tengakhat bund from Jokai R.F. to AT Road	13.5	Original	1955	1957
				1st R/S	1971	1972

3.5 Master Plan for the basin, fitment of the project and priority

A sustainable development in the region cannot be achieved without Water Resource Development in Brahmaputra river basin. To that end an integrated basin wise approach is needed considering social, political, economic, administrative, cultural and legal consideration with scientific and technological approach. The proposed project will fit into the overall structure of the master plan of Brahmaputra basin prepared by Brahmaputra Board. The proposed project does not have any interstate or international ramifications.

3.6 Non-structural measures

The provisions made in this Detailed Project Report(DPR) are to prevent erosions and overtopping during high stage of flood. Though many reaches exposed to flood pressure and damage, only the most vulnerable reaches where raising and strengthening works are required are considered under this proposal. While preparing the DPR due consideration is made for utilizing local man power and material resources at bare minimum cost. The works would provide employment to the local people besides protecting the life and property of general public of these chronic flood ravaged areas.

3.7 Survey/Investigation conducted

Detailed survey works were conducted to prepare this DPR which comprised of hydrographical and topographical survey works with equipments like geodetic positioning systems and sounders of the latest technologies. River cross-sectional surveys were conducted at about 150m intervals for flood profiling of the river through mathematical modelling. Banks and embankments were surveyed using DGPS to determine levels and positions and to generate the construction drawings and BOQ.

River Survey with remote controlled hydrographic survey boat

Topographic Survey works on banks & embankments

3.8 Various alternatives

While formulating this DPR, considerable efforts were made to explore the various alternatives of remedial measures to the problems of flood and erosion, the most significant been the methodologies and materials for the bank protection works. The most economically and technically viable alternatives along with consideration of the eco-friendly measures are considered and approved by the State T.A.C. for the various works proposed in this project.

3.9 Scope of the project

Considering the gravity of the situation that has been arising out of overtopping and flood inundation to the vast areas on both bank of Buridehing river, the most vulnerable reaches chronically affected by flood spill of dyke are identified and earth work for raising and strengthening of the dyke section at the different reaches has been proposed.

Therefore, this Detailed Project Report is prepared with provisions for raising and strengthening of the embankment on both bank of Buridehing to the specified norms of CWC including renovation of existing sluice gates, bank stabilization works with anti-erosion measures and pro-siltation works. The estimate is worked out with bare minimum cost and with locally available manpower and resources.

The implementation of the scheme will not only protect the area from flood devastation but also create assets and will guarantee employment to the local people.

The scope of works has been sub-divided into 4(four) parts under Flood Management Work

PART A: R/S works on right bank embankments including construction of new embankment

PART B: R/S works on Left Bank embankments including construction of new embankments

PART C: Renovation of existing Sluice gates

PART D: Anti-erosion works at different most vulnerable reaches on both bank of Buridehing River alongwith porcupine screens at upstream and downstream

3.9.1 PART A:
R/S works on Right Bank Embankments including construction of new embankment:

The right bank embankment from Deochali hills to Tiplingghat was constructed in 1955-56 and details information regarding the right bank embankment are given above. Most of the embankment is in deplorable condition due to continuous flood pressure and natural wears and tears. The dyke system has already outlived its design life. Therefore, Raising and strengthening of the existing dyke is urgently required. Natural wear and tear has reduced the dyke section to considerable extend and the dyke section is in deplorable condition and are suffering from seepage leakage etc. As such this dyke section is most vulnerable for breach during high stage of flood.

Now the proposed work is incorporated as a part in this Detailed Project Report considering the entire Buridehing basis in a comprehensive matter.

RIGHT BANK EMBANKMENT					
Sl No.	Index No.		Name of Embankment	Length in Km	Proposed length Km
1	E	9	Dehing Marginal bund from Kotuha to Bhogamur	8.4	8.4
2	E	10	Extension of Tengakhat Bund from Bhogamur to Sessamukh	18.6	4.5

3	E	30	Closing spill channel from Deochalli hills to TiplingghatPh - I	8.25	8.25
4	E	29	Construction of embankment from Deochali Hills to TiplingGhatPh - II (Fakia grazing)	11.33	11.33
5	E	26	Construction of T/Dyke from Deochali hills to TiplingghatPh - III	1.5	1.5
6	E	25	T/Dyke from Bhekulajan to Tipling river	13.3	13.3
12	E	14	Extension of Tengakhat bund upto Jokai R.F.	20.2	20.2
13	E	15	Extension of Tengakhat bund from Jokai R.F. to AT Road	13.5	13.5
TOTAL				**94.88**	**80.98**

Note: E-10 will be upgraded for 4.5 Km only from Ch. 0m to Ch. 3200 & Ch. 15200m to Ch. 16500m (D/S portion is under construction with State SOPD project. As such the value of R/S work has been deducted from the DPR submitted earlier.

TRIBUTARY DYKES ON RIGHT BANK OF BURIDEHING RIVER					
Sl No.	Index No.		Name of Embankment	Length in Km	Proposed length
7	E	24	Tingrai left bank dyke from Balijan to Tingraimukh	4.7	4.7
8	E	23	Reclamation of low laying areas of near TingraimukhinKheremiaMouza	5.4	5.4
9	E	27	Construction of embankment along the TiplingBgidge to Tipling TE	3.8	3.8
10	E	28	Construction of embankment along left bank of Tipling river	4.0	4.0
TOTAL				17.90	17.90

Sl. No	Index No		Newly proposed Right bank embankment	Proposed length of embankment (in Km)
11	E	41	Proposed Embankment at MaichangPathar Area	8.5
Total				8.5

3.9.2 PART B:

R/S works on Left Bank Embankments including construction of new embankment.

The left bank embankment was constructed in the year 1953-54 to provide protection to vast areas under Tingkhong, Tengakhat and Moran Revenue Circle under Dibrugarh District. The details of the embankment system is already given above. The proposed R/S works are tabulated below. Moreover, provision for R/S to sub-tributary dykes of the Tipling river and Tingrai river are also made as they are also exist in dilapidated conditions.

LEFT BANK EMBANKMENT					
Sl No.	Index No.		Name of Embankment	Length in Km	Proposed length
1	E	39	T/Dyke along L/B of Buridehing river from Chippibsti to Mollong	2.7	2.7
3	E	31	T/Dyke from Joypur to Naharkatia	7.2	7.2
4	E	19	Dehing bund 1st section from Aghunibari to Sessughat (WEST)	25.2	25.2
5	E	12	Dehing bund 1st section from Aghunibari to Sessughat (EAST)	9.1	9.1
6	E	16	Extension of SassoniTingkhong Bund Ph - I	12.8	12
7	E	17	Extension of SassoniTingkhong Bund Ph - II	15.3	5.5
9	E	11	Dehing bund old AT road Sessughat to Joan gaon	5.1	5.1
10	E	22	Tie bund of Gela Desam	7.2	7.2
Total				77.5	74.00

Sl No.	Index No.	Newly Proposed Left Bank Embankments	Proposed Length of Embankment (In Km)
11	E 40	EXTENSION OF T/DYKE ALONG THE L/B OF BURIDEHING RIVER FROM CHIPPIBASTI TO MOLONG GAON	2.1
Total			2.1

TOTAL LENGTH OF EXISTING EMBANKMENT FOR UPGRADATION	154.98 KM
TOTAL LENGTH OF TRIBUTARY DYKE FOR UPGRADATION	17.90 KM
TOTAL LENGTH FOR NEW/EXTENSION OF EMBANKMENT	10.60KM
TOTAL	183.48 KM

3.9.3 PART C:
Renovation of existing sluice gates

There are several sluice gates at various locations of the existing embankments which were built long back and are in a state of deterioration due to lack of timely repairs. Even though most of the sluice gates are still functional, with the up gradation of the embankments to the latest norms of CWC, the barrel lengths of the sluices are proposed to be extended to maintain minimum width of embankment crest. Also considering future provisions of usage of embankments for communication and conversion into arterial road cum embankment, the barrel lengths are proposed to be lengthened sufficiently to accommodate future widening of embankment.

The various sluices and the proposals are tabularized as follows:

SLUICE GATES				
Sl. No.	Sluice Code	Location	No. of cells	Status/nature of works proposed
1	E-09/1	94° 52' 0.405" E, 27° 18' 6.292" N	Single	Damaged, to be newly constructed
2	E-09/2	94° 49' 52.324" E, 27° 17' 3.133" N	Single	Partially Working, Damages to be restored & barrel length to be extended
3	E-12/1	94° 51' 54.115" E, 27° 15' 44.940" N	Single	Damaged, to be newly constructed
4	E-12/2	94° 50' 10.440" E, 27° 15' 46.117" N	Single	
5	E-12/3	94° 47' 52.406" E, 27° 15' 2.192" N	Single	
6	E-13/1	95° 11' 26.109" E, 27° 21' 42.862" N	Single	Partially Working, Damages to be restored & barrel length to be extended
7	E-13/2	95° 10' 12.668" E, 27° 21' 4.927" N	Single	Working Condition, Barrel length to be extended
8	E-13/3	95° 9' 5.404" E, 27° 21' 22.309" N	Single	
9	E-14/1	95° 6' 16.281" E, 27° 19' 51.711" N	Single	
10	E-14/2	95° 1' 55.791" E, 27° 21' 4.219" N	Double	Working Condition, Barrel length to be extended
11	E-14/3	95° 1' 28.394" E, 27° 21' 18.295" N	Single	

12	E-14/4	94° 59' 33.686" E, 27° 22' 40.825" N	Single	
13	E-14/5	94° 58' 45.528" E, 27° 21' 25.449" N	Single	
14	E-15/1	94° 56' 19.703" E, 27° 20' 18.703" N	Single	
15	E-15/2	94° 53' 57.598" E, 27° 19' 27.793" N	Single	Partially Working, Damages to be restored & barrel length to be extended
16	E-15/3	94° 53' 16.701" E, 27° 19' 14.441" N	Single	Working Condition, Barrel length to be extended
17	E-15/4	94° 52' 43.277" E, 27° 18' 40.289" N	Single	
18	E-16/1	95° 11' 21.297" E, 27° 20' 11.778" N	Single	Damaged, to be newly constructed
19	E-16/2	95° 10' 49.643" E, 27° 19' 51.058" N	Single	
20	E-16/3	95° 10' 28.344" E, 27° 19' 53.860" N	Double	
21	E-16/4	95° 8' 48.477" E, 27° 19' 41.922" N	Single	Partially Working, Damages to be restored & barrel length to be extended
22	E-16/5	95° 7' 27.537" E, 27° 19' 19.467" N	Single	
23	E-19/1	94° 57' 45.383" E, 27° 19' 37.381" N	Single	Working Condition, Barrel length to be extended
24	E-23/1	95° 13' 26.517" E, 27° 22' 34.106" N	Single	
25	E-23/2	95° 12' 19.632" E, 27° 21' 40.979" N	Single	
26	E-24/1	95° 13' 48.589" E, 27° 22' 16.926" N	Single	
27	E-24/2	95° 13' 34.966" E, 27° 22' 12.628" N	Single	
28	E-24/3	95° 13' 25.988" E, 27° 22' 7.638" N	Single	
29	E-24/4	95° 12' 55.086" E, 27° 21' 50.814" N	Single	Completely damaged, to be newly constructed
30	E-25/1	95° 16' 27.607" E, 27° 19' 13.474" N	Single	Working Condition, Barrel length to be extended
31	E-25/2	95° 14' 55.720" E, 27° 20' 3.335" N	Single	
32	E-25/3	95° 14' 41.504" E, 27° 20' 10.938" N	Single	
33	E-25/4	95° 14' 35.620" E, 27° 20' 16.783" N	Double	
34	E-25/5	95° 13' 39.088" E, 27° 20' 54.950" N	Double	
35	E-27/1	95° 20' 46.368" E, 27° 20' 20.795" N	Single	Partially Working, Damages to be restored & barrel length to be extended
36	E-27/2	95° 19' 44.715" E, 27° 20' 32.318" N	Single	Damaged, to be newly constructed
37	E-27/3	95° 19' 40.636" E, 27° 20' 28.585" N	Single	
38	E-27/4	95° 19' 30.154" E, 27° 20' 3.973" N	Single	Partially Working, Damages to be restored & barrel length to be extended
39	E-28/1	95° 20' 21.353" E, 27° 20' 13.481" N	Single	Damaged, to be newly constructed

3.9.4 PART D:

Anti-erosion works at different vulnerable reaches on both bank of Buridehing River

As explained above, there are several reaches which are in critical condition due to severe bank erosion. If these vulnerable locations are not protected with permanent anti erosion works, the erosion may eat away the embankment section and breach of embankment may occur during high stage of flood. Therefore. To tackle the situation, provision of anti-erosion works are provided and the list of locations with proposed length for A/E work is given bellow.

However, the scope of work included in the previous DPR have 37 locations & were on the basis of the river configuration and the erosion affected reaches during 2018. In the meanwhile, severe bank erosion occurred at number of places and were immediately restored under different head of accounts. It is to be added that the pervious reaches were further more extended towards D/S and U/S. There are four new locations where erosion got activated and are incorporated in this revised DPR.

As such Total Nos. of Protection Reach = 1. 37 (Old locations) +
2. 10 (Extension at U/S or D/S) +
3. 4 (new AE-11, AE-39, AE-45 & AE-49)
} 51 Nos.

The new locations incorporated in this revised DPR are located in between the existing locations of the previous DPR. As such same design has been adopted.

Sl. No.	Reach	Co-ordinate of		Reach Length in m
		Starting Ch.	End Ch.	
AE-1	MANMOW PATHAR	27°21'29.38"N 95°46'32.72"E	27°21'35.70"N 95°46'5.49"E	800
AE-2	MOULANG GAON	27°19'29.11"N 95°43'49.04"E	27°19'37.67"N 95°43'17.96"E	1000
AE-3	BORFAKIAL-A	27°20'8.48"N 95°42'43.15"E	27°19'54.32"N 95°42'32.74"E	600
AE-4	BORFAKIAL-B	27°19'45.24"N 95°42'35.29"E	27°19'13.61"N 95°42'36.17"E	1000
AE-5	BANSBARI	27°18'3.03"N 95°42'15.22"E	27°17'48.00"N 95°41'50.08"E	1000
AE-6	TANTIPATHAR MANIPURI BASTI A	27°15'35.97"N 95°24'14.19"E	27°15'42.55"N 95°24'6.33"E	300
AE-7	TANTIPATHAR MANIPURI BASTI B	27°15'53.80"N 95°23'58.39"E	27°15'59.71"N 95°23'55.54"E	200
AE-8	NOCTE GAON	27°16'51.72"N 95°23'22.84"E	27°17'11.87"N 95°23'11.48"E	700
AE-9	KONWARGAON A	27°17'46.66"N 95°22'58.60"E	27°17'52.22"N 95°22'39.45"E	600
AE-10	KONWARGAON B	27°17'50.04"N 95°22'31.01"E	27°17'44.61"N 95°22'14.40"E	500
AE-11	UTTAMMATI	27°17'24.03"N 95°21'17.05"E	27°17'40.90"N 95°21'3.40"E	650
AE-12	BAMUNGAON-1	27°18'7.45"N 95°20'52.34"E	27°18'9.51"N 95°20'42.64"E	280
AE-13	BAMUNGAON-2	27°18'5.62"N 95°20'28.61"E	27°18'0.57"N 95°20'17.61"E	340
AE-14	JAGUNGAON	27°18'4.55"N 95°19'46.00"E	27°18'22.93"N 95°19'51.06"E	600

AE-15	NAGAON 1	27°18'34.42"N 95°20'7.20"E	27°18'41.48"N 95°20'8.76"E	220
AE-16	NAGAON 2	27°18'46.88"N 95°20'8.93"E	27°19'4.75"N 95°20'1.10"E	595
AE-17	BORDOLOICHUK	27°18'48.77"N 95°17'57.95"E	27°18'31.08"N 95°17'42.39"E	700
AE-18	MOHMARI	27°19'5.14"N 95°16'31.28"E	27°19'16.75"N 95°16'20.29"E	500
AE-19	AMGURI	27°19'26.02"N 95°15'53.67"E	27°19'35.28"N 95°15'30.39"E	700
AE-20	PANCHUTI	27°20'0.55"N 95°14'53.08"E	27°20'8.05"N 95°14'31.11"E	650
AE-21	TINGRAI NEPALIGAON A	27°20'54.63"N 95°13'40.66"E	27°21'3.01"N 95°13'28.72"E	450
AE-22	TINGRAI NEPALIGAON B	27°21'6.05"N 95°13'19.81"E	27°21'6.24"N 95°13'16.59"E	90
AE-23	TINGRAI NEPALIGAON C	27°21'7.98"N 95°13'4.82"E	27°21'10.44"N 95°12'58.19"E	410
AE-24	KAIBARTAGAON	27°21'9.78"N 95°12'23.14"E	27°21'16.11"N 95°12'10.59"E	400
AE-25	URIAMGURI	27°20'10.00"N 95°10'14.00"E	27°20'27.19"N 95° 9'58.17"E	700
AE-26	BAMUNIBEEL	27°19'43.13"N 95° 8'47.24"E	27°19'42.07"N 95° 8'36.48"E	300
AE-27	KOLAGORA	27°19'22.77"N 95° 6'46.57"E	27°19'27.75"N 95° 6'29.80"E	400
AE-28	SESSA NEPALI	27°19'1.58"N 95° 5'15.66"E	27°19'3.31"N 95° 4'54.88"E	600
AE-29	DEHINGHOLLA	27°19'37.35"N 95° 5'55.52"E	27°19'20.42"N 95° 5'25.15"E	1000
AE-30	AGHUNIBARI	27°18'29.93"N 95° 3'34.05"E	27°18'39.41"N 95° 3'32.05"E	300
AE-31	SOLOGURI	27°19'25.95"N 95° 2'18.53"E	27°19'32.27"N 95° 2'1.97"E	500
AE-32	TELPANI BONGAON	27°20'17.93"N 95° 2'28.83"E	27°20'33.48"N 95° 2'26.26"E	500
AE-33	KORAIGURI	27°20'44.47"N 95° 1'58.18"E	27°20'37.98"N 95° 1'41.74"E	500
AE-34	SINGIMARI	27°21'28.28"N 95° 1'13.24"E	27°21'29.83"N 95° 0'55.27"E	500
AE-35	BHURBHURI-1	27°22'6.18"N 95° 0'8.90"E	27°22'54.94"N 95° 0'0.86"E	2150
AE-36	BHURBHURI-2	27°21'26.14"N 94°58'52.46"E	27°21'13.86"N 94°58'39.89"E	515
AE-37	BORBEEL A	27°20'58.64"N 94°57'59.20"E	27°20'53.80"N 94°57'41.03"E	525
AE-38	BORBEEL B	27°20'40.67"N 94°57'25.08"E	27°20'28.48"N 94°57'20.34"E	400
AE-39	CHARAIHABI KHAMTIGHAT	27°20'15.74"N 94°57'24.68"E	27°20'4.37"N 94°56'59.31"E	880
AE-40	KOLOLUA DEORI GAON	27°18'25.72"N 94°54'49.40"E	27°18'47.03"N 94°54'28.61"E	1125

AE-41	NATUNBOLAI	27°19'15.97"N 94°54'17.51"E	27°19'13.14"N 94°53'56.64"E	600
AE-42	KOTOHA	27°19'1.52"N 94°53'11.69"E	27°18'46.48"N 94°52'56.70"E	675
AE-43	BHOGAMUR A	27°17'53.22"N 94°50'49.57"E	27°17'15.36"N 94°50'25.14"E	600
AE-44	BHOGAMUR B	27°16'59.52"N 94°50'28.62"E	27°16'42.36"N 94°50'29.68"E	300
AE-45	PANIMIRI	27°17'25.46"N 94°48'27.13"E	27°17'26.31"N 94°48'12.21"E	450
AE-46	JHANJIMUKH GAON	27°16'45.78"N 94°47'57.71"E	27°16'30.02"N 94°48'1.37"E	500
AE-47	SESSUGHAT A	27°15'17.72"N 94°47'57.29"E	27°15'3.13"N 94°47'50.82"E	300
AE-48	SESSUGHAT B	27°15'0.17"N 94°47'47.38"E	27°14'54.85"N 94°47'38.55"E	300
AE-49	CHARAIBAHI	27°15'3.89"N 94°47'1.96"E	27°14'55.85"N 94°46'46.50"E	500
AE-50	ITAKHULI	27°14'35.83"N 94°46'13.74"E	27°14'50.11"N 94°45'56.71"E	700
AE-51	THANGAON	27°14'57.16"N 94°45'3.81"E	27°14'57.26"N 94°44'34.86"E	700
Total				**29805**

Porcupine works:

Provision of porcupine screen works have also been proposed at upstream and down steam of the proposed 51 nos. of anti-erosion work to minimize intensity of flow and also to augment the protection work by conditioning the river flow for depositing the silt along the protected reach. It is also to substantially reduce the cost of the project by supplementing the permanent anti erosion structure by diverting the current away from the affected reaches at the protection reaches.

3.9.5 Specifications of work

Specifications of earth work in embankment are as follows:

1) *Crest width – 6.00m*
2) *River side slope - 2:1*
3) *Country side slope - 3:1 and 0.60m coverage over H.G line of 6:1 with 1.50M berm*
4) *Hydraulic Gradient - 6:1*
5) *Free Board - 1.50m above the designed H.F.L.*

Specifications of anti-erosion works are as follows:

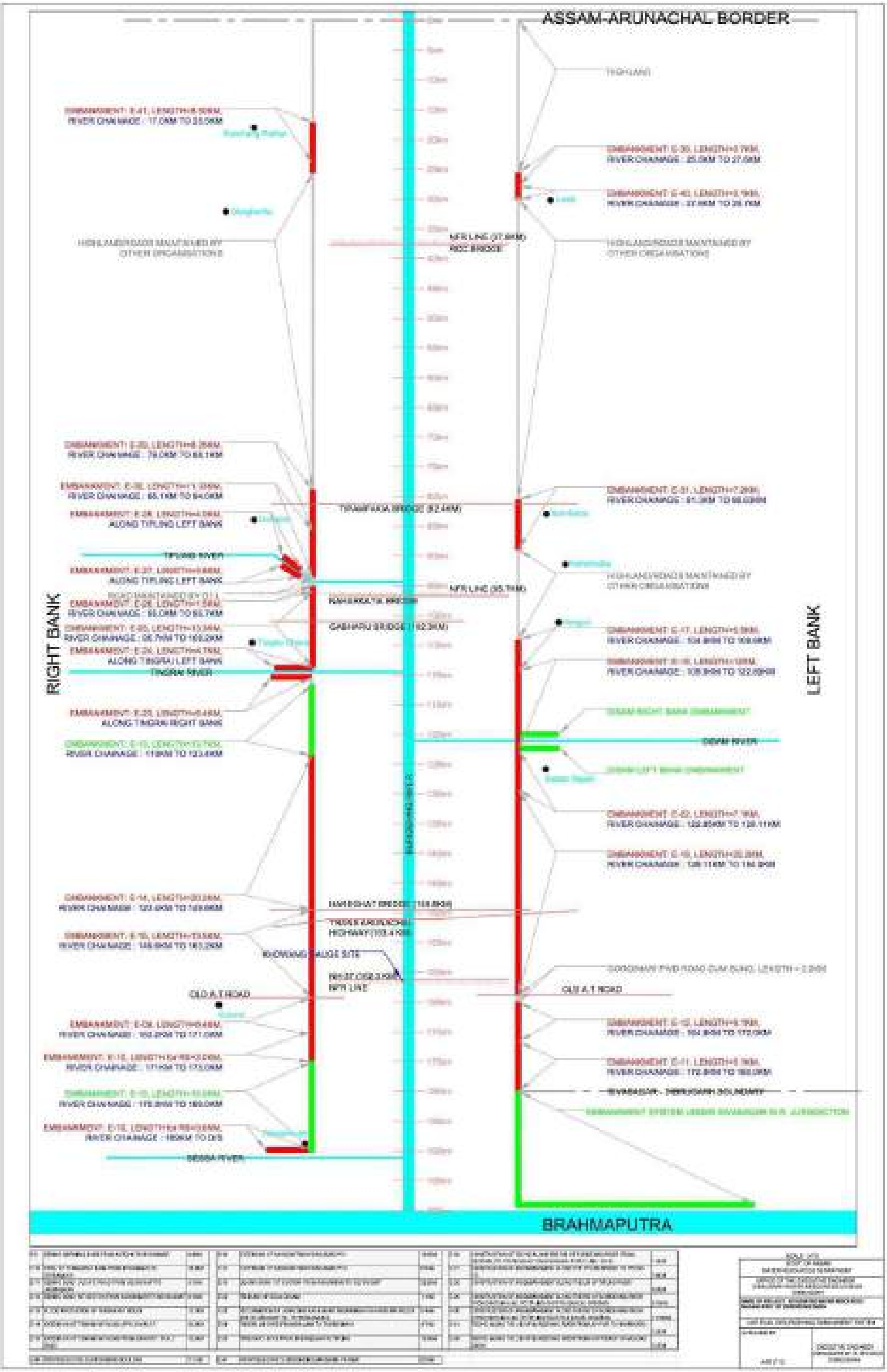
1) *Apron of size 16.50m Width x 0.60m Thickness (Type-A geo-bag) (Thickness as directed by TAC)*
2) *Slope pitching with cc block of size 0.30m X 0.30m X 0.30m over geo-textile filter media on trimmed bank slope of 1:2 for 5.190km*
3) *Toe-key of PVC coated wire netting cages of size 1.50mx1.50mx0.45m in two layers filled with sand filled geo-bags*
4) *Porcupine screens in double layers@ 60m intervals at U/S & D/S of proposed anti-erosion reaches. 6Nos of screens at both U/S & D/S.*

3.9.6 PART E:

Construction of interlocking concrete block pavement for 139.44 Km with a carriageway width of 4.00m. This length of embankment has been considered on priority basic for conversion to road cum bund. The left out portion will be taken up for road conversion in the future and as such crest width has been kept similar to accommodating pavers block carriageway.

Sl No.	Embankment	Length in Km	Remarks
1	E-12	9.10	
2	E-19	25.20	
3	E-9	8.40	
4	E-14	20.20	
5	E-15	13.50	
6	E-22	7.10	
7	E-16	10.40	- 1.6 Km BT
8	E-17	5.50	
9	E-25	13.30	
10	E-29	8.25	
11	E-30	11.33	
12	E-31	7.20	
Total Length		139.48	

The Road work is as per MORD (Ministry of Rural Development) Specifications for Rural Roads 2014, Line plan diagram for works on embankment system proposed in this DPR (Enlarged Map in Drawings Section)



3.10 Design features

While preparing this DPR, all designs are prepared as per the relevant IS Codes and specifications as described in the manual "Guidelines for preparation of DPR for Flood Management Works" of the CWC published on April 2018.

3.11 Basis of rates & cost estimates

The cost estimate has been prepared adopting the approved rates of SoR of WR for 2018-19, SoR of WRD Assam 2020-21 (as per circular no. WR (ED) Tech/7728/2021/10 on Dt. 08/11/2021 & WR (ED) Tech/7728/2021/11 on Dt. 29/11/2021) approved rates of W.R. Dept., Govt of Assam and as APWD 2020-2021 (Rural Roads). Preliminary survey works have been conducted to determine the BOQ of materials for this DPR, however detailed survey works will have to be conducted before commencement of works. All the works will be carried out as per general specification of APWD/ W.R.D and with the approved rates.

3.12 Benefit cost ratio

After execution of the scheme, approximately 6,00,000 no of population and 65,000 Hectare of area is likely to be benefited covering a vast thickly populated areas covering many prosperous towns and villages of District of Dibrugarh and Tinisukia. Besides these prosperous villages, a number of Govt. & private buildings, educational institutions, public utilities, vast agricultural land etc. are to be benefited from the implementation of this project.

The Annual Benefit is considered on the basis of the documents available for annual loss of life and properties, agricultural crops, cattle etc. at 2020-21 price level.

The Benefit Cost ratio is calculated as 1.97:1.

3.13 Construction material and construction program

The various construction materials required for the various works of the project are readily available adjacent to the project sites or by demand on the local market.

3.14 Socio-economic aspects

A sustainable development in the region cannot be achieved without Water Resource Development in Brahmaputra river basin. To that end an integrated basin wise approach is needed considering social, political, economic, administrative, cultural and legal consideration with scientific and technological approach

It is widely acknowledged that the Assam plains depend fundamentally on flood protection through embankments independently of all future storage dam concepts as explained above. The construction of embankment on both bank of Buridehing river for flood protection, have been successful, though in few situation, washing away of embankment due to erosion and retirements of embankment, occurred due to meandering as well as widening of the Buridehing river.

Though in earlier cases since 1970's the retirement of the embankment was practiced frequently to prevent flood inundation due bank over spill, however, there were general opinion that permanent retirement is no solution (MoWR, 1988) and in fact local people object in places to the construction of another retired embankment (ADB, 2006). Embankments are widely accepted as cost-effective flood protection. Ideally embankments are built sufficiently away from river, which, however, is socially undesirable due to the increased land-use and fact that large parts of the more densely populated areas along the higher natural levees would be kept outside the flood protection. Due to the flood protection provided by the embankment and due increase in demand for land followed by gradual encroachment to the flood plain, the retirement of the embankment was gradually being avoided. It is also been opined that the existing embankment system has been effectively providing flood protection to vast agricultural land including many townships and other valuable installation etc, and as such the efficacies of the existing dyke system has been time-proven. However, the present deplorable condition of the dyke is the major cause of concern and to avoid any eventuality in the future, its upgradation is very much essential. Beside the upgradation of the both bank embankment of Buridehing dyke, the affective protection from bank erosion which has been endangering the safety of the existing dyke, is to be addressed to have an overall benefit from the existing flood protection structures. Therefore, presently appropriate bank protection measures are being executed at vulnerable locations to provide embankment stability by protecting flood embankments and abandoning the practice of permanent retirement. The setback is the comparatively high cost and little availability of funds.

The existing age-old Buridehing dyke are weak and reduced in its design sections. The crest level is mostly bellow design specification for flood protection against the design flood level. As such they have a limited degree of flood protection and not reliable. As such have noticeable impacts on the development. Frequent embankment breaches, flooding and drainage problems are major causes of disaster, distress, and poverty. Therefore, the productivity of the areas is low. Farmers demonstrate risk-averse behavior by planting only the minimum for their own consumption while the development of pond fisheries suffers from the risk of flooding and losing the catch. Overall, the poverty incidence is above national average in most of the project areas. Even though substantial investments have been made in the past into embankments but in most cases these investments were made on segmental and priority reaches and as such, they lacked any comprehensive and integrated approach. Such piecemeal investment approach is now observed to be insufficient and as such, its purpose of providing stability not achieved. Embankments only protect from flooding if they provide complete protection without any breach or unclosed gaps.

The implementation of the scheme will ensure the safety of huge population, major communication systems, huge public and govt. properties etc. within the benefited area and will boost the socio-economic development of the area.

3.15 Environmental aspects

The project mainly incorporates raising & strengthening of the embankment system of Buridehing River along with stabilization of the erosion prone reaches only. The works of the project will maintain the natural flow course of the river as no diversion or obstruction of flow by construction of headworks is proposed here. Thus, on implementation of this project there will be no environmental interferences.

3.16 Status of Administrative and Statutory clearances from State/Central Govt. Authorities :

The necessary approval and recommendation of the proposed memo of Works (reviewed) has been accorded by the 82nd (Special) Meeting of State T.A.C. held on Dtd. 18th May'2021 for an amount of Rs. 1105.523 Cr. The revised memo of works envisages additional protection reach length of 9.065 Km, increase of Earth work crest width to 6.00 m instead of 5.00m for accommodating interlocking concrete block pavement, supply of sand for geo bag filling and compaction of earthwork.

However, this Detailed Project Report has been framed with rates adopted from the Schedule of rates of APWD 2020-2021 (Rural Roads), APWD 2018- 2019 (State Highway) & WRD Assam 2018-19 as per direction of the Chief Engineer, Water Resources Department, Guwahati on Dt. 12/08/2021. And again, the rates have been adopted for major items as per WRD Assam Circular WR (ED) Tech/7728/2021/10 on Dt. 08/11/2021 & WR (ED) Tech/7728/2021/11 on Dt. 29/11/2021.

After having sanction from the competent authority of the Central Govt., Administrative Approval will be accorded by the State Govt. and the Technical Sanction will be given by the Water Resources Department, Assam. As the scheme is proposed to raise and strengthen the existing dyke under Water Resources Department by earth work and parts of the embankment falls under Forest area, the clearance from Forest Departments are also accorded. The scheme is also not related to any pollution related activities and hence clearance from the Pollution Control Board is not felt necessary.

3.17 Readiness for implementation of the project:

The implementation agency will be the Water Resources Department, Govt. of Assam. The Executive Engineers of the Dibrugarh W.R. Division will be the Nodal officer and in-charge of the project. The implementation team will comprise of the Executive Engineer W.R. Department with his highly-experienced Field Engineers with proper guidance from the Chief Engineer W.R. Deptt, the Additional Chief Engineer, Upper Assam Zone and the Superintending Engineer, Nagaghuli Maijan Protection Circle, Water Resources Department.

The major construction material of the scheme is earth which is available in the nearby areas. The Geo-bags, geofilter, PVC coated crates, PSC porcupine etc. for the protection work are available in the market and could readily be supplied. The construction materials of RCC porcupines etc. are also readily available from local factories.

Therefore, the scheme may be started immediately as soon as receipt of the sanction from the concerned authorities of the Central and State Govts.

3.18 Phasing of the Project:

i) Estimated Cost ;

The estimated cost comes out to be 850.214 Cr adopting the latest norms and rate.

3.18.1 Physical and Financial Phasing:

3.18.1.1 Physical:

Time Frame

Physical		Period
i)	Detailed Surveys, finalisation of BOQ, soil investigation, Technical Sanction etc.	1 month.
ii)	NIT & Issue of work order	2 month.
ii)	Time of completion.	36 months (Three working seasons)

3.19 Recommendations

The benefit-cost ratio of the project has been found to be justified and it found to be 2.28:1. The benefited area consists of several revenue villages of Dibrugarh & Tinsukia District.

The Project will fit in with the overall structure of the Master plan for flood control pertaining to the Buridehing River prepared by the Brahmaputra Boards. The flood and erosion protection measures taken up under various head of accounts provide a comprehensive and integrated approach to the flood and erosion management works for Dibrugarh &Tinsukia districts.

For an integrated comprehensive Flood and Erosion Management Project to tackle the flood and erosion activity by Buridehing and also to maximize the result of the existing flood and erosion management works, subsequent implementation of work proposed under "Flood and River Erosion risk management works on the both banks of Buridehing River Basin" is outmost necessary.

Therefore, immediate implementation of the scheme is required to derive maximum benefit of the overall works under Dibrugarh WR Division.

Strips of land in the Buridehing valley being highly valuable due to density of population, oil fields, tea estates, fertile agricultural land, and a vast potential for pisciculture and horticulture, existence of nos. of Govt. & Public institutions & steps to preserve such land are highly essential at present. Keeping this in mind, importance of improvement of the above area has become a top priority. The scheme is found to be the only viable solution to protect the area from flood inundation, erosion & sloughening both technically and economically and hence, is highly recommended.

Executive Engineer
Dibrugarh Water Resources Division,
Dibrugarh

CHAPTER 4: Prioritization of schemes

4.1 PRIORITIZED PROJECT LOCATION AREAS

Within the flood plains of Assam the prioritized project sites are located at the following two stretches of the river

i) The stretch within the flood plains of Assam from the interstate border to downstream of Margherita upto the Dehing-Patkai Wildlife sanctuary

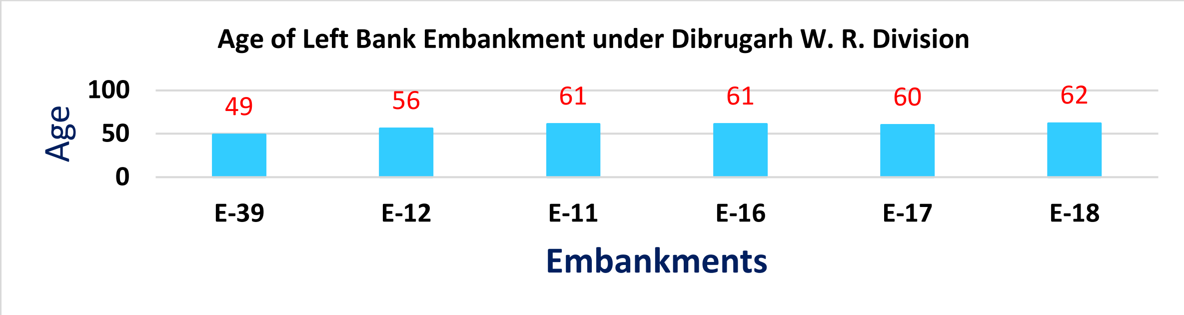
This stretch of the river from the interstate border to about 46km downstream upto Dehing-Patkai Wildlife Sanctuary where the soil characteristics is of alluvial nature. Here the river tends to meander, thereby causing erosion at several concave bends. Most of the banks are high and bank spillage during high stages is insignificant except for a few reaches. In this stretch of the river, the locations proposed for various works are Manmow Pathar, Moulang, Borfakial, Bansbari & Maichang Pathar which are thickly populated, besides the area being highly industrialized with tea-estates and coal mines. Notable townships of Ledo & Margherita with important industries of Tea, Oil & Coal Mines, Railway installations etc are located in this stretch of the river. In this stretch of river, a new embankment is proposed to protect a thickly populated area of Maichang Pathar on the right bank and also a new embankment is proposed to be constructed on left bank at Moulang near Ledo, where an existing embankment had already been washed off by erosion.

ii) The stretch from Jeypore at the upstream of Naharkatia Town to the out fall at Buridehing into river Brahmaputra.

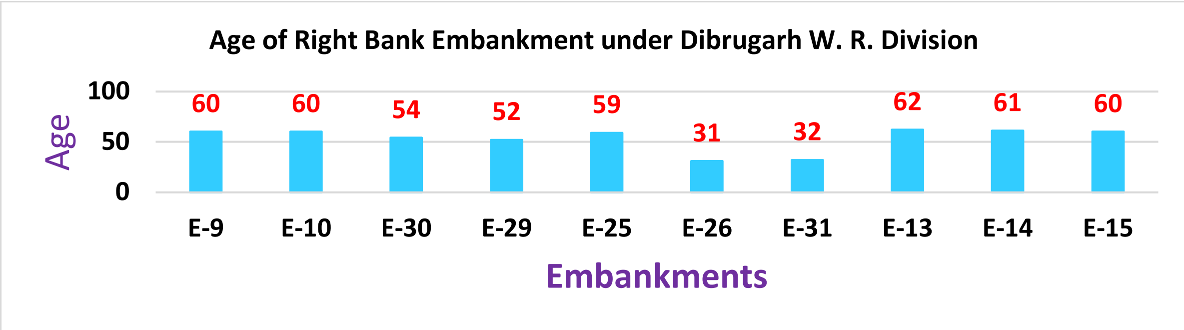
Most of the project sites are located in this stretch which includes up gradation of the embankment system and bank stabilization of erosion prone reach at locations with high significance of population, industries , agricultural land and tea-estates, oil mining areas etc. Important areas like Naharkatia, Duliajan, Jagun, Tengakhat, Sassoni, Khowang etc are located within this stretch of the river.

Here the river flows through alluvial soil and severe meandering has been observed since the past decades from satellite imageries. Most of the banks at this stretch of river are overtopped by flood water during high stage and thus both the banks of the river in this stretch are fortified with embankments for flood protection to the adjacent areas. The river is very problematic here due to the meandering tendency, which causes severe erosion and eventually erodes away parts of embankments. Moreover with the increase of population and development of the areas at these locations, the existing embankment system also serves as the arterial link for communication of the people of these area. Areas benefited by these embankment system are villages like *Thangaon, Bordoibam, Majgaon, Moinamirigaon, Dighaliagaon, Chakoipather, Gohaigaon, Itakhuligaon, RongagoraMishinggaon, Bharatchukgaon, Panimirigaon, Jajimukhgaon, Kolakhowa, Bhabanigaon, Gojaigaon, KolakhowaCharialigaon, Bam Kolakhowa, Kutuha, Bhogamur, Baligaon, KotuhaBarbeel, KutuhaHalmari, Naojan, Baruahgaon, Panigaon, Rongagor, Dalnikur, Goroimari, Barbeel, Mainamirigaon, Haldhibarichetiagaon, Joangaon, Namphakial, Tingraigaon, Tingrai Nepali gaon,Kolagora, Bantona, Pandhuwaghat, Bamunibeel, Uriumguri, Kolagora, NatunBharali, NatunBolai, HologuriDeurigaon, Hingari, Thangaon, Bhogmur, ,etc*

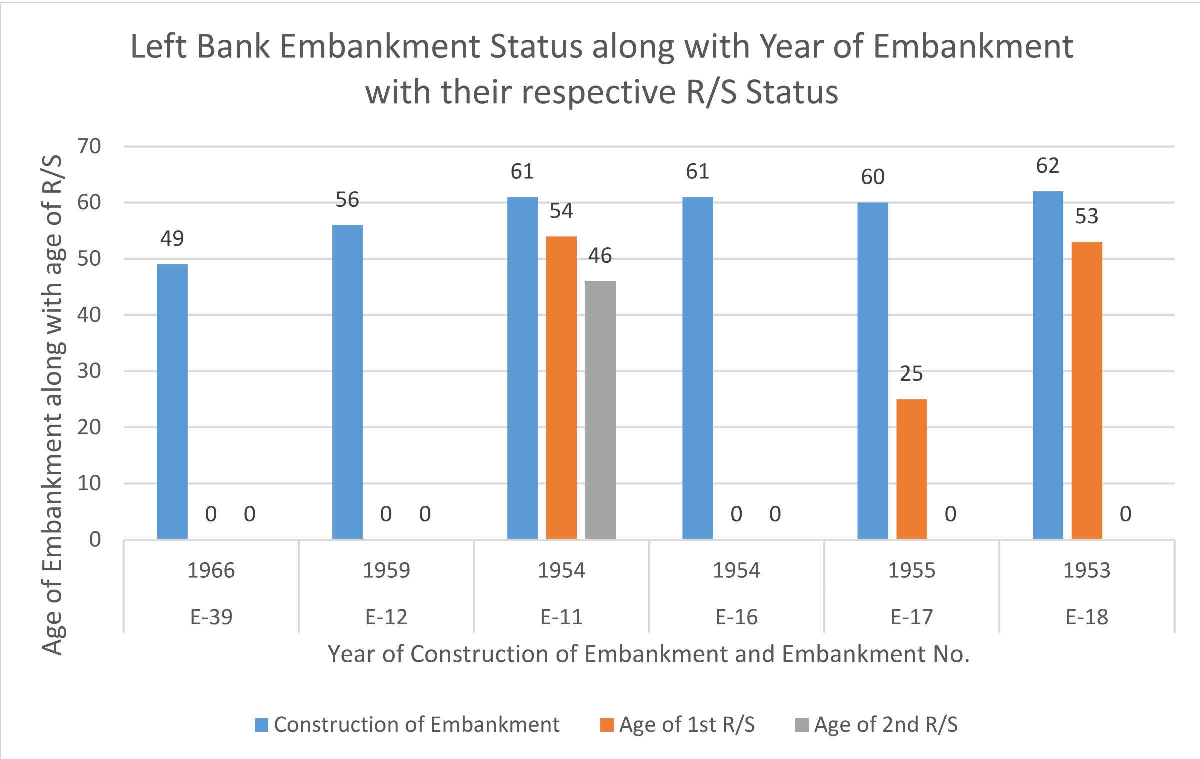
In addition to the above areas, several problematic reaches of erosion and bank spillage during high stage of flood are not considered in this DPR due to insignificant population and other factors of importance like agricultural productivity, existence of nearby road and railways etc



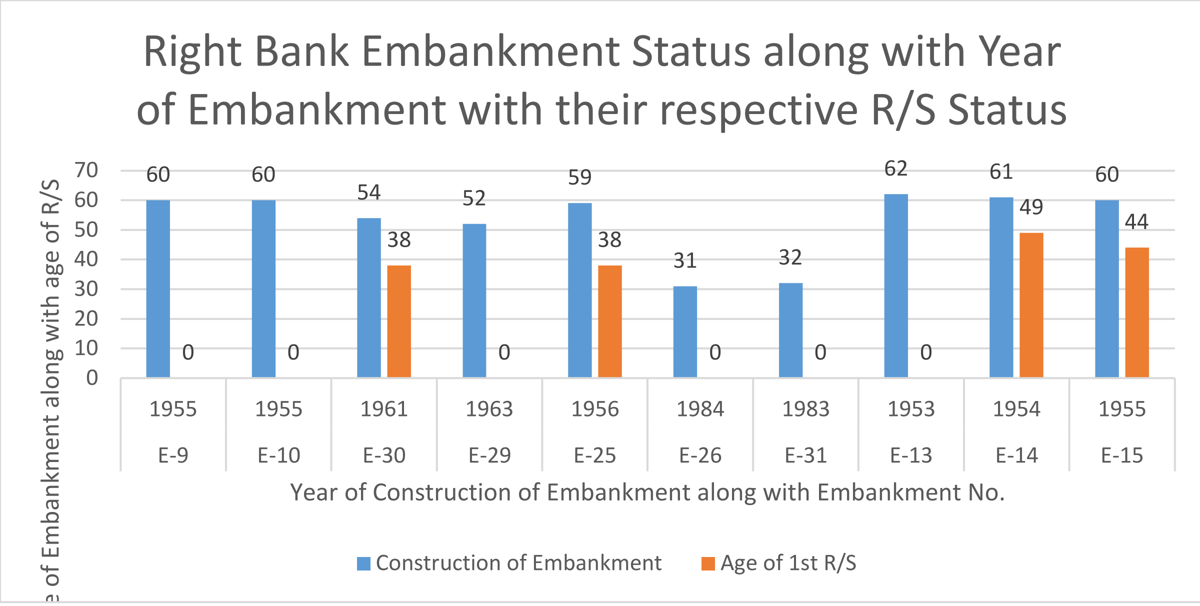
Age of Left Bank Embankment under Dibrugarh W. R. Division
Age
100
50
0
49
56
61
61
60
62
E-39
E-12
E-11
E-16
E-17
E-18
Embankments



Age of Right Bank Embankment under Dibrugarh W. R. Division
Age
100
50
0
60
60
54
52
59
31
32
62
61
60
E-9
E-10
E-30
E-29
E-25
E-26
E-31
E-13
E-14
E-15
Embankments



Left Bank Embankment Status along with Year of Embankment with their respective R/S Status
Age of Embankment along with age of R/S
70
60
50
40
30
20
10
0
49
0
0
56
0
0
61
54
46
61
0
0
60
25
0
62
53
0
1966
E-39
1959
E-12
1954
E-11
1954
E-16
1955
E-17
1953
E-18
Year of Construction of Embankment and Embankment No.
Construction of Embankment
Age of 1st R/S
Age of 2nd R/S



4.2 LONG TERM STRATEGY & SHORT TERM PLANS:

4.2.1 Road cum bund up gradation:

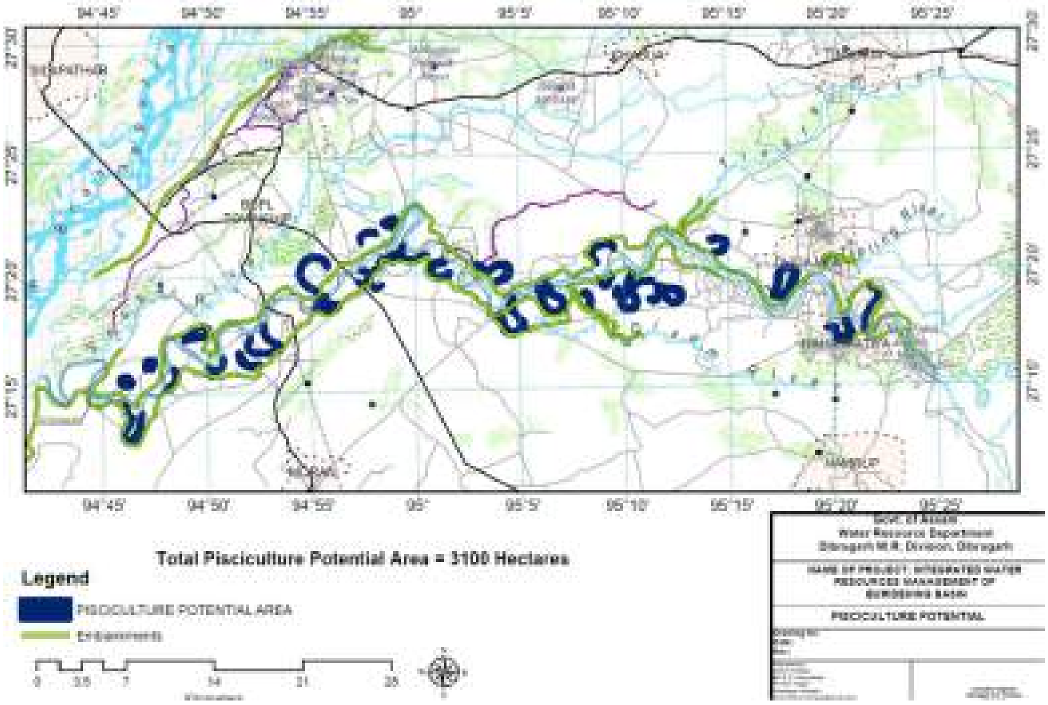
As stated above, as a flood protection structure on both bank of the river Buridehing, a series of embankments were constructed in 1960's-70's. The total length of the both bank embankment is 205.04Km out of which 90.00Km is on left bank and 115.04Km is on right bank. As these embankments traverse mostly through rural inhabited areas, as such these dykes are the only means of surface communication to the rural conglomerations. In some location, some portion of these embankments are being converted to gravel road under local rural Panchayat raj institution, however, in most cases due to non-maintenance the crest of the embankment get damaged due to frequent plying of vehicles.

The frequent movement of vehicles on these embankments further deteriorates its structural condition which has already been in bad shape due to natural wear and tears. These embankments has not been upgraded with raising and strengthening works and therefore, are reduced in sections. Therefore, along with the upgradation of these embankment with earth work, to make it more sustainable and durable, these embankment structures are proposed be upgraded to paved with interlocking cement concrete blocks at specific reaches with more density of population with appropriate specification by component authority. Moreover, there exist several horse shoe type water bodies formed due to cutting of the meandering loops and several wetlands along the Buridehing River which have tremendous potential of being developed for fisheries as well as ecofriendly tourist attraction stations.

The improvement and upgradation of these parallel roads would not only link up many rural areas for socio-economic activity, but also provide necessary impetus to growth many ethnically, historically and culturally significant areas which are located areas and now remain in oblivion due to loss of physical link. Development of link road to these significant areas boast the socio-economic activities of these areas by way of tourist attraction spots of cultural heritage temples, historical monuments eco-diversity natural parks. These areas could be developed to their full potentials. In these the utilization of the embankment as a means of linking networks with proper upgradation would minimized the infrastructural development cost. Such upgradation of the embankments into all season road with appropriate specification / black topping etc. would also make these embankment structure more sustainable and durable.

4.2.2 Wetland conservation and Fisheries:

Assam is endowed with copious aquatic wealth in the form of beels, swamps, ponds and rivers. The floodplain wetlands (beels), extending over one lakh hectare, constitute the most important fishery resource of the state. The average productivity of Assam beels is 150-200 kg./ha/year.



Wetlands are unique ecosystems which provide water and habitat for a diverse range of plants and animals. Natural wetlands occur where surface water collects or where groundwater discharges to the surface. Due to the water filtration processes, which occur at wetlands, they are sometimes referred to as the ‘kidneys’ of a catchment area.

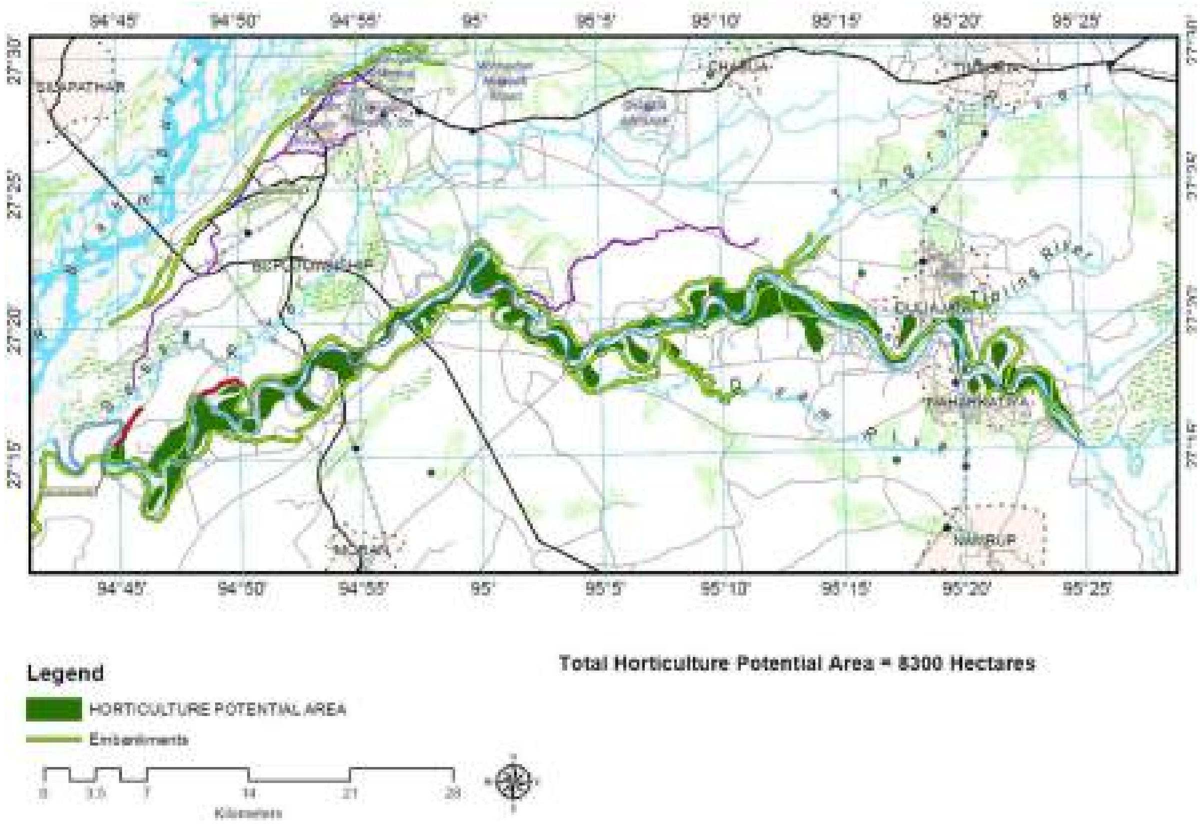
In addition to hosting a wide variety of plant and animal life, wetlands also provide water storage, filtration and offer us protection from floods. Now, almost everyone has recently put focus on restoration and wetland creation.

Wetland environments have a variety of important functions in natural and urban areas including: Wildlife support, Water detention, Improving water quality, Flood control, Erosion control, Groundwater aquifer recharge, Coastal buffer zones, Natural fire breaks, Education, Eco–tourism, Recreation.

It is therefore felt to be an imperative need to conserve these wetlands and protect their unique biodiversity. If properly managed, the wetlands are going to be a source of immense wealth for this state leading also to enrichment of the quality of its environment

4.2.3 Horticulture Potential

The banks of the river are highly fertile being, top soil being replenished every flood by fertile deposits. Approximately 8300 hectares of such land are identified which can be systematically utilized for periodic horticultural activities during the non-flood season if erosion in checked in a controlled manner.



4.2.4 Irrigation:

Irrigation is considered as an important infrastructure for agriculture. Though irrigation as supplying water to the agricultural for increase productivity of crops has been used since time immemorial, its scientific use with knowledge base on its availability, its conservation and applications based on requirement of land and crops etc. are now been emphasized for achieved a sustainable and eco-friendly agro-economic development. Though several studies have been made on the irrigation potentiality in Assam, there are still large scope of executing projects for increasing agricultural yield in Assam.

The Buridehing basin also have tremendous irrigation potential and the use of water resources of the Buridehing river by its stake holders are essentially to be explored. The lift irrigation potential is very much in river Buridehing as most the areas on both bank of Buridehing is agricultural intensive areas. Though there have been several small irrigation plant under government institution for lifting water from Buridehing river for irrigation purposes, there is a need for major irrigation projects to explore and utilized the water resources of Buridehing for agricultural purposes.

As learned from the Agricultural and Irrigation Department, a pilot irrigation project utilizing the water from the Buridehing river was taken up in Khowang area and the utilization of the water for irrigation purposes was started for nearby targeted area. However, full potential has not been tapped so far. Therefore, this aspect of usage of water of Buridehing for irrigation purposes can be studied and appropriate mechanism could be evolved to derive maximum benefit to the surrounding areas.

4.2.5 Micro hydel Plant for power generation for rural usage:

The flow of the river Buridehing can perhaps be utilized for production of electricity for rural areas by a mini hydel project. Such activity has already been implemented in several areas of USA, Germany, France, Nepal etc.and therefore, it can be tried here in Assam as a pilot project. Production and utilization of the electricity produced by river flow not only significantly reiterate the importance of electricity for overall socio-economic development of rural areas but also provide a boost to the concept of using the water as renewable sources of energy. The water being a renewable resource which is abundant in Assam, a positive approach for its judicious and positive utilization is need of the honour.

The importance of electricity is never understood unless we do not have it. In our neighboring country, Nepal under the UNDPProjects, are transforming their community by powering their way out of energy poverty with a one simple solution at a time, harnessing the river water resources. They have developed their own system of community development where the electricity generation has been playing important part. They have developed small hydroelectric plant to generated electrify from the river. Such model could be adopted with little modification required as per ground situation to provide electricity to light up homes, roads, to start up machine for plant etc.

A mini-hydro system normally consists of a weir (diversion dam, thrash rack and intake), desander (desilting, spillway), headrace (open canal, culvert, pipe, tunnel), forebay (temporary storage, pressure relief, surge tank, spillway), penstock (pressurized pipe), water turbine (converts static head and velocity head to rotating mechanical energy), generator (converts rotating mechanical energy to electrical energy), tailrace (directs diverted water back into the main river), power house (protects turbine-generator and other electro-mechanical equipment, metering, monitoring and control), sub-station and transformer (raises low voltage of generator to high voltage of transmission line), and transmission line (connects the transformer to the main grid). Diversion Mini Hydel power plant – also called *run-of-river*, channels a portion of a river through a canal or penstock to run a turbine; may not require the use of a dam.

Generation of electricity is not a new concept, but with help of external agency and with the guidance experts in this field this large untamed resources could be converted to boom in our society. In general, in Nepal, for example, the micro hydel project generates around 30Mw of electricity to provide electrify to small villages. Similar, model could be tried and detail project report are to be prepared for inclusion in the comprehensive project for infrastructure development of the project area.

There are also several models of micro hydro power low head turbine for production of electricity used in many countries like USA, Germany, France, Middle east, Nepal etc. and now a days in India also. In Germany, such low head turbine are used for generate electricity. Around 500w can be developed with head of 1.5M can generate 3500Kwh. The involvement is also low with cost. It also needs simple arrangement of weir, canal, turbine house and draft tube & tail race. Many Indian model also available. Accredited institutions like IIT's, Research institutes etc. may be requested for low cost efficient micro turbine for using the available water resources of the Buridehing river.

The provisions made in this Detailed Project Report (DPR) are to raise and strengthen the deteriorated embankments to prevent breach and overtopping during high stage of flood. While preparing the DPR due consideration is made for utilizing local man power and material resources at bare minimum cost. The works would provide employment to the local people besides protecting the life and property of general public of these chronic flood ravaged areas.

The project has been placed before the 82nd (Special) TAC meeting held on 18th May'2021 for a mount of Rs. 11027660000. The Technical Advisory Committee has elaborately discussed the memo of works and recommended for onward necessary approval. This revised Detailed Project Report has been framed with modifications as directed by TAC.

4.3 Sustainability, Operation and maintenance of Assets after Completion of the Project:

Water Resources Deptt, Govt. of Assam bears the responsibility for maintenance and repairing of the project after completion. Separate provision of fund is made by the State Govt. for that purpose. The Executive Engineers of the Divisions under W.R. Department will be the nodal agency for maintenance of the scheme.

Executive Engineer
Dibrugarh W.R. Division
Dibrugarh

CHAPTER-5

HYDROLOGY

5.1. DESIGN DISCHARGE

For the design of the various works of embankments and anti-erosion works in this project, the design flood is kept at 50 years return period considering the location of the project area in predominantly rural areas. The peak run-off for design of the different sluice gates are computed by taking into consideration the 3 days rainfall for 50 years return period and the catchment areas.

5.1.1 DESIGN DISCHARGE AT CHENIMARI G&D site

The design discharges of Chenimari G&D site as **2737, 2994 & 3250 cumecs** respectively for 25, 50 & 100 years return period and recommended by the Hydrology (NE) Directorate of CWC, New Delhi vide letter no. CWC U.O. No. 4/266/2018-Hyd(NE)/100 dated 16/04/2018 which is annexed as Annexure-D(i) has been adopted in this project

5.1.2 DESIGN DISCHARGES AT CONFLUENCES OF VARIOUS TRIBUTARIES OF BURIDEHING RIVER.

The design discharges at the various confluence points of tributaries of Buridehing has been computed by adopting Dicken's Formula i.e. $Q2= Q1(A2/A1)^{3/4}$ for computing discharge for proportionate catchment areas and is tabularised as follows:

River station of main-stream	*Location area/reach at end point of catchment area*	*Major tributaies within sub-catchment*	*Sub-catchment area*	*Cummulative catchment area upto river station*	*Design Discharge (50 years)*	*Remarks*
16 km	Tokowpathar	Namchik, Namphuk	1626 km	1626 sq.km	1298 cumecs	Using Dicken's Formula
38.5 km	Margherita NH Bridge	Tirap, Tipong	1150 km	2776 sq.km	1938 cumecs	
78.2 km	Tatipathar Manipuri Basti, Naharkatia	Namsang, Dirak	870 km	3646 sq.km	2378 cumecs	
102.2 km	Gabharu Bridge, Mohmari	Tipling, Digboi	277 km	3923 sq.km	2512 cumecs	
121 km	Tikirabali	Tingrai	540 km	4463 sq.km	2767 cumecs	
129 km	D/S Gela-disam Outfall, Aghunibari	Disam	264 km	4727 sq.km	2889 cumecs	
149.5 km	Bhurbhuri	Miscellaneous small streams/drains	189 km	4916 sq.km	2975 cumecs	
162.5 km	Chenimari G&D site	Miscellaneous small streams/drains	41 km	4957 sq.km	2994 cumecs	CWC Data
200 km	Brahmaputra Outfall, Dehingmukh	Sessa	634 km	5591 sq.km	3277 cumecs	Using Dicken's Formula
0km of mainstream considered at Interstate Boundary of Assam-Arunachal Pradesh						

Catchment area map is annexed as Annexure-D(ii)

5.1.3 The various hydrological parameters considered for design of the sluice gates are summarised as follows.

Detailed designs are annexed in the design chapter of this DPR.

Sl. No	Sluice No.	Geographic Location of Sluice in Easting & Northng	HEC-RAS Stn.		Catchment Area in sq.km	Rain gauge Station	50years 3 days PMP in mm	Net Eff. rainfall (loss of 1mm/hr in mm)	Total run-off accumulation during worst case in cum	Max. C/S W.L. during worst case in m	Sill Level in m	Worst Head in C/S	Worst Head in R/S
			Station (m)	DHFL (m)									
1	E-09/1	94° 52' 0.405" E, 27° 18' 6.292" N	35215	104.33	4	Khowang	345	273	1,09,20,000.00	103.59	102	1.59	2.33
2	E-09/2	94° 49' 52.324" E, 27° 17' 3.133" N	28033	103.28	4	Khowang	345	273	1,09,20,000.00	102.64	101.2	1.44	2.08
3	E-16/2	95° 10' 49.643" E, 27° 19' 51.058" N	88964	114.46	1	Naharkatia	337	265	26,50,000.00	113.89	112.3	1.59	2.16
4	E-24/4	95° 12' 55.086" E, 27° 21' 50.814" N	94016	115.64	1	Khowang	345	273	27,30,000.00	114.61	113.1	1.51	2.54
5	E-27/2	95° 19' 44.715" E, 27° 20' 32.318" N	109671	118.63	3	Naharkatia	337	265	79,50,000.00	118.14	116	2.14	2.63
6	E-27/3	95° 19' 40.636" E, 27° 20' 28.585" N	109671	118.63	2	Naharkatia	337	265	53,00,000.00	118.14	116.2	1.94	2.43
7	E-27/4	95° 19' 30.154" E, 27° 20' 3.973" N	109671	118.63	3	Naharkatia	337	265	79,50,000.00	118.14	116.2	1.94	2.43
8	E-28/1	95° 20' 21.353" E, 27° 20' 13.481" N	109671	118.63	3	Naharkatia	337	265	79,50,000.00	118.14	116.2	1.94	2.43
9	E-12/1	94° 51' 54.115" E, 27° 15' 44.940" N	32771	104.14	14	Khowang	345	273	3,82,20,000.00	103.96	102.1	1.86	2.04
10	E-12/2	94° 50' 10.440" E, 27° 15' 46.117" N	29312	103.45	9	Khowang	345	273	2,45,70,000.00	102.59	101.2	1.39	2.25
11	E-12/3	94° 47' 52.406" E, 27° 15' 2.192" N	20751	102.43	15	Khowang	345	273	4,09,50,000.00	101.91	100	1.91	2.43
12	E-16/1	95° 11' 21.297" E, 27° 20' 11.778" N	89711	114.53	10	Naharkatia	337	265	2,65,00,000.00	113.66	112.5	1.16	2.03
13	E-16/3	95° 10' 28.344" E, 27° 19' 53.860" N	88381	114.39	39	Naharkatia	337	265	10,33,50,000.00	114.36	112.3	2.06	2.09
21	E-15/4	94° 52' 43.277" E, 27° 18' 40.289" N	37506	104.64	3	Khowang	345	273	81,90,000.00	103.86	102.2	1.66	2.44

22	E-16/4	95° 8' 48.477" E, 27° 19' 41.922" N	83239	113.25	4	Naharkatia	337	265	1,06,00,000.00	112.73	111.2	1.53	2.05
15	E-13/2	95° 10' 12.668" E, 27° 21' 4.927" N	86899	114.04	3	Khowang	345	273	81,90,000.00	113.41	112	1.41	2.04
16	E-13/3	95° 9' 5.404" E, 27° 21' 22.309" N	86007	113.99	2	Khowang	345	273	54,60,000.00	113.47	112	1.47	1.99
24	E-23/1	95° 13' 26.517" E, 27° 22' 34.106" N	94016	115.64	2	Khowang	345	273	54,60,000.00	114.68	113	1.68	2.64
25	E-23/2	95° 12' 19.632" E, 27° 21' 40.979" N	94016	115.64	3	Khowang	345	273	81,90,000.00	114.51	113.2	1.31	2.44
26	E-24/1	95° 13' 48.589" E, 27° 22' 16.926" N	94016	115.64	2	Khowang	345	273	54,60,000.00	114.61	113.2	1.41	2.44
27	E-24/2	95° 13' 34.966" E, 27° 22' 12.628" N	94016	115.64	1	Khowang	345	273	27,30,000.00	114.61	113.1	1.51	2.54
28	E-24/3	95° 13' 25.988" E, 27° 22' 7.638" N	94016	115.64	1	Khowang	345	273	27,30,000.00	114.61	113.1	1.51	2.54
31	E-25/3	95° 14' 41.504" E, 27° 20' 10.938" N	98867	116.66	2	Naharkatia	337	265	53,00,000.00	115.59	114.3	1.29	2.36
14	E-13/1	95° 11' 26.109" E, 27° 21' 42.862" N	92256	115.12	5	Khowang	345	273	1,36,50,000.00	114.46	113	1.46	2.12
17	E-14/1	95° 6' 16.281" E, 27° 19' 51.711" N	78916	112.37	7	Khowang	345	273	1,91,10,000.00	111.64	110	1.64	2.37
18	E-14/4	94° 59' 33.686" E, 27° 22' 40.825" N	54666	107.3	4	Khowang	345	273	1,09,20,000.00	106.38	105.1	1.28	2.2
19	E-14/5	94° 58' 45.528" E, 27° 21' 25.449" N	52271	106.85	6	Khowang	345	273	1,63,80,000.00	105.89	104.5	1.39	2.35
20	E-15/3	94° 53' 16.701" E, 27° 19' 14.441" N	38706	104.92	4	Khowang	345	273	1,09,20,000.00	104.09	102.6	1.49	2.32
23	E-16/5	95° 7' 27.537" E, 27° 19' 19.467" N	80573	112.69	6	Naharkatia	337	265	1,59,00,000.00	111.84	110.1	1.74	2.59
29	E-25/1	95° 16' 27.607" E, 27° 19' 13.474" N	102182	117.3	7	Naharkatia	337	265	1,85,50,000.00	116.71	114.7	2.01	2.6
30	E-25/2	95° 14' 55.720" E, 27° 20' 3.335" N	99326	116.76	7	Naharkatia	337	265	1,85,50,000.00	115.9	114.3	1.6	2.46
32	E-14/3	95° 1' 28.394" E, 27° 21' 18.295" N	63589	108.36	8	Khowang	345	273	2,18,40,000.00	107.71	106.2	1.51	2.16
33	E-15/2	94° 53' 57.598" E, 27° 19' 27.793" N	40053	105.01	8	Khowang	345	273	2,18,40,000.00	104.32	102.7	1.62	2.31
37	E-15/1	94° 56' 19.703" E, 27° 20' 18.703" N	47006	106.21	15	Khowang	345	273	4,09,50,000.00	105.89	104.5	1.39	1.71
38	E-27/1	95° 20' 46.368" E, 27° 20' 20.795" N	109671	118.63	16	Naharkatia	337	265	4,24,00,000.00	117.89	116.4	1.49	2.23
34	E-14/2	95° 1' 55.791" E, 27° 21' 4.219" N	64966	108.57	60	Khowang	345	273	16,38,00,000.00	107.84	106.7	1.14	1.87
35	E-25/4	95° 14' 35.620" E, 27° 20' 16.783" N	98701	116.65	53	Naharkatia	337	265	14,04,50,000.00	115.91	114.6	1.31	2.05
36	E-25/5	95° 13' 39.088" E, 27° 20' 54.950" N	96374	116.12	48	Naharkatia	337	265	12,72,00,000.00	115.31	114	1.31	2.12
39	E-19/1	94° 57' 45.383" E, 27° 19' 37.381" N	48398	106.37	25	Khowang	345	273	6,82,50,000.00	105.8	104.3	1.5	2.07

** Catchment Area Map for Sluice Gates is enclosed in Drawings chapter of this DPR.

ANNEXURE-D(i)

No. 9/1/PR-41/2018-FMP – 805 – 807
भारत सरकार/ GOVERNMENT OF INDIA
केंद्रीय जल आयोग/ CENTRAL WATER COMMISSION
बाढ़ प्रबंधन आयोजना निदेशालय/ FLOOD MANAGEMENT PLANNING Dte.
*****

कमरा संख्या- 906-J(S), सेवा भवन
रामा कृष्णा पुरम , नई दिल्ली
दिनांक 19-4-2018

To,
Chief Engineer
Water Resources Department
Government of Assam
Chandmari ,Guwahati-781003
Assam
email: cewrdassam@yahoo.co.in
dibwrd1@gmail.com

Sub: Examination of the scheme "Integrated Water Resources Management of Buridehing Basin" (Estt. Cost: Rs. 658.023 Crore)

Ref: Letter No. 9/1/PR-41/2018-FMP/652-654 dated 16.03.2018

Sir,

Reference is invited to the above mentioned letter vide which the observations/comments of this office on the DPR of the above scheme were sent to your office. However, no response has been received so far.

In continuation to the above letter, please find enclosed the observations of Hydrology (NE) Dte of CWC. Further, a site visit may be conducted along with the officials of CWC field office and the State Government and the report may be submitted to this office.

It is requested that the revised DPR incorporating all the observations of CWC may be sent to this office at the earliest.

Encl: As above

(पीयूष कुमार)/Piyush Kumar
निदेशक/Director

Copy to:
Chief Engineer, B&BBO, CWC, Shillong – with a request to depute officials for the site visit of the above project in coordination with the State Government officials

Copy for kind information to:
PPS to Chief Engineer (FMO), CWC

Government of India
Central Water Commission
Hydrology(NE) Directorate

7th Floor,Sewa Bhawan,
R.K. Puram,New Delhi-66

Sub: Examination of hydrology aspects of the Flood Management Scheme "Integrated Water Resources Management of Burldehing Basin"

Ref: CWC letter No. 9/1/PR-41/2018-FMP/486, dated 27.02.2018

Kindly refer to CWC letter no cited above on the subject received from Director (FMP), CWC along with the DPR of the said scheme. The hydrology aspects of the scheme have been examined.

The Project authorities have worked out the design flood at different locations in the Burldehing river where the proposed works are to be taken up, based on the discharge data of Chenimari G&D site maintained by CWC. The 50-year return period flood has been computed by the project authorities using Flood frequency analysis by Log Pearson Type-III Distribution considering the G&D site's observed annual flood peaks. The 50 year return period flood estimated by project authorities comes out to be 2352.24 cumec.

The annual peak discharge data of the Chenimari G&D site used for computation of design flood has a few missing years, and the data length is also for 21 years only. The annual peak discharge data of this site was collected from RDC Dte, CWC for 39 years for the period 1978-79 to 2016-17, which is enclosed at Annexure-I.

Flood frequency analysis was carried out on the observed annual flood peaks at site for the period 1978-79 to 2016-17 and the 25, 50 and 100 year return period flood were estimated by using Log Pearson Type III distribution, Gumbel distribution and Pearson type III distribution methods.

Accordingly, the 25, 50 and 100 year return period flood for the G&D site obtained from Gumbel distribution, i.e. 2737, 2994 and 3250 cumecs respectively is recommended for planning and design purposes.

This issues with the approval of Chief Engineer (HSO).

