A MINI PROJECT REPORT

ON

FEASIBILITY OF WATER INTAKE WELL AT RIVER JALJALI FOR USE IN KOHINOOR PAPER PLANT AT MATIA INDUSTRIAL AREA, MORNOI, GOALPARA

Partial fulfilment of the requirements for the award of the degree of

MASTER OF TECHNOLOGY IN CIVIL ENGINEERING

(With specialization in Water Resources Engineering)

Under

ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY

SESSION: 2023-2025

Submitted

by

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STATEMENT

The work contained on the report "FEASIBILITY OF WATER INTAKE WELL AT RIVER JALJALI FOR USE IN KOHINOOR PAPER PLANT AT MATIA INDUSTRIAL AREA, MORNOI, GOALPARA" has been carried out by me under the supervision of Dr. Bibhash Sarma, Professor, Department of Civil Engineering, Assam Engineering College, Guwahati.

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CERTIFICATE OF APPROVAL

SESSION (2023-2025)

CERTIFICATE

This is to certify that the work contained in the report entitled "FEASIBILITY OF WATER INTAKE WELL AT RIVER JALJALI FOR USE IN KOHINOOR PAPER PLANT AT MATIA INDUSTRIAL AREA, MORNOI, GOALPARA" has been carried out by Prerona Bhuyan, Roll No PG/C/23/32, a student of 3rd semester in the Department of Civil Engineering with specialization in Water Resources Engineering, Assam Engineering College, Guwahati for the award of degree of Masters of Technology under my supervision.

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SESSION (2023-2025)

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This is to certify that Prerona Bhuyan, Roll No: 230620061013 a student of MTech 3rd semester of Civil Engineering Department (Water Resources Engineering), Assam Engineering College, has submitted her Mini Project on "FEASIBILITY OF WATER INTAKE WELL AT RIVER JALJALI FOR USE IN KOHINOOR PAPER PLANT AT MATIA INDUSTRIAL AREA, MORNOI, GOALPARA" in partial fulfillment of the requirement for the award of the degree of Master of Technology in Civil Engineering with specialization in Water Resources Engineering under Assam Science and Technology.

Dr. Jayanta Pathak

Professor & Head

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I am indebted to Dr. Jayanta Pathak, Head, Department of Civil Engineering and all the faculties of Department of Civil Engineering, Assam Engineering College, for the deep insights and discernment given through the various courses they had taught.

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ABSTRACT

Rivers are among the most dynamic entities over the earth’s surface. They persistently shift their courses over the space through time. Bank erosion is an unavoidable and disastrous phenomenon has resulted the displacement or shifting of river banks around the world. This study presents a comprehensive 30-year analysis (1990-2020) of left bank of Brahmaputra River at a particular location i.e. 26º06′54.9″ N and 90º43′47.4″E (Project Coordinate) in Jaljali river, which is a branch channel of Brahmaputra River, Goalpara District, Assam, emphasizing on changes in shifting nature of river and deposition and erosion. Using ArcGIS 10.4.1 software and Landsat imagery, the study helps to quantifies river bank migration across various sections. With the help of Google Earth Pro, we located the coordinate and take a required length of the river. Also, we extend the study to anti erosion measures by Boulder and Geobag protection with the help of AutoCAD software. Along with the protection measure, a design of an intake well is also carried out for withdrawal of water to use in the plant in future purpose.

The study assesses the spatial-temporal changes of the Brahmaputra River banks for the last 3 decades (Jan,1990-Dec,2020). The results offer important new information about how anthropogenic activities and natural processes affect river morphology, which in turn influences the larger themes of morphology, environment, and management. The studies historical tendencies can be valuable in future studies on the impacts of extreme river bank shifting.

CHAPTER 1
INTRODUCTION

1.1 PROLOGUE

The Kohinoor Paper and Newsprint (P) Ltd. is one of the biggest writing and printing paper manufacturer in eastern India incorporated on 26 December 2006. The huge demand of paper has powered the need to lay the foundation of KPNPL- A plant based on production from virgin pulp and also through recycling of waste paper, eventually contributing towards cleaner & greener environment. Kohinoor Pulp & Paper Private Limited is in the process of setting up an integrated paper plant at Matia industrial area, Mornoi, Goalpara. For the plant to operate, about 23,000 m^3 of water must be drawn daily has made contact with the Assam Engineering College (AEC), Guwahati's Civil Engineering Department (CED) to finalize the water intake site on the Brahmaputra River in order to deliver water to its plant area. As a result, the visit was made by the faculties of civil engineering department to the location.

1.2 MOTIVATION FOR THE WORK

This study aims to propose solving a real-life problem. As I have a keen interest on emerging myself on an ongoing project so I got an opportunity with the civil engineering department, Assam Engineering College to do the required work.

1.3 THE PLANT AND THE SITE

As the demand for paper is steadily rising and meeting this requirement is a major challenge to the Indian pulp and paper sector, the Kohinoor Pulp & Paper Private Limited (KPPL) would help the country satisfy the growing need for high-quality virgin bamboo pulp. After entering into an MOU with the Govt. of Assam, KPPL has begun this project to build a 2,00,000-ton-per-year pulp and paper manufacturing plant on roughly 200 acres of land in Goalpara. The project also includes a chemical recovery plant and a captive power plant. The Kohinoor group private limited delivers different sectors for the development of country such as steel, paper, infrastructure, mining cement Finance etc.

The study area, located at 26°06'54.9"N, 90°43'47.4"E is at Jaljali river, which is a branch channel of river Brahmaputra in Goalpara district. The Jaljali river is also known as Kulshi river which rises in the foothills of Meghalaya and meets other tributaries before flowing through the densely populated areas of Chaygaon and Boko LAC. The river is bright in appearance. The coordinates of Jaljali river are 26º06′35.49″N and 91º01′24.25″E. The river Jaljali meanders in nature, causing migration at several lengths up to its outfall at Nagarbera which causing shifting of bank line of the river for the last few years.

ARCHEOLOGICAL SITE

An important but little-known archaeological site in Assam, India, Sri Surya Pahar is situated roughly 132 miles northwest of Guwahati and 12 km southeast of Goalpara. The archaeological site is 2.41 km away from the study area. The city that is closest to the location is Goalpara. The location is a steep area with a number of rock-cut Shivalinga’s, votive stupas, and the Hindu, Buddhist, and Jain pantheon's deities dispersed over a one-kilometre radius. The location is cantered on Sri Surya's Pahar hills, which are teeming with Shiva Lingas.

1.4 OBJECTIVE OF THE STUDY:

- To assess the stability of the proposed intake, point with respect to riverbank migration.
- To assess the inputs from the output of bathymetric data as there is no discharge data available.
- Design of anti-erosion bank protection measures with the help of IS: 8408:1994.
- Design of an intake.

1.5 METHODOLOGY

The following methodology is followed: -

a) To determine bankline migration pattern of left bank of Brahmaputra River, ArcGIS 10.4.1 software used in the study area to check the feasibility of water intake point.

b) Anti-erosion bank protection measures carried out with the help of AutoCAD software through the guidelines taken from IS: 8408:1994.

c) Design of an intake is prepared by AutoCAD software with the bathymetric survey reports taken from water resources department, govt. of Assam.

1.6 CHAPTERWISE SCHEME OF THE STUDY

The project report contains following chapters: -

Chapter 1: This chapter deals with a brief introduction on the topic of the study and discusses about plant and study according to achieve the objectives.

Chapter 2: This chapter depicts the literature review.

Chapter 3: This chapter depicts the results and discussions which include the shifting pattern of left bank of the River through ArcGIS software use. Design of anti-erosion protection measures and intake is proceeded through AutoCAD software.

Chapter 4: This chapter deals with conclusion and future scope of the work.

CHAPTER 2
LITERATURE REVIEW

2.1 PROLOGUE

The literature review for this study encompasses a diverse range of research examining the fluvial dynamics, geomorphological processes, the effected ecological and biodiversity changes in the river system. Numerous studies have investigated the bankline shifting pattern on river morphology highlighting the software uses in the research. Additionally, research has explored the implications of ArcGIS and AutoCAD software for showing the bankline migration of Brahmaputra River and its protection measures. By synthesizing findings from these diverse bodies of literature, this study aims to contribute to its own way to solve the real problems of the work involved in the project.

