TE-27/3/2021-GIS NMCG

ANNEXURE-I

HINDON RIVER REJUVENATION FOR SUSTAINABLE WATER MANAGEMENT

Submitted by

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(NEER)

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Detailed Project Report (DPR) for River Rejuvenation: Hindon River, Uttar Pradesh, India

1. Executive Summary

Project Title: Hindon River Rejuvenation for Sustainable Water Management

2. Introduction

The Hindon River, a vital water source for Uttar Pradesh, faces challenges such as pollution, sedimentation, and bank erosion. This project aims to implement river rejuvenation approaches to enhance water quality, mitigate erosion, and promote sustainable management.

Mitigating natural river incision and maintaining a predetermined path for a river involves a combination of engineering, ecological, and sustainable management approaches. It's important to note that while human interventions can influence rivers, there are environmental and regulatory considerations that must be taken into account.

Meander Patterns Analysis: Satellite imagery, GIS data, and topographic maps were utilized to analyze the meander patterns of the Hindon River. Meanders represent dynamic zones where the river interacts significantly with its surroundings, influencing the potential for groundwater recharge. Points with pronounced meanders were prioritized for further assessment.

Soil Texture Classification: To assess the hydrogeological suitability for recharge, detailed soil texture analysis was conducted. Data from soil surveys, remote sensing, and ground sampling were integrated to classify the soil into categories such as gravelly sand, slightly gravelly muddy sand, and slightly gravelly sand. These soil types are known for their high infiltration capacities, essential for effective groundwater recharge.

Integration of Meander Patterns and Soil Texture: The overlay of meander patterns and identified soil textures revealed specific zones along the riverbanks with high potential for groundwater recharge. Areas exhibiting gravelly sand, slightly gravelly muddy sand, and slightly gravelly sand within the meander belts were earmarked as priority