Encl: As above

16/4/20
Director
Hyd(NE) Dte

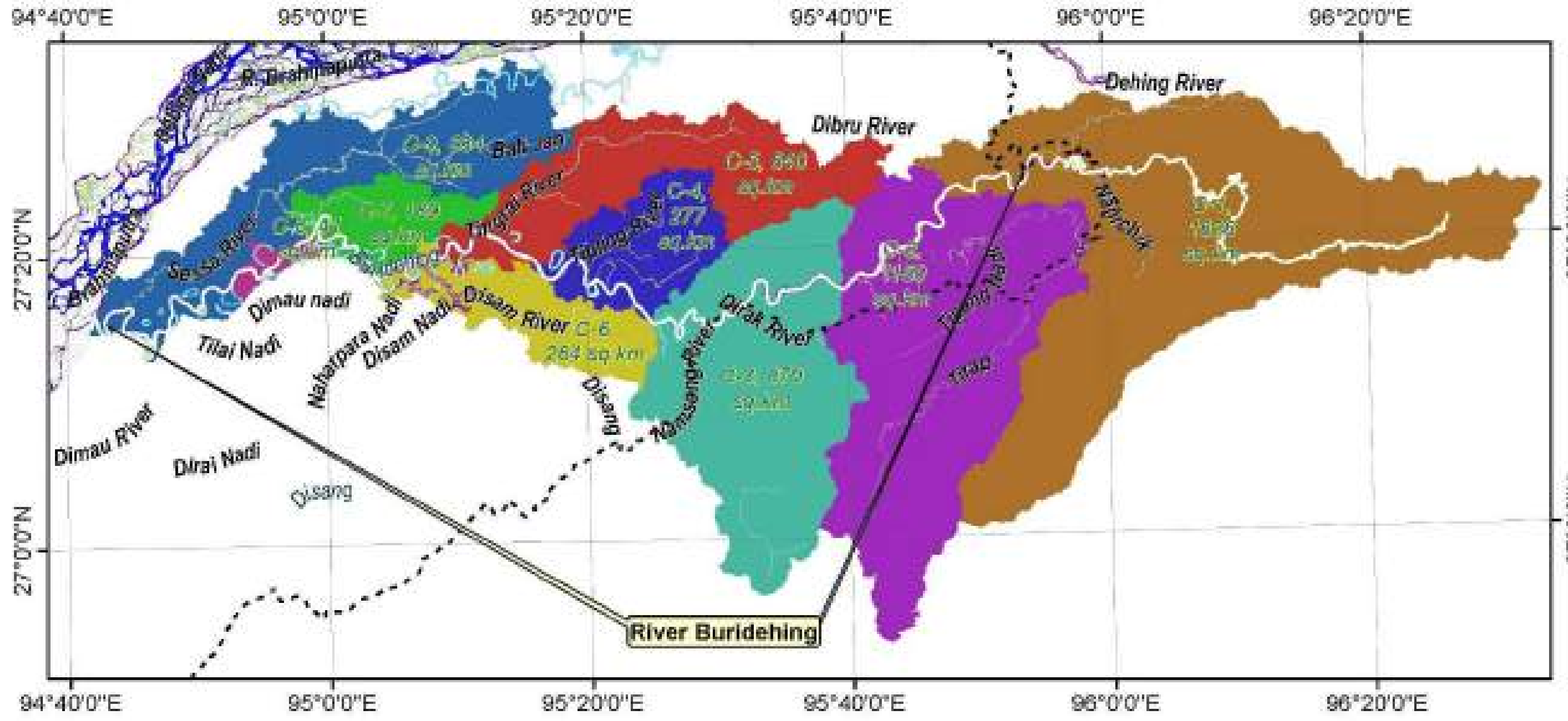
Director, FMP Dte., CWC, New Delhi
CWC U.O. No 4/266/2018-Hyd(NE)/1070 Dated: 16 April, 2018

Pl forward P state Govt

Annexure - I

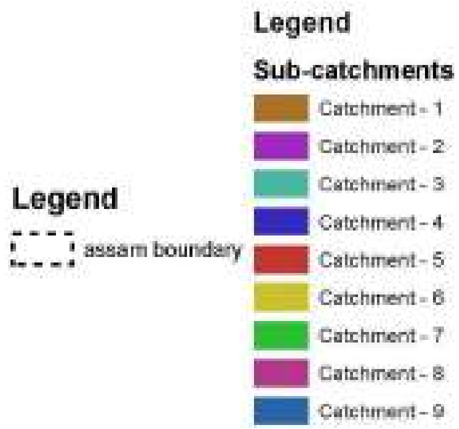
Observed annual flood peaks at Chenimari G&D site for the period 1978-79 to 2016-17		
Year	Maximum Q	Date
1978-1979	1966.54	21-07-1978
1979-1980	2096.92	09-10-1979
1980-1981	2138.36	18-08-1980
1981-1982	1403.38	05-07-1981
1982-1983	2013.00	29-07-1982
1983-1984	2523.22	05-07-1983
1984-1985	1624.26	17-07-1984
1985-1986	2180.00	26-07-1985
1986-1987	1072.79	21-07-1986
1987-1988	1622.95	12-07-1987
1988-1989	2570.19	11-07-1988
1989-1990	1910.25	31-07-1989
1990-1991	1274.98	26-06-1990
1991-1992	1917.67	13-07-1991
1992-1993	1590.86	29-06-1992
1993-1994	2325.10	08-07-1993
1994-1995	1860.81	23-06-1994
1995-1996	2326.00	25-09-1995
1996-1997	1853.00	18-07-1996
1997-1998	1629.00	11-07-1997
1998-1999	2247.00	07-09-1998
1999-2000	1616.00	21-07-1999
2000-2001	1273.70	28-07-2000
2001-2002	810.40	31-07-2001
2002-2003	1429.00	25-07-2002
2003-2004	2100.48	10-07-2003
2004-2005	1933.95	12-07-2004
2005-2006	1893.57	15-07-2005
2006-2007	1169.72	21-07-2006
2007-2008	1803.48	28-07-2007
2008-2009	1372.95	07-07-2008
2009-2010	1438.37	24-04-2010
2010-2011	1669.80	23-07-2010
2011-2012	1243.35	09-07-2011
2012-2013	1529.44	20-07-2012
2013-2014	1274.16	10-07-2013
2014-2015	1769.07	27-08-2014
2015-2016	2247.40	02-09-2015
2016-2017	2113.31	26-07-2016

ANNEXURE D(ii)



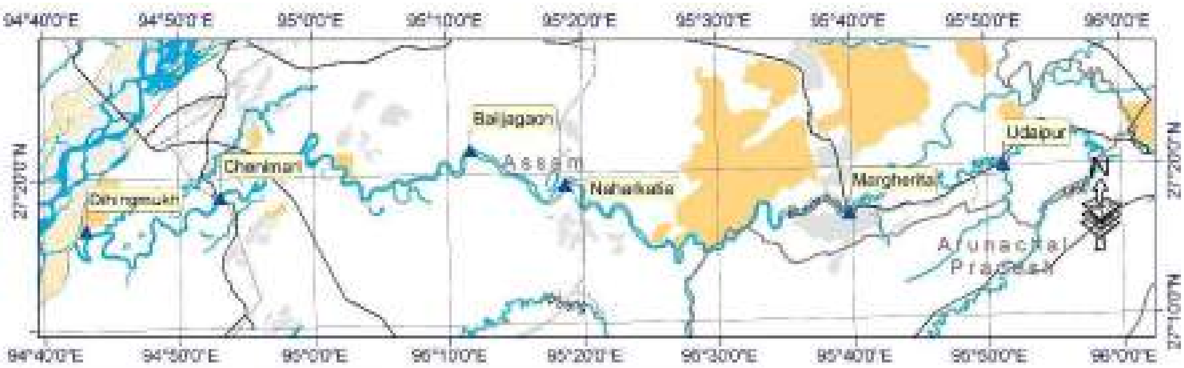
River station of mainstream	Location area/reach at end point of catchment area	Major tributaries within sub-catchment	Sub-catchment area	Cummulative catchment area upto river station
16 km	Tokowpathar	Namchik, Namphuk	1626 km	1626 sq.km
36.5 km	Margherita NH Bridge	Tirap, Tipong	1150 km	2776 sq.km
78.2 km	Tatipathar Manipuri Basti, Naharkatia	Namsang, Dirak	870 km	3646 sq.km
102.2 km	Gabharu Bridge, Mohmari	Tipling, Digboi	277 km	3923 sq.km
121 km	Tikirabali	Tingrai	540 km	4463 sq.km
129 km	D/S Gela-disam Outfall, Aghunibari	Disam	264 km	4727 sq.km
149.5 km	Bhurbhuri	Miscellaneous small streams/drains	189 km	4916 sq.km
162.5 km	**Chenimari G&D site**	Miscellaneous small streams/drains	41 km	**4957 sq.km**
200 km	Brahmaputra Outfall, Dehingmukh	Seesa	634 km	5591 sq.km

0km of mainstream considered at Interstate Boundary of Assam-Arunachal Pradesh



CATCHMENT AREA MAP OF RIVER BURIDEHING

5.2. COMPUTATION OF DESIGN HFL FROM RATING CURVE FOR CHENIMARI G&D SITE

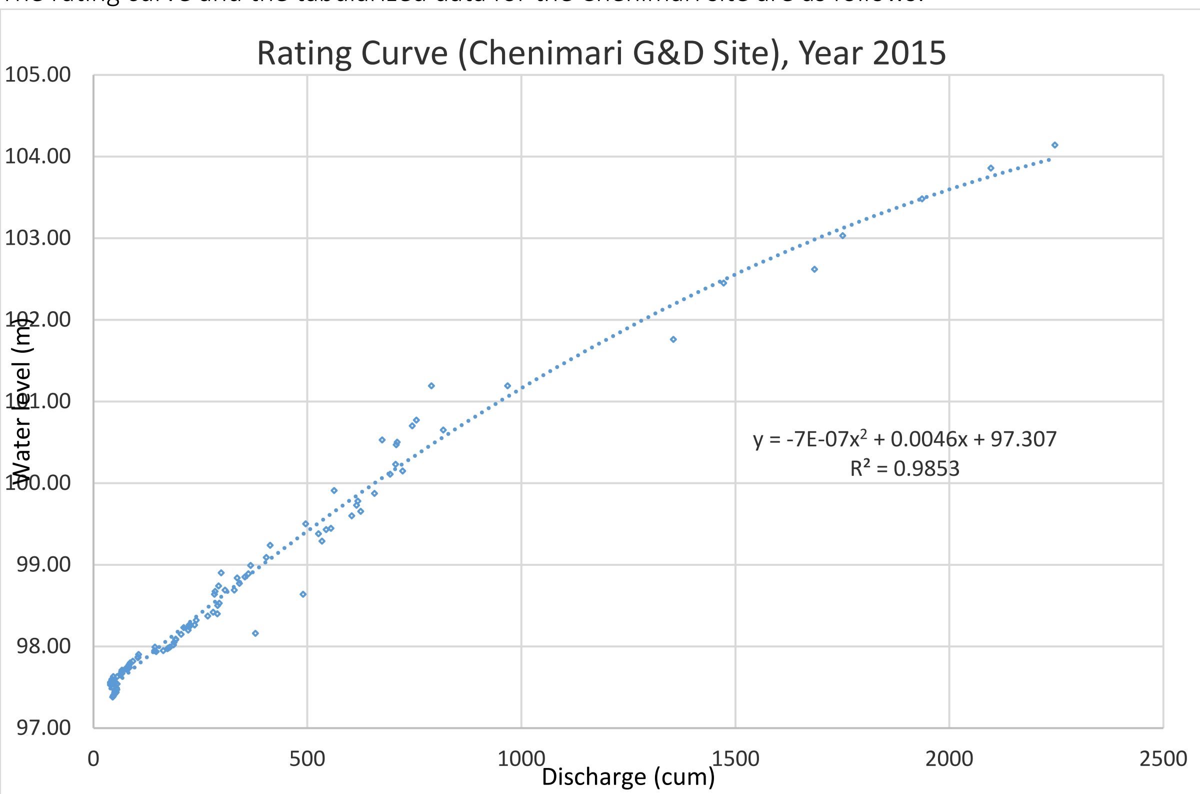


CWC Observation Sites at Buridehing			
Site Name	Type	Lat	Lon
Chenimari	GDSQ1	94° 53' 4.000" E	27° 18' 42.998" N
Naharkatia	GQ	95° 18' 43.000" E	27° 19' 14.002" N
Margherita	GQ	95° 39' 48.000" E	27° 17' 3.001" N
Jagunghat	GD	95° 51' 55.361" E	27° 24' 41.040" N
Dihingmukh	GDSQ	94° 43' 5.225" E	27° 16' 38.280" N
Baljagaon	GD	95° 11' 42.144" E	27° 21' 36.360" N

Fig. 5.2.1: Various Observation sites of Buridehing River

The only gauge and discharge site (G&D Site) of Buridehing having available record of consistent data is the Chenimari site located at the downstream of NH-37 Bridge crossing. The maximum observed discharge is recorded for the year 2015 and the rating curve equation has been derived from the stage-discharge data for the year 2015.

The rating curve and the tabularized data for the Chenimari site are as follows:



G&D Data at Chenimari G&D site for the year 2015

Date	Observed Discharge (m^3/s)	Gauge Reading (m)
02 September 2015	2247	104.14
03 September 2015	2097	103.86
04 September 2015	1936	103.48
05 September 2015	1751	103.03
06 September 2015	1685	102.62
07 September 2015	1473	102.45
08 September 2015	1355	101.76
09 September 2015	968	101.19
10 September 2015	818	100.65
11 September 2015	723	100.15
12 September 2015	615	99.73
13 September 2015	618	99.78
14 September 2015	694	100.11
15 September 2015	657	99.88
16 September 2015	625	99.66
17 September 2015	604	99.60
18 September 2015	555	99.45
19 September 2015	544	99.43
20 September 2015	534	99.29
21 September 2015	526	99.38
22 September 2015	706	100.23
23 September 2015	745	100.70
24 September 2015	708	100.47
25 September 2015	710	100.50
26 September 2015	755	100.77
27 September 2015	790	101.19
28 September 2015	675	100.53
29 September 2015	563	99.91
30 September 2015	497	99.50
01 October 2015	414	99.24
02 October 2015	404	99.09
03 October 2015	367	98.99
04 October 2015	362	98.89
05 October 2015	354	98.85
06 October 2015	342	98.77
07 October 2015	307	98.69
08 October 2015	284	98.67
09 October 2015	283	98.64
10 October 2015	293	98.74
11 October 2015	299	98.90
12 October 2015	490	98.64
13 October 2015	379	98.16
14 October 2015	336	98.84
15 October 2015	330	98.69
16 October 2015	294	98.53
17 October 2015	291	98.50
18 October 2015	290	98.40
19 October 2015	280	98.42
20 October 2015	267	98.37
21 October 2015	240	98.32
22 October 2015	237	98.26
23 October 2015	224	98.24

Date	Observed Discharge (m^3/s)	Gauge Reading (m)
24 October 2015	222	98.20
25 October 2015	224	98.26
26 October 2015	227	98.26
27 October 2015	211	98.23
28 October 2015	206	98.15
29 October 2015	193	98.09
30 October 2015	193	98.08
31 October 2015	189	98.05
01 November 2015	187	98.02
02 November 2015	179	97.99
03 November 2015	175	97.98
04 November 2015	173	97.97
05 November 2015	164	97.95
06 November 2015	147	97.94
07 November 2015	143	97.95
08 November 2015	144	97.99
09 November 2015	106	97.90
10 November 2015	105	97.87
11 November 2015	104	97.86
12 November 2015	92	97.82
13 November 2015	87	97.80
14 November 2015	84	97.78
15 November 2015	83	97.77
16 November 2015	80	97.75
17 November 2015	84	97.74
18 November 2015	79	97.74
19 November 2015	76	97.73
20 November 2015	77	97.72
21 November 2015	67	97.71
22 November 2015	66	97.69
23 November 2015	67	97.67
24 November 2015	64	97.66
25 November 2015	63	97.65
26 November 2015	55	97.63
27 November 2015	47	97.63
28 November 2015	44	97.60
29 November 2015	43	97.59
30 November 2015	44	97.58
01 December 2015	44	97.58
02 December 2015	43	97.57
03 December 2015	42	97.57
04 December 2015	42	97.56
05 December 2015	40	97.55
06 December 2015	40	97.56
07 December 2015	44	97.57
08 December 2015	43	97.57
09 December 2015	43	97.56
10 December 2015	40	97.53
11 December 2015	46	97.50
12 December 2015	46	97.49
13 December 2015	46	97.49
14 December 2015	45	97.50
15 December 2015	47	97.54
16 December 2015	49	97.56

Date	Observed Discharge (m^3/s)	Gauge Reading (m)
17 December 2015	50	97.57
18 December 2015	56	97.54
19 December 2015	54	97.49
20 December 2015	54	97.48
21 December 2015	55	97.47
22 December 2015	51	97.45
23 December 2015	53	97.44
24 December 2015	53	97.44
25 December 2015	52	97.43
26 December 2015	51	97.43
27 December 2015	50	97.43
28 December 2015	51	97.42
29 December 2015	47	97.40
30 December 2015	47	97.39
31 December 2015	45	97.38

Computation of Design H.F.L. at Chenimari Gauge Site (50 years return period)

A. FROM RATING CURVE

From rating curve at Cheninari G&D Site, curve equation is $y = -7E\text{-}07x^2 + 0.0046x + 97.307$

Design discharge at Chenimari G&D site (As per CWC data)	=	2994.00	cumecs
Hence, from rating curve, Design HFL at Chenimari G&D site	=	104.80	m

5.3. COMPUTATION OF WATER SURFACE PROFILE FOR 50 YEARS RETURN PERIOD FOR THE BURIDEHING RIVER

The different worksites of this project are located at diverse locations within the span of 200km of the river with only one G&D site having consistent data. Hence it becomes necessary to determine the hydraulic parameters required for the design of the various works components of this project by mathematical modelling. Thus necessary survey works had been carried out on the river to determine the cross-sections required for modelling of the river.

For estimating the maximum water surface profile corresponding to 50 year flood, the necessary flow simulation has been carried out using one dimensional mathematical model HEC-RAS. The entire stretch of Buridehing river for 200kms in the floodplains of Assam wherein all the proposed project sites are located is modelled by river cross sections taken at an interval of 150 m. The Manning's n for the study reach has been adopted as 0.035 for the waterway and 0.06 for the banks. Altogether 10 nos. of bridges at different locations are also modelled. Contraction and expansion coefficient have been considered as 0.1 & 0.3 for the river sections and as 0.3 & 0.5 at different bride locations.

Design discharges computed at various confluence points of tributaries of Buridehing (i.e Tingrai, Tipling, Disam, Sessa, Tirap etc) as per respective sub-catchments have been considered for the upstream boundary of HEC-RAS model set up has been adopted as 1302m^3/s, 1994 m^3/s, 2375 m^3/s, 2510 m^3/s, 2766 m^3/s, 2889 m^3/s, 2975 m^3/s, 2994 m^3/s & 3278 m^3/s at river stations of 208km, 161km, 121.8km, 97.8km, 79km, 70km, 50km, 37.5km & 7.7km respectively.

The downstream boundary has been adopted as normal depth and applied at the downstream most river cross sections. The HEC-RAS model set up the river is shown in Fig.5.3.1

The water surface profile of Buridehing river for 50 year flood as obtained from HEC-RAS simulation is presented in Fig-5.3.2. The maximum water level at different locations of the river reach is given in Table-5.3.4.

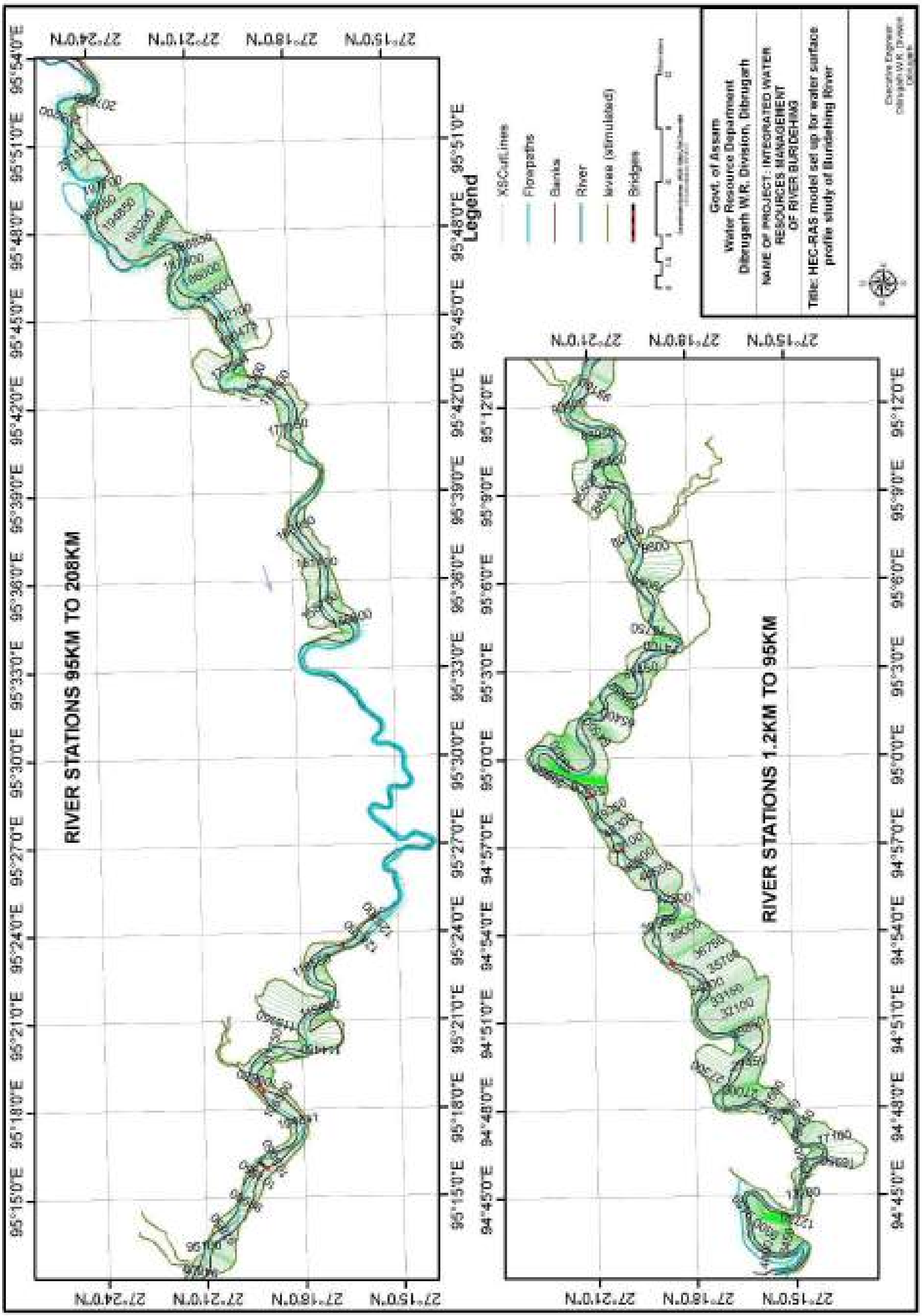


Fig 5.3.1 (HEC RAS Model Setup)

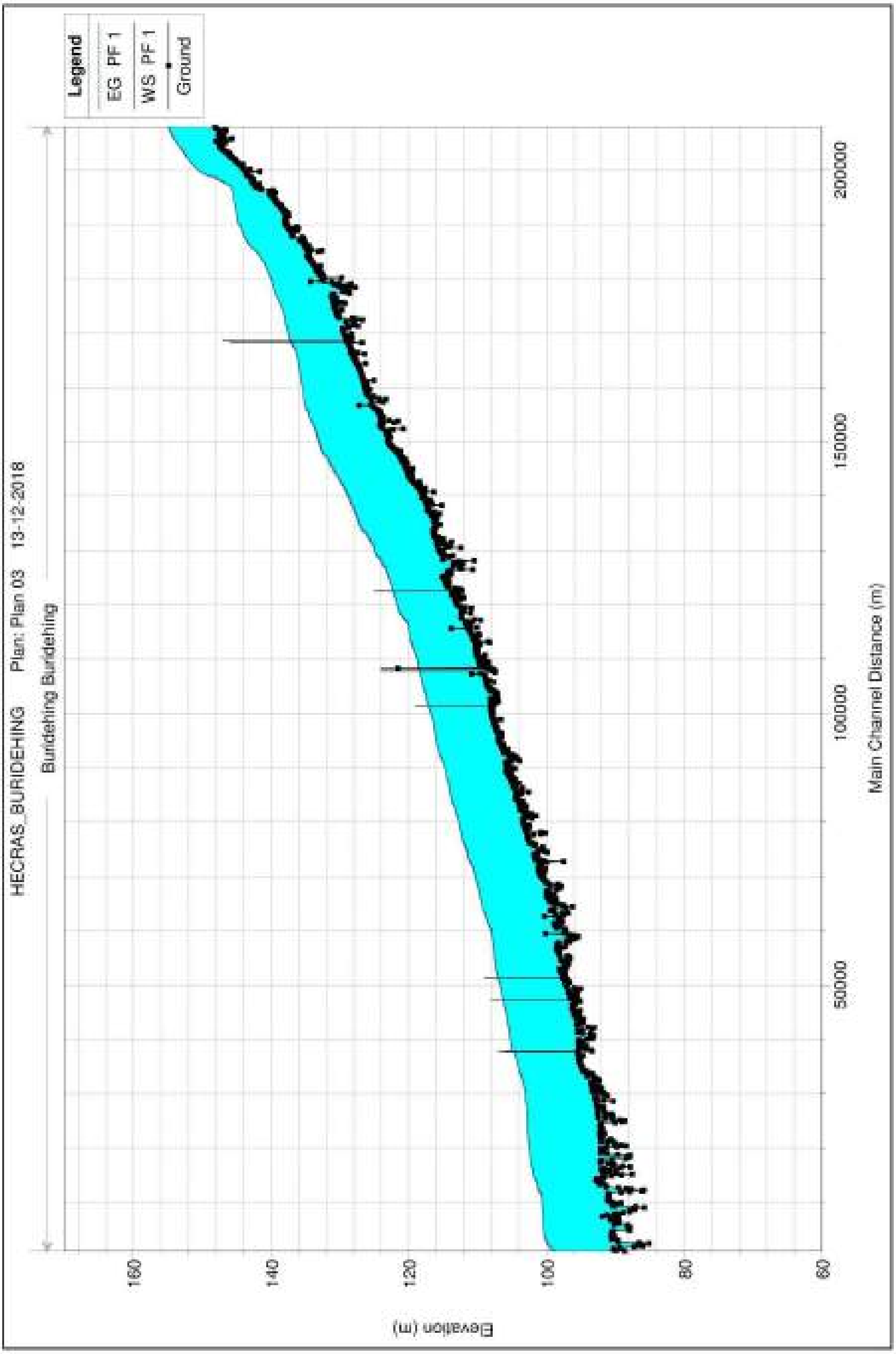


Fig 5.3.2 (Profile Plot)

Table: 5.3.4

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)
Buridehing	209107.6	PF 1	1302	148.38	155.52	3.06	741.46	223.23
Buridehing	208957.4	PF 1	1302	148.28	155.48	2.84	810.36	200.36
Buridehing	208807.2	PF 1	1302	148.15	155.35	2.92	750.85	184.52
Buridehing	208655.6	PF 1	1302	147.97	155.22	3.08	734.04	177.1
Buridehing	208501.4	PF 1	1302	147.77	155.19	2.61	774.44	164.78
Buridehing	208350.6	PF 1	1302	147.63	155.16	2.33	829.89	175.1
Buridehing	208188.3	PF 1	1302	147.57	155.15	1.88	941.81	199.5
Buridehing	208031	PF 1	1302	146.94	155.15	1.56	1090.94	220.44
Buridehing	207874.9	PF 1	1302	146.21	155.14	1.41	1210.95	246.73
Buridehing	207723.1	PF 1	1302	146.05	155.09	1.61	1045.32	187.37
Buridehing	207579.7	PF 1	1302	146.31	154.97	2.18	899.08	205.59
Buridehing	207422.4	PF 1	1302	146.84	154.88	2.46	851.93	189.29
Buridehing	207275.5	PF 1	1302	146.78	154.84	2.25	853.94	230.01
Buridehing	207114.3	PF 1	1302	146.98	154.79	2.2	820.08	178.74
Buridehing	206962.9	PF 1	1302	146.97	154.77	1.8	915.76	222.28
Buridehing	206812.2	PF 1	1302	147.08	154.72	1.99	921.58	216.8
Buridehing	206664	PF 1	1302	147.29	154.68	1.95	995.93	245.64
Buridehing	206509.7	PF 1	1302	146.32	154.64	1.93	1000.3	252.09
Buridehing	206356.8	PF 1	1302	146.27	154.52	2.2	762.48	164.36
Buridehing	206206.7	PF 1	1302	145.79	154.48	2.13	802.84	172.71
Buridehing	206050.4	PF 1	1302	145.37	154.48	1.75	835.49	148.07
Buridehing	205900.3	PF 1	1302	146.98	154.29	2.41	621.78	129.05
Buridehing	205754.1	PF 1	1302	147.34	154.21	2.51	667.8	159.28
Buridehing	205597.4	PF 1	1302	146.76	154.16	2.51	817.59	232.2
Buridehing	205409.6	PF 1	1302	147.64	154.04	2.67	848.84	283.21
Buridehing	205244	PF 1	1302	147.44	153.49	4.2	598.91	230.89
Buridehing	205094.6	PF 1	1302	146.27	153.55	2.75	668.05	197.61
Buridehing	204940.5	PF 1	1302	146.41	153.61	1.86	848.16	172.59
Buridehing	204777.2	PF 1	1302	146.75	153.49	2.41	820.46	209.68
Buridehing	204638.5	PF 1	1302	147.11	153.29	3.06	759.57	236.53
Buridehing	204487.9	PF 1	1302	146.74	153.25	2.36	858.1	249.68
Buridehing	204334.6	PF 1	1302	146.42	153.23	1.96	1073.68	264.28
Buridehing	204180.3	PF 1	1302	146.32	153.12	2.06	998.54	277.17
Buridehing	204039.2	PF 1	1302	146.32	152.86	2.49	602.07	157.82
Buridehing	203889.7	PF 1	1302	146.01	152.77	2.39	720.72	180.92
Buridehing	203746.4	PF 1	1302	145.67	152.57	2.89	715.18	209.25
Buridehing	203602.8	PF 1	1302	145.85	152.43	2.78	678.57	190.31
Buridehing	203438.5	PF 1	1302	145.11	152.49	1.81	987.93	231.58
Buridehing	203335.1	PF 1	1302	145.01	152.38	2.2	813.53	195.33
Buridehing	203177.8	PF 1	1302	145.45	152.36	1.76	907.28	189.45
Buridehing	203033.9	PF 1	1302	145.37	152.13	2.54	701.98	157.98
Buridehing	202886.2	PF 1	1302	144.99	152.08	2.48	784.65	188.68
Buridehing	202735.7	PF 1	1302	145.19	151.77	3.27	599.26	183.88
Buridehing	202587.3	PF 1	1302	144.92	151.75	2.52	747.35	233.22
Buridehing	202437	PF 1	1302	144.47	151.7	2.3	905.41	237.71
Buridehing	202287	PF 1	1302	144.61	151.56	2.46	739.08	198.02
Buridehing	202136.9	PF 1	1302	144.49	151.29	2.97	566.83	168.75
Buridehing	201985.4	PF 1	1302	144.39	151.11	3.13	536.76	172.26
Buridehing	201834.7	PF 1	1302	144.43	151.16	2.42	727.56	205.98
Buridehing	201685.3	PF 1	1302	144.08	151.06	2.5	690.29	197.26
Buridehing	201533.1	PF 1	1302	143.92	150.99	2.45	672.3	179.46
Buridehing	201385.4	PF 1	1302	143.79	150.97	2.18	735.95	158.19
Buridehing	201234.7	PF 1	1302	143.41	150.92	2.22	739.33	161.45
Buridehing	201089.7	PF 1	1302	143.39	150.87	2.13	728.91	191.58
Buridehing	200941.1	PF 1	1302	143.65	150.47	3.34	555.99	202.1
Buridehing	200790.4	PF 1	1302	143.55	150.4	3	583.99	217.38
Buridehing	200640.4	PF 1	1302	143.21	150.29	3.07	640.48	222.25
Buridehing	200491.1	PF 1	1302	142.54	150.36	2.25	834.51	188.06
Buridehing	200339.7	PF 1	1302	142.26	150.32	2.11	771.11	153.47
Buridehing	200186.4	PF 1	1302	142.43	150.2	2.37	645.27	133.27
Buridehing	200051.9	PF 1	1302	142.82	149.94	3.12	551.84	133.78
Buridehing	199897.6	PF 1	1302	142.98	149.97	2.4	685.01	179.59
Buridehing	199751.5	PF 1	1302	142.94	149.97	1.88	753.13	160.44

Buridehing	199611	PF 1	1302	143	149.87	2.1	716.54	151.59
Buridehing	199493.6	PF 1	1302	142.82	149.87	1.88	804.39	176.7
Buridehing	199393.1	PF 1	1302	142.82	149.4	3.35	446.14	107.74
Buridehing	199248.3	PF 1	1302	142.5	149.14	3.67	434	110.68
Buridehing	199099.3	PF 1	1302	142.06	149.27	2.44	603.45	123.63
Buridehing	198948.4	PF 1	1302	142.27	149.33	1.72	839.59	199.23
Buridehing	198798.4	PF 1	1302	142.14	149.33	1.55	1673.52	1099.73
Buridehing	198650.3	PF 1	1302	142.15	149.29	1.57	1565.42	1224.04
Buridehing	198500.2	PF 1	1302	142.14	149.1	2.25	708.29	161.18
Buridehing	198350.1	PF 1	1302	142.18	149.02	2.64	834.35	233.48
Buridehing	198200.1	PF 1	1302	142.31	148.97	2.47	876.7	256.08
Buridehing	198051.3	PF 1	1302	142.85	148.49	3.65	541.59	173.49
Buridehing	197904.4	PF 1	1302	141.79	148.41	2.73	546.2	131.4
Buridehing	197753.3	PF 1	1302	141.25	148.38	2.48	669.09	138.95
Buridehing	197604.2	PF 1	1302	141.09	148.38	2	714.45	158.31
Buridehing	197442.2	PF 1	1302	141.34	148.03	3.08	555.67	148.57
Buridehing	197288.5	PF 1	1302	141.42	147.87	3.25	585.16	167.55
Buridehing	197135.2	PF 1	1302	141.61	147.73	3.18	606.29	220.96
Buridehing	196977.9	PF 1	1302	140.99	147.64	2.83	746.02	278.95
Buridehing	196818	PF 1	1302	140.07	147.56	2.59	758.11	229.07
Buridehing	196672.9	PF 1	1302	140.5	147.23	3.18	459.06	108.24
Buridehing	196522.9	PF 1	1302	139.7	147.28	2.47	724	219.31
Buridehing	196370.5	PF 1	1302	138.95	147.25	2.2	726.67	152.47
Buridehing	196218.8	PF 1	1302	139.63	147.23	1.99	748.65	149
Buridehing	196061.3	PF 1	1302	139.79	147.05	2.63	718.73	203.23
Buridehing	195910	PF 1	1302	139.8	147.02	2.23	848.39	228.96
Buridehing	195749.5	PF 1	1302	139.43	146.96	2.14	945.64	269.13
Buridehing	195611.9	PF 1	1302	139.44	146.91	2.17	965.81	250.56
Buridehing	195459	PF 1	1302	139.36	146.8	2.32	867.09	235.36
Buridehing	195308.2	PF 1	1302	139.34	146.74	2.22	839.23	227.31
Buridehing	195161.7	PF 1	1302	138.95	146.7	2.15	886.03	225.82
Buridehing	195006.2	PF 1	1302	138.8	146.6	2.45	875.57	242.03
Buridehing	194867.3	PF 1	1302	138.79	146.49	2.54	751.04	230.92
Buridehing	194726	PF 1	1302	138.78	146.54	1.78	1031.68	293.68
Buridehing	194567.3	PF 1	1302	138.77	146.46	2.03	1073.87	440.58
Buridehing	194411.5	PF 1	1302	138.93	146.37	2.19	1104.56	580.4
Buridehing	194270.3	PF 1	1302	138.77	146.33	2.01	1175.08	627.3
Buridehing	194117.6	PF 1	1302	138.33	146.31	1.8	982.39	279.32
Buridehing	193956.4	PF 1	1302	138.27	146.28	1.71	1266.81	670.6
Buridehing	193815.9	PF 1	1302	138.06	146.3	1.32	1977.63	686.37
Buridehing	193686.2	PF 1	1302	138.08	146.22	1.65	1650.29	681.81
Buridehing	193529.9	PF 1	1302	138.07	146.17	1.73	1582.96	734.47
Buridehing	193373.1	PF 1	1302	138.01	146.06	2.13	1612.81	1184.58
Buridehing	193211.4	PF 1	1302	138.09	145.77	3.13	938.82	991.79
Buridehing	193089.8	PF 1	1302	137.6	145.81	2.05	1067.34	929.53
Buridehing	192934.5	PF 1	1302	137.37	145.76	1.95	1104.51	880.82
Buridehing	192781.8	PF 1	1302	137.55	145.78	1.44	1318.29	948.06
Buridehing	192631.5	PF 1	1302	137.33	145.8	1.04	1709.52	1033.09
Buridehing	192510.1	PF 1	1302	137.4	145.8	0.95	1747.17	1126.07
Buridehing	192355.4	PF 1	1302	137.46	145.78	1.01	1692.05	1150.4
Buridehing	192204.6	PF 1	1302	138.09	145.75	1.05	1375.56	1177.36
Buridehing	192063.9	PF 1	1302	137.89	145.72	1.23	1586.67	1153.38
Buridehing	191919.4	PF 1	1302	137.47	145.66	1.48	1333.92	1130.06
Buridehing	191763.8	PF 1	1302	137.43	145.54	2.03	1246.18	1060.42
Buridehing	191632.5	PF 1	1302	137.53	145.56	1.59	1534.9	1041.11
Buridehing	191461.3	PF 1	1302	137.36	145.57	1.14	1554	990.7
Buridehing	191358.7	PF 1	1302	136.97	145.56	1.17	1729.68	832.42
Buridehing	191228	PF 1	1302	137.39	145.52	1.38	1524.63	725.15
Buridehing	191134.7	PF 1	1302	137.36	145.49	1.46	1427.56	545.36
Buridehing	190968.4	PF 1	1302	137.45	145.48	1.32	1517.15	650.37
Buridehing	190816	PF 1	1302	137.34	145.4	1.74	1247.42	568.45
Buridehing	190665.9	PF 1	1302	137.41	145.34	1.97	1274.14	613.11
Buridehing	190480.6	PF 1	1302	137.74	145.32	1.56	1375.81	641.79
Buridehing	190368.4	PF 1	1302	137.32	145.28	1.67	1358.8	683.56
Buridehing	190227.3	PF 1	1302	138.53	144.98	2.9	939.17	697
Buridehing	190068.5	PF 1	1302	137.06	144.95	2.69	1192.01	724.8

Buridehing	189909.5	PF 1	1302	137.3	144.92	2.22	1222.88	745.75
Buridehing	189757.6	PF 1	1302	137.13	144.87	2.2	1254.43	740.14
Buridehing	189607.5	PF 1	1302	136.89	144.86	1.89	1515.38	763.75
Buridehing	189455.3	PF 1	1302	137.38	144.82	1.98	1535.45	774.53
Buridehing	189300.5	PF 1	1302	137.09	144.78	1.96	1521.37	752.43
Buridehing	189150.4	PF 1	1302	136.72	144.67	2.08	1218.89	703.47
Buridehing	188998.9	PF 1	1302	136.47	144.65	1.9	1073.21	305.71
Buridehing	188844	PF 1	1302	136.43	144.65	1.61	1734.92	735.24
Buridehing	188680.7	PF 1	1302	136.57	144.61	1.88	1693.17	745.45
Buridehing	188546.2	PF 1	1302	136.54	144.53	2.03	1379.18	651.25
Buridehing	188383.9	PF 1	1302	136.26	144.55	1.31	1520.38	493.81
Buridehing	188203.7	PF 1	1302	137.49	144.1	3.32	606.46	307.5
Buridehing	188049.8	PF 1	1302	136.28	143.92	3.26	705.93	489.96
Buridehing	187899	PF 1	1302	136.13	143.98	2.5	1024.98	480.38
Buridehing	187745.6	PF 1	1302	136.93	143.91	2.45	1098.68	516.68
Buridehing	187577.7	PF 1	1302	137.09	143.89	1.92	1204.3	459.26
Buridehing	187410	PF 1	1302	135.46	143.72	2.58	1054.19	460.85
Buridehing	187241.4	PF 1	1302	135.3	143.76	1.63	1297.19	465.85
Buridehing	187100.3	PF 1	1302	134.97	143.59	2.3	1011.79	483.39
Buridehing	186937.3	PF 1	1302	134.92	143.58	2.08	1201.95	415.86
Buridehing	186793.4	PF 1	1302	134.69	143.56	1.97	1146.11	387.14
Buridehing	186653.9	PF 1	1302	134.78	143.37	2.53	884.2	356.16
Buridehing	186506.2	PF 1	1302	134.57	143.38	2.04	941.81	368.08
Buridehing	186424	PF 1	1302	134.44	143.38	1.83	999.19	351.72
Buridehing	186284.2	PF 1	1302	133.78	143.2	2.84	979.46	367.94
Buridehing	186085.1	PF 1	1302	134.53	143.22	1.97	1053.43	362.33
Buridehing	185953.9	PF 1	1302	132.94	143.18	1.95	1000.86	328.46
Buridehing	185791.6	PF 1	1302	135.2	142.98	2.68	820.67	339.69
Buridehing	185615.9	PF 1	1302	134.79	143.06	1.72	1169.08	357.5
Buridehing	185457.3	PF 1	1302	134.75	142.81	2.61	853.09	487.21
Buridehing	185292	PF 1	1302	134.13	142.9	1.62	1528.17	580.14
Buridehing	185153.5	PF 1	1302	134.38	142.85	1.78	1356.5	587.79
Buridehing	185007.3	PF 1	1302	134.55	142.78	1.97	1247.54	580.75
Buridehing	184867.5	PF 1	1302	134.8	142.72	2.12	1247.7	615.02
Buridehing	184698.2	PF 1	1302	134.55	142.71	1.8	1399.77	666.54
Buridehing	184545.4	PF 1	1302	135.06	142.64	2.46	1487.96	692.53
Buridehing	184380.4	PF 1	1302	134.4	142.66	1.7	1829.83	696.7
Buridehing	184225.6	PF 1	1302	134.73	142.64	1.38	1820.91	695.26
Buridehing	184071.5	PF 1	1302	134.8	142.58	1.79	1653.51	697.52
Buridehing	183922.3	PF 1	1302	135.1	142.56	1.69	1751.8	655.19
Buridehing	183765.2	PF 1	1302	134.62	142.54	1.33	1918.01	659.93
Buridehing	183614.8	PF 1	1302	136.12	142.49	1.98	1630.86	664.5
Buridehing	183445.4	PF 1	1302	135.59	142.27	2.72	1234.25	667.67
Buridehing	183306.5	PF 1	1302	135.86	142.15	2.93	1236.97	671.39
Buridehing	183140	PF 1	1302	135.21	141.98	2.76	1189.81	667.17
Buridehing	183036.6	PF 1	1302	136.12	141.74	3.4	883.76	704.58
Buridehing	182948.1	PF 1	1302	134.9	141.87	1.93	1621.61	719.25
Buridehing	182722.5	PF 1	1302	133.91	141.87	1.5	2078.85	765.4
Buridehing	182587.7	PF 1	1302	134.69	141.82	1.68	1879.26	795
Buridehing	182423.4	PF 1	1302	134.14	141.69	2.02	1371.43	650.86
Buridehing	182282	PF 1	1302	134.19	141.56	2.39	1206.29	646.23
Buridehing	182139.9	PF 1	1302	133.52	141.6	1.72	1742.47	647.6
Buridehing	182041.7	PF 1	1302	133.52	141.53	1.94	1501	633
Buridehing	181958.8	PF 1	1302	133.83	141.47	2.22	1424.28	624.84
Buridehing	181795.3	PF 1	1302	133.07	141.42	2.2	1412.09	594.07
Buridehing	181646.6	PF 1	1302	133.1	141.33	2.31	1268.75	567.42
Buridehing	181528.7	PF 1	1302	133.53	141.29	2.16	1231.65	539.09
Buridehing	181426.8	PF 1	1302	132.75	141.34	1.34	1937.22	515.87
Buridehing	181327.3	PF 1	1302	134.77	141.18	2.24	1001.49	329.87
Buridehing	181258.8	PF 1	1302	134.41	140.95	2.81	685.98	377.66
Buridehing	181145.1	PF 1	1302	134.04	140.99	2.19	947.99	360.55
Buridehing	181021.1	PF 1	1302	130.61	141.09	1	3041.05	793.85
Buridehing	180844.1	PF 1	1302	133.45	140.9	2.54	1177.07	429.28
Buridehing	180677.2	PF 1	1302	132.46	140.88	1.91	1249.69	465.93
Buridehing	180527.1	PF 1	1302	132.82	140.72	2.7	1067.48	515.42
Buridehing	180372.2	PF 1	1302	133.49	140.65	3.03	1189.07	535.28

Buridehing	180221.6	PF 1	1302	131.31	140.44	2.87	907.7	548.93
Buridehing	180053	PF 1	1302	131.56	140.53	2.01	1351.67	536.24
Buridehing	179901.1	PF 1	1302	133.19	140.53	1.86	1537.68	502.93
Buridehing	179757.4	PF 1	1302	132.86	140.47	1.94	1484.8	715.36
Buridehing	179607.3	PF 1	1302	132.21	140.37	2.19	1500.92	881.37
Buridehing	179463.2	PF 1	1302	130.94	140.37	1.59	1686.48	1435.33
Buridehing	179305.3	PF 1	1302	131.95	140.35	1.58	1755.5	1339
Buridehing	179150.9	PF 1	1302	132.24	140.34	1.33	1807.92	1672.04
Buridehing	179000.7	PF 1	1302	129.17	140.34	1.33	2669.41	1628.86
Buridehing	178876.8	PF 1	1302	129.4	140.33	1.24	2642.98	1811.07
Buridehing	178751.6	PF 1	1302	129.52	140.32	1.27	2778.38	1842.68
Buridehing	178543.9	PF 1	1302	129.39	140.31	1.1	3696.95	2749.2
Buridehing	178371.5	PF 1	1302	132.32	140.3	1.23	3565	2301.07
Buridehing	178209.5	PF 1	1302	130.6	140.16	1.91	1932.94	1886.17
Buridehing	178012.2	PF 1	1302	129.81	139.95	2.75	1292.92	1221.13
Buridehing	177840.9	PF 1	1302	130.55	140.04	1.67	1945.77	1677.69
Buridehing	177676.2	PF 1	1302	130.79	140.03	1.56	2316.76	1589.76
Buridehing	177525.1	PF 1	1302	130.43	140.02	1.47	2406.86	1430.29
Buridehing	177372.3	PF 1	1302	130.65	139.98	1.53	1844.14	1240.29
Buridehing	177220.2	PF 1	1302	130.88	139.89	2.03	1655.39	1162.07
Buridehing	177068.1	PF 1	1302	130.67	139.91	1.66	2206.91	1071.83
Buridehing	176909.8	PF 1	1302	130.19	139.92	1.24	2472.97	1075.39
Buridehing	176767.1	PF 1	1302	130.97	139.86	1.48	1794.34	1077.08
Buridehing	176611.1	PF 1	1302	131.07	139.77	1.92	1448.64	820.49
Buridehing	176472.2	PF 1	1302	131.12	139.74	1.93	1570.93	987.99
Buridehing	176318.1	PF 1	1302	130.08	139.77	1.33	2149.62	1090.17
Buridehing	176162.6	PF 1	1302	129.85	139.77	1.18	2472.67	1065.83
Buridehing	176004.1	PF 1	1302	131.3	139.62	2.17	1424.62	679.29
Buridehing	175848.3	PF 1	1302	131.65	139.35	2.86	1027.72	938.34
Buridehing	175689.1	PF 1	1302	131.27	139.22	2.89	873.46	538.62
Buridehing	175538.6	PF 1	1302	131.14	139.12	2.81	790.01	347.4
Buridehing	175381.8	PF 1	1302	130.98	139.2	1.83	1117.64	408.66
Buridehing	175230.8	PF 1	1302	130.72	139.21	1.47	1437.67	518.62
Buridehing	175077.5	PF 1	1302	129.68	139.21	1.31	1527.47	487.48
Buridehing	174931.5	PF 1	1302	129.86	139.15	1.56	1327.15	554.21
Buridehing	174774.5	PF 1	1302	130.85	139.04	2.05	1098.48	586
Buridehing	174623.5	PF 1	1302	130.74	138.94	2.21	889.64	368.45
Buridehing	174476.1	PF 1	1302	130.86	138.91	2.11	1123.69	515.56
Buridehing	174333	PF 1	1302	130.78	138.96	1.29	1319.06	358.89
Buridehing	174176	PF 1	1302	130.62	138.84	1.89	1047.62	331.56
Buridehing	174062	PF 1	1302	130.22	138.86	1.5	1245.56	351.89
Buridehing	173944.4	PF 1	1302	130.2	138.86	1.29	1358.65	349.53
Buridehing	173782.2	PF 1	1302	130.39	138.86	1.18	1495.73	530.56
Buridehing	173605.2	PF 1	1302	130.18	138.81	1.46	1351.59	379.56
Buridehing	173404.9	PF 1	1302	130.2	138.61	2.37	1055.13	565.2
Buridehing	173240.3	PF 1	1302	128.51	138.69	1.32	1531.21	422.56
Buridehing	173096.8	PF 1	1302	130.34	138.67	1.36	1509.8	414.39
Buridehing	172945.2	PF 1	1302	128.69	138.64	1.43	1532.04	397
Buridehing	172755	PF 1	1302	129.24	138.56	1.85	1307.52	401.43
Buridehing	172659.4	PF 1	1302	128.86	138.42	2.35	1073.07	559.27
Buridehing	172566.8	PF 1	1302	128.61	138.46	1.88	1573.73	820.9
Buridehing	172451.4	PF 1	1302	127.4	138.29	2.74	1208.17	676.27
Buridehing	172300.5	PF 1	1302	128.6	138.25	2.28	976.53	354.87
Buridehing	172084	PF 1	1302	128.52	138.15	2.44	910.84	336
Buridehing	171830	PF 1	1302	131.07	138.12	2.04	1051.51	320.6
Buridehing	171623.4	PF 1	1302	130.32	138.07	1.1	1126.78	312.67
Buridehing	171523.1	PF 1	1302	129.96	138.05	1.15	1292.5	353.04
Buridehing	171260.1	PF 1	1302	129.1	138.02	1.16	1294.38	230.35
Buridehing	171113.7	PF 1	1302	129.21	137.94	1.56	950.56	181.34
Buridehing	170960.5	PF 1	1302	129.26	137.89	1.71	921.82	188.05
Buridehing	170810.5	PF 1	1302	129.27	137.88	1.58	1131.89	254.18
Buridehing	170658.7	PF 1	1302	129.12	137.88	1.38	1583.48	384.98
Buridehing	170505.6	PF 1	1302	129.13	137.87	1.35	1810.48	456.56
Buridehing	170366.5	PF 1	1302	129.06	137.79	1.81	1419.8	461.59
Buridehing	170210.8	PF 1	1302	128.38	137.67	2.25	1035.96	295.91
Buridehing	170064.1	PF 1	1302	128.83	137.56	2.44	856.72	239.4

Buridehing	169910.4	PF 1	1302	128.75	137.61	1.66	1310.8	423.63
Buridehing	169746.7	PF 1	1302	128.36	137.59	1.55	1249.52	244.49
Buridehing	169588.9	PF 1	1302	128.51	137.59	1.36	1494.33	295.5
Buridehing	169422	PF 1	1302	128.44	137.54	1.58	1317.15	272.77
Buridehing	169252.4	PF 1	1302	128.37	137.52	1.52	1192.59	214.09
Buridehing	169127.8	PF 1	1302	127.96	137.54	1.01	1290.44	182.45
Buridehing	169121.4		Bridge					
Buridehing	169116.9	PF 1	1302	127.94	137.53	1.01	1286.88	181.84
Buridehing	169093	PF 1	1302	128.05	137.52	1.09	1191.94	172.31
Buridehing	168943.3	PF 1	1302	128.31	137.5	1.18	1110.03	173.44
Buridehing	168788	PF 1	1302	128.26	137.42	1.67	990.07	181.49
Buridehing	168585.5	PF 1	1302	127.91	137.38	1.4	931.37	161.42
Buridehing	168580		Bridge					
Buridehing	168572.6	PF 1	1302	127.93	137.36	1.44	906.36	160.46
Buridehing	168445.8	PF 1	1302	128.31	137.19	2.17	770.01	159.73
Buridehing	168286.1	PF 1	1302	127.89	137.16	1.97	818.04	159.29
Buridehing	168141	PF 1	1302	128.02	137.18	1.4	986.84	180.74
Buridehing	167983.4	PF 1	1302	128.09	137.16	1.36	1024.74	182.67
Buridehing	167834.3	PF 1	1302	127.9	137.08	1.76	896.13	172.21
Buridehing	167698.5	PF 1	1302	128.23	137	1.96	756.83	143.67
Buridehing	167522.1	PF 1	1302	127.9	136.93	1.98	700.74	132.85
Buridehing	167382.8	PF 1	1302	127.75	136.95	1.57	870.19	150.26
Buridehing	167247.5	PF 1	1302	127.63	136.97	1.19	1269.57	224.02
Buridehing	167080.9	PF 1	1302	127.4	136.96	1.13	1306	202.31
Buridehing	166933.1	PF 1	1302	127.46	136.95	1.27	1512.91	269.48
Buridehing	166784.7	PF 1	1302	129	136.83	2.14	1113.08	289.99
Buridehing	166640.8	PF 1	1302	129.59	136.81	1.78	1249.16	294.38
Buridehing	166488.4	PF 1	1302	129.02	136.76	1.78	1254.26	296.85
Buridehing	166329	PF 1	1302	127.68	136.74	1.51	1311.71	307.65
Buridehing	166172.4	PF 1	1302	129.23	136.73	1.31	1316.09	301.97
Buridehing	166002	PF 1	1302	130.08	136.67	1.66	1250.37	302.06
Buridehing	165853.5	PF 1	1302	130.1	136.65	1.56	1348.34	304.39
Buridehing	165711.1	PF 1	1302	127.66	136.62	1.47	1509.86	326.05
Buridehing	165571	PF 1	1302	127.75	136.6	1.41	1452.2	340.75
Buridehing	165376.5	PF 1	1302	127.6	136.59	1.21	1580.08	348.43
Buridehing	165133.3	PF 1	1302	127.2	136.59	0.95	1960.36	391.75
Buridehing	165029.3	PF 1	1302	127.48	136.57	1.24	1814.01	407.61
Buridehing	164941.2	PF 1	1302	127.35	136.55	1.17	1943.5	414.59
Buridehing	164844.1	PF 1	1302	126.95	136.54	0.99	2203.16	457.31
Buridehing	164618	PF 1	1302	128.3	136.54	0.55	2219	437.65
Buridehing	164413.2	PF 1	1302	126.98	136.45	1.44	1613.98	429.72
Buridehing	164264	PF 1	1302	127.16	136.4	1.63	1314.59	371.48
Buridehing	164126.7	PF 1	1302	126.75	136.36	1.72	1313.34	357.64
Buridehing	163966.7	PF 1	1302	126.7	136.36	1.47	1422.52	359.09
Buridehing	163814.9	PF 1	1302	126.6	136.35	1.21	1697.55	404.66
Buridehing	163658.4	PF 1	1302	126.66	136.34	1.16	1775.55	418.53
Buridehing	163507.7	PF 1	1302	126.48	136.32	1.34	1791.92	418.9
Buridehing	163364.2	PF 1	1302	126.36	136.31	1.22	1917.04	423.41
Buridehing	163203.9	PF 1	1302	126.57	136.29	1.38	1745.59	407.6
Buridehing	163052.3	PF 1	1302	126.85	136.25	1.51	1568.87	374.33
Buridehing	162885.8	PF 1	1302	126.52	136.25	1.27	1819.25	421.03
Buridehing	162727.3	PF 1	1302	126.33	136.24	1.09	1757.5	368.95
Buridehing	162578.5	PF 1	1302	126.23	136.22	1.12	1598.69	338.3
Buridehing	162434	PF 1	1302	126.26	136.22	1.03	1754.34	319.04
Buridehing	162322.6	PF 1	1302	127.72	136.21	0.62	1734.63	313.23
Buridehing	162170.4	PF 1	1302	126.35	136.21	0.82	1823.78	325.35
Buridehing	162056.5	PF 1	1302	126.15	136.2	0.86	1885.96	320.02
Buridehing	161878.3	PF 1	1302	126.24	136.17	1.23	1848.42	341.32
Buridehing	161723.5	PF 1	1302	126.22	136.16	1.22	1898.13	370.42
Buridehing	161565.8	PF 1	1944	127.18	136.11	1.48	2112.31	417.82
Buridehing	161408.5	PF 1	1944	125.96	136.09	1.33	2143.76	407.62
Buridehing	161262.8	PF 1	1944	125.93	136.07	1.35	2035.33	424.87
Buridehing	161138.7	PF 1	1944	125.87	136.03	1.52	2004.58	500.46
Buridehing	160995.8	PF 1	1944	125.95	135.98	1.75	1996.78	559.09
Buridehing	160833.8	PF 1	1944	126.03	135.93	1.95	1944.63	536.59
Buridehing	160679.5	PF 1	1944	126.08	135.89	2.06	1876.19	514

Buridehing	160529.1	PF 1	1944	126.07	135.78	2.46	1641.04	484.79
Buridehing	160379.7	PF 1	1944	126.06	135.74	2.26	1497.02	438.44
Buridehing	160225.5	PF 1	1944	125.85	135.77	1.57	2033.57	407.02
Buridehing	160067.6	PF 1	1944	125.86	135.76	1.51	2211.64	431.61
Buridehing	159926.8	PF 1	1944	127.03	135.75	1.55	2221.6	453.94
Buridehing	159796	PF 1	1944	127.89	135.72	1.66	2116.53	464.98
Buridehing	159732.2	PF 1	1944	127.28	135.72	1.24	2245.39	481.39
Buridehing	159651.9	PF 1	1944	125.82	135.69	1.4	2359.06	507.92
Buridehing	159538.7	PF 1	1944	125.77	135.64	1.73	2081.56	544.79
Buridehing	159430.2	PF 1	1944	125.51	135.62	1.65	2367.52	594
Buridehing	159317.1	PF 1	1944	125.54	135.61	1.57	2510.94	617.9
Buridehing	159135	PF 1	1944	125.55	135.61	1.18	2907.6	634.33
Buridehing	158921.1	PF 1	1944	125.38	135.6	1.01	3079.39	657.54
Buridehing	158728.1	PF 1	1944	126.5	135.59	0.8	2339.09	663.1
Buridehing	158571	PF 1	1944	126.76	135.54	1.22	2315.77	660.8
Buridehing	158461.1	PF 1	1944	125.12	135.5	1.48	2356.41	685.78
Buridehing	158256.6	PF 1	1944	124.06	135.48	1.52	2468.26	647.13
Buridehing	158087.6	PF 1	1944	123.62	135.48	1.45	2618.1	597.17
Buridehing	157942.5	PF 1	1944	124.38	135.46	1.44	2446.1	586.43
Buridehing	157793.2	PF 1	1944	124.93	135.42	1.65	2120.64	547.41
Buridehing	157641.7	PF 1	1944	125.87	135.3	2.19	1661.68	500.26
Buridehing	157500.3	PF 1	1944	125.05	135.34	1.43	1973.85	430.76
Buridehing	157305.8	PF 1	1944	125.23	135.29	1.61	1701.79	342.4
Buridehing	157131.6	PF 1	1944	125.94	135.04	3.08	1248.84	320.14
Buridehing	156897.6	PF 1	1944	128.33	135.04	2.08	1589.81	417.22
Buridehing	156668.5	PF 1	1944	126.21	135	1.96	1825.45	397.66
Buridehing	156600.7	PF 1	1944	126.05	134.99	1.82	1667.22	308.33
Buridehing	156494.5	PF 1	1944	124.51	134.95	1.89	1700.54	363.09
Buridehing	156278.7	PF 1	1944	124.31	134.86	2.06	1440.66	368.96
Buridehing	156111.7	PF 1	1944	124.08	134.74	2.4	1228.27	329.69
Buridehing	155930.7	PF 1	1944	126.25	134.17	3.79	631.36	180.04
Buridehing	155774.2	PF 1	1944	124.01	134.21	3.1	758.14	141.27
Buridehing	155620.9	PF 1	1944	123.74	134.24	2.57	909.35	140.99
Buridehing	155473	PF 1	1944	123.75	134.2	2.47	938.49	144.8
Buridehing	155317.3	PF 1	1944	123.31	134.24	2.04	1256.64	180.05
Buridehing	155151	PF 1	1944	123.73	134.2	2.16	1345.91	221.04
Buridehing	154996.4	PF 1	1944	123.58	134.17	2.08	1419.74	246.36
Buridehing	154847.3	PF 1	1944	123.63	134.14	2.11	1523.12	292.99
Buridehing	154681.3	PF 1	1944	123.43	134.14	1.82	1867.16	349.62
Buridehing	154528.8	PF 1	1944	123.82	133.78	2.97	977.37	335.91
Buridehing	154379.2	PF 1	1944	123.68	133.68	3.13	1137.22	425.48
Buridehing	154203.4	PF 1	1944	123.58	133.65	2.68	1090.95	447.64
Buridehing	154053.3	PF 1	1944	122.83	133.62	2.46	1067.69	406.06
Buridehing	153900.8	PF 1	1944	122.52	133.57	2.43	1143.39	465.24
Buridehing	153747.5	PF 1	1944	122.86	133.45	2.68	1012.23	386.35
Buridehing	153595.5	PF 1	1944	122.64	133.34	2.81	930.75	260.97
Buridehing	153459.4	PF 1	1944	123.77	133.29	2.63	812.11	183.1
Buridehing	153341.4	PF 1	1944	123.7	133.34	2.06	987.51	158.32
Buridehing	153219.8	PF 1	1944	123.6	133.37	1.66	1319.36	209.55
Buridehing	153022.9	PF 1	1944	123.59	133.31	1.86	1372.93	253.69
Buridehing	152855.3	PF 1	1944	119.68	133.3	1.78	1616.42	262.18
Buridehing	152699.5	PF 1	1944	124.85	133.27	1.75	1429.91	251.02
Buridehing	152527.8	PF 1	1944	123.75	133.21	1.67	1199.69	188.3
Buridehing	152325.7	PF 1	1944	123.15	132.93	2.73	879.63	162.03
Buridehing	152184.2	PF 1	1944	122.85	132.88	2.64	889.69	142.01
Buridehing	151998.1	PF 1	1944	122.95	132.86	2.28	911.94	142.75
Buridehing	151831.2	PF 1	1944	122.6	132.86	1.91	1023.58	140.07
Buridehing	151698.8	PF 1	1944	122.81	132.9	1.44	1370.49	189.27
Buridehing	151548.8	PF 1	1944	122.34	132.89	1.3	1503.62	203.22
Buridehing	151416.2	PF 1	1944	122.66	132.86	1.38	1414.23	199.03
Buridehing	151271.8	PF 1	1944	122.45	132.81	1.72	1266.57	165.12
Buridehing	151119.8	PF 1	1944	122.57	132.75	1.89	1231.91	166.04
Buridehing	150969.6	PF 1	1944	122.64	132.61	2.45	1067.69	174.56
Buridehing	150817.4	PF 1	1944	123.06	132.6	2.12	1111.65	176.82
Buridehing	150667.4	PF 1	1944	122.48	132.59	1.86	1153.26	164.62
Buridehing	150514.1	PF 1	1944	122.7	132.51	2.26	1204.58	185.61

Buridehing	150372.2	PF 1	1944	122.47	132.55	1.42	1375.35	215.94
Buridehing	150222.1	PF 1	1944	122.41	132.51	1.55	1374.04	291.09
Buridehing	150081.9	PF 1	1944	122.41	132.47	1.63	1350.5	305.75
Buridehing	149936	PF 1	1944	122.53	132.37	2.08	1252.15	303.58
Buridehing	149792.8	PF 1	1944	122.77	132.3	2.28	1257.82	294.4
Buridehing	149642.7	PF 1	1944	122.49	132.24	2.15	1061.17	229.04
Buridehing	149491.1	PF 1	1944	122.39	132.22	1.93	1011.62	160.65
Buridehing	149341.1	PF 1	1944	122.16	132.17	1.96	992.47	150.15
Buridehing	149192.4	PF 1	1944	121.74	132.16	1.8	1128.05	152.03
Buridehing	149042.3	PF 1	1944	121.73	132.01	2.44	975.27	153.73
Buridehing	148898.9	PF 1	1944	122.06	131.87	2.77	907.98	154.98
Buridehing	148747.5	PF 1	1944	121.47	131.97	1.67	1165.94	144.11
Buridehing	148595.7	PF 1	1944	121.08	131.98	1.35	1444.11	185.93
Buridehing	148445.5	PF 1	1944	121.42	131.96	1.37	1422.47	245.24
Buridehing	148294.8	PF 1	1944	121.78	131.97	1.12	1736.78	264.48
Buridehing	148138.6	PF 1	1944	121.67	131.87	1.59	1224.52	191.03
Buridehing	147989.3	PF 1	1944	121.37	131.73	2.11	921.33	128
Buridehing	147839.6	PF 1	1944	120.93	131.73	1.88	1035.62	141.73
Buridehing	147689.4	PF 1	1944	120.9	131.75	1.47	1328.23	162.25
Buridehing	147539.1	PF 1	1944	121.01	131.49	2.51	787.59	118.42
Buridehing	147381.5	PF 1	1944	121.35	131.39	2.67	781.26	116.92
Buridehing	147220.4	PF 1	1944	121.27	131.23	2.92	701.22	100.8
Buridehing	147070.1	PF 1	1944	121.33	130.82	3.75	559.26	89.69
Buridehing	146918.5	PF 1	1944	120.66	130.91	2.93	686.55	87.24
Buridehing	146769.1	PF 1	1944	120.48	130.99	2.19	890.86	123.68
Buridehing	146619.1	PF 1	1944	120.48	130.9	2.33	841.57	114.56
Buridehing	146469	PF 1	1944	120.59	130.88	2.2	916.78	127.49
Buridehing	146322	PF 1	1944	120.77	130.79	2.47	933.32	152.54
Buridehing	146171.9	PF 1	1944	120.37	130.77	2.17	981.85	172.04
Buridehing	146027.1	PF 1	1944	120.46	130.67	2.4	940.92	146.14
Buridehing	145894	PF 1	1944	120.34	130.65	2.12	918.73	133.58
Buridehing	145752.5	PF 1	1944	120.49	130.62	2.07	949.3	138.54
Buridehing	145616.5	PF 1	1944	120.29	130.62	1.83	1069.62	148.91
Buridehing	145474.5	PF 1	1944	120.84	130.42	2.48	796.13	120.31
Buridehing	145322.5	PF 1	1944	120.02	130.32	2.59	753.77	106.1
Buridehing	145174.5	PF 1	1944	119.94	130.18	2.83	695.21	96.27
Buridehing	145024.1	PF 1	1944	119.42	130.1	2.87	690.96	85.37
Buridehing	144873	PF 1	1944	119.84	130.11	2.57	890.24	129.29
Buridehing	144720.5	PF 1	1944	119.82	130.08	2.65	1056.75	174.17
Buridehing	144566.7	PF 1	1944	119.89	129.35	4.29	540.64	92.4
Buridehing	144417.1	PF 1	1944	119.96	129.63	2.5	812.09	126.66
Buridehing	144273	PF 1	1944	119.6	129.51	2.71	748.62	117.82
Buridehing	144128.8	PF 1	1944	119.57	129.46	2.55	765.9	121.75
Buridehing	143979.2	PF 1	1944	119.67	129.38	2.58	755.55	125.34
Buridehing	143829	PF 1	1944	119.63	129.31	2.53	768.09	119.82
Buridehing	143677.1	PF 1	1944	119.35	129.23	2.52	773.43	125.06
Buridehing	143525.6	PF 1	1944	120.67	129.03	2.89	684.28	132.99
Buridehing	143377	PF 1	1944	120.53	128.99	2.52	777.68	168.48
Buridehing	143234.8	PF 1	1944	119.36	128.95	2.27	857.67	140.58
Buridehing	143085.2	PF 1	1944	119.18	128.88	2.3	847.55	130.07
Buridehing	142933.5	PF 1	1944	119.23	128.79	2.43	802.29	123.88
Buridehing	142781.6	PF 1	1944	119.21	128.68	2.56	762.08	120.84
Buridehing	142629.7	PF 1	1944	118.71	128.66	2.27	857.39	137.94
Buridehing	142481.5	PF 1	1944	118.61	128.54	2.46	791.03	119.2
Buridehing	142331.5	PF 1	1944	118.66	128.49	2.4	811.6	127.89
Buridehing	142180.7	PF 1	1944	118.61	128.42	2.39	813.63	132.34
Buridehing	142032.6	PF 1	1944	119.38	128.28	2.62	744	133.75
Buridehing	141890.3	PF 1	1944	118.44	128.27	2.23	874.44	147.3
Buridehing	141756.5	PF 1	1944	118.58	128.02	2.86	682.12	116.33
Buridehing	141603.7	PF 1	1944	117.77	127.98	2.59	751.86	116.66
Buridehing	141452.1	PF 1	1944	117.9	128.06	1.83	1065.11	141.37
Buridehing	141304.5	PF 1	1944	117.73	128.03	1.83	1066.75	144.44
Buridehing	141176.2	PF 1	1944	117.73	128.01	1.79	1087.84	152.85
Buridehing	141029.9	PF 1	1944	117.92	127.87	2.25	883.23	144.88
Buridehing	140900.6	PF 1	1944	118.76	127.84	2.08	939.38	148.66
Buridehing	140755.1	PF 1	1944	118.63	127.8	2.02	962.49	148.11

Buridehing	140628.4	PF 1	1944	118.19	127.69	2.32	842.38	125.35
Buridehing	140482.6	PF 1	1944	117.35	127.62	2.38	821.34	122.73
Buridehing	140338.3	PF 1	1944	117.1	127.62	2.05	956.16	124.27
Buridehing	140184	PF 1	1944	117.21	127.6	1.92	1012.99	143.49
Buridehing	140037.5	PF 1	1944	117.4	127.59	1.78	1090.91	165.71
Buridehing	139904.8	PF 1	1944	117.39	127.52	1.93	1008.13	160.02
Buridehing	139772.8	PF 1	1944	117.47	127.4	2.27	860.29	137.58
Buridehing	139638.4	PF 1	1944	117.03	127.35	2.25	864.73	126.67
Buridehing	139496.4	PF 1	1944	117.22	127.29	2.29	856.38	132.21
Buridehing	139350.2	PF 1	1944	118.14	127.3	1.92	1018.66	157.79
Buridehing	139208.6	PF 1	1944	117.16	127.26	1.92	1018.8	149.84
Buridehing	139057.8	PF 1	1944	116.74	127.21	1.96	991.19	141.1
Buridehing	138909.1	PF 1	1944	116.09	127.19	1.87	1043.62	129.48
Buridehing	138755.3	PF 1	1944	116.24	127.19	1.68	1159.92	150.56
Buridehing	138602.1	PF 1	1944	117.43	126.88	2.75	712.2	108.1
Buridehing	138461.3	PF 1	1944	115.33	126.84	2.64	738.12	96.73
Buridehing	138311.8	PF 1	1944	116.63	126.77	2.62	743.92	109.28
Buridehing	138160.9	PF 1	1944	116.64	126.76	2.32	837.46	124.36
Buridehing	138005	PF 1	1944	116.69	126.77	1.92	1016.18	151.13
Buridehing	137858.1	PF 1	1944	116.71	126.75	1.83	1067.65	174.15
Buridehing	137732.3	PF 1	1944	116.51	126.75	1.54	1264.85	194.77
Buridehing	137591.5	PF 1	1944	116.48	126.7	1.69	1152.14	172.09
Buridehing	137457.6	PF 1	1944	116.23	126.6	2.01	971.11	139.79
Buridehing	137322.7	PF 1	1944	115.87	126.51	2.24	870.94	122.17
Buridehing	137178.6	PF 1	1944	115.57	126.48	2.14	911.32	128.53
Buridehing	137031.6	PF 1	1944	115.61	126.31	2.58	755.55	110.95
Buridehing	136886.8	PF 1	1944	115.93	126.32	2.18	896.51	118.64
Buridehing	136736.1	PF 1	1944	115.9	126.34	1.81	1079.83	141.77
Buridehing	136588.7	PF 1	1944	115.48	126.34	1.64	1199.83	152.24
Buridehing	136438.4	PF 1	1944	115.93	126.25	1.92	1017.73	151.17
Buridehing	136299.8	PF 1	1944	116.21	126.21	1.92	1016.84	159.65
Buridehing	136152	PF 1	1944	115.72	126.18	1.88	1054.51	149.63
Buridehing	136001	PF 1	1944	115.78	126.08	2.17	938.86	133.19
Buridehing	135846.9	PF 1	1944	116.13	126.04	2.15	907.12	136.75
Buridehing	135699.3	PF 1	1944	115.78	126	2.05	949.31	132.78
Buridehing	135550.4	PF 1	1944	115.74	125.99	1.86	1046.38	145.05
Buridehing	135401.6	PF 1	1944	115.72	125.94	1.93	1006.55	145.15
Buridehing	135249.7	PF 1	1944	115.66	125.94	1.71	1137.87	167.22
Buridehing	135099.9	PF 1	1944	114.72	125.96	1.35	1441.13	184.34
Buridehing	134982.5	PF 1	1944	114.3	125.94	1.33	1465.28	185.67
Buridehing	134847.6	PF 1	1944	114.29	125.85	1.78	1106.41	134.83
Buridehing	134693.1	PF 1	1944	114.86	125.77	1.99	981.41	131.53
Buridehing	134558.6	PF 1	1944	114.92	125.68	2.22	883.73	131.7
Buridehing	134408.1	PF 1	1944	114.9	125.61	2.31	844.32	118.78
Buridehing	134258.7	PF 1	1944	114.92	125.57	2.21	883.24	119
Buridehing	134107.5	PF 1	1944	115.04	125.58	1.95	1020.37	130.46
Buridehing	133960.4	PF 1	1944	115.11	125.42	2.53	907.61	136.58
Buridehing	133813.1	PF 1	1944	115.44	125.2	2.95	690.47	110.49
Buridehing	133663.4	PF 1	1944	115.28	125.04	3.11	629.22	91.68
Buridehing	133514.5	PF 1	1944	115.27	125	2.82	690.29	119.77
Buridehing	133364.1	PF 1	1944	115.28	125.08	1.98	983.81	154.59
Buridehing	133216.8	PF 1	1944	115.28	125.04	1.92	1011.45	167.86
Buridehing	133065.8	PF 1	1944	115	124.99	1.93	1007.21	155.93
Buridehing	132914.1	PF 1	1944	115.05	124.94	1.97	988.98	149.67
Buridehing	132764.2	PF 1	1944	114.89	124.91	1.94	1013.71	137.27
Buridehing	132645.7	PF 1	1944	114.82	124.75	2.43	802.71	113.63
Buridehing	132494.1	PF 1	1944	114.48	124.59	2.74	712.21	108.47
Buridehing	132338.7	PF 1	1944	115.29	124.67	1.9	1024.51	156.49
Buridehing	132190.6	PF 1	1944	115.08	124.71	1.32	1474.53	242.72
Buridehing	132046	PF 1	1944	115.08	124.59	1.86	1047.66	169.54
Buridehing	131897.9	PF 1	1944	114.33	124.55	1.86	1043.77	145.39
Buridehing	131747.1	PF 1	1944	114.57	124.31	2.64	742.07	113.31
Buridehing	131597	PF 1	1944	114.55	124.34	2.1	930.8	140.31
Buridehing	131446.9	PF 1	1944	114.39	124.22	2.4	825.76	117.46
Buridehing	131297.3	PF 1	1944	113.25	124.23	2.02	977.7	124.86
Buridehing	131147.3	PF 1	1944	112.85	124.22	1.87	1057.79	128.97