Dutta et al. (2010) undertook a thorough analysis on erosion-deposition processes in Majuli Island, Assam, using Survey of India toposheets and Indian Remote Sensing satellite imagery spanning 33 years. The study's key goals were examining migratory patterns, erosion-deposition phenomena caused by the Brahmaputra and Subansiri rivers, evaluating floodplain geomorphology, channel and bank morphology, and erosion/deposition activities. Furthermore, it hoped to provide critical insights into erosion's effects on Majuli Island's landscape and ecosystem. The study concluded that the erosive forces of the Brahmaputra and Subansiri rivers had a significant impact on Majuli Island, causing significant changes to its landmass. Erosion greatly outpaced deposition, particularly in places with high erosion rates. The examination highlighted the braided character of the Brahmaputra River, along with sedimentary strata consisting silt and sand. The study’s findings hold a significant impact on Majuli islands inhabitants and ecosystem due to erosive effect.

Sharma et al. (2012) study's goal is to thoroughly examine the characteristics and dynamics of the Brahmaputra River, with an emphasis on bank line modifications, wetland ecosystem changes in Deepor Beel, and the identification of turbidity patterns using satellite photography. The work comprises mapping wetland dynamics and turbidity patterns in Deepor Beel using multi-temporal satellite images from the Brahmaputra basin. Using a rule-based decision tree classification method, the study aims to identify and extract wetlands for further examination, linking observed wetland changes with turbidity patterns detected in satellite imagery. The study uses Indian Remote Sensing (IRS) LISS-III sensor images from 1990, 1997, 2000, and 2007 to assess the morphological features and dynamics of the Brahmaputra

River and the nearby wetland environment. The investigation picked the Brahmaputra River from Kobo to the Bangladesh border (a distance of 622.73 kilometers). the research selected cloud-free imagery during the dry season, ensuring consistency in water levels, vegetation cover, and ground conditions. Utilizing a decision tree classification technique based on NDWI, LISS I, and LISS III data, the study delineates wetlands, unveiling hierarchical, non-linear data relationships.

Nath et al. (2013) suggested that, the frequent shifting of river channels causes riverbank erosion in Bangladesh, which is primarily composed of alluvial deposits. The goal of the current study is to investigate the patterns of riverbank erosion in the Chandpur district. Google Earth high resolution satellite photos from 2002 to 2010 and Landsat TM & MSS satellite images from 1980 to 1990 were used to map the river's historical alterations, particularly with regard to the left bank alignment of the river flow. According to the report, the Meghna River's changing features and erosion issue have long plagued this region. Additionally, analysis revealed that, over the previous 30 years, the erosion rate was higher in the 1990–2002 decade than in the previous two decades, covering an area of almost 3517 square meters. The proposed work recommends that recent interpretation results show deposition is higher than erosion.

Lovric and Tosic (2016) proposed the morphological changes attained in a river in his research work. The three most significant geomorphological processes that have drawn the greatest attention from river engineering scientists in the past century are lateral channel migration, accretion, and river bank erosion. In the study he presented, GIS and remote sensing to evaluate the changes in the river's position and morphology between 1958 and 2013. The entire area of bank erosion during the specified period was 8.3430 km2, of which 5.0837 km2 were on the right bank and 3.2593 km2 were on the left. Between 1958 and 2013, the total area of bank accretion was 10.7074 km2, of which 5.2958 km2 were on the right bank and 5.4115 km2 were on the left. The average movement of the Bosna riverbed between 1958 and 2013 was determined 132.4 m in total. The average annual lateral channel migration during this time was 2.5 meters. The information provided here is important for real-world problems including managing soil and water, and forecasting channel migration rates for engineering and planning purposes.

Hossain and Hasan (2016) implemented one of Bangladesh's biggest issues is river bank erosion. Every monsoon, a sizable portion of riverbank land is eroded, displacing people, leaving them penniless, and ultimately impacting the socioeconomic structure of the nation.

The Bangladesh Water Development Board (BWDB) receives a substantial amount of funding each year from the government of Bangladesh to stop river bank erosion, but thus far, no discernible progress has been made. Comparing the effectiveness of cement concrete (CC) blocks and geo-bags in bank security projects was the goal of this study. The essential data from BWDB, engineers, and locals who were involved in the preparation, placement, dumping, and maintenance process of both CC blocks and geo-bags was gathered during the visitation of the revetment sites for geo-bags and CC blocks. Lastly, expenses, according to volume, coverage area and photographic images collected from different riverbank protection sites were analyzed. This study concluded that each material is more of a mixed bag, containing both positive and negative aspects that are appropriate for certain situations, based on field observations, picture analysis, and data from many sources. Nonetheless, this study will assist the relevant parties in comprehending the possible reasons why geo-bags and CC block revetments fail, which could result in the implementation of the required measures for improved river bank protection projects.

Sarma and Acharjee (2018) undertook a comprehensive study to evaluate the temporal changes in channel width and braiding intensity of the Brahmaputra River in Assam, India, as well as the underlying mechanisms causing these fluctuations. The nine-decade study found a considerable rise in the river's channel width throughout the Assam valley. Furthermore, it discovered a direct relationship between channel width and braiding intensity, emphasizing the influence of discharge fluctuations, sediment loads, alluvial bank erosion, and width/depth ratios on braiding formation. This study underlines the importance of an interdisciplinary approach to river management, arguing for collaboration among engineers, earth scientists, and social scientists to evaluate various management alternatives while taking economic and social effects into account throughout time. The findings highlight the importance of these insights in understanding the Brahmaputra River's behavior and its significant ramifications for the surrounding environment and communities, providing a helpful framework for educated river management methods [T1-T6].

Jain (2019) examines that the bankline shifting of Subarnarekha River is mainly caused by monsoonal hydrodynamic behavior and intensive sand mining from the river bed in the middle-lower course of the river. As the estimation and future prediction of riverbank shifting is difficult so to pursue a more generalized approach, the study seeks to apply Digital Shoreline Analysis System (DSAS) which supported statistical models to estimate the riverbank shifting and future prediction considering the six different multi-temporal banklines.

The result shows that in vicinity of meandering bend, river course undergoes a higher rate of shifting. The model derived positional error is high (0.121 m) in the estuary section with an overall mean error of 0.02 m. The approach shows its suitability for estimating variability of riverbank shifting and short-term prediction to take erosion prevention action plans on an immediate basis.

Khan et al. (2020) conducted a thorough examination into erosion and deposition along the Padma River's riverbank at the international boundary zone, focusing on the region stretching from Dhuliyan in the Murshidabad District of India to Chapa Nawabganj District in Bangladesh. The principal goals were to create a database of transboundary rivers in assess erosion and deposition rates in south-western Bangladesh from 1995 to 2015, as well as riverbank dynamics. The study indicated that river channel migration, erosion, and deposition greatly contribute to poverty in Bangladesh, with implications for rural unemployment in both Bangladesh and India. It stressed the significance of ongoing riverbank monitoring in order to reduce potential hazards and losses. Furthermore, the study revealed regional and temporal differences in bank lines, erosion, and deposition while pinpointing underlying causes. These findings underscore the need for further research and the development of strategies to manage the impact of river to manage the river migration.

Symmank et al. (2020) suggested that through human impact the biodiversity is highly affected the people lived bear riverbank. So, the need of restoration is high but its realization is often hampered by antagonistic human efforts. The bioengineering technique which is a straightforward technique for replacing artificial riverbank protection to restore riparian ecosystems. Denitrification and phosphorous retention are estimated by applying proxy-based models. With these models' one can show the self-purification of rivers and contribute to mitigating climate change, especially if conducted on a larger scale.

Kumar et al. (2021) employes the detection of course changes in one of the major rivers i.e. Ganga River, between the period of 1980-2020 to demonstrate the visibility of shifting in its course with the help of Landsat images. The study concluded that with the help of remote sensing and GIS methods the shifting of river course with different sections has been viewed and the amount of erosion and deposition has also been detected. The Erosion and depositional development occurred due to infrastructure damage by sedimentation, flood and changing river course. The Ganga course has shifted towards the south and north direction places which as a result leads to village erosion. The study leads to have an interaction with physical and socio-cultural environment with the upstream and downstream section.

Mahanta et al. (2022) proposed that how the bankline migration of river Brahmaputra is the main factor for effecting the largest island Majuli. Though the bankline composition is nearly consistent throughout, it has been discovered that a few spots along the bank are particularly susceptible to erosion. To further understand the reasons for this selective erosion, spatiotemporal analysis and ground surveys using bathymetry were done in two areas along the banks of the Brahmaputra and Subansiri rivers. This research examines the influence of underlying tectonic factors in the island's erosion problem.

Bhuyan et al. (2023) develops the bank line migration of middle reaches of Brahmaputra River over a 30-year period using digital shoreline analysis system (DSAS). With the help of End Point Rate (EPR) and Linear Regression Rate (LRR) the average bank line shift in a year was calculated. The study helps us to understand the river would likely continue to erode its bank leading to channel widening also the severity of the study area due to the erosion happening on shifting of a river course.

Debnath et al. (2023) analysis examined changes to the Jia-Bharali River channel in India using the GIS based Digital Shoreline Analysis System (DSAS). The analysis used for 45 years (1976-2021) and showed that the rivers erosion and deposition rates were higher in the yearly years than towards the later part of the period under analysis. The study evaluates the spatial- temporal change of the river in sensitive regions where neighboring settlements and infrastructure were at risk of channel dynamics. Using the actual and forecasted bankline, the degree of accuracy was confirmed. The results of the automated prediction approach could be useful for river hazard management in the Jia Bharali and in similar environment settings with tropical high precipitation zones.

Akhter and Rayhan (2024) shows a dynamically evolving changes in Jamuna River and erosion-accretion patterns of Jamuna is salient in assessing the rivers impacts on its floodplain and surrounding landscapes. The study assesses the spatial-temporal changes of the Jamuna River banks for the last 4 decades (Jan,1984-Jan,2024) and predict changes in 2034 and 2024. With the help of Digital Shoreline Analysis System (DSAS) and ArcGIS the bank lines are digitized and rate of changes was analyzed based on Linear Regression Rate (LRR), End Point Rate (EPR) and Net Shoreline Movement (NSM). Predictions were obtained by simple extrapolation using Kalman Filter Model. The results obtained from historical trends for the upcoming years and contemporary predictions of the study can be useful in further studies for the impacts of river shifting.

2.2 CONCLUSION

The review of literature on the bankline shifting nature of rivers highlights the dynamic behavior of river systems influenced by various natural and anthropogenic factors. The effects of sediment transport, erosion, deposition, which are governed by hydrological, geological and climatic conditions are all observed in a river. Various structural measures (e.g., embankments, revetments, gryones, geobags, boulders) have been explored which mitigating risks while maintaining the riverine health. Advanced technologies like GIS and Remote Sensing with traditional knowledge and sustainable practices comprehensively showcase the river geomorphology and hydrodynamics. This study contributes not only to the river shifting pattern in the projected area, but also offers with bank protection measures and design of an intake well which will help in the future studies to implement more such projects on the field for long term monitoring and usefulness of the sources of water.

CHAPTER 3
RESULTS AND DISCUSSION

3.1 INTRODUCTION

The study represents bankline migration work on the river to check the feasibility of water intake point on the study area. Also, the anti-erosion measures taken along with the design of an intake point to draw water directly from the river for the usage of paper plant.

3.2 BANKLINE MIGRATION STUDY

Using ArcGIS 10.4.1, Landsat 4-5 TM and Landsat 8-9 OLI/TIRS C2L2 images for the study area were downloaded and initially processed. The Landsat images underwent band compositing to facilitate spatial analysis. Utilizing the polyline creation tool, individual bankline delineations were generated for each year (1990-2020), enabling temporal analysis of bankline changes. Subsequently the river cross section was determined based on changes observed in the bankline. The shifting of the bankline has taken into 18 cross sections. The sections labelled as XS-1 to XS-18. The project coordinate was taken from google earth pro by plotting the 26º06′54.9″N and 90º43′47.4″E. Google Earth Pro was utilized for spatial analysis and coordinate measurements.

3.2.1 LANDSAT IMAGES DATA

Table 1: Satellite Images Acquisition Details

Year	Date	Landsat Images
1990	01-01-1990 to 31-12-1990	Landsat-5
1995	01-01-1995 to 31-12-1995	Landsat-5
2000	01-01-2000 to 31-12-2000	Landsat-5
2005	01-01-2005 to 31-12-2005	Landsat-5
2010	01-01-2010 to 31-12-2010	Landsat-5
2015	01-01-2015 to 31-12-2015	Landsat-8
2020	01-01-2020 to 31-12-2020	Landsat-8

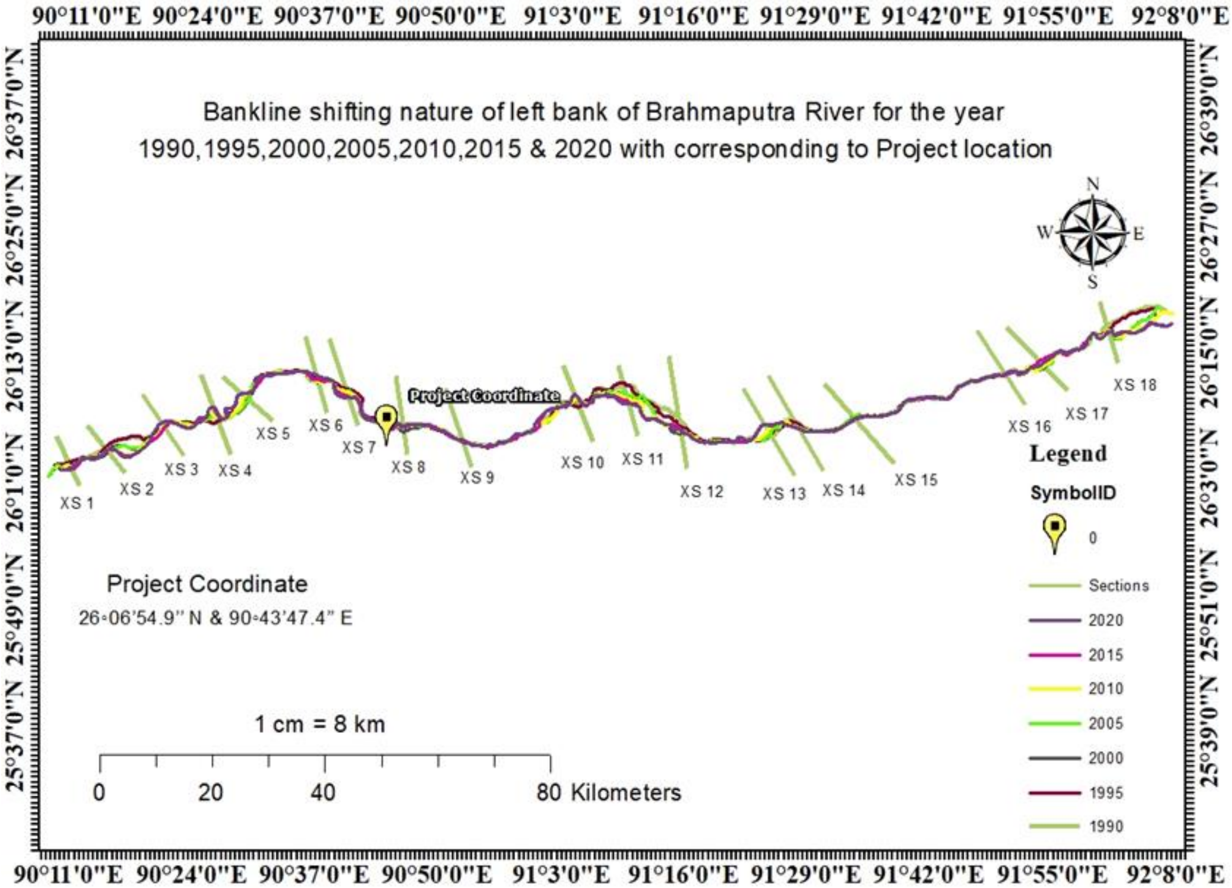

Fig 1: Spatial changes in bankline positions from 1990-2020

From the above, it can be inferred that the point "project Coordinate" was very much stable throughout the year 1990-2020 study period. Thus, this location is appropriate for the Kohinoor Paper Plant's water intake at Matia Industrial Area, Mornoi, Goalpara.