Buridehing	130996.2	PF 1	1944	112.91	124.2	1.84	1070.75	135.09
Buridehing	130845.6	PF 1	1944	111.09	124.11	2.09	933.6	101.23
Buridehing	130691.1	PF 1	1944	114.4	124.1	1.99	981.37	129.64
Buridehing	130544.2	PF 1	1944	114.37	124.16	1.27	1539.06	230.06
Buridehing	130391.7	PF 1	1944	114.32	124.16	1.01	1945.4	304.21
Buridehing	130240.4	PF 1	1944	115.16	124.15	0.99	1964.8	328
Buridehing	130088.2	PF 1	1944	114.73	124.11	1.2	1620.48	332.06
Buridehing	129940.4	PF 1	1944	114.19	124.1	1.14	1712.62	294.68
Buridehing	129788.8	PF 1	1944	114.28	124.07	1.21	1608.11	246.99
Buridehing	129637.3	PF 1	1944	114.38	124.03	1.36	1434.35	237
Buridehing	129459	PF 1	1944	113.85	123.95	1.64	1199.89	187.56
Buridehing	129325.3	PF 1	1944	113.49	123.94	1.53	1271.78	177.16
Buridehing	129220.6	PF 1	1944	113.08	123.91	1.62	1211.05	162.95
Buridehing	129109.3	PF 1	1944	113.86	123.66	2.58	768.9	110.12
Buridehing	128962.5	PF 1	1944	113.74	123.53	2.78	701.4	101.89
Buridehing	128813.8	PF 1	1944	113.76	123.57	2.21	881.12	125.65
Buridehing	128673.4	PF 1	1944	113.85	123.57	1.95	1008.4	139.63
Buridehing	128532	PF 1	1944	111.74	123.56	1.78	1099.75	141.41
Buridehing	128380	PF 1	1944	113.14	123.4	2.3	849.95	152.92
Buridehing	128231	PF 1	1944	112.93	123.42	1.88	1046.99	140.89
Buridehing	128080.4	PF 1	1944	111.32	123.44	1.53	1284.48	134.57
Buridehing	127926.9	PF 1	1944	110.83	123.45	1.25	1558.27	156.17
Buridehing	127776.8	PF 1	1944	111.18	123.37	1.68	1167.63	129.67
Buridehing	127626.9	PF 1	1944	112.14	123.22	2.22	879.06	105.86
Buridehing	127478.4	PF 1	1944	111.49	123.22	1.98	983.47	117.09
Buridehing	127329.9	PF 1	1944	111.26	123.15	2.15	905.46	109.09
Buridehing	127184.1	PF 1	1944	111.41	122.9	2.87	678.67	88.6
Buridehing	127041.7	PF 1	1944	111.22	122.94	2.34	831.46	105.34
Buridehing	126892	PF 1	1944	110.51	123	1.74	1121.23	127.2
Buridehing	126744.8	PF 1	1944	112.1	122.98	1.67	1184.19	146.07
Buridehing	126590.5	PF 1	1944	112.55	123	1.36	1438.61	182.12
Buridehing	126436.7	PF 1	1944	112.7	123	1.18	1664.98	218.61
Buridehing	126282.7	PF 1	1944	111.88	123.01	0.98	1996.94	276.88
Buridehing	126131.2	PF 1	1944	112.2	123.01	0.81	2399.65	332.56
Buridehing	125974.9	PF 1	1944	112.28	123	0.8	2446.43	371.12
Buridehing	125824.4	PF 1	1944	114.5	122.97	1.13	2147.88	380.56
Buridehing	125673.5	PF 1	1944	112.9	122.95	1.18	2365.6	539.24
Buridehing	125525.6	PF 1	1944	112.93	122.96	0.69	3054.49	597.07
Buridehing	125398.1	PF 1	1944	112.66	122.96	0.67	3043.65	631.98
Buridehing	125248.1	PF 1	1944	111.18	122.76	2.66	1867.44	657.11
Buridehing	125098.1	PF 1	1944	112.21	122.87	0.54	3708.81	709.02
Buridehing	124948.1	PF 1	1944	112.56	122.87	0.57	3655.02	705.34
Buridehing	124791.3	PF 1	1944	112.47	122.85	0.73	2875.71	699.27
Buridehing	124634.3	PF 1	1944	112.06	122.85	0.7	3202.82	693.18
Buridehing	124473.4	PF 1	1944	112.14	122.84	0.75	3036.25	644.51
Buridehing	124322.3	PF 1	1944	112.58	122.78	1.46	2874.94	822.75
Buridehing	124169.9	PF 1	1944	112.56	122.74	1.62	2476.87	776.94
Buridehing	123989.4	PF 1	1944	112.06	122.75	1.22	3242.36	704.8
Buridehing	123850.2	PF 1	1944	111.95	122.71	1.43	2771.14	634.67
Buridehing	123757.3	PF 1	1944	111.97	122.71	1.16	2475.07	556.2
Buridehing	123608.4	PF 1	1944	111.81	122.67	1.43	2144.37	488.69
Buridehing	123492.5	PF 1	1944	110.69	122.68	1.13	2587.8	501.68
Buridehing	123393.6	PF 1	1944	110.3	122.68	1.06	2776.98	514.09
Buridehing	123236.7	PF 1	1944	110.52	122.68	0.95	2727.93	493.15
Buridehing	123086.1	PF 1	1944	109.61	122.68	0.78	2886.11	459.07
Buridehing	122970.1	PF 1	1944	111	122.67	0.85	2540.57	425.75
Buridehing	122963.9		Bridge					
Buridehing	122955.9	PF 1	1944	111.15	122.67	0.84	2649.56	427.8
Buridehing	122924.9	PF 1	1944	111.48	122.66	0.87	2483.33	446.26
Buridehing	122770.3	PF 1	1944	111.8	122.64	1.01	2333.88	479.07
Buridehing	122646.5	PF 1	1944	111.99	122.61	1.24	2307.09	601.52
Buridehing	122498.8	PF 1	1944	111.33	122.41	2.46	1683.05	697.8
Buridehing	122329.1	PF 1	1944	110.33	122.45	1.8	2258.21	739
Buridehing	122172.9	PF 1	1944	110.39	122.3	2.68	1961.98	789.11
Buridehing	122030.9	PF 1	1944	113.52	122.32	1.88	2061.4	853.59
Buridehing	121880.6	PF 1	1944	111.63	122.32	1.37	2418.03	955.3

Buridehing	121727.7	PF 1	2375	110.71	122.2	2.06	2393.2	1091.53
Buridehing	121576.2	PF 1	2375	111.57	122.08	2.63	2161.17	1238.58
Buridehing	121431.4	PF 1	2375	111.54	122.1	2.31	2724.72	1265.97
Buridehing	121271.3	PF 1	2375	111.75	122.11	1.8	2977.96	1299.59
Buridehing	121120.9	PF 1	2375	111.64	122.02	2.26	2857.81	1294.75
Buridehing	120993.1	PF 1	2375	111.89	122.06	1.48	3154.76	1309.44
Buridehing	120832.7	PF 1	2375	113	122.01	1.71	2911.93	1339.73
Buridehing	120694.1	PF 1	2375	112.92	121.99	1.72	3026.34	1357.86
Buridehing	120510.6	PF 1	2375	112.98	121.95	1.75	2899.46	1341.58
Buridehing	120378.2	PF 1	2375	112.92	121.89	2.26	2748.81	1266.14
Buridehing	120224.4	PF 1	2375	112.8	121.86	1.65	2823.03	1286.94
Buridehing	120075.4	PF 1	2375	110.61	121.84	1.61	2819.22	1298.37
Buridehing	119914.2	PF 1	2375	111.23	121.72	2.24	2434.45	1306.77
Buridehing	119706	PF 1	2375	110.81	121.66	2.31	2370.24	1304.59
Buridehing	119539.2	PF 1	2375	111.05	121.58	2.6	2449.97	1216.35
Buridehing	119439.3	PF 1	2375	111.07	121.59	2.09	2562.31	1156.2
Buridehing	119314.5	PF 1	2375	110.89	121.52	2.36	2440.54	1095.15
Buridehing	119181.7	PF 1	2375	110.98	121.42	2.64	2104.43	1035.43
Buridehing	119034	PF 1	2375	111.16	121.25	3.02	1792.99	983.78
Buridehing	118890.3	PF 1	2375	111.07	121.24	2.62	1701.97	978.97
Buridehing	118736.1	PF 1	2375	111.09	121.2	2.85	1783.31	942.09
Buridehing	118592.1	PF 1	2375	111.14	121.14	2.08	2081.52	841.55
Buridehing	118446.2	PF 1	2375	110.98	121.05	2.41	2066.98	844.7
Buridehing	118311.8	PF 1	2375	111.38	121.04	2.09	2041.54	906.9
Buridehing	118213.4	PF 1	2375	111.08	121.03	1.94	2019.24	591.21
Buridehing	118056.4	PF 1	2375	111.07	120.73	3.21	1535.01	570.66
Buridehing	117892.1	PF 1	2375	110.39	120.67	3.06	1617.97	570.98
Buridehing	117737.3	PF 1	2375	110.4	120.29	3.63	1076.39	559.25
Buridehing	117586.5	PF 1	2375	110.21	120.23	3.36	1139.21	581.59
Buridehing	117433.3	PF 1	2375	110.28	120.34	2.38	1494.23	700.52
Buridehing	117282.7	PF 1	2375	110.55	120.39	1.72	1864.09	982.92
Buridehing	117133	PF 1	2375	110.23	120.42	1.25	2659.26	1409.79
Buridehing	116977.8	PF 1	2375	109.99	120.42	1.06	2936.36	2260.75
Buridehing	116817.7	PF 1	2375	109.68	120.43	0.9	4356.9	3459.21
Buridehing	116694.7	PF 1	2375	110.06	120.42	0.84	4226.78	3825.78
Buridehing	116544.7	PF 1	2375	110.31	120.42	0.8	5309.13	4070.78
Buridehing	116386.8	PF 1	2375	109.75	120.42	0.73	5973.69	4255.9
Buridehing	116231.5	PF 1	2375	113.23	120.4	0.86	4330.83	4333.38
Buridehing	116106.8	PF 1	2375	110.08	120.39	0.86	4451.69	4116.86
Buridehing	115973.3	PF 1	2375	110.5	120.39	0.75	6173.48	4382.44
Buridehing	115758.8	PF 1	2375	109.96	120.38	0.88	6297.71	3931.1
Buridehing	115521.5	PF 1	2375	109.75	120.35	1.18	5941.31	3279.2
Buridehing	115253.9	PF 1	2375	109.46	120.27	1.64	3479.77	1614.16
Buridehing	115124.9	PF 1	2375	110.08	120.07	2.81	2637.18	2008.01
Buridehing	114967	PF 1	2375	108.56	120.1	1.13	6333.87	2541.95
Buridehing	114800.9	PF 1	2375	109.19	120.1	0.86	8276.51	2413.6
Buridehing	114638.6	PF 1	2375	109.93	120.07	1.05	6795.49	2415.84
Buridehing	114466.5	PF 1	2375	109.43	120.04	1.15	6278.12	2235.69
Buridehing	114290.9	PF 1	2375	109.3	120.01	1.35	5449.43	2028.26
Buridehing	114147.2	PF 1	2375	109.22	120.03	0.66	6945.19	1998.15
Buridehing	114022.2	PF 1	2375	109.32	120.01	0.8	5634.12	1900.08
Buridehing	113846.3	PF 1	2375	109.86	119.97	1.16	4576.73	1688.05
Buridehing	113687.6	PF 1	2375	109.27	119.92	1.48	3284.31	1285.31
Buridehing	113493.1	PF 1	2375	108.77	119.76	2.15	2362.37	1101.56
Buridehing	113339.6	PF 1	2375	109.54	119.44	3.26	1699.8	1082.36
Buridehing	113181.7	PF 1	2375	109.8	119.46	2.86	2205.36	1088.64
Buridehing	113027.1	PF 1	2375	109.39	119.37	2.74	1941	1081.31
Buridehing	112876.2	PF 1	2375	109.02	119.33	2.72	2278.19	1037.13
Buridehing	112719.4	PF 1	2375	108.8	119.27	2.65	2276.65	1003.87
Buridehing	112567.9	PF 1	2375	108.9	119.24	2.54	2350.73	930.07
Buridehing	112420.3	PF 1	2375	108.92	119.17	2.57	2118.84	848.14
Buridehing	112264.8	PF 1	2375	109.26	119.07	2.82	2014.02	779.93
Buridehing	112114.3	PF 1	2375	109.06	119.02	2.43	1770.07	747.52
Buridehing	111964.9	PF 1	2375	108.97	119.03	2.19	2502.87	935.43
Buridehing	111814.9	PF 1	2375	108.37	119.06	1.49	2890.72	958.6
Buridehing	111666	PF 1	2375	108.77	119.05	1.48	3078.23	851.81

Buridehing	111507.1	PF 1	2375	108.5	119.03	1.55	2940.97	728.04
Buridehing	111360.7	PF 1	2375	108.3	118.98	1.83	2672.81	656.34
Buridehing	111210.6	PF 1	2375	108.63	118.96	1.82	2547.65	636.73
Buridehing	111061.7	PF 1	2375	108.56	118.92	2.1	2596.68	664.79
Buridehing	110910.8	PF 1	2375	108.52	118.82	2.71	2255.51	706.8
Buridehing	110760.7	PF 1	2375	108.5	118.78	2.23	2318.52	706.36
Buridehing	110610.3	PF 1	2375	108.29	118.72	2.38	2252.75	693.43
Buridehing	110463.7	PF 1	2375	108.18	118.65	2.51	2160.82	768.83
Buridehing	110319.4	PF 1	2375	108.3	118.64	2.34	2377.21	772.46
Buridehing	110144.7	PF 1	2375	108.32	118.62	2.12	2525.72	791.77
Buridehing	109990.3	PF 1	2375	108.23	118.63	1.74	3008.84	786.58
Buridehing	109863.4	PF 1	2375	106.99	118.63	1.53	3217.64	756.88
Buridehing	109771.6	PF 1	2375	106.77	118.62	1.43	3320.04	791.82
Buridehing	109671.6	PF 1	2375	107.12	118.63	1.22	3741.38	957.69
Buridehing	109567	PF 1	2375	107.95	118.61	1.33	3475.43	877.17
Buridehing	109436.3	PF 1	2375	108.18	118.6	1.37	3389.23	838.29
Buridehing	109311.3	PF 1	2375	107.8	118.6	1.09	3929.02	721.67
Buridehing	109156.9	PF 1	2375	109.63	118.54	1.6	2791.06	624.76
Buridehing	109003.8	PF 1	2375	109.4	118.55	0.57	2930.72	590.11
Buridehing	108840	PF 1	2375	107.49	118.48	1.37	2487.18	573.73
Buridehing	108669.4	PF 1	2375	108.86	118.48	1.18	2020.9	485.46
Buridehing	108649	PF 1	2375	108.78	118.47	1.22	1944.04	498.47
Buridehing	108636.8		Bridge					
Buridehing	108622.2	PF 1	2375	108.14	118.46	1.24	1912.23	491.04
Buridehing	108541.9	PF 1	2375	107.24	118.38	1.78	1846.6	467.69
Buridehing	108394.8	PF 1	2375	107.02	118.37	1.64	1927.73	562.63
Buridehing	108236.7	PF 1	2375	106.72	118.39	1.14	2079.39	535.64
Buridehing	108231.9		Bridge					
Buridehing	108218.1	PF 1	2375	106.81	118.39	1.1	2165.9	525.27
Buridehing	108093.8	PF 1	2375	106.62	118.34	1.54	2899.56	965.3
Buridehing	107940.1	PF 1	2375	106.61	118.34	1.46	3381.66	986.07
Buridehing	107784.2	PF 1	2375	108.03	118.33	1.47	3586.18	1047.33
Buridehing	107628.8	PF 1	2375	108.86	118.29	1.65	3394.68	1094.31
Buridehing	107473.6	PF 1	2375	107.04	118.27	1.62	3467.93	1119.42
Buridehing	107312.1	PF 1	2375	107.24	118.27	1.36	3941.2	1148.91
Buridehing	107161.8	PF 1	2375	107.24	118.25	1.45	3621.8	1174.18
Buridehing	107006.7	PF 1	2375	107.29	118.21	1.65	3446.48	1146.81
Buridehing	106850.6	PF 1	2375	107.29	118.18	1.85	3281.47	1132.53
Buridehing	106699.5	PF 1	2375	107.36	118.16	1.72	3359.12	1095.89
Buridehing	106544.7	PF 1	2375	103.46	118	2.64	2706.51	1045.62
Buridehing	106390.2	PF 1	2375	103.25	118	2.45	2850.2	996.08
Buridehing	106236.9	PF 1	2375	104.25	117.98	2.34	2926.57	971.59
Buridehing	106086.7	PF 1	2375	103.45	117.96	2	3121.97	1036.62
Buridehing	105934.8	PF 1	2375	107.05	117.99	1.25	3242.31	1075.68
Buridehing	105782.6	PF 1	2375	108.72	117.98	1.19	3005.87	1062.77
Buridehing	105631.8	PF 1	2375	108.96	117.97	1.17	3155.05	1083.3
Buridehing	105492.9	PF 1	2375	110.16	117.95	1.25	2907.75	1116.51
Buridehing	105345.7	PF 1	2375	106.91	117.89	2.01	3403.61	1127.22
Buridehing	105194.3	PF 1	2375	106.84	117.87	1.79	3373.38	1069.5
Buridehing	105034.9	PF 1	2375	106.7	117.85	1.71	3306.25	1018.04
Buridehing	104891.5	PF 1	2375	106.69	117.84	1.68	3295.4	946.48
Buridehing	104735.3	PF 1	2375	106.35	117.78	1.9	2727.81	860.36
Buridehing	104585.2	PF 1	2375	106.95	117.73	1.96	2388.21	810.39
Buridehing	104439.2	PF 1	2375	106.78	117.64	2.18	2066.04	815.15
Buridehing	104289.2	PF 1	2375	105.79	117.68	1.64	2463.83	793.74
Buridehing	104138.2	PF 1	2375	105.69	117.68	1.41	2433.28	783.85
Buridehing	103987	PF 1	2375	105.62	117.68	1.31	2598.61	766.29
Buridehing	103833.7	PF 1	2375	105.53	117.67	1.19	2700.15	802.48
Buridehing	103683.6	PF 1	2375	105.55	117.67	1.15	2902.02	819.35
Buridehing	103533.4	PF 1	2375	105.61	117.66	1.11	3128.05	832.97
Buridehing	103384.1	PF 1	2375	105.84	117.65	1.15	3287.32	891.75
Buridehing	103234.1	PF 1	2375	106.21	117.62	1.31	2907.94	948
Buridehing	103090.2	PF 1	2375	106.37	117.62	1.23	3116.31	998.64
Buridehing	102933.7	PF 1	2375	106.52	117.6	1.34	3302.08	1039.04
Buridehing	102782.4	PF 1	2375	106.2	117.55	1.75	3157.76	1045.32
Buridehing	102629	PF 1	2375	106.92	117.42	2.31	2433.89	1061.64

Buridehing	102477.9	PF 1	2375	106.45	117.36	2.35	2459.81	1065.98
Buridehing	102330	PF 1	2375	105.74	117.36	2.11	2726.09	1123.35
Buridehing	102182.5	PF 1	2375	106.27	117.32	2.22	2811.51	1093.62
Buridehing	102029	PF 1	2375	104.61	117.27	2.61	2693.94	1116.55
Buridehing	101887.9	PF 1	2375	106.5	117.28	2.08	3118.06	1135.92
Buridehing	101826.9	PF 1	2375	106.41	117.3	1.79	3240.69	1153.2
Buridehing	101801.2		Bridge					
Buridehing	101784.3	PF 1	2375	106.37	117.27	1.81	3244.86	1161.98
Buridehing	101741.9	PF 1	2375	106.25	117.26	1.83	3234.45	1157.18
Buridehing	101591.6	PF 1	2375	106.54	117.23	1.9	3077.49	1131.75
Buridehing	101437.8	PF 1	2375	106.47	117.19	1.88	2891.88	1110.09
Buridehing	101287.7	PF 1	2375	106.43	117.17	1.94	3180.04	1110.9
Buridehing	101136.9	PF 1	2375	106.45	117.13	2.26	3104.86	1124.73
Buridehing	100986.9	PF 1	2375	106.48	117.05	2.25	2768.85	1127.99
Buridehing	100836.9	PF 1	2375	106.21	117.05	2.01	3089.33	1121.24
Buridehing	100686.5	PF 1	2375	106.27	117.03	1.82	3170.71	1120.6
Buridehing	100534.8	PF 1	2375	106.3	117	1.9	3061.8	1151.99
Buridehing	100383.1	PF 1	2375	106.27	116.98	1.87	3072.7	1137.14
Buridehing	100231.9	PF 1	2375	106.39	116.92	2.13	2915.13	1116.58
Buridehing	100081.6	PF 1	2375	104.01	116.84	2.46	2774.63	1049.92
Buridehing	99931.42	PF 1	2375	106.29	116.86	1.84	3046.88	1029.45
Buridehing	99781.09	PF 1	2375	106.24	116.85	1.77	3334.42	998.01
Buridehing	99632.74	PF 1	2375	106.3	116.83	1.79	3292.82	968.34
Buridehing	99475.88	PF 1	2375	106.26	116.79	2.01	3009.77	942.36
Buridehing	99326.66	PF 1	2375	106.07	116.76	2.07	3077.18	914.03
Buridehing	99176.77	PF 1	2375	105.86	116.7	2.28	2827.94	876.86
Buridehing	99024.47	PF 1	2375	105.9	116.68	1.97	2961.21	840.13
Buridehing	98867.36	PF 1	2375	106.09	116.66	1.95	2996.26	961.96
Buridehing	98701.38	PF 1	2375	106.05	116.65	1.79	3339.67	1005.08
Buridehing	98548.85	PF 1	2375	105.88	116.66	1.35	3999.29	1014.22
Buridehing	98453.34	PF 1	2375	105.95	116.66	1.42	3972.71	1027.18
Buridehing	98393.59	PF 1	2375	105.72	116.48	2.59	2557.62	919.4
Buridehing	98253.77	PF 1	2375	105.81	116.53	1.81	3477.78	1018.91
Buridehing	97991.81	PF 1	2375	105.95	116.51	1.59	3696.4	1087.19
Buridehing	97810.82	PF 1	2510	105.34	116.42	2.05	3210.93	1202.99
Buridehing	97598.16	PF 1	2510	105.56	116.34	2.22	3067.52	1388.34
Buridehing	97575.78	PF 1	2510	105.48	116.4	1.42	4652.47	1498.72
Buridehing	97480.56	PF 1	2510	105.44	116.38	1.63	4458.92	1487.74
Buridehing	97352.96	PF 1	2510	105.72	116.22	2.44	3049.47	1518.9
Buridehing	97176.91	PF 1	2510	105.66	116.18	2.34	3004.26	1550.23
Buridehing	97034.09	PF 1	2510	105.99	116.15	2.49	3094.74	1637.73
Buridehing	96865.69	PF 1	2510	105.37	116.19	1.52	4119.96	1731.51
Buridehing	96676.83	PF 1	2510	105.16	116.16	1.75	4370.36	1818.72
Buridehing	96488.2	PF 1	2510	105.31	116.14	1.8	4404.68	1856.47
Buridehing	96374.92	PF 1	2510	105.25	116.12	1.71	4485.51	1953.32
Buridehing	96298.41	PF 1	2510	105.11	116.11	1.54	4759.32	2024.72
Buridehing	96131.97	PF 1	2510	105.44	116.11	1.44	5025.64	2031.79
Buridehing	95924.42	PF 1	2510	105.47	116.1	1.31	5313.95	2018.58
Buridehing	95725.35	PF 1	2510	105.48	116.06	1.63	4452.54	1866.54
Buridehing	95567.28	PF 1	2510	103.35	115.93	2.45	3518.02	1810.65
Buridehing	95415.23	PF 1	2510	105.3	115.98	1.57	4314.49	1785.46
Buridehing	95263.34	PF 1	2510	105.03	115.96	1.55	4751.1	2012.46
Buridehing	95108.93	PF 1	2510	105.18	115.95	1.62	4801.78	2041.78
Buridehing	94958.09	PF 1	2510	105.22	115.93	1.58	4558.15	1907.2
Buridehing	94801.88	PF 1	2510	106.38	115.89	1.85	3751.62	1686.7
Buridehing	94606.88	PF 1	2510	105.87	115.86	1.86	3551.16	1252.26
Buridehing	94467.34	PF 1	2510	105.55	115.81	1.98	3350.77	1174.85
Buridehing	94331.48	PF 1	2510	105.29	115.76	2.16	3277.31	1106.63
Buridehing	94169.63	PF 1	2510	105.2	115.63	2.61	2645.3	1005.95
Buridehing	94016.89	PF 1	2510	104.96	115.64	2.17	2951.88	926.49
Buridehing	93861.98	PF 1	2510	104.84	115.52	2.6	2340.57	916.29
Buridehing	93701.6	PF 1	2510	104.3	115.52	1.99	2702.16	979.26
Buridehing	93506.88	PF 1	2510	104.55	115.52	1.8	3344.94	1096.84
Buridehing	93390.32	PF 1	2510	104.6	115.51	1.77	3653.28	1124.98
Buridehing	93201.91	PF 1	2510	104.83	115.5	1.56	3706.73	1249.65
Buridehing	93038.71	PF 1	2510	104.77	115.48	1.53	3571.42	1472.45

Buridehing	92904.55	PF 1	2510	104.68	115.42	1.86	3303.42	1524.48
Buridehing	92783.63	PF 1	2510	104.96	115.4	1.71	3509.99	1387.94
Buridehing	92754.94	PF 1	2510	106.09	115.37	1.92	3115.41	1326.86
Buridehing	92580.09	PF 1	2510	105.61	115.33	1.79	2725.56	1320.93
Buridehing	92411.19	PF 1	2510	106.22	115.13	2.72	2267.63	1336.19
Buridehing	92256.48	PF 1	2510	104.9	115.12	2.16	2461.28	1301.09
Buridehing	92106.42	PF 1	2510	105.2	115.04	2.37	2350.65	1183.47
Buridehing	91957.61	PF 1	2510	105.08	115.02	2.06	2289.03	1012.49
Buridehing	91807.49	PF 1	2510	105.09	114.99	1.99	2185.67	911.61
Buridehing	91657.13	PF 1	2510	105.4	114.9	2.23	2001.5	845.44
Buridehing	91505.75	PF 1	2510	104.9	114.79	2.51	1880.05	789.69
Buridehing	91355.05	PF 1	2510	105.59	114.83	1.8	2135.57	898.86
Buridehing	91208.64	PF 1	2510	104.21	114.81	1.91	2573.6	1178.15
Buridehing	91061	PF 1	2510	104.43	114.74	2.16	2688.5	1302.35
Buridehing	90902.94	PF 1	2510	104.37	114.76	1.88	3478.37	1370.38
Buridehing	90758.7	PF 1	2510	104.37	114.72	1.8	3180.3	1444.14
Buridehing	90608.52	PF 1	2510	104.32	114.66	1.93	2991.45	1607.3
Buridehing	90459.66	PF 1	2510	103.49	114.66	1.65	3405.7	1668.37
Buridehing	90314.81	PF 1	2510	103.28	114.64	1.61	3290.93	1738.74
Buridehing	90160	PF 1	2510	103.54	114.61	1.65	3206.72	1709.96
Buridehing	90011.3	PF 1	2510	103.73	114.57	1.79	3011.8	1779.37
Buridehing	89874.17	PF 1	2510	104.02	114.56	1.7	3499.22	1793.56
Buridehing	89711.46	PF 1	2510	104.39	114.53	1.82	3565.02	1946.1
Buridehing	89574.09	PF 1	2510	104.47	114.54	1.37	3935.71	1946.95
Buridehing	89408.09	PF 1	2510	104.34	114.56	1.05	4280.11	1988.19
Buridehing	89238.49	PF 1	2510	104.28	114.49	1.52	4151.75	2036.15
Buridehing	89145.91	PF 1	2510	104.37	114.47	1.5	4252.08	2089.87
Buridehing	88964.76	PF 1	2510	104.09	114.46	1.3	4564.59	2150.79
Buridehing	88798.4	PF 1	2510	103.77	114.46	0.97	4865.65	2216.6
Buridehing	88657.1	PF 1	2510	103.62	114.43	1.23	4576.93	2156.27
Buridehing	88512.8	PF 1	2510	103.45	114.4	1.45	4378.56	2097.61
Buridehing	88381.55	PF 1	2510	103.34	114.39	1.32	4423.77	1903.38
Buridehing	88230.83	PF 1	2510	105.2	114.34	1.67	3475.26	1718.86
Buridehing	88107.12	PF 1	2510	103.91	114.13	2.72	2615.5	1610.21
Buridehing	87958.09	PF 1	2510	103.55	114.14	2.23	2969.04	1666.22
Buridehing	87805.28	PF 1	2510	103.53	114.18	1.42	3558.66	1739.09
Buridehing	87653.89	PF 1	2510	103.41	114.18	1.23	3831.03	1860.33
Buridehing	87503.18	PF 1	2510	103.01	114.17	1.12	3829.86	1938.55
Buridehing	87352.59	PF 1	2510	102.81	114.15	1.27	4117.73	1983.63
Buridehing	87207.18	PF 1	2510	103.52	114.06	2.02	3699.83	2024.35
Buridehing	86989.33	PF 1	2510	103.54	114.06	1.9	4455.14	2170.03
Buridehing	86899.09	PF 1	2510	103.45	114.04	1.68	4444.98	2137.32
Buridehing	86839.02	PF 1	2510	103.31	114.05	1.34	4854.77	2224.13
Buridehing	86717.04	PF 1	2510	103.38	114.06	0.97	5707.93	2652.74
Buridehing	86531.88	PF 1	2510	103.57	114.04	1.32	5546.26	2685.77
Buridehing	86354.25	PF 1	2510	103.35	114	1.62	5298.33	2680.32
Buridehing	86200.02	PF 1	2510	103.47	114	1.5	5662.05	2699.52
Buridehing	86007.57	PF 1	2510	102.24	113.99	1.24	6482.74	2858.24
Buridehing	85841	PF 1	2510	101.52	113.97	1.39	6379.08	3044.83
Buridehing	85660.4	PF 1	2510	102.04	113.96	1.48	6248.75	3138.71
Buridehing	85458.52	PF 1	2510	103.29	113.93	1.53	5605.86	3164.43
Buridehing	85296.88	PF 1	2510	103.18	113.92	1.48	5915.74	3216.9
Buridehing	85143.55	PF 1	2510	103.21	113.89	1.61	5341.94	2621.18
Buridehing	84998.66	PF 1	2510	103.24	113.84	1.7	4377.38	2426.24
Buridehing	84837.21	PF 1	2510	103.32	113.82	1.81	4555.55	2186.7
Buridehing	84694.61	PF 1	2510	103.37	113.74	2.3	3859.51	2008.87
Buridehing	84531.13	PF 1	2510	103.4	113.73	1.87	3917.08	1795.68
Buridehing	84372.66	PF 1	2510	103.46	113.71	1.58	3843.51	1692.05
Buridehing	84218.78	PF 1	2510	103.35	113.64	2.08	3573.15	1594.68
Buridehing	84024.27	PF 1	2510	102.4	113.61	2.08	3459.51	1455.82
Buridehing	83851.91	PF 1	2510	102.55	113.55	2.18	3183.11	1405.38
Buridehing	83692.99	PF 1	2510	100.93	113.44	2.53	2779.47	1347.54
Buridehing	83534.98	PF 1	2510	103.58	113.32	2.7	2243.93	1274.78
Buridehing	83385.2	PF 1	2510	103.44	113.25	2.71	2120.05	1177.48
Buridehing	83239.84	PF 1	2510	102.74	113.25	2.18	2215.82	1194.91
Buridehing	83085.55	PF 1	2510	102.62	113.25	1.8	2420.96	1113.13

Buridehing	82938.7	PF 1	2510	102.56	113.24	1.8	2571.24	1025.22
Buridehing	82784.29	PF 1	2510	102.37	113.23	1.6	2793.44	1096.89
Buridehing	82632.48	PF 1	2510	104.06	113.18	1.8	2745.18	1026.48
Buridehing	82475.17	PF 1	2510	103.78	113.21	0.94	3076.44	977.56
Buridehing	82325.96	PF 1	2510	103.97	113.19	0.83	3228.36	1022.76
Buridehing	82172.22	PF 1	2510	104.18	113.01	2.28	2601.27	1045.1
Buridehing	82022.16	PF 1	2510	104.66	112.91	2.48	2318.15	1009.58
Buridehing	81874.82	PF 1	2510	101.71	112.91	1.88	2428.73	957.3
Buridehing	81721.18	PF 1	2510	100.79	112.91	1.66	2561.9	880.35
Buridehing	81588.95	PF 1	2510	101.9	112.92	1.46	2536.79	733.81
Buridehing	81483.7	PF 1	2510	101.63	112.94	1.09	2894.24	696.39
Buridehing	81352.67	PF 1	2510	100.4	112.93	1.03	2994.01	708.24
Buridehing	81182.95	PF 1	2510	101.39	112.8	1.9	2257.99	890.35
Buridehing	81031.81	PF 1	2510	101.84	112.67	2.44	2187.14	1149.78
Buridehing	80878.02	PF 1	2510	102.76	112.63	2.48	2377.6	1401.8
Buridehing	80725.78	PF 1	2510	102.5	112.65	2	3031.13	1599.62
Buridehing	80573.16	PF 1	2510	102.17	112.69	1.41	4063.94	2110.73
Buridehing	80422.64	PF 1	2510	102.08	112.69	1.1	4370.83	2271.23
Buridehing	80270.42	PF 1	2510	103.74	112.67	1	4021.41	2469.95
Buridehing	80095.51	PF 1	2510	102.27	112.6	1.64	4597.72	2632.57
Buridehing	79981	PF 1	2510	102	112.61	1.04	6370.4	3083.58
Buridehing	79874.62	PF 1	2510	101.93	112.61	1.03	6610.05	3195.65
Buridehing	79788.26	PF 1	2510	101.1	112.59	1.17	6587.05	3277.79
Buridehing	79677.81	PF 1	2510	101.53	112.58	1.24	6627.5	3287.22
Buridehing	79543.03	PF 1	2510	101.85	112.59	0.91	7149.58	3212.35
Buridehing	79355.6	PF 1	2510	101.9	112.57	1.35	6187	3117.54
Buridehing	79200.56	PF 1	2510	102.32	112.41	2.66	3874.09	2823.26
Buridehing	79049.78	PF 1	2766	101.87	112.4	1.98	4648.49	2692
Buridehing	78916.7	PF 1	2766	101.84	112.37	1.83	4513.7	2544.82
Buridehing	78776.88	PF 1	2766	101.78	112.35	1.77	4413.99	2330.3
Buridehing	78632.78	PF 1	2766	101.63	112.32	1.75	3996.72	1970.43
Buridehing	78480.92	PF 1	2766	100.94	112.3	1.88	4127.54	1794.3
Buridehing	78331.44	PF 1	2766	97.81	112.15	2.44	3274.12	1662.85
Buridehing	78173.52	PF 1	2766	100.11	112.19	1.87	3902.57	1507.72
Buridehing	78020.73	PF 1	2766	100.73	112.17	1.84	3786.87	1406.35
Buridehing	77870.41	PF 1	2766	101.47	112.18	1.49	3952.8	1370.85
Buridehing	77721.04	PF 1	2766	101.54	112.13	1.81	3687.53	1300.41
Buridehing	77564.96	PF 1	2766	101.42	112.11	1.65	3591.76	1201.46
Buridehing	77429.32	PF 1	2766	101.35	112.11	1.44	3927.58	1143.36
Buridehing	77276.17	PF 1	2766	101.33	112.11	1.16	4305.35	1281.93
Buridehing	77124.89	PF 1	2766	101.22	112.09	1.21	3932.38	1155.57
Buridehing	76986.76	PF 1	2766	98.55	112.06	1.33	3572.55	1095.67
Buridehing	76879.24	PF 1	2766	101.01	112.05	1.37	3446.84	1077.41
Buridehing	76726.48	PF 1	2766	99.97	111.78	3.05	2573.4	1261.46
Buridehing	76569.43	PF 1	2766	99.51	111.81	2.56	3361.74	1318.59
Buridehing	76421.88	PF 1	2766	100.9	111.8	1.93	3274.55	1367.73
Buridehing	76279.05	PF 1	2766	100.41	111.79	1.75	3456.54	1355.18
Buridehing	76121.2	PF 1	2766	100.39	111.78	1.47	3616.44	1340.17
Buridehing	75975.87	PF 1	2766	100.3	111.78	1.45	3975.39	1279.31
Buridehing	75822.44	PF 1	2766	99.8	111.7	1.97	3267.74	1048.06
Buridehing	75669.98	PF 1	2766	101.26	111.58	2.63	2740.69	986.28
Buridehing	75519.09	PF 1	2766	100.12	111.54	2.41	2799.12	988.56
Buridehing	75370.96	PF 1	2766	100.34	111.56	1.87	3045.72	981.71
Buridehing	75220.01	PF 1	2766	100.48	111.55	1.67	3258.93	1088.23
Buridehing	75071.59	PF 1	2766	101.7	111.5	1.89	3128.3	1202.52
Buridehing	74926.34	PF 1	2766	100.44	111.48	1.82	3339.47	1342.87
Buridehing	74778.4	PF 1	2766	99.92	111.46	1.73	3561.18	1476.58
Buridehing	74630.31	PF 1	2766	100.27	111.44	1.68	3423.38	1555.19
Buridehing	74482.36	PF 1	2766	100.55	111.44	1.52	3852.05	1648.89
Buridehing	74330.16	PF 1	2766	100.56	111.43	1.4	3846.42	1699.21
Buridehing	74174.74	PF 1	2766	100.47	111.43	1.21	4279.02	1740.73
Buridehing	74027.35	PF 1	2766	100.27	111.42	1.16	4783.52	1786.85
Buridehing	73903.71	PF 1	2766	100.34	111.41	1.29	4853.08	1685.86
Buridehing	73782.91	PF 1	2766	100.36	111.4	1.29	5008.13	1703.21
Buridehing	73645.28	PF 1	2766	100.78	111.31	2.17	4062	1774.48
Buridehing	73501.09	PF 1	2766	100.45	111.22	2.39	3709.15	1828.69

Buridehing	73350	PF 1	2766	97.85	111.16	2.48	3700.54	1758.57
Buridehing	73196.78	PF 1	2766	98.25	111.13	2.21	3224.06	1561.43
Buridehing	73048.45	PF 1	2766	98.95	111.11	2.06	3194.97	1576.54
Buridehing	72888.09	PF 1	2766	99.65	111.04	2.21	2874.06	1468.49
Buridehing	72738.55	PF 1	2766	99.97	110.97	2.25	2493.52	1381.4
Buridehing	72580.03	PF 1	2766	100.93	110.99	1.85	3173.19	1835.07
Buridehing	72430.06	PF 1	2766	100.13	110.92	2.03	2710.03	1808.76
Buridehing	72278.38	PF 1	2766	100	110.9	1.85	3005.87	1774.34
Buridehing	72165.62	PF 1	2766	100.01	110.88	1.96	3108.28	1696.98
Buridehing	72040.5	PF 1	2766	99.92	110.83	2.1	3301.43	1629.81
Buridehing	71892.97	PF 1	2766	99.72	110.81	2	3466.69	1630.86
Buridehing	71733.19	PF 1	2766	99.71	110.81	1.51	3522.9	1645.88
Buridehing	71561.88	PF 1	2766	99.51	110.77	1.74	4089.84	1668.78
Buridehing	71417.77	PF 1	2766	99.66	110.68	2.4	3600.86	1722.99
Buridehing	71264.35	PF 1	2766	100.01	110.48	2.85	2801.56	1809.88
Buridehing	71101.23	PF 1	2766	99.19	110.53	2.07	3380.17	1867.62
Buridehing	70936.7	PF 1	2889	100.07	110.54	1.66	3678.25	1870.44
Buridehing	70773.64	PF 1	2889	97.92	110.45	2.77	3777.74	1939.86
Buridehing	70612.21	PF 1	2889	98.02	110.47	1.96	4838.4	1829.34
Buridehing	70457.83	PF 1	2889	98.22	110.35	2.59	3752.92	1573.54
Buridehing	70311.09	PF 1	2889	101.02	110.21	2.68	2737.62	1615.53
Buridehing	70158.69	PF 1	2889	97.83	110.27	1.77	4264.06	1707.91
Buridehing	70007.83	PF 1	2889	99.97	110.17	2.22	3470.1	1776.18
Buridehing	69852.01	PF 1	2889	99.15	110.2	1.47	4387.5	2048.04
Buridehing	69695.91	PF 1	2889	98.96	110.13	1.85	4057.02	2119.99
Buridehing	69538.83	PF 1	2889	99.09	110.12	1.73	4405.67	2130.41
Buridehing	69456.44	PF 1	2889	98.85	110.13	1.43	4695.92	2072.13
Buridehing	69354.19	PF 1	2889	98.65	110.12	1.22	4418.05	1940.22
Buridehing	69205.3	PF 1	2889	98.61	110	2.36	4007.85	1973.33
Buridehing	69023.62	PF 1	2889	99.23	109.91	2.79	3758.05	2022.9
Buridehing	68866.26	PF 1	2889	100.3	109.87	2.81	3706.18	2135.77
Buridehing	68654.28	PF 1	2889	98.36	109.71	3.13	3621.84	2204.09
Buridehing	68476.21	PF 1	2889	98.64	109.67	3.01	3753.27	2238.33
Buridehing	68304.29	PF 1	2889	99.27	109.61	3.09	3712.87	2281.02
Buridehing	68153.73	PF 1	2889	99.1	109.5	2.75	3064	2268.04
Buridehing	67972.3	PF 1	2889	98.55	109.54	1.97	3447.67	2331.86
Buridehing	67816.3	PF 1	2889	98.4	109.55	1.57	4039.3	2340.11
Buridehing	67684.16	PF 1	2889	98.57	109.54	1.49	3640.99	2329.83
Buridehing	67530.84	PF 1	2889	98.59	109.52	1.43	3705.29	2353.26
Buridehing	67387.8	PF 1	2889	98.4	109.48	1.61	3531.15	2323.1
Buridehing	67242.34	PF 1	2889	98.05	109.47	1.65	4224.93	2263.4
Buridehing	67103.99	PF 1	2889	97.44	109.45	1.67	4247.96	2199.13
Buridehing	66979.22	PF 1	2889	97.82	109.42	1.81	4087.61	2129.11
Buridehing	66825.9	PF 1	2889	99.46	109.2	2.82	2872.21	2058.74
Buridehing	66667.76	PF 1	2889	98.6	109.19	2.69	2867.81	2042.19
Buridehing	66517.8	PF 1	2889	97.84	109.16	2.6	3471.6	2040.42
Buridehing	66358.65	PF 1	2889	98.13	109.14	2.66	3702.91	2071.83
Buridehing	66195.7	PF 1	2889	98.64	109.03	2.57	3102.27	2151.63
Buridehing	66022.53	PF 1	2889	99.4	108.99	2.55	3225.22	2274.28
Buridehing	65854.54	PF 1	2889	98.73	108.67	3.25	2178.52	2153.9
Buridehing	65694.39	PF 1	2889	98.28	108.59	3.36	2456.09	2386.18
Buridehing	65553.49	PF 1	2889	97.79	108.65	2.65	3186.82	2401.17
Buridehing	65397.98	PF 1	2889	97.45	108.59	2.82	3462.31	2396.84
Buridehing	65271.95	PF 1	2889	97.74	108.59	2.37	3244.69	2379.93
Buridehing	65126.71	PF 1	2889	97.72	108.6	2.21	4438.76	2731.3
Buridehing	64966.58	PF 1	2889	98.65	108.57	2.42	4539.18	2847.72
Buridehing	64796.12	PF 1	2889	95.46	108.6	1.67	6188.13	2835.21
Buridehing	64607.88	PF 1	2889	97.16	108.58	1.71	6160.81	2877.53
Buridehing	64436.45	PF 1	2889	96.94	108.53	1.89	5447	2857.2
Buridehing	64260.14	PF 1	2889	97.65	108.52	1.81	5619.1	2874.33
Buridehing	64114.97	PF 1	2889	97.31	108.47	2.08	5389.39	2693.11
Buridehing	63953.88	PF 1	2889	97.49	108.41	2.11	4606.83	2611.84
Buridehing	63858.32	PF 1	2889	97.35	108.37	2.24	4354.3	2413.66
Buridehing	63752.8	PF 1	2889	97.03	108.4	1.4	5001.85	2257.24
Buridehing	63589.85	PF 1	2889	97.93	108.37	1.82	4967.34	2235.21
Buridehing	63444.45	PF 1	2889	98.47	108.23	2.68	3876.23	2232.89

Buridehing	63280.77	PF 1	2889	97.46	108.2	2.22	4044.37	2293.49
Buridehing	63127.32	PF 1	2889	97.35	108.2	1.92	4609.52	2349.87
Buridehing	62983.36	PF 1	2889	97.84	108.19	1.7	4915.72	2431.32
Buridehing	62837.66	PF 1	2889	99.11	108.16	1.75	4496.21	2286.74
Buridehing	62704.46	PF 1	2889	98.69	108.14	1.66	4623.17	2195.48
Buridehing	62537.32	PF 1	2889	97.57	108.11	1.76	4466.66	2151.49
Buridehing	62381.36	PF 1	2889	97.51	108.09	1.72	4601.89	2197.51
Buridehing	62225.13	PF 1	2889	97.54	108	2.12	3694.02	2212.18
Buridehing	62066.27	PF 1	2889	97.18	108	1.92	4499.24	2337.25
Buridehing	61891.79	PF 1	2889	97.64	107.98	1.9	4904.19	2457.9
Buridehing	61748.43	PF 1	2889	96.12	107.93	2	4559.16	2577.25
Buridehing	61590.46	PF 1	2889	96.83	107.86	2.19	3990.33	2627.91
Buridehing	61454.51	PF 1	2889	96.86	107.87	1.74	4330.13	2685.61
Buridehing	61335.42	PF 1	2889	96.76	107.88	1.37	4862.64	2672.32
Buridehing	61189.67	PF 1	2889	96.09	107.88	1.23	5242.66	2737.37
Buridehing	61042.4	PF 1	2889	97.06	107.85	1.45	5144.89	2859.93
Buridehing	60885.39	PF 1	2889	97.08	107.74	2.08	4236.46	3001.91
Buridehing	60724.42	PF 1	2889	96.25	107.68	2.47	4750.85	3121.48
Buridehing	60560.68	PF 1	2889	96.09	107.7	1.92	5609.7	3235.37
Buridehing	60399.06	PF 1	2889	96.21	107.63	2.16	4931.23	3289.69
Buridehing	60245.98	PF 1	2889	96.03	107.59	2.2	4892.1	3395.32
Buridehing	60091.57	PF 1	2889	95.61	107.62	1.64	6519.99	3493.38
Buridehing	59938.43	PF 1	2889	95.13	107.61	1.57	6530.35	3588.28
Buridehing	59787.23	PF 1	2889	95.32	107.58	1.66	6020.12	3691.26
Buridehing	59636.89	PF 1	2889	95.59	107.58	1.46	6886.64	3805.48
Buridehing	59486.3	PF 1	2889	95.01	107.57	1.33	6654.77	3905.27
Buridehing	59347.48	PF 1	2889	94.35	107.58	0.9	7993.33	3984.31
Buridehing	59189.66	PF 1	2889	94.13	107.59	0.68	10340.6	4128.02
Buridehing	59056	PF 1	2889	93.26	107.59	0.64	10918.61	4273.47
Buridehing	58927.67	PF 1	2889	93.36	107.59	0.68	11572.88	4379.1
Buridehing	58778.99	PF 1	2889	93.93	107.58	0.78	11743.18	4458.81
Buridehing	58623.75	PF 1	2889	95.42	107.57	1.05	10493.44	4590.23
Buridehing	58464.05	PF 1	2889	96.98	107.57	1.05	11524.84	4694.33
Buridehing	58317.05	PF 1	2889	96.86	107.56	1.07	11316.15	4785.93
Buridehing	58158.79	PF 1	2889	95.69	107.56	1.05	11867.87	4946.79
Buridehing	58009.13	PF 1	2889	96	107.55	1.03	11563.19	4947.97
Buridehing	57840.86	PF 1	2889	96.1	107.54	0.94	11067.96	5135.56
Buridehing	57745.93	PF 1	2889	96.13	107.54	0.79	12431.74	5179.12
Buridehing	57580.36	PF 1	2889	96.22	107.51	1.03	7332.02	3384.28
Buridehing	57440.72	PF 1	2889	94.89	107.52	0.78	11792.39	5021.66
Buridehing	57277.55	PF 1	2889	95.78	107.52	0.7	14125.84	5087.53
Buridehing	57119.44	PF 1	2889	96.34	107.52	0.7	14475.66	5129.05
Buridehing	56949.77	PF 1	2889	96.36	107.52	0.67	14590.97	5084.36
Buridehing	56787.9	PF 1	2889	97.13	107.51	0.86	11803.24	4985.55
Buridehing	56635.82	PF 1	2889	96.46	107.5	0.82	12804.42	4832.13
Buridehing	56463.63	PF 1	2889	96.22	107.5	0.66	13858.67	4816.91
Buridehing	56374.96	PF 1	2889	96.23	107.5	0.72	13378.69	4677.58
Buridehing	56250.2	PF 1	2889	96.11	107.49	0.79	12226.74	4725.01
Buridehing	56143.82	PF 1	2889	96.03	107.49	0.77	13079.98	4836.82
Buridehing	55967.37	PF 1	2889	95.91	107.49	0.71	13181.43	4839.5
Buridehing	55792.61	PF 1	2889	95.81	107.48	0.8	11926.99	4742.21
Buridehing	55609.6	PF 1	2889	96.49	107.46	1.19	9808.46	4644.73
Buridehing	55432.64	PF 1	2889	95.75	107.29	2.66	4905.04	4489.25
Buridehing	55270.47	PF 1	2889	95.19	107.25	2.46	5301.34	4350.24
Buridehing	55116.73	PF 1	2889	95.58	107.34	1.08	9845.16	4267.33
Buridehing	54967.75	PF 1	2889	95.52	107.35	0.51	17839.6	4228.34
Buridehing	54817.72	PF 1	2889	95.87	107.32	1.18	8812.91	4097.77
Buridehing	54666.57	PF 1	2889	95.52	107.3	1.21	8144.49	3945.05
Buridehing	54515.32	PF 1	2889	95.37	107.3	0.95	9368.01	3804.5
Buridehing	54367.04	PF 1	2889	94.88	107.3	0.68	11775.8	3678.79
Buridehing	54216.67	PF 1	2889	94.58	107.3	0.66	11504.56	3579.08
Buridehing	54072.64	PF 1	2889	94.38	107.3	0.7	10535.32	3425.24
Buridehing	53921.25	PF 1	2889	94.72	107.29	0.74	10039.55	3254.24
Buridehing	53771.34	PF 1	2889	95.22	107.28	0.96	8664.89	3091.8
Buridehing	53615.52	PF 1	2889	96.26	107.26	1.37	7692.88	2980.59
Buridehing	53463.99	PF 1	2889	96.77	107.25	1.42	7628.46	2837.28

Buridehing	53317.77	PF 1	2889	95.78	107.23	1.3	7162.26	2711.21
Buridehing	53163.19	PF 1	2889	95.92	107.21	1.19	6286.23	2552.21
Buridehing	53013.82	PF 1	2889	95.99	107.2	0.98	6207.66	2418.24
Buridehing	52860.14	PF 1	2889	96.03	107.17	1.29	5731.64	2257.94
Buridehing	52708.66	PF 1	2889	96.02	107.06	1.98	3925.66	2075.44
Buridehing	52565.74	PF 1	2889	95.9	106.94	2.51	3320.06	1955.22
Buridehing	52424.83	PF 1	2889	95.7	106.95	2.15	3591.28	1916.5
Buridehing	52271.87	PF 1	2889	95.76	106.85	2.45	2998.22	1940.8
Buridehing	52129.27	PF 1	2889	95.91	106.84	2.28	3723.87	1866.92
Buridehing	52002.56	PF 1	2889	96.15	106.8	2.28	3596.54	1806.35
Buridehing	51917.5	PF 1	2889	95.93	106.87	1.16	4321.69	1660.7
Buridehing	51825.91	PF 1	2889	95.9	106.88	0.79	5153.01	1585.91
Buridehing	51772.61	PF 1	2889	95.85	106.88	0.67	5638.96	1573.73
Buridehing	51761.84		Bridge					
Buridehing	51744.47	PF 1	2889	95.86	106.88	0.66	5605.05	1552.72
Buridehing	51615.32	PF 1	2889	95.83	106.86	0.94	4976.97	1521.43
Buridehing	51427.63	PF 1	2889	95.29	106.83	1.21	4598.96	1450.97
Buridehing	51270.71	PF 1	2889	95.03	106.77	1.77	3834.91	1253.07
Buridehing	51117.26	PF 1	2889	96.38	106.61	2.81	2849.64	1094.26
Buridehing	50959.35	PF 1	2889	95.98	106.6	2.4	3046.96	1200.65
Buridehing	50808.1	PF 1	2889	95.5	106.6	2.04	3659.07	1524.94
Buridehing	50657.14	PF 1	2889	95.41	106.58	1.86	3808.5	1614.58
Buridehing	50495.3	PF 1	2975	95.54	106.57	1.46	4257.2	1719.38
Buridehing	50364.3	PF 1	2975	95.54	106.56	1.34	4275.99	1648.09
Buridehing	50230.99	PF 1	2975	95.5	106.55	1.37	4438.02	1583.18
Buridehing	50088.07	PF 1	2975	95.43	106.53	1.46	4508.04	1574.93
Buridehing	49937.06	PF 1	2975	95.32	106.51	1.59	4578.81	1584.14
Buridehing	49787.98	PF 1	2975	94.85	106.48	1.88	4628	1629.48
Buridehing	49626.54	PF 1	2975	93.75	106.47	1.64	4944.45	1733.29
Buridehing	49470.87	PF 1	2975	93.87	106.46	1.54	4976.34	1804.65
Buridehing	49320.89	PF 1	2975	93.8	106.43	1.64	4696.09	1833.46
Buridehing	49168.89	PF 1	2975	94.29	106.39	1.82	4434.75	1883.09
Buridehing	49018.45	PF 1	2975	95.12	106.38	1.67	4356.88	1883.37
Buridehing	48860.45	PF 1	2975	95.11	106.4	1.23	5778.73	1983.5
Buridehing	48706.8	PF 1	2975	94.71	106.4	1	6527.13	2098.12
Buridehing	48551.68	PF 1	2975	94.14	106.39	1.14	6739.55	2274.98
Buridehing	48398.36	PF 1	2975	95.81	106.37	1.53	6144.99	2369.24
Buridehing	48234.66	PF 1	2975	95.88	106.36	1.58	5601.54	2121.35
Buridehing	48067.2	PF 1	2975	95.51	106.32	1.69	5724.52	2173.21
Buridehing	47915.73	PF 1	2975	94.88	106.31	1.54	6021.52	2235.78
Buridehing	47764.65	PF 1	2975	94.87	106.29	1.48	6029.24	2344.76
Buridehing	47579.27	PF 1	2975	94.38	106.3	0.8	6586.3	2440.91
Buridehing	47560.6		Bridge					
Buridehing	47537.11	PF 1	2975	94.23	106.28	0.8	6661.66	2469.69
Buridehing	47461.89	PF 1	2975	93.82	106.24	1.31	6121.6	2554.3
Buridehing	47308.64	PF 1	2975	93.49	106.23	1.26	6957.86	2650.88
Buridehing	47156.14	PF 1	2975	94.69	106.22	1.48	6641.34	2640.32
Buridehing	47006.13	PF 1	2975	95.88	106.21	1.46	6485.68	2494.88
Buridehing	46847.31	PF 1	2975	96.01	106.18	1.61	5969.43	2256.08
Buridehing	46688.36	PF 1	2975	95.18	106.18	1.29	6593.48	2219.27
Buridehing	46527.8	PF 1	2975	95.49	106.1	1.95	5083.69	2227.67
Buridehing	46370.98	PF 1	2975	94.87	106.07	1.8	4887.93	2207.87
Buridehing	46215.13	PF 1	2975	94.65	106.06	1.66	4996.65	2220.16
Buridehing	46059.21	PF 1	2975	94.64	106.03	1.67	4791.01	2266.29
Buridehing	45909.08	PF 1	2975	94.71	106.02	1.54	4772.83	2188.61
Buridehing	45790.75	PF 1	2975	94.62	106	1.48	4520.22	2071.6
Buridehing	45645.42	PF 1	2975	94.44	105.98	1.6	4787.4	2062.64
Buridehing	45488.2	PF 1	2975	94.17	105.96	1.74	5120.1	2073.98
Buridehing	45336.59	PF 1	2975	95.15	105.91	2.08	4611.18	2089.8
Buridehing	45181.48	PF 1	2975	94.61	105.9	1.84	4913.4	2122.98
Buridehing	45019.44	PF 1	2975	94.94	105.9	1.63	5697.36	2299.29
Buridehing	44869.23	PF 1	2975	94.89	105.89	1.44	6143.15	2382.53
Buridehing	44716.81	PF 1	2975	94.45	105.85	1.75	5125.31	2439.81
Buridehing	44564.43	PF 1	2975	94.33	105.85	1.35	6546.68	2424.41
Buridehing	44411.9	PF 1	2975	93.45	105.84	1.33	6509.89	2335.01
Buridehing	44261	PF 1	2975	94.01	105.83	1.19	6394.89	2099.47

Buridehing	44109.08	PF 1	2975	94.21	105.78	1.37	4618.93	1764.42
Buridehing	43957.53	PF 1	2975	93.85	105.78	1.52	5268.49	1638.76
Buridehing	43808.14	PF 1	2975	94.68	105.7	2.15	4187.65	1594.54
Buridehing	43657.91	PF 1	2975	94.8	105.52	2.7	3005.08	1610.58
Buridehing	43506.33	PF 1	2975	95.48	105.56	2.06	3967.21	1609.47
Buridehing	43355.06	PF 1	2975	93.97	105.57	1.68	4868.87	1625.92
Buridehing	43201.49	PF 1	2975	93.51	105.52	1.82	4192.98	1560.67
Buridehing	43049.59	PF 1	2975	93.94	105.53	1.42	4730.41	1454.75
Buridehing	42901.14	PF 1	2975	93.89	105.52	1.38	4460.41	1404.69
Buridehing	42762.28	PF 1	2975	93.78	105.5	1.35	4055.09	1369.84
Buridehing	42634.01	PF 1	2975	92.74	105.44	1.95	3431.53	1374.7
Buridehing	42483.63	PF 1	2975	92.3	105.3	2.45	3162.04	1489.89
Buridehing	42339.11	PF 1	2975	91.86	105.33	2.32	4449.31	1766.69
Buridehing	42145.8	PF 1	2975	92.01	105.31	2.38	4995.03	2009.84
Buridehing	41964.55	PF 1	2975	93.76	105.29	2.3	5019.71	2144.3
Buridehing	41778.23	PF 1	2975	94.97	105.26	2.15	5019.33	2265.29
Buridehing	41597.04	PF 1	2975	93.66	105.25	1.71	5493.61	2375.98
Buridehing	41425.26	PF 1	2975	93.84	105.21	1.84	5288.87	2514.88
Buridehing	41271.04	PF 1	2975	93.65	105.19	1.59	5339.97	2556.7
Buridehing	41121.02	PF 1	2975	93.22	105.15	1.84	5380.76	2577.21
Buridehing	40976.39	PF 1	2975	93.31	105.15	1.65	5506.61	2490.25
Buridehing	40832.2	PF 1	2975	92.76	105.11	1.76	4995.02	2406.52
Buridehing	40676.59	PF 1	2975	91.88	105.11	1.64	5672.41	2375.83
Buridehing	40523.36	PF 1	2975	93.47	105	2.37	4077.15	2476.29
Buridehing	40365.92	PF 1	2975	93.79	104.94	2.6	3957.72	2644.66
Buridehing	40212.67	PF 1	2975	93.18	105.01	1.56	6602.91	2844.25
Buridehing	40053.13	PF 1	2975	94.4	105.01	1.34	6803.86	3131.97
Buridehing	39900.48	PF 1	2975	93.8	105	1.22	7885.99	3379.08
Buridehing	39750.48	PF 1	2975	93.56	104.99	1.24	7954.61	3423.35
Buridehing	39602.23	PF 1	2975	93.33	104.97	1.37	7792.67	3434.63
Buridehing	39452.31	PF 1	2975	93.37	104.96	1.21	7863.53	3451.23
Buridehing	39301.68	PF 1	2975	93.67	104.95	1.34	7951.39	3472.54
Buridehing	39156.71	PF 1	2975	93.02	104.94	1.25	8031.39	3516.41
Buridehing	39006.38	PF 1	2975	93.42	104.93	1.13	8417.37	3575.92
Buridehing	38856.73	PF 1	2975	93.12	104.93	1.11	9646.3	3600.36
Buridehing	38706.52	PF 1	2975	92.94	104.92	1.1	9713.59	3562.57
Buridehing	38557.36	PF 1	2975	92.82	104.92	1.05	9374.26	3420.33
Buridehing	38407.01	PF 1	2975	93.51	104.91	1.02	9048.39	3416.09
Buridehing	38257.6	PF 1	2975	92.91	104.9	1.19	8725.12	3394.31
Buridehing	38110.3	PF 1	2975	93.2	104.89	1.23	8404.15	3344.49
Buridehing	38032.32	PF 1	2975	91.43	104.89	0.78	8450.72	3232.91
Buridehing	37871.79	PF 1	2975	91.24	104.88	0.87	8543.93	3166.18
Buridehing	37857.41	PF 1	2975	91.2	104.88	0.74	8366.88	3147.46
Buridehing	37846.5		Bridge					
Buridehing	37738.54	PF 1	2975	93.14	104.79	0.95	8155.24	3139.99
Buridehing	37717.65		Bridge					
Buridehing	37702.55	PF 1	2975	93.42	104.73	0.91	7810.1	3128.74
Buridehing	37506.23	PF 1	2994	93.23	104.64	1.92	5878.02	3353.35
Buridehing	37354.28	PF 1	2994	92.18	104.54	2.48	5221.81	3284.52
Buridehing	37213.43	PF 1	2994	93.39	104.52	2.37	5320.54	3228.82
Buridehing	37077.69	PF 1	2994	93.17	104.57	0.94	7603.71	3216.33
Buridehing	36935.45	PF 1	2994	93.35	104.56	0.86	7955.8	3265.98
Buridehing	36781.16	PF 1	2994	89.21	104.53	1.49	7838.12	3348.57
Buridehing	36624.71	PF 1	2994	89.46	104.52	1.4	8207.12	3361.35
Buridehing	36468.87	PF 1	2994	89.04	104.49	1.47	7864.15	3273.47
Buridehing	36325.83	PF 1	2994	89.12	104.45	1.78	7013.7	3304.83
Buridehing	36181.02	PF 1	2994	93.15	104.44	1.57	6151.16	3249.75
Buridehing	36052.95	PF 1	2994	93.27	104.44	1.51	7040.4	3378.5
Buridehing	35886.62	PF 1	2994	93.21	104.41	1.58	6536.53	3457.06
Buridehing	35711.64	PF 1	2994	93.15	104.35	1.95	5656.01	3494.24
Buridehing	35587.1	PF 1	2994	93.09	104.33	1.89	5895.97	3588.16
Buridehing	35440.2	PF 1	2994	93.17	104.32	1.72	6629.83	3683.8
Buridehing	35348.61	PF 1	2994	93.17	104.35	0.87	8896.62	3743.8
Buridehing	35215.38	PF 1	2994	93.73	104.33	1.03	7366.23	3806.2
Buridehing	35118.25	PF 1	2994	93.22	104.3	1.32	7944.17	3870.66
Buridehing	34982.78	PF 1	2994	92.98	104.27	1.72	7112.83	3977.52

Buridehing	34818	PF 1	2994	92.89	104.25	1.52	7769.91	4042.14
Buridehing	34669.05	PF 1	2994	92.8	104.25	1.31	8421.15	4099.78
Buridehing	34522.55	PF 1	2994	92.96	104.23	1.43	7971.77	4056.13
Buridehing	34369.55	PF 1	2994	92.06	104.21	1.31	7970.51	4062.68
Buridehing	34217.51	PF 1	2994	92.56	104.22	1	9560.04	4356.51
Buridehing	34073.13	PF 1	2994	91.92	104.21	0.95	9547.56	4592.59
Buridehing	33964.81	PF 1	2994	92.29	104.2	1.1	9107.05	4642.18
Buridehing	33807.75	PF 1	2994	91.88	104.18	1.26	8812.23	4730.25
Buridehing	33653.21	PF 1	2994	91.87	104.18	1.11	9446.8	4783.2
Buridehing	33515.89	PF 1	2994	92.12	104.17	1.08	9777.91	4784.3
Buridehing	33372.31	PF 1	2994	92.02	104.17	1.05	10424.01	4815.95
Buridehing	33226.88	PF 1	2994	91.61	104.16	1.13	10264.22	4809.63
Buridehing	33111.03	PF 1	2994	91.08	104.16	1.04	11089.81	4787.61
Buridehing	32926.28	PF 1	2994	90.85	104.16	0.9	12457.75	4647.49
Buridehing	32771.25	PF 1	2994	90.91	104.14	1.05	10419.51	4499.04
Buridehing	32628.14	PF 1	2994	91.32	104.13	1.05	10165.76	4354.34
Buridehing	32478.11	PF 1	2994	91.6	104.11	1.16	8781.16	4176.16
Buridehing	32337.27	PF 1	2994	91.8	104.11	1.1	8680.23	4037.57
Buridehing	32185.01	PF 1	2994	91.77	104.11	0.97	9597.54	3807.03
Buridehing	32033.85	PF 1	2994	89.58	103.98	2.05	5714.49	3605.01
Buridehing	31888.82	PF 1	2994	89.16	104	1.78	5640.36	3414.57
Buridehing	31747.32	PF 1	2994	89.37	104.01	1.52	7691.41	3285.53
Buridehing	31605.09	PF 1	2994	89.41	103.97	1.81	6157.06	3173.16
Buridehing	31456.71	PF 1	2994	89.81	103.88	2.33	4880.95	2992.74
Buridehing	31306.57	PF 1	2994	90.16	103.78	2.28	3840.31	2815.65
Buridehing	31152.05	PF 1	2994	89.33	103.8	1.96	4825.44	2666.92
Buridehing	30981.06	PF 1	2994	91.44	103.82	1.39	5232.62	2562.5
Buridehing	30856.36	PF 1	2994	91.6	103.81	1.45	5202.13	2490.91
Buridehing	30707.42	PF 1	2994	91.63	103.83	0.75	10128.6	2304.69
Buridehing	30541.76	PF 1	2994	91.82	103.74	1.68	5498.9	2173.81
Buridehing	30278.68	PF 1	2994	93.04	103.73	1.71	6029.49	2182.84
Buridehing	30132.14	PF 1	2994	92.11	103.68	1.86	5305.92	2204.16
Buridehing	30083.3	PF 1	2994	92.51	103.69	1.54	6155.68	2079.97
Buridehing	29994.36	PF 1	2994	90.94	103.68	1.17	5939.66	2183.65
Buridehing	29758.57	PF 1	2994	92.33	103.61	2.09	5021.88	2188.33
Buridehing	29605.22	PF 1	2994	91.17	103.58	2.03	4995.37	2257.1
Buridehing	29453.14	PF 1	2994	91.02	103.58	1.69	5544.43	2231.83
Buridehing	29312.46	PF 1	2994	91.37	103.45	2.29	4127.71	2123.3
Buridehing	29156.84	PF 1	2994	91.56	103.42	2.32	4266.51	1857.06
Buridehing	28986.98	PF 1	2994	90.07	103.38	2.26	4358.1	1762.24
Buridehing	28789.42	PF 1	2994	89.68	103.33	2.11	3976.12	1779.52
Buridehing	28634.66	PF 1	2994	90.89	103.3	2.03	3640.31	1819.06
Buridehing	28481.66	PF 1	2994	90.94	103.26	2.16	3585.39	1850.87
Buridehing	28330.83	PF 1	2994	90.91	103.3	1.49	4278.59	1895.48
Buridehing	28180.8	PF 1	2994	90.91	103.29	1.41	4425.29	1969.56
Buridehing	28033.49	PF 1	2994	90.8	103.28	1.46	4776.04	2131.56
Buridehing	27881.08	PF 1	2994	90.32	103.28	1.44	6337.9	3483.85
Buridehing	27740.05	PF 1	2994	90.81	103.28	1.38	7564.82	3731.21
Buridehing	27585.24	PF 1	2994	91.2	103.08	2.44	3480.51	2718.32
Buridehing	27426.47	PF 1	2994	90.72	103.18	1.55	7689.21	3924.93
Buridehing	27275.16	PF 1	2994	90.39	103.17	1.4	8263.56	3985.63
Buridehing	27124.19	PF 1	2994	90.62	103.13	1.49	6680.45	3764.93
Buridehing	26973.75	PF 1	2994	90.76	103.13	1.19	7587.33	3617.11
Buridehing	26823.33	PF 1	2994	90.76	103.13	1.1	7886.69	3465.31
Buridehing	26674.04	PF 1	2994	90.69	103.13	1.01	7902.84	3174.18
Buridehing	26542.11	PF 1	2994	89.71	103.11	1.17	7224.41	3042.65
Buridehing	26417.15	PF 1	2994	91.73	103.1	1.29	7237.23	2979
Buridehing	26230.68	PF 1	2994	91.76	103.09	1.5	7414.75	2998.99
Buridehing	26093.91	PF 1	2994	90.59	103.08	1.45	7472.05	2990.36
Buridehing	25926.71	PF 1	2994	90.49	103.05	1.53	7173.19	3011.65
Buridehing	25778.35	PF 1	2994	90.67	103.04	1.4	6850.54	2952.15
Buridehing	25640.18	PF 1	2994	89.75	103.06	1.03	8910.21	2727.32
Buridehing	25515.05	PF 1	2994	88.72	103.05	1.13	8605.09	2632.18
Buridehing	25362.31	PF 1	2994	88.1	102.93	2.41	5318.14	2669.73
Buridehing	25209.64	PF 1	2994	88.12	102.9	2.36	5215.23	2694.17
Buridehing	25064.01	PF 1	2994	89.78	102.93	1.78	6521.49	2715.4

Buridehing	24914.75	PF 1	2994	89.96	102.94	1.2	7897.27	2680.83
Buridehing	24767.15	PF 1	2994	89.98	102.94	1.04	8263.77	2602.89
Buridehing	24617.13	PF 1	2994	90.56	102.92	1.11	7419.95	2533.28
Buridehing	24467.47	PF 1	2994	89.94	102.9	1.3	6727.96	2471.41
Buridehing	24315.32	PF 1	2994	90.19	102.9	1.09	7443.32	2390.07
Buridehing	24163.91	PF 1	2994	90.38	102.89	1.17	6839.13	2305.08
Buridehing	24014.1	PF 1	2994	90.53	102.88	1.1	6806.7	2196.56
Buridehing	23864.04	PF 1	2994	90.22	102.85	1.24	5728.24	2096.9
Buridehing	23713.95	PF 1	2994	90.13	102.81	1.45	4905.6	2044.22
Buridehing	23562.91	PF 1	2994	90.48	102.84	1.04	6910.59	1958.97
Buridehing	23412.34	PF 1	2994	90.35	102.83	1.04	6563.73	1913.34
Buridehing	23262.32	PF 1	2994	90.19	102.82	1.07	6386.79	1920.64
Buridehing	23115.16	PF 1	2994	89.99	102.82	0.97	6771.79	1880.93
Buridehing	22960.13	PF 1	2994	89.96	102.81	0.99	6329.97	1804.42
Buridehing	22804.75	PF 1	2994	90.55	102.79	1.11	5829.65	1721.4
Buridehing	22648.04	PF 1	2994	90.87	102.77	1.37	5576.87	1692.01
Buridehing	22506.73	PF 1	2994	90.97	102.75	1.45	5503.29	1649.59
Buridehing	22358.62	PF 1	2994	90.06	102.73	1.52	5369.25	1659.06
Buridehing	22207.2	PF 1	2994	90.29	102.7	1.54	4833.39	1620.75
Buridehing	22056.36	PF 1	2994	90.46	102.69	1.41	4641.1	1493.86
Buridehing	21910.69	PF 1	2994	88.84	102.7	1.16	5062.09	1373.82
Buridehing	21782.99	PF 1	2994	88.98	102.67	1.42	4857.34	1383.56
Buridehing	21638.45	PF 1	2994	89.52	102.65	1.62	4934	1423.3
Buridehing	21486.25	PF 1	2994	90.36	102.62	1.67	4401.11	1355.04
Buridehing	21337.95	PF 1	2994	90.6	102.57	1.85	3841.57	1280.19
Buridehing	21187.24	PF 1	2994	90.56	102.55	1.77	3914.47	1187.6
Buridehing	21038.53	PF 1	2994	89.4	102.54	1.7	3946.88	1137.11
Buridehing	20901.19	PF 1	2994	89.49	102.5	1.9	3385.29	946.34
Buridehing	20751.82	PF 1	2994	88.72	102.43	2.26	3236.04	908.69
Buridehing	20600.04	PF 1	2994	89.77	102.41	2.23	3288.11	932.61
Buridehing	20449.21	PF 1	2994	89.68	102.38	2.21	3362.26	947.64
Buridehing	20295.79	PF 1	2994	90.36	102.35	2.41	3517.04	998.97
Buridehing	20134.49	PF 1	2994	90	102.36	2.05	3984.85	1136.78
Buridehing	19976.7	PF 1	2994	90.41	102.34	1.89	4199.84	1230.35
Buridehing	19838.81	PF 1	2994	90.66	102.33	1.79	4466.53	1337.98
Buridehing	19668.4	PF 1	2994	90.13	102.32	1.49	4819.28	1403.36
Buridehing	19516.56	PF 1	2994	89.88	102.33	1.22	5183.45	1445.23
Buridehing	19373.2	PF 1	2994	90.44	102.32	1.18	5051.41	1466.15
Buridehing	19238.86	PF 1	2994	89.76	102.31	1.19	5106.64	1462.66
Buridehing	19130.93	PF 1	2994	88.88	102.29	1.42	4853.07	1473.71
Buridehing	18970.96	PF 1	2994	87.35	102.25	1.71	4850.42	1518.73
Buridehing	18817.01	PF 1	2994	86.79	102.24	1.61	4989.37	1557.45
Buridehing	18665.19	PF 1	2994	87.11	102.23	1.39	5027.84	1572.94
Buridehing	18516.61	PF 1	2994	87.39	102.22	1.36	5166.97	1627.25
Buridehing	18365.05	PF 1	2994	87.51	102.2	1.45	4964.38	1614.43
Buridehing	18216.17	PF 1	2994	89.26	102.17	1.7	4596.22	1583.7
Buridehing	18066.54	PF 1	2994	90.32	102.15	1.73	4752.34	1659.37
Buridehing	17916.24	PF 1	2994	90.4	102.14	1.69	5056.76	1732.09
Buridehing	17765.96	PF 1	2994	90.47	102.14	1.36	5299.51	1754.27
Buridehing	17613.18	PF 1	2994	90.45	102.1	1.64	5303.01	1788.83
Buridehing	17455.47	PF 1	2994	89.3	102.07	1.69	4991.23	1721.32
Buridehing	17307.39	PF 1	2994	89.75	102.06	1.65	5237.62	1889.66
Buridehing	17147.56	PF 1	2994	89.56	102.07	1.41	7346.88	2695.68
Buridehing	16979.58	PF 1	2994	90.09	102.05	1.79	7020.91	3012.29
Buridehing	16807.26	PF 1	2994	89.73	102.03	1.48	7341.84	2950.24
Buridehing	16620.76	PF 1	2994	89.19	101.93	1.85	3456.9	1110.74
Buridehing	16441.67	PF 1	2994	90.85	101.82	2.25	2841.8	949.4
Buridehing	16273.23	PF 1	2994	90.44	101.78	2.22	2723.47	862.33
Buridehing	16109.48	PF 1	2994	89.78	101.7	2.42	2569.72	848.07
Buridehing	15951.75	PF 1	2994	89	101.69	2.23	2890.67	868.2
Buridehing	15803.36	PF 1	2994	89.24	101.71	1.81	3234.59	866.88
Buridehing	15654.1	PF 1	2994	90.12	101.69	1.86	3247.68	809.05
Buridehing	15509.09	PF 1	2994	88.43	101.64	2.26	3067.71	738.52
Buridehing	15344.11	PF 1	2994	88.98	101.6	2.47	2970.85	753.78
Buridehing	15189.67	PF 1	2994	87.8	101.6	2.12	3197.07	717.74
Buridehing	15038.47	PF 1	2994	88.97	101.53	2.21	2825.86	793.45