3.2.2 SHIFTING PATTERN OF LEFT BANK OF THE RIVER

Table 2: Shifting pattern of left bank of the river for the 30-year time period analysis

Cross Sections	1990-1995	1995-2000	2000-2005	2005-2010	2010-2015	2015-2020	Total Erosion	Total Deposition
XS 1	-0.308	-0.468	-0.393	0.117	-0.597	0.095	1.766	0.212
XS 2	0.282	-2.142	0.043	-0.129	-0.355	0.006	2.626	0.331
XS 3	0.016	-0.106	-0.138	0.223	-0.088	1.038	0.332	1.277

XS 4	0.250	0.942	-0.048	0.006	1.728	0.040	0.048	2.966
XS 5	-0.030	-0.219	-0.044	1.032	0.585	0.078	0.293	1.695
XS 6	-0.448	-0.577	-0.040	0.072	0.357	0.935	1.065	1.364
XS 7	1.416	-0.390	-0.043	-0.332	-0.708	-0.202	1.675	1.416
XS 8	-0.152	-1.233	0.912	0.270	-0.068	-0.242	1.695	1.182
XS 9	-0.499	-0.165	0.020	0.141	1.228	0.112	0.664	1.501
XS 10	-0.025	-1.105	-0.048	0.007	-0.166	0.162	1.344	0.169
XS 11	-0.317	-2.066	-0.008	0.007	-0.275	-0.303	2.969	0.007
XS 12	-0.027	-0.224	0.099	0.065	-0.061	0.773	0.312	0.937
XS 13	0.057	-0.102	0.053	0.701	1.545	-0.040	0.142	2.356
XS 14	-0.187	-1.008	0.098	0.001	-0.290	0.011	1.485	1.312
XS 15	0.174	0.415	0.011	0.400	-0.035	0.058	0.035	1.058
XS 16	-0.276	-0.015	0.030	-0.003	-0.073	0.032	0.364	0.062
XS 17	0.006	0.134	-0.078	0.157	1.162	-0.748	0.826	1.459
XS 18	-0.964	-0.153	-0.021	0.156	-0.179	-0.010	1.327	0.156

In the abovementioned table the negative values indicate 'erosion' and positive values signify 'deposition' of the river.

3.2.3 FINDINGS OBTAINED

Average depth of erosion $= \frac{\sum(\text{TOTAL EROSION OF ALL THE CROSS SECTIONS})}{\text{TOTAL NO OF CROSS SECTIONS}}$

$= \frac{18.968}{18}$

$= 1.053$ Km

Average depth of deposition $= \frac{\sum(\text{TOTAL DEPOSITIONS OF ALL THE CROSS SECTIONS})}{\text{TOTAL NO OF CROSS SECTIONS}}$

$= \frac{19.46}{18}$ Km

$= 1.081$ Km

3.2.4 CHANGES IN CROSS-SECTIONS

Highest erosion occurred in cross-section 11 i.e. 2.969 km throughout the 30-year time period analysis.

Highest deposition occurred in cross-section 4 i.e. 2.966 km throughout the 30-year time period analysis.

Subsequently, comprehensive analysis was conducted by generating graphical representation in excel.

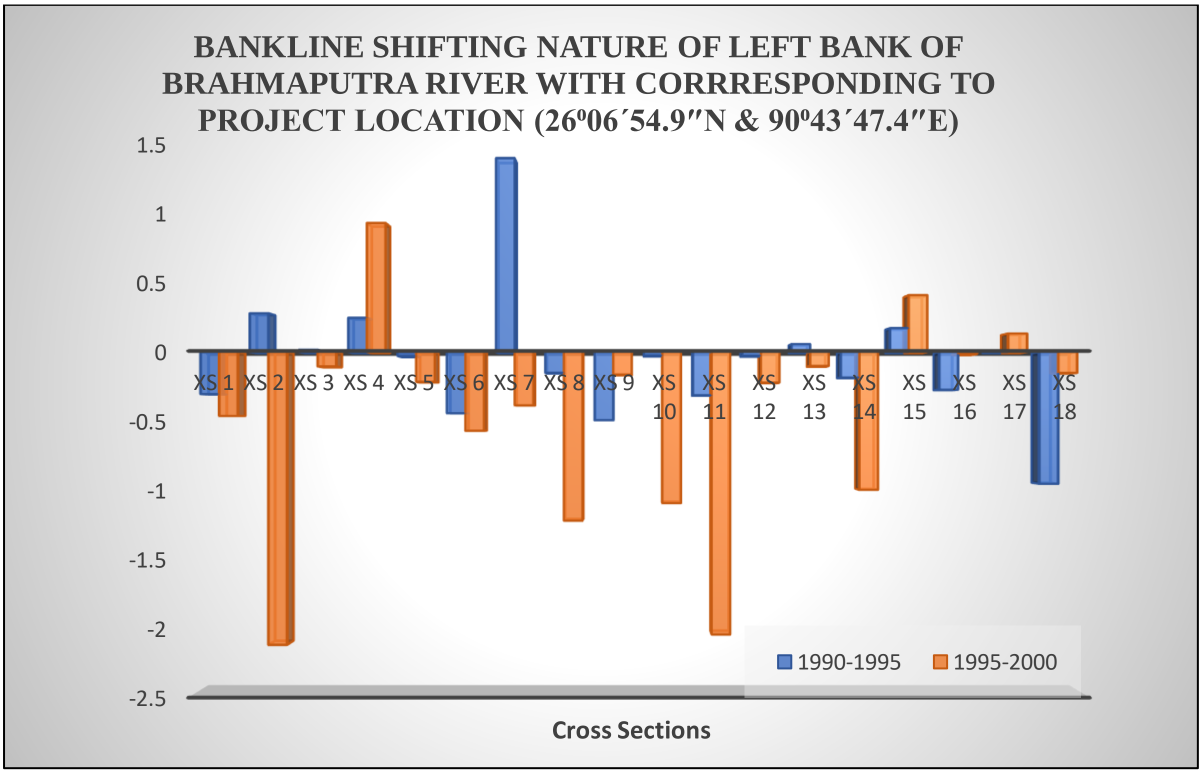

Fig 2: Shifting of left bank of the river for the year 1990 to 2000

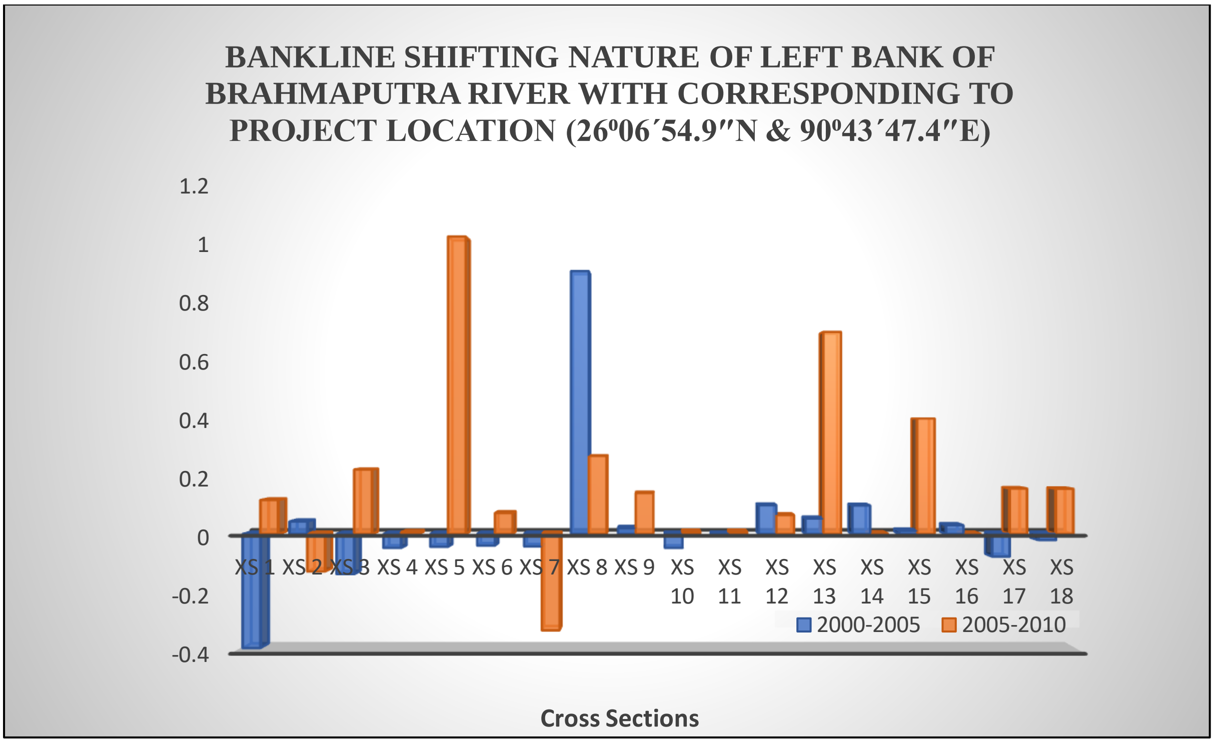

Fig 3: Shifting of left bank of the river for the year 2000 to 2010

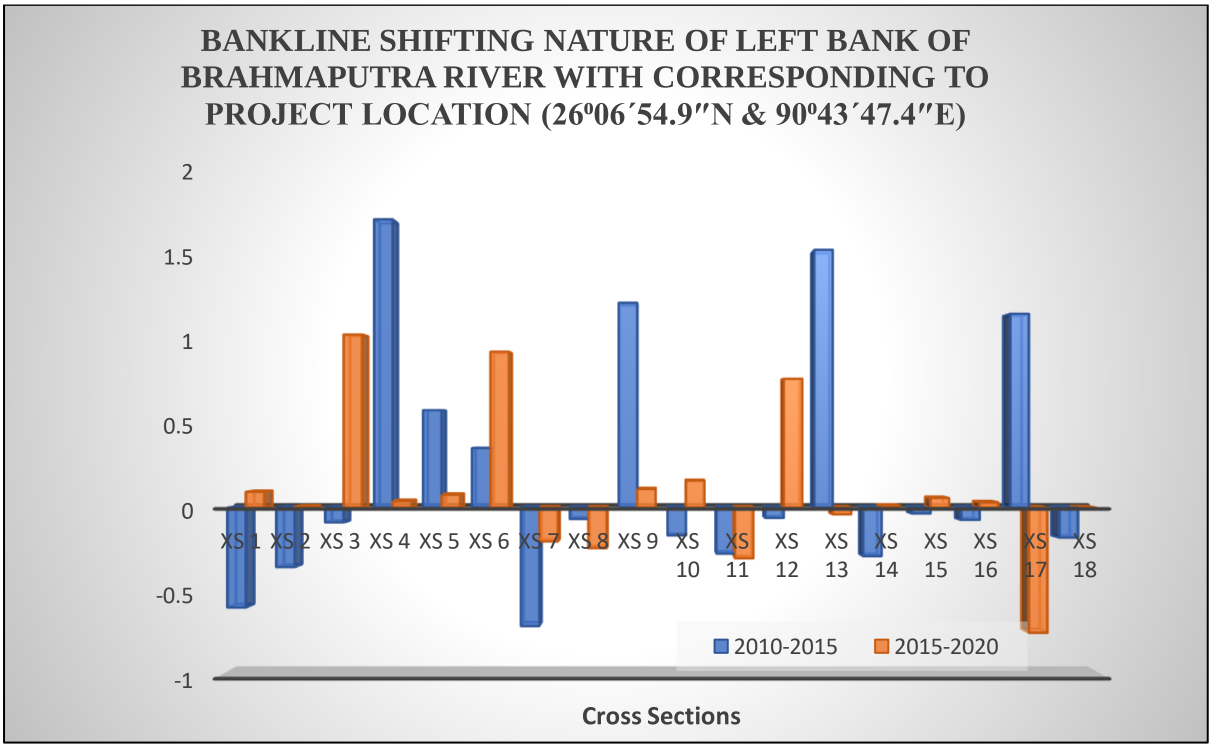

Fig 4: Shifting of left bank of the river for the year 2010 to 2020

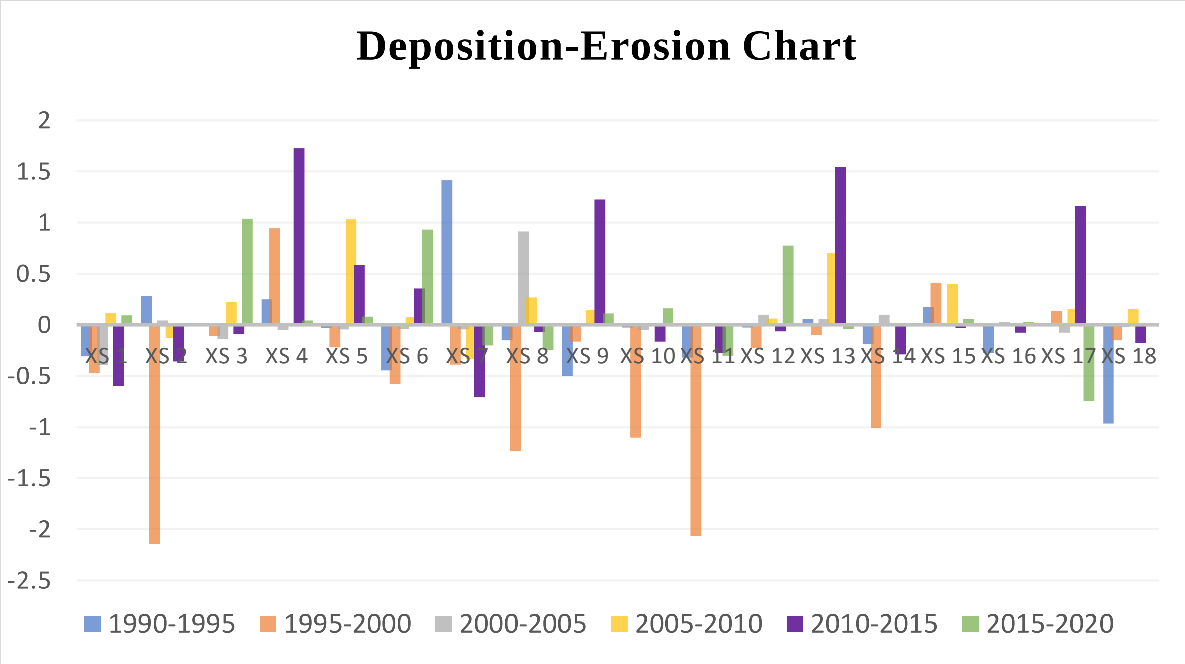

Fig 5: Deposition-Erosion Chart for the 30-year of left bank of the river

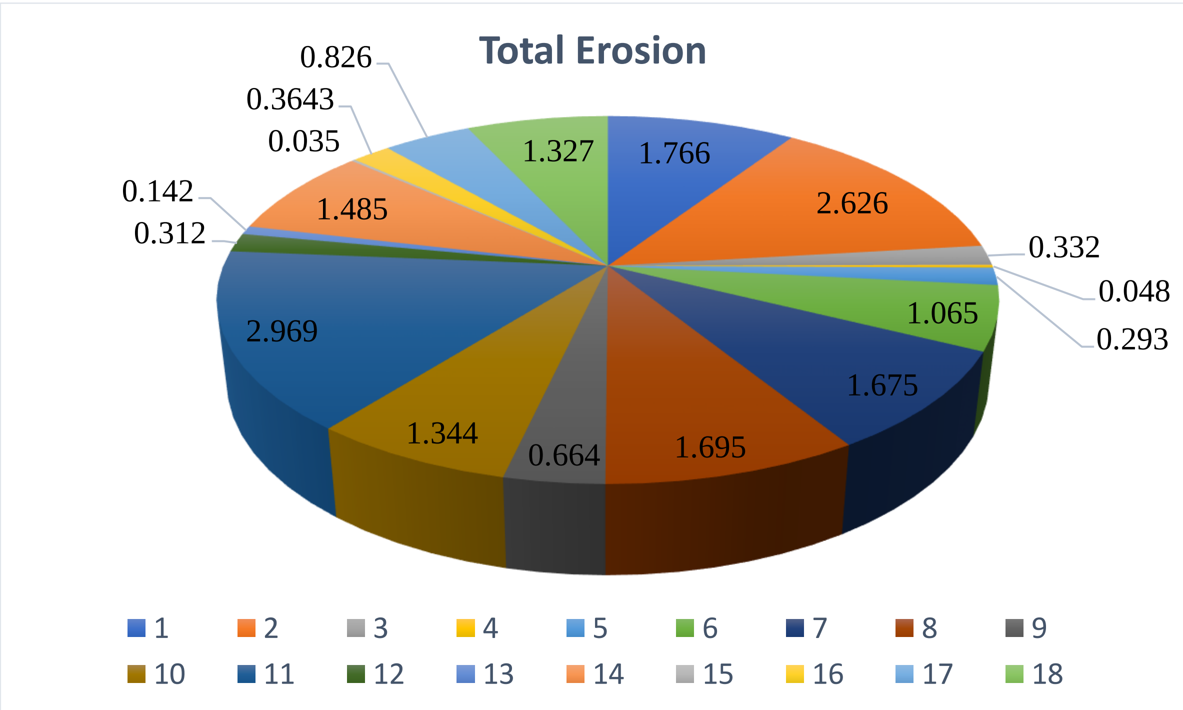

Fig 6: Total-Erosion of all the Cross-Sections throughout the 30-year time period