Buridehing	14888.28	PF 1	2994	89.91	101.48	2.18	2653.3	897.15
Buridehing	14736.76	PF 1	2994	90.01	101.5	1.79	3134.06	942.62
Buridehing	14586.76	PF 1	2994	90.66	101.42	2.05	2646.33	891.14
Buridehing	14436.28	PF 1	2994	91.08	101.35	2.18	2158.03	765.12
Buridehing	14293.47	PF 1	2994	91.06	101.35	1.97	2330.8	679
Buridehing	14142.03	PF 1	2994	90.99	101.32	1.89	2257.29	607.45
Buridehing	13990.13	PF 1	2994	90.83	101.3	1.81	2318.42	624.83
Buridehing	13840.37	PF 1	2994	90.68	101.28	1.7	2539.55	690.66
Buridehing	13689.18	PF 1	2994	90.08	101.29	1.49	3026.91	749.53
Buridehing	13547.24	PF 1	2994	90.65	101.27	1.56	2999.15	818.68
Buridehing	13396.58	PF 1	2994	90.67	101.22	1.87	3061.61	881.05
Buridehing	13246.48	PF 1	2994	89.77	101.07	2.53	2726.13	959.33
Buridehing	13095.44	PF 1	2994	89.58	101.12	1.87	3529.42	1048.21
Buridehing	12945.7	PF 1	2994	89.42	101.03	2	2252.88	956.01
Buridehing	12799.65	PF 1	2994	87.88	101.06	1.59	3069.91	982.36
Buridehing	12651.72	PF 1	2994	88.19	101.03	1.83	3386.54	1007.67
Buridehing	12504.32	PF 1	2994	87.69	100.88	2.44	2397.05	720.7
Buridehing	12351.24	PF 1	2994	88.69	100.55	3.47	1708.14	554.79
Buridehing	12201.38	PF 1	2994	84.92	100.68	2.22	1970.18	489.58
Buridehing	12050.57	PF 1	2994	86.51	100.61	2.36	1797.24	443.04
Buridehing	11896.73	PF 1	2994	90.26	100.37	3.09	1448.28	459.99
Buridehing	11747.55	PF 1	2994	89.75	100.4	2.53	1682.06	511.4
Buridehing	11597.49	PF 1	2994	89.38	100.42	2.18	2042.12	676.31
Buridehing	11447.43	PF 1	2994	89.42	100.35	2.3	2096.22	836.25
Buridehing	11297.37	PF 1	2994	89.4	100.36	1.97	2517.78	1060.38
Buridehing	11145.21	PF 1	2994	89.4	100.38	1.61	3186.29	1289.96
Buridehing	10994.53	PF 1	2994	89.43	100.38	1.41	3788.38	1523.4
Buridehing	10847.11	PF 1	2994	89.32	100.38	1.29	4334.09	1732.08
Buridehing	10696.95	PF 1	2994	89.45	100.37	1.3	4573.41	2005.25
Buridehing	10535.33	PF 1	2994	89.16	100.36	1.21	4836.88	2176.16
Buridehing	10405.27	PF 1	2994	88.86	100.33	1.45	4698.85	2392.57
Buridehing	10255.24	PF 1	2994	88.79	100.3	1.49	4742.41	2544.75
Buridehing	10106.8	PF 1	2994	89.17	100.28	1.52	4846.36	2747.45
Buridehing	9953.043	PF 1	2994	88.7	100.27	1.47	5086.95	2951.01
Buridehing	9799.901	PF 1	2994	88.69	100.23	1.65	5115.11	3037.8
Buridehing	9648.489	PF 1	2994	88.32	100.2	1.65	5251.37	3092.46
Buridehing	9500.231	PF 1	2994	88.44	100.2	1.52	5615.69	3169.36
Buridehing	9360.239	PF 1	2994	84.64	100.19	1.4	5974.4	3321.48
Buridehing	9224.977	PF 1	2994	86.07	100.16	1.7	5648.59	3712.12
Buridehing	9072.251	PF 1	2994	86.63	100.1	2.02	5290.35	3637.17
Buridehing	8914.432	PF 1	2994	86.64	100.04	2.27	5023.58	3515.01
Buridehing	8746.349	PF 1	2994	87.09	100.02	2.17	4905.44	3382.85
Buridehing	8578.646	PF 1	2994	86.99	100.01	2	4900.98	3329.13
Buridehing	8424.679	PF 1	2994	87.66	99.93	2.32	4430.9	3255.98
Buridehing	8274.554	PF 1	2994	87	99.93	1.96	4699.51	3176.03
Buridehing	8130.407	PF 1	2994	88.3	99.93	1.63	4926.6	3065.32
Buridehing	7980.372	PF 1	2994	88.09	99.92	1.51	4729.01	2996.01
Buridehing	7830.268	PF 1	2994	88.14	99.91	1.46	4626.09	2927.52
Buridehing	7694.621	PF 1	2994	86.35	99.87	1.57	4390.17	2833.77
Buridehing	7537.284	PF 1	3278	86.3	99.82	1.72	4388.03	2787.52
Buridehing	7387.008	PF 1	3278	88.87	99.8	1.68	4478.83	2762.48
Buridehing	7236.766	PF 1	3278	88.12	99.8	1.39	5399.23	2738.28
Buridehing	7087.19	PF 1	3278	89.07	99.8	1.2	5871.67	2716.22
Buridehing	6936.037	PF 1	3278	88.79	99.8	1.1	5924.18	2701.34
Buridehing	6784.875	PF 1	3278	87.91	99.79	1.06	5869.31	2693.63
Buridehing	6633.718	PF 1	3278	88.02	99.78	1.1	5441.68	2693.93
Buridehing	6494.96	PF 1	3278	87.72	99.76	1.2	5293.28	2671.19
Buridehing	6361.122	PF 1	3278	87.82	99.74	1.29	5113.42	2705.6
Buridehing	6227.281	PF 1	3278	88.55	99.71	1.48	4640.64	2645.67
Buridehing	6077.14	PF 1	3278	88.27	99.66	1.68	4303.9	2572.23
Buridehing	5927.105	PF 1	3278	86.58	99.63	1.7	4156.11	2500.52
Buridehing	5783.135	PF 1	3278	86.46	99.62	1.6	4732.19	2471.33
Buridehing	5631.518	PF 1	3278	86.53	99.58	1.75	4253.46	2410.73
Buridehing	5484.107	PF 1	3278	87.14	99.51	2.01	3788.06	2411.19
Buridehing	5333.912	PF 1	3278	86.72	99.49	1.97	3899.4	2379.89
Buridehing	5185.106	PF 1	3278	86.7	99.42	2.12	3612.03	2361.12

Buridehing	5026.3	PF 1	3278	86.69	99.39	2.11	3560.19	2295.89
Buridehing	4890.407	PF 1	3278	88.43	99.34	2.24	3387.24	2215.18
Buridehing	4730.644	PF 1	3278	89	99.35	1.85	3550.84	2143.74
Buridehing	4579.251	PF 1	3278	88.79	99.35	1.67	3664.49	2069.29
Buridehing	4426.394	PF 1	3278	88.74	99.35	1.45	3893.37	2040.35
Buridehing	4271.571	PF 1	3278	89.03	99.32	1.54	3559.71	1972.69
Buridehing	4121.451	PF 1	3278	88.76	99.27	1.72	3121.09	1850.13
Buridehing	3969.66	PF 1	3278	88.58	99.17	2.06	2617.82	1760.78
Buridehing	3818.425	PF 1	3278	88.49	99.04	2.49	2375.27	1526.68
Buridehing	3666.967	PF 1	3278	88.62	98.63	3.54	1521.6	1197.22
Buridehing	3510.889	PF 1	3278	88.59	98.63	3.43	1357.72	1038.4
Buridehing	3353.926	PF 1	3278	88.94	98.57	3.34	1535.22	891.65
Buridehing	3203.608	PF 1	3278	87.94	98.41	3.39	1149.5	194.17
Buridehing	3071.944	PF 1	3278	87.93	98.36	3.12	1598.01	647.98
Buridehing	2908.412	PF 1	3278	87.95	98.13	3.52	1362.98	463.58
Buridehing	2765.311	PF 1	3278	85.53	98.24	2.61	1611.99	393.61
Buridehing	2604.755	PF 1	3278	84.87	97.78	3.68	1036.99	296.66
Buridehing	2448.582	PF 1	3278	84.8	97.79	3.27	1145.84	237.57
Buridehing	2289.207	PF 1	3278	85.09	97.81	2.9	1316.19	257.18
Buridehing	2137.777	PF 1	3278	85.46	97.75	2.87	1281.65	222.76
Buridehing	1986.537	PF 1	3278	86.61	97.58	3.17	1140.93	189.75
Buridehing	1836.373	PF 1	3278	87.39	97.58	2.81	1225.42	184.93
Buridehing	1686.92	PF 1	3278	88.56	97.55	2.62	1284.58	191.02
Buridehing	1536.812	PF 1	3278	88.4	97.42	2.82	1197.36	213.23
Buridehing	1386.323	PF 1	3278	87.82	97.21	3.17	1045.9	156.64
Buridehing	1235.112	PF 1	3278	87.2	96.85	3.77	873.61	137.35
Buridehing	1089.436	PF 1	3278	87.7	96.57	4.01	821.02	134.58
Buridehing	938.6218	PF 1	3278	88.33	95.99	4.69	699.01	132.49
Buridehing	789.9064	PF 1	3278	85.76	95.92	4.13	793.73	128.74
Buridehing	639.595	PF 1	3278	87.07	95.7	4.12	797.2	141.99
Buridehing	489.6194	PF 1	3278	88.3	95.51	3.96	828.71	163.17
Buridehing	339.4025	PF 1	3278	87.52	95.58	3.01	1087.37	197.8
Buridehing	189.1807	PF 1	3278	89.13	95.37	3.18	1030.71	223.5
Buridehing	35.06098	PF 1	3278	89.74	95.28	2.8	1169.37	268.6

5.4. Conclusion

The 50 years design HFL computed from rating curve equation as discussed in para 5.2 is 104.80m whereas the maximum water surface computed for the same discharge from HEC-RAS modelling iS 104.88m (at R.S. 37857m). Thus the result derived from mathematical modelling is comparable to the data derived from the actual stage-discharge relationship at the particular site. For this project, the hydraulic parameters obtained from HEC-RAS modelling as tabularized in Table No. 5.3 are adopted for the designs.

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CHAPTER-6

Design of Works

6.1 DESIGN OF EMBANKMENTS (AS PER IS 12094: 2000)

50 years return period for design discharge is considered for design of the Embankments as Anti-erosion works is also considered to be taken up in this project and the area is predominantly located in rural area.

Freeboard of 1.5m is considered above the design H.F.L. since design discharge is less than 3000cumecs.

Crest width of the embankment is proposed to be kept at 5m and slopes of 2H:1V and 3H:1V at the river side and country side respectively.

The DHFL for the embankments is considered from the flood profiling by mathematical modelling in HEC-RAS and the various levels for designs are tabularized as follows:

Design of Embankment Levels from HEC-RAS analysis output data for Flood Profiling of River Buridehing

Embankment	Chainage/Station		DHFL in m	F.L. In m
	Embankment Chainage (km)	Nearest HEC-RAS Chainage (m)		
E-29	0.00	125700	122.95	124.45
	8.25	118349	121.04	122.54
E-30	0.00	118349	121.04	122.54
	11.33	110550	118.65	120.15
E-26	0.00	109200	118.54	120.04
	1.50	108435	118.37	119.87
E-25	0.00	108435	118.37	119.87
	13.30	94050	115.64	117.14
E-14	0.00	79202	112.41	113.91
	20.20	51599	106.85	108.35
E-15	0.00	51599	106.85	108.35
	13.50	36900	104.56	106.06
E-09	0.00	36900	104.56	106.06
	8.40	27750	103.28	104.78
E-10	0.00	27750	103.28	104.78
	3.20	25650	103.06	104.56
	15.20	10950	100.38	101.88

	16.5	9360	100.29	101.79
E-23	5.4	92992	115.48	116.98
E-24	4.7	94050	115.64	117.14
E-27	3.8	109460	118.60	120.10
E-28	4	109460	118.60	120.10
E-41	0.00	192150	145.74	147.24
	8.50	181193	140.99	142.49
E-31	0.00	124200	122.74	124.24
	7.20	114750	120.10	121.60
E-17	0.00	99150	116.70	118.20
	5.50	93746	115.52	117.02
E-16	0.00	93746	115.52	117.02
	12.00	79982	112.61	114.11
E-22	0.00	79982	112.61	114.11
	7.20	73203	111.13	112.63
E-19	0.00	73203	111.13	112.63
	25.20	36300	104.45	105.95
E-12	0.00	34050	104.21	105.71
	9.10	20700	102.43	103.93
E-11	0.00	20700	102.43	103.93
	5.10	16950	102.05	103.55
E-39	2.70	179999	140.54	142.04
E-40	0.00	179999	140.53	142.03
	2.10	175500	139.12	140.62

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6.2 DESIGN OF ANTI-EROSION WORKS

The design of revetment has been done as per the provisions of IS 14262:1995 while the launching apron has been designed by adopting the provisions of IS 8408:1994 & 14262:1995. Design discharge of 50 years return period as provided by the Hydrology N.E. Dte. of CWC has been adopted for consideration of design discharges. The hydraulic parameters of velocity and channel discharges for various erosion affected reaches as obtained through Mathematical modelling of the river has been adopted for calculation of the designs. Out of the 51 anti-erosion sites proposed for works in this project, the detailed designs of 37 erosion sites have been appended here and it is established that the specifications for the revetment and apron for all the sites remains the same. Hence for the intermediate sites where designs are not appended here, the same specifications for apron and revetment are also considered.

DESIGN OF PITCHING & APRON AT MANMOW PATHAR (AE-1) ON RB, (HEC RAS STN. 185791.6)
(Design as per IS code 8408 : 1994)

DHFL	=	143.09 m
LWL (Observed)	=	137.79 m
Design discharge 'Q' for 50 years return period (Through channel)	=	1217 m^3/s
Avg. width of channel	=	72 m
Discharge intensity 'q'	=	17 m^2/s
Maximum observed velocity, v	=	2.82 m/s
Mean Dia of river bed material d	=	0.18 mm
Silt Factor $f= 1.76*(d)^{1/2}$	=	0.75
<u>Launching Apron</u>		
Scour depth below DHFL, $D = 1.33x(q^2/f)^{1/3}$	=	9.63 m
Maximum Scour Depth below DHFL, $D_{max} = 1.5 \times D_s$	=	14.44 m
Max. Scour depth below LWL = D_{max}-(DHFL-LWL)		
= 14.44-(143.09-137.79)	=	9.14 m
Width of Launching Apron, W = 1.5x Max. Scour depth below LWL		
Hence, W	=	13.71 m
<u>Considering Bank Pitching using geo-bags of size 0.90mx0.60mx0.15m (Type-A geo-bags) in loose</u>		
Specific gravity of g-bags (wet packed with silt)	=	1.9
Angle of sloping bank(2H:1V) θ	=	26.57 ⁰
Angle of repose, Φ	=	30 ⁰
Value of $K=[1-Sin^2θ/ Sin^2Φ]^{1/2}$	=	0.447
Weight of geo-bags (Min. reqd) $W =0.02323*Ss*V^6/(K*(S_s-1)^3$	=	68.09 kg
Unit weight of geo-bag filled with dry sand	=	126 kg
		126kg >39.49kg, hence safe
The minimum thickness of bank pitching from negative head criteria 't'	=	$v^2 / [2 \times g \times (S_s - 1)]$
Where g is acceleration due to gravity	=	9.81 m² / sec
Hence, t	=	0.45 m
Thickness of launching apron T = 1.5 x thickness of pitching	=	0.68 m

Adopting 4 layers of geobags for apron, hence thickness of apron = 4 x 0.15m = 0.60m

Hence length of apron = $\frac{13.71 \times 0.68}{0.6}$ m

= 15.44 m

However width is considered as 16.5m to maintain uniformity with the other reaches of this project

Width of Launching Apron,	**'W'**	**=**	**16.50 m**
Thickness of launching apron	**'T'**	**=**	**0.60 m**

Bank Pitching using C.C. Blocks

Specific gravity of M15 concrete block	=	2.4
Angle of sloping bank(2H:1V) θ	=	26.57^{0}
Angle of repose, Φ	=	30^{0}
Value of $K=[1-\sin^2\theta / \sin^2\Phi]^{1/2}$	=	0.447
Min. weight reqd, $W = 0.02323*Ss*V^6/(K*(S_s-1)^3$	=	22.85 kg
Unit weight of CC Block of size 0.3mx0.3mx0.3m	=	64.80 kg
		64.8kg >14.69kg, hence safe
The minimum thickness of bank pitching from negative head criteria 't'	=	$v^2 / [2 \times g \times (S_s - 1)]$
Where g is acceleration due to gravity	=	9.81 m^2 / sec
Hence, t	=	0.29 m

Let us provide pitching with CC Blocks of M15 grade, size of block = 0.3m x 0.3m x 0.3m

Toe Key

For the toe key, two layers of PVC coated wire netting box of size 1.5m x 1.5m x 0.45m filled with geo-bags is to be provided at the transition portion of bank pitching and launching apron. Hence size of toe-key = 1.50m x 0.90m

HEC-RAS DATA

Plan: Plan 01 Buridehing Buridehing RS: 185791.6 Profile: PF 1					
E.G. Elev (m)	143.09	Element	Left OB	Channel	Right OB
Vel Head (m)	0.38	Wt. n-Val.	0.06	0.03	0.06
W.S. Elev (m)	142.71	Reach Len.	90.58	175.79	187.84
Crit W.S. (m)	139.97	Flow Area (ı	199.23	431.93	21.28
E.G. Slope (m/m	0.000666	Area (m2)	199.23	431.93	21.28
Q Total (m3/s)	1302	Flow (m3/s)	73.99	1217.41	10.6
Top Width (m)	336.3	Top Width (	248.16	72.33	15.81
Vel Total (m/s)	2	Avg. Vel. (m	0.37	2.82	0.5
Max Chl Dpth (m	7.47	Hydr. Depth	0.8	5.97	1.35
Conv. Total (m3/	50445.1	Conv. (m3/s	2866.7	47167.6	410.8
Length Wtd. (m)	166.49	Wetted Per.	248.37	72.84	17.07
Min Ch El (m)	135.24	Shear (N/m:	5.24	38.74	8.14
Alpha	1.87	Stream Pow	1.95	109.18	4.06
Frctn Loss (m)	0.07	Cum Volum	305716.4	193234.1	125600.3
C & E Loss (m)	0.07	Cum SA (1(	148648.2	24081.08	74781.34

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NAME OF PROJECT: FLOOD MANAGEMENT OF RIVER BURIDEHING ALONG WITH ANTI-EROSION MEASURES

DESIGN OF PITCHING & APRON AT NOCTE GAON (AE-8) ON LB, 2ND KM OF E-31 (HEC RAS STN. 122498.8)
(Design as per IS code 8408 : 1994)

DHFL	=	122.44 m
LWL (Observed)	=	115.84 m
Design discharge 'Q' for 50 years return period (Through channel)	=	1330 m^3/s
Avg. width of channel	=	60 m
Discharge intensity 'q'	=	22 m^2/s
Maximum observed velocity, v	=	2.7 m/s
Mean Dia of river bed material d	=	0.18 mm
Silt Factor f= $1.76*(d)^{1/2}$	=	0.75
Launching Apron		
Scour depth below DHFL, D = $1.33x(q^2/f)^{1/3}$	=	11.57 m
Maximum Scour Depth below DHFL, D_{max} = 1.5 x D_s	=	17.36 m
Max. Scour depth below LWL = D_{max}-(DHFL-LWL)		
= 17.36-(122.44-115.84)	=	10.76 m
Width of Launching Apron, W = 1.5x Max. Scour depth below LWL		
Hence, W	=	16.13 m
Bank Pitching using geo-bags of size 0.90mx0.60mx0.15m (Type-A geo-bags) in loose		
Specific gravity of g-bags (wet packed with silt)	=	1.9
Angle of sloping bank(2H:1V) θ	=	26.57 ^{0}
Angle of repose, Φ	=	30 ^{0}
Value of K=$[1-Sin^2θ/ Sin^2Φ]^{1/2}$	=	0.447
Weight of geo-bags (Min. reqd) W =$0.02323*Ss*V^6/(K*(S_s-1)^3$	=	52.45 kg
Unit weight of geo-bag filled with dry sand	=	126 kg
		126kg >39.49kg, hence safe
The minimum thickness of bank pitching from negative head criteria 't'	=	v^2 / [2 x g x (S_s - 1)]
Where g is acceleration due to gravity	=	9.81 m^2 / sec
Hence, t	=	0.41 m
Thickness of launching apron T = 1.5 x thickness of pitching	=	0.62 m

Adopting 4 layers of geobags for apron, hence thickness of apron = 4 x 0.15m = 0.60m

Hence length of apron = $\frac{16.13 \times 0.62}{0.6}$ m

		=	16.65 m
	Say	=	16.50 m
Width of Launching Apron,	**'W'**	**=**	**16.50 m**
Thickness of launching apron	**'T'**	**=**	**0.60 m**

Bank Pitching using C.C. Blocks

Specific gravity of M15 concrete block	=	2.4
Angle of sloping bank(2H:1V) θ	=	26.57 ^{0}
Angle of repose, Φ	=	30 ^{0}
Value of $K=[1-\sin^2\theta / \sin^2\Phi]^{1/2}$	=	0.447
Min. weight reqd, $W = 0.02323*Ss*V^6/(K*(S_s-1)^3$	=	17.60 kg
Unit weight of CC Block of size 0.3mx0.3mx0.3m	=	64.80 kg
		64.8kg >14.69kg, hence safe
The minimum thickness of bank pitching from negative head criteria 't'	=	$v^2 / [2 \times g \times (S_s - 1)]$
Where g is acceleration due to gravity	=	9.81 m² / sec
Hence, t	=	0.27 m

Let us provide pitching with CC Blocks of M15 grade, size of block = 0.3m x 0.3m x 0.3m

Toe Key

For the toe key, two layers of PVC coated wire netting box of size 1.5m x 1.5m x 0.45m filled with geo-bags is to be provided at the transition portion of bank pitching and launching apron. Hence size of toe-key = 1.50m x 0.90m

HEC-RAS DATA

Plan: Plan 01 Buridehing Buridehing RS: 122498.8 Profile: PF 1					
E.G. Elev (m)	122.44	Element	Left OB	Channel	Right OB
Vel Head (m)	0.26	Wt. n-Val.	0.06	0.03	0.044
W.S. Elev (m)	122.18	Reach Len.	175.23	169.7	124.33
Crit W.S. (m)	118.41	Flow Area (	47.21	493.59	867.41
E.G. Slope (m/m	0.000422	Area (m2)	47.21	493.59	867.41
Q Total (m3/s)	1944	Flow (m3/s)	10.11	1330.46	603.44
Top Width (m)	697.8	Top Width (	95.09	60.03	542.68
Vel Total (m/s)	1.38	Avg. Vel. (m	0.21	2.7	0.7
Max Chl Dpth (m	10.67	Hydr. Depth	0.5	8.22	1.6
Conv. Total (m3/	94577.3	Conv. (m3/s	491.7	64728	29357.7
Length Wtd. (m)	153.3	Wetted Per.	95.58	63.26	543.15
Min Ch El (m)	111.51	Shear (N/m2	2.05	32.33	6.62
Alpha	2.69	Stream Pow	0.44	87.14	4.6
Frctn Loss (m)	0.05	Cum Volum	293778.2	140166.3	107189.4
C & E Loss (m)	0.04	Cum SA (10	143781.5	16279.25	66201.23

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NAME OF PROJECT: FLOOD MANAGEMENT OF RIVER BURIDEHING ALONG WITH ANTI-EROSION MEASURES

DESIGN OF PITCHING & APRON AT BORDOLOICHUK (AE-17) ON RB, 2ND KM OF E-25 (HEC RAS STN. 106236.9)

(Design as per IS code 8408 : 1994)

DHFL	=	118.05 m
LWL (Observed)	=	111.55 m
Design discharge 'Q' for 50 years return period (Through channel)	=	1211 m^3/s
Avg. width of channel	=	43 m
Discharge intensity 'q'	=	28 m^2/s
Maximum observed velocity, v	=	2.39 m/s
Mean Dia of river bed material d	=	0.18 mm
Silt Factor f= $1.76*(d)^{1/2}$	=	0.75
<u>Launching Apron</u>		
Scour depth below DHFL, D = $1.33x(q^2/f)^{1/3}$	=	13.55 m
Maximum Scour Depth below DHFL, D_{max} = 1.5 x D_s	=	20.33 m
Max. Scour depth below LWL = D_{max}-(DHFL-LWL)		
= 20.33-(118.05-111.55)	=	13.83 m
Width of Launching Apron, W = 1.5x Max. Scour depth below LWL		
Hence, W	=	20.75 m
Considering Bank Pitching using geo-bags of size 0.90mx0.60mx0.15m (Type-A geo-bags) in loose		
Specific gravity of g-bags (wet packed with silt)	=	1.9
Angle of sloping bank(2H:1V) θ	=	26.57 ^{0}
Angle of repose, Φ	=	30 ^{0}
Value of K=$[1-Sin^2θ/ Sin^2Φ]^{1/2}$	=	0.447
Weight of geo-bags (Min. reqd) W =$0.02323*Ss*V^6/(K*(S_s-1)^3$	=	25.23 kg
Unit weight of geo-bag filled with dry sand	=	126 kg
		126kg >39.49kg, hence safe
The minimum thickness of bank pitching from negative head criteria 't'	=	v^2 / [2 x g x (S_s - 1)]
Where g is acceleration due to gravity	=	9.81 m^2 / sec
Hence, t	=	0.32 m
Thickness of launching apron T = 1.5 x thickness of pitching	=	0.49 m

Adopting 4 layers of geobags for apron, hence thickness of apron = 4 x 0.15m = 0.60m

Hence length of apron = $\frac{20.75 \times 0.49}{0.6}$ m

= 16.78 m

Say = 16.50 m

Width of Launching Apron,	**'W'**	**=**	**16.50 m**
Thickness of launching apron	**'T'**	**=**	**0.60 m**

Bank Pitching using C.C. Blocks

Specific gravity of M15 concrete block	=	2.4
Angle of sloping bank(2H:1V) θ	=	26.57 ^{0}
Angle of repose, Φ	=	30 ^{0}
Value of $K=[1-Sin^2\theta/ Sin^2\Phi]^{1/2}$	=	0.447
Min. weight reqd, $W = 0.02323*Ss*V^6/(K*(S_s-1)^3$	=	8.47 kg
Unit weight of CC Block of size 0.3mx0.3mx0.3m	=	64.80 kg
		64.8kg >14.69kg, hence safe
The minimum thickness of bank pitching from negative head criteria 't'	=	$v^2 / [2 \times g \times (S_s - 1)]$
Where g is acceleration due to gravity	=	9.81 m² / sec
Hence, t	=	0.21 m

Let us provide pitching with CC Blocks of M15 grade, size of block = 0.3m x 0.3m x 0.3m

Toe Key

For the toe key, two layers of PVC coated wire netting box of size 1.5m x 1.5m x 0.45m filled with geo-bags is to be provided at the transition portion of bank pitching and launching apron. Hence size of toe-key = 1.50m x 0.90m

HEC-RAS DATA

Plan: Plan 01 Buridehing Buridehing RS: 106236.9 Profile: PF 1					
E.G. Elev (m)	118.05	Element	Left OB	Channel	Right OB
Vel Head (m)	0.15	Wt. n-Val.	0.056	0.03	0.06
W.S. Elev (m)	117.89	Reach Len.	151.42	150.28	152.51
Crit W.S. (m)	114.4	Flow Area (	1995.1	507.11	351.65
E.G. Slope (m/m	0.000213	Area (m2)	1995.1	507.11	351.65
Q Total (m3/s)	2375	Flow (m3/s)	1052.66	1210.83	111.52
Top Width (m)	971.59	Top Width (	695.67	43.07	232.85
Vel Total (m/s)	0.83	Avg. Vel. (m	0.53	2.39	0.32
Max Chl Dpth (m	13.59	Hydr. Depth	2.87	11.77	1.51
Conv. Total (m3/	162832.2	Conv. (m3/s	72171	83015.3	7645.9
Length Wtd. (m)	150.89	Wetted Per.	696.68	46.59	236
Min Ch El (m)	104.3	Shear (N/m	5.97	22.71	3.11
Alpha	4.38	Stream Pow	3.15	54.21	0.99
Frctn Loss (m)	0.02	Cum Volum	260348.5	122706.9	97908.73
C & E Loss (m)	0.02	Cum SA (10	132837.3	14004.4	58621.03

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NAME OF PROJECT: FLOOD MANAGEMENT OF RIVER BURIDEHING ALONG WITH ANTI-EROSION MEASURES

DESIGN OF PITCHING & APRON AT KORAIGURI (AE-33) ON RB, 9TH KM OF E-14 (HEC RAS STN. 66358.65)

(Design as per IS code 8408 : 1994)

DHFL	=	109.60	m
LWL (Observed)	=	103.00	m
Design discharge 'Q' for 50 years return period (Through channel)	=	1048	m^3/s
Avg. width of channel	=	40	m
Discharge intensity 'q'	=	26	m^2/s
Maximum observed velocity, v	=	2.44	m/s
Mean Dia of river bed material d	=	0.18	mm
Silt Factor $f= 1.76*(d)^{1/2}$	=	0.75	

Launching Apron

Scour depth below DHFL, $D = 1.33x(q^2/f)^{1/3}$	=	13.02	m
Maximum Scour Depth below DHFL, $D_{max} = 1.5 \times D_s$	=	19.53	m
Max. Scour depth below LWL = D_{max}-(DHFL-LWL) = 19.53-(109.6-103)	=	12.93	m
Width of Launching Apron, W = 1.5x Max. Scour depth below LWL. Hence, W	=	19.40	m

Considering Bank Pitching using geo-bags of size 0.90mx0.60mx0.15m (Type-A geo-bags) in loose

Specific gravity of g-bags (wet packed with silt)	=	1.9	
Angle of sloping bank(2H:1V) θ	=	26.57	⁰
Angle of repose, Φ	=	30	⁰
Value of $K=[1-\sin^2\theta/ \sin^2\Phi]^{1/2}$	=	0.447	
Weight of geo-bags (Min. reqd) $W =0.02323*Ss*V^6/(K*(S_s-1)^3$	=	28.57	kg
Unit weight of geo-bag filled with dry sand	=	126 kg	
	126kg >39.49kg, hence safe		
The minimum thickness of bank pitching from negative head criteria 't'	=	v^2 / [2 x g x (S_s -	
Where g is acceleration due to gravity	=	9.81	m² / sec
Hence, t	=	0.34	m
Thickness of launching apron T = 1.5 x thickness of pitching	=	0.51	m

Adopting 4 layers of geobags for apron, hence thickness of apron = 4 x 0.15m = 0.60m

Hence length of apron = $\frac{19.40 \times 0.51}{0.6}$ m

		=	16.35	m
	Say	=	16.50	m
Width of Launching Apron,	**'W'**	**=**	**16.50**	**m**
Thickness of launching apron	**'T'**	**=**	**0.60**	**m**

Bank Pitching using C.C. Blocks

Specific gravity of M15 concrete block	=	2.4
Angle of sloping bank(2H:1V) θ	=	26.57^{0}
Angle of repose, Φ	=	30^{0}
Value of $K=[1-\sin^2\theta/\sin^2\Phi]^{1/2}$	=	0.447
Min. weight reqd, $W = 0.02323 * Ss * V^6/(K*(S_s-1)^3$	=	9.59 kg
Unit weight of CC Block of size 0.3mx0.3mx0.3m	=	64.80 kg
		64.8kg >14.69kg, hence safe
The minimum thickness of bank pitching from negative head criteria 't'	=	$v^2 / [2 \times g \times (S_s - 1)]$
Where g is acceleration due to gravity	=	9.81 m² / sec
Hence, t	=	0.22 m

Let us provide pitching with CC Blocks of M15 grade, size of block = 0.3m x 0.3m x 0.3m

Toe Key

to be provided at the transition portion of bank pitching and launching apron. Hence size of toe-key = 1.50m x 0.90m

HEC-RAS DATA

Plan: Plan 01 Buridehing Buridehing RS: 66358.65 Profile: PF 1					
E.G. Elev (m)	109.6	Element	Left OB	Channel	Right OB
Vel Head (m)	0.12	Wt. n-Val.	0.057	0.03	0.06
W.S. Elev (m)	109.48	Reach Len.	73.78	162.94	181.4
Crit W.S. (m)	107.18	Flow Area (	3989.7	429.44	147.59
E.G. Slope (m/m	0.000242	Area (m2)	3989.7	429.44	147.59
Q Total (m3/s)	2889	Flow (m3/s)	1747.64	1047.98	93.38
Top Width (m)	2071.83	Top Width (	1995.75	39.59	36.49
Vel Total (m/s)	0.63	Avg. Vel. (m	0.44	2.44	0.63
Max Chl Dpth (m	11.42	Hydr. Depth	2	10.85	4.04
Conv. Total (m3/	185700.3	Conv. (m3/s	112335.2	67362.5	6002.5
Length Wtd. (m)	116.16	Wetted Per.	1998.38	42.07	38.72
Min Ch El (m)	98.06	Shear (N/m	4.74	24.23	9.05
Alpha	5.72	Stream Pow	2.08	59.13	5.72
Frctn Loss (m)	0.02	Cum Volum	214407.9	81189.21	52281.98
C & E Loss (m)	0.01	Cum SA (10	106275.5	9071.75	32573.93

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NAME OF PROJECT: FLOOD MANAGEMENT OF RIVER BURIDEHING ALONG WITH ANTI-EROSION MEASURES

DESIGN OF PITCHING & APRON AT KOLOLUA DEORI GAON (AE-40) ON LB, 20TH KM OF E-19 (HEC RAS STN. 41965m)

(Design as per IS code 8408 : 1994)

DHFL	=	105.40 m
LWL (Observed)	=	98.60 m
Design discharge 'Q' for 50 years return period	=	1203.15 m^3/s
Avg. width of channel	=	45.61 m
Discharge intensity 'q'	=	26 m^2/s
Maximum observed velocity, v	=	2.46 m/s
Mean Dia of river bed material d	=	0.18 mm
Silt Factor $f= 1.76*(d)^{1/2}$	=	0.75
Launching Apron		
Scour depth below DHFL, $D = 1.33x(q^2/f)^{1/3}$	=	12.99 m
Maximum Scour Depth below DHFL, $D_{max} = 1.5 \times D_s$	=	19.49 m
Max. Scour depth below LWL = D_{max}-(DHFL-LWL)		
= 19.49-(105.4-98.6)	=	12.69 m
Width of Launching Apron, W = 1.5x Max. Scour depth below LWL		
Hence, W	=	19.03 m

Considering Bank Pitching using geo-bags of size 0.90mx0.60mx0.15m (Type-A geo-bags) in loose

Specific gravity of g-bags (wet packed with silt)	=	1.9
Angle of sloping bank(2H:1V) θ	=	26.57 ⁰
Angle of repose, Φ	=	30 ⁰
Value of $K=[1-Sin^2\theta/ Sin^2\Phi]^{1/2}$	=	0.447
Weight of geo-bags (Min. reqd) $W =0.02323*Ss*V^6/(K*(S_s-1)^3$	=	30.00 kg
Unit weight of geo-bag filled with dry sand	=	126 kg
		126kg >39.49kg, hence safe
The minimum thickness of bank pitching from negative head criteria 't'	=	$v^2 / [2 \times g \times (S_s - 1)]$
Where g is acceleration due to gravity	=	9.81 m² / sec
Hence, t	=	0.34 m
Thickness of launching apron T = 1.5 x thickness of pitching	=	0.51 m

Adopting 4 layers of geobags for apron, hence thickness of apron = 4 x 0.15m = 0.60m

Hence length of apron = $\frac{19.03 \times 0.51}{0.6}$ m

		=	16.30 m
	Say	=	16.50 m
Width of Launching Apron,	**'W'**	**=**	**16.50 m**
Thickness of launching apron	**'T'**	**=**	**0.60 m**

<u>Bank Pitching using C.C. Blocks</u>

Specific gravity of M15 concrete block	=	2.4
Angle of sloping bank(2H:1V) θ	=	26.57^{0}
Angle of repose, Φ	=	30^{0}
Value of $K=[1-\sin^2\theta/ \sin^2\Phi]^{1/2}$	=	0.447
Min. weight reqd, $W = 0.02323 * Ss * V^6/(K*(S_s-1)^3$	=	10.07 kg
Unit weight of CC Block of size 0.3mx0.3mx0.3m	=	64.80 kg
		64.8kg >14.69kg, hence safe
The minimum thickness of bank pitching from negative head criteria 't'	=	$v^2 / [2 \times g \times (S_s - 1)]$
Where g is acceleration due to gravity	=	$9.81\ m^2 / sec$
Hence, t	=	0.22 m

Let us provide pitching with CC Blocks of M15 grade, size of block = 0.3m x 0.3m x 0.3m

<u>Toe Key</u>

For the toe key, two layers of PVC coated wire netting box of size 1.5m x 1.5m x 0.45m filled with geo-bags is to be provided at the transition portion of bank pitching and launching apron. Hence size of toe-key = 1.50m x 0.90m

HEC-RAS Data

Plan: Plan 01 Buridehing Buridehing RS: 41964.55 Profile: PF 1					
E.G. Elev (m)	105.46	Element	Left OB	Channel	Right OB
Vel Head (m)	0.14	Wt. n-Val.	0.06	0.03	0.06
W.S. Elev (m)	105.32	Reach Len.	202.66	186.32	130.54
Crit W.S. (m)	102.27	Flow Area (	1682.82	500.64	2451.13
E.G. Slope (m/m	0.000249	Area (m2)	1682.82	500.64	2451.13
Q Total (m3/s)	2975	Flow (m3/s)	637.8	1254.16	1083.05
Top Width (m)	2144.3	Top Width (	971.98	47.89	1124.43
Vel Total (m/s)	0.64	Avg. Vel. (m	0.38	2.51	0.44
Max Chl Dpth (m	11.29	Hydr. Depth	1.73	10.45	2.18
Conv. Total (m3/	188346.5	Conv. (m3/s	40378.7	79400.3	68567.5
Length Wtd. (m)	170.61	Wetted Per.	974.18	48.24	1127.23
Min Ch El (m)	94.03	Shear (N/m2	4.23	25.39	5.32
Alpha	6.67	Stream Pow	1.6	63.61	2.35
Frctn Loss (m)	0.04	Cum Volum	122041.1	52241.93	29308.21
C & E Loss (m)	0	Cum SA (10	67568.27	5795.6	16168.67

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NAME OF PROJECT: FLOOD MANAGEMENT OF RIVER BURIDEHING ALONG WITH ANTI-EROSION MEASURES

DESIGN OF PITCHING & APRON AT BHOGAMUR (AE-43/44) ON RB, 4TH KM OF E-09 (HEC RAS STN. 31456.71)
(Design as per IS code 8408 : 1994)

DHFL	=	103.99 m
LWL (Observed)	=	97.39 m
Design discharge 'Q' for 50 years return period (Through channel)	=	1824 m^3/s
Avg. width of channel	=	64 m
Discharge intensity 'q'	=	29 m^2/s
Maximum observed velocity, v	=	2.35 m/s
Mean Dia of river bed material d	=	0.18 mm
Silt Factor f= $1.76*(d)^{1/2}$	=	0.75
<u>Launching Apron</u>		
Scour depth below DHFL, D = $1.33x(q^2/f)^{1/3}$	=	13.71 m
Maximum Scour Depth below DHFL, D_{max} = 1.5 x D_s	=	20.56 m
Max. Scour depth below LWL = D_{max}-(DHFL-LWL)		
= 20.56-(103.99-97.39)	=	13.96 m
Width of Launching Apron, W = 1.5x Max. Scour depth below LWL		
Hence, W	=	20.94 m
<u>Considering Bank Pitching using geo-bags of size 0.90mx0.60mx0.15m (Type-A geo-bags) in loose</u>		
Specific gravity of g-bags (wet packed with silt)	=	1.9
Angle of sloping bank(2H:1V) θ	=	26.57 ⁰
Angle of repose, Φ	=	30 ⁰
Value of K=$[1-Sin^2θ/ Sin^2Φ]^{1/2}$	=	0.447
Weight of geo-bags (Min. reqd) W =$0.02323*Ss*V^6/(K*(S_s-1)^3$	=	22.80 kg
Unit weight of geo-bag filled with dry sand	=	126 kg
		126kg >39.49kg, hence safe
The minimum thickness of bank pitching from negative head criteria 't'	=	v^2 / [2 x g x (S_s - 1)]
Where g is acceleration due to gravity	=	9.81 m^2 / sec
Hence, t	=	0.31 m
Thickness of launching apron T = 1.5 x thickness of pitching	=	0.47 m

Adopting 4 layers of geobags for apron, hence thickness of apron = 4 x 0.15m = 0.60m

Hence length of apron = $\frac{20.94 \times 0.47}{0.6}$ m

		=	16.37 m
	Say	=	16.50 m
Width of Launching Apron,	**'W'**	**=**	**16.50 m**
Thickness of launching apron	**'T'**	**=**	**0.60 m**

Bank Pitching using C.C. Blocks

Specific gravity of M15 concrete block	=	2.4
Angle of sloping bank(2H:1V) θ	=	26.57 ^{0}
Angle of repose, Φ	=	30 ^{0}
Value of $K=[1-Sin^2\theta/ Sin^2\Phi]^{1/2}$	=	0.447
Min. weight reqd, W $=0.02323*Ss*V^6/(K*(S_s-1)^3$	=	7.65 kg
Unit weight of CC Block of size 0.3mx0.3mx0.3m	=	64.80 kg
		64.8kg >14.69kg, hence safe
The minimum thickness of bank pitching from negative head criteria 't'	=	$v^2 / [2 \times g \times (S_s - 1)]$
Where g is acceleration due to gravity	=	9.81 m² / sec
Hence, t	=	0.20 m

Let us provide pitching with CC Blocks of M15 grade, size of block = 0.3m x 0.3m x 0.3m

Toe Key

For the toe key, two layers of PVC coated wire netting box of size 1.5m x 1.5m x 0.45m filled with geo-bags is to be provided at the transition portion of bank pitching and launching apron. Hence size of toe-key = 1.50m x 0.90m

HEC-RAS DATA

Plan: Plan 01 Buridehing Buridehing RS: 31456.71 Profile: PF 1					
E.G. Elev (m)	103.99	Element	Left OB	Channel	Right OB
Vel Head (m)	0.17	Wt. n-Val.	0.05	0.03	0.06
W.S. Elev (m)	103.81	Reach Len.	151.83	150.13	150.26
Crit W.S. (m)	98.37	Flow Area (	3407.11	776.17	50.53
E.G. Slope (m/m	0.000189	Area (m2)	3407.11	776.17	50.53
Q Total (m3/s)	2994	Flow (m3/s)	1148.59	1823.83	21.58
Top Width (m)	2992.74	Top Width (	2911.36	63.88	17.5
Vel Total (m/s)	0.71	Avg. Vel. (m	0.34	2.35	0.43
Max Chl Dpth (m	13.98	Hydr. Depth	1.17	12.15	2.89
Conv. Total (m3/	217869.4	Conv. (m3/s	83581.5	132717.5	1570.4
Length Wtd. (m)	150.56	Wetted Per.	2912.62	66.81	19.85
Min Ch El (m)	89.83	Shear (N/m	2.17	21.52	4.72
Alpha	6.82	Stream Pow	0.73	50.56	2.01
Frctn Loss (m)	0.03	Cum Volum	72943.73	39602.88	23027.64
C & E Loss (m)	0.01	Cum SA (10	37996.28	4318.77	12363.13

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CHAPTER- 6.3

Design of Sluice Gate

PROJECT: INTEGRATED WATER RESOURCES MANAGEMENT OF BURIDEHING BASIN

SUMMARY OF HYDRAULIC PARAMETERS & DESIGN CONSIDERATIONS FOR VARIOUS SLUICE GATES

Sl. No	Sluice No.	Remarks	HEC-RAS Stn. Station (m)	HEC-RAS Stn. DHFL (m)	Catchment Area in sq.km	Rain gauge Station	50years 3 days PMP in mm	Net Eff. rainfall (loss of 1mm/hr in mm)	Total run-off accumulation during worst case in cum	Max. C/S W.L. during worst case in m (as per hydraulic parameters calculations)	Sill Level in m	Worst Head in C/S	Worst Head in R/S	Openings as per Design	Stilling Basin as per design	U/S protection: Length of C.C. Block Protection (0.5m cubical blocks over 0.5m thick layer of filter gravel	U/S protection: Length of Launching Apron 1m thick	D/S protection: Length of C.C. Block Protection (0.5m cubical blocks over 0.5m thick layer of filter gravel	D/S protection: Length of Launching Apron 1m thick	Ref. to Design	Ref. to Sub-Estimate
1	E-09/1	Completely damaged, to be newly constructed as per design	35215	104.33	4	Khowang	345	273	1,09,20,000.00	103.59	102	1.59	2.33	1 No (2.1m x 2.7m)	L = 5m, 2m below sill	2	4	4	4	Design: SG-1 Design for E-27/2 adopted for the other sluice gates considering worst head in both C/S and R/S amongst all sluices.	Sub-Est: SG-1
2	E-09/2		28033	103.28	4	Khowang	345	273	1,09,20,000.00	102.64	101.2	1.44	2.08	1 No (2.1m x 2.7m)	L = 5m, 2m below sill	2	4	4	4		
3	E-16/2		88964	114.46	1	Naharkatia	337	265	26,50,000.00	113.89	112.3	1.59	2.16	1 No (2.1m x 2.7m)	L = 5m, 2m below sill	2	4	4	4		
4	E-24/4		94016	115.64	1	Khowang	345	273	27,30,000.00	114.61	113.1	1.51	2.54	1 No (2.1m x 2.7m)	L = 5m, 2m below sill	2	4	4	4		
5	**E-27/2**		1E+05	118.63	3	Naharkatia	337	265	79,50,000.00	118.14	116	**2.14**	**2.63**	1 No (2.1m x 2.7m)	L = 5m, 2m below sill	2	4	4	4		
6	E-27/3		1E+05	118.63	2	Naharkatia	337	265	53,00,000.00	118.14	116.2	1.94	2.43	1 No (2.1m x 2.7m)	L = 5m, 2m below sill	2	4	4	4		
7	E-27/4		1E+05	118.63	3	Naharkatia	337	265	79,50,000.00	118.14	116.2	1.94	2.43	1 No (2.1m x 2.7m)	L = 5m, 2m below sill	2	4	4	4		
8	E-28/1		1E+05	118.63	3	Naharkatia	337	265	79,50,000.00	118.14	116.2	1.94	2.43	1 No (2.1m x 2.7m)	L = 5m, 2m below sill	2	4	4	4		
9	E-12/1		32771	104.14	14	Khowang	345	273	3,82,20,000.00	103.96	102.1	1.86	2.04	1 No (2.1m x 2.7m)	L = 9m, 2m below sill	4	8	8	10	Design: SG-2 Design for E-12/3 adopted for the other sluice gates considering worst head in both C/S and R/S amongst	Sub-Est: SG-2
10	E-12/2		29312	103.45	9	Khowang	345	273	2,45,70,000.00	102.59	101.2	1.39	2.25	1 No (2.1m x 2.7m)	L = 9m, 2m below sill	4	8	8	10		
11	**E-12/3**		20751	102.43	15	Khowang	345	273	4,09,50,000.00	101.91	100	**1.91**	**2.43**	1 No (2.1m x 2.7m)	L = 9m, 2m below sill	4	8	8	10		
12	E-16/1		89711	114.53	10	Naharkatia	337	265	2,65,00,000.00	113.66	112.5	1.16	2.03	1 No (2.1m x 2.7m)	L = 9m, 2m below sill	4	8	8	10		
13	**E-16/3**		88381	114.39	39	Naharkatia	337	265	10,33,50,000.00	114.36	112.3	**2.06**	**2.09**	2 Nos. (2.1m x 2.7m)	L = 10m, 2m below sill	4	8	8	10	Design: SG-3	Sub-Est: SG-3
21	E-15/4	1. These Sluice gates are in working Condition, however Barrel length to be extended due to proposed widening of embankmet as per new specifications by restructuring country side of structure. 2. All other designs for the existing structures are checked as per computed design hydraulic parameters and found to be adequate. 3. Protection works are mostly detoriated and hence proposed to be complety rebuilt as per	37506	104.64	3	Khowang	345	273	81,90,000.00	103.86	102.2	1.66	2.44	1 No (2.1m x 2.7m)	L = 4m, 2m below sill	2	4	4	4	Design: SG-4 Design for E-23/1 adopted for the other sluice gates considering worst head in both C/S and R/S amongst all sluices.	Sub-Est: SG-4
22	E-16/4		83239	113.25	4	Naharkatia	337	265	1,06,00,000.00	112.73	111.2	1.53	2.05	1 No (2.1m x 2.7m)	L = 5m, 2m below sill	2	4	4	4		
15	E-13/2		86899	114.04	3	Khowang	345	273	81,90,000.00	113.41	112	1.41	2.04	1 No (2.1m x 2.7m)	L = 4m, 2m below sill	2	4	4	4		
16	E-13/3		86007	113.99	2	Khowang	345	273	54,60,000.00	113.47	112	1.47	1.99	1 No (2.1m x 2.7m)	L = 4m, 2m below sill	2	4	4	4		
24	**E-23/1**		94016	115.64	2	Khowang	345	273	54,60,000.00	114.68	113	**1.68**	**2.64**	1 No (2.1m x 2.7m)	L = 4m, 2m below sill	2	4	4	4		
25	E-23/2		94016	115.64	3	Khowang	345	273	81,90,000.00	114.51	113.2	1.31	2.44	1 No (2.1m x 2.7m)	L = 4m, 2m below sill	2	4	4	4		
26	E-24/1		94016	115.64	2	Khowang	345	273	54,60,000.00	114.61	113.2	1.41	2.44	1 No (2.1m x 2.7m)	L = 4m, 2m below sill	2	4	4	4		
27	E-24/2		94016	115.64	1	Khowang	345	273	27,30,000.00	114.61	113.1	1.51	2.54	1 No (2.1m x 2.7m)	L = 2m, 2m below sill	2	4	4	4		
28	E-24/3		94016	115.64	1	Khowang	345	273	27,30,000.00	114.61	113.1	1.51	2.54	1 No (2.1m x 2.7m)	L = 2m, 2m below sill	2	4	4	4		
31	E-25/3		98867	116.66	2	Naharkatia	337	265	53,00,000.00	115.59	114.3	1.29	2.36	1 No (2.1m x 2.7m)	L = 6m, 2m below sill	2	4	4	4		
14	E-13/1		92256	115.12	5	Khowang	345	273	1,36,50,000.00	114.46	113	1.46	2.12	1 No (2.1m x 2.7m)	L = 6m, 2m below sill	2	4	4	6	Design: SG-5 Design for E-25/1 adopted for the other sluice gates considering worst head in both C/S and R/S amongst all sluices.	Sub-Est: SG-5
17	E-14/1		78916	112.37	7	Khowang	345	273	1,91,10,000.00	111.64	110	1.64	2.37	1 No (2.1m x 2.7m)	L = 6m, 2m below sill	2	4	4	6		
18	E-14/4		54666	107.3	4	Khowang	345	273	1,09,20,000.00	106.38	105.1	1.28	2.2	1 No (2.1m x 2.7m)	L = 5m, 2m below sill	2	4	4	6		
19	E-14/5		52271	106.85	6	Khowang	345	273	1,63,80,000.00	105.89	104.5	1.39	2.35	1 No (2.1m x 2.7m)	L = 6m, 2m below sill	2	4	4	6		
20	E-15/3		38706	104.92	4	Khowang	345	273	1,09,20,000.00	104.09	102.6	1.49	2.32	1 No (2.1m x 2.7m)	L = 5m, 2m below sill	2	4	4	6		
23	E-16/5		80573	112.69	6	Naharkatia	337	265	1,59,00,000.00	111.84	110.1	1.74	2.59	1 No (2.1m x 2.7m)	L = 6m, 2m below sill	2	4	4	6		
29	**E-25/1**		1E+05	117.3	7	Naharkatia	337	265	1,85,50,000.00	116.71	114.7	**2.01**	**2.6**	1 No (2.1m x 2.7m)	L = 6m, 2m below sill	2	4	4	6		
30	E-25/2		99326	116.76	7	Naharkatia	337	265	1,85,50,000.00	115.9	114.3	1.6	2.46	1 No (2.1m x 2.7m)	L = 6m, 2m below sill	2	4	4	6		
32	E-14/3		63589	108.36	8	Khowang	345	273	2,18,40,000.00	107.71	106.2	1.51	2.16	1 No (2.1m x 2.7m)	L = 7m, 2m below sill	2	4	4	8	Design: SG-6 Design for E-15/2 adopted for the	Sub-Est: SG-6
33	**E-15/2**		40053	105.01	8	Khowang	345	273	2,18,40,000.00	104.32	102.7	**1.62**	**2.31**	1 No (2.1m x 2.7m)	L = 7m, 2m below sill	2	4	4	8		
37	E-15/1		47006	106.21	15	Khowang	345	273	4,09,50,000.00	105.89	104.5	1.39	1.71	1 No (2.1m x 2.7m)	L = 9m, 2m below sill	4	6	8	10	Design: SG-7 Design for E-27/1adopted for the	Sub-Est: SG-7
38	**E-27/1**		1E+05	118.63	16	Naharkatia	337	265	4,24,00,000.00	117.89	116.4	**1.49**	**2.23**	1 No (2.1m x 2.7m)	L = 9m, 2m below sill	4	6	8	10		
34	E-14/2		64966	108.57	60	Khowang	345	273	16,38,00,000.00	107.84	106.7	1.14	1.87	2 Nos. (2.1m x 2.7m)	L = 12m, 2m below sill	5	8	10	14	Design: SG-8 Design for E-25/4 adopted for the other sluice gates considering worst	Sub-Est: SG-8
35	**E-25/4**		98701	116.65	53	Naharkatia	337	265	14,04,50,000.00	115.91	114.6	**1.31**	**2.05**	2 Nos. (2.1m x 2.7m)	L = 12m, 2m below sill	5	8	10	14		
36	E-25/5		96374	116.12	48	Naharkatia	337	265	12,72,00,000.00	115.31	114	1.31	2.12	2 Nos. (2.1m x 2.7m)	L = 11m, 2m below sill	5	8	10	14		
39	**E-19/1**		48398	106.37	25	Khowang	345	273	6,82,50,000.00	105.8	104.3	**1.5**	**2.07**	1 No (2.1m x 2.7m)	L = 12m, 2m below sill	5	8	10	14	Design: SG-9	Sub-Est: SG-9

Executive Engineer
Dibrugarh W.R. Division
Dibrugarh

CHAPTER- 6.3.1

Computation of Hydraulic Parameters for Sluice Gate

Name of Project - Integrated Water Resources Management of Buridehing Basin

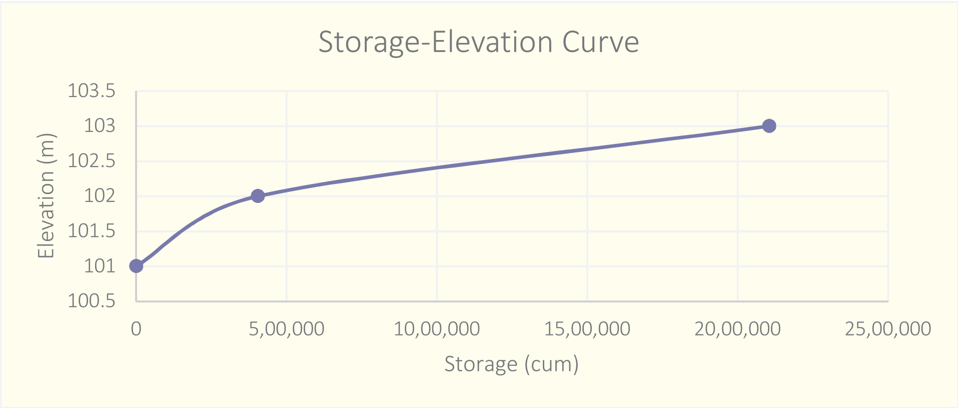
Computation of Hyd. Parameters for Sluice Gate E-09/2 (HEC-RAS Station 28033m) on RB

R.L. of DHFL at Sluice site (HEC-RAS Station 28033m)	=	103.28	m
Ground level at Sluice site	=	102	m
Bed level at Sluice site	=	101.2	m
Crest level of embankment at sluice site	=	104.78	m
Total drainage area	=	400	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Khowang Raingauge)	=	34.5	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	27.3	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	10920	Ha.cm
high flood	=	**10,92,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 101m contour	=	10000	sq.m
Area covered by 102m contour	=	800000	sq.m
Area covered by 103m contour	=	2600000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 101m	0	0	101
Volume between 102m and 101m	4,05,000	4,05,000	102
Volume between 103m and 102m	17,00,000	21,05,000	103



The ruling level is fixed at 102m
Total water accumulated upto 102m = 405000cum
Total water accumulation in worst case = vol. of water upto 102m + volume of water accumulated through runoff

= 14,97,000 cum

Probable Maximum WL at C/S during worst case =102+ (1497000-405000) x (103-102)/(2105000-405000) = 102.64 m
Minimum discharge capacity of sluice required to drain out water within 7 days = 1.81 cumecs

CALCULATION OF SIZE OF OPENING

We have, $$Q = C_d \times A \times \sqrt{2gh}$$

Min. discharge capacity required 'Q'	=	1.81	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \frac{Q}{C_d\sqrt{2gh}}$	=	0.76	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.13	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 6.49 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.32 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

Time require to completely evacuate during worst condition = 22.49 hrs = 1 day 0 hrs Approx.

Name of Project - Integrated Water Resources Management of Buridehing Basin

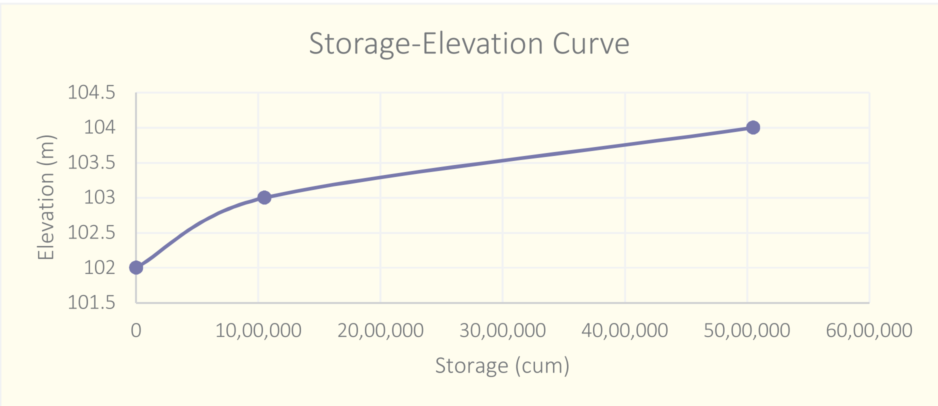
Computation of Hyd. Parameters for Sluice Gate E-12/1 (HEC-RAS Station 32771m) on RB

R.L. of DHFL at Sluice site (HEC-RAS Station 32771m)	=	104.14	m
Ground level at Sluice site	=	103	m
Bed level at Sluice site	=	102.1	m
Crest level of embankment at sluice site	=	105.64	m
Total drainage area	=	1400	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Khowang Raingauge)	=	34.5	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	27.3	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	38220	Ha.cm
high flood	=	**38,22,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 102m contour	=	100000	sq.m
Area covered by 103m contour	=	2000000	sq.m
Area covered by 104m contour	=	6000000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 102m	0	0	102
Volume between 103m and 102m	10,50,000	10,50,000	103
Volume between 104m and 103m	40,00,000	50,50,000	104



The ruling level is fixed at 103m

Total water accumulated upto 103m = 1050000cum

Total water accumulation in worst case = vol. of water upto 103m + volume of water accumulated through runoff

Total water accumulation in worst case = 48,72,000 cum

Probable Maximum WL at C/S during worst case =103+ (4872000-1050000) x (104-103)/(5050000-1050000) = 103.96 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 6.32 cumecs

CALCULATION OF SIZE OF OPENING

We have, $Q = C_d \times A \times \sqrt{2gh}$

Min. discharge capacity required 'Q'	=	6.32	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \dfrac{Q}{C_d \sqrt{2gh}}$	=	2.66	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.47	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 12.14 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.17 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

ime require to completely evacuate during worst condition = 78.73 hrs = 3 day 7 hrs Approx.

Name of Project - Integrated Water Resources Management of Buridehing Basin

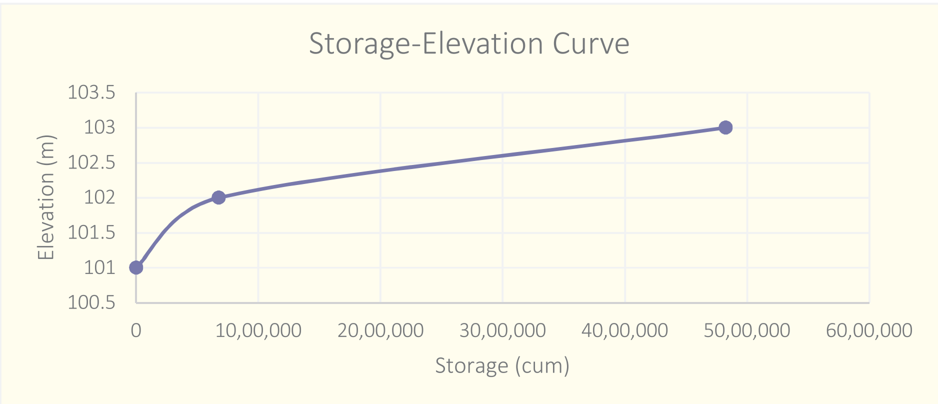
Computation of Hyd. Parameters for Sluice Gate E-12/2 (HEC-RAS Station 29312m) on RB

R.L. of DHFL at Sluice site (HEC-RAS Station 32771m)	=	103.45	m
Ground level at Sluice site	=	102	m
Bed level at Sluice site	=	101.2	m
Crest level of embankment at sluice site	=	104.95	m
Total drainage area	=	900	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Khowang Raingauge)	=	34.5	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	27.3	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	24570	Ha.cm
high flood	=	**24,57,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 101m contour	=	50000	sq.m
Area covered by 102m contour	=	1300000	sq.m
Area covered by 103m contour	=	7000000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 101m	0	0	101
Volume between 102m and 101m	6,75,000	6,75,000	102
Volume between 103m and 102m	41,50,000	48,25,000	103



The ruling level is fixed at 102m
Total water accumulated upto 102m = 675000cum
Total water accumulation in worst case = vol. of water upto 102m + volume of water accumulated through runoff

Total water accumulation in worst case = 31,32,000 cum

Probable Maximum WL at C/S during worst case =102+ (3132000-675000) x (103-102)/(4825000-675000) = 102.59 m
Minimum discharge capacity of sluice required to drain out water within 7 days = 4.06 cumecs

CALCULATION OF SIZE OF OPENING

We have, $Q = C_d \times A \times \sqrt{2gh}$

Min. discharge capacity required 'Q'	=	4.06	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \frac{Q}{C_d\sqrt{2gh}}$	=	1.71	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.30	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 9.74 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.22 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

ime require to completely evacuate during worst condition = 50.61 hrs = 2 day 3 hrs Approx.

Name of Project - Integrated Water Resources Management of Buridehing Basin

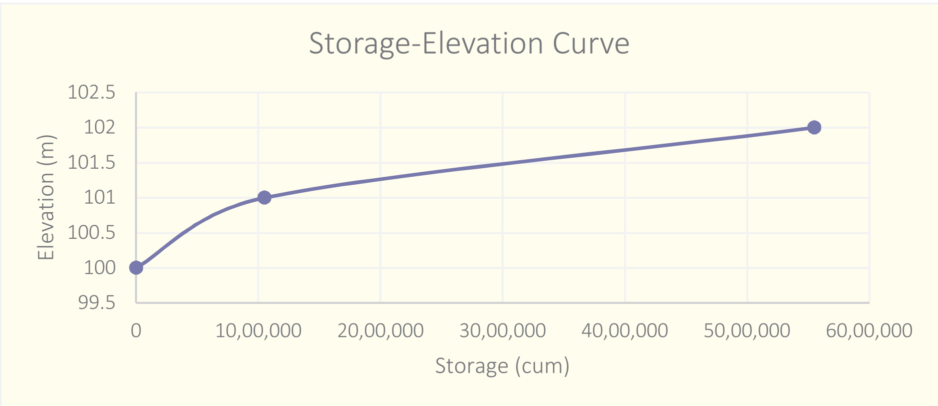
Computation of Hyd. Parameters for Sluice Gate E-12/3 (HEC-RAS Station 20751m) on RB

R.L. of DHFL at Sluice site (HEC-RAS Station 20751m)	=	102.43	m
Ground level at Sluice site	=	101	m
Bed level at Sluice site	=	100	m
Crest level of embankment at sluice site	=	103.93	m
Total drainage area	=	1500	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Khowang Raingauge)	=	34.5	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	27.3	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	40950	Ha.cm
high flood	=	**40,95,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 100m contour	=	100000	sq.m
Area covered by 101m contour	=	2000000	sq.m
Area covered by 102m contour	=	7000000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 100m	0	0	100
Volume between 101m and 100m	10,50,000	10,50,000	101
Volume between 102m and 101m	45,00,000	55,50,000	102



The ruling level is fixed at 101m
Total water accumulated upto 101m = 1050000cum
Total water accumulation in worst case = vol. of water upto 101m + volume of water accumulated through runoff

= 51,45,000 cum

Probable Maximum WL at C/S during worst case =101+ (5145000-1050000) x (102-101)/(5550000-1050000) = 101.91 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 6.77 cumecs

CALCULATION OF SIZE OF OPENING

We have, $Q = C_d \times A \times \sqrt{2gh}$

Min. discharge capacity required 'Q'	=	6.77	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \dfrac{Q}{C_d \sqrt{2gh}}$	=	2.85	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.50	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 12.57 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.17 < 1, o.k

Discharge capacity of regulator	=	13.5	m^3/sec		
ime require to completely evacuate during worst condition	=	84.35	hrs	=	4 day 0 hrs Approx.

Name of Project - Integrated Water Resources Management of Buridehing Basin

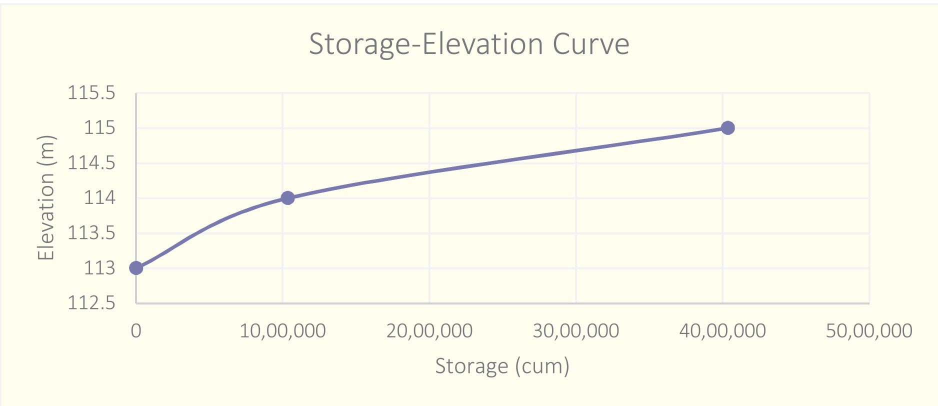
Computation of Hyd. Parameters for Sluice Gate E-13/1 (HEC-RAS Station 92256m) on RB

R.L. of DHFL at Sluice site (HEC-RAS Station 92256m)	=	115.12	m
Ground level at Sluice site	=	114	m
Bed level at Sluice site	=	113	m
Crest level of embankment at sluice site	=	116.62	m
Total drainage area	=	500	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Khowang Raingauge)	=	34.5	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	27.3	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	13650	Ha.cm
high flood	=	**13,65,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 113m contour	=	70000	sq.m
Area covered by 114m contour	=	2000000	sq.m
Area covered by 115m contour	=	4000000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 113m	0	0	113
Volume between 114m and 113m	10,35,000	10,35,000	114
Volume between 115m and 114m	30,00,000	40,35,000	115



The ruling level is fixed at 114m
Total water accumulated upto 114m = 1035000cum
Total water accumulation in worst case = vol. of water upto 114m + volume of water accumulated through runoff

= 24,00,000 cum

Probable Maximum WL at C/S during worst case =114+ (2400000-1035000) x (115-114)/(4035000-1035000) = 114.46 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 2.26 cumecs

CALCULATION OF SIZE OF OPENING

We have, $$Q = C_d \times A \times \sqrt{2gh}$$

Min. discharge capacity required 'Q'	=	2.26	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \dfrac{Q}{C_d\sqrt{2gh}}$	=	0.95	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.17	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 7.26 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.29 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

ime require to completely evacuate during worst condition = 28.12 hrs = 1 day 4 hrs Approx.

Name of Project - Integrated Water Resources Management of Buridehing Basin

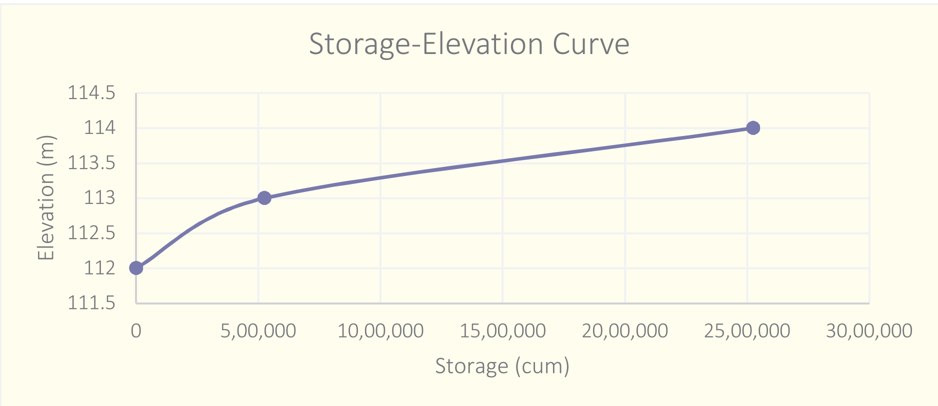
Computation of Hyd. Parameters for Sluice Gate E-13/2 (HEC-RAS Station 86899m) on RB

R.L. of DHFL at Sluice site (HEC-RAS Station 86899m)	=	114.04	m
Ground level at Sluice site	=	112.8	m
Bed level at Sluice site	=	112	m
Crest level of embankment at sluice site	=	115.54	m
Total drainage area	=	300	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Khowang Raingauge)	=	34.5	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	27.3	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	8190	Ha.cm
high flood	=	**8,19,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 112m contour	=	50000	sq.m
Area covered by 113m contour	=	1000000	sq.m
Area covered by 114m contour	=	3000000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 112m	0	0	112
Volume between 113m and 112m	5,25,000	5,25,000	113
Volume between 114m and 113m	20,00,000	25,25,000	114



The ruling level is fixed at 113m

Total water accumulated upto 113m = 525000cum

Total water accumulation in worst case = vol. of water upto 113m + volume of water accumulated through runoff

= 13,44,000 cum

Probable Maximum WL at C/S during worst case =113+ (1344000-525000) x (114-113)/(2525000-525000) = 113.41 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 1.35 cumecs

CALCULATION OF SIZE OF OPENING

We have, $$Q = C_d \times A \times \sqrt{2gh}$$

Min. discharge capacity required 'Q'	=	1.35	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \dfrac{Q}{C_d \sqrt{2gh}}$	=	0.57	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.10	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 5.62 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.37 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

ime require to completely evacuate during worst condition = 16.87 hrs = 1 day 0 hrs Approx.