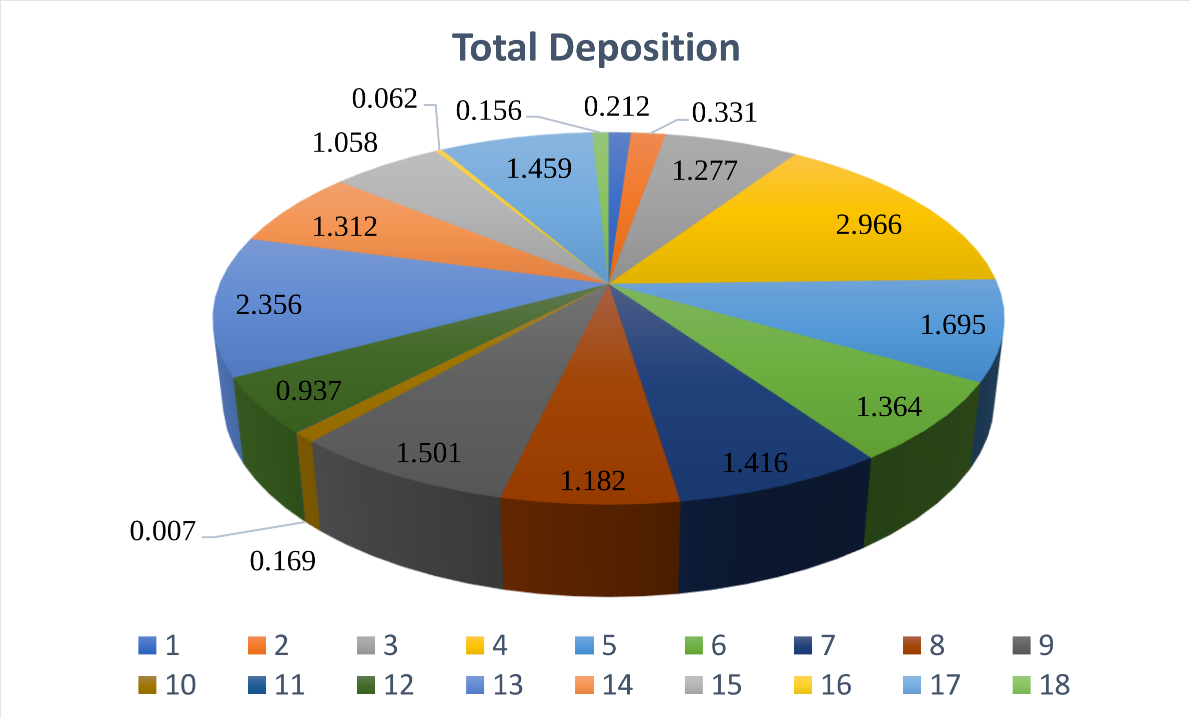

Fig 7: Total Depositions of all the cross sections throughout the 30-year time period

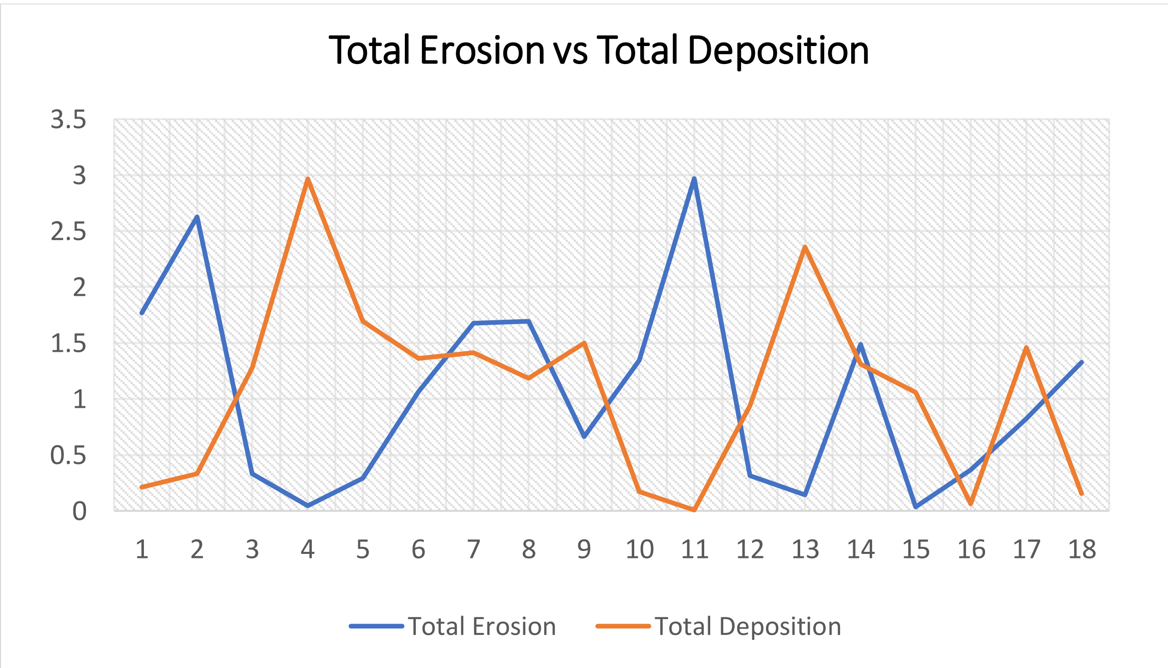

Fig 8: Line Chart graph of Total Erosion vs Total Deposition

3.3 HYDROLOGY

As there is no recorded discharge data available for the study area, so with the help of local people L.W.L is obtained. The parameters for river bank protection works and the design of an intake are derived from discussions with Water Resources Department, Govt. of Assam by bathymetric survey reports. The outputs from those reports are taken into consideration in the project work as inputs and the experimental study has been done according to it.

Table 3: Rivers flowing into the study area

River	coordinates	Origin	Approx. Distance from Study Area(km)
Mornoi river	26° 06' 52.77" N, 90° 44' 39.55" E	The Krishnai and Dudhnoi rivers converge at Matia village, Goalpara district, to form the Mornoi River, which then flows into the Brahmaputra River.	1.69
Krishna river	26° 04' 32.89" N, 90° 45' 08.52" E	The Krishnai River originates in the West Garo Hills of Meghalaya	10.13
Dudhnoi River	26° 04' 32.70" N, 90° 45' 14.29" E	The Dudhnoi River originates in the East Garo Hills of Meghalaya	10.13
Kulsi River	26° 06' 57.82" N, 90° 59' 33.80" E	The river originates from West Khasi Hills of Meghalaya	29.06

All of the aforementioned rivers, with the exception of Jaljali, have their source in Meghalaya. Meghalaya receives a high amount of rainfall. Every river that empties into the designated intake site is a perennial.

3.4 BANK PROTECTION WORKS FOR THE STUDY AREA

Even if a study of bank migration shows that the proposed intake location is historically stable, the river reach must be protected from erosion before the water intake is built since the pumping process will draw more water to the bank. For 200 meters upstream and 100 meters downstream of the intake point, the river reach shall be preserved.

Boulders should preferably be used to defend the river reach. However, using boulders may be subject to environmental constraints. Therefore, both boulders and conventional Type A geo-bags are used in the river bank protection design. Type C geo-bags are not necessary for the river hydrology.

For designing the river bank protection works, the following parameters are considered after discussion with the officials of the Water Resources Department, Govt. of Assam and from river model study and bathymetric survey reports.

1. Design discharge	: 2000 cumec sec
2. Design H. F. L.	: 96.274 m
3. L. W. L.	: 89.5 m
4. Velocity of flow (V)	: 2.5 m/sec
5. Specific gravity of boulder	: 2.65
6. Specific gravity of geo-bag (wet packed with sand)	: 1.90
7. Silt factor, f	:0.8

A side slope of 2H:1V is considered.