Name of Project - Integrated Water Resources Management of Buridehing Basin

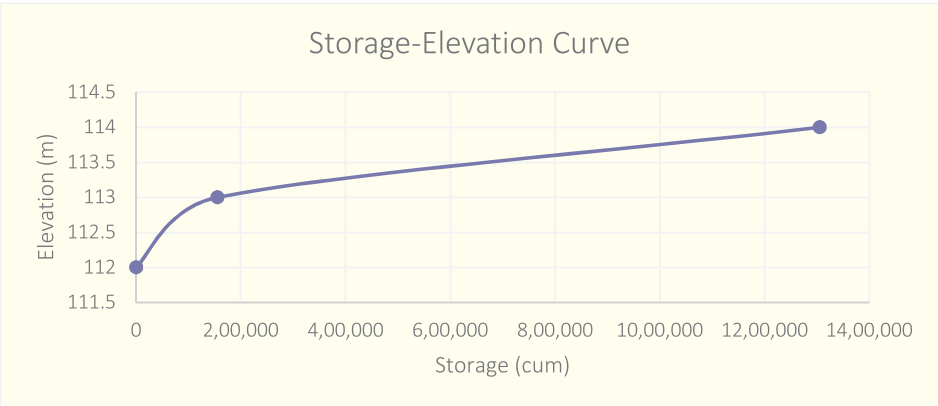
Computation of Hyd. Parameters for Sluice Gate E-13/3 (HEC-RAS Station 86007m) on RB

R.L. of DHFL at Sluice site (HEC-RAS Station 86007m)	=	113.99	m
Ground level at Sluice site	=	112.6	m
Bed level at Sluice site	=	112	m
Crest level of embankment at sluice site	=	115.49	m
Total drainage area	=	200	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Khowang Raingauge)	=	34.5	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	27.3	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	5460	Ha.cm
high flood	=	**5,46,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 112m contour	=	10000	sq.m
Area covered by 113m contour	=	300000	sq.m
Area covered by 114m contour	=	2000000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 112m	0	0	112
Volume between 113m and 112m	1,55,000	1,55,000	113
Volume between 114m and 113m	11,50,000	13,05,000	114



The ruling level is fixed at 113m
Total water accumulated upto 113m = 155000cum
Total water accumulation in worst case = vol. of water upto 113m + volume of water accumulated through runoff

= 7,01,000 cum

Probable Maximum WL at C/S during worst case =113+ (701000-155000) x (114-113)/(1305000-155000) = 113.47 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 0.90 cumecs

CALCULATION OF SIZE OF OPENING

We have, $$Q = C_d \times A \times \sqrt{2gh}$$

Min. discharge capacity required 'Q'	=	0.90	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \dfrac{Q}{C_d \sqrt{2gh}}$	=	0.38	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.07	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 4.59 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.46 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

ime require to completely evacuate during worst condition = 11.25 hrs = 0 day 11 hrs Approx.

Name of Project - Integrated Water Resources Management of Buridehing Basin

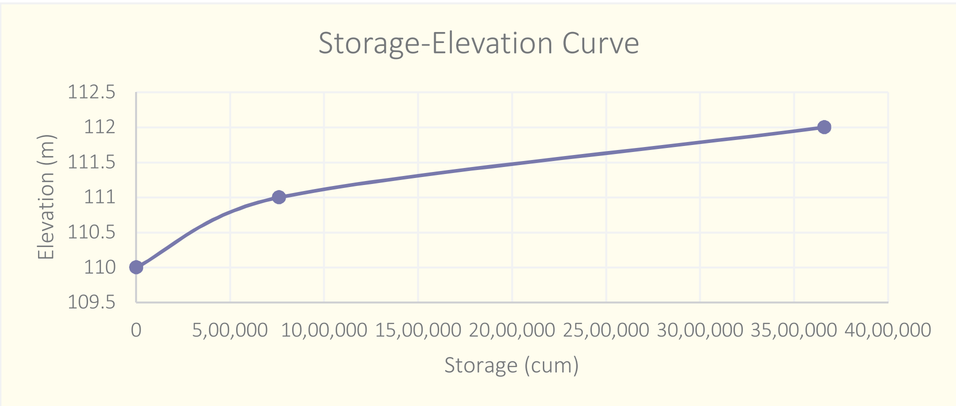
Computation of Hyd. Parameters for Sluice Gate E-14/1 (HEC-RAS Station 78916m) on LB

R.L. of DHFL at Sluice site (HEC-RAS Station 78916m)	=	112.37	m
Ground level at Sluice site	=	110.8	m
Bed level at Sluice site	=	110	m
Crest level of embankment at sluice site	=	113.87	m
Total drainage area	=	700	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Naharkatia Raingauge)	=	33.7	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	26.5	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	18550	Ha.cm
high flood	=	**18,55,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 110m contour	=	20000	sq.m
Area covered by 111m contour	=	1500000	sq.m
Area covered by 112m contour	=	4300000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 110m	0	0	110
Volume between 111m and 110m	7,60,000	7,60,000	111
Volume between 112m and 111m	29,00,000	36,60,000	112



The ruling level is fixed at 111m
Total water accumulated upto 111m = 760000cum
Total water accumulation in worst case = vol. of water upto 111m + volume of water accumulated through runoff

= 26,15,000 cum

Probable Maximum WL at C/S during worst case =111+ (2615000-760000) x (112-111)/(3660000-760000) = 111.64 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 3.07 cumecs

CALCULATION OF SIZE OF OPENING

We have, $$Q = C_d \times A \times \sqrt{2gh}$$

Min. discharge capacity required 'Q'	=	3.07	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \frac{Q}{C_d \sqrt{2gh}}$	=	1.29	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.23	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 8.46 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.25 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

Time require to completely evacuate during worst condition = 38.21 hrs = 2 day 0 hrs Approx.

Name of Project - Integrated Water Resources Management of Buridehing Basin

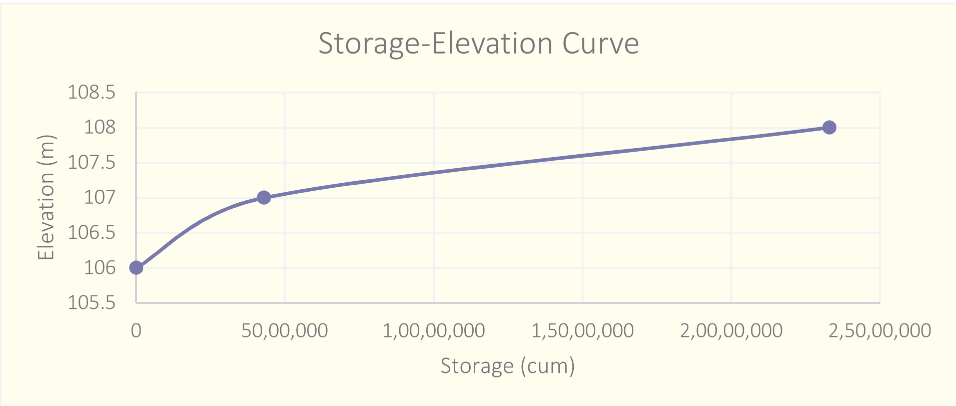
Computation of Hyd. Parameters for Sluice Gate E-14/2 (HEC-RAS Station 64966m) on RB

R.L. of DHFL at Sluice site (HEC-RAS Station 64966m)	=	108.57	m
Ground level at Sluice site	=	107.4	m
Bed level at Sluice site	=	106.7	m
Crest level of embankment at sluice site	=	110.07	m
Total drainage area	=	6000	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Naharkatia Raingauge)	=	33.7	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	26.5	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	159000	Ha.cm
high flood	=	**1,59,00,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 106m contour	=	2600000	sq.m
Area covered by 107m contour	=	6000000	sq.m
Area covered by 108m contour	=	32000000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 106m	0	0	106
Volume between 107m and 106m	43,00,000	43,00,000	107
Volume between 108m and 107m	1,90,00,000	2,33,00,000	108



The ruling level is fixed at 107.4m
Total water accumulated upto 107m = 4300000cum
Total water accumulation in worst case = vol. of water upto 107m + volume of water accumulated through runoff

= 2,02,00,000 cum

Probable Maximum WL at C/S during worst case=
107+(20200000-4300000) x (108-107)/(23300000-4300000) = 107.84 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 26.29 cumecs

CALCULATION OF SIZE OF OPENING

We have, $$Q = C_d \times A \times \sqrt{2gh}$$

Min. discharge capacity required 'Q'	=	26.29	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \dfrac{Q}{C_d\sqrt{2gh}}$	=	11.05	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	1.95	Say 2
Hence, total area provided	=	11.34	m^2

Let us provide 2 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	4.7	m
Lacey's regime width = 4.83x√Q	=	24.77	m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.19 < 1, o.k

Discharge capacity of regulator = 27.0 m^3/sec

Time require to completely evacuate during worst condition = 163.76 hrs = 7 day 0 hrs Approx.

Name of Project - Integrated Water Resources Management of Buridehing Basin

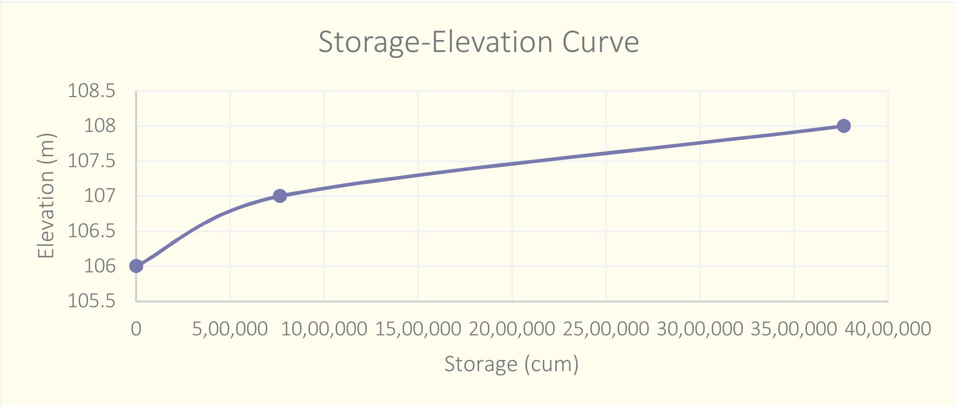
Computation of Hyd. Parameters for Sluice Gate E-14/3 (HEC-RAS Station 63589m) on LB

R.L. of DHFL at Sluice site (HEC-RAS Station 63589m)	=	108.36	m
Ground level at Sluice site	=	107	m
Bed level at Sluice site	=	106.2	m
Crest level of embankment at sluice site	=	109.86	m
Total drainage area	=	800	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Naharkatia Raingauge)	=	33.7	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	26.5	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	21200	Ha.cm
high flood	=	**21,20,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 106m contour	=	30000	sq.m
Area covered by 107m contour	=	1500000	sq.m
Area covered by 108m contour	=	4500000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 106m	0	0	106
Volume between 107m and 106m	7,65,000	7,65,000	107
Volume between 108m and 107m	30,00,000	37,65,000	108



The ruling level is fixed at 107m

Total water accumulated upto 107m = 765000cum

Total water accumulation in worst case = vol. of water upto 107m + volume of water accumulated through runoff

= 28,85,000 cum

Probable Maximum WL at C/S during worst case =107+ (2885000-765000) x (108-107)/(3765000-765000) = 107.71 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 3.51 cumecs

CALCULATION OF SIZE OF OPENING

We have, $$Q = C_d \times A \times \sqrt{2gh}$$

Min. discharge capacity required 'Q'	=	3.51	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \frac{Q}{C_d\sqrt{2gh}}$	=	1.47	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.26	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 9.04 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.23 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

Time require to completely evacuate during worst condition = 43.67 hrs = 2 day 0 hrs Approx.

Name of Project - Integrated Water Resources Management of Buridehing Basin

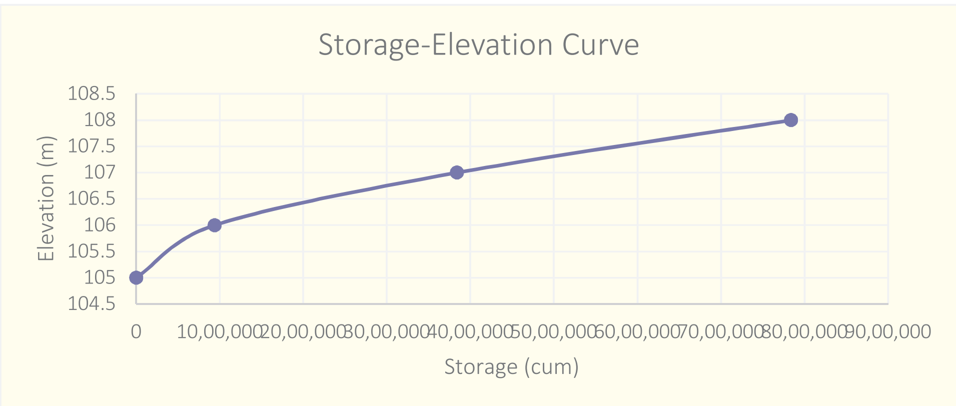
Computation of Hyd. Parameters for Sluice Gate E-14/4 (HEC-RAS Station 54666m) on LB

R.L. of DHFL at Sluice site (HEC-RAS Station 54666m)	=	107.30	m
Ground level at Sluice site	=	106	m
Bed level at Sluice site	=	105.1	m
Crest level of embankment at sluice site	=	108.80	m
Total drainage area	=	400	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Khowang Raingauge)	=	34.5	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	27.3	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	10920	Ha.cm
high flood	=	**10,92,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 105m contour	=	80000	sq.m
Area covered by 106m contour	=	1800000	sq.m
Area covered by 107m contour	=	4000000	sq.m
Area covered by 108m contour	=	4000000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 105m	0	0	105
Volume between 106m and 105m	9,40,000	9,40,000	106
Volume between 107m and 106m	29,00,000	38,40,000	107
Volume between 108m and 107m	40,00,000	78,40,000	108



The ruling level is fixed at 106m
Total water accumulated upto 106m = 940000cum
Total water accumulation in worst case = vol. of water upto 106m + volume of water accumulated through runoff

= 20,32,000 cum

Probable Maximum WL at C/S during worst case =106+ (2032000-940000) x (107-106)/(3840000-940000) = 106.38 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 1.81 cumecs

CALCULATION OF SIZE OF OPENING

We have, $Q = C_d \times A \times \sqrt{2gh}$

Min. discharge capacity required 'Q'	=	1.81	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \frac{Q}{C_d \sqrt{2gh}}$	=	0.76	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.13	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 6.49 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.32 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

Time require to completely evacuate during worst condition = 22.49 hrs = 1 day 0 hrs Approx.

Name of Project - Integrated Water Resources Management of Buridehing Basin

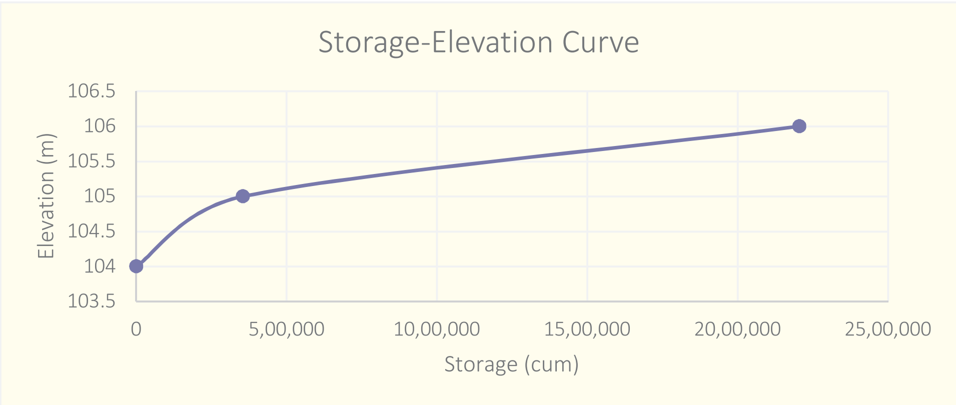
Computation of Hyd. Parameters for Sluice Gate E-14/5 (HEC-RAS Station 52271m) on LB

R.L. of DHFL at Sluice site (HEC-RAS Station 52271m)	=	106.85	m
Ground level at Sluice site	=	105.3	m
Bed level at Sluice site	=	104.5	m
Crest level of embankment at sluice site	=	108.35	m
Total drainage area	=	600	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Khowang Raingauge)	=	34.5	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	27.3	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	16380	Ha.cm
high flood	=	**16,38,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 104m contour	=	10000	sq.m
Area covered by 105m contour	=	700000	sq.m
Area covered by 106m contour	=	3000000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 104m	0	0	104
Volume between 105m and 104m	3,55,000	3,55,000	105
Volume between 106m and 105m	18,50,000	22,05,000	106



The ruling level is fixed at 105.3m

Total water accumulated upto 105m = 355000cum

Total water accumulation in worst case = vol. of water upto 105m + volume of water accumulated through runoff

= 19,93,000 cum

Probable Maximum WL at C/S during worst case =105+ (1993000-355000) x (106-105)/(2205000-355000) = 105.89 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 2.71 cumecs

CALCULATION OF SIZE OF OPENING

We have, $$Q = C_d \times A \times \sqrt{2gh}$$

Min. discharge capacity required 'Q'	=	2.71	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \frac{Q}{C_d \sqrt{2gh}}$	=	1.14	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.20	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 7.95 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.26 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

Time require to completely evacuate during worst condition = 33.74 hrs = 1 day 10 hrs Approx.

Name of Project - Integrated Water Resources Management of Buridehing Basin

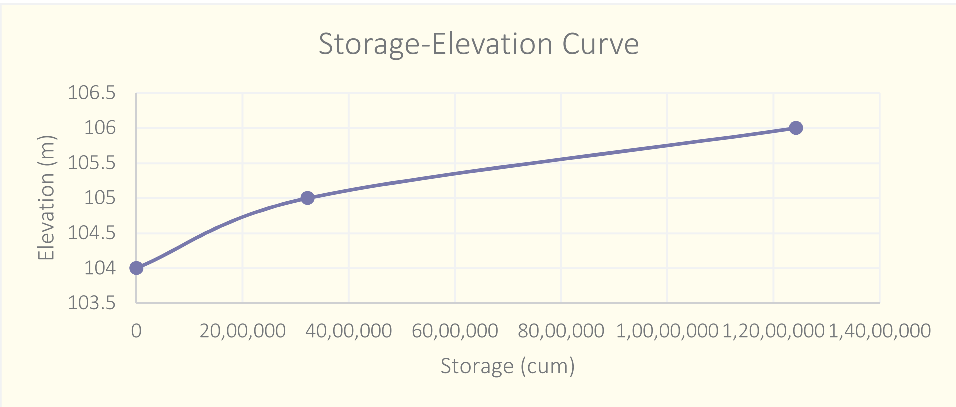
Computation of Hyd. Parameters for Sluice Gate E-15/1 (HEC-RAS Station 47006m) on RB

R.L. of DHFL at Sluice site (HEC-RAS Station 47006m)	=	106.21	m
Ground level at Sluice site	=	105	m
Bed level at Sluice site	=	104	m
Crest level of embankment at sluice site	=	107.71	m
Total drainage area	=	1500	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Khowang Raingauge)	=	34.5	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	27.3	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	40950	Ha.cm
high flood	=	**40,95,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 104m contour	=	50000	sq.m
Area covered by 105m contour	=	6400000	sq.m
Area covered by 106m contour	=	12000000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 104m	0	0	104
Volume between 105m and 104m	32,25,000	32,25,000	105
Volume between 106m and 105m	92,00,000	1,24,25,000	106



The ruling level is fixed at 105m

Total water accumulated upto 105m = 3225000cum

Total water accumulation in worst case = vol. of water upto 105m + volume of water accumulated through runoff

= 73,20,000 cum

Probable Maximum WL at C/S during worst case =105+ (7320000-3225000) x (106-105)/(12425000-3225000) = 105.45 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 6.77 cumecs

CALCULATION OF SIZE OF OPENING

We have, $Q = C_d \times A \times \sqrt{2gh}$

Min. discharge capacity required 'Q'	=	6.77	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \dfrac{Q}{C_d \sqrt{2gh}}$	=	2.85	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.50	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 12.57 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.17 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

Time require to completely evacuate during worst condition = 84.35 hrs = 4 day 0 hrs Approx.

Name of Project - Integrated Water Resources Management of Buridehing Basin

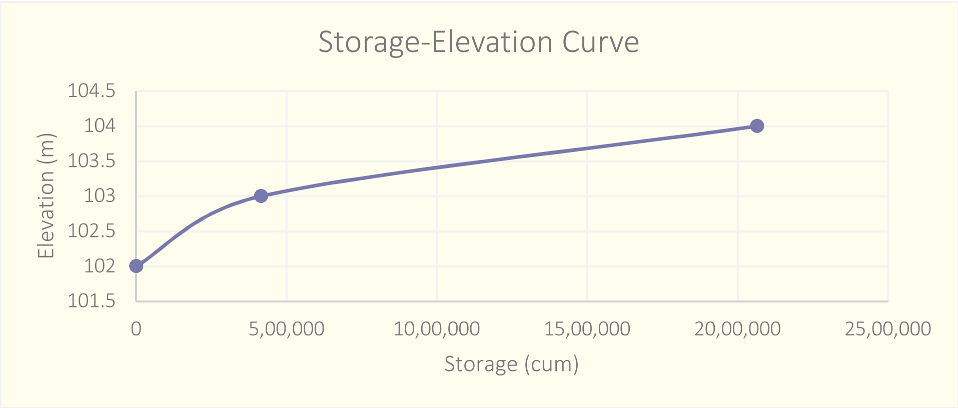
Computation of Hyd. Parameters for Sluice Gate E-15/2 (HEC-RAS Station 40053m) on RB

R.L. of DHFL at Sluice site (HEC-RAS Station 40053m)	=	105.01	m
Ground level at Sluice site	=	103.7	m
Bed level at Sluice site	=	102.7	m
Crest level of embankment at sluice site	=	106.51	m
Total drainage area	=	800	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Khowang Raingauge)	=	34.5	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	27.3	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	21840	Ha.cm
high flood	=	**21,84,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 102m contour	=	30000	sq.m
Area covered by 103m contour	=	800000	sq.m
Area covered by 104m contour	=	2500000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 102m	0	0	102
Volume between 103m and 102m	4,15,000	4,15,000	103
Volume between 104m and 103m	16,50,000	20,65,000	104



The ruling level is fixed at 103m

Total water accumulated upto 103m = 415000cum

Total water accumulation in worst case = vol. of water upto 103m + volume of water accumulated through runoff

= 25,99,000 cum

Probable Maximum WL at C/S during worst case =103+ (2599000-415000) x (104-103)/(2065000-415000) = 104.32 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 3.61 cumecs

CALCULATION OF SIZE OF OPENING

We have, $Q = C_d \times A \times \sqrt{2gh}$

Min. discharge capacity required 'Q'	=	3.61	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \dfrac{Q}{C_d \sqrt{2gh}}$	=	1.52	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.27	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 9.18 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.23 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

Time require to completely evacuate during worst condition = 44.99 hrs = 2 day 0 hrs Approx.

Name of Project - Integrated Water Resources Management of Buridehing Basin

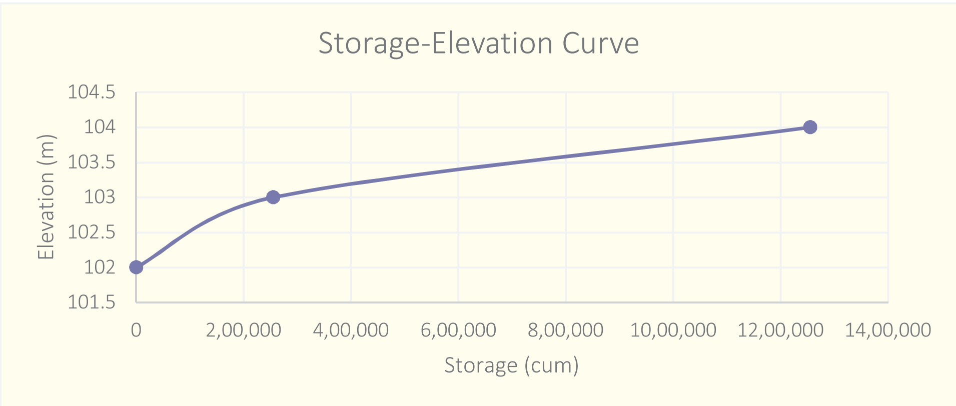
Computation of Hyd. Parameters for Sluice Gate E-15/3 (HEC-RAS Station 38706m) on RB

R.L. of DHFL at Sluice site (HEC-RAS Station 38706m)	=	104.92	m
Ground level at Sluice site	=	103.5	m
Bed level at Sluice site	=	102.6	m
Crest level of embankment at sluice site	=	106.42	m
Total drainage area	=	400	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Khowang Raingauge)	=	34.5	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	27.3	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	10920	Ha.cm
high flood	=	**10,92,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 102m contour	=	10000	sq.m
Area covered by 103m contour	=	500000	sq.m
Area covered by 104m contour	=	1500000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 102m	0	0	102
Volume between 103m and 102m	2,55,000	2,55,000	103
Volume between 104m and 103m	10,00,000	12,55,000	104



The ruling level is fixed at 103m

Total water accumulated upto 103m = 255000cum

Total water accumulation in worst case = vol. of water upto 103m + volume of water accumulated through runoff

= 13,47,000 cum

Probable Maximum WL at C/S during worst case =103+ (1347000-255000) x (104-103)/(1255000-255000) = 104.09 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 1.81 cumecs

CALCULATION OF SIZE OF OPENING

We have, $Q = C_d \times A \times \sqrt{2gh}$

Min. discharge capacity required 'Q'	=	1.81	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \frac{Q}{C_d \sqrt{2gh}}$	=	0.76	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.13	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 6.49 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.32 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

Time require to completely evacuate during worst condition = 22.49 hrs = 1 day 0 hrs Approx.

Name of Project - Integrated Water Resources Management of Buridehing Basin

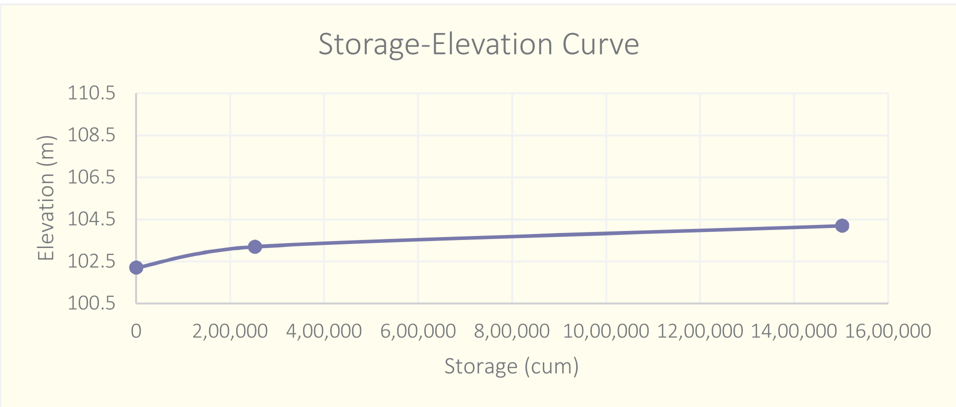
Computation of Hyd. Parameters for Sluice Gate E-15/4 (HEC-RAS Station 37506m) on RB

R.L. of DHFL at Sluice site (HEC-RAS Station 37506m)	=	104.64	m
Ground level at Sluice site	=	103.2	m
Bed level at Sluice site	=	102.2	m
Crest level of embankment at sluice site	=	106.14	m
Total drainage area	=	300	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Khowang Raingauge)	=	34.5	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	27.3	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	8190	Ha.cm
high flood	=	**8,19,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 102.2m contour	=	5000	sq.m
Area covered by 103.2m contour	=	500000	sq.m
Area covered by 104.2m contour	=	2000000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 102.2m	0	0	102.2
Volume between 103.2m and 102.2m	2,52,500	2,52,500	103.2
Volume between 104.2m and 103.2m	12,50,000	15,02,500	104.2



The ruling level is fixed at 103.2m

Total water accumulated upto 103.2m = 252500cum

Total water accumulation in worst case = vol. of water upto 103.2m + volume of water accumulated through runoff

= 10,71,500 cum

Probable Maximum WL at C/S during worst case =103.2+ (1071500-252500) x (104.2-103.2)/(1502500-252500) = 103.86 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 1.35 cumecs

CALCULATION OF SIZE OF OPENING

We have, $$Q = C_d \times A \times \sqrt{2gh}$$

Min. discharge capacity required 'Q'	=	1.35	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \dfrac{Q}{C_d\sqrt{2gh}}$	=	0.57	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.10	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 5.62 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.37 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

Time require to completely evacuate during worst condition = 16.87 hrs = 1 day 0 hrs Approx.

Name of Scheme: - Assam Integrated Flood and River Bank Erosion Risk Management Project. (Kaziranga Sub-Project).

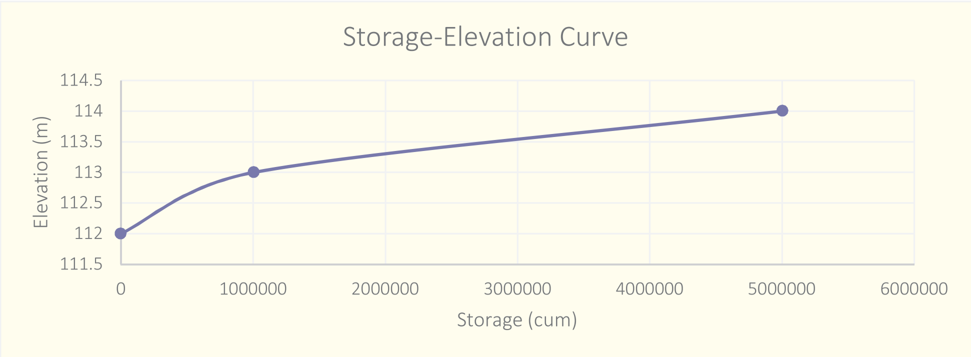
Computation of Hyd. Parameters for Sluice Gate E-16/1 (HEC-RAS Station 89711m) on LB

R.L. of DHFL at Sluice site (HEC-RAS Station 89711m)	=	114.53	m
Ground level at Sluice site	=	113.1	m
Bed level at Sluice site	=	112.5	m
Crest level of embankment at sluice site	=	116.03	m
Total drainage area	=	1000	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Naharkatia Raingauge)	=	33.7	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	26.5	cm
Total runof accumulation in catchment during worst conditions of both rainfall and high flood	=	26500	Ha.cm
	=	**2650000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 112m contour	=	10000	sq.m
Area covered by 113m contour	=	2000000	sq.m
Area covered by 114m contour	=	6000000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 112m	0	0	112
Volume between 113m and 112m	1005000	1005000	113
Volume between 114m and 113m	4000000	5005000	114



The ruling level is fixed at 113m
Total water accumulated upto 113m = 1005000cum
Total water accumulation in worst case = vol. of water upto 113m + volume of water accumulated through runoff

Total water accumulation in worst case = 3655000 cum

Probable Maximum WL at C/S during worst case =113+2650000x (114-113)/(5005000-1005000) = 113.66 m
Minimum discharge capacity of sluice required to drain out water within 7 days = 6.05 cumecs

CALCULATION OF SIZE OF OPENING

We have, $$Q = C_d \times A \times \sqrt{2gh}$$

Min. discharge capacity required 'Q'	=	6.05	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \frac{Q}{C_d \sqrt{2gh}}$	=	2.55	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.45	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 11.88 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.18 **< 1, o.k**

Discharge capacity of regulator = 13.5 m^3/sec

Time require to completely evacuate during worst condition = 54.59 hrs

= 2 days & 6.6 hrs

Name of Scheme: - Assam Integrated Flood and River Bank Erosion Risk Management Project. (Kaziranga Sub-Project).

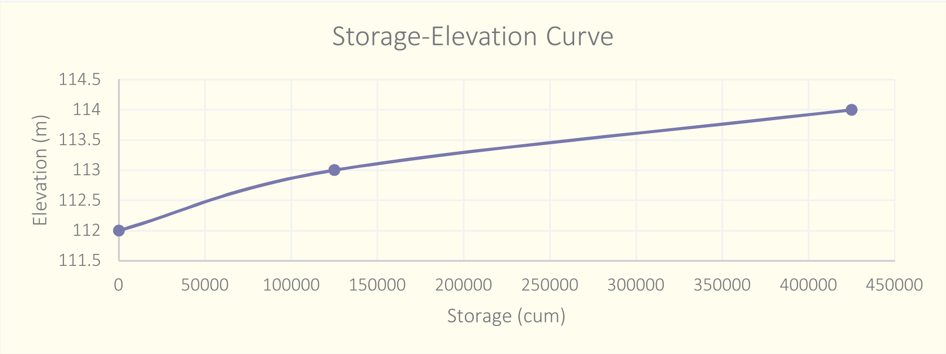
Computation of Hyd. Parameters for Sluice Gate E-16/2 (HEC-RAS Station 88964m) on LB

R.L. of DHFL at Sluice site (HEC-RAS Station 88964m)	=	114.46	m
Ground level at Sluice site	=	113.3	m
Bed level at Sluice site	=	112.3	m
Crest level of embankment at sluice site	=	115.96	m
Total drainage area	=	100	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Naharkatia Raingauge)	=	33.7	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	26.5	cm
Total runof accumulation in catchment during worst conditions of both rainfall and high flood	=	2650	Ha.cm
	=	**265000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 112m contour	=	50000	sq.m
Area covered by 113m contour	=	200000	sq.m
Area covered by 114m contour	=	400000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 112m contour	0	0	112
Volume in between 112m & 113m contour	125000	125000	113
Volume in between 113m & 114m contour	300000	425000	114



The ruling level is fixed at 113m
Total water accumulated upto 113m = 125000cum
Total water accumulation in worst case = vol. of water upto 113m + volume of water accumulated through runoff
Total accumulated water =

= 390000 cum

Probable Maximum WL at C/S during worst case =113+265000x (114-113)/(425000-125000)	=	113.88	m
Minimum discharge capacity of sluice required to drain out water within 7 days	=	0.65	cumecs

CALCULATION OF SIZE OF OPENING

We have, $$Q = C_d \times A \times \sqrt{2gh}$$

Min. discharge capacity required 'Q'	=	0.65	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \frac{Q}{C_d\sqrt{2gh}}$	=	0.28	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.05	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 3.91 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.54 **< 1, o.k**

Discharge capacity of regulator = 13.5 m^3/sec

Time require to completely evacuate during worst condition = 5.46 hrs

= 0 days & 5.5 hrs

Name of Project - Integrated Water Resources Management of Buridehing Basin

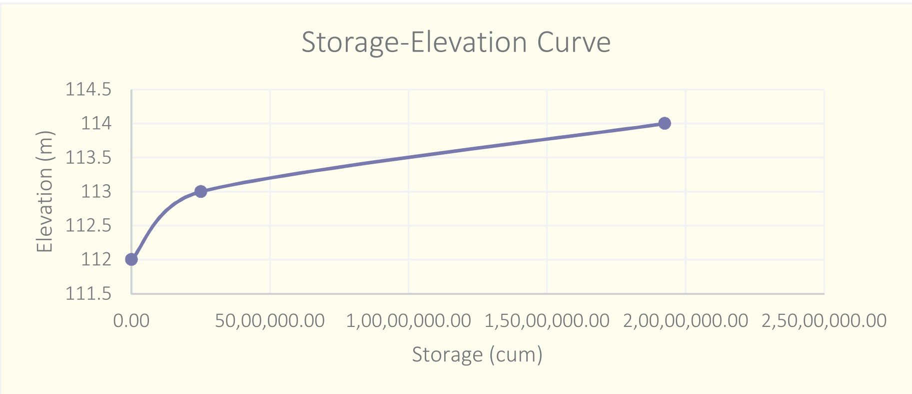
Computation of Hyd. Parameters for Sluice Gate E-16/3 (HEC-RAS Station 88381m) on LB

R.L. of DHFL at Sluice site (HEC-RAS Station 88381m)	=	114.39	m
Ground level at Sluice site	=	113.3	m
Bed level at Sluice site	=	112.3	m
Crest level of embankment at sluice site	=	115.89	m
Total drainage area	=	3900	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Naharkatia Raingauge)	=	33.7	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	26.5	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	103350	Ha.cm
	=	**1,03,35,000.00**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 112m contour	=	500000	sq.m
Area covered by 113m contour	=	4500000	sq.m
Area covered by 114m contour	=	29000000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 111m contour	0	0.00	112
Volume in between 111m & 112m contour	2500000	25,00,000.00	113
Volume in between 112m & 113m contour	16750000	1,92,50,000.00	114



The ruling level is fixed at 113m
Total water accumulated upto 113m = 2500000cum
Total water accumulation in worst case = vol. of water upto 113m + volume of water accumulated through runoff

Water accumulation in worst case = 1,28,35,000.00 cum

Probable Maximum WL at C/S during worst case =113+10335000x (114-113)/(19250000-2500000) = 113.62 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 17.09 cumecs

CALCULATION OF SIZE OF OPENING

We have, $Q = C_d \times A \times \sqrt{2gh}$

Min. discharge capacity required 'Q'	=	17.09	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \frac{Q}{C_d\sqrt{2gh}}$	=	7.19	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	1.27	Say 2
Hence, total area provided	=	11.34	m^2

Let us provide 2 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	4.7	m

Lacey's regime width = 4.83x√Q = 19.97 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.24 < 1, o.k

Discharge capacity of regulator = 27.0 m^3/sec

Time require to completely evacuate during worst condition = 106.44 hrs = 4 days 10 hrs 27 min

Name of Project - Integrated Water Resources Management of Buridehing Basin

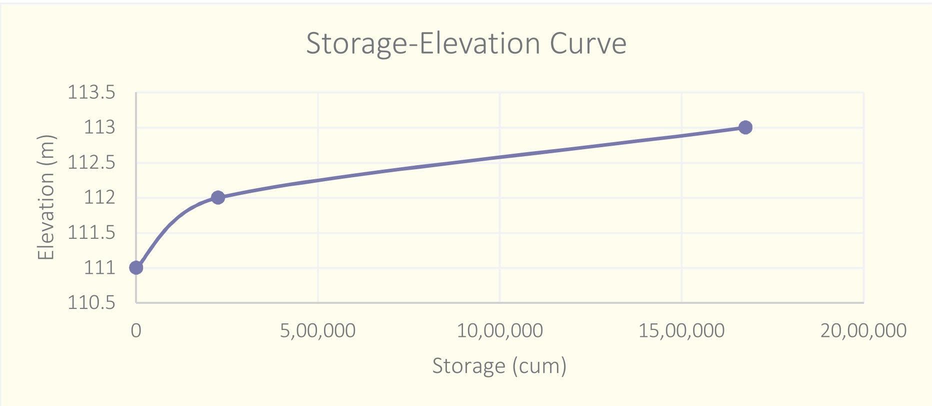
Computation of Hyd. Parameters for Sluice Gate E-16/4 (HEC-RAS Station 83239m) on LB

R.L. of DHFL at Sluice site (HEC-RAS Station 88381m)	=	113.25	m
Ground level at Sluice site	=	112.3	m
Bed level at Sluice site	=	111.2	m
Crest level of embankment at sluice site	=	114.75	m
Total drainage area	=	400	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Naharkatia Raingauge)	=	33.7	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	26.5	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	10600	Ha.cm
high flood	=	**10,60,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 111m contour	=	50000	sq.m
Area covered by 112m contour	=	400000	sq.m
Area covered by 113m contour	=	2500000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 111m contour	0	0	111
Volume in between 111m & 112m contour	2,25,000	2,25,000	112
Volume in between 112m & 113m contour	14,50,000	16,75,000	113



The ruling level is fixed at 112m
Total water accumulated upto 112m = 225000cum
Total water accumulation in worst case = vol. of water upto 112m + volume of water accumulated through runoff

= 1285000 cum

Probable Maximum WL at C/S during worst case =112+1060000x (113-112)/(1675000-225000) = 112.73 m
Minimum discharge capacity of sluice required to drain out water within 7 days = 1.75 cumecs

CALCULATION OF SIZE OF OPENING

We have, $Q = C_d \times A \times \sqrt{2gh}$

Min. discharge capacity required 'Q'	=	1.75	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \frac{Q}{C_d \sqrt{2gh}}$	=	0.74	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.13	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 6.39 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.33 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

Time require to completely evacuate during worst condition = 21.83 hrs = 1 days -2 hrs -10 min

Name of Project - Integrated Water Resources Management of Buridehing Basin

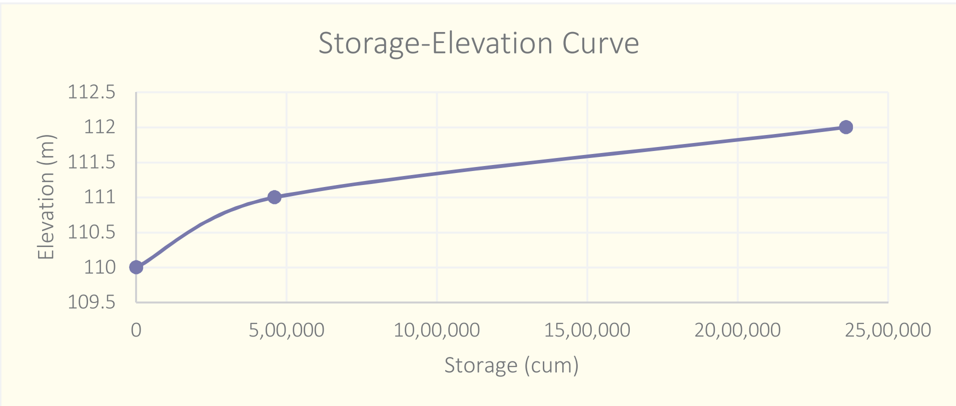
Computation of Hyd. Parameters for Sluice Gate E-16/5 (HEC-RAS Station 80573m) on LB

R.L. of DHFL at Sluice site (HEC-RAS Station 80573m)	=	112.69	m
Ground level at Sluice site	=	111.3	m
Bed level at Sluice site	=	110.1	m
Crest level of embankment at sluice site	=	114.19	m
Total drainage area	=	600	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Naharkatia Raingauge)	=	33.7	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	26.5	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	15900	Ha.cm
high flood	=	**15,90,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 110m contour	=	20000	sq.m
Area covered by 111m contour	=	900000	sq.m
Area covered by 112m contour	=	2900000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 110m	0	0	110
Volume between 111m and 110m	4,60,000	4,60,000	111
Volume between 112m and 111m	19,00,000	23,60,000	112



The ruling level is fixed at 111m
Total water accumulated upto 111m = 460000cum
Total water accumulation in worst case = vol. of water upto 111m + volume of water accumulated through runoff

= 20,50,000 cum

Probable Maximum WL at C/S during worst case =111+ (2050000-460000) x (112-111)/(2360000-460000) = 111.84 m
Minimum discharge capacity of sluice required to drain out water within 7 days = 2.63 cumecs

CALCULATION OF SIZE OF OPENING

We have, $$Q = C_d \times A \times \sqrt{2gh}$$

Min. discharge capacity required 'Q'	=	2.63	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \frac{Q}{C_d \sqrt{2gh}}$	=	1.11	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.19	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 7.83 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.27 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

Time require to completely evacuate during worst condition = 32.75 hrs = 1 day 9 hrs Approx.

Name of Project - Integrated Water Resources Management of Buridehing Basin

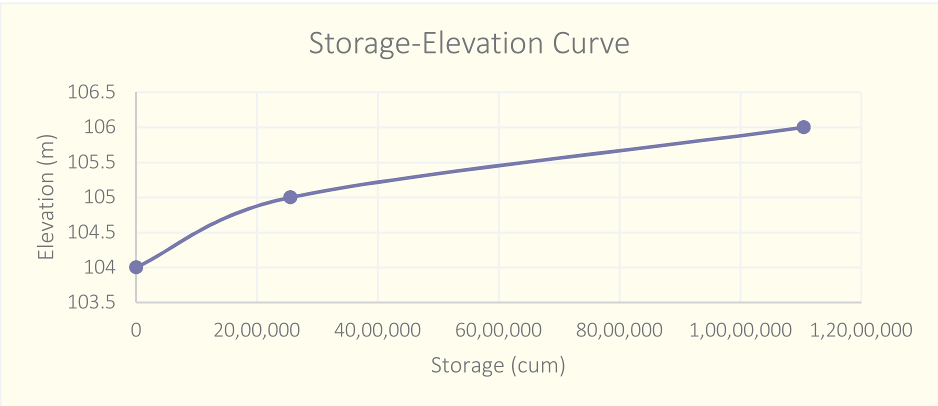
Computation of Hyd. Parameters for Sluice Gate E-19/1 (HEC-RAS Station 48398 m) on RB

R.L. of DHFL at Sluice site (HEC-RAS Station 48398m)	=	106.37	m
Ground level at Sluice site	=	105.2	m
Bed level at Sluice site	=	104.3	m
Crest level of embankment at sluice site	=	107.87	m
Total drainage area	=	2500	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Khowang Raingauge)	=	34.5	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	27.3	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	68250	Ha.cm
high flood	=	**68,25,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 104m contour	=	100000	sq.m
Area covered by 105m contour	=	5000000	sq.m
Area covered by 106m contour	=	12000000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 104m	0	0	104
Volume between 105m and 104m	25,50,000	25,50,000	105
Volume between 106m and 105m	85,00,000	1,10,50,000	106



The ruling level is fixed at 105.2m

Total water accumulated upto 105m = 2550000cum

Total water accumulation in worst case = vol. of water upto 105m + volume of water accumulated through runoff

= 93,75,000 cum

Probable Maximum WL at C/S during worst case =105+ (9375000-2550000) x (106-105)/(11050000-2550000) = 105.80 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 11.28 cumecs

CALCULATION OF SIZE OF OPENING

We have, $Q = C_d \times A \times \sqrt{2gh}$

Min. discharge capacity required 'Q'	=	11.28	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \frac{Q}{C_d \sqrt{2gh}}$	=	4.74	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.84	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 16.23 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.13 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

ime require to completely evacuate during worst condition = 140.59 hrs = 6 day 0 hrs Approx.

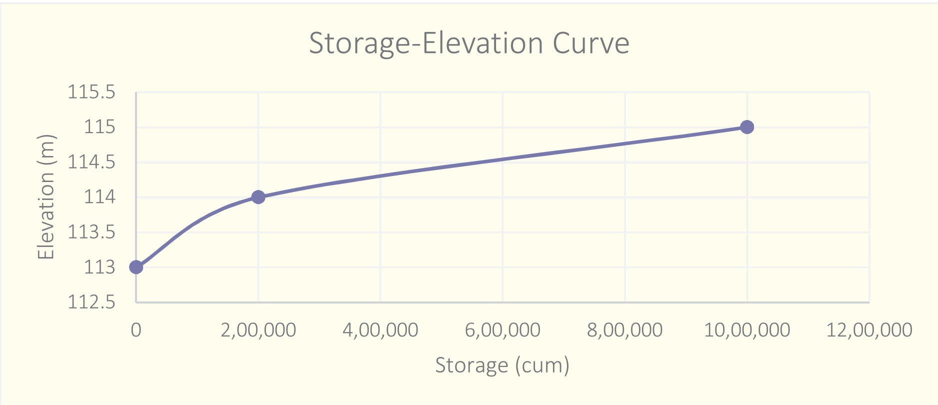
Computation of Hyd. Parameters for Sluice Gate E-23/1 (HEC-RAS Station 94016 m) on Tingrai LB

R.L. of DHFL at Sluice site (HEC-RAS Station 94016m)	=	115.64	m
Ground level at Sluice site	=	114	m
Bed level at Sluice site	=	113	m
Crest level of embankment at sluice site	=	117.14	m
Total drainage area	=	200	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Khowang Raingauge)	=	34.5	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	27.3	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	5460	Ha.cm
high flood	=	**5,46,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 113m contour	=	100000	sq.m
Area covered by 114m contour	=	300000	sq.m
Area covered by 115m contour	=	1300000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 113m	0	0	113
Volume between 114m and 113m	2,00,000	2,00,000	114
Volume between 115m and 114m	8,00,000	10,00,000	115



The ruling level is fixed at 114m
Total water accumulated upto 114m = 200000cum
Total water accumulation in worst case = vol. of water upto 114m + volume of water accumulated through runoff

= 7,46,000 cum

Probable Maximum WL at C/S during worst case =114+ (746000-200000) x (115-114)/(1000000-200000) = 114.68 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 0.90 cumecs

CALCULATION OF SIZE OF OPENING

We have, $$Q = C_d \times A \times \sqrt{2gh}$$

Min. discharge capacity required 'Q'	=	0.90	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \frac{Q}{C_d \sqrt{2gh}}$	=	0.38	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.07	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 4.59 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.46 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

ime require to completely evacuate during worst condition = 11.25 hrs = 0 day 11 hrs Approx.

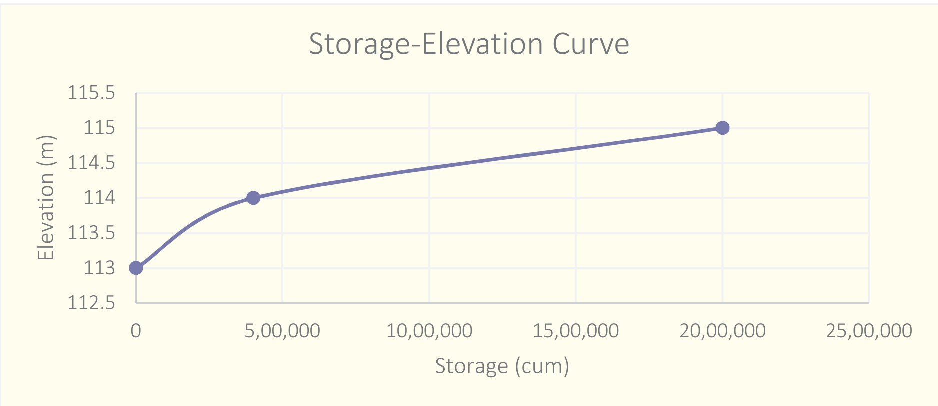
Computation of Hyd. Parameters for Sluice Gate E-23/2 (HEC-RAS Station 94016 m) on Tingrai LB

R.L. of DHFL at Sluice site (HEC-RAS Station 94016m)	=	115.64	m
Ground level at Sluice site	=	114.2	m
Bed level at Sluice site	=	113.2	m
Crest level of embankment at sluice site	=	117.14	m
Total drainage area	=	300	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Khowang Raingauge)	=	34.5	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	27.3	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	8190	Ha.cm
high flood	=	**8,19,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 113m contour	=	100000	sq.m
Area covered by 114m contour	=	700000	sq.m
Area covered by 115m contour	=	2500000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 113m	0	0	113
Volume between 114m and 113m	4,00,000	4,00,000	114
Volume between 115m and 114m	16,00,000	20,00,000	115



The ruling level is fixed at 114m
Total water accumulated upto 114m = 400000cum
Total water accumulation in worst case = vol. of water upto 114m + volume of water accumulated through runoff

= 12,19,000 cum

Probable Maximum WL at C/S during worst case =114+ (1219000-400000) x (115-114)/(2000000-400000) = 114.51 m
Minimum discharge capacity of sluice required to drain out water within 7 days = 1.35 cumecs

CALCULATION OF SIZE OF OPENING

We have, $$Q = C_d \times A \times \sqrt{2gh}$$

Min. discharge capacity required 'Q'	=	1.35	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \dfrac{Q}{C_d \sqrt{2gh}}$	=	0.57	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.10	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 5.62 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.37 < 1, o.k

Discharge capacity of regulator	=	13.5	m^3/sec		
ime require to completely evacuate during worst condition	=	16.87	hrs	=	1 day 0 hrs Approx.

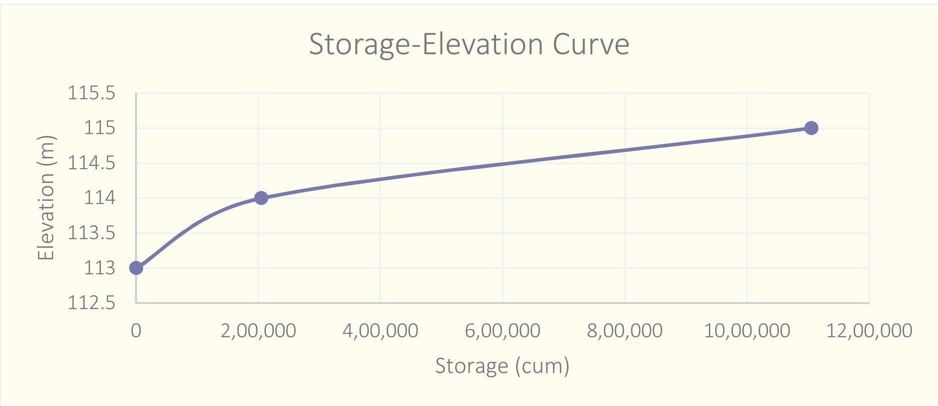
Computation of Hyd. Parameters for Sluice Gate E-24/1 (HEC-RAS Station 94016 m) on Tingrai LB

R.L. of DHFL at Sluice site (HEC-RAS Station 94016m)	=	115.64	m
Ground level at Sluice site	=	114.2	m
Bed level at Sluice site	=	113.2	m
Crest level of embankment at sluice site	=	117.14	m
Total drainage area	=	200	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Khowang Raingauge)	=	34.5	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	27.3	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	5460	Ha.cm
high flood	=	**5,46,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 113m contour	=	10000	sq.m
Area covered by 114m contour	=	400000	sq.m
Area covered by 115m contour	=	1400000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 113m	0	0	113
Volume between 114m and 113m	2,05,000	2,05,000	114
Volume between 115m and 114m	9,00,000	11,05,000	115



The ruling level is fixed at 114.2m
Total water accumulated upto 114m = 205000cum
Total water accumulation in worst case = vol. of water upto 114m + volume of water accumulated through runoff

= 7,51,000 cum

Probable Maximum WL at C/S during worst case =114+ (751000-205000) x (115-114)/(1105000-205000) = 114.61 m
Minimum discharge capacity of sluice required to drain out water within 7 days = 0.90 cumecs

CALCULATION OF SIZE OF OPENING

We have, $$Q = C_d \times A \times \sqrt{2gh}$$

Min. discharge capacity required 'Q'	=	0.90	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \dfrac{Q}{C_d\sqrt{2gh}}$	=	0.38	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.07	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 4.59 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.46 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

ime require to completely evacuate during worst condition = 11.25 hrs = 0 day 11 hrs Approx.

Computation of Hyd. Parameters for Sluice Gate E-24/2 (HEC-RAS Station 94016 m) on Tingrai LB

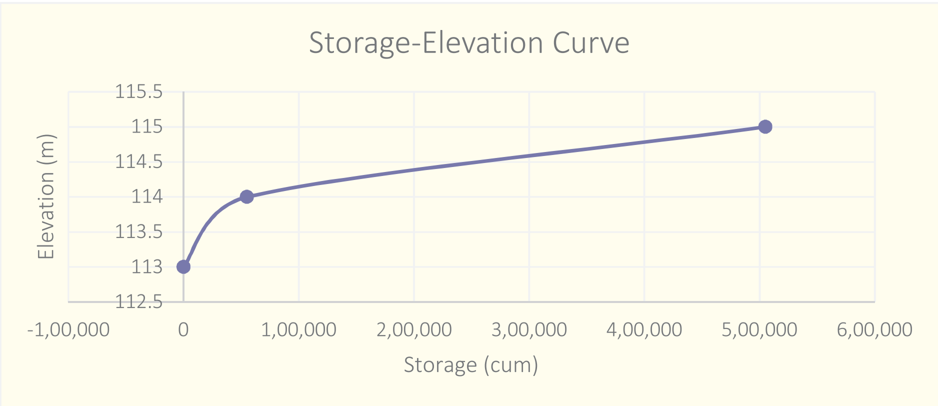
(To be also adopted for Sluice Gates E-24/3 & E-24/4 on Tingrai LB due to similar site conditions)

R.L. of DHFL at Sluice site (HEC-RAS Station 94016m)	=	115.64	m
Ground level at Sluice site	=	114.1	m
Bed level at Sluice site	=	113.1	m
Crest level of embankment at sluice site	=	117.14	m
Total drainage area	=	100	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Khowang Raingauge)	=	34.5	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	27.3	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	2730	Ha.cm
high flood	=	**2,73,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 113m contour	=	10000	sq.m
Area covered by 114m contour	=	100000	sq.m
Area covered by 115m contour	=	800000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 113m	0	0	113
Volume between 114m and 113m	55,000	55,000	114
Volume between 115m and 114m	4,50,000	5,05,000	115



The ruling level is fixed at 114m
Total water accumulated upto 114m = 55000cum
Total water accumulation in worst case = vol. of water upto 114m + volume of water accumulated through runoff

Total water accumulation in worst case	=	3,28,000	cum
Probable Maximum WL at C/S during worst case =114+ (328000-55000) x (115-114)/(505000-55000) =		114.61	m
Minimum discharge capacity of sluice required to drain out water within 7 days	=	0.45	cumecs

CALCULATION OF SIZE OF OPENING

We have, $$Q = C_d \times A \times \sqrt{2gh}$$

Min. discharge capacity required 'Q'	=	0.45	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \dfrac{Q}{C_d\sqrt{2gh}}$	=	0.19	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.03	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 3.25 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.65 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

ime require to completely evacuate during worst condition = 5.62 hrs = 0 day 6 hrs Approx.

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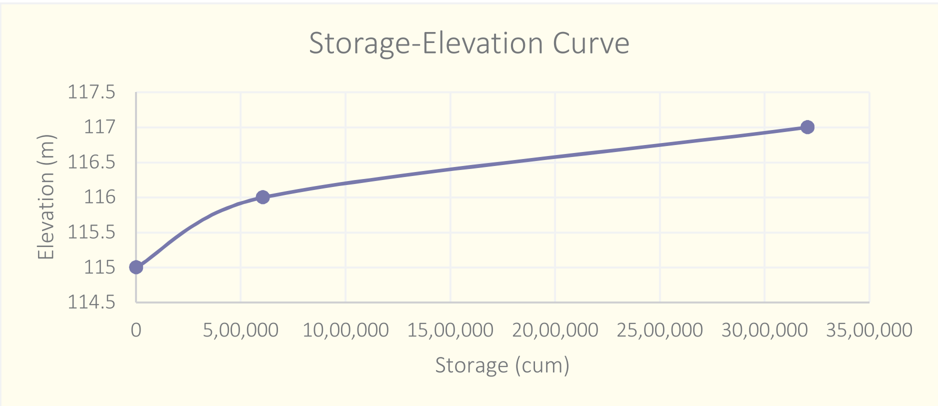
Computation of Hyd. Parameters for Sluice Gate E-25/1 (HEC-RAS Station 102182 m) on RB

R.L. of DHFL at Sluice site (HEC-RAS Station 102182m)	=	117.30	m
Ground level at Sluice site	=	116	m
Bed level at Sluice site	=	114.7	m
Crest level of embankment at sluice site	=	118.80	m
Total drainage area	=	700	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Naharkatia Raingauge)	=	33.7	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	26.5	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	18550	Ha.cm
high flood	=	**18,55,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 115m contour	=	10000	sq.m
Area covered by 116m contour	=	1200000	sq.m
Area covered by 117m contour	=	4000000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 115m	0	0	115
Volume between 116m and 115m	6,05,000	6,05,000	116
Volume between 117m and 116m	26,00,000	32,05,000	117



The ruling level is fixed at 116m
Total water accumulated upto 116m = 605000cum
Total water accumulation in worst case = vol. of water upto 116m + volume of water accumulated through runoff

= 24,60,000 cum

Probable Maximum WL at C/S during worst case =116+ (2460000-605000) x (117-116)/(3205000-605000) = 116.71 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 3.07 cumecs

CALCULATION OF SIZE OF OPENING

We have, $$Q = C_d \times A \times \sqrt{2gh}$$

Min. discharge capacity required 'Q'	=	3.07	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \dfrac{Q}{C_d\sqrt{2gh}}$	=	1.29	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.23	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 8.46 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.25 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

ime require to completely evacuate during worst condition = 38.21 hrs = 2 day 0 hrs Approx.

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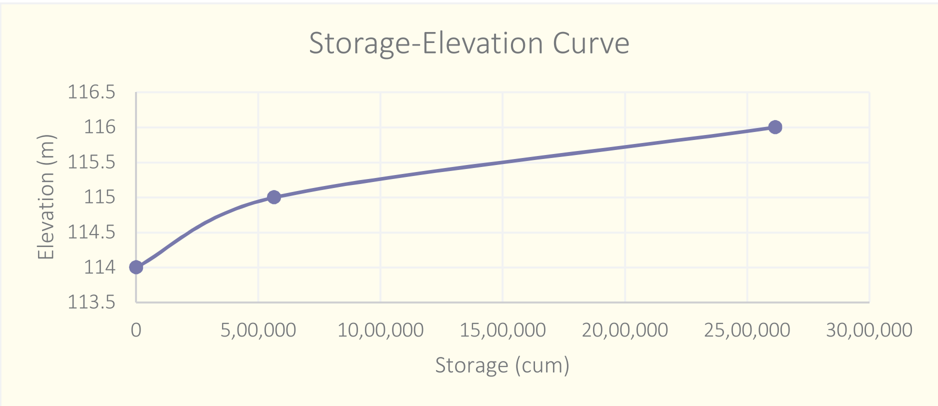
Computation of Hyd. Parameters for Sluice Gate E-25/2 (HEC-RAS Station 99326 m) on RB

R.L. of DHFL at Sluice site (HEC-RAS Station 99326m)	=	116.76	m
Ground level at Sluice site	=	115.3	m
Bed level at Sluice site	=	114.3	m
Crest level of embankment at sluice site	=	118.26	m
Total drainage area	=	700	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Naharkatia Raingauge)	=	33.7	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	26.5	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	18550	Ha.cm
high flood	=	**18,55,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 114m contour	=	30000	sq.m
Area covered by 115m contour	=	1100000	sq.m
Area covered by 116m contour	=	3000000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 114m	0	0	114
Volume between 115m and 114m	5,65,000	5,65,000	115
Volume between 116m and 115m	20,50,000	26,15,000	116



The ruling level is fixed at 115m
Total water accumulated upto 115m = 565000cum
Total water accumulation in worst case = vol. of water upto 115m + volume of water accumulated through runoff

= 24,20,000 cum

Probable Maximum WL at C/S during worst case =115+ (2420000-565000) x (116-115)/(2615000-565000) = 115.90 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 3.07 cumecs

CALCULATION OF SIZE OF OPENING

We have, $Q = C_d \times A \times \sqrt{2gh}$

Min. discharge capacity required 'Q'	=	3.07	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \dfrac{Q}{C_d\sqrt{2gh}}$	=	1.29	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.23	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 8.46 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.25 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

ime require to completely evacuate during worst condition = 38.21 hrs = 2 day 0 hrs Approx.

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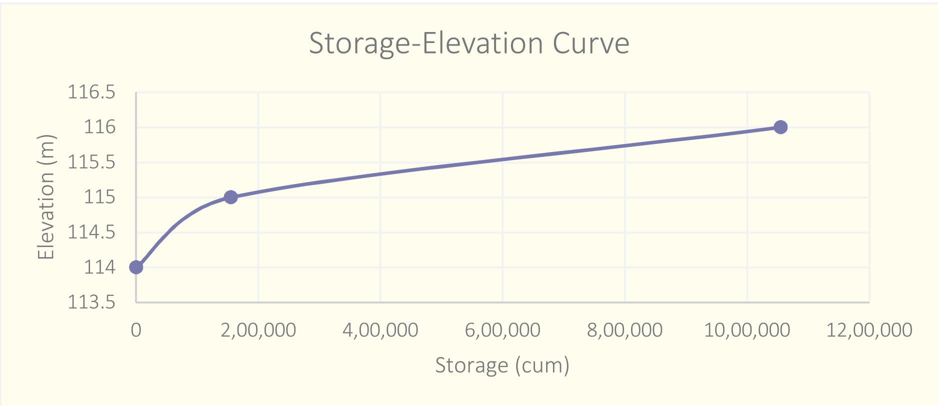
Computation of Hyd. Parameters for Sluice Gate E-25/3 (HEC-RAS Station 98867 m) on RB

R.L. of DHFL at Sluice site (HEC-RAS Station 98867m)	=	116.66	m
Ground level at Sluice site	=	115.3	m
Bed level at Sluice site	=	114.3	m
Crest level of embankment at sluice site	=	118.16	m
Total drainage area	=	200	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Naharkatia Raingauge)	=	33.7	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	26.5	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	5300	Ha.cm
high flood	=	**5,30,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 114m contour	=	10000	sq.m
Area covered by 115m contour	=	300000	sq.m
Area covered by 116m contour	=	1500000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 114m	0	0	114
Volume between 115m and 114m	1,55,000	1,55,000	115
Volume between 116m and 115m	9,00,000	10,55,000	116



The ruling level is fixed at 115m
Total water accumulated upto 115m = 155000cum
Total water accumulation in worst case = vol. of water upto 115m + volume of water accumulated through runoff

= 6,85,000 cum

Probable Maximum WL at C/S during worst case =115+ (685000-155000) x (116-115)/(1055000-155000) = 115.59 m
Minimum discharge capacity of sluice required to drain out water within 7 days = 0.88 cumecs

CALCULATION OF SIZE OF OPENING

We have, $Q = C_d \times A \times \sqrt{2gh}$

Min. discharge capacity required 'Q'	=	0.88	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \dfrac{Q}{C_d\sqrt{2gh}}$	=	0.37	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.06	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 4.52 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.46 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

ime require to completely evacuate during worst condition = 10.92 hrs = 0 day 11 hrs Approx.

Name of Project - Integrated Water Resources Management of Buridehing Basin

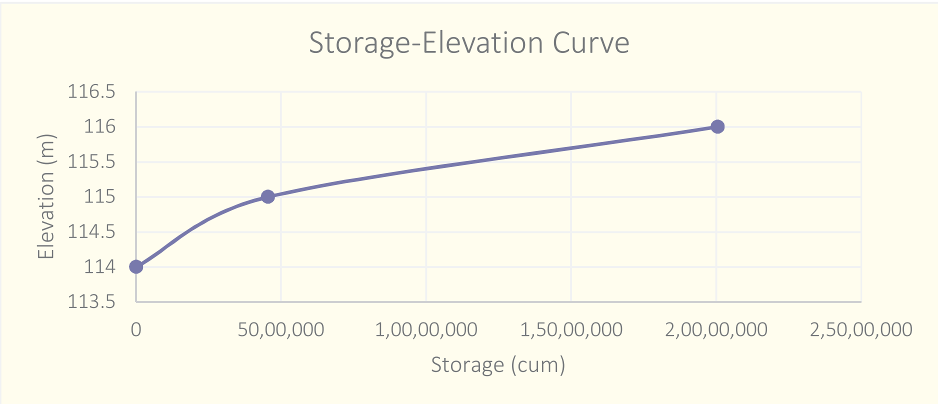
Computation of Hyd. Parameters for Sluice Gate E-25/4 (HEC-RAS Station 98701 m) on RB

R.L. of DHFL at Sluice site (HEC-RAS Station 98701m)	=	116.65	m
Ground level at Sluice site	=	115.4	m
Bed level at Sluice site	=	114.6	m
Crest level of embankment at sluice site	=	118.15	m
Total drainage area	=	5300	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Naharkatia Raingauge)	=	33.7	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	26.5	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	140450	Ha.cm
high flood	=	**1,40,45,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 114m contour	=	100000	sq.m
Area covered by 115m contour	=	9000000	sq.m
Area covered by 116m contour	=	22000000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 114m	0	0	114
Volume between 115m and 114m	45,50,000	45,50,000	115
Volume between 116m and 115m	1,55,00,000	2,00,50,000	116



The ruling level is fixed at 115m

Total water accumulated upto 115m = 4550000cum

Total water accumulation in worst case = vol. of water upto 115m + volume of water accumulated through runoff

= 1,85,95,000 cum

Probable Maximum WL at C/S during worst case =115+ (18595000-4550000) x (116-115)/(20050000-4550000) = 115.91 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 23.22 cumecs

CALCULATION OF SIZE OF OPENING

We have, $$Q = C_d \times A \times \sqrt{2gh}$$

Min. discharge capacity required 'Q'	=	23.22	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \dfrac{Q}{C_d \sqrt{2gh}}$	=	9.76	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	1.72	Say 2
Hence, total area provided	=	11.34	m^2

Let us provide 2 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	4.7	m

Lacey's regime width = 4.83x√Q = 23.28 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.20 < 1, o.k

Discharge capacity of regulator = 27.0 m^3/sec

ime require to completely evacuate during worst condition = 144.66 hrs = 6 day 1 hrs Approx.

Name of Project - Integrated Water Resources Management of Buridehing Basin

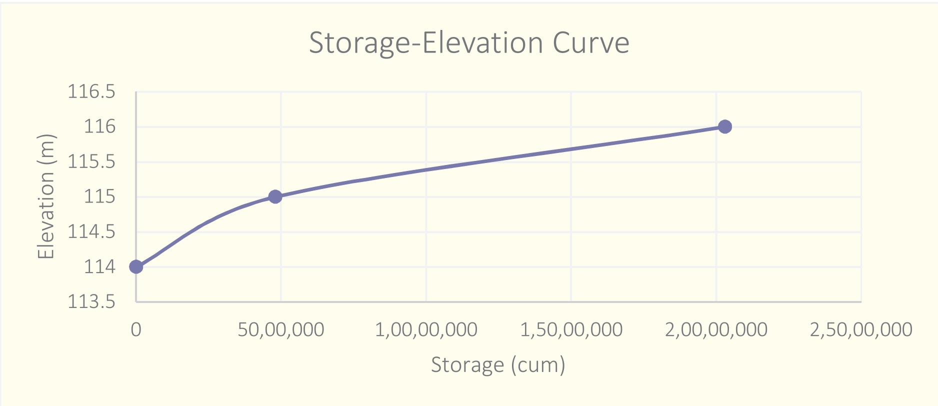
Computation of Hyd. Parameters for Sluice Gate E-25/5 (HEC-RAS Station 96374 m) on RB

R.L. of DHFL at Sluice site (HEC-RAS Station 96374 m)	=	116.12	m
Ground level at Sluice site	=	115	m
Bed level at Sluice site	=	114	m
Crest level of embankment at sluice site	=	117.62	m
Total drainage area	=	4800	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Naharkatia Raingauge)	=	33.7	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	26.5	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	127200	Ha.cm
high flood	=	**1,27,20,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 114m contour	=	600000	sq.m
Area covered by 115m contour	=	9000000	sq.m
Area covered by 116m contour	=	22000000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 114m	0	0	114
Volume between 115m and 114m	48,00,000	48,00,000	115
Volume between 116m and 115m	1,55,00,000	2,03,00,000	116



The ruling level is fixed at 115m

Total water accumulated upto 115m = 4800000cum

Total water accumulation in worst case = vol. of water upto 115m + volume of water accumulated through runoff

= 1,75,20,000 cum

Probable Maximum WL at C/S during worst case =115+ (17520000-4800000) x (116-115)/(20300000-4800000) = 115.82 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 21.03 cumecs

CALCULATION OF SIZE OF OPENING

We have, $$Q = C_d \times A \times \sqrt{2gh}$$

Min. discharge capacity required 'Q'	=	21.03	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \dfrac{Q}{C_d\sqrt{2gh}}$	=	8.84	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	1.56	Say 2
Hence, total area provided	=	11.34	m^2

Let us provide 2 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	4.7	m

Lacey's regime width = 4.83x√Q = 22.15 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.21 < 1, o.k

Discharge capacity of regulator = 27.0 m^3/sec

ime require to completely evacuate during worst condition = 131.01 hrs = 5 day 11 hrs Approx.

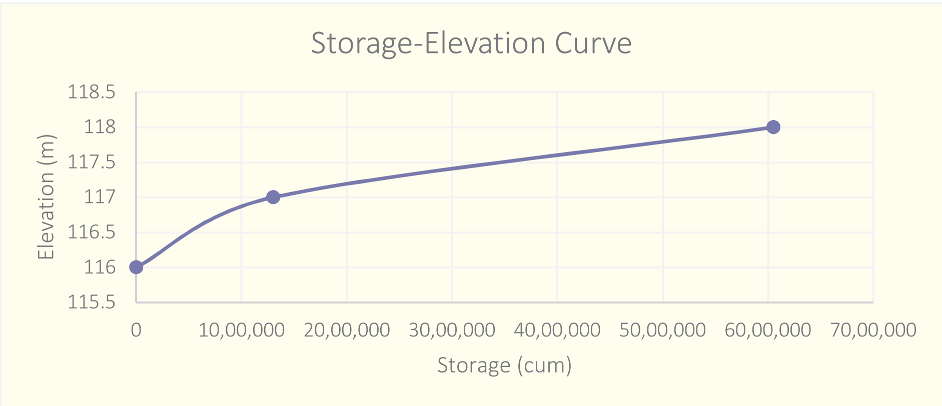
Computation of Hyd. Parameters for Sluice Gate E-27/1 (HEC-RAS Station 109671 m) on Tipling LB

R.L. of DHFL at Sluice site (HEC-RAS Station 109671 m)	=	118.63	m
Ground level at Sluice site	=	117.3	m
Bed level at Sluice site	=	116.4	m
Crest level of embankment at sluice site	=	120.13	m
Total drainage area	=	1600	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Naharkatia Raingauge)	=	33.7	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	26.5	cm
Total runof accumulation in catchment during worst conditions of both rainfall and high flood	=	42400	Ha.cm
	=	**42,40,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 116m contour	=	100000	sq.m
Area covered by 117m contour	=	2500000	sq.m
Area covered by 118m contour	=	7000000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 116m	0	0	116
Volume between 117m and 116m	13,00,000	13,00,000	117
Volume between 118m and 117m	47,50,000	60,50,000	118



The ruling level is fixed at 117m
Total water accumulated upto 117m = 1300000cum
Total water accumulation in worst case = vol. of water upto 117m + volume of water accumulated through runoff

= 55,40,000 cum

Probable Maximum WL at C/S during worst case =117+ (5540000-1300000) x (118-117)/(6050000-1300000) = 117.89 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 7.01 cumecs

CALCULATION OF SIZE OF OPENING

We have, $$Q = C_d \times A \times \sqrt{2gh}$$

Min. discharge capacity required 'Q'	=	7.01	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \dfrac{Q}{C_d \sqrt{2gh}}$	=	2.95	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.52	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 12.79 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.16 < 1, o.k

Discharge capacity of regulator	=	13.5	m^3/sec		
ime require to completely evacuate during worst condition	=	87.34	hrs	=	4 day 0 hrs Approx.

Computation of Hyd. Parameters for Sluice Gate E-27/2 (HEC-RAS Station 109671 m) on Tipling LB

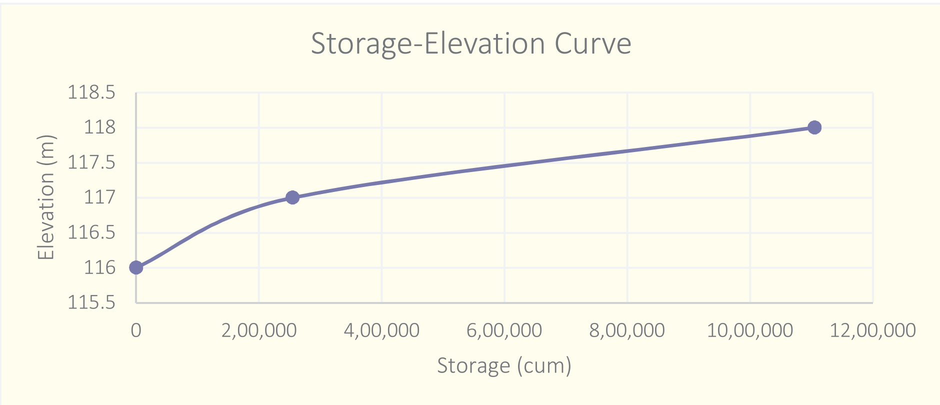
(To be also adopted for Sluice Gates E-27/3, 27/4 & 28/1 due to similar site conditions)

R.L. of DHFL at Sluice site (HEC-RAS Station 109671 m)	=	118.63	m
Ground level at Sluice site	=	117	m
Bed level at Sluice site	=	116	m
Crest level of embankment at sluice site	=	120.13	m
Total drainage area	=	300	Ha
Observed maximum no of consequitive days with WL at sluice site above GL	=	6.00	days
Cummulative max. 3 day rainfall for 50 years return period (Naharkatia Raingauge)	=	33.7	cm
Considering loss rate of 1mm/hr, total loss in 3 days	=	7.2	cm
Hence, net effective rainfall considered	=	26.5	cm
Total runof accumulation in catchment during worst conditions of both rainfall and	=	7950	Ha.cm
high flood	=	**7,95,000**	**cum**

Calculation of volume of water upto ruling level from the storage elevation curve

Area covered by 116m contour	=	10000	sq.m
Area covered by 117m contour	=	500000	sq.m
Area covered by 118m contour	=	1200000	sq.m

Water storage in between Contour Line	Volume in cum	Cummulative Total in cum	WL in m
Volume below 116m	0	0	116
Volume between 117m and 116m	2,55,000	2,55,000	117
Volume between 118m and 117m	8,50,000	11,05,000	118



The ruling level is fixed at 117m

Total water accumulated upto 117m = 255000cum

Total water accumulation in worst case = vol. of water upto 117m + volume of water accumulated through runoff

Total water accumulation in worst case = 10,50,000 cum

Probable Maximum WL at C/S during worst case =117+ (1050000-255000) x (118-117)/(1105000-255000) = 117.94 m

Minimum discharge capacity of sluice required to drain out water within 7 days = 1.31 cumecs

CALCULATION OF SIZE OF OPENING

We have, $$Q = C_d \times A \times \sqrt{2gh}$$

Min. discharge capacity required 'Q'	=	1.31	m^3/sec
C_d = Coefficient of discharge	=	0.62	
A = Opening size			
h = minimum head difference	=	0.75	m
g = accelaration due to gravity	=	9.81	m/sec^2
$A = \frac{Q}{C_d \sqrt{2gh}}$	=	0.55	m^2
Let us provide H	=	2.70	m
W	=	2.10	m
a = Area of opening	=	5.67	m^2
Hence No. of opening required = A/a	=	0.10	Say 1
Hence, total area provided	=	5.67	m^2

Let us provide 1 nos openings of size 2.1m width and 2.7m height.

Assume thickness of side walls	=	0.50	m
b = Width of waterway	=	2.1	m

Lacey's regime width = 4.83x√Q = 5.54 m

Looseness Factor = Total width between abutments / Lacey's regime width

So, The looseness Factor = b/(4.83x√Q) = 0.38 < 1, o.k

Discharge capacity of regulator = 13.5 m^3/sec

ime require to completely evacuate during worst condition = 16.38 hrs = 1 day 0 hrs Approx.

Discharge intensity = $\frac{Q}{width \times Nos.}$ = 0.63 cum/sec/m

6.3.2 Detailed Designs for Sluice gates.

Design for Sluice Gate E-27/2 (HEC-RAS Station 109671 m) on Tipling LB

DESIGN DATA

1	Maximum discharge through the sluice required	=	1.31	cumecs
2	Maximum Country side water level (U/S)	=	117.94	m
3	Maximum River side water level (D/S) (HFL)	=	118.63	m
4	Avearege minimum water level (D/S)	=	117.00	m
5	Crest level of embankment	=	120.13	m
6	Ground level at sluice site	=	117	m
7	Avg. size of bed material 'd'	=	0.21	mm
8	Silt factor 'f' = 1.76 x $d^{0.5}$		0.81	
9	Permissible exit gradient	=	1 in 6	
10	No. of openings	=	1	
11	Sill level of of sluice	=	116	m
12	Length of barrel	=	12.00	
13	Soil properties			
	a) Dry unit weight	=	18.65	kN/m^3
	b) Wet unit weight	=	21.60	kN/m^3
	c) φ	=	25	
14	Bearing capacity of soil	=	90.25	kN/m^2

HYDRAULIC CALCULATION FOR VARIOUS FLOW CONDITION

(a) During high flood condition:-

Up stream H.F.L.	= 118.63	
Down stream water level for full discharge condition	= 118.63 - 0.75 = 117.88	m
Assuming 0.50m retrogration, Down stream water level	= 117.88 - 0.50 = 117.38	m
Assuming 0.50m afflux, Up stream water level	= 118.63 + 0.50 = 119.13	m
Average discharge intensity, q = Q/b	= 1.31 / 2.10 = 0.63	m3/sec/m
Scour depth , R = $1.35 * (q^2/f)$ ^ (1/3)	= 1.06	m
Velocity of approach, V = q/R	= 0.59	m/sec

Hence loss of head at entry = $\frac{V^2}{2g}$ = 0.02 m

T.E.L. just Down Stream of the Gate	= 119.13 - 0.02 = 119.11	m
Down Stream water level (T.E.L.)	= 117.38	m
Hence head loss	119.11 - 117.38 = 1.73	m

(b) Normal flow condition

Up stream N.F.L.	= 117.00	
Down stream water level for full discharge condition	= 117.00 - 1.00 = 116.00	m
Assuming 0.30m retrogration, Down stream water level	= 116.00 - 0.30 = 115.70	m
Assuming 0.30m afflux, Up stream water level	= 117.00 + 0.30 = 117.30	m
T.E.L. just Down Stream of the Gate	= 117.30 - 0.02 = 117.28	m
Down Stream water level (T.E.L.)	= 115.70	m
Heance head loss	= 117.28 - 115.70 = 1.58	m

Discharge intensity = $\frac{Q}{width \times Nos.}$ = 0.63 cum/sec/m

Sl.No.	Item	High flood		Normal flood	
1	Discharge intensity	0.63 cum/sec/m		0.63 cum/sec/m	
2	D/S T.E.L.	117.38	m	115.70	m
3	U/S T.E.L.	119.11	m	117.28	m
4	Head loss (H_L)	1.73	m	1.58	m
5	D/S specific energy Ef_2	0.91	m	0.88	m
6	U/S specific energy $Ef_1 = (Ef_2 + H_L)$	2.64	m	2.46	m
7	Level at which jump would from (D/S T.E.L. - Ef_2)	116.47	m	114.82	m
8	Pre jump depth D_1 ($Ef_1 = D_1 + (q/D_1)^2/2g$	0.10	m	0.10	m
9	Post jump depth D_2 ($Ef_2 = D_2 + (q/D_2)^2/2g$	0.90	m	0.90	m
10	Length of concrete floor = 5.00 x (D_2 - D_1)	4.00	m	4.00	m
11	Froude No. $F_1 = \frac{q}{\sqrt{gD_1^3}}$	6.32	m	6.32	m

Let us provide length of stilling basin = 5.00 m (Required =4 m) & slope of glacis as 1:2
R.L. of floor level of the stilling basin required = 114.82 m
Let us provide R.L. of stilling basin = 114.00 m
Depth of stilling basin = 116.00 - 114.00 = 2.00 m

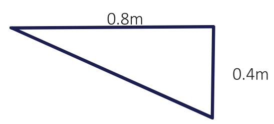
Side sply:- angle of sply = $\tan^{-1}\left(\frac{1}{3 \times F_1}\right)$ = 3.02 °

Let us provide a sply of30 ° in the U/S side and sply of 23 ° in D/S

DESIGN OF ENERGY DESSIPITATION DEVICE

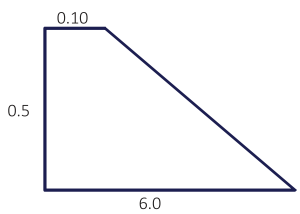
Chute blocks at glacis slope

Height = D_1 =	0.10 m, Provide =	0.10 m	D_1 = 0.10 m
Width = D_1 =	0.10 m, Provide =	0.10 m	
Length = $2D_1$ =	0.20 m, Provide =	0.20 m	
Clear spacing = D_1 =	0.10 m, Provide =	0.10 m	



Baffle blocks at 0.70 m from D/S face of chute blocks

Height = h_b =	0.12 m, provide =	0.20 m	h_b/D_1=1.2
Top Width =$0.2h_b$ =	0.02 m, provide =	0.10 m	
Width =$0.5h_b$ =	0.06 m, provide =	0.10 m	h_b = 0.12
Bottom width =$0.2h_b + h_b$ =	0.30 m, provide =	0.30 m	
Clear spacing =$0.75h_b$ =	0.09 m, provide =	0.10 m	



End blocks	Height = $0.2D_2$ =	0.18 m, provide =	0.20 m
	Top length = $0.15D_2$ =	0.14 m, provide =	0.20 m
	Width = $0.15D_2$ =	0.14 m, provide =	0.20 m
	Clear spacing = $0.15D_2$ =	0.14 m, provide =	0.20 m

Provide two rows at D/S end of stilling basin

CALCULATION OF SCOUR DEPTH

Discharge = Q = 1.31 cumec

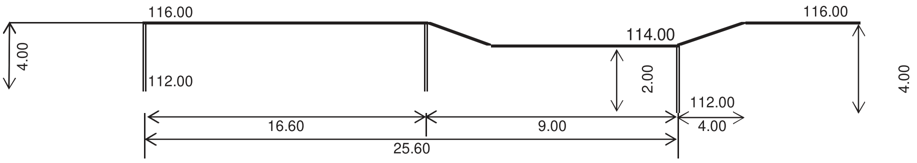
Water way = L_o 2.10 m

Discharge intensity = q = $\frac{Q}{L_o}$ = 0.63 cum/sec/m

Silt factor = f = 0.81

Regime scour depth = $R = 1.35\left(\frac{q^2}{f}\right)^{\frac{1}{3}}$ = 1.06 m Say 1.10 m

Say Design scour depth = R_d = 1.25xR =	1.38 m		
For U/S cut off wall depth = 1.25 xR =	1.38 m		
For D/S cut off wall depth = 1.50 xR =	1.65 m		
U/S cut off wall level =	117.26 m (Required)		
D/S cut off wall level =	116.98 m (Required)		
U/S cut off wall depth from floor =	-1.26 m	Provide	4.00 m
D/S cut off wall depth from floor =	-0.98 m	Provide	4.00 m
Depth of D/S cut-off wall from stilling basin =	2.00 m		



Let us provide the length of different portion of sluice as follows

1	U/S floor	4.00 m
2	Barrel	12.00 m
3	Gate grove	0.60 m
4	U/S slope of stilling basin	4.00 m
5	Stilling basin	5.00 m
6	D/S slope of stilling basin	4.00 m
	Total =	29.60 m

CALCULATION OF EXIT GRADIENT

a) Considering the worst condition, when there will be H.F.L. on R/S and C/S is empty

R/S H.F.L.	= 118.63 m
Assuming 0.50m afflux, R/S water level	= 118.63 + 0.50 = 119.13 m
C/S level	= 116.00 m
Worst head = H	= 119.13 - 116.00 = 3.13 m
Let us consider worst head (H)	= 4.00 m
d = Depth of U/S curtain wall	= 4.00 m
b = distance between piles	= 25.60 m
G_E = exit gradient = 1 : 6	= 0.167

$\alpha = \frac{b}{d}$ = 6.40 $\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 3.74

$G_E = \frac{H}{d}\frac{1}{\pi\sqrt{\lambda}}$ = 0.165 < 0.167 Hence O.K.

b) Considering the worst condition, when there will be H.F.L. on C/S and R/S is empty

C/S H.F.L.	= 117.94 m
R/S level	= 116.00 m
Worst head = H	= 1.94 m
Let us consider worst head (H)	= 2.00 m for safety
d = Depth of D/S curtain wall	= 2.00 m
b = length of floor	= 25.60 m
G_E = exit gradient = 1 : 6	= 0.167

$\alpha = \frac{b}{d}$ = 12.80 $\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 6.92

$G_E = \frac{H}{d}\frac{1}{\pi\sqrt{\lambda}}$ = 0.12 < 0.167 Hence O.K.

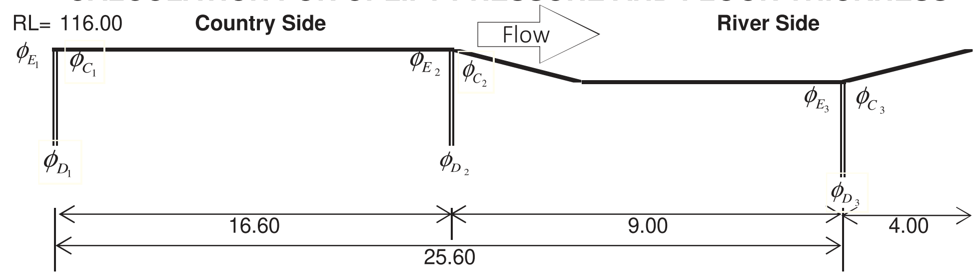
Maintain D/S cutoff wall depth up to 2.00

Hence Provide U/S cutoff depth = 4.00 m (C/S)

Hence Provide D/S cutoff wall depth = 2.00 m (R/S)

Additionaly Provide Intermediate cutoff wall depth = 4.00 m at end of floor

CALCULATION FOR UPLIFT PRESSURE AND FLOOR THICKNESS



Case(1) For seepage flow from country side to river side

Pile line 1	:	RL of floor (Top) =	116.00	Considering floor thickness =	1.00
		RL of floor (Bottom) =	115.00		
		RL of pile (Bottom) =	112.00		
Pile line 2	:	RL of floor (Top) =	116.00	Considering floor thickness =	1.00
		RL of floor (Bottom) =	115.00		
		RL of pile (Bottom) =	112.00		
Pile line 3	:	RL of floor (Top) =	114.00	Considering floor thickness =	1.00
		RL of floor (Bottom) =	113.00		
		RL of pile (Bottom) =	112.00		

Total length of floor =	*b* =	25.60	Distance between pile 1 & 2 =	16.60
Depth of pile line 1 =	d(1) =	4.00	Distance between pile 2 & 3 =	9.00
Depth of pile line 2 =	d(2) =	4.00		
Depth of pile line 3 =	d(3) =	2.00		

Khosla's curve for seepage calculation

Pile line 1

$\alpha = \frac{b}{d}$ = 4.15

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 2.63

$$\phi_E = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-2}{\lambda}\right)$$

$$\phi_D = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-1}{\lambda}\right)$$

$$\phi_{C_1} = 100 - \phi_E$$

$$\phi_{D_1} = 100 - \phi_D$$

ϕ_E = 42.24 %

ϕ_D = 28.69 %

ϕ_{C_1} = 57.76 %

ϕ_{D_1} = 71.31 %

$\phi_{D_1} - \phi_{C_1}$ = 13.56 %

Correction at c_1 due to floor thickness

Correction = $\frac{\phi_{D_1} - \phi_{C_1}}{d} \times t$ = 4.52 % (+Ve)

(a) Correction at C_1 for Mutual Interference of Piles (affected by intermediate pile No.2)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 1.89 % (+Ve)

D	=	3.00		Depth of pile whose effect is required to be determined on
b'	=	16.60	m	Distance between the piles
b	=	25.60	m	Total length of floor
d	=	3.00	m	Depth of pile on whose the effect of another pile of depth D is required to be determined

Hence

Corrected ϕ_{C_1} = ϕ_{C_1} + Correction for floor thickness + Correction for interference

ϕ_{C_1} = 64.17 %

ϕ_{D_1} = 71.31 %

Pile Line 2

$\alpha_1 = \frac{b_1}{d}$ = 4.15 $\alpha_2 = \frac{b_2}{d}$ = 2.25

$$\lambda_1 = \frac{\sqrt{1+\alpha_1^2} - \sqrt{1+\alpha_2^2}}{2} = 0.903284$$

$$\lambda_2 = \frac{\sqrt{1+\alpha_1^2} + \sqrt{1+\alpha_2^2}}{2} = 3.37$$

$$\phi_{E_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 - 1}{\lambda_2}\right) = 50.89 \ \%$$

$$\phi_{C_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 + 1}{\lambda_2}\right) = 30.85 \ \%$$

$$\phi_{D_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1}{\lambda_2}\right) = 41.33 \ \%$$

(a) Correction at E_2 due to floor thickness assuming 1.00m thick floor

$\frac{\phi_{E_2} - \phi_{D_2}}{d} \times t$ = -3.19 % (-ve)

9.56

(b) Correction at E_2 due to pile interference. Pressure at E_2 is affected by pile No. 1

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -1.89 % (-ve)

D	=	3.00	Depth of pile No.1, the effect of which is considered
b'	=	16.60	Distance between two piles
b	=	25.60	Total length of floor
d	=	3.00	Depth of pile No. 2, the effect on

Corrected ϕ_{E_2} = 45.81 %

(a) Correction at C_2 due to floor thickness. This correction shall be + ve and its amount is the same as was calculated for the point E_2

= 3.19 % (+ve)

(b) Correction at C_2 due to pile interference. Pressure at C_2 is affected by pile No. 3

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 0.99 % (+Ve)

D	=	1.00	Depth of pile No.3, the effect of which is considered below the level
b'	=	9.00	Distance between two piles
b	=	25.60	Total length of floor
d	=	3.00	Depth of pile No. 2, the effect on which is considered

Corrected ϕ_{C_2} = 35.03 %

Pile Line No. 3

$\alpha = \frac{b}{d}$ = 4.50

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 2.80

ϕ_{E_3} = 40.72 %

ϕ_{D_3} = 27.74 %

Correction at E_3 due to floor thickness

Correction = $\frac{\phi_{E_3} - \phi_{D_3}}{d} \times t$ = 12.98 % (+Ve)

(b) Correction due to piles

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -1.71 % (-ve)

D	=	3.00	Depth of pile No.2
b'	=	9.00	Distance between two piles
b	=	25.60	Total floor length
d	=	1.00	Depth of pile No. 3

Corrected ϕ_{E_3} = 51.99

Pressure Head = 1.94 m

The corrected pressure at various key points are

Upstream Pile No. 1			*Intermediate Pile No. 2*			*Downstream Pille No. 3*		
Points	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*
ϕ_{E_1}	100.00	1.94	ϕ_{E_2}	45.81	0.89	ϕ_{E_3}	51.99	1.01
ϕ_{D_1}	71.31	1.38	ϕ_{D_2}	41.33	0.80	ϕ_{D_3}	27.74	0.54
ϕ_{C_1}	64.17	1.24	ϕ_{C_2}	35.03	0.68	ϕ_{C_3}	0.00	0.00

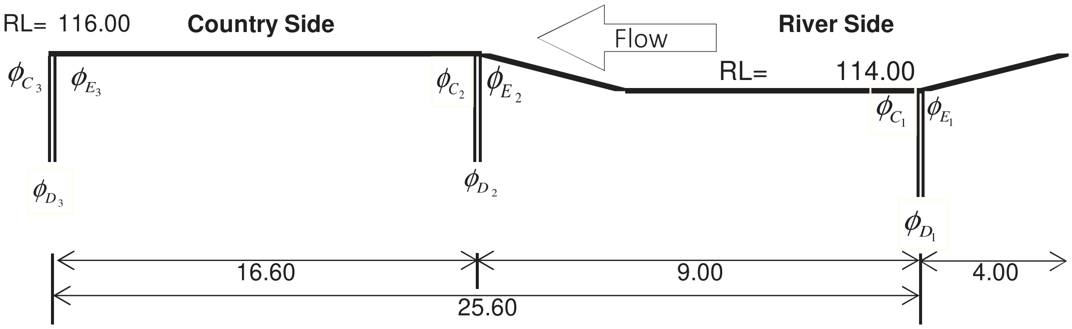
Uplift pressure at x = $P_X = P_{C_1} - \left(\frac{P_{C_1} - P_E}{b'}\right) \times X$

Floor thickness required at T_x = $\frac{P_X}{G-1}$

Distance from the U/S (C/S) end = X

Unit	m	m	m	m
Distance (X)	4.00	16.60	20.60	25.60
Uplift Pressure (P_x)	1.16	0.52	0.94	0.37
Floor thickness required (T_x)	0.93	0.42	0.75	0.30
Floor thickness provided	1.00	1.00	1.00	1.00

CALCULATION FOR UPLIFT PRESSURE AND FLOOR THICKNESS



Case(2) For seepage flow from River side to Country side side

Pile line 1	:	RL of floor (Top) =	114.00	Considering floor thickness =	1.00
		RL of floor (Bottom) =	113.00		
		RL of pile (Bottom) =	112.00		
Pile line 2	:	RL of floor (Top) =	116.00	Considering floor thickness =	1.00
		RL of floor (Bottom) =	115.00		
		RL of pile (Bottom) =	112.00		
Pile line 3	:	RL of floor (Top) =	116.00	Considering floor thickness =	1.00
		RL of floor (Bottom) =	115.00		
		RL of pile (Bottom) =	112.00		

Total length of floor =	b =	25.60	Distance between pile 1 & 2 =	9.00
Depth of pile line 1 =	d(1) =	2.00	Distance between pile 2 & 3 =	16.60
Depth of pile line 2 =	d(2) =	4.00		
Depth of pile line 3 =	d(3) =	4.00		

Khosla's curve for seepage calculation

Pile line 1

$\alpha = \frac{b}{d}$ = 4.50

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 2.80

ϕ_E = 40.72 %

ϕ_D = 27.74 %

ϕ_{C_1} = 59.28 %

ϕ_{D_1} = 72.26 %

$$\phi_E = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-2}{\lambda}\right)$$

$$\phi_D = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-1}{\lambda}\right)$$

$$\phi_{C_1} = 100 - \phi_E$$

$$\phi_{D_1} = 100 - \phi_D$$

$\phi_{D_1} - \phi_{C_1}$ = 12.98 %

Correction at c_1 due to floor thickness

Correction = $\frac{\phi_{D_1} - \phi_{C_1}}{d} \times t$ = 4.33 % (+Ve)

(a) Correction at C_1 for Mutual Interference of Piles (affected by intermediate pile No.2)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 0.73 % (+Ve)

D	=	1.00	Depth of pile whose effect is required to be determined on neighbouring pile of depth d	
b'	=	16.60	m	Distance betwwen the piles
b	=	25.60	m	Total length of floor
d	=	3.00	m	Depth of pile on whose the effect of another pile of depth D is required to be determined

Hence

Corrected ϕ_{C_1} = ϕ_{C_1} + Correction for floor thickness + Crrection for interference

ϕ_{C_1} = 64.34 %

ϕ_{D_1} = 72.26 %

Pile Line 2

$\alpha_1 = \frac{b_1}{d}$ = 8.30 $\alpha_2 = \frac{b_2}{d}$ = 2.25

$$\lambda_1 = \frac{\sqrt{1+\alpha_1^2} - \sqrt{1+\alpha_2^2}}{2} = 2.95$$

$$\lambda_2 = \frac{\sqrt{1+\alpha_1^2} + \sqrt{1+\alpha_2^2}}{2} = 5.41$$

$$\phi_{E_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 - 1}{\lambda_2}\right) = 38.26 \ \%$$

$$\phi_{C_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 + 1}{\lambda_2}\right) = 23.95 \ \%$$

$$\phi_{D_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1}{\lambda_2}\right) = 31.64 \ \%$$

(a) Correction at E_2 due to floor thickness assuming 1.00m thick floor

$\frac{\phi_{E_2} - \phi_{D_2}}{d} \times t$ = -2.21 % (-ve)

(b) Correction at E_2 due to pile interference. Pressure at E_2 is affected by pile No.(1)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -0.73 % (-ve)

D	=	1.00	Depth of pile No.1, the effect of which is considered
b'	=	16.60	Distance between two piles
b	=	25.60	Total length of floor
d	=	3.00	Depth of pile No. 2, the effect on

Corrected ϕ_{E_2} = 35.32

(a) Correction at C_2 due to floor thickness. This correction shall be + ve and its amount is the same as was calculated for the point E_2

= 2.21 % (+ve)

(b) Correction at C_2 due to pile interference. Pressure at C_2 is affected by pile No.(3)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 2.57 % (+Ve)

D	=	3.00	Depth of pile No.3, the effect of which is considered below the
b'	=	9.00	Distance between two piles

b = 25.60 Total length of floor
d = 3.00 Depth of pile No. 2, the effect on which is considered

Corrected ϕ_{C_2} = 28.73 %

Pile Line No. 3

$\alpha = \frac{b}{d}$ = 4.15

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 2.63

ϕ_{E_3} = 42.24 %

ϕ_{D_3} = 28.69 %

Correction at E_3 due to floor thickness

Correction = $\frac{\phi_{E_3} - \phi_{D_3}}{d} \times t$ = 4.52 % (+Ve)

(b) Correction due to piles

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -2.57 % (-ve)

D = 3.00 m, Depth of pile No.2
b' = 9.00 m, Distance between two piles
b = 25.60 m, Total floor length
d = 3.00 m, Depth of pile No. 3

Corrected ϕ_{E_3} = 44.19

Pressure Head = 2.63 m

The corrected pressure at various key points are

Upstream Pile No. 1			Intermediate Pile No. 2			Downstream Pille No. 3		
Points	% Pressure	Residual Head	Points	% Pressure	Residual Head	Points	% Pressure	Residual Head
ϕ_{E_1}	100.00	2.63	ϕ_{E_2}	35.32	0.93	ϕ_{E_3}	44.19	1.16
ϕ_{D_1}	72.26	1.90	ϕ_{D_2}	31.64	0.83	ϕ_{D_3}	28.69	0.75
ϕ_{C_1}	64.34	1.69	ϕ_{C_2}	28.73	0.76	ϕ_{C_3}	0.00	0.00

Uplift pressure at x = $P_X = P_{C_1} - \left(\frac{P_{C_1} - P_E}{b'}\right) \times X$

Floor thickness required at T_x = $\frac{P_X}{G-1}$

Distance from the D/S (R/S) end = X

Unit	m	m	m	m
Distance (X)	5.00	9.00	21.60	25.60
Uplift Pressure (P_x)	1.27	0.93	1.13	0.75
Floor thickness required (T_x)	1.01	0.74	0.90	0.60
Floor thickness provided	1.00	1.00	1.00	1.00

Protection Work

Upstream protection works:

Scour depth already computed 'R'	1.1 m
Block protection:	
U/S scour depth R.L. = U/S W.L. - 1.2R =	116.56 m
Scour depth below u/s floor =	-0.56 m
let us provide length of inverted filter	2.00 m

C.C. block (0.45m x 0.45m x 0.5m) are provided for a length of 2m above 0.50m thick filter gravel (13mm to 19mm) with spacing of 0.05m filled with stone gravel

U/S launching apron:

Length of U/S apron = 2 x d1, where d1 is required depth of U/S cut off wall	-2.51 m
However let us provide length of u/d apron =	4 m
Let us provide thickness =	1 m

Toe-wall of dimension 1.0m x 0.5m is provided between C.C. Block and launching apron in U/S side

Downstream protection works:

Anticipated scour = 1.5 x R	1.65 m
Block protection:	
D/Sscour depth R.L. = D/S W.L. - 1.5R	114.53 m
Scour depth below D/S floor =	1.47 m
let us provide length of inverted filter	2.00 m

C.C. block (0.45m x 0.45m x 0.5m) are provided for a length of 2m above 0.50m thick filter gravel (13mm to 19mm) with spacing of 0.05m filled with stone gravel

D/S launching apron:

Length of D/S apron = 2 x d2, where d2 is required depth of D/S cut off wall	4 m
Let us provide thickness =	1 m

Toe-wall of dimension 1.0m x 0.5m is provided between C.C. Block and launching apron in D/S side

Executive Engineer
Dibrugarh W.R. Division
Dibrugarh

Design for Sluice Gate E-12/3 (HEC-RAS Station 20751m) on RB

DESIGN DATA

1	Maximum discharge through the sluice required	=	6.77	cumecs
2	Maximum Country side water level (U/S)	=	101.91	m
3	Maximum River side water level (D/S) (HFL)	=	102.43	m
4	Avearege minimum water level (D/S)	=	100.80	m
5	Crest level of embankment	=	103.93	m
6	Ground level at sluice site	=	101	m
7	Avg. size of bed material 'd'	=	0.21	mm
8	Silt factor 'f' = 1.76 x $d^{0.5}$		0.81	
9	Permissible exit gradient	=	1 in 6	
10	No. of openings	=	1	
11	Sill level of of sluice	=	100	m
12	Length of barrel	=	12.00	
13	Soil properties			
	a) Dry unit weight	=	18.65	kN/m^3
	b) Wet unit weight	=	21.60	kN/m^3
	c) φ	=	25	
14	Bearing capacity of soil	=	90.25	kN/m^2

HYDRAULIC CALCULATION FOR VARIOUS FLOW CONDITION

(a) During high flood condition:-

Up stream H.F.L. = 102.43

Down stream water level for full discharge condition = 102.43 - 0.75 = 101.68 m

Assuming 0.50m retrogration, Down stream water level = 101.68 - 0.50 = 101.18 m

Assuming 0.50m afflux, Up stream water level = 102.43 + 0.50 = 102.93 m

Average discharge intensity, q = Q/b = 6.77 / 2.10 = 3.22 m3/sec/m

Scour depth , R = 1.35 * (q^2/f) ^ (1/3) = 3.17 m

Velocity of approach, V = q/R = 1.02 m/sec

Hence loss of head at entry = $\frac{V^2}{2g}$ = 0.05 m

T.E.L. just Down Stream of the Gate = 102.93 - 0.05 = 102.88 m

Down Stream water level (T.E.L.) = 101.18 m

Hence head loss 102.88 - 101.18 = 1.70 m

(b) Normal flow condition

Up stream N.F.L. = 100.80

Down stream water level for full discharge condition = 100.80 - 1.00 = 99.80 m

Assuming 0.30m retrogration, Down stream water level = 99.80 - 0.30 = 99.50 m

Assuming 0.30m afflux, Up stream water level = 100.80 + 0.30 = 101.10 m

T.E.L. just Down Stream of the Gate = 101.10 - 0.05 = 101.05 m

Down Stream water level (T.E.L.) = 99.50 m

Heance head loss = 101.05 - 99.50 = 1.55 m

Discharge intensity = $\frac{Q}{width \times Nos.}$ = 3.22 cum/sec/m

Sl.No.	Item	High flood		Normal flood	
1	Discharge intensity	3.22 cum/sec/m		3.22 cum/sec/m	
2	D/S T.E.L.	101.18	m	99.50	m
3	U/S T.E.L.	102.88	m	101.05	m
4	Head loss (H_L)	1.70	m	1.55	m
5	D/S specific energy Ef_2	1.57	m	1.54	m
6	U/S specific energy Ef_1 =(Ef_2 + H_L)	3.27	m	3.09	m
7	Level at which jump would from (D/S T.E.L. - Ef_2)	99.61	m	97.96	m
8	Pre jump depth D_1 ($Ef_1 = D_1 + (q/D_1)^2/2g$)	0.40	m	0.40	m
9	Post jump depth D_2 ($Ef_2 = D_2 + (q/D_2)^2/2g$)	2.10	m	2.10	m
10	Length of concrete floor = 5.00 x (D_2 - D_1)	8.50	m	8.50	m
11	Froude No. $F_1 = \frac{q}{\sqrt{gD_1^3}}$	4.07	m	4.07	m

Let us provide length of stilling basin = 9.00 m (Required =8.5 m) & slope of glacis as 1:2

R.L. of floor level of the stilling basin required = 97.96 m

Let us provide R.L. of stilling basin = 98.00 m

Depth of stilling basin = 100.00 - 98.00 = 2.00 m

Side sply:- angle of sply = $\tan^{-1}\left(\frac{1}{3 \times F_1}\right)$ = 4.68 °

Let us provide a sply of30 ° in the U/S side and sply of 23 ° in D/S

DESIGN OF ENERGY DESSIPITATION DEVICE

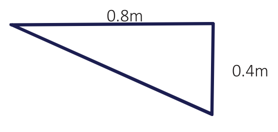
Chute blocks at glacis slope

Height = D_1 = 0.40 m, Provide = 0.40 m D_1 = 0.40 m

Width = D_1 = 0.40 m, Provide = 0.40 m

Length = $2D_1$ = 0.80 m, Provide = 0.80 m

Clear spacing = D_1 = 0.40 m, Provide = 0.40 m



Baffle blocks at 1.70 m from D/S face of chute blocks

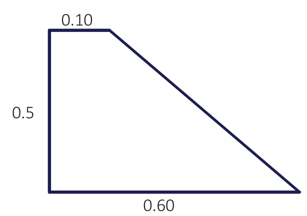
Height = h_b = 0.48 m, provide = 0.50 m h_b/D_1=1.2

Top Width =0.2h_b = 0.10 m, provide = 0.10 m

Width =0.5h_b = 0.24 m, provide = 0.30 m h_b = 0.48

Bottom width =0.2h_b + h_b = 0.60 m, provide = 0.60 m

Clear spacing =0.75h_b = 0.36 m, provide = 0.40 m



End blocks Height = $0.2D_2$ = 0.42 m, provide = 0.50 m

Top length = $0.15D_2$ = 0.32 m, provide = 0.40 m

Width = $0.15D_2$ = 0.32 m, provide = 0.40 m

Clear spacing = $0.15D_2$ = 0.32 m, provide = 0.40 m

Provide two rows at D/S end of stilling basin

CALCULATION OF SCOUR DEPTH

Discharge = Q = 6.77 cumec

Water way = L_o 2.10 m

Discharge intensity = q = $\frac{Q}{L_o}$ = 3.22 cum/sec/m

Silt factor = f = 0.81

Regime scour depth = $R = 1.35\left(\frac{q^2}{f}\right)^{\frac{1}{3}}$ = 3.17 m Say 3.20 m

Say Design scour depth = R_d = 1.25xR = 4.00 m

For U/S cut off wall depth = 1.25 xR = 4.00 m

For D/S cut off wall depth = 1.50 xR = 4.80 m

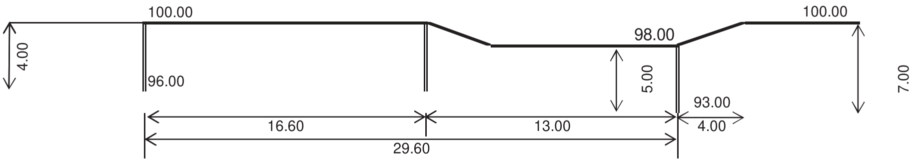
U/S cut off wall level = 98.43 m (Required)

D/S cut off wall level = 97.63 m (Required)

U/S cut off wall depth from floor = 1.57 m Provide 4.00 m

D/S cut off wall depth from floor = 2.37 m Provide 7.00 m

Depth of D/S cut-off wall from stilling basin = 5.00 m



Let us provide the length of different portion of sluice as follows

1	U/S floor	4.00 m
2	Barrel	12.00 m
3	Gate grove	0.60 m
4	U/S slope of stilling basin	4.00 m
5	Stilling basin	9.00 m
6	D/S slope of stilling basin	4.00 m
	Total =	33.60 m

CALCULATION OF EXIT GRADIENT

a) Considering the worst condition, when there will be H.F.L. on R/S and C/S is empty

R/S H.F.L.	= 102.43 m
Assuming 0.50m afflux, R/S water level	= 102.43 + 0.50 = 102.93 m
C/S level	= 100.00 m
Worst head = H	= 102.93 - 100.00 = 2.93 m
Let us consider worst head (H)	= 3.00 m
d = Depth of U/S curtain wall	= 4.00 m
b = distance between piles	= 29.60 m
G_E = exit gradient = 1 : 6	= 0.167

$\alpha = \frac{b}{d}$ = 7.40 $\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 4.23

$G_E = \frac{H}{d}\frac{1}{\pi\sqrt{\lambda}}$ = 0.116 < 0.167 Hence O.K.

b) Considering the worst condition, when there will be H.F.L. on C/S and R/S is empty

C/S H.F.L.	= 101.91 m
R/S level	= 100.00 m
Worst head = H	= 1.91 m
Let us consider worst head (H)	= 2.00 m for safety
d = Depth of D/S curtain wall	= 5.00 m
b = length of floor	= 29.60 m
G_E = exit gradient = 1 : 6	= 0.167

$\alpha = \frac{b}{d}$ = 5.92 $\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 3.50

$G_E = \frac{H}{d}\frac{1}{\pi\sqrt{\lambda}}$ = 0.06 < 0.167 Hence O.K.

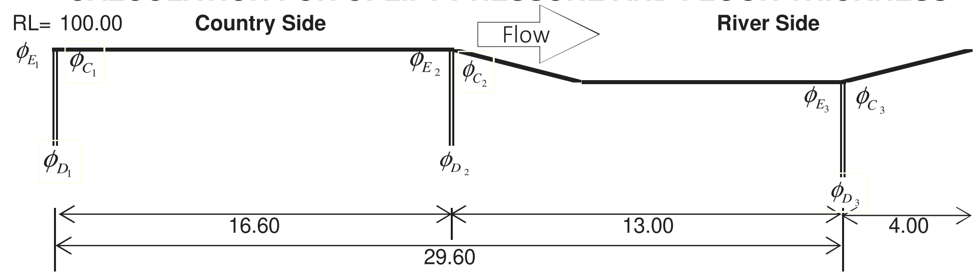
Maintain D/S cutoff wall depth up to 5.00

Hence Provide U/S cutoff depth = 4.00 m (C/S)

Hence Provide D/S cutoff wall depth = 5.00 m (R/S)

Additionaly Provide Intermediate cutoff wall depth = 4.00 m at end of floor

CALCULATION FOR UPLIFT PRESSURE AND FLOOR THICKNESS



Case(1) For seepage flow from country side to river side

Pile line 1	:	RL of floor (Top) =	100.00	Considering floor thickness =	1.00
		RL of floor (Bottom) =	99.00		
		RL of pile (Bottom) =	96.00		
Pile line 2	:	RL of floor (Top) =	100.00	Considering floor thickness =	1.00
		RL of floor (Bottom) =	99.00		
		RL of pile (Bottom) =	96.00		
Pile line 3	:	RL of floor (Top) =	98.00	Considering floor thickness =	1.00
		RL of floor (Bottom) =	97.00		
		RL of pile (Bottom) =	93.00		

Total length of floor =	*b* =	29.60	Distance between pile 1 & 2 =	16.60
Depth of pile line 1 =	d(1) =	4.00	Distance between pile 2 & 3 =	13.00
Depth of pile line 2 =	d(2) =	4.00		
Depth of pile line 3 =	d(3) =	5.00		

Khosla's curve for seepage calculation

Pile line 1

$\alpha = \frac{b}{d}$ = 4.15

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 2.63

$\phi_E = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-2}{\lambda}\right)$

$\phi_D = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-1}{\lambda}\right)$

$\phi_{C_1} = 100 - \phi_E$

$\phi_{D_1} = 100 - \phi_D$

ϕ_E = 42.24 %

ϕ_D = 28.69 %

ϕ_{C_1} = 57.76 %

ϕ_{D_1} = 71.31 %

$\phi_{D_1} - \phi_{C_1}$ = 13.56 %

Correction at c_1 due to floor thickness

Correction = $\frac{\phi_{D_1} - \phi_{C_1}}{d} \times t$ = 4.52 % (+Ve)

(a) Correction at C_1 for Mutual Interference of Piles (affected by intermediate pile No.2)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 1.64 % (+Ve)

D	=	3.00		Depth of pile whose effect is required to be determined on
b'	=	16.60	m	Distance between the piles
b	=	29.60	m	Total length of floor
d	=	3.00	m	Depth of pile on whose the effect of another pile of depth D is required to be determined

Hence

Corrected ϕ_{C_1} = ϕ_{C_1} + Correction for floor thickness + Correction for interference

ϕ_{C_1} = 63.91 %

ϕ_{D_1} = 71.31 %

Pile Line 2

$\alpha_1 = \frac{b_1}{d}$ = 4.15 $\alpha_2 = \frac{b_2}{d}$ = 3.25

$$\lambda_1 = \frac{\sqrt{1+\alpha_1^2} - \sqrt{1+\alpha_2^2}}{2} = 0.434207$$

$$\lambda_2 = \frac{\sqrt{1+\alpha_1^2} + \sqrt{1+\alpha_2^2}}{2} = 3.83$$

$$\phi_{E_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 - 1}{\lambda_2}\right) = 54.69 \ \%$$

$$\phi_{C_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 + 1}{\lambda_2}\right) = 37.78 \ \%$$

$$\phi_{D_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1}{\lambda_2}\right) = 46.37 \ \%$$

(a) Correction at E_2 due to floor thickness assuming 1.00m thick floor

$\frac{\phi_{E_2} - \phi_{D_2}}{d} \times t$ = -2.77 % (-ve)

8.32

(b) Correction at E_2 due to pile interference. Pressure at E_2 is affected by pile No. 1

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -1.64 % (-ve)

D	=	3.00	Depth of pile No.1, the effect of which is considered
b'	=	16.60	Distance between two piles
b	=	29.60	Total length of floor
d	=	3.00	Depth of pile No. 2, the effect on

Corrected ϕ_{E_2} = 50.28 %

(a) Correction at C_2 due to floor thickness. This correction shall be + ve and its amount is the same as was calculated for the point E_2

= 2.77 % (+ve)

(b) Correction at C_2 due to pile interference. Pressure at C_2 is affected by pile No. 3

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 2.49 % (+Ve)

D	=	4.00	Depth of pile No.3, the effect of which is considered below the level
b'	=	13.00	Distance between two piles
b	=	29.60	Total length of floor
d	=	3.00	Depth of pile No. 2, the effect on which is considered

Corrected ϕ_{C_2} = 43.05 %

Pile Line No. 3

$\alpha = \frac{b}{d}$ = 2.60

$$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2} = 1.89$$

ϕ_{E_3} = 51.78 %

ϕ_{D_3} = 34.35 %

Correction at E_3 due to floor thickness

Correction = $\frac{\phi_{E_3} - \phi_{D_3}}{d} \times t$ = 4.36 % (+Ve)

(b) Correction due to piles

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -2.16 % (-ve)

D	=	3.00	Depth of pile No.2
b'	=	13.00	Distance between two piles
b	=	29.60	Total floor length
d	=	4.00	Depth of pile No. 3

Corrected ϕ_{E_3} = 53.98

Pressure Head = 1.91 m

The corrected pressure at various key points are

Upstream Pile No. 1			*Intermediate Pile No. 2*			*Downstream Pille No. 3*		
Points	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*
ϕ_{E_1}	100.00	1.91	ϕ_{E_2}	50.28	0.96	ϕ_{E_3}	53.98	1.03
ϕ_{D_1}	71.31	1.36	ϕ_{D_2}	46.37	0.89	ϕ_{D_3}	34.35	0.66
ϕ_{C_1}	63.91	1.22	ϕ_{C_2}	43.05	0.82	ϕ_{C_3}	0.00	0.00

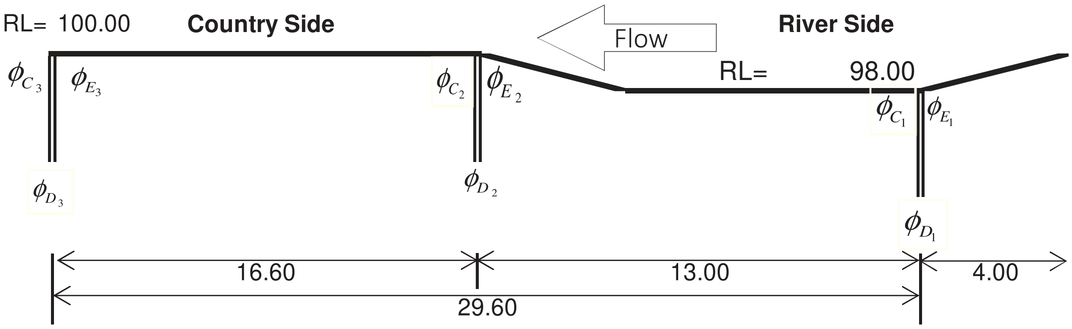
Uplift pressure at x = $P_X = P_{C_1} - \left(\frac{P_{C_1} - P_E}{b'}\right) \times X$

Floor thickness required at T_x = $\frac{P_X}{G-1}$

Distance from the U/S (C/S) end = X

Unit	m	m	m	m
Distance (X)	4.00	16.60	20.60	29.60
Uplift Pressure (P_x)	1.16	0.52	0.92	0.37
Floor thickness required (T_x)	0.93	0.42	0.73	0.30
Floor thickness provided	1.00	1.00	1.00	1.00

CALCULATION FOR UPLIFT PRESSURE AND FLOOR THICKNESS



Case(2) For seepage flow from River side to Country side side

Pile line 1	:	RL of floor (Top) =	98.00	Considering floor thickness =	1.00
		RL of floor (Bottom) =	97.00		
		RL of pile (Bottom) =	93.00		
Pile line 2	:	RL of floor (Top) =	100.00	Considering floor thickness =	1.00
		RL of floor (Bottom) =	99.00		
		RL of pile (Bottom) =	96.00		
Pile line 3	:	RL of floor (Top) =	100.00	Considering floor thickness =	1.00
		RL of floor (Bottom) =	99.00		
		RL of pile (Bottom) =	96.00		

Total length of floor =	b =	29.60	Distance between pile 1 & 2 =	13.00
Depth of pile line 1 =	d(1) =	5.00	Distance between pile 2 & 3 =	16.60
Depth of pile line 2 =	d(2) =	4.00		
Depth of pile line 3 =	d(3) =	4.00		

Khosla's curve for seepage calculation

Pile line 1

$\alpha = \frac{b}{d}$ = 2.60

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 1.89

ϕ_E = 51.78 %

ϕ_D = 34.35 %

ϕ_{C_1} = 48.22 %

ϕ_{D_1} = 65.65 %

$$\phi_E = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-2}{\lambda}\right)$$

$$\phi_D = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-1}{\lambda}\right)$$

$$\phi_{C_1} = 100 - \phi_E$$

$$\phi_{D_1} = 100 - \phi_D$$

$\phi_{D_1} - \phi_{C_1}$ = 17.43 %

Correction at c_1 due to floor thickness

Correction = $\frac{\phi_{D_1} - \phi_{C_1}}{d} \times t$ = 5.81 % (+Ve)

(a) Correction at C_1 for Mutual Interference of Piles (affected by intermediate pile No.2)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 2.21 % (+Ve)

D	=	4.00	Depth of pile whose effect is required to be determined on neighbouring pile of depth d	
b'	=	16.60	m	Distance betwwen the piles
b	=	29.60	m	Total length of floor
d	=	3.00	m	Depth of pile on whose the effect of another pile of depth D is required to be determined

Hence

Corrected ϕ_{C_1} = ϕ_{C_1} + Correction for floor thickness + Crrection for interference

ϕ_{C_1} = 56.23 %

ϕ_{D_1} = 65.65 %

Pile Line 2

$\alpha_1 = \frac{b_1}{d}$ = 3.32 $\alpha_2 = \frac{b_2}{d}$ = 3.25

$$\lambda_1 = \frac{\sqrt{1+\alpha_1^2} - \sqrt{1+\alpha_2^2}}{2} = 0.03$$

$$\lambda_2 = \frac{\sqrt{1+\alpha_1^2} + \sqrt{1+\alpha_2^2}}{2} = 3.43$$

$$\phi_{E_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 - 1}{\lambda_2}\right) = 59.06\ \%$$

$$\phi_{C_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 + 1}{\lambda_2}\right) = 40.25\ \%$$

$$\phi_{D_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1}{\lambda_2}\right) = 49.67\ \%$$

(a) Correction at E_2 due to floor thickness assuming 1.00m thick floor

$\frac{\phi_{E_2} - \phi_{D_2}}{d} \times t$ = -3.13 % (-ve)

(b) Correction at E_2 due to pile interference. Pressure at E_2 is affected by pile No.(1)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -2.21 % (-ve)

D	=	4.00	Depth of pile No.1, the effect of which is considered
b'	=	16.60	Distance between two piles
b	=	29.60	Total length of floor
d	=	3.00	Depth of pile No. 2, the effect on

Corrected ϕ_{E_2} = 53.72

(a) Correction at C_2 due to floor thickness. This correction shall be + ve and its amount is the same as was calculated for the point E_2

= 3.13 % (+ve)

(b) Correction at C_2 due to pile interference. Pressure at C_2 is affected by pile No.(3)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 1.85 % (+Ve)

D	=	3.00	Depth of pile No.3, the effect of which is considered below the
b'	=	13.00	Distance between two piles

b = 29.60 Total length of floor
d = 3.00 Depth of pile No. 2, the effect on which is considered

Corrected ϕ_{C_2} = 45.23 %

Pile Line No. 3

$\alpha = \frac{b}{d}$ = 4.15

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 2.63

ϕ_{E_3} = 42.24 %

ϕ_{D_3} = 28.69 %

Correction at E_3 due to floor thickness

Correction = $\frac{\phi_{E_3} - \phi_{D_3}}{d} \times t$ = 4.52 % (+Ve)

(b) Correction due to piles

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -1.85 % (-ve)

D = 3.00 m, Depth of pile No.2
b' = 13.00 m, Distance between two piles
b = 29.60 m, Total floor length
d = 3.00 m, Depth of pile No. 3

Corrected ϕ_{E_3} = 44.91

Pressure Head = 2.43 m

The corrected pressure at various key points are

Upstream Pile No. 1			Intermediate Pile No. 2			Downstream Pille No. 3		
Points	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*
ϕ_{E_1}	100.00	2.43	ϕ_{E_2}	53.72	1.31	ϕ_{E_3}	44.91	1.09
ϕ_{D_1}	65.65	1.60	ϕ_{D_2}	49.67	1.21	ϕ_{D_3}	28.69	0.70
ϕ_{C_1}	56.23	1.37	ϕ_{C_2}	45.23	1.10	ϕ_{C_3}	0.00	0.00

Uplift pressure at x = $P_X = P_{C_1} - \left(\frac{P_{C_1} - P_E}{b'}\right) \times X$

Floor thickness required at T_x = $\frac{P_X}{G-1}$

Distance from the D/S (R/S) end = X

Unit	m	m	m	m
Distance (X)	9.00	13.00	25.60	29.60
Uplift Pressure (P_x)	1.32	1.31	1.09	0.70
Floor thickness required (T_x)	1.06	1.04	0.87	0.56
Floor thickness provided	1.00	1.00	1.00	1.00

Protection Work

Upstream protection works:

Scour depth already computed 'R' 3.2 m

Block protection:

U/S scour depth R.L. = U/S W.L. - 1.2R = 97.91 m

Scour depth below u/s floor = 2.09 m

let us provide length of inverted filter 4.00 m

C.C. block (0.45m x 0.45m x 0.5m) are provided for a length of 4m above 0.50m thick filter gravel (13mm to 19mm) with spacing of 0.05m filled with stone gravel

U/S launching apron:

Length of U/S apron = 2 x d1, where d1 is required depth of U/S cut off wall 8 m

Let us provide thickness = 1 m

Toe-wall of dimension 1.0m x 0.5m is provided between C.C. Block and launching apron in U/S side

Downstream protection works:

Anticipated scour = 1.5 x R 4.80 m

Block protection:

D/Sscour depth R.L. = D/S W.L. - 1.5R 93.60 m

Scour depth below D/S floor = 6.40 m

let us provide length of inverted filter 8.00 m

C.C. block (0.45m x 0.45m x 0.5m) are provided for a length of 8m above 0.50m thick filter gravel (13mm to 19mm) with spacing of 0.05m filled with stone gravel

D/S launching apron:

Length of D/S apron = 2 x d2, where d2 is required depth of D/S cut off wall 10 m

Let us provide thickness = 1 m

Toe-wall of dimension 1.0m x 0.5m is provided between C.C. Block and launching apron in D/S side

Executive Engineer
Dibrugarh W.R. Division
Dibrugarh

Design for Sluice Gate E-16/3 (HEC-RAS Station 88381m) on LB

DESIGN DATA

1	Maximum discharge through the sluice required	=	17.09	cumecs
2	Maximum Country side water level (U/S)	=	113.62	m
3	Maximum River side water level (D/S) (HFL)	=	114.39	m
4	Avearege minimum water level (D/S)	=	112.93	m
5	Crest level of embankment	=	116.19	m
6	Ground level at sluice site	=	113.3	m
7	Avg. size of bed material 'd'	=	0.21	mm
8	Silt factor 'f' = 1.76 x $d^{0.5}$		0.81	
9	Permissible exit gradient	=	1 in 6	
10	No. of openings	=	2	
11	Sill level of of sluice	=	112.3	m
12	Length of barrel	=	12.00	
13	Soil properties			
	a) Dry unit weight	=	18.65	kN/m^3
	b) Wet unit weight	=	21.60	kN/m^3
	c) φ	=	25	
14	Bearing capacity of soil	=	90.25	kN/m^2

HYDRAULIC CALCULATION FOR VARIOUS FLOW CONDITION

(a) During high flood condition:-

Up stream H.F.L.	=	114.39					
Down stream water level for full discharge condition	=	114.39	-	0.75	=	113.64	m
Assuming 0.50m retrogration, Down stream water level	=	113.64	-	0.50	=	113.14	m
Assuming 0.50m afflux, Up stream water level	=	114.39	+	0.50	=	114.89	m
Average discharge intensity, q = Q/b	=	17.09	/	4.70	=	3.64	m3/sec/m

Scour depth , R = $1.35 * (q^2/f)$ ^ (1/3) = 3.43 m

Velocity of approach, V = q/R = 1.06 m/sec

Hence loss of head at entry = $\frac{V^2}{2g}$ = 0.06 m

T.E.L. just Down Stream of the Gate	=	114.89	-	0.06	=	114.83	m
Down Stream water level (T.E.L.)	=	113.14	m				
Hence head loss		114.83	-	#####	=	1.69	m

(b) Normal flow condition

Up stream N.F.L.	=	112.93					
Down stream water level for full discharge condition	=	112.93	-	1.00	=	111.93	m
Assuming 0.30m retrogration, Down stream water level	=	111.93	-	0.30	=	111.63	m
Assuming 0.30m afflux, Up stream water level	=	112.93	+	0.30	=	113.23	m
T.E.L. just Down Stream of the Gate	=	113.23	-	0.06	=	113.17	m
Down Stream water level (T.E.L.)	=	111.63	m				
Heance head loss	=	113.17	-	#####	=	1.54	m

Discharge intensity = $\frac{Q}{width \times Nos.}$ = 4.07 cum/sec/m

Sl.No.	Item	High flood		Normal flood	
1	Discharge intensity	4.07 cum/sec/m		4.07 cum/sec/m	
2	D/S T.E.L.	113.14	m	111.63	m
3	U/S T.E.L.	114.83	m	113.17	m
4	Head loss (H_L)	1.69	m	1.54	m
5	D/S specific energy Ef_2	2.70	m	2.55	m
6	U/S specific energy $Ef_1 = (Ef_2 + H_L)$	4.39	m	4.09	m
7	Level at which jump would from (D/S T.E.L. - Ef_2)	110.44	m	109.08	m
8	Pre jump depth D_1 ($Ef_1 = D_1 + (q/D_1)^2/2g$	0.50	m	0.50	m
9	Post jump depth D_2 ($Ef_2 = D_2 + (q/D_2)^2/2g$	2.50	m	2.40	m
10	Length of concrete floor = 5.00 x (D_2 - D_1)	10.00	m	9.50	m
11	Froude No. $F_1 = \frac{q}{\sqrt{gD_1^3}}$	3.67	m	3.67	m

Let us provide length of stilling basin = 10.00 m (Required =10 m) & slope of glacis as 1:2

R.L. of floor level of the stilling basin required = 109.08 m

Let us provide R.L. of stilling basin = 110.30 m

Depth of stilling basin = 112.30 - ##### = 2.00 m

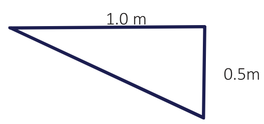
Side sply:- angle of sply = $\tan^{-1}\left(\frac{1}{3 \times F_1}\right)$ = 5.18 ^{o}

Let us provide a sply of30 ^{o} in the U/S side and sply of 23 ^{o} in D/S

DESIGN OF ENERGY DESSIPITATION DEVICE

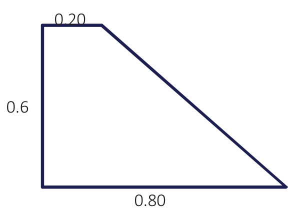
Chute blocks at glacis slope

Height = D_1 =	0.50	m, Provide	0.50 m	D_1 = 0.50 m
Width = D_1 =	0.50	m, Provide	0.50 m	
Length = $2D_1$ =	1.00	m, Provide	1.00 m	
Clear spacing = D_1 =	0.50	m, Provide	0.50 m	



Baffle blocks at 2.00 m from D/S face of chute blocks

Height = h_b	=	0.60 m, provide =	0.60 m	h_b/D_1=1.2
Top Width =$0.2h_b$	=	0.12 m, provide =	0.20 m	
Width =$0.5h_b$	=	0.30 m, provide =	0.30 m	h_b = 0.60
Bottom width =$0.2h_b + h_b$	=	0.80 m, provide =	0.80 m	
Clear spacing =$0.75h_b$	=	0.45 m, provide =	0.50 m	



End blocks Height = $0.2D_2$ = 0.50 m, provide = 0.50 m
Top length = $0.15D_2$ = 0.38 m, provide = 0.40 m
Width = $0.15D_2$ = 0.38 m, provide = 0.40 m
Clear spacing = $0.15D_2$ = 0.38 m, provide = 0.40 m
Provide two rows at D/S end of stilling basin

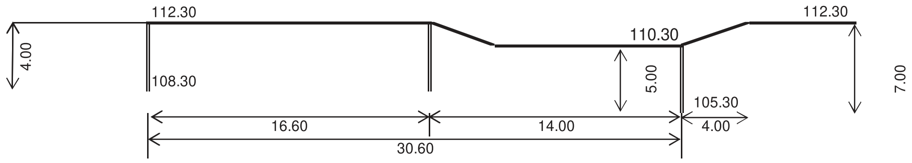
CALCULATION OF SCOUR DEPTH

Discharge = Q = 17.09 cumec
Water way = L_o 4.65 m
Discharge intensity = q = $\frac{Q}{L_o}$ = 3.67 cum/sec/m

Silt factor = f = 0.81

Regime scour depth = $R = 1.35\left(\frac{q^2}{f}\right)^{\frac{1}{3}}$ = 3.45 m Say 3.50 m

Say Design scour depth = R_d = 1.25xR = 4.38 m
For U/S cut off wall depth = 1.25 xR = 4.38 m
For D/S cut off wall depth = 1.50 xR = 5.25 m
U/S cut off wall level = 110.02 m (Required)
D/S cut off wall level = 109.14 m (Required)
U/S cut off wall depth from floor = 2.29 m Provide 4.00 m
D/S cut off wall depth from floor = 3.16 m Provide 7.00 m
Depth of D/S cut-off wall from stilling basin = 5.00 m



Let us provide the length of different portion of sluice as follows

1	U/S floor	4.00 m
2	Barrel	12.00 m
3	Gate grove	0.60 m
4	U/S slope of stilling basin	4.00 m
5	Stilling basin	10.00 m
6	D/S slope of stilling basin	4.00 m
	Total =	34.60 m

CALCULATION OF EXIT GRADIENT

a) Considering the worst condition, when there will be H.F.L. on R/S and C/S is empty

R/S H.F.L.	=	114.39 m				
Assuming 0.50m afflux, R/S water level	=	114.39	+	0.50	=	114.89 m
C/S level	=	12.00 m				
Worst head = H	=	114.89	-	12.00	=	102.89 m
Let us consider worst head (H)	=	103.00 m				
d = Depth of U/S curtain wall	=	4.00 m				
b = distance between piles	=	30.60 m				
G_E = exit gradient = 1 : 6	=	0.167				

$\alpha = \frac{b}{d}$ = 7.65 $\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 4.36

$G_E = \frac{H}{d}\frac{1}{\pi\sqrt{\lambda}}$ = 3.925 < 0.167 Hence O.K.

b) Considering the worst condition, when there will be H.F.L. on C/S and R/S is empty

C/S H.F.L.	=	113.62 m
R/S level	=	112.30 m
Worst head = H	=	1.32 m
Let us consider worst head (H)	=	2.00 m for safty
d = Depth of D/S curtain wall	=	5.00 m
b = length of floor	=	30.60 m
G_E = exit gradient = 1 : 6	=	0.167

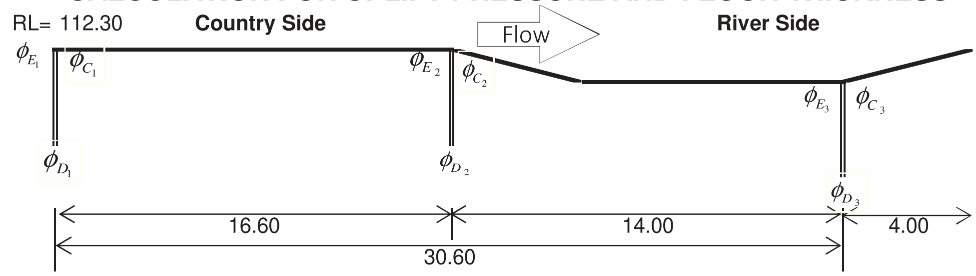
$\alpha = \frac{b}{d}$ = 6.12 $\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 3.60

$G_E = \frac{H}{d}\frac{1}{\pi\sqrt{\lambda}}$ = 0.04 < 0.167 Hence O.K.

Maintain D/S cutoff wall depth up to 5.00

Hence Provide U/S cutoff depth = 4.00 m (C/S)
Hence Provide D/S cutoff wall depth = 5.00 m (R/S)
Additionaly Provide Intermediate cutoff wall depth = 4.00 m at end of floor

CALCULATION FOR UPLIFT PRESSURE AND FLOOR THICKNESS



Case(1) For seepage flow from country side to river side

Pile line 1	:	RL of floor (Top) =	112.30	Considering floor thickness =	1.00
		RL of floor (Bottom) =	111.30		
		RL of pile (Bottom) =	108.30		
Pile line 2	:	RL of floor (Top) =	112.30	Considering floor thickness =	1.00
		RL of floor (Bottom) =	111.30		
		RL of pile (Bottom) =	108.30		
Pile line 3	:	RL of floor (Top) =	110.30	Considering floor thickness =	1.00
		RL of floor (Bottom) =	109.30		
		RL of pile (Bottom) =	105.30		

Total length of floor =	*b* =	30.60	Distance between pile 1 & 2 =	16.60
Depth of pile line 1 =	d(1) =	4.00	Distance between pile 2 & 3 =	14.00
Depth of pile line 2 =	d(2) =	4.00		
Depth of pile line 3 =	d(3) =	5.00		

Khosla's curve for seepage calculation

Pile line 1

$\alpha = \frac{b}{d}$ = 7.65

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 4.36

$$\phi_E = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-2}{\lambda}\right)$$

$$\phi_D = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-1}{\lambda}\right)$$

$$\phi_{C_1} = 100 - \phi_E$$

$$\phi_{D_1} = 100 - \phi_D$$

ϕ_E = 31.79 %

ϕ_D = 21.99 %

ϕ_{C_1} = 68.21 %

ϕ_{D_1} = 78.01 %

$\phi_{D_1} - \phi_{C_1}$ = 9.80 %

Correction at c_1 due to floor thickness

Correction = $\frac{\phi_{D_1} - \phi_{C_1}}{d} \times t$ = 3.27 % (+Ve)

(a) Correction at C_1 for Mutual Interference of Piles (affected by intermediate pile No.2)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 1.58 % (+Ve)

D	=	3.00		Depth of pile whose effect is required to be determined on
b'	=	16.60	m	Distance between the piles
b	=	30.60	m	Total length of floor
d	=	3.00	m	Depth of pile on whose the effect of another pile of depth D is required to be determined

Hence

Corrected ϕ_{C_1} = ϕ_{C_1} + Correction for floor thickness + Correction for interference

ϕ_{C_1} = 73.06 %

ϕ_{D_1} = 78.01 %

Pile Line 2

$\alpha_1 = \frac{b_1}{d}$ = 4.15 $\alpha_2 = \frac{b_2}{d}$ = 3.50

$$\lambda_1 = \frac{\sqrt{1+\alpha_1^2} - \sqrt{1+\alpha_2^2}}{2} = 0.314364$$

$$\lambda_2 = \frac{\sqrt{1+\alpha_1^2} + \sqrt{1+\alpha_2^2}}{2} = 3.95$$

$$\phi_{E_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 - 1}{\lambda_2}\right) = 55.52 \ \%$$

$$\phi_{C_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 + 1}{\lambda_2}\right) = 39.20 \ \%$$

$$\phi_{D_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1}{\lambda_2}\right) = 47.45 \ \%$$

(a) Correction at E_2 due to floor thickness assuming 1.00m thick floor

$\frac{\phi_{E_2} - \phi_{D_2}}{d} \times t$ = -2.69 % (-ve)

8.08

(b) Correction at E_2 due to pile interference. Pressure at E_2 is affected by pile No. 1

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -1.58 % (-ve)

D	=	3.00	Depth of pile No.1, the effect of which is considered
b'	=	16.60	Distance between two piles
b	=	30.60	Total length of floor
d	=	3.00	Depth of pile No. 2, the effect on

Corrected ϕ_{E_2} = 51.25 %

(a) Correction at C_2 due to floor thickness. This correction shall be + ve and its amount is the same as was calculated for the point E_2

= 2.69 % (+ve)

(b) Correction at C_2 due to pile interference. Pressure at C_2 is affected by pile No. 3

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 2.32 % (+Ve)

D	=	4.00	Depth of pile No.3, the effect of which is considered below the level
b'	=	14.00	Distance between two piles
b	=	30.60	Total length of floor
d	=	3.00	Depth of pile No. 2, the effect on which is considered

Corrected ϕ_{C_2} = 44.21 %

Pile Line No. 3

$\alpha = \frac{b}{d}$ = 6.12

$$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2} = 3.60$$

ϕ_{E_3} = 35.32 %

ϕ_{D_3} = 24.30 %

Correction at E_3 due to floor thickness

Correction = $\frac{\phi_{E_3} - \phi_{D_3}}{d} \times t$ = 2.76 % (+Ve)

(b) Correction due to piles

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -2.01 % (-ve)

D = 3.00 Depth of pile No.2

b' = 14.00 Distance between two piles

b = 30.60 Total floor length

d = 4.00 Depth of pile No. 3

Corrected ϕ_{E_3} = 36.07

Pressure Head = 1.32 m

The corrected pressure at various key points are

Upstream Pile No. 1			*Intermediate Pile No. 2*			*Downstream Pille No. 3*		
Points	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*
ϕ_{E_1}	100.00	1.32	ϕ_{E_2}	51.25	0.67	ϕ_{E_3}	36.07	0.47
ϕ_{D_1}	78.01	1.03	ϕ_{D_2}	47.45	0.62	ϕ_{D_3}	24.30	0.32
ϕ_{C_1}	73.06	0.96	ϕ_{C_2}	44.21	0.58	ϕ_{C_3}	0.00	0.00

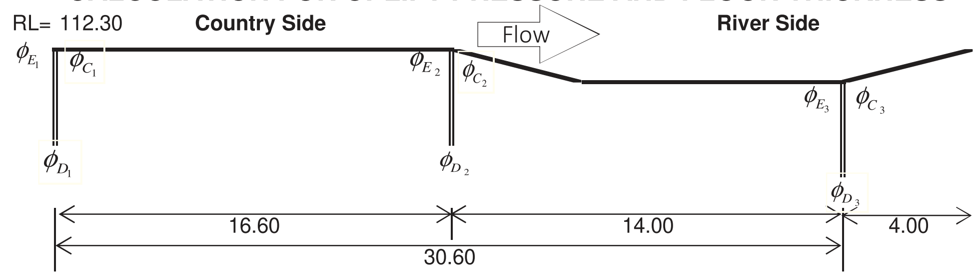
Uplift pressure at x = $P_X = P_{C_1} - \left(\frac{P_{C_1} - P_E}{b'}\right) \times X$

Floor thickness required at T_x = $\frac{P_X}{G-1}$

Distance from the U/S (C/S) end = X

Unit	m	m	m	m
Distance (X)	4.00	16.60	20.60	30.60
Uplift Pressure (P_x)	0.89	0.52	0.54	0.37
Floor thickness required (T_x)	0.71	0.42	0.43	0.30
Floor thickness provided	1.00	1.00	1.00	1.00

CALCULATION FOR UPLIFT PRESSURE AND FLOOR THICKNESS



Case(1) For seepage flow from country side to river side

Pile line 1	:	RL of floor (Top) =	112.30	Considering floor thickness =	1.00
		RL of floor (Bottom) =	111.30		
		RL of pile (Bottom) =	108.30		
Pile line 2	:	RL of floor (Top) =	112.30	Considering floor thickness =	1.00
		RL of floor (Bottom) =	111.30		
		RL of pile (Bottom) =	108.30		
Pile line 3	:	RL of floor (Top) =	110.30	Considering floor thickness =	1.00
		RL of floor (Bottom) =	109.30		
		RL of pile (Bottom) =	105.30		

Total length of floor =	*b* =	30.60	Distance between pile 1 & 2 =	16.60
Depth of pile line 1 =	d(1) =	4.00	Distance between pile 2 & 3 =	14.00
Depth of pile line 2 =	d(2) =	4.00		
Depth of pile line 3 =	d(3) =	5.00		

Khosla's curve for seepage calculation

Pile line 1

$\alpha = \frac{b}{d}$ = 7.65

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 4.36

$$\phi_E = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-2}{\lambda}\right)$$

$$\phi_D = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-1}{\lambda}\right)$$

$$\phi_{C_1} = 100 - \phi_E$$

$$\phi_{D_1} = 100 - \phi_D$$

ϕ_E = 31.79 %

ϕ_D = 21.99 %

ϕ_{C_1} = 68.21 %

ϕ_{D_1} = 78.01 %

$\phi_{D_1} - \phi_{C_1}$ = 9.80 %

Correction at c_1 due to floor thickness

Correction = $\frac{\phi_{D_1} - \phi_{C_1}}{d} \times t$ = 3.27 % (+Ve)

(a) Correction at C_1 for Mutual Interference of Piles (affected by intermediate pile No.2)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 1.58 % (+Ve)

D	=	3.00		Depth of pile whose effect is required to be determined on
b'	=	16.60	m	Distance between the piles
b	=	30.60	m	Total length of floor
d	=	3.00	m	Depth of pile on whose the effect of another pile of depth D is required to be determined

Hence

Corrected ϕ_{C_1} = ϕ_{C_1} + Correction for floor thickness + Correction for interference

ϕ_{C_1} = 73.06 %

ϕ_{D_1} = 78.01 %

Pile Line 2

$\alpha_1 = \frac{b_1}{d}$ = 4.15 $\alpha_2 = \frac{b_2}{d}$ = 3.50

$$\lambda_1 = \frac{\sqrt{1+\alpha_1^2} - \sqrt{1+\alpha_2^2}}{2} = 0.314364$$

$$\lambda_2 = \frac{\sqrt{1+\alpha_1^2} + \sqrt{1+\alpha_2^2}}{2} = 3.95$$

$$\phi_{E_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 - 1}{\lambda_2}\right) = 55.52 \%$$

$$\phi_{C_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 + 1}{\lambda_2}\right) = 39.20 \%$$

$$\phi_{D_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1}{\lambda_2}\right) = 47.45 \%$$

(a) Correction at E_2 due to floor thickness assuming 1.00m thick floor

$\frac{\phi_{E_2} - \phi_{D_2}}{d} \times t$ = -2.69 % (-ve)

8.08

(b) Correction at E_2 due to pile interference. Pressure at E_2 is affected by pile No. 1

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -1.58 % (-ve)

D	=	3.00	Depth of pile No.1, the effect of which is considered
b'	=	16.60	Distance between two piles
b	=	30.60	Total length of floor
d	=	3.00	Depth of pile No. 2, the effect on

Corrected ϕ_{E_2} = 51.25 %

(a) Correction at C_2 due to floor thickness. This correction shall be + ve and its amount is the same as was calculated for the point E_2

= 2.69 % (+ve)

(b) Correction at C_2 due to pile interference. Pressure at C_2 is affected by pile No. 3

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 2.32 % (+Ve)

D	=	4.00	Depth of pile No.3, the effect of which is considered below the level
b'	=	14.00	Distance between two piles
b	=	30.60	Total length of floor
d	=	3.00	Depth of pile No. 2, the effect on which is considered

Corrected ϕ_{C_2} = 44.21 %

Pile Line No. 3

$\alpha = \frac{b}{d}$ = 6.12

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 3.60

ϕ_{E_3} = 35.32 %

ϕ_{D_3} = 24.30 %

Correction at E_3 due to floor thickness

Correction = $\frac{\phi_{E_3} - \phi_{D_3}}{d} \times t$ = 2.76 % (+Ve)

(b) Correction due to piles

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -2.01 % (-ve)

D = 3.00 Depth of pile No.2

b' = 14.00 Distance between two piles

b = 30.60 Total floor length

d = 4.00 Depth of pile No. 3

Corrected ϕ_{E_3} = 36.07

Pressure Head = 1.32 m

The corrected pressure at various key points are

Upstream Pile No. 1			*Intermediate Pile No. 2*			*Downstream Pille No. 3*		
Points	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*
ϕ_{E_1}	100.00	1.32	ϕ_{E_2}	51.25	0.67	ϕ_{E_3}	36.07	0.47
ϕ_{D_1}	78.01	1.03	ϕ_{D_2}	47.45	0.62	ϕ_{D_3}	24.30	0.32
ϕ_{C_1}	73.06	0.96	ϕ_{C_2}	44.21	0.58	ϕ_{C_3}	0.00	0.00

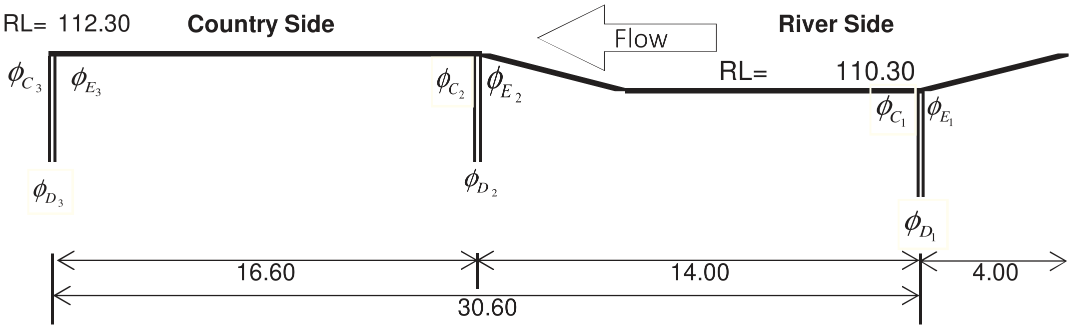
Uplift pressure at x = $P_X = P_{C_1} - \left(\frac{P_{C_1} - P_E}{b'}\right) \times X$

Floor thickness required at T_x = $\frac{P_X}{G-1}$

Distance from the U/S (C/S) end = X

Unit	m	m	m	m
Distance (X)	4.00	16.60	20.60	30.60
Uplift Pressure (P_x)	0.89	0.52	0.54	0.37
Floor thickness required (T_x)	0.71	0.42	0.43	0.30
Floor thickness provided	1.00	1.00	1.00	1.00

CALCULATION FOR UPLIFT PRESSURE AND FLOOR THICKNESS



Case(2) For seepage flow from River side to Country side side

Pile line 1	:	RL of floor (Top) =	110.30	Considering floor thickness =	0.90
		RL of floor (Bottom) =	109.40		
		RL of pile (Bottom) =	105.30		
Pile line 2	:	RL of floor (Top) =	112.30	Considering floor thickness =	0.90
		RL of floor (Bottom) =	111.40		
		RL of pile (Bottom) =	108.30		
Pile line 3	:	RL of floor (Top) =	112.30	Considering floor thickness =	0.90
		RL of floor (Bottom) =	111.40		
		RL of pile (Bottom) =	108.30		

Total length of floor =	b =	34.60	Distance between pile 1 & 2 =	14.00
Depth of pile line 1 =	d(1) =	5.00	Distance between pile 2 & 3 =	16.60
Depth of pile line 2 =	d(2) =	4.00		
Depth of pile line 3 =	d(3) =	4.00		

Khosla's curve for seepage calculation

Pile line 1

$\alpha = \frac{b}{d}$ = 6.92

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 4.00

ϕ_E = 33.34 %

ϕ_D = 23.01 %

ϕ_{C_1} = 66.66 %

ϕ_{D_1} = 76.99 %

$$\phi_E = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-2}{\lambda}\right)$$

$$\phi_D = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-1}{\lambda}\right)$$

$$\phi_{C_1} = 100 - \phi_E$$

$$\phi_{D_1} = 100 - \phi_D$$

$\phi_{D_1} - \phi_{C_1}$ = 10.33 %

Correction at c_1 due to floor thickness

Correction = $\frac{\phi_{D_1} - \phi_{C_1}}{d} \times t$ = 3.00 % (+Ve)

(a) Correction at C_1 for Mutual Interference of Piles (affected by intermediate pile No.2)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 1.96 % (+Ve)

D	=	4.10	Depth of pile whose effect is required to be determined on neighbouring pile of depth d	
b'	=	16.60	m	Distance betwwen the piles
b	=	34.60	m	Total length of floor
d	=	3.10	m	Depth of pile on whose the effect of another pile of depth D is required to be determined

Hence

Corrected ϕ_{C_1} = ϕ_{C_1} + Correction for floor thickness + Crrection for interference

ϕ_{C_1} = 71.63 %

ϕ_{D_1} = 76.99 %

Pile Line 2

$\alpha_1 = \frac{b_1}{d}$ = 3.32 $\alpha_2 = \frac{b_2}{d}$ = 3.50

$$\lambda_1 = \frac{\sqrt{1+\alpha_1^2} - \sqrt{1+\alpha_2^2}}{2} = -0.09$$

$$\lambda_2 = \frac{\sqrt{1+\alpha_1^2} + \sqrt{1+\alpha_2^2}}{2} = 3.55$$

$$\phi_{E_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 - 1}{\lambda_2}\right) = 59.86 \%$$

$$\phi_{C_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 + 1}{\lambda_2}\right) = 41.71 \%$$

$$\phi_{D_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1}{\lambda_2}\right) = 50.75 \%$$

(a) Correction at E_2 due to floor thickness assuming 1.00m thick floor

$\frac{\phi_{E_2} - \phi_{D_2}}{d} \times t$ = -2.65 % (-ve)

(b) Correction at E_2 due to pile interference. Pressure at E_2 is affected by pile No.(1)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -1.96 % (-ve)

D	=	4.10	Depth of pile No.1, the effect of which is considered
b'	=	16.60	Distance between two piles
b	=	34.60	Total length of floor
d	=	3.10	Depth of pile No. 2, the effect on

Corrected ϕ_{E_2} = 55.25

(a) Correction at C_2 due to floor thickness. This correction shall be + ve and its amount is the same as was calculated for the point E_2

= 2.65 % (+ve)

(b) Correction at C_2 due to pile interference. Pressure at C_2 is affected by pile No.(3)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 1.60 % (+Ve)

D	=	3.10	Depth of pile No.3, the effect of which is considered below the
b'	=	14.00	Distance between two piles

b = 34.60 Total length of floor

d = 3.10 Depth of pile No. 2, the effect on which is considered

Corrected ϕ_{C_2} = 45.95 %

Pile Line No. 3

$\alpha = \frac{b}{d}$ = 8.65

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 4.85

ϕ_{E_3} = 29.98 %

ϕ_{D_3} = 20.79 %

Correction at E_3 due to floor thickness

Correction = $\frac{\phi_{E_3} - \phi_{D_3}}{d} \times t$ = 2.67 % (+Ve)

(b) Correction due to piles

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -1.60 % (-ve)

D = 3.10 m, Depth of pile No.2

b' = 14.00 m, Distance between two piles

b = 34.60 m, Total floor length

d = 3.10 m, Depth of pile No. 3

Corrected ϕ_{E_3} = 31.05

Pressure Head = 2.09 m

The corrected pressure at various key points are

Upstream Pile No. 1			*Intermediate Pile No. 2*			*Downstream Pille No. 3*		
Points	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*
ϕ_{E_1}	100.00	2.09	ϕ_{E_2}	55.25	1.15	ϕ_{E_3}	31.05	0.65
ϕ_{D_1}	76.99	1.61	ϕ_{D_2}	50.75	1.06	ϕ_{D_3}	20.79	0.43
ϕ_{C_1}	71.63	1.50	ϕ_{C_2}	45.95	0.96	ϕ_{C_3}	0.00	0.00

Uplift pressure at x = $P_X = P_{C_1} - \left(\frac{P_{C_1} - P_E}{b'}\right) \times X$

Floor thickness required at T_x = $\frac{P_X}{G-1}$

Distance from the D/S (R/S) end = X

Unit	m	m	m	m
Distance (X)	10.00	14.00	26.60	30.60
Uplift Pressure (P_x)	1.25	1.15	0.68	0.43
Floor thickness required (T_x)	1.00	0.92	0.54	0.35
Floor thickness provided	1.00	1.00	1.00	1.00

Protection Work

Upstream protection works:

Scour depth already computed 'R' — 3.5 m

Block protection:

U/S scour depth R.L. = U/S W.L. - 1.2R = — 109.24 m

Scour depth below u/s floor = — 3.06 m

let us provide length of inverted filter — 4.00 m

C.C. block (0.45m x 0.45m x 0.5m) are provided for a length of 2.0 m above 0.50m thick filter gravel (13mm to 19mm) with spacing of 0.05m filled with stone gravel

U/S launching apron:

Length ofU/S apron = 2 x d1, where d1 is required depth of U/S cut off wall — 8 m

Let us provide thickness = — 1 m

Toe-wall of dimension 1.0m x 0.5m is provided between C.C. Block and launching apron in U/S side

Downstream protection works:

Anticipated scour = 1.5 x R — 5.25 m

Block protection:

D/Sscour depth R.L. = D/S W.L. - 1.5R — 105.06 m

Scour depth below D/S floor = — 7.24 m

let us provide length of inverted filter — 8.00 m

C.C. block (0.45m x 0.45m x 0.5m) are provided for a length of 5.0 m above 0.50m thick filter gravel (13mm to 19mm) with spacing of 0.05m filled with stone gravel

D/S launching apron:

Length of D/S apron = 2 x d2, where d2 is required depth of D/S cut off wall — 10 m

Let us provide thickness = — 1 m

Toe-wall of dimension 1.0m x 0.5m is provided between C.C. Block and launching apron in D/S side

Executive Engineer
Dibrugarh W.R. Division
Dibrugarh

Design for Sluice Gate E-23/1 (HEC-RAS Station 94016 m) on Tingrai LB

DESIGN DATA

1	Maximum discharge through the sluice required	=	0.90	cumecs
2	Maximum Country side water level (U/S)	=	114.68	m
3	Maximum River side water level (D/S) (HFL)	=	115.64	m
4	Avearege minimum water level (D/S)	=	114.01	m
5	Crest level of embankment	=	117.14	m
6	Ground level at sluice site	=	114	m
7	Avg. size of bed material 'd'	=	0.21	mm
8	Silt factor 'f' = 1.76 x $d^{0.5}$		0.81	
9	Permissible exit gradient	=	1 in 6	
10	No. of openings	=	1	
11	Sill level of of sluice	=	113	m
12	Length of barrel	=	12.00	
13	Soil properties			
	a) Dry unit weight	=	18.65	kN/m^3
	b) Wet unit weight	=	21.60	kN/m^3
	c) φ	=	25	
14	Bearing capacity of soil	=	90.25	kN/m^2

HYDRAULIC CALCULATION FOR VARIOUS FLOW CONDITION

(a) During high flood condition:-

Up stream H.F.L.		= 115.64
Down stream water level for full discharge condition		= 115.64 - 0.75 = 114.89 m
Assuming 0.50m retrogration, Down stream water level		= 114.89 - 0.50 = 114.39 m
Assuming 0.50m afflux, Up stream water level		= 115.64 + 0.50 = 116.14 m
Average discharge intensity, q = Q/b		= 0.90 / 2.10 = 0.43 m3/sec/m
Scour depth , R =	$1.35 * (q^2/f)$ ^ (1/3)	= 0.83 m
Velocity of approach, V =	q/R	= 0.52 m/sec
Hence loss of head at entry =	$\frac{V^2}{2g}$	= 0.01 m
T.E.L. just Down Stream of the Gate		= 116.14 - 0.01 = 116.13 m
Down Stream water level (T.E.L.)		= 114.39 m
Hence head loss		116.13 - 114.39 = 1.74 m

(b) Normal flow condition

Up stream N.F.L.		= 114.01
Down stream water level for full discharge condition		= 114.01 - 1.00 = 113.01 m
Assuming 0.30m retrogration, Down stream water level		= 113.01 - 0.30 = 112.71 m
Assuming 0.30m afflux, Up stream water level		= 114.01 + 0.30 = 114.31 m
T.E.L. just Down Stream of the Gate		= 114.31 - 0.01 = 114.30 m
Down Stream water level (T.E.L.)		= 112.71 m
Heance head loss		= 114.30 - 112.71 = 1.59 m
Discharge intensity =	$\frac{Q}{width \times Nos.}$	= 0.43 cum/sec/m

Sl.No.	Item	High flood		Normal flood	
1	Discharge intensity	0.43 cum/sec/m		0.43 cum/sec/m	
2	D/S T.E.L.	114.39	m	112.71	m
3	U/S T.E.L.	116.13	m	114.30	m
4	Head loss (H_L)	1.74	m	1.59	m
5	D/S specific energy Ef_2	0.78	m	0.74	m
6	U/S specific energy $Ef_1 = (Ef_2 + H_L)$	2.52	m	2.33	m
7	Level at which jump would from (D/S T.E.L. - Ef_2)	113.61	m	111.97	m
8	Pre jump depth D_1 ($Ef_1 = D_1 + (q/D_1)^2/2g$	0.10	m	0.10	m
9	Post jump depth D_2 ($Ef_2 = D_2 + (q/D_2)^2/2g$	0.80	m	0.70	m
10	Length of concrete floor = 5.00 x (D_2 - D_1)	3.50	m	3.00	m
11	Froude No. $F_1 = \frac{q}{\sqrt{gD_1^3}}$	4.34	m	4.34	m

Let us provide length of stilling basin = 4.00 m (Required =3.5 m) & slope of glacis as 1:2

R.L. of floor level of the stilling basin required = 111.97 m

Let us provide R.L. of stilling basin = 111.00 m

Depth of stilling basin = 113.00 - 111.00 = 2.00 m

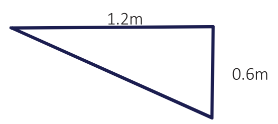
Side sply:- angle of sply = $\tan^{-1}\left(\frac{1}{3 \times F_1}\right)$ = 4.39 °

Let us provide a sply of30 ° in the U/S side and sply of 23 ° in D/S

DESIGN OF ENERGY DESSIPITATION DEVICE

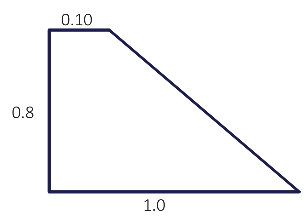
Chute blocks at glacis slope

Height = D_1 =	0.10 m, Provide =	0.10 m	D_1 = 0.10 m
Width = D_1 =	0.10 m, Provide =	0.10 m	
Length = $2D_1$ =	0.20 m, Provide =	0.20 m	
Clear spacing = D_1 =	0.10 m, Provide =	0.10 m	



Baffle blocks at 0.60 m from D/S face of chute blocks

Height = h_b =	0.12 m, provide =	0.20 m	h_b/D_1=1.2
Top Width =$0.2h_b$ =	0.02 m, provide =	0.10 m	
Width =$0.5h_b$ =	0.06 m, provide =	0.10 m	h_b = 0.12
Bottom width =$0.2h_b + h_b$ =	0.30 m, provide =	0.30 m	
Clear spacing =$0.75h_b$ =	0.09 m, provide =	0.10 m	



End blocks Height = $0.2D_2$ = 0.16 m, provide = 0.20 m

Top length = $0.15D_2$ = 0.12 m, provide = 0.20 m

Width = $0.15D_2$ = 0.12 m, provide = 0.20 m

Clear spacing = $0.15D_2$ = 0.12 m, provide = 0.20 m

Provide two rows at D/S end of stilling basin

CALCULATION OF SCOUR DEPTH

Discharge = Q = 0.90 cumec

Water way = L_o 2.10 m

Discharge intensity = q = $\frac{Q}{L_o}$ = 0.43 cum/sec/m

Silt factor = f = 0.81

Regime scour depth = $R = 1.35\left(\frac{q^2}{f}\right)^{\frac{1}{3}}$ = 0.83 m Say 0.90 m

Say Design scour depth = R_d = 1.25xR = 1.13 m

For U/S cut off wall depth = 1.25 xR = 1.13 m

For D/S cut off wall depth = 1.50 xR = 1.35 m

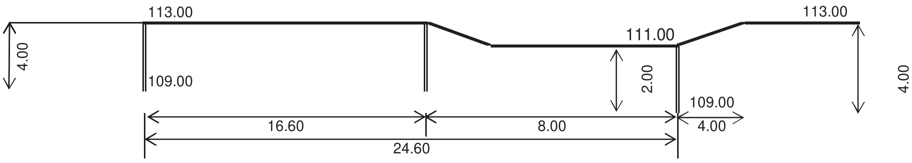
U/S cut off wall level = 114.52 m (Required)

D/S cut off wall level = 114.29 m (Required)

U/S cut off wall depth from floor = -1.52 m Provide 4.00 m

D/S cut off wall depth from floor = -1.29 m Provide 4.00 m

Depth of D/S cut-off wall from stilling basin = 2.00 m



Let us provide the length of different portion of sluice as follows

1	U/S floor	4.00 m
2	Barrel	12.00 m
3	Gate grove	0.60 m
4	U/S slope of stilling basin	4.00 m
5	Stilling basin	4.00 m
6	D/S slope of stilling basin	4.00 m
	Total =	28.60 m

CALCULATION OF EXIT GRADIENT

a) Considering the worst condition, when there will be H.F.L. on R/S and C/S is empty

R/S H.F.L.	= 115.64 m
Assuming 0.50m afflux, R/S water level	= 115.64 + 0.50 = 116.14 m
C/S level	= 113.00 m
Worst head = H	= 116.14 - 113.00 = 3.14 m
Let us consider worst head (H)	= 4.00 m
d = Depth of U/S curtain wall	= 4.00 m
b = distance between piles	= 24.60 m
G_E = exit gradient = 1 : 6	= 0.167

$\alpha = \frac{b}{d}$ = 6.15 $\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 3.62

$G_E = \frac{H}{d}\frac{1}{\pi\sqrt{\lambda}}$ = 0.167 < 0.167 Hence O.K.

b) Considering the worst condition, when there will be H.F.L. on C/S and R/S is empty

C/S H.F.L.	= 114.68 m
R/S level	= 113.00 m
Worst head = H	= 1.68 m
Let us consider worst head (H)	= 2.00 m for safety
d = Depth of D/S curtain wall	= 2.00 m
b = length of floor	= 24.60 m
G_E = exit gradient = 1 : 6	= 0.167

$\alpha = \frac{b}{d}$ = 12.30 $\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 6.67

$G_E = \frac{H}{d}\frac{1}{\pi\sqrt{\lambda}}$ = 0.10 < 0.167 Hence O.K.

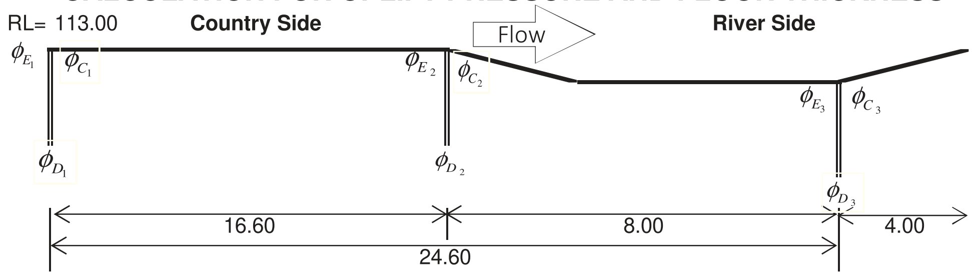
Maintain D/S cutoff wall depth up to 2.00

Hence Provide U/S cutoff depth = 4.00 m (C/S)

Hence Provide D/S cutoff wall depth = 2.00 m (R/S)

Additionaly Provide Intermediate cutoff wall depth = 4.00 m at end of floor

CALCULATION FOR UPLIFT PRESSURE AND FLOOR THICKNESS



Case(1) For seepage flow from country side to river side

Pile line 1	:	RL of floor (Top) =	113.00	Considering floor thickness =	1.00
		RL of floor (Bottom) =	112.00		
		RL of pile (Bottom) =	109.00		
Pile line 2	:	RL of floor (Top) =	113.00	Considering floor thickness =	1.00
		RL of floor (Bottom) =	112.00		
		RL of pile (Bottom) =	109.00		
Pile line 3	:	RL of floor (Top) =	111.00	Considering floor thickness =	1.00
		RL of floor (Bottom) =	110.00		
		RL of pile (Bottom) =	109.00		

Total length of floor =	*b* =	24.60	Distance between pile 1 & 2 =	16.60
Depth of pile line 1 =	d(1) =	4.00	Distance between pile 2 & 3 =	8.00
Depth of pile line 2 =	d(2) =	4.00		
Depth of pile line 3 =	d(3) =	2.00		

Khosla's curve for seepage calculation

Pile line 1

$\alpha = \frac{b}{d}$ = 4.15

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 2.63

$$\phi_E = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-2}{\lambda}\right)$$

$$\phi_D = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-1}{\lambda}\right)$$

$$\phi_{C_1} = 100 - \phi_E$$

$$\phi_{D_1} = 100 - \phi_D$$

ϕ_E = 42.24 %

ϕ_D = 28.69 %

ϕ_{C_1} = 57.76 %

ϕ_{D_1} = 71.31 %

$\phi_{D_1} - \phi_{C_1}$ = 13.56 %

Correction at c_1 due to floor thickness

Correction = $\frac{\phi_{D_1} - \phi_{C_1}}{d} \times t$ = 4.52 % (+Ve)

(a) Correction at C_1 for Mutual Interference of Piles (affected by intermediate pile No.2)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 1.97 % (+Ve)

D	=	3.00		Depth of pile whose effect is required to be determined on
b'	=	16.60	m	Distance between the piles
b	=	24.60	m	Total length of floor
d	=	3.00	m	Depth of pile on whose the effect of another pile of depth D is required to be determined

Hence

Corrected ϕ_{C_1} = ϕ_{C_1} + Correction for floor thickness + Correction for interference

ϕ_{C_1} = 64.25 %

ϕ_{D_1} = 71.31 %

Pile Line 2

$\alpha_1 = \frac{b_1}{d}$ = 4.15 $\qquad \alpha_2 = \frac{b_2}{d}$ = 2.00

$$\lambda_1 = \frac{\sqrt{1+\alpha_1^2} - \sqrt{1+\alpha_2^2}}{2} = 1.016357$$

$$\lambda_2 = \frac{\sqrt{1+\alpha_1^2} + \sqrt{1+\alpha_2^2}}{2} = 3.25$$

$$\phi_{E_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 - 1}{\lambda_2}\right) = 49.82 \ \%$$

$$\phi_{C_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 + 1}{\lambda_2}\right) = 28.70 \ \%$$

$$\phi_{D_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1}{\lambda_2}\right) = 39.87 \ \%$$

(a) Correction at E_2 due to floor thickness assuming 1.00m thick floor

$\frac{\phi_{E_2} - \phi_{D_2}}{d} \times t$ = -3.32 % (-ve)

9.95

(b) Correction at E_2 due to pile interference. Pressure at E_2 is affected by pile No. 1

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -1.97 % (-ve)

D	=	3.00	Depth of pile No.1, the effect of which is considered
b'	=	16.60	Distance between two piles
b	=	24.60	Total length of floor
d	=	3.00	Depth of pile No. 2, the effect on

Corrected ϕ_{E_2} = 44.53 %

(a) Correction at C_2 due to floor thickness. This correction shall be + ve and its amount is the same as was calculated for the point E_2

= 3.32 % (+ve)

(b) Correction at C_2 due to pile interference. Pressure at C_2 is affected by pile No. 3

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 1.09 % (+Ve)

D	=	1.00	Depth of pile No.3, the effect of which is considered below the level
b'	=	8.00	Distance between two piles
b	=	24.60	Total length of floor
d	=	3.00	Depth of pile No. 2, the effect on which is considered

Corrected ϕ_{C_2} = 33.11 %

Pile Line No. 3

$\alpha = \frac{b}{d}$ = 4.00

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 2.56

ϕ_{E_3} = 42.95 %

ϕ_{D_3} = 29.12 %

Correction at E_3 due to floor thickness

Correction = $\frac{\phi_{E_3} - \phi_{D_3}}{d} \times t$ = 13.83 % (+Ve)

(b) Correction due to piles

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -1.89 % (-ve)

D	=	3.00	Depth of pile No.2
b'	=	8.00	Distance between two piles
b	=	24.60	Total floor length
d	=	1.00	Depth of pile No. 3

Corrected ϕ_{E_3} = 54.88

Pressure Head = 1.68 m

The corrected pressure at various key points are

Upstream Pile No. 1			*Intermediate Pile No. 2*			*Downstream Pille No. 3*		
Points	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*
ϕ_{E_1}	100.00	1.68	ϕ_{E_2}	44.53	0.75	ϕ_{E_3}	54.88	0.92
ϕ_{D_1}	71.31	1.20	ϕ_{D_2}	39.87	0.67	ϕ_{D_3}	29.12	0.49
ϕ_{C_1}	64.25	1.08	ϕ_{C_2}	33.11	0.56	ϕ_{C_3}	0.00	0.00

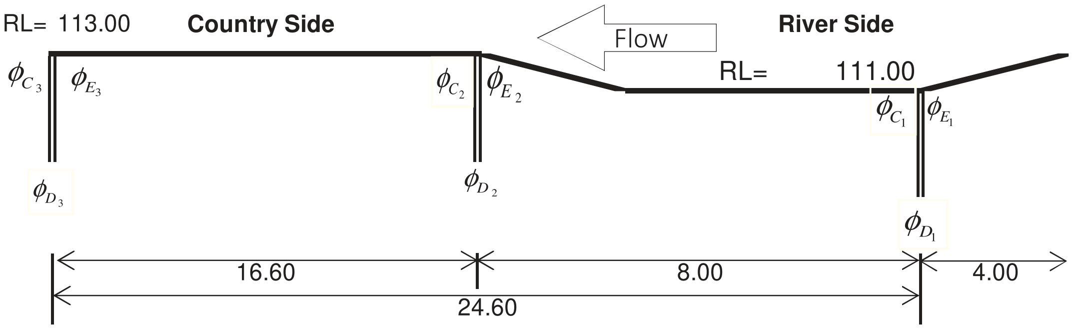
Uplift pressure at x = $P_X = P_{C_1} - \left(\frac{P_{C_1} - P_E}{b'}\right) \times X$

Floor thickness required at T_x = $\frac{P_X}{G-1}$

Distance from the U/S (C/S) end = X

Unit	m	m	m	m
Distance (X)	4.00	16.60	20.60	24.60
Uplift Pressure (P_x)	1.00	0.52	0.92	0.37
Floor thickness required (T_x)	0.80	0.42	0.74	0.30
Floor thickness provided	1.00	1.00	1.00	1.00

CALCULATION FOR UPLIFT PRESSURE AND FLOOR THICKNESS



Case(2) For seepage flow from River side to Country side side

Pile line 1	:	RL of floor (Top) =	111.00	Considering floor thickness =	1.00
		RL of floor (Bottom) =	110.00		
		RL of pile (Bottom) =	109.00		
Pile line 2	:	RL of floor (Top) =	113.00	Considering floor thickness =	1.00
		RL of floor (Bottom) =	112.00		
		RL of pile (Bottom) =	109.00		
Pile line 3	:	RL of floor (Top) =	113.00	Considering floor thickness =	1.00
		RL of floor (Bottom) =	112.00		
		RL of pile (Bottom) =	109.00		

Total length of floor =	*b* =	24.60	Distance between pile 1 & 2 =	8.00
Depth of pile line 1 =	d(1) =	2.00	Distance between pile 2 & 3 =	16.60
Depth of pile line 2 =	d(2) =	4.00		
Depth of pile line 3 =	d(3) =	4.00		

Khosla's curve for seepage calculation

Pile line 1

$\alpha = \frac{b}{d}$ = 4.00

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 2.56

$$\phi_E = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-2}{\lambda}\right)$$

$$\phi_D = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-1}{\lambda}\right)$$

$$\phi_{C_1} = 100 - \phi_E$$

$$\phi_{D_1} = 100 - \phi_D$$

ϕ_E = 42.95 %

ϕ_D = 29.12 %

ϕ_{C_1} = 57.05 %

ϕ_{D_1} = 70.88 %

$\phi_{D_1} - \phi_{C_1}$ = 13.83 %

Correction at c_1 due to floor thickness

Correction = $\frac{\phi_{D_1} - \phi_{C_1}}{d} \times t$ = 4.61 % (+Ve)

(a) Correction at C_1 for Mutual Interference of Piles (affected by intermediate pile No.2)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 0.76 % (+Ve)

D	=	1.00	Depth of pile whose effect is required to be determined on neighbouring pile of depth d	
b'	=	16.60	m	Distance betwwen the piles
b	=	24.60	m	Total length of floor
d	=	3.00	m	Depth of pile on whose the effect of another pile of depth D is required to be determined

Hence

Corrected ϕ_{C_1} = ϕ_{C_1} + Correction for floor thickness + Crrection for interference

ϕ_{C_1} = 62.42 %

ϕ_{D_1} = 70.88 %

Pile Line 2

$\alpha_1 = \frac{b_1}{d}$ = 8.30 $\alpha_2 = \frac{b_2}{d}$ = 2.00

$$\lambda_1 = \frac{\sqrt{1+\alpha_1^2} - \sqrt{1+\alpha_2^2}}{2} = 3.06$$

$$\lambda_2 = \frac{\sqrt{1+\alpha_1^2} + \sqrt{1+\alpha_2^2}}{2} = 5.30$$

$$\phi_{E_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 - 1}{\lambda_2}\right) = 37.26 \ \%$$

$$\phi_{C_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 + 1}{\lambda_2}\right) = 22.18 \ \%$$

$$\phi_{D_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1}{\lambda_2}\right) = 30.37 \ \%$$

(a) Correction at E_2 due to floor thickness assuming 1.00m thick floor

$$\frac{\phi_{E_2} - \phi_{D_2}}{d} \times t = -2.30 \ \% \ (-ve)$$

(b) Correction at E_2 due to pile interference. Pressure at E_2 is affected by pile No.(1)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -0.76 % (-ve)

D	=	1.00	Depth of pile No.1, the effect of which is considered
b'	=	16.60	Distance between two piles
b	=	24.60	Total length of floor
d	=	3.00	Depth of pile No. 2, the effect on

Corrected ϕ_{E_2} = 34.21

(a) Correction at C_2 due to floor thickness. This correction shall be + ve and its amount is the same as was calculated for the point E_2

= 2.30 % (+ve)

(b) Correction at C_2 due to pile interference. Pressure at C_2 is affected by pile No.(3)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 2.84 % (+Ve)

D	=	3.00	Depth of pile No.3, the effect of which is considered below the
b'	=	8.00	Distance between two piles

b = 24.60 Total length of floor

d = 3.00 Depth of pile No. 2, the effect on which is considered

Corrected ϕ_{C_2} = 27.31 %

Pile Line No. 3

$\alpha = \frac{b}{d}$ = 4.15

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 2.63

ϕ_{E_3} = 42.24 %

ϕ_{D_3} = 28.69 %

Correction at E_3 due to floor thickness

Correction = $\frac{\phi_{E_3} - \phi_{D_3}}{d} \times t$ = 4.52 % (+Ve)

(b) Correction due to piles

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -2.84 % (-ve)

D = 3.00 m, Depth of pile No.2

b' = 8.00 m, Distance between two piles

b = 24.60 m, Total floor length

d = 3.00 m, Depth of pile No. 3

Corrected ϕ_{E_3} = 43.92

Pressure Head = 2.64 m

The corrected pressure at various key points are

Upstream Pile No. 1			Intermediate Pile No. 2			Downstream Pille No. 3		
Points	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*
ϕ_{E_1}	100.00	2.64	ϕ_{E_2}	34.21	0.90	ϕ_{E_3}	43.92	1.16
ϕ_{D_1}	70.88	1.87	ϕ_{D_2}	30.37	0.80	ϕ_{D_3}	28.69	0.76
ϕ_{C_1}	62.42	1.65	ϕ_{C_2}	27.31	0.72	ϕ_{C_3}	0.00	0.00

Uplift pressure at x = $P_X = P_{C_1} - \left(\frac{P_{C_1} - P_E}{b'}\right) \times X$

Floor thickness required at T_x = $\frac{P_X}{G-1}$

Distance from the D/S (R/S) end = X

Unit	m	m	m	m
Distance (X)	4.00	8.00	20.60	24.60
Uplift Pressure (P_x)	1.28	0.90	1.12	0.76
Floor thickness required (T_x)	1.02	0.72	0.90	0.61
Floor thickness provided	1.00	1.00	1.00	1.00

Protection Work

Upstream protection works:

Scour depth already computed 'R'	0.9 m
Block protection:	
U/S scour depth R.L. = U/S W.L. - 1.2R =	113.56 m
Scour depth below u/s floor =	-0.56 m
let us provide length of inverted filter	2.00 m

C.C. block (0.45m x 0.45m x 0.5m) are provided for a length of 2m above 0.50m thick filter gravel (13mm to 19mm) with spacing of 0.05m filled with stone gravel

U/S launching apron:

Length of U/S apron = 2 x d1, where d1 is required depth of U/S cut off wall	4 m
Let us provide thickness =	1 m

Toe-wall of dimension 1.0m x 0.5m is provided between C.C. Block and launching apron in U/S side

Downstream protection works:

Anticipated scour = 1.5 x R	1.35 m
Block protection:	
D/Sscour depth R.L. = D/S W.L. - 1.5R	111.99 m
Scour depth below D/S floor =	1.02 m
let us provide length of inverted filter	4.00 m

C.C. block (0.45m x 0.45m x 0.5m) are provided for a length of 4m above 0.50m thick filter gravel (13mm to 19mm) with spacing of 0.05m filled with stone gravel

D/S launching apron:

Length of D/S apron = 2 x d2, where d2 is required depth of D/S cut off wall	4 m
Let us provide thickness =	1 m

Toe-wall of dimension 1.0m x 0.5m is provided between C.C. Block and launching apron in D/S side

Executive Engineer
Dibrugarh W.R. Division
Dibrugarh

<u>Design for Sluice Gate E-25/1 (HEC-RAS Station 102182 m) on RB</u>

DESIGN DATA

1	Maximum discharge through the sluice required	=	3.07	cumecs
2	Maximum Country side water level (U/S)	=	116.71	m
3	Maximum River side water level (D/S) (HFL)	=	117.30	m
4	Avearege minimum water level (D/S)	=	115.67	m
5	Crest level of embankment	=	118.80	m
6	Ground level at sluice site	=	116	m
7	Avg. size of bed material 'd'	=	0.21	mm
8	Silt factor 'f' = 1.76 x $d^{0.5}$		0.81	
9	Permissible exit gradient	=	1 in 6	
10	No. of openings	=	1	
11	Sill level of of sluice	=	114.7	m
12	Length of barrel	=	12.00	
13	Soil properties			
	a) Dry unit weight	=	18.65	kN/m^3
	b) Wet unit weight	=	21.60	kN/m^3
	c) φ	=	25	
14	Bearing capacity of soil	=	90.25	kN/m^2

HYDRAULIC CALCULATION FOR VARIOUS FLOW CONDITION

(a) During high flood condition:-

Up stream H.F.L.	= 117.30	
Down stream water level for full discharge condition	= 117.30 - 0.75	= 116.55 m
Assuming 0.50m retrogration, Down stream water level	= 116.55 - 0.50	= 116.05 m
Assuming 0.50m afflux, Up stream water level	= 117.30 + 0.50	= 117.80 m
Average discharge intensity, q = Q/b	= 3.07 / 2.10	= 1.46 m3/sec/m
Scour depth , R = $1.35 * (q^2/f) ^{\wedge} (1/3)$	= 1.87 m	
Velocity of approach, V = q/R	= 0.78 m/sec	

Hence loss of head at entry = $\frac{V^2}{2g}$ = 0.03 m

T.E.L. just Down Stream of the Gate	= 117.80 - 0.03	= 117.77 m
Down Stream water level (T.E.L.)	= 116.05 m	
Hence head loss	117.77 - 116.05	= 1.72 m

(b) Normal flow condition

Up stream N.F.L.	= 115.67	
Down stream water level for full discharge condition	= 115.67 - 1.00	= 114.67 m
Assuming 0.30m retrogration, Down stream water level	= 114.67 - 0.30	= 114.37 m
Assuming 0.30m afflux, Up stream water level	= 115.67 + 0.30	= 115.97 m
T.E.L. just Down Stream of the Gate	= 115.97 - 0.03	= 115.94 m
Down Stream water level (T.E.L.)	= 114.37 m	
Heance head loss	= 115.94 - 114.37	= 1.57 m

Discharge intensity = $\frac{Q}{width \times Nos.}$ = 1.46 cum/sec/m

Sl.No.	Item	High flood		Normal flood	
1	Discharge intensity	1.46 cum/sec/m		1.46 cum/sec/m	
2	D/S T.E.L.	116.05	m	114.37	m
3	U/S T.E.L.	117.77	m	115.94	m
4	Head loss (H_L)	1.72	m	1.57	m
5	D/S specific energy Ef_2	1.49	m	1.46	m
6	U/S specific energy $Ef_1 = (Ef_2 + H_L)$	3.21	m	3.03	m
7	Level at which jump would from (D/S T.E.L. - Ef_2)	114.56	m	112.91	m
8	Pre jump depth D_1 ($Ef_1 = D_1 + (q/D_1)^2/2g$	0.20	m	0.20	m
9	Post jump depth D_2 ($Ef_2 = D_2 + (q/D_2)^2/2g$	1.40	m	1.40	m
10	Length of concrete floor = 5.00 x (D_2 - D_1)	6.00	m	6.00	m
11	Froude No. $F_1 = \frac{q}{\sqrt{gD_1^3}}$	5.21	m	5.21	m

Let us provide length of stilling basin =	6.00 m (Required =6 m) & slope of glacis as 1:2	
R.L. of floor level of the stilling basin required =	112.91 m	
Let us provide R.L. of stilling basin =	112.70 m	
Depth of stilling basin =	114.70 - 112.70	= 2.00 m

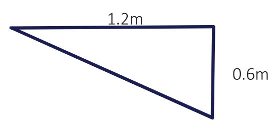
Side sply:- angle of sply = $\tan^{-1}\left(\frac{1}{3 \times F_1}\right)$ = 3.66 °

Let us provide a sply of30 ° in the U/S side and sply of 23 ° in D/S

DESIGN OF ENERGY DESSIPITATION DEVICE

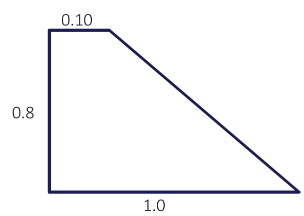
Chute blocks at glacis slope

Height = D_1 =	0.20 m, Provide =	0.20 m	D_1 = 0.20 m
Width = D_1 =	0.20 m, Provide =	0.20 m	
Length = $2D_1$ =	0.40 m, Provide =	0.40 m	
Clear spacing = D_1 =	0.20 m, Provide =	0.20 m	



Baffle blocks at 1.10 m from D/S face of chute blocks

Height = h_b =	0.24 m, provide =	0.30 m	h_b/D_1=1.2
Top Width =$0.2h_b$ =	0.05 m, provide =	0.10 m	
Width =$0.5h_b$ =	0.12 m, provide =	0.20 m	h_b = 0.24
Bottom width =$0.2h_b + h_b$ =	0.40 m, provide =	0.40 m	
Clear spacing =$0.75h_b$ =	0.18 m, provide =	0.20 m	



End blocks Height = $0.2D_2$ =	0.28 m, provide =	0.30 m	
Top length = $0.15D_2$ =	0.21 m, provide =	0.30 m	
Width = $0.15D_2$ =	0.21 m, provide =	0.30 m	
Clear spacing = $0.15D_2$ =	0.21 m, provide =	0.30 m	

Provide two rows at D/S end of stilling basin

CALCULATION OF SCOUR DEPTH

Discharge = Q = 3.07 cumec

Water way = L_o 2.10 m

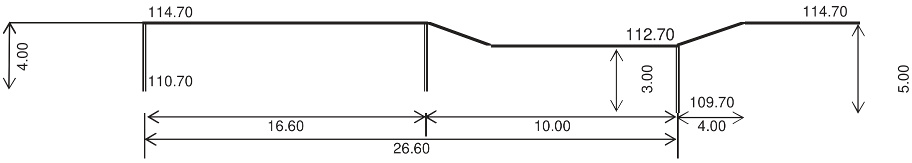
Discharge intensity = q = $\frac{Q}{L_o}$ = 1.46 cum/sec/m

Silt factor = f = 0.81

Regime scour depth = $R = 1.35\left(\frac{q^2}{f}\right)^{\frac{1}{3}}$ = 1.87 m Say 1.90 m

Say Design scour depth = R_d = 1.25xR = 2.38 m

For U/S cut off wall depth = 1.25 xR =	2.38 m		
For D/S cut off wall depth = 1.50 xR =	2.85 m		
U/S cut off wall level =	114.93 m (Required)		
D/S cut off wall level =	114.45 m (Required)		
U/S cut off wall depth from floor =	-0.22 m	Provide	4.00 m
D/S cut off wall depth from floor =	0.25 m	Provide	5.00 m
Depth of D/S cut-off wall from stilling basin =	3.00 m		



Let us provide the length of different portion of sluice as follows

1	U/S floor	4.00 m
2	Barrel	12.00 m
3	Gate grove	0.60 m
4	U/S slope of stilling basin	4.00 m
5	Stilling basin	6.00 m
6	D/S slope of stilling basin	4.00 m
	Total =	30.60 m

CALCULATION OF EXIT GRADIENT

a) Considering the worst condition, when there will be H.F.L. on R/S and C/S is empty

R/S H.F.L.	= 117.30 m
Assuming 0.50m afflux, R/S water level	= 117.30 + 0.50 = 117.80 m
C/S level	= 114.70 m
Worst head = H	= 117.80 - 114.70 = 3.10 m
Let us consider worst head (H)	= 4.00 m
d = Depth of U/S curtain wall	= 4.00 m
b = distance between piles	= 26.60 m
G_E = exit gradient = 1 : 6	= 0.167

$\alpha = \frac{b}{d}$ = 6.65 $\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 3.86

$G_E = \frac{H}{d}\frac{1}{\pi\sqrt{\lambda}}$ = 0.162 < 0.167 Hence O.K.

b) Considering the worst condition, when there will be H.F.L. on C/S and R/S is empty

C/S H.F.L.	= 116.71 m
R/S level	= 114.70 m
Worst head = H	= 2.01 m
Let us consider worst head (H)	= 3.00 m for safety
d = Depth of D/S curtain wall	= 3.00 m
b = length of floor	= 26.60 m
G_E = exit gradient = 1 : 6	= 0.167

$\alpha = \frac{b}{d}$ = 8.87 $\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 4.96

$G_E = \frac{H}{d}\frac{1}{\pi\sqrt{\lambda}}$ = 0.10 < 0.167 Hence O.K.

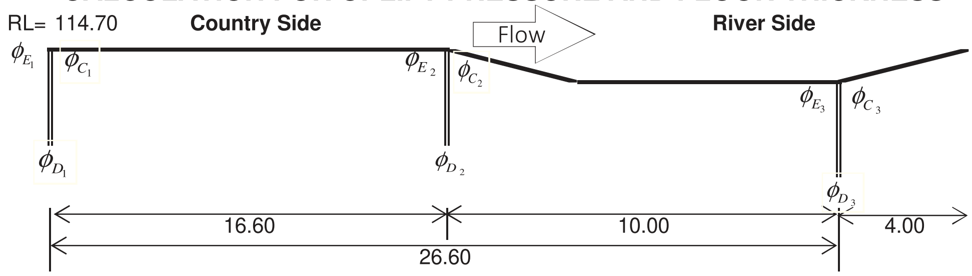
Maintain D/S cutoff wall depth up to 3.00

Hence Provide U/S cutoff depth = 4.00 m (C/S)

Hence Provide D/S cutoff wall depth = 3.00 m (R/S)

Additionaly Provide Intermediate cutoff wall depth = 4.00 m at end of floor

CALCULATION FOR UPLIFT PRESSURE AND FLOOR THICKNESS



Case(1) For seepage flow from country side to river side

Pile line 1	:	RL of floor (Top) =	114.70	Considering floor thickness =	1.00
		RL of floor (Bottom) =	113.70		
		RL of pile (Bottom) =	110.70		
Pile line 2	:	RL of floor (Top) =	114.70	Considering floor thickness =	1.00
		RL of floor (Bottom) =	113.70		
		RL of pile (Bottom) =	110.70		
Pile line 3	:	RL of floor (Top) =	112.70	Considering floor thickness =	1.00
		RL of floor (Bottom) =	111.70		
		RL of pile (Bottom) =	109.70		

Total length of floor =	*b* =	26.60	Distance between pile 1 & 2 =	16.60
Depth of pile line 1 =	d(1) =	4.00	Distance between pile 2 & 3 =	10.00
Depth of pile line 2 =	d(2) =	4.00		
Depth of pile line 3 =	d(3) =	3.00		

Khosla's curve for seepage calculation

Pile line 1

$\alpha = \frac{b}{d}$ = 4.15

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 2.63

$\phi_E = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-2}{\lambda}\right)$

$\phi_D = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-1}{\lambda}\right)$

$\phi_{C_1} = 100 - \phi_E$

$\phi_{D_1} = 100 - \phi_D$

ϕ_E = 42.24 %

ϕ_D = 28.69 %

ϕ_{C_1} = 57.76 %

ϕ_{D_1} = 71.31 %

$\phi_{D_1} - \phi_{C_1}$ = 13.56 %

Correction at c_1 due to floor thickness

Correction = $\frac{\phi_{D_1} - \phi_{C_1}}{d} \times t$ = 4.52 % (+Ve)

(a) Correction at C_1 for Mutual Interference of Piles (affected by intermediate pile No.2)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 1.82 % (+Ve)

D	=	3.00	Depth of pile whose effect is required to be determined on
b'	=	16.60 m	Distance between the piles
b	=	26.60 m	Total length of floor
d	=	3.00 m	Depth of pile on whose the effect of another pile of depth D is required to be determined

Hence

Corrected ϕ_{C_1} = ϕ_{C_1} + Correction for floor thickness + Correction for interference

ϕ_{C_1} = 64.10 %

ϕ_{D_1} = 71.31 %

Pile Line 2

$\alpha_1 = \frac{b_1}{d}$ = 4.15 $\alpha_2 = \frac{b_2}{d}$ = 2.50

$$\lambda_1 = \frac{\sqrt{1+\alpha_1^2} - \sqrt{1+\alpha_2^2}}{2} = 0.7881$$

$$\lambda_2 = \frac{\sqrt{1+\alpha_1^2} + \sqrt{1+\alpha_2^2}}{2} = 3.48$$

$$\phi_{E_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 - 1}{\lambda_2}\right) = 51.92\ \%$$

$$\phi_{C_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 + 1}{\lambda_2}\right) = 32.81\ \%$$

$$\phi_{D_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1}{\lambda_2}\right) = 42.71\ \%$$

(a) Correction at E_2 due to floor thickness assuming 1.00m thick floor

$\frac{\phi_{E_2} - \phi_{D_2}}{d} \times t$ = -3.07 % (-ve)

9.21

(b) Correction at E_2 due to pile interference. Pressure at E_2 is affected by pile No. 1

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -1.82 % (-ve)

D	=	3.00	Depth of pile No.1, the effect of which is considered
b'	=	16.60	Distance between two piles
b	=	26.60	Total length of floor
d	=	3.00	Depth of pile No. 2, the effect on

Corrected ϕ_{E_2} = 47.03 %

(a) Correction at C_2 due to floor thickness. This correction shall be + ve and its amount is the same as was calculated for the point E_2

= 3.07 % (+ve)

(b) Correction at C_2 due to pile interference. Pressure at C_2 is affected by pile No. 3

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 1.60 % (+Ve)

D	=	2.00	Depth of pile No.3, the effect of which is considered below the level
b'	=	10.00	Distance between two piles
b	=	26.60	Total length of floor
d	=	3.00	Depth of pile No. 2, the effect on which is considered

Corrected ϕ_{C_2} = 37.48 %

Pile Line No. 3

$\alpha = \frac{b}{d}$ = 3.33

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 2.24

ϕ_{E_3} = 46.56 %

ϕ_{D_3} = 31.31 %

Correction at E_3 due to floor thickness

Correction = $\frac{\phi_{E_3} - \phi_{D_3}}{d} \times t$ = 7.63 % (+Ve)

(b) Correction due to piles

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -1.96 % (-ve)

D	=	3.00	Depth of pile No.2
b'	=	10.00	Distance between two piles
b	=	26.60	Total floor length
d	=	2.00	Depth of pile No. 3

Corrected ϕ_{E_3} = 52.23

Pressure Head = 2.01 m

The corrected pressure at various key points are

Upstream Pile No. 1			Intermediate Pile No. 2			Downstream Pille No. 3		
Points	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*
ϕ_{E_1}	100.00	2.01	ϕ_{E_2}	47.03	0.95	ϕ_{E_3}	52.23	1.05
ϕ_{D_1}	71.31	1.44	ϕ_{D_2}	42.71	0.86	ϕ_{D_3}	31.31	0.63
ϕ_{C_1}	64.10	1.29	ϕ_{C_2}	37.48	0.75	ϕ_{C_3}	0.00	0.00

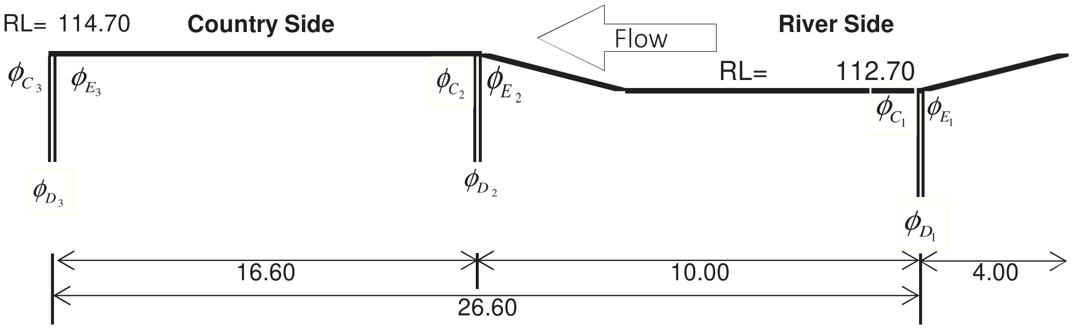
Uplift pressure at x = $P_X = P_{C_1} - \left(\frac{P_{C_1} - P_E}{b'}\right) \times X$

Floor thickness required at T_x = $\frac{P_X}{G-1}$

Distance from the U/S (C/S) end = X

Unit	m	m	m	m
Distance (X)	4.00	16.60	20.60	26.60
Uplift Pressure (P_x)	1.21	0.52	0.95	0.37
Floor thickness required (T_x)	0.97	0.42	0.76	0.30
Floor thickness provided	1.00	1.00	1.00	1.00

CALCULATION FOR UPLIFT PRESSURE AND FLOOR THICKNESS



Case(2) For seepage flow from River side to Country side side

Pile line 1	:	RL of floor (Top) =	112.70	Considering floor thickness =	1.00
		RL of floor (Bottom) =	111.70		
		RL of pile (Bottom) =	109.70		
Pile line 2	:	RL of floor (Top) =	114.70	Considering floor thickness =	1.00
		RL of floor (Bottom) =	113.70		
		RL of pile (Bottom) =	110.70		
Pile line 3	:	RL of floor (Top) =	114.70	Considering floor thickness =	1.00
		RL of floor (Bottom) =	113.70		
		RL of pile (Bottom) =	110.70		

Total length of floor =	b =	26.60	Distance between pile 1 & 2 =	10.00
Depth of pile line 1 =	d(1) =	3.00	Distance between pile 2 & 3 =	16.60
Depth of pile line 2 =	d(2) =	4.00		
Depth of pile line 3 =	d(3) =	4.00		

Khosla's curve for seepage calculation

Pile line 1

$\alpha = \dfrac{b}{d}$ = 3.33

$\lambda = \dfrac{1+\sqrt{1+\alpha^2}}{2}$ = 2.24

ϕ_E = 46.56 %

ϕ_D = 31.31 %

ϕ_{C_1} = 53.44 %

ϕ_{D_1} = 68.69 %

$$\phi_E = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-2}{\lambda}\right)$$

$$\phi_D = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-1}{\lambda}\right)$$

$$\phi_{C_1} = 100 - \phi_E$$

$$\phi_{D_1} = 100 - \phi_D$$

$\phi_{D_1} - \phi_{C_1}$ = 15.25 %

Correction at c_1 due to floor thickness

Correction = $\dfrac{\phi_{D_1} - \phi_{C_1}}{d} \times t$ = 5.08 % (+Ve)

(a) Correction at C_1 for Mutual Interference of Piles (affected by intermediate pile No.2)

Correction = $C = 19\sqrt{\dfrac{D}{b'}}\left(\dfrac{d+D}{b}\right)$ = 1.24 % (+Ve)

D	=	2.00	Depth of pile whose effect is required to be determined on neighbouring pile of depth d	
b'	=	16.60	m	Distance betwwen the piles
b	=	26.60	m	Total length of floor
d	=	3.00	m	Depth of pile on whose the effect of another pile of depth D is required to be determined

Hence

Corrected ϕ_{C_1} = ϕ_{C_1} + Correction for floor thickness + Crrection for interference

ϕ_{C_1} = 59.76 %

ϕ_{D_1} = 68.69 %

Pile Line 2

$\alpha_1 = \frac{b_1}{d}$ = 5.53 $\alpha_2 = \frac{b_2}{d}$ = 2.50

$$\lambda_1 = \frac{\sqrt{1+\alpha_1^2} - \sqrt{1+\alpha_2^2}}{2} = 1.47$$

$$\lambda_2 = \frac{\sqrt{1+\alpha_1^2} + \sqrt{1+\alpha_2^2}}{2} = 4.16$$

$$\phi_{E_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 - 1}{\lambda_2}\right) = 46.41 \ \%$$

$$\phi_{C_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 + 1}{\lambda_2}\right) = 29.79 \ \%$$

$$\phi_{D_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1}{\lambda_2}\right) = 38.52 \ \%$$

(a) Correction at E_2 due to floor thickness assuming 1.00m thick floor

$\frac{\phi_{E_2} - \phi_{D_2}}{d} \times t$ = -2.63 % (-ve)

(b) Correction at E_2 due to pile interference. Pressure at E_2 is affected by pile No.(1)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -1.24 % (-ve)

D	=	2.00	Depth of pile No.1, the effect of which is considered
b'	=	16.60	Distance between two piles
b	=	26.60	Total length of floor
d	=	3.00	Depth of pile No. 2, the effect on

Corrected ϕ_{E_2} = 42.54

(a) Correction at C_2 due to floor thickness. This correction shall be + ve and its amount is the same as was calculated for the point E_2

= 2.63 % (+ve)

(b) Correction at C_2 due to pile interference. Pressure at C_2 is affected by pile No.(3)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 2.35 % (+Ve)

D	=	3.00	Depth of pile No.3, the effect of which is considered below the
b'	=	10.00	Distance between two piles

b	=	26.60	Total length of floor
d	=	3.00	Depth of pile No. 2, the effect on which is considered

Corrected ϕ_{C_2} = 34.76 %

Pile Line No. 3

$\alpha = \frac{b}{d}$ = 4.15

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 2.63

ϕ_{E_3} = 42.24 %

ϕ_{D_3} = 28.69 %

Correction at E_3 due to floor thickness

Correction = $\frac{\phi_{E_3} - \phi_{D_3}}{d} \times t$ = 4.52 % (+Ve)

(b) Correction due to piles

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -2.35 % (-ve)

D	=	3.00	m, Depth of pile No.2
b'	=	10.00	m, Distance between two piles
b	=	26.60	m, Total floor length
d	=	3.00	m, Depth of pile No. 3

Corrected ϕ_{E_3} = 44.41

Pressure Head = 2.60 m

The corrected pressure at various key points are

Upstream Pile No. 1			Intermediate Pile No. 2			Downstream Pille No. 3		
Points	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*
ϕ_{E_1}	100.00	2.60	ϕ_{E_2}	42.54	1.11	ϕ_{E_3}	44.41	1.15
ϕ_{D_1}	68.69	1.79	ϕ_{D_2}	38.52	1.00	ϕ_{D_3}	28.69	0.75
ϕ_{C_1}	59.76	1.55	ϕ_{C_2}	34.76	0.90	ϕ_{C_3}	0.00	0.00

Uplift pressure at x = $P_X = P_{C_1} - \left(\frac{P_{C_1} - P_E}{b'}\right) \times X$

Floor thickness required at T_x = $\frac{P_X}{G-1}$

Distance from the D/S (R/S) end = X

Unit	m	m	m	m
Distance (X)	6.00	10.00	22.60	26.60
Uplift Pressure (P_x)	1.29	1.11	1.13	0.75
Floor thickness required (T_x)	1.03	0.88	0.91	0.60
Floor thickness provided	1.00	1.00	1.00	1.00

Protection Work

Upstream protection works:

Scour depth already computed 'R'	1.9 m
Block protection:	
U/S scour depth R.L. = U/S W.L. - 1.2R =	114.34 m
Scour depth below u/s floor =	0.36 m
let us provide length of inverted filter	2.00 m

C.C. block (0.45m x 0.45m x 0.5m) are provided for a length of 2m above 0.50m thick filter gravel (13mm to 19mm) with spacing of 0.05m filled with stone gravel

U/S launching apron:

Length of U/S apron = 2 x d1, where d1 is required depth of U/S cut off wall	4 m
Let us provide thickness =	1 m

Toe-wall of dimension 1.0m x 0.5m is provided between C.C. Block and launching apron in U/S side

Downstream protection works:

Anticipated scour = 1.5 x R	2.85 m
Block protection:	
D/Sscour depth R.L. = D/S W.L. - 1.5R	111.40 m
Scour depth below D/S floor =	3.31 m
let us provide length of inverted filter	4.00 m

C.C. block (0.45m x 0.45m x 0.5m) are provided for a length of 4m above 0.50m thick filter gravel (13mm to 19mm) with spacing of 0.05m filled with stone gravel

D/S launching apron:

Length of D/S apron = 2 x d2, where d2 is required depth of D/S cut off wall	6 m
Let us provide thickness =	1 m

Toe-wall of dimension 1.0m x 0.5m is provided between C.C. Block and launching apron in D/S side

Executive Engineer
Dibrugarh W.R. Division
Dibrugarh

Design for Sluice Gate E-15/2 (HEC-RAS Station 40053m) on RB

DESIGN DATA

1	Maximum discharge through the sluice required	=	3.61	cumecs
2	Maximum Country side water level (U/S)	=	104.32	m
3	Maximum River side water level (D/S) (HFL)	=	105.01	m
4	Avearege minimum water level (D/S)	=	103.38	m
5	Crest level of embankment	=	106.51	m
6	Ground level at sluice site	=	103.7	m
7	Avg. size of bed material 'd'	=	0.21	mm
8	Silt factor 'f' = 1.76 x $d^{0.5}$		0.81	
9	Permissible exit gradient	=	1 in 6	
10	No. of openings	=	1	
11	Sill level of of sluice	=	102.7	m
12	Length of barrel	=	12.00	
13	Soil properties			
	a) Dry unit weight	=	18.65	kN/m^3
	b) Wet unit weight	=	21.60	kN/m^3
	c) φ	=	25	
14	Bearing capacity of soil	=	90.25	kN/m^2

HYDRAULIC CALCULATION FOR VARIOUS FLOW CONDITION

(a) During high flood condition:-

Up stream H.F.L. = 105.01

Down stream water level for full discharge condition = 105.01 - 0.75 = 104.26 m

Assuming 0.50m retrogration, Down stream water level = 104.26 - 0.50 = 103.76 m

Assuming 0.50m afflux, Up stream water level = 105.01 + 0.50 = 105.51 m

Average discharge intensity, q = Q/b = 3.61 / 2.10 = 1.72 m3/sec/m

Scour depth , R = 1.35 * (q^2/f) ^ (1/3) = 2.08 m

Velocity of approach, V = q/R = 0.83 m/sec

Hence loss of head at entry = $\frac{V^2}{2g}$ = 0.03 m

T.E.L. just Down Stream of the Gate = 105.51 - 0.03 = 105.48 m

Down Stream water level (T.E.L.) = 103.76 m

Hence head loss 105.48 - 103.76 = 1.72 m

(b) Normal flow condition

Up stream N.F.L. = 103.38

Down stream water level for full discharge condition = 103.38 - 1.00 = 102.38 m

Assuming 0.30m retrogration, Down stream water level = 102.38 - 0.30 = 102.08 m

Assuming 0.30m afflux, Up stream water level = 103.38 + 0.30 = 103.68 m

T.E.L. just Down Stream of the Gate = 103.68 - 0.03 = 103.65 m

Down Stream water level (T.E.L.) = 102.08 m

Heance head loss = 103.65 - 102.08 = 1.57 m

Discharge intensity = $\frac{Q}{width \times Nos.}$ = 1.72 cum/sec/m

Sl.No.	Item	High flood		Normal flood	
1	Discharge intensity	1.72 cum/sec/m		1.72 cum/sec/m	
2	D/S T.E.L.	103.76	m	102.08	m
3	U/S T.E.L.	105.48	m	103.65	m
4	Head loss (H_L)	1.72	m	1.57	m
5	D/S specific energy Ef_2	1.62	m	1.56	m
6	U/S specific energy Ef_1 =(Ef_2 + H_L)	3.34	m	3.13	m
7	Level at which jump would from (D/S T.E.L. - Ef_2)	102.14	m	100.52	m
8	Pre jump depth D_1 ($Ef_1 = D_1 + (q/D_1)^2/2g$	0.20	m	0.20	m
9	Post jump depth D_2 ($Ef_2 = D_2 + (q/D_2)^2/2g$	1.50	m	1.50	m
10	Length of concrete floor = 5.00 x (D_2 - D_1)	6.50	m	6.50	m
11	Froude No. $F_1 = \frac{q}{\sqrt{gD_1^3}}$	6.14	m	6.14	m

Let us provide length of stilling basin = 7.00 m (Required =6.5 m) & slope of glacis as 1:2

R.L. of floor level of the stilling basin required = 100.52 m

Let us provide R.L. of stilling basin = 100.70 m

Depth of stilling basin = 102.70 - 100.70 = 2.00 m

Side sply:- angle of sply = $\tan^{-1}\left(\frac{1}{3\times F_1}\right)$ = 3.11 °

Let us provide a sply of30 ° in the U/S side and sply of 23 ° in D/S

DESIGN OF ENERGY DESSIPITATION DEVICE

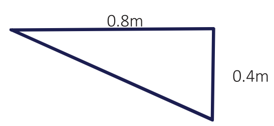
Chute blocks at glacis slope

Height = D_1 = 0.20 m, Provide = 0.20 m D_1 = 0.20 m

Width = D_1 = 0.20 m, Provide = 0.20 m

Length = $2D_1$ = 0.40 m, Provide = 0.40 m

Clear spacing = D_1 = 0.20 m, Provide = 0.20 m



Baffle blocks at 1.20 m from D/S face of chute blocks

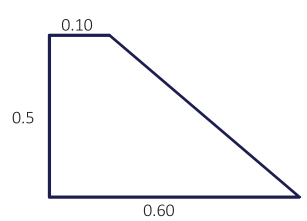
Height = h_b = 0.24 m, provide = 0.30 m h_b/D_1=1.2

Top Width =0.2h_b = 0.05 m, provide = 0.10 m

Width =0.5h_b = 0.12 m, provide = 0.20 m h_b = 0.24

Bottom width =0.2h_b + h_b = 0.40 m, provide = 0.40 m

Clear spacing =0.75h_b = 0.18 m, provide = 0.20 m



End blocks Height = $0.2D_2$ = 0.30 m, provide = 0.30 m

Top length = $0.15D_2$ = 0.23 m, provide = 0.30 m

Width = $0.15D_2$ = 0.23 m, provide = 0.30 m

Clear spacing = $0.15D_2$ = 0.23 m, provide = 0.30 m

Provide two rows at D/S end of stilling basin

CALCULATION OF SCOUR DEPTH

Discharge = Q = 3.61 cumec

Water way = L_o 2.10 m

Discharge intensity = q = $\frac{Q}{L_o}$ = 1.72 cum/sec/m

Silt factor = f = 0.81

Regime scour depth = $R = 1.35\left(\frac{q^2}{f}\right)^{\frac{1}{3}}$ = 2.08 m Say 2.10 m

Say Design scour depth = R_d = 1.25xR = 2.63 m

For U/S cut off wall depth = 1.25 xR = 2.63 m

For D/S cut off wall depth = 1.50 xR = 3.15 m

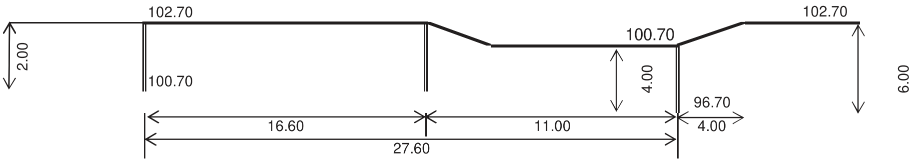
U/S cut off wall level = 102.39 m (Required)

D/S cut off wall level = 101.86 m (Required)

U/S cut off wall depth from floor = 0.31 m Provide 2.00 m

D/S cut off wall depth from floor = 0.84 m Provide 6.00 m

Depth of D/S cut-off wall from stilling basin = 4.00 m



Let us provide the length of different portion of sluice as follows

1	U/S floor	4.00 m
2	Barrel	12.00 m
3	Gate grove	0.60 m
4	U/S slope of stilling basin	4.00 m
5	Stilling basin	7.00 m
6	D/S slope of stilling basin	4.00 m
	Total =	31.60 m

CALCULATION OF EXIT GRADIENT

a) Considering the worst condition, when there will be H.F.L. on R/S and C/S is empty

R/S H.F.L.	= 105.01 m
Assuming 0.50m afflux, R/S water level	= 105.01 + 0.50 = 105.51 m
C/S level	= 102.70 m
Worst head = H	= 105.51 - 102.70 = 2.81 m
Let us consider worst head (H)	= 3.00 m
d = Depth of U/S curtain wall	= 2.00 m
b = distance between piles	= 27.60 m
G_E = exit gradient = 1 : 6	= 0.167

$\alpha = \frac{b}{d}$ = 13.80 $\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 7.42

$G_E = \frac{H}{d}\frac{1}{\pi\sqrt{\lambda}}$ = 0.175 < 0.167 Hence O.K.

b) Considering the worst condition, when there will be H.F.L. on C/S and R/S is empty

C/S H.F.L.	= 104.32 m
R/S level	= 102.70 m
Worst head = H	= 1.62 m
Let us consider worst head (H)	= 2.00 m for safety
d = Depth of D/S curtain wall	= 4.00 m
b = length of floor	= 27.60 m
G_E = exit gradient = 1 : 6	= 0.167

$\alpha = \frac{b}{d}$ = 6.90 $\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 3.99

$G_E = \frac{H}{d}\frac{1}{\pi\sqrt{\lambda}}$ = 0.06 < 0.167 Hence O.K.

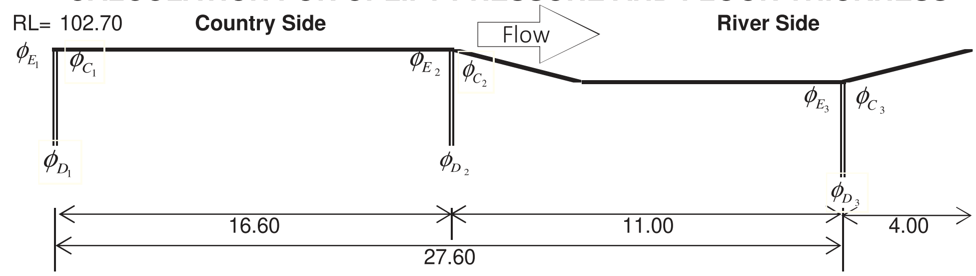
Maintain D/S cutoff wall depth up to 4.00

Hence Provide U/S cutoff depth = 2.00 m (C/S)

Hence Provide D/S cutoff wall depth = 4.00 m (R/S)

Additionaly Provide Intermediate cutoff wall depth = 2.00 m at end of floor

CALCULATION FOR UPLIFT PRESSURE AND FLOOR THICKNESS



Case(1) For seepage flow from country side to river side

Pile line 1	:	RL of floor (Top) =	102.70	Considering floor thickness =	1.00
		RL of floor (Bottom) =	101.70		
		RL of pile (Bottom) =	100.70		
Pile line 2	:	RL of floor (Top) =	102.70	Considering floor thickness =	1.00
		RL of floor (Bottom) =	101.70		
		RL of pile (Bottom) =	100.70		
Pile line 3	:	RL of floor (Top) =	100.70	Considering floor thickness =	1.00
		RL of floor (Bottom) =	99.70		
		RL of pile (Bottom) =	96.70		

Total length of floor =	*b* =	27.60	Distance between pile 1 & 2 =	16.60
Depth of pile line 1 =	d(1) =	2.00	Distance between pile 2 & 3 =	11.00
Depth of pile line 2 =	d(2) =	2.00		
Depth of pile line 3 =	d(3) =	4.00		

Khosla's curve for seepage calculation

Pile line 1

$\alpha = \frac{b}{d}$ = 8.30

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 4.68

$\phi_E = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-2}{\lambda}\right)$

$\phi_D = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-1}{\lambda}\right)$

$\phi_{C_1} = 100 - \phi_E$

$\phi_{D_1} = 100 - \phi_D$

ϕ_E = 30.58 %

ϕ_D = 21.19 %

ϕ_{C_1} = 69.42 %

ϕ_{D_1} = 78.81 %

$\phi_{D_1} - \phi_{C_1}$ = 9.39 %

Correction at c_1 due to floor thickness

Correction = $\frac{\phi_{D_1} - \phi_{C_1}}{d} \times t$ = 9.39 % (+Ve)

(a) Correction at C_1 for Mutual Interference of Piles (affected by intermediate pile No.2)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 0.34 % (+Ve)

D	=	1.00		Depth of pile whose effect is required to be determined on
b'	=	16.60	m	Distance between the piles
b	=	27.60	m	Total length of floor
d	=	1.00	m	Depth of pile on whose the effect of another pile of depth D is required to be determined

Hence

Corrected ϕ_{C_1} = ϕ_{C_1} + Correction for floor thickness + Correction for interference

ϕ_{C_1} = 79.15 %

ϕ_{D_1} = 78.81 %

Pile Line 2

$\alpha_1 = \frac{b_1}{d}$ = 8.30 $\quad \alpha_2 = \frac{b_2}{d}$ = 5.50

$$\lambda_1 = \frac{\sqrt{1+\alpha_1^2} - \sqrt{1+\alpha_2^2}}{2} = 1.384927$$

$$\lambda_2 = \frac{\sqrt{1+\alpha_1^2} + \sqrt{1+\alpha_2^2}}{2} = 6.98$$

$$\phi_{E_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 - 1}{\lambda_2}\right) = 48.22 \ \%$$

$$\phi_{C_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 + 1}{\lambda_2}\right) = 38.88 \ \%$$

$$\phi_{D_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1}{\lambda_2}\right) = 43.62 \ \%$$

(a) Correction at E_2 due to floor thickness assuming 1.00m thick floor

$\frac{\phi_{E_2} - \phi_{D_2}}{d} \times t$ = -4.60 % (-ve)

4.60

(b) Correction at E_2 due to pile interference. Pressure at E_2 is affected by pile No. 1

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -0.34 % (-ve)

D	=	1.00	Depth of pile No.1, the effect of which is considered
b'	=	16.60	Distance between two piles
b	=	27.60	Total length of floor
d	=	1.00	Depth of pile No. 2, the effect on

Corrected ϕ_{E_2} = 43.28 %

(a) Correction at C_2 due to floor thickness. This correction shall be + ve and its amount is the same as was calculated for the point E_2

= 4.60 % (+ve)

(b) Correction at C_2 due to pile interference. Pressure at C_2 is affected by pile No. 3

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 1.44 % (+Ve)

D	=	3.00	Depth of pile No.3, the effect of which is considered below the level
b'	=	11.00	Distance between two piles
b	=	27.60	Total length of floor
d	=	1.00	Depth of pile No. 2, the effect on which is considered

Corrected ϕ_{C_2} = 44.92 %

Pile Line No. 3

$\alpha = \frac{b}{d}$ = 2.75

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 1.96

ϕ_{E_3} = 50.58 %

ϕ_{D_3} = 33.66 %

Correction at E_3 due to floor thickness

Correction = $\frac{\phi_{E_3} - \phi_{D_3}}{d} \times t$ = 5.64 % (+Ve)

(b) Correction due to piles

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -0.83 % (-ve)

D	=	1.00	Depth of pile No.2
b'	=	11.00	Distance between two piles
b	=	27.60	Total floor length
d	=	3.00	Depth of pile No. 3

Corrected ϕ_{E_3} = 55.39

Pressure Head = 1.62 m

The corrected pressure at various key points are

Upstream Pile No. 1			*Intermediate Pile No. 2*			*Downstream Pille No. 3*		
Points	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*
ϕ_{E_1}	100.00	1.62	ϕ_{E_2}	43.28	0.70	ϕ_{E_3}	55.39	0.90
ϕ_{D_1}	78.81	1.28	ϕ_{D_2}	43.62	0.71	ϕ_{D_3}	33.66	0.55
ϕ_{C_1}	79.15	1.29	ϕ_{C_2}	44.92	0.73	ϕ_{C_3}	0.00	0.00

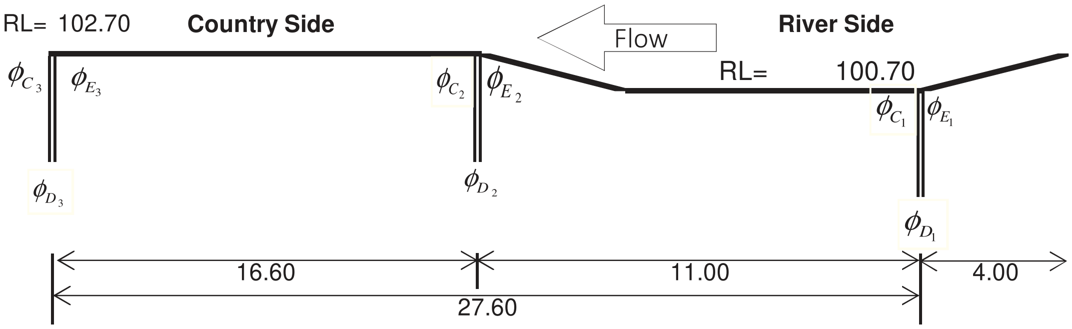
Uplift pressure at x = $P_X = P_{C_1} - \left(\frac{P_{C_1} - P_E}{b'}\right) \times X$

Floor thickness required at T_x = $\frac{P_X}{G-1}$

Distance from the U/S (C/S) end = X

Unit	m	m	m	m
Distance (X)	4.00	16.60	20.60	27.60
Uplift Pressure (P_x)	1.14	0.52	0.83	0.37
Floor thickness required (T_x)	0.92	0.42	0.66	0.30
Floor thickness provided	1.00	1.00	1.00	1.00

CALCULATION FOR UPLIFT PRESSURE AND FLOOR THICKNESS



Case(2) For seepage flow from River side to Country side side

Pile line 1	:	RL of floor (Top) =	100.70	Considering floor thickness =	1.00
		RL of floor (Bottom) =	99.70		
		RL of pile (Bottom) =	96.70		
Pile line 2	:	RL of floor (Top) =	102.70	Considering floor thickness =	1.00
		RL of floor (Bottom) =	101.70		
		RL of pile (Bottom) =	100.70		
Pile line 3	:	RL of floor (Top) =	102.70	Considering floor thickness =	1.00
		RL of floor (Bottom) =	101.70		
		RL of pile (Bottom) =	100.70		

Total length of floor =	b =	27.60	Distance between pile 1 & 2 =	11.00
Depth of pile line 1 =	d(1) =	4.00	Distance between pile 2 & 3 =	16.60
Depth of pile line 2 =	d(2) =	2.00		
Depth of pile line 3 =	d(3) =	2.00		

Khosla's curve for seepage calculation

Pile line 1

$\alpha = \frac{b}{d}$ = 2.75

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 1.96

ϕ_E = 50.58 %

ϕ_D = 33.66 %

ϕ_{C_1} = 49.42 %

ϕ_{D_1} = 66.34 %

$$\phi_E = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-2}{\lambda}\right)$$

$$\phi_D = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-1}{\lambda}\right)$$

$$\phi_{C_1} = 100 - \phi_E$$

$$\phi_{D_1} = 100 - \phi_D$$

$\phi_{D_1} - \phi_{C_1}$ = 16.91 %

Correction at c_1 due to floor thickness

Correction = $\frac{\phi_{D_1} - \phi_{C_1}}{d} \times t$ = 16.91 % (+Ve)

(a) Correction at C_1 for Mutual Interference of Piles (affected by intermediate pile No.2)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 1.17 % (+Ve)

D	=	3.00	Depth of pile whose effect is required to be determined on neighbouring pile of depth d	
b'	=	16.60	m	Distance betwwen the piles
b	=	27.60	m	Total length of floor
d	=	1.00	m	Depth of pile on whose the effect of another pile of depth D is required to be determined

Hence

Corrected ϕ_{C_1} = ϕ_{C_1} + Correction for floor thickness + Crrection for interference

ϕ_{C_1} = 67.51 %

ϕ_{D_1} = 66.34 %

Pile Line 2

$\alpha_1 = \frac{b_1}{d}$ = 4.15 $\alpha_2 = \frac{b_2}{d}$ = 5.50

$$\lambda_1 = \frac{\sqrt{1+\alpha_1^2} - \sqrt{1+\alpha_2^2}}{2} = -0.66$$

$$\lambda_2 = \frac{\sqrt{1+\alpha_1^2} + \sqrt{1+\alpha_2^2}}{2} = 4.93$$

$$\phi_{E_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 - 1}{\lambda_2}\right) = 60.91 \ \%$$

$$\phi_{C_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1 + 1}{\lambda_2}\right) = 47.79 \ \%$$

$$\phi_{D_2} = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda_1}{\lambda_2}\right) = 54.26 \ \%$$

(a) Correction at E_2 due to floor thickness assuming 1.00m thick floor

$$\frac{\phi_{E_2} - \phi_{D_2}}{d} \times t = -6.66 \ \% \text{ (-ve)}$$

(b) Correction at E_2 due to pile interference. Pressure at E_2 is affected by pile No.(1)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -1.17 % (-ve)

D	=	3.00	Depth of pile No.1, the effect of which is considered
b'	=	16.60	Distance between two piles
b	=	27.60	Total length of floor
d	=	1.00	Depth of pile No. 2, the effect on

Corrected ϕ_{E_2} = 53.09

(a) Correction at C_2 due to floor thickness. This correction shall be + ve and its amount is the same as was calculated for the point E_2

= 6.66 % (+ve)

(b) Correction at C_2 due to pile interference. Pressure at C_2 is affected by pile No.(3)

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = 0.42 % (+Ve)

D	=	1.00	Depth of pile No.3, the effect of which is considered below the
b'	=	11.00	Distance between two piles

b = 27.60 Total length of floor
d = 1.00 Depth of pile No. 2, the effect on which is considered

Corrected ϕ_{C_2} = 54.86 %

Pile Line No. 3

$\alpha = \frac{b}{d}$ = 8.30

$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 4.68

ϕ_{E_3} = 30.58 %

ϕ_{D_3} = 21.19 %

Correction at E_3 due to floor thickness

Correction = $\frac{\phi_{E_3} - \phi_{D_3}}{d} \times t$ = 9.39 % (+Ve)

(b) Correction due to piles

Correction = $C = 19\sqrt{\frac{D}{b'}}\left(\frac{d+D}{b}\right)$ = -0.42 % (-ve)

D = 1.00 m, Depth of pile No.2
b' = 11.00 m, Distance between two piles
b = 27.60 m, Total floor length
d = 1.00 m, Depth of pile No. 3

Corrected ϕ_{E_3} = 39.55

Pressure Head = 2.31 m

The corrected pressure at various key points are

Upstream Pile No. 1			*Intermediate Pile No. 2*			*Downstream Pille No. 3*		
Points	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*	*Points*	*% Pressure*	*Residual Head*
ϕ_{E_1}	100.00	2.31	ϕ_{E_2}	53.09	1.23	ϕ_{E_3}	39.55	0.91
ϕ_{D_1}	66.34	1.53	ϕ_{D_2}	54.26	1.25	ϕ_{D_3}	21.19	0.49
ϕ_{C_1}	67.51	1.56	ϕ_{C_2}	54.86	1.27	ϕ_{C_3}	0.00	0.00

Uplift pressure at x = $P_X = P_{C_1} - \left(\frac{P_{C_1} - P_E}{b'}\right) \times X$

Floor thickness required at T_x = $\frac{P_X}{G-1}$

Distance from the D/S (R/S) end = X

Unit	m	m	m	m
Distance (X)	7.00	11.00	23.60	27.60
Uplift Pressure (P_x)	1.35	1.23	0.95	0.49
Floor thickness required (T_x)	1.08	0.98	0.76	0.39
Floor thickness provided	1.00	1.00	1.00	1.00

Protection Work

Upstream protection works:

Scour depth already computed 'R'	2.1 m
Block protection:	
U/S scour depth R.L. = U/S W.L. - 1.2R =	101.70 m
Scour depth below u/s floor =	1.00 m
let us provide length of inverted filter	1.00 m

C.C. block (0.45m x 0.45m x 0.5m) are provided for a length of 1m above 0.50m thick filter gravel (13mm to 19mm) with spacing of 0.05m filled with stone gravel

U/S launching apron:

Length of U/S apron = 2 x d1, where d1 is required depth of U/S cut off wall	4 m
Let us provide thickness =	1 m

Toe-wall of dimension 1.0m x 0.5m is provided between C.C. Block and launching apron in U/S side

Downstream protection works:

Anticipated scour = 1.5 x R	3.15 m
Block protection:	
D/Sscour depth R.L. = D/S W.L. - 1.5R	98.66 m
Scour depth below D/S floor =	4.04 m
let us provide length of inverted filter	4.00 m

C.C. block (0.45m x 0.45m x 0.5m) are provided for a length of 4m above 0.50m thick filter gravel (13mm to 19mm) with spacing of 0.05m filled with stone gravel

D/S launching apron:

Length of D/S apron = 2 x d2, where d2 is required depth of D/S cut off wall	8 m
Let us provide thickness =	1 m

Toe-wall of dimension 1.0m x 0.5m is provided between C.C. Block and launching apron in D/S side

Executive Engineer
Dibrugarh W.R. Division
Dibrugarh

Design for Sluice Gate E-27/1 (HEC-RAS Station 109671 m) on Tipling LB

DESIGN DATA

1	Maximum discharge through the sluice required	=	7.01	cumecs
2	Maximum Country side water level (U/S)	=	117.89	m
3	Maximum River side water level (D/S) (HFL)	=	118.63	m
4	Avearege minimum water level (D/S)	=	117.00	m
5	Crest level of embankment	=	120.13	m
6	Ground level at sluice site	=	117.3	m
7	Avg. size of bed material 'd'	=	0.21	mm
8	Silt factor 'f' = 1.76 x $d^{0.5}$		0.81	
9	Permissible exit gradient	=	1 in 6	
10	No. of openings	=	1	
11	Sill level of of sluice	=	116.4	m
12	Length of barrel	=	12.00	
13	Soil properties			
	a) Dry unit weight	=	18.65	kN/m^3
	b) Wet unit weight	=	21.60	kN/m^3
	c) φ	=	25	
14	Bearing capacity of soil	=	90.25	kN/m^2

<u>**HYDRAULIC CALCULATION FOR VARIOUS FLOW CONDITION**</u>

(a) During high flood condition:-

Up stream H.F.L. = 118.63

Down stream water level for full discharge condition = 118.63 - 0.75 = 117.88 m

Assuming 0.50m retrogration, Down stream water level = 117.88 - 0.50 = 117.38 m

Assuming 0.50m afflux, Up stream water level = 118.63 + 0.50 = 119.13 m

Average discharge intensity, q = Q/b = 7.01 / 2.10 = 3.34 m3/sec/m

Scour depth , R = $1.35 * (q^2/f)$ ^ (1/3) = 3.24 m

Velocity of approach, V = q/R = 1.03 m/sec

Hence loss of head at entry = $\frac{V^2}{2g}$ = 0.05 m

T.E.L. just Down Stream of the Gate = 119.13 - 0.05 = 119.08 m

Down Stream water level (T.E.L.) = 117.38 m

Hence head loss 119.08 - 117.38 = 1.70 m

(b) Normal flow condition

Up stream N.F.L. = 117.00

Down stream water level for full discharge condition = 117.00 - 1.00 = 116.00 m

Assuming 0.30m retrogration, Down stream water level = 116.00 - 0.30 = 115.70 m

Assuming 0.30m afflux, Up stream water level = 117.00 + 0.30 = 117.30 m

T.E.L. just Down Stream of the Gate = 117.30 - 0.05 = 117.25 m

Down Stream water level (T.E.L.) = 115.70 m

Heance head loss = 117.25 - 115.70 = 1.55 m

Discharge intensity = $\frac{Q}{width \times Nos.}$ = 3.34 cum/sec/m

Sl.No.	Item	High flood		Normal flood	
1	Discharge intensity	3.34 cum/sec/m		3.34 cum/sec/m	
2	D/S T.E.L.	117.38	m	115.70	m
3	U/S T.E.L.	119.08	m	117.25	m
4	Head loss (H_L)	1.70	m	1.55	m
5	D/S specific energy Ef_2	2.31	m	2.27	m
6	U/S specific energy $Ef_1 = (Ef_2 + H_L)$	4.01	m	3.82	m
7	Level at which jump would from (D/S T.E.L. - Ef_2)	115.07	m	113.43	m
8	Pre jump depth D_1 ($Ef_1 = D_1 + (q/D_1)^2/2g$)	0.40	m	0.40	m
9	Post jump depth D_2 ($Ef_2 = D_2 + (q/D_2)^2/2g$)	2.20	m	2.20	m
10	Length of concrete floor = 5.00 x (D_2 - D_1)	9.00	m	9.00	m
11	Froude No. $F_1 = \frac{q}{\sqrt{gD_1^3}}$	4.21	m	4.21	m

Let us provide length of stilling basin = 9.00 m (Required =9 m) & slope of glacis as 1:2

R.L. of floor level of the stilling basin required = 113.43 m

Let us provide R.L. of stilling basin = 114.40 m

Depth of stilling basin = 116.40 - 114.40 = 2.00 m

Side sply:- angle of sply = $\tan^{-1}\left(\frac{1}{3 \times F_1}\right)$ = 4.52 °

Let us provide a sply of30 ° in the U/S side and sply of 23 ° in D/S

DESIGN OF ENERGY DESSIPITATION DEVICE

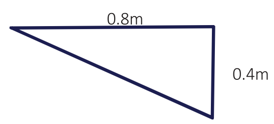
Chute blocks at glacis slope

Height = D_1 = 0.40 m, Provide = 0.40 m D_1 = 0.40 m

Width = D_1 = 0.40 m, Provide = 0.40 m

Length = $2D_1$ = 0.80 m, Provide = 0.80 m

Clear spacing = D_1 = 0.40 m, Provide = 0.40 m



Baffle blocks at 1.80 m from D/S face of chute blocks

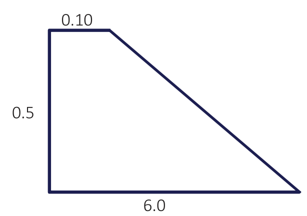
Height = h_b = 0.48 m, provide = 0.50 m h_b/D_1=1.2

Top Width =$0.2h_b$ = 0.10 m, provide = 0.10 m

Width =$0.5h_b$ = 0.24 m, provide = 0.30 m h_b = 0.48

Bottom width =$0.2h_b + h_b$ = 0.60 m, provide = 0.60 m

Clear spacing =$0.75h_b$ = 0.36 m, provide = 0.40 m



End blocks	Height = $0.2D_2$ =	0.44 m, provide =	0.50	m
	Top length = $0.15D_2$ =	0.33 m, provide =	0.40	m
	Width = $0.15D_2$ =	0.33 m, provide =	0.40	m
	Clear spacing = $0.15D_2$ =	0.33 m, provide =	0.40	m

Provide two rows at D/S end of stilling basin

CALCULATION OF SCOUR DEPTH

Discharge = Q = 7.01 cumec

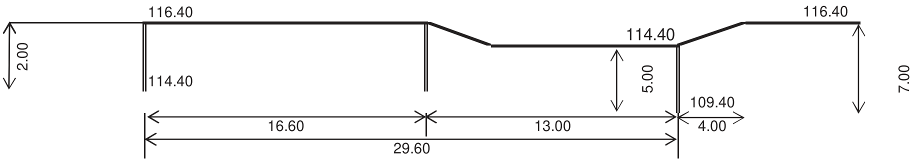
Water way = L_o 2.10 m

Discharge intensity = q = $\frac{Q}{L_o}$ = 3.34 cum/sec/m

Silt factor = f = 0.81

Regime scour depth = $R = 1.35\left(\frac{q^2}{f}\right)^{\frac{1}{3}}$ = 3.24 m Say 3.30 m

Say Design scour depth = R_d = 1.25xR =	4.13 m			
For U/S cut off wall depth = 1.25 xR =	4.13 m			
For D/S cut off wall depth = 1.50 xR =	4.95 m			
U/S cut off wall level =	114.51 m (Required)			
D/S cut off wall level =	113.68 m (Required)			
U/S cut off wall depth from floor =	1.90 m	Provide	2.00	m
D/S cut off wall depth from floor =	2.72 m	Provide	7.00	m
Depth of D/S cut-off wall from stilling basin =	5.00 m			



Let us provide the length of different portion of sluice as follows

1	U/S floor	4.00 m
2	Barrel	12.00 m
3	Gate grove	0.60 m
4	U/S slope of stilling basin	4.00 m
5	Stilling basin	9.00 m
6	D/S slope of stilling basin	4.00 m
	Total =	33.60 m

CALCULATION OF EXIT GRADIENT

a) Considering the worst condition, when there will be H.F.L. on R/S and C/S is empty

R/S H.F.L.	= 118.63 m
Assuming 0.50m afflux, R/S water level	= 118.63 + 0.50 = 119.13 m
C/S level	= 116.40 m
Worst head = H	= 119.13 - 116.40 = 2.73 m
Let us consider worst head (H)	= 3.00 m
d = Depth of U/S curtain wall	= 2.00 m
b = distance between piles	= 29.60 m
G_E = exit gradient = 1 : 6	= 0.167

$\alpha = \frac{b}{d}$ = 14.80 $\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 7.92

$G_E = \frac{H}{d}\frac{1}{\pi\sqrt{\lambda}}$ = 0.170 < 0.167 Hence O.K.

b) Considering the worst condition, when there will be H.F.L. on C/S and R/S is empty

C/S H.F.L.	= 117.89 m
R/S level	= 116.40 m
Worst head = H	= 1.49 m
Let us consider worst head (H)	= 2.00 m for safety
d = Depth of D/S curtain wall	= 5.00 m
b = length of floor	= 29.60 m
G_E = exit gradient = 1 : 6	= 0.167

$\alpha = \frac{b}{d}$ = 5.92 $\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$ = 3.50

$G_E = \frac{H}{d}\frac{1}{\pi\sqrt{\lambda}}$ = 0.05 < 0.167 Hence O.K.

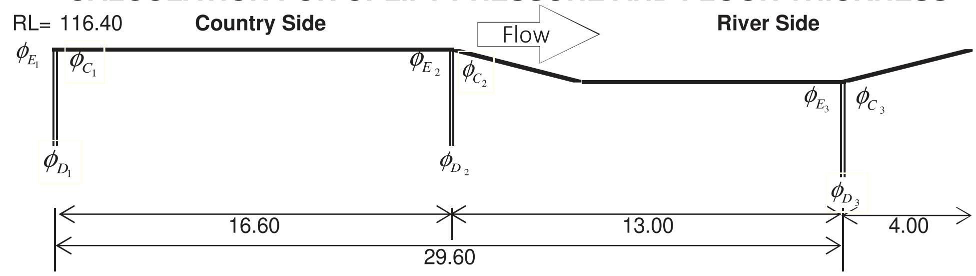
Maintain D/S cutoff wall depth up to 5.00

Hence Provide U/S cutoff depth = 2.00 m (C/S)

Hence Provide D/S cutoff wall depth = 5.00 m (R/S)

Additionaly Provide Intermediate cutoff wall depth = 2.00 m at end of floor

CALCULATION FOR UPLIFT PRESSURE AND FLOOR THICKNESS



Case(1) For seepage flow from country side to river side

Pile line 1	:	RL of floor (Top) =	116.40	Considering floor thickness =	1.00
		RL of floor (Bottom) =	115.40		
		RL of pile (Bottom) =	114.40		
Pile line 2	:	RL of floor (Top) =	116.40	Considering floor thickness =	1.00
		RL of floor (Bottom) =	115.40		
		RL of pile (Bottom) =	114.40		
Pile line 3	:	RL of floor (Top) =	114.40	Considering floor thickness =	1.00
		RL of floor (Bottom) =	113.40		
		RL of pile (Bottom) =	109.40		

Total length of floor =	*b* =	29.60	Distance between pile 1 & 2 =	16.60
Depth of pile line 1 =	d(1) =	2.00	Distance between pile 2 & 3 =	13.00
Depth of pile line 2 =	d(2) =	2.00		
Depth of pile line 3 =	d(3) =	5.00		

Khosla's curve for seepage calculation

Pile line 1

$$\alpha = \frac{b}{d} = 8.30$$

$$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2} = 4.68$$

$$\phi_E = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-2}{\lambda}\right)$$

$$\phi_D = \left(\frac{1}{\pi}\right)\cos^{-1}\left(\frac{\lambda-1}{\lambda}\right)$$

$$\phi_{C_1} = 100-\phi_E$$

$$\phi_{D_1} = 100-\phi_D$$

ϕ_E = 30.58 %

ϕ_D = 21.19 %

ϕ_{C_1} = 69.42 %

ϕ_{D_1} = 78.81 %

$\phi_{D_1}-\phi_{C_1}$ = 9.39 %

Correction at c_1 due to floor thickness

Correction = $\dfrac{\phi_{D_1}-\phi_{C_1}}{d}\times t$ = 9.39 % (+Ve)

(a) Correction at C_1 for Mutual Interference of Piles (affected by intermediate pile No.2)

Correction = $C = 19\sqrt{\dfrac{D}{b'}}\left(\dfrac{d+D}{b}\right)$ = 0.32 % (+Ve)

D	=	1.00		Depth of pile whose effect is required to be determined on
b'	=	16.60	m	Distance between the piles
b	=	29.60	m	Total length of floor
d	=	1.00	m	Depth of pile on whose the effect of another pile of depth D is required to be determined

Hence

Corrected ϕ_{C_1} = ϕ_{C_1} + Correction for floor thickness + Correction for interference

ϕ_{C_1} = 79.13 %

ϕ_{D_1} = 78.81 %

CHAPTER- 7

BC RATIO

Name of the Scheme: Integrated Water Resources Management of Buridehing Basin

BENEFIT COST RATIO

CAPITAL COST		
1	Cost of the scheme	₹ 733,04,73,000.00
ANNUAL COST		
(i)	Interest Charge @10% of the Capital cost	₹ 73,30,47,300.00
(ii)	Depreciation @2% 0f the Capital Cost	₹ 14,66,09,460.00
(iii)	Maintenance @5% 0f the Capital Cost	₹ 36,65,23,650.00
		₹ 124,61,80,410.00
	Total Annual Cost	**₹ 124,61,80,410.00**
ANNUAL Loss		
(i)	Dibrugarh East Revenue Circle	₹ 17,34,00,000.00
(ii)	Dibrugarh West Revenue Circle	₹ 65,99,00,000.00
(iii)	Moran Revenue Circle, Dibrugarh	₹ 29,15,00,000.00
(iv)	Naharkatia Revenue Circle	₹ 48,43,00,000.00
(v)	Tingkhong Revenue Circle	₹ 36,04,00,000.00
(vi)	Tengakhat Revenue Circle	₹ 38,34,00,000.00
(vii)	Chabua Revenue Circle	₹ 4,03,00,000.00
(viii)	Margherita Revenue Circle	₹ 45,09,00,000.00
		₹ 2,84,41,00,000.00
	Total Annual Loss	**₹ 2,84,41,00,000.00**

Benefit Cost Ratio=Annaual Benefit/Annual Cost

= ₹ 2,84,41,00,000.00 / ₹ 124,61,80,410.00

= 2.282:1

Say. 2.28 **:1**

Superintending Engineer W.R. Department NMP Circle, Dibrugarh	Executive Engineer Dibrugarh WR Division Dibrugarh

GOVT. OF ASSAM

OFFICE OF THE CIRCLE OFFICER : DIBRUGARH EAST REVENUE CIRCLE

DIBRUGARH

No. DEC6/2014-18/part3/224/1701 Date: 1.1/2/18

To

The Executive Engineer
Dibrugarh W.R. Division,
Dibrugarh

Subject: Statement of actual loss/anticipated loss due to flooding & erosion problem of Burideing River under Dibrugarh East Revenue Circle

Ref: Your letter no. M-14/8/Dib/17-18/765-70 Dt. 15/02/2018
Name of scheme: Integrated Water Resources Management of Burideing Basin.

Sir,

With refrence to the subject cited, I would like to furnish the following information in respect of anticipated loss due to breach/damage of embankment

A. Anticipated loss due to breach of embankment

a. Tea Estates including land, plantation and other properties	=	₹ 100.00 Cr.
b. Oil India Limited	=	₹ 60.00 Cr.
c. Assam PWD Buildings	=	₹ 60.00 Cr.
d. Assam PWD Roads	=	₹ 120.00 Cr.
e. Assam Health Department	=	₹ 22.00 Cr.
f. Assam Agricultural Department	=	₹ 22.00 Cr.
g. Assam Tourism Department	=	Cr.
h. Forest Department	=	₹ 150.00 Cr.
i. Assam Electricity Department	=	₹ 48.00 Cr.
j. Other loss such as veterinary and fishery	=	₹ 65.00 Cr.
k. Private land and properties	=	₹ 220.00 Cr.
l. N.F. Railway	=	₹ 0.00 Cr.
Total anticipated loss	=	₹ 867.00 Cr.
Total annual anticipated loss due to flooding and inundation considering 50 years life of project	=	***₹ 17.34 Cr.***

Circle Officer
Dibrugarh East Revenue Circle
Dibrugarh

GOVT. OF ASSAM
OFFICE OF THE CIRCLE OFFICER : DIBRUGARH WEST REVENUE CIRCLE
DIBRUGARH

No. [illegible]/2011/Misc/1045 Date: 19-[illegible]-2018

To

The Executive Engineer
Dibrugarh W.R. Division,
Dibrugarh

Subject: Statement of actual loss/anticipated loss due to flooding & erosion problem of Burldehing River under Dibrugarh West Revenue Circle

Ref: Your letter no. M-14/B/Dib/17-18/765-70 Dt. 15/02/2018
Name of scheme: Integrated Water Resources Management of Buridehing Basin.

Sir,

With refrence to the subject cited, I would like to furnish the following information in respect of actual loss of crops, buildings, public properties/institutions etc due to flooding & erosion of River Buridehing and also the anticipated loss due to breach/damage of embankment

A. Loss due to erosion in last 30 years

Total area eroded due to erosion	=	200.00 Hectares	=	1494 bighas		
a. Homestead Land Lost	=	1698 bighas	@	₹ 45,000.00 /bigha	=	₹ 76,387,500.00
b. Cultivable Land Lost	=	11883 bighas	@	₹ 33,000.00 /bigha	=	₹ 392,122,500.00
c. Fallow Land Lost	=	3395 bighas	@	₹ 20,000.00 /bigha	=	₹ 67,900,000.00
d. Loss of crop in cultivable land(Paddy production @ 4Qtl/Bigha)	=	47530 Qtl	@	₹ 1,100.00 /qtl	=	₹ 52,283,000.00
e. Damage to house	=	670 Nos.	@	₹ 50,000.00 /hous	=	₹ 33,500,000.00
				Total Loss during 30 years	=	₹ 622,193,000.00
Total annual damage due to erosion =					=	₹ 20,739,766.67
				Total annual damage due to erosion	=	***₹ 2.07 Cr.***

B. Anticipated loss due to bank erosion

a. Tea Estates including land, plantation and other properties	=	₹ 80.00 Cr.
b. BCP Ltd	=	₹ 55.00 Cr.
c. Assam PWD Buildings	=	₹ 45.00 Cr.
d. Assam PWD Roads	=	₹ 110.00 Cr.
e. Assam Health Department	=	₹ 20.00 Cr.
f. Assam Agricultural Department	=	₹ 20.00 Cr.
g. Assam Tourism Department	=	₹ 160.00 Cr.
h. Forest Department	=	₹ 8.00 Cr.
i. Assam Electricity Department	=	₹ 48.00 Cr.
j. Other loss such as veterinary and fishery	=	₹ 90.00 Cr.
k. Private land and properties	=	₹ 185.00 Cr.
l. N.F. Railway	=	₹ 230.00 Cr.
Total anticipated loss due to bank erosion	=	₹ 1,051.00 Cr.
Total annual anticipated loss due to bank erosion considering 50 years life of project	=	***₹ 21.02 Cr.***

B. Anticipated loss due to breach of embankment

a. Tea Estates including land, plantation and other properties	=	₹ 160.00 Cr.
b. BCP Ltd	=	₹ 1,130.00 Cr.
c. Assam PWD Buildings	=	₹ 85.00 Cr.
d. Assam PWD Roads	=	₹ 220.00 Cr.
e. Assam Health Department	=	₹ 35.00 Cr.
f. Assam Agricultural Department	=	₹ 30.00 Cr.
g. Assam Tourism Department	=	₹ 25.00 Cr.
h. Forest Department	=	₹ 15.00 Cr.
i. Assam Electricity Department	=	₹ 60.00 Cr.
j. Other loss such as veterinary and fishery	=	₹ 45.00 Cr.
k. Private land and properties	=	₹ 160.00 Cr.
l. N.F. Railway	=	₹ 180.00 Cr.
Total anticipated loss	=	₹ 2,145.00 Cr.
Total annual anticipated loss due to flooding and innundation considering 50 years life of project	=	***₹ 42.90 Cr.***

HENCE TOTAL LOSS OF PROPERTIES WITH LAND & CROP = A + B + C = ₹ 65.99 *Cr.*

Circle Officer
Dibrugarh West Revenue Circle
Dibrugarh

GOVT. OF ASSAM

OFFICE OF THE CIRCLE OFFICER : MORAN REVENUE CIRCLE

MORAN, DIBRUGARH

No. MRC/56/Releof/2016-17/107 Date: 19-2-2018

To

The Executive Engineer

Dibrugarh W.R. Division,

Dibrugarh

Subject: Statement of actual loss/anticipated loss due to flooding & erosion problem of Burideling River under Moran Revenue Circle

Ref; Your letter no. M-14/8/Dib/17-18/765-70 Dt. 15/02/2018

Name of scheme: Integrated Water Resources Management of Burideling Basin.

Sir,

With refrence to the subject cited, I would like to furnish the following information in respect of actual loss of crops, buildings, public properties/institutions etc due to flooding & erosion of River Burideling and also the anticipated loss due to breach/damage of embankment

A. Loss due to erosion in last 30 years

Total area eroded due to erosion	= 125.00 Hectares =	934 bighas		
a. Homestead Land Lost	= 868.1 bighas	@ ₹ 45,000.00 /bigha =		₹ 39,064,500.00
b. Cultivable Land Lost	= 6077 bighas	@ ₹ 33,000.00 /bigha =		₹ 200,531,100.00
c. Fallow Land Lost	= 1736 bighas	@ ₹ 20,000.00 /bigha =		₹ 34,724,000.00
d. Loss of crop in cultivable land(Paddy production @ 4Qtl/Bigha)	= 24307 Qtl	@ ₹ 1,100.00 /qtl =		₹ 26,737,480.00
e. Damage to house	= 300 Nos.	@ ₹ 50,000.00 /hous =		₹ 15,000,000.00
		Total Loss during 30 years =		₹ 316,057,080.00
Total annual damage due to erosion =			=	₹ 10,535,236.00
		Total annual damage due to erosion	=	***₹ 1.05 Cr.***

B. Anticipated loss due to bank erosion

a. Tea Estates including land, plantation and other properties	=	₹ 40.00 Cr.
b. N.F. Railway	=	₹ 150.00 Cr.
c. Assam PWD Buildings	=	₹ 25.00 Cr.
d. Assam PWD Roads	=	₹ 70.00 Cr.
e. Assam Health Department	=	₹ 15.00 Cr.
f. Assam Agricultural Department	=	₹ 22.00 Cr.
g. Assam Tourism Department	=	₹ 20.00 Cr.
h. Forest Department	=	₹ 5.00 Cr.
i. Assam Electricity Department	=	₹ 25.00 Cr.
j. Other loss such as veterinary and fishery	=	₹ 50.00 Cr.
k. Private land and properties	=	₹ 110.00 Cr.
Total anticipated loss due to bank erosion	=	₹ 532.00 Cr.
Total annual anticipated loss due to bank erosion considering 50 years life of project	=	***₹ 10.64 Cr.***

B. Anticipated loss due to breach of embankment

a. Tea Estates including land, plantation and other properties	=	₹ 260.00 Cr.
b. N.F. Railway	=	₹ 180.00 Cr.
c. Assam PWD Buildings	=	₹ 50.00 Cr.
d. Assam PWD Roads	=	₹ 135.00 Cr.
e. Assam Health Department	=	₹ 10.00 Cr.
f. Assam Agricultural Department	=	₹ 20.00 Cr.
g. Assam Tourism Department	=	₹ 100.00 Cr.
h. Forest Department	=	₹ 6.00 Cr.
i. Assam Electricity Department	=	₹ 27.00 Cr.
j. Other loss such as veterinary and fishery	=	₹ 40.00 Cr.
k. Private land and properties	=	₹ 45.00 Cr.
Total anticipated loss due to bank erosion	=	₹ 873.00 Cr.
Total annual anticipated loss due to flooding and inundation considering 50 years life of project	=	***₹ 17.46 Cr.***

HENCE TOTAL LOSS OF PROPERTIES WITH LAND & CROP = A + B + C = **₹ 29.15 Cr.**

Circle Officer
Moran Revenue Circle
Moran, Dibrugarh

GOVT. OF ASSAM

OFFICE OF THE CIRCLE OFFICER : NAHARKATIA REVENUE CIRCLE

NAHARKATIA, DIBRUGARH

No. NRC/DM/25/12-13/98 Date: 20.02.18

To

The Executive Engineer
Dibrugarh W.R. Division,
Dibrugarh

Subject: Statement of actual loss/anticipated loss due to flooding & erosion problem of Buridehing River under Naharkatia Revenue Circle

Ref: Your letter no. M-14/B/Dib/17-18/765-70 Dt. 15/02/2018
Name of scheme: Integrated Water Resources Management of Buridehing Basin.

Sir,

With refrence to the subject cited, I would like to furnish the following information in respect of actual loss of crops, buildings, public properties/institutions etc due to flooding & erosion of River Buridehing and also the anticipated loss due to breach/damage of embankment

A. Loss due to erosion in last 30 years

Total area eroded due to erosion	=	80.00 Hectares	=	598 bighas		
a. Homestead Land Lost	=	829.5 bighas	@	₹ 45,000.00 /bigha	=	₹ 37,327,500.00
b. Cultivable Land Lost	=	5807 bighas	@	₹ 33,000.00 /bigha	=	₹ 191,614,500.00
c. Fallow Land Lost	=	1659 bighas	@	₹ 20,000.00 /bigha	=	₹ 33,180,000.00
d. Loss of crop in cultivable land(Paddy production @ 4Qtl/Bigha)	=	23226 Qtl	@	₹ 1,100.00 /qtl	=	₹ 25,548,600.00
e. Damage to house	=	450 Nos.	@	₹ 50,000.00 /house	=	₹ 22,500,000.00
				Total Loss during 30 years	=	₹ 310,170,600.00
Total annual damage due to erosion =					=	₹ 10,339,020.00
				Total annual damage due to erosion	=	***₹ 1.03 Cr.***

B. Anticipated loss due to bank erosion

a. Tea Estates including land, plantation and other properties	=	₹ 50.00 Cr.
b. Oil India Limited Installations	=	₹ 30.00 Cr.
c. Assam PWD Buildings	=	₹ 30.00 Cr.
d. Assam PWD Roads	=	₹ 75.00 Cr.
e. Assam Health Department	=	₹ 15.00 Cr.
f. Assam Agricultural Department	=	₹ 15.00 Cr.
g. Assam Tourism Department	=	₹ 110.00 Cr.
h. Forest Department	=	₹ 5.00 Cr.
i. Assam Electricity Department	=	₹ 30.00 Cr.
j. Other loss such as veterinary and fishery	=	₹ 60.00 Cr.
k. Private land and properties	=	₹ 120.00 Cr.
l. N.F. Railway	=	₹ 150.00 Cr.
Total anticipated loss due to bank erosion	=	₹ 690.00 Cr.
Total annual anticipated loss due to bank erosion considering 50 years life of project	=	***₹ 13.80 Cr.***

B. Anticipated loss due to breach of embankment

a. Tea Estates including land, plantation and other properties	=	₹ 300.00 Cr.
b. Oil India Limited Installations	=	₹ 500.00 Cr.
c. Assam PWD Buildings	=	₹ 120.00 Cr.
d. Assam PWD Roads	=	₹ 180.00 Cr.
e. Assam Health Department	=	₹ 25.00 Cr.
f. Assam Agricultural Department	=	₹ 75.00 Cr.
g. Assam Tourism Department	=	₹ 110.00 Cr.
h. Forest Department	=	₹ 120.00 Cr.
i. Assam Electricity Department	=	₹ 65.00 Cr.
j. Other loss such as veterinary and fishery	=	₹ 55.00 Cr.
k. Private land and properties	=	₹ 60.00 Cr.
l. N.F. Railway	=	₹ 70.00 Cr.
Total anticipated loss	=	₹ 1,680.00 Cr.
Total annual anticipated loss due to flooding and innundation considering 50 years life of project	=	***₹ 33.60 Cr.***

HENCE TOTAL LOSS OF PRPPERTIES WITH LAND & CROP = A + B + C = **₹ 48.43 Cr.**

Shadique
S.K
20/2/18

Circle Officer
Naharkatia Revenue Circle
Naharkatia, Dibrugarh
Naharkatia

GOVT. OF ASSAM

OFFICE OF THE CIRCLE OFFICER : TINGKHONG REVENUE CIRCLE, TINGKHONG

DIBRUGARH

No. TKG. 17/2017/MO/2229 Date: 22/02/2018

Receipt No. 458
Date 26/2/18
File No. M-14/B
Dibrugarh W. R. Division

To

The Executive Engineer
Dibrugarh W.R. Division,
Dibrugarh

Subject: Statement of actual loss/anticipated loss due to flooding & erosion problem of Buridehing River under Tingkhong Revenue Circle, Tingkhong, Dibrugarh

Ref: Your letter no. M-14/B/Dib/17-18/765-70 Dt. 15/02/2018
Name of scheme: Integrated Water Resources Management of Buridehing Basin.

Sir,

With refrence to the subject cited, I would like to furnish the following information in respect of actual loss of crops, buildings, public properties/institutions etc due to flooding & erosion of River Buridehing and also the anticipated loss due to breach/damage of embankment

A. Loss due to erosion in last 30 years

Total area eroded due to erosion	= 256.00 Hectares	= 1912 bighas	
a. Homestead Land Lost	= 800 bighas	@ ₹ 45,000.00 /bigha =	₹ 36,000,000.00
b. Cultivable Land Lost	= 5600 bighas	@ ₹ 33,000.00 /bigha =	₹ 184,800,000.00
c. Fallow Land Lost	= 1600 bighas	@ ₹ 20,000.00 /bigha =	₹ 32,000,000.00
d. Loss of crop in cultivable land(Paddy production @ 4Qtl/Bigha)	= 22400 Qtl	@ ₹ 1,100.00 /qtl =	₹ 24,640,000.00
e. Damage to house	= 670 Nos.	@ ₹ 50,000.00 /hous =	₹ 33,500,000.00
		Total Loss during 30 years =	₹ 310,940,000.00
Total annual damage due to erosion =		=	₹ 10,364,666.67
		Total annual damage due to erosion =	***₹ 1.04 Cr.***

B. Anticipated loss due to bank erosion

a. Tea Estates including land, plantation and other properties	=	₹ 80.00 Cr.
b. Oil India Limited Installations	=	₹ 25.00 Cr.
c. Assam PWD Buildings	=	₹ 45.00 Cr.
d. Assam PWD Roads	=	₹ 110.00 Cr.
e. Assam Health Department	=	₹ 25.00 Cr.
f. Assam Agricultural Department	=	₹ 22.00 Cr.
g. Assam Tourism Department	=	₹ 120.00 Cr.
h. Forest Department	=	₹ 15.00 Cr.
i. Assam Electricity Department	=	₹ 24.00 Cr.
j. Other loss such as veterinary and fishery	=	₹ 36.00 Cr.
k. Private land and properties	=	₹ 110.00 Cr.
l. N.F. Railway	=	Cr.
Total anticipated loss due to bank erosion	=	₹ 612.00 Cr.
Total annual anticipated loss due to bank erosion considering 50 years life of project =		***₹ 12.24 Cr.***

B. Anticipated loss due to breach of embankment

a. Tea Estates including land, plantation and other properties	=	₹ 325.00 Cr.
b. Oil India Limited Installations	=	₹ 30.00 Cr.
c. Assam PWD Buildings	=	₹ 75.00 Cr.
d. Assam PWD Roads	=	₹ 240.00 Cr.
e. Assam Health Department	=	₹ 41.00 Cr.
f. Assam Agricultural Department	=	₹ 29.00 Cr.
g. Assam Tourism Department	=	₹ 40.00 Cr.
h. Forest Department	=	₹ 30.00 Cr.
i. Assam Electricity Department	=	₹ 68.00 Cr.
j. Other loss such as veterinary and fishery	=	₹ 120.00 Cr.
k. Private land and properties	=	₹ 140.00 Cr.
l. N.F. Railway	=	Cr.
Total anticipated loss	=	₹ 1,138.00 Cr.
Total annual anticipated loss due to flooding and innundation considering 50 years life of project	=	*₹ 22.76 Cr.*

HENCE TOTAL LOSS OF PROPERTIES WITH LAND & CROP = A + B + C = **₹ 36.04 *Cr.***

Office of the Circle Officer, Tingkhong Revenue Circle, Rajgarh

Circle Officer
Tingkhong Revenue Circle
Tingkhong, Dibrugarh

Circle Officer
Tingkhong Revenue Circle
Rajgarh

GOVT. OF ASSAM

OFFICE OF THE CIRCLE OFFICER : TENGAKHAT REVENUE CIRCLE, TENGAKHAT

DIBRUGARH

No. TC/CM/BC/20/Pt-II/2014-15/1132 Date: 20-02-2018

Receipt No. 796
Date 02/03/2018
File No. M-14/F
Dibrugarh W. R. Division

To

The Executive Engineer
Dibrugarh W.R. Division,
Dibrugarh

Subject: Statement of actual loss/anticipated loss due to flooding & erosion problem of Burldehing River under Dibrugarh Tengakhat Revenue Circle, Tengakhat, Dibrugarh

Ref: Your letter no. M-14/B/Dib/17-18/765-70 Dt. 15/02/2018
Name of scheme: Integrated Water Resources Management of Buridehing Basin.

Sir,

With refrence to the subject cited, I would like to furnish the following information in respect of actual loss of crops, buildings, public properties/institutions etc due to flooding & erosion of River Buridehing and also the anticipated loss due to breach/damage of embankment

A. Loss due to erosion in last 30 years

Total area eroded due to erosion	=	120.00 Hectares	=	896 bighas	
a. Homestead Land Lost	=	1532 bighas	@	₹45,000.00 /bigha =	₹68,922,000.00
b. Cultivable Land Lost	=	10721 bighas	@	₹33,000.00 /bigha =	₹353,799,600.00
c. Fallow Land Lost	=	3063 bighas	@	₹20,000.00 /bigha =	₹61,264,000.00
d. Loss of crop in cultivable land(Paddy production @ 4Qtl/Bigha)	=	42885 Qtl	@	₹1,100.00 /qtl =	₹47,173,280.00
e. Damage to house	=	670 Nos.	@	₹50,000.00 /hous =	₹33,500,000.00
				Total Loss during 30 years =	₹564,658,880.00
Total annual damage due to erosion =				=	₹18,821,962.67
				Total annual damage due to erosion =	***₹1.88 Cr.***

B. Anticipated loss due to bank erosion

a. Tea Estates including land, plantation and other properties	=	₹25.00 Cr.
b. Oil India Limited Installations	=	₹25.00 Cr.
c. Assam PWD Buildings	=	₹45.00 Cr.
d. Assam PWD Roads	=	₹50.00 Cr.
e. Assam Health Department	=	₹20.00 Cr.
f. Assam Agricultural Department	=	₹10.00 Cr.
g. Assam Tourism Department	=	₹20.00 Cr.
h. Forest Department	=	₹8.00 Cr.
i. Assam Electricity Department	=	₹20.00 Cr.
j. Other loss such as veterinary and fishery	=	₹26.00 Cr.
k. Private land and properties	=	₹25.00 Cr.
l. N.F. Railway	=	₹230.00 Cr.
Total anticipated loss due to bank erosion	=	₹504.00 Cr.
Total annual anticipated loss due to bank erosion considering 50 years life of project	=	***₹10.08 Cr.***

B. Anticipated loss due to breach of embankment

a. Tea Estates including land, plantation and other properties	=	₹ 300.00 Cr.
b. Oil India Limited Installations	=	₹ 250.00 Cr.
c. Assam PWD Buildings	=	₹ 85.00 Cr.
d. Assam PWD Roads	=	₹ 210.00 Cr.
e. Assam Health Department	=	₹ 45.00 Cr.
f. Assam Agricultural Department	=	₹ 28.00 Cr.
g. Assam Tourism Department	=	₹ 26.00 Cr.
h. Forest Department	=	₹ 25.00 Cr.
i. Assam Electricity Department	=	₹ 65.00 Cr.
j. Other loss such as veterinary and fishery	=	₹ 120.00 Cr.
k. Private land and properties	=	₹ 140.00 Cr.
l. N.F. Railway	=	₹ 25.00 Cr.
Total anticipated loss due to bank erosion	=	₹ 1,319.00 Cr.
Total annual anticipated loss due to bank erosion considering 50 years life of project	=	***₹ 26.38 Cr.***

HENCE TOTAL LOSS OF PRPPERTIES WITH LAND & CROP = A + B + C = ₹ 38.34 Cr.

20/2/18

Circle Officer
Tengakhat Revenue Circle
Tengakhat, Dibrugarh

OFFICE OF THE CIRCLE OFFICER

GOVT. OF ASSAM
OFFICE OF THE CIRCLE OFFICER : CHABUA REVENUE CIRCLE, CHABUA
DIBRUGARH

No. CRC.29/2012-13/761

Date: 23/2/2018

Receipt No. 459
Date 24/2/18
File No. M-14/B
Dibrugarh W. R. Division

To

The Executive Engineer
Dibrugarh W.R. Division,
Dibrugarh

Subject: Statement of actual loss/anticipated loss due to flooding & erosion problem of Burideharing River under Chabua Revenue Circle, Chabua, Dibrugarh

Ref: Your letter no. M-14/B/Dib/17-18/938 Dt. 21/02/2018
Name of scheme: Integrated Water Resources Management of Burideharing Basin.

Sir,

With refrence to the subject cited, I would like to furnish the following information in respect of actual loss of crops, buildings, public properties/institutions etc due to flooding & erosion of River Buridehing and also the anticipated loss due to breach/damage of embankment

A. Loss due to erosion in last 30 years

Total area eroded due to erosion	=	24.00 Hectares	=	179.00	bighas	
a. Homestead Land Lost	=	41.7 bighas	@	45,000.00	/bigha =	18,76,500.00
b. Cultivable Land Lost	=	291.9 bighas	@	33,000.00	/bigha =	96,32,700.00
c. Fallow Land Lost	=	83.4 bighas	@	20,000.00	/bigha =	16,68,000.00
d. Loss of crop in cultivable land(Paddy production @ 4Qtl/Bigha)	=	1168 Qtl	@	1,100.00	/qtl =	12,84,360.00
e. Damage to house	=	670 Nos.	@	50,000.00	/hous =	3,35,00,000.00
				Total Loss during 30 years =		4,79,61,560.00
Total annual damage due to erosion =					=	15,98,718.67
				Total annual damage due to erosion =		***0.16 Cr.***

B. Anticipated loss due to bank erosion

a. Tea Estates including land, plantation and other properties	=	2.00 Cr.
b. Oil India Limited Installations	=	Cr.
c. Assam PWD Buildings	=	2.00 Cr.
d. Assam PWD Roads	=	3.00 Cr.
e. Assam Health Department	=	1.00 Cr.
f. Assam Agricultural Department	=	10.00 Cr.
g. Assam Tourism Department	=	Cr.
h. Forest Department	=	0.50 Cr.
i. Assam Electricity Department	=	1.00 Cr.
j. Other loss such as veterinary and fishery	=	2.00 Cr.
k. Private land and properties	=	3.00 Cr.
l. N.F. Railway	=	Cr.
Total anticipated loss due to bank erosion	=	24.50 Cr.
Total annual anticipated loss due to bank erosion considering 50 years life of project	=	***0.49 Cr.***

B. Anticipated loss due to breach of embankment

a. Tea Estates including land, plantation and other properties	=	15.00 Cr.
b. O[illegible]dia Limited Installations	=	25.00 Cr.
c. Assam PWD Buildings	=	30.00 Cr.
d. Assam PWD Roads	=	22.00 Cr.
e. Assam Health Department	=	4.00 Cr.
f. Assam Agricultural Department	=	12.00 Cr.
g. Assam Tourism Department	=	20.00 Cr.
h. Forest Department	=	8.00 Cr.
i. Assam Electricity Department	=	3.00 Cr.
j. Other loss such as veterinary and fishery	=	12.00 Cr.
k. Private land and properties	=	15.00 Cr.
l. N.F. Railway	=	3.00 Cr.
Total anticipated loss due to bank erosion	=	169.00 Cr.
Total annual anticipated loss due to bank erosion considering 50 years life of project	=	***3.38 Cr.***

HENCE TOTAL LOSS OF PRPPERTIES WITH LAND & CROP = A + B + C = **4.03 *Cr.***

Circle Officer
Chabua Revenue Circle
Chabua, Dibrugarh

Circle Officer
Chabua Revenue Circle
Chabua

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GOVERNMENT OF ASSAM

Receipt No. 507
Date 03/03/18
File No. M-14F
Dibrugarh W. R. Division

GOVT. OF ASSAM

OFFICE OF THE CIRCLE OFFICER ::::::::::::::::::::MARGHERITA REVENUE CIRCLE

NO.MRC.(Misc).52/2006-18/ 1284

Dated, Margherita the 20th. Feb 2018.

To,

The Executive Engineer,
Dibrugarh W.R.Division,
Dibrugarh.

Sub:- Submission of report, regarding actual loss/ anticipated loss due to flooding & erosion problem of Buridehing river under Margherita Revenue Circle.

Sir,

With refrence to the subject cited, I would like to furnish the following information in respect of actual loss of crops, buildings, public properties/institutions etc due to flooding & erosion of River Burideheing and also the anticipated loss due to breach/damage of embankment for the preparation of project **"Integrated water resources management of Burideheing basin"**.

A. Loss due to erosion in last 30 years

Total area eroded due to erosion	= 585 Hectares	= 4370 bighas	
a. Homestead Land Lost	= 1093 bighas	@ ₹ 45,000.00 /bigha =	₹ 491,85,000.00
b. Cultivable Land Lost	= 3059 bighas	@ ₹ 33,000.00 /bigha =	₹ 1009,47,000.00
c. Fallow Land Lost	= 219 bighas	@ ₹ 20,000.00 /bigha =	₹ 43,80,000.00
d. Loss of crop in cultivable land(Paddy production @ 4Qtl/Bigha)	= 12236 Qtl	@ ₹ 1,100.00 /qtl =	₹ 134,59,600.00
e. Damage to house	= 550 Nos.	@ ₹ 50,000.00 /house =	₹ 275,00,000.00
		Total Loss during 30 years =	₹ 1954,71,600.00
Total annual damage due to erosion =		=	₹ 65,15,720.00
		Total annual damage due to erosion =	***₹ 0.65 Cr.***

B. Anticipated loss due to bank erosion

	=	₹ 450.00 Cr.
a. Tea Estates including land, plantation and other properties	=	₹ 300.00 Cr.
b. N.F. Railway	=	₹ 250.00 Cr.
c. Assam PWD Buildings	=	₹ 300.00 Cr.
d. Assam PWD Roads	=	₹ 10.00 Cr.
e. Assam Health Department	=	₹ 10.00 Cr.
f. Assam Agricultural Department	=	₹ 25.00 Cr.
g. Assam Tourism Department	=	₹ 80.00 Cr.
h. Forest Department	=	₹ 35.00 Cr.
i. Assam Electricity Department	=	₹ 50.00 Cr.
j. Other loss such as veterinary and fishery	=	₹ 180.00 Cr.
k. Private land and properties		
Total anticipated loss due to bank erosion	=	₹ 1,690.00 Cr.
Total annual anticipated loss due to bank erosion considering 50 years life of project =		***₹ 33.80 Cr.***

Contd. Page-2

(Page-2)

C. Anticipated loss due to breach of embankment

a. Tea Estates including land, plantation and other properties	=	₹ 40.00
b. N.F. Railway	=	₹ 150.00
c. Assam PWD Buildings	=	₹ 25.00
d. Assam PWD Roads	=	₹ 70.00
e. Assam Health Department	=	₹ 15.00
f. Assam Agricultural Department	=	₹ 22.00
g. Assam Tourism Department	=	₹ 20.00
h. Forest Department	=	₹ 5.00
i. Assam Electricity Department	=	₹ 25.00
j. Other loss such as veterinary and fishery	=	₹ 50.00
k. Private land and properties	=	₹ 110.00
Total anticipated loss due to bank erosion	=	₹ 532.00
Total annual anticipated loss due to bank erosion considering 50 years life of project	=	***₹ 10.64***

HENCE TOTAL LOSS OF PRPPERTIES WITH LAND & CROP = A + B + C = **₹ 45.09**

Circle Officer,
Margherita Rev. Circle,
Margherita

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CHAPTER 8

ABSTRACT OF COST/ DETAILED ESTIMATE

NAME OF PROJECT: INTEGRATED WATER RESOURCES MANAGEMENT OF BURIDEHING BASIN

General Abstract of Cost

Sl No	Item		Amount
I	**Direct charges**	**A. Flood Management Work**	₹ 7,31,21,84,538.00
		B. Road Component	₹ 0.00
II	**Indirect charges**		₹ 1,82,88,380.43
Total Cost			₹ 7,33,04,72,918.43
TOTAL COST Rounded off			**₹ 7,33,04,73,000.00**

(Rupees Seven hundred thirty three Crores, four Lakhs and seventy three Thousands only)

Recommended By

Addl. Chief Engineer
Upper Assam Zone
W.R. Department
Dibrugarh

Countersigned by

Superintending Engineer
Nagaghuli Maijan Protection Circle, W.R. Department
Dibrugarh

Executive Engineer,
Dibrugarh W.R. Division
Dibrugarh

Name of the Scheme: Integrated Water Resources Management of Buridehing Basin

Abstract of cost

Sl. No.	Item	Amount
I	A. Preliminary	₹ 94,20,365.00
	B. Land	₹ 0.00
	C. Works	₹ 7,27,36,36,341.53
	K. Building	₹ 2,11,17,570.00
	M. Plantation	₹ 1,11,77,896.00
	O. Miscellaneous	₹ 0.00
	P. Maintenance during construction	₹ 0.00
	Q. Special T&P	₹ 0.00
	R. Communication	₹ 0.00
	X-Env & Ecology	₹ 0.00
	Y. Losses in stock	₹ 0.00
	Total I-Works	₹ 7,31,53,52,172.53
II	Establishment @ 8% of I-Works - B-Land	₹ 0.00
III	T&P	₹ 0.00
IV	Suspense	₹ 0.00
V	Less: Receipt and recoveries on Capital Accounts (sub estimate no – 10)	₹ 31,67,635.50
	Total Direct Charge Part-A	₹ 7,31,21,84,537.03
	Total Direct Charge	₹ 7,31,21,84,537.03
	Indirect Charges (Audit + Account charges @ 0.25% of I works)	₹ 1,82,88,380.43
	TOTAL	₹ 7,33,04,72,917.46

Executive Engineer
Dibrugarh WR Division
Dibrugarh

Name of the Scheme: Integrated Water Resources Management of Buridehing Basin

Details of I-Works		
A. Flood Management Work		
A-Preliminary	=	₹ 94,20,365.00
B-Land	=	₹ 0.00
C-Works	=	₹ 7,27,36,36,341.53
K-Building	=	₹ 2,11,17,570.00
M-Plantation	=	₹ 1,11,77,896.00
O-Miscellaneous	=	₹ 0.00
P-Maintenance	=	₹ 0.00
Q-Spl T&P	=	₹ 0.00
R-Communication	=	₹ 0.00
V-Receipt and recoveries on Capital Accounts (-) (	=	-₹ 31,67,635.50
X-Env & Ecology	=	₹ 0.00
Y-Losses on Stock	=	₹ 0.00
I-Works	=	₹ 7,31,21,84,537.03

Executive Engineer
Dibrugarh Water Resources Division
Dibrugarh

Name of the Scheme: Integrated Water Resources Management of Buridehing Basin

Sub-Estimate A (Preliminary)

Item no.	Item	Quantity	Unit	Rate	Amount
A. Pre-construction Survey Works before execution of works					
1	Topographical survey works to derive existing embankment cross-sections at 25m interval to an offset of atleast 40m from the centreline on both the sides including marking of structures, crossings, trees etc and preparation of drawings as per design of embankment and calculation of BOQ etc including submission in soft copies and 6 sets of hard copies, complete as directed by the Engineer-in-charge				
	(Rate as per alotted rate of Dibrugarh W.R. Division Qty. = Total length of embankments proposed = 185.58km	183.58	km	₹ 31,402.78	₹ 57,64,923.00
2	Hydrographic survey to depict river/reservoir bed profile and preparation of maps in requisite scales to supply them in both soft and hard formats with four copies complete, including cost of manpower, labour, surveying instruments, camp equipage, transportation, etc, as per directions of engineer-in-charge. At 5 m grid interval				
	(Rate as per analysis 1) Qty: Reach Length 29.805 Km Taking 1.5 times of 29.805 Km (At U/S and D/S) x 0.2Km (Avg.) = 8.94 SqKm Considering three times (Before, during and after execution) = 26.82 SqKm	26.82	SqKm	₹ 1,02,660.00	₹ 27,53,342.00
3	Standard soil tests to determine C, ø, y etc of borrow pit area for earthwork in embankment				
	(Rate as per alotted rate of Dibrugarh W.R. Division Qty: 1 site per km of embankment = 186 Nos	186.00	No.	₹ 4,850.00	₹ 9,02,100.00
					₹ 94,20,365.00

Executive Engineer
Dibrugarh WR Division
Dibrugarh

Analysis of Rate - I

Item of Work: Hydrographic survey to depict river/reservoir bed profi le and preparation of maps in requisite scales to supply them in both soft and hard formats with four copies complete, including cost of manpower, labour, surveying instruments, camp equipage, transportation, etc, as per directions of engineer-in-charge. At 5 m grid interva

Unit: Sq.km

Sl. No.	Item	Rate	Remarks
1	Hydrographic survey to depict river/reservoir bed profi le and preparation of maps in requisite scales to supply them in both soft and hard formats with four copies complete, including cost of manpower, labour, surveying instruments, camp equipage, transportation, etc, as per directions of engineer-in-charge. At 5 m grid interval	₹ 80,000.00	As as per item no. 3.2.8.3 of SOR of CWC for 2012 (Annexure-A)
2	Basic Rate on item no. 1	₹ 71,428.57	Deduction 12% Service Tax as applicable during 2012
3	Present basic rate considering price excalation	₹ 88,142.86	Price Escalation from 2011-12 to 2020-21 as per Ministry of Economic Advisor = 23.4% as per Annexure-B
	Present rate inclusive of GST	₹ 1,04,008.57	18% GST on services related to survey & mapping

Superintending Engineer
NMP W. R. Circle
Dibrugarh

Executive Engineer
Dibrugarh W. R. Division
Dibrugarh

Name of the Scheme: Integrated Water Resources Management of Buridehing Basin

Sub-Estimate K (Buildings)

1 **Construction of temporary shed of two roof with mud plinth of minimum plinth height, with Bhaluka bamboo post 1.5 m apart driven at atleast 0.75 m below ground and height above plinth 2.5m. Split Jatti bamboo/tarza wall, 10 cm thick thatched roofing over bamboo rua frame placing at 0.15 m clear apart fitted with bamboo kamies for binding doors and windows with Bamboo Chattai strengthening with Bamboo frame binding with wire etc. complete as directed. (Using Bhaluka Bamboo at the rate of 6.00 nos/ Rm & Jati Bamboo at the rate of 61.00nos / Rm)**

1. Protection Reach			
1 No. (10m x 5m) @ 51 reaches		**2550**	**SqM**
2. Earthwork			
1 No. (10m x 5m) / Km (183.48/1 = 184 Nos.) **(184 Nos. x 10m x 5x)**		**9200**	**SqM**
		11750	**SqM**
Rate as per SoR of WRD 2021-2022, Item No. 14 (WR (ED) Tech/7728/2021/10 on Dt. 08/11/2021	**Ra.**	**1797.24**	**/ SqM**
Amount	**Rs.**	**21117570**	

Executive Engineer
Dibrugarh WR Division
Dibrugarh

SUB-ESTIMATE - III ('M' - PLANTATION)

Name of the Scheme: Integrated Water Resources Management of Buridehing Basin

Item	Qty.	Rate	Amount
Planting of Trees and their Maintenance for three Year (Planting of trees by the road side (Avenue trees) in 0.60 m dia holes, 1 m deep dug in the ground, mixing the soil with decayed farm yard/sludge mannure, planting the saplings, backfilling the trenches, watering , fixing the tree guatrd and maintaining the plants for three year Quantity = 1 No. of tree per 25m intervals on both sides for 183.48km of embankment = 183.48 x 1000 x 2/25 = 14,678.4 Nos Rate as per SOR 2020-21 of PWRD (Rural Roads), Item no. 16.60 = Rs. 673.20/no + 12% GST + 1& LC = Rs. 761.52	14678	₹ 761.52	₹ 1,11,77,896.00

Total ₹ 1,11,77,896.00

Executive Engineer
Dibrugarh Water Resources Division
Dibrugarh

V-Reciepts & Recoveries

Name of the Scheme: Integrated Water Resources Management of Buridehing Basin

1	Recovery 15% of Temporary Bulidings	=	₹ 31,67,635.50
2	Recovery 20% of Q-Special T&P	=	₹ 0.00
	Total	=	₹ 31,67,635.50

Executive Engineer
Dibrugarh WR Division
Dibrugarh

DETAILED ESTIMATE

Name of the Scheme: Integrated Water Resources Management of Buridehing Basin

Sl	Item of work	Qntty	Unit	Rate (Rs.)	Amount (Rs.)
A. Flood Management Work					
	RAISING & STRENGTHENING OF EMBANKMENT				
1	Felling trees including uprooting roots and stumps upto 50 cm. below ground, cutting into pieces and removing the same from the site of work as directed. Trees above 0.50m and upto 1m girth:ii Girth above 600 mm to 900 mm	34,679	Nos.	414.78	14384155.62
	Quantity: As per statement No - I				
	Rate : As per SoR of WRD 2021-2022, Item No. 2 (WR (ED) Tech/7728/2021/10 on Dt. 08/11/2021				
2	Earthwork in grabbing the seat of the embankment. upto 0.3 m depth and depositing the soils outside the country side toe of the proposed structures , etc. complete as directed.	8,30,888.23	Cum	161.55	134229993.97
	As per statement No.- II				
	Rate : As per SoR of WRD 2021-2022, Item No. 8 (WR (ED) Tech/7728/2021/10 on Dt. 08/11/2021				
3	Earth work in embankment by truck carriage in ordinary/normal soil excluding sandy and rocky soil free from roots & vegetation and filling in uniform layers not exceeding 25 cm thick including ploughing or roughening or benching the seats, removing all debries, breaking clods up to 4cm cube, dressing as per design section including payment of forest royalty if any, etc. complete as directed. (10% deduction will be made from the section measured quantities of the completed and compacted on account of shrinkage) For initial lead beyond ½ Km and upto 4Km and for all lifts	1,18,35,966.92	Cum	335.86	3975227848.10
	As per statement No.- II				
	Rate : As per SoR of WRD 2021-2022, Item No. 4 (WR (ED) Tech/7728/2021/10 on Dt. 08/11/2021				
4	Turfing with grass sods of largest possible rectangles of 12 cm. minimum thickness placed closely including dressing earth pegging with Jati bamboo split, watering till the grass grows for a lead up to 90m and all lifts.	42,84,603.15	Sqm	28.83	123525108.76
	As per statement No.- II				
	Rate : As per SoR of WRD 2021-2022, Item No. 10 (WR (ED) Tech/7728/2021/10 on Dt. 08/11/2021				

Sl	Item of work	Qntty	Unit	Rate (Rs.)	Amount (Rs.)
A. Flood Management Work					
	ANTI EROSION WORKS				
5	Supply of Geo-textile bags of type-A (1.03 × 0.70M) inner to inner made of Geo-textile non-woven fabric sheets of 400 GSM manufactured from 100% virgin Polypropylene (PP) fibre with minimum properties as per IS 16653 : 2017 (i) Wide Tensile strength(MD) ≥20KN/m & Wide Tensile strength(CD) ≥20 KN/m (ii) Elongation (MD) ≥50% & Elongation (CD) ≥50% (iii) Abrasion ≥95% (iv)Trapezoidal Tear Strength (MD) ≥450N & Trapezoidal Tear Strength (CD) ≥450N (v)CBR Puncture strength≥4000N (vi)Permittivity≥1.10s-1 (vii)Permeability≥40l/m2/sec (viii)AOS ≤75micron (ix) UV Resistance @500 hours retained Tensile strength (MD) & (CD) ≥ 80% (x)Mass≥400 gm/m² (xi) Thickness at 2 KPa≥3 mm (xii) Seam strength ≥80 % of actual fabric strength. Stitching of Bags should be Ring Spun Yarn stitches with 2500-3000 denier double line chain stitch with overlap with stitches along the edge @ minimum 15 stitches per 100mm. (Bags are to be supplied of 100 numbers in a bundle, properly packed with each bag having proper tag with name of Manufacturer, Batch Number, the GSM and type of polymer encrypted and stitched on top corner and each bag is to be marked with "WRD Govt of ASSAM" to be printed distinctly. Test Certificate from approved NABL	3989600	No.	198.75	792933000.00
	Quantity: As per statement No - S				
	Rate : As per SoR of WRD 2021-2022, Item No. 1 (WR (ED) Tech/7728/2021/11 on Dt. 29/11/2021				
6	Filling and laying of Geo bags of size 1.03m X 0.70m excluding excavation of specified sand from flood plain or adjacent chars within a distance of 90m of the work site, filling geo bags with sand having minimum weighing 126.00 Kg and minimum volume 0.084 cum after filling , double locking chain stitching the mouth of the filled bags with polypropylene thread by power driven double needle double stitched machine, stacking the same in batches of 100, carrying the same to the dumping site including all handling charges and local carriage within a distance of 150m and laying properly as directed. (sand, Geo Bag and Polypropylene thread will be supplied by the department free of cost) b)With Boat	3512732	Bag	71.40	250809064.80
	Quantity: As per statement No - S				
	Rate : As per SoR of WRD 2021-2022, Item No. 15 (b) (WR (ED) Tech/7728/2021/10 on Dt. 08/11/2021				

Sl	Item of work	Qntty	Unit	Rate (Rs.)	Amount (Rs.)
A. Flood Management Work					
7	Filling and laying in cage with silt filled Geo bags of size 1.03m X 0.70m excluding excavation of specified silt from flood plain or adjacent chars within a distance of 90m of the work site, filling geo bags with silt having minimum weighing 126.00 Kg and minimum volume 0.084 cum after filling ,double locking chain stitching the mouth of the filled bags with polypropylene thread by power driven double needle machine, stacking the same in batches of 100, carrying the same to the dumping site including all handling charges and local carriage within a distance of 150m and laying properly. in cages made of wire netting sheets of size 2.57x1.66m of 8G galvanized wire making the cage from 2 nos. of wire netting sheet by tying the projected wires complete as directed. (Geo Bag , Wire Netting Sheets and Polypropylene thread will be supplied by the department free of cost) a)Without Boat	476868	Bag	48.62	23185322.16
	Quantity: As per statement No - S				
	Rate : As per SoR of WRD 2021-2022, Item No. 17 (a) (WR (ED) Tech/7728/2021/10 on Dt. 08/11/2021				
8	Supply of non-woven Geo-textile fabric sheets of 300 GSM manufactured from 100% virgin Polypropylene (PP) fibre with minimum properties as per IS 16653: 2017 (i) Wide Tensile strength (MD) ≥15KN/m & Wide Tensile strength (CD) ≥15KN/m (ii) Elongation (MD) ≥50% & Elongation (CD) ≥50% (iii) Abrasion ≥95% (iv) Trapezoidal Tear Strength (MD) ≥340 N & Trapezoidal Tear Strength (CD) ≥340 N (v) CBR Puncture strength ≥3000 N (vi) Permittivity ≥1.25 s-1 (vii)Permeability ≥60l/m2/sec (viii)AOS ≤75micron (ix)UV Resistance @500 hours retained Tensile strength (MD) & (CD) ≥80% (x) Mass ≥ 300gm/m² (xi)Thickness at 2KPa ≥3mm. (Each Roll of Geo Fabric Sheet should be supplied in properly packed Bundles and should be marked with the Name of Manufacturer, Batch Number & its dimensions clearly on each roll with “WRD Govt of ASSAM” to be printed on it and mentioning properly the GSM and type of polymer and Test Certificate from approved NABL accredited and ISO Certified Laboratory should invariably be submitted against each batch of material)	1060411.55	Sqm	100.00	106041155.00
	Quantity: As per statement No - S				
	Rate : As per SoR of WRD 2021-2022, Item No. 5 (WR (ED) Tech/7728/2021/11 on Dt. 29/11/2021				
9	Labour charge for laying Geo fabric sheet as filter bellow pitching including anchoring and complete as directed.	964010.50	Sqm	37.39	36044352.60
	Quantity: As per statement No - S				
	Rate : As per SoR of WRD 2021-2022, Item No. 18 (WR (ED) Tech/7728/2021/10 on Dt. 08/11/2021				

Sl	Item of work	Qntty	Unit	Rate (Rs.)	Amount (Rs.)
A. Flood Management Work					
10	Supply of sewing thread/yarn PPMF stiching thread (2000 Den.Kaplan) i/c payment of taxes.	43885600.00	Rm	0.12	5266272.00
	Quantity: As per statement No - S				
	Rate : As per SR of WRD 2018-2019, Item No. (11.08)				
11	Construction and supply of Wire -netting box of size 1.50 m × 1.50 m × 0.45 m made with mechanically woven, double twisted, hexagonal shaped wire mesh with wire made of low carbon, high ductile MS wire with heavy class of galvanization woth an additional layer of PVC coating with mesh type of 10 × 12 as per EN 10223 & ASTM A975, mesh wire of 2.70 mm (I.D) /3.70 mm (OD) tensile strength of 450-500/mm2, edge wire slevdge around it at least 2.5 times, lacing wire (zinc PVC coated) of 2.20mm (I.D) /3.20mm (OD), VC coating thickness of 0.50mm nominal, 0.38 mm minimum, Mesh opening size 150mm × 150mm and with average weight per unit being 12 kg with additional 3% of the weigth of box for lacing wire supplied separately, supporting the facing of the box with zinc coated steel wire of required length as directed, compling with ASTM and Europian norms.	39,739	No.	2400.00	95373600.00
	Quantity: As per statement No - S				
	Rate : As per SoR of WRD 2021-2022, Item No. 14 (WR (ED) Tech/7728/2021/11 on Dt. 29/11/2021				
12	Earthwork in bank trimming to the designed section /slope including removing the soils at a minimum distance of 30 m, complete as directed.	3,57,660.00	Cum	167.74	59993888.40
	Quantity: As per statement No - S				
	Rate : As per SoR of WRD 2021-2022, Item No. 7 (WR (ED) Tech/7728/2021/10 on Dt. 08/11/2021				
13	Earth work in excavation of drainage channel to the proper grade and slopes as required including depositing the excavated debris/soil to a safe distance of minimum 50 m distance as directed. Normal Soil	27495.15	Cum	199.03	5472359.70
	Quantity: As per statement No - S				
	Rate : As per SoR of WRD 2021-2022, Item No. 6 (WR (ED) Tech/7728/2021/10 on Dt. 08/11/2021				
14	Providing and laying filter material underneath pitching in slopes complete as per drawing and technical specifications Clause 1302	54,739.50	Cum	2051.54	112300273.83
	Quantity: As per statement No - S				
	Rate : Rate : As per SR of APWD 2020-2021 (Rural Roads), Item No. 14.60 (Rs. 1813.6 + 12 % GST + 1% LC = Rs. 2051.54)				
15	Supply of Coarse sand for filling of Geo Bag	335126	Cum	1074.64	360140223.75
	Quantity as per Statement S				
	Rate : Rate : As per SR of APWD 2020-2021 (Rural Roads), Item No. M-115 (Rs. 950 + 12 % GST + 1% LC = Rs. 1074.64)				
16	Providing and laying pitching on slopes laid over prepared filter media as per drawing and technical specifications Clause 1302 II) Cement concrete blocks of size as per Table 1300.2 cast in cement concrete of grade M 15 a) Concrete grade M 15	128256.90	Cum	6018.44	771906457.24
	Quantity: As per statement No - S				
	Rate : Rate : As per SR of APWD 2020-2021 (Rural Roads), Item No. 14.5 II (a)				

Sl	Item of work	Qntty	Unit	Rate (Rs.)	Amount (Rs.)
A. Flood Management Work					
	Bill 4: PRO SILTATION WORK				
17	Supply of Pre stressed Cement Concrete (PSC) Porcupine members of size 0.10m X 0.10mX 3.00m with M-30 grade of cement concrete conforming to IS 1343 : 2012 using super-plasticizer @1.2 lit/bag of cement with graded broken coarse aggregates up to 20mm size down conforming to IS 10262:2009 & IS 456:2000 and reinforced with 4 Nos. of 4 mm dia high tensile steel wire cable with necessary cover and 4mm high tensile stirrups at 250mm C/C, in conformity with IS-6403:R2002 and stressed to required strength not exceeding 9.18 N/mm, holes of 16 mm dia at 50 cm inside from both ends in the same face and in either face of post another 2 Nos. of holes of size 16 mm dia at 65mm inside from both ends including properly curing for 21 (twenty one) days and carriage of porcupine members from factory to the stack yard within a distance up to 20 Km including loading, unloading & stacking complete as directed. (Including forest royalty and all taxes as admissible)	221508	No.	784.71	173819542.68
	Quantity as per Statement IV				
	Rate : As per SoR of WRD 2021-2022, Item No. 21 (WR (ED) Tech/7728/2021/10 on Dt. 08/11/2021				
18	Labour charge for launching of PSC Porcupine including carriage of PSC porcupine members of size 0.10m × 0.10m × 3.00m from the stack yard to the place of launching ,erection of the Porcupine with 6 (six) members properly, supply & fitting/fixing with 12 mm dia 25 Cm long M.S. Nuts and bolts and launching the porcupine properly as directed. (Lead up to 150 m) a)Without Boat	918	No.	661.94	607660.92
	Quantity as per Statement IV				
	Rate : As per SoR of WRD 2021-2022, Item No. 23 (a) (WR (ED) Tech/7728/2021/10 on Dt. 08/11/2021				
19	Labour charge for launching of PSC Porcupine including carriage of PSC porcupine members of size 0.10m × 0.10m × 3.00m from the stack yard to the place of launching ,erection of the Porcupine with 6 (six) members properly, supply & fitting/fixing with 12 mm dia 25 Cm long M.S. Nuts and bolts and launching the porcupine properly as directed. (Lead up to 150 m) b)With Boat	36000	No.	954.34	34356240.00
	Quantity as per Statement IV				
	Rate : As per SoR of WRD 2021-2022, Item No. 23 (a) (WR (ED) Tech/7728/2021/10 on Dt. 08/11/2021				
REPAIRING OF SLUICE GATE AS PER SUB-EST 1 (39 Nos.)					168019822.00
				Total	7243636341.53
				Say	7243636000.00
	Adding Contingency LS				30000000.00
	Total C- works				₹ 7,27,36,36,341.53

Sl	Item of work	Qntty	Unit	Rate (Rs.)	Amount (Rs.)
A. Flood Management Work					
I	A. Preliminary				₹ 94,20,365.00
	B. Land				0
	K. Building (0.05%)				₹ 2,11,17,570.00
					.
	L. Earth Work				₹ 0.00
	M. Plantation				₹ 1,11,77,896.00
	O. Miscellaneous (LS)				₹ 0.00
	P. Maintenance during construction (sub estimate no – VI)				₹ 0.00
	Q. Special T&P				₹ 0.00
	R. Communication				₹ 0.00
	X-Env & Ecology (Catchment area treatment and flood resielient Village) @5% of C-Works				₹ 0.00
	Y. Losses in stock (sub estimate no – VI)				₹ 0.00
				Total I-Works	₹ 7,31,53,52,172.53
II	Establishment (For hired/deputation service)@2% of C works.				₹ 0.00
III	Ordinary T&P (1% 0f I-works)				₹ 0.00
IV	Suspense				₹ 0.00
V	Receipt and recoveries on Capital Accounts (-) (L/S)				₹ 31,67,635.50
				Total of Flood Management Work	₹ 7,31,21,84,538.00
B. Road Component					
PROVIDING INTERLOCKING CONCRETE BLOCK PAVEMENT AS PER SUB-EST 2 for 139.44 KM					₹ 0.00
Total Cost of the Project					₹ 7,31,21,84,538.00

Executive Engineer
Dibrugarh Water Resources Division
Dibrugarh

Head wise Percentage Variation Statement

Name of the Scheme: Integrated Water Resources Management of Buridehing Basin

Sl No.	Major Provisions	As per New proposal	As per Earlier proposal	% Variation
	A. Flood Management Work			
1	i. Embankment Works	₹ 424.737 Cr.	423.00 Cr.	0.41%
2	ii. Protection Works			
	a. Anti-erosion works	₹ 261.947 Cr.	159.63 Cr.	64.09%
	b. Porcupine dampener screens	₹ 20.878 Cr.	28.29 Cr.	-26.20%
3	iii. Sluice Gates	₹ 16.802 Cr.	20.40 Cr.	-17.63%
4	Contingency	₹ 3.00 Cr.	0 Cr.	100.00%
5	A. Preliminary	₹ 0.94 Cr.	0.79 Cr.	19.62%
6	K Building	₹ 2.11 Cr.	0.09 Cr.	2334.59%
7	M. Plantation	₹ 1.12 Cr.	1.46 Cr.	-23.18%
8	Receipt & Recoveries		-0.01 Cr.	-100.00%
	Sub-Total of A	₹ 731.54 Cr.	633.64 Cr.	15.45%
	B. Road Component			
1	INTERLOCKING CONCRETE BLOCK PAVEMENT	₹ 0.00 Cr.	0 Cr.	100.00%
	Direct charges	₹ 731.54 Cr.	633.64 Cr.	15.45%
	Indirect charges	₹ 1.83 Cr.	1.58 Cr.	15.45%
	Total Cost of the Project	₹ 733.36 Cr.	635.22 Cr.	15.45%

Executive Engineer
Dibrugarh WR Division
Dibrugarh