All design calculations are done as per **IS: 8408:1994.**

River bank protection using Boulder:

Stone pitching

(i) Stone weight, W $$W = \frac{0.02323 S_s}{K(S_s - 1)^3} V^6$$

Where,

$$K = \left[1 - \frac{Sin^2\theta}{Sin^2\phi}\right]^{1/2}$$

ϕ = angle of repose of stone= 30^0,

θ = angle of sloping bank (2H:1V) =26.56^0

K= 0.4475

W= 7.5 kg

ii) Stone size, $d = 0.124(\frac{W}{S_s})^{1/3}$

d = 0.18 m

Provide two layers of boulders in loose of total thickness = 2×0.18= 0.36 m

Required minimum thickness of pitching, T is given by:

$$\boxed{T = \frac{V^2}{2g(S_s - 1)}}$$

T= 0.19 m,

which is less than the thickness provided, hence safe.

Launching apron

Depth of scour below HFL as per Lacey's formula, $\boxed{D = 0.473(Q/f)^{1/3}}$

D = 6.42 m

Design depth of scour, R = 1.5xD = 9.63 m

R. L. of scour bed level = Design HFL – R

= 96.274 – 9.63 = 86.644 m

(iv) Scour depth below LWL, D_{max} = LWL – R. L. of scour bed level

= 89.5 – 86.644

= 2.856m

Apron width required =1.5x D_{max}

= 4.284 m

Provide apron width = 5.0 m

Thickness of apron =1.5 X thickness of pitching

Thickness of apron = 0.54 m

Provide apron thickness = 0.54 m

River bank protection using Geo-Bag:

Required bag weight, W

K= 0.4475

W= 33 kg

Since, weight of sand filled geo-bag is126 kg, it is safe.

Thickness of Type A bag, d = 0.15 m

Required minimum thickness of bank pitching from negative head criteria, T= 0.3 m

So, provide 2 layers of geo-bags (Type A) in bank pitching.

Overall, thickness of pitching = 2 x 0.15 = 0.3 m

Launching apron

Depth of scour below HFL as per Lacey's formula,

$$\boxed{D = 0.473(Q/f)^{1/3}}$$

D = 6.42 m

Design depth of scour, R	= 1.5xD= 9.63 m
R. L. of scour bed level	= Design HFL – R
	= 96.274 – 9.63
	= 86.644 m
(iv) Scour depth below LWL, D_{max}	= LWL – R. L. of scour bed level
	= 89.5 – 86.644
	= 2.856m
Apron width required	=1.5x D_{max}
	= 4.284 m
Provide apron width	= 5.0 m
Thickness of apron	=1.5 X thickness of pitching
Thickness of apron	= 0.45 m
Provide apron thickness	= 0.45 m

Summary Design,

Angle of sloping bank (2H:1V)

Protection with boulders:

Required minimum weight of each stone	= 7.5 kg
Required minimum thickness of each stone	= 0.18 m
Provide two layers of boulders in loose of total thickness=2×0.18	= 0.36 m in pitching.
Provide apron width	= 5.0 m
Provide apron thickness	= 0.54 m

Protection with Geo-bags:

Provide 2 layers of geo-bags (Type A) in bank pitching.

Overall, thickness of pitching = 2 x 0.15	= 0.30 m
Provide apron width	= 5.0 m
Provide 3 layers of Type A geo-bags for apron.	
Apron thickness	= 0.45 m

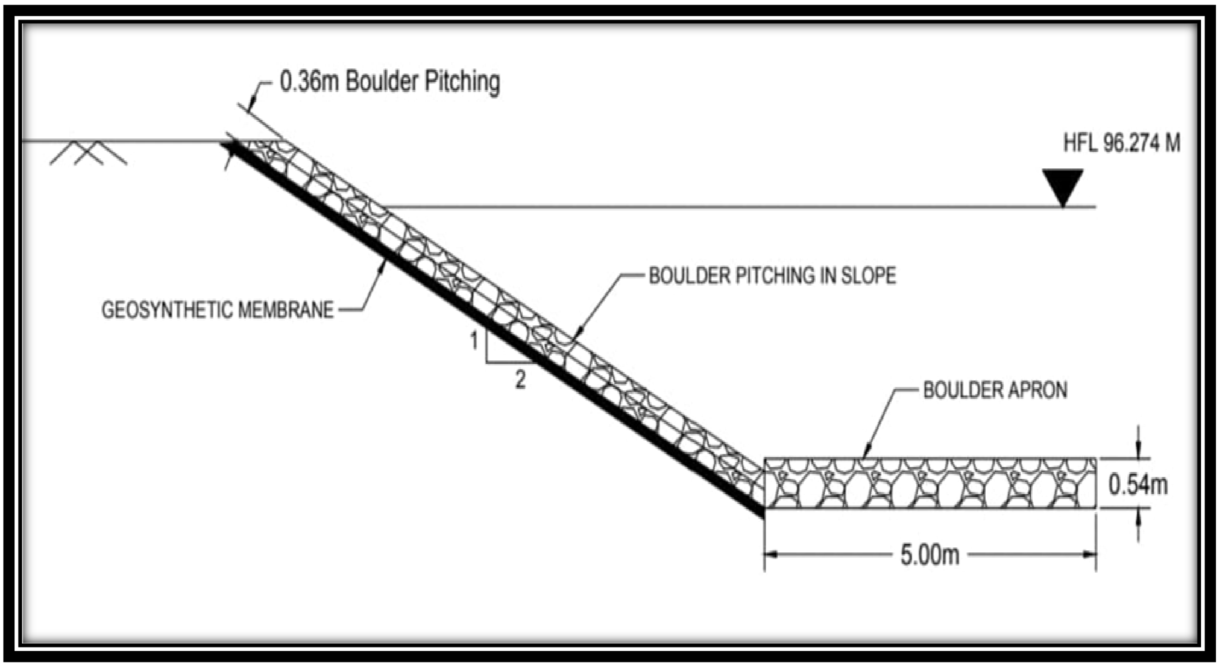

Fig 9: Riverbank protection using Boulders

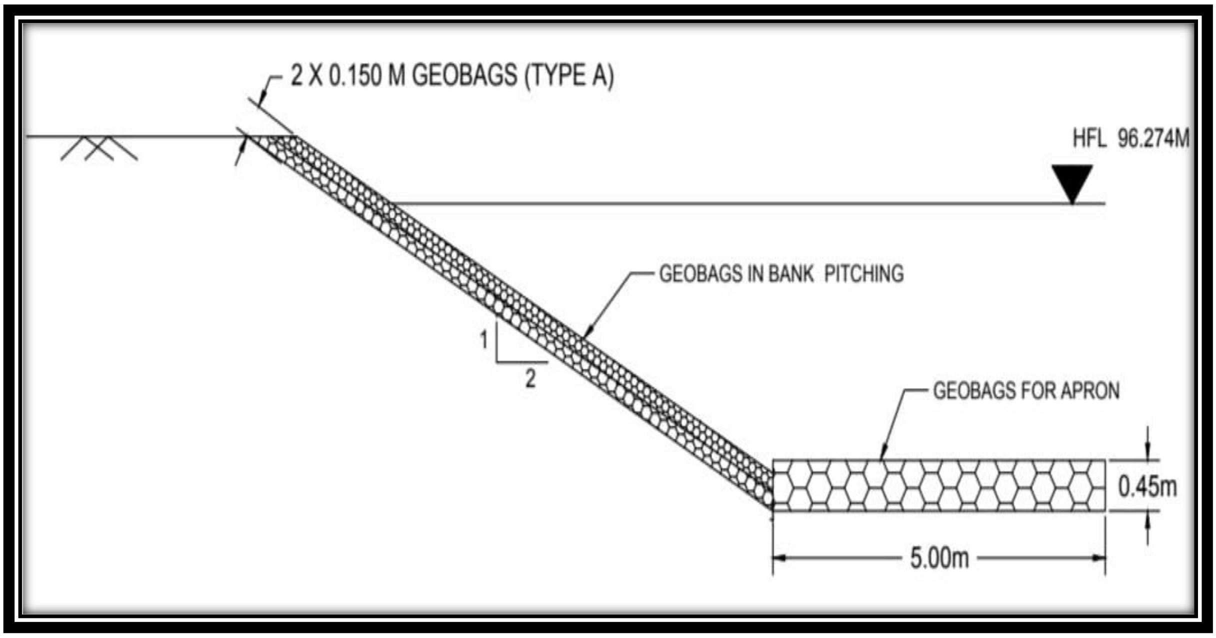

Fig 10: Riverbank protection using type-A Geo-bags

3.5 HYDRAULIC DESIGN OF AN INTAKE WELL

To design the water intake, the following parameters are considered:

Design discharge of river	= 2000 m^3/s
High Flood Level	= 96.274 m
River bed level	= 88.5 m
Low water level	= 89.5 m
Required yield	= 23,000 cubic meters (m^3) of water per day
	= 0.266 m3/s
	= 266 lit/s

The intake is planned to draw water directly from the river. The intake pipe will be at the center of two co-centric circular ring wells having external diameter of 7m and 3.5m. Both the outer ring wells will have strainers to enter water within the rings in its downstream side to minimize entry of sediments. The strainers will start from a depth of 0.5 m above the river bed level up to the HFL (High Flood Level). Both the wells will have steel stairs in their inner faces, so that a man can enter the wells when required. Wells should be placed at a distance from the bank, such that the bank protection apron can be placed comfortably. Wells should be closed at the top with opening facilities, so that periodically men can enter for cleaning purposes. The depth of foundation will be at 13.00 m below the HFL. Wells will be connected to the bank with a cat walk. The cat walk will facilitate movement of inspection/cleaning team to the well, as well as support the intake pipe. The plan and section of the intake well is given in fig: 11

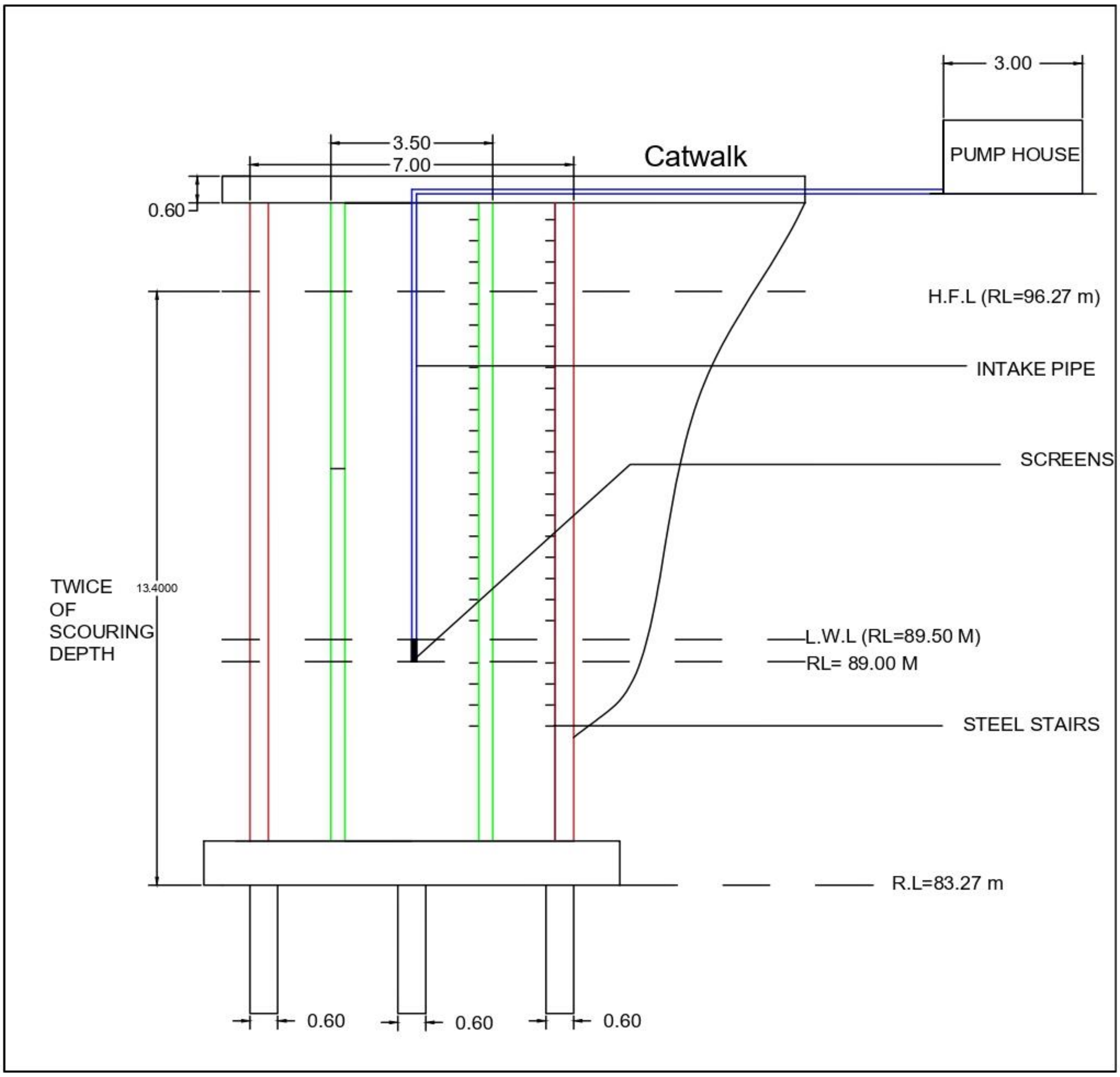

Fig 11 (a): The Section of an Intake Well

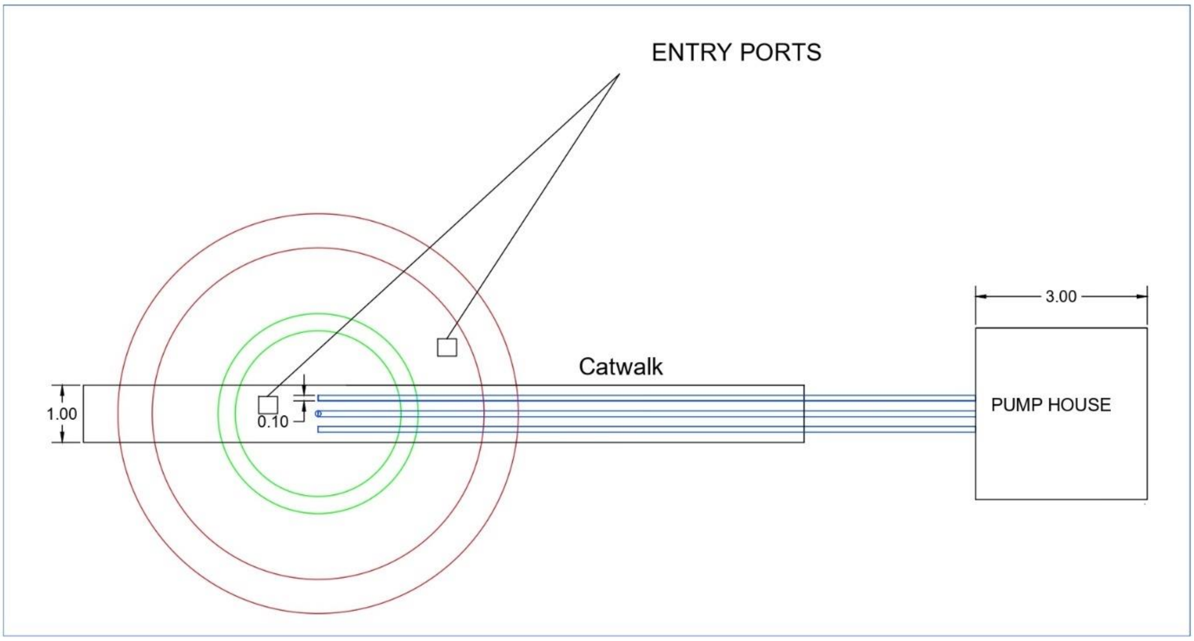

Fig 11 (b): The Plan of an Intake Well

CHAPTER 4

CONCLUSION

The study assessed the feasibility of water intake point at river jaljali for the use of Kohinoor paper plant at Matia industrial area. The results obtained by analysing a shifting nature of the river with 30-year time period in ArcGIS software is quite satisfactorily shown. This allowed tracking of the movement of left bank of the river during specific years (1990, 1995, 2000, 2005, 2010, 2015, 2020). After compositing the bands for the abovementioned years, the intake point is found quite stable throughout the duration.

The study further work on the bankline protection works by Boulder and Type-A Geobag design with the help of IS: 8408:1994, on which data taken from the bathymetric survey reports. This protection measures useful to mitigate erosion and adjacent infrastructure. The intake well design is also done in AutoCAD software which was optimized to ensure reliable water withdrawal, even under varying flow conditions caused by shifting banks.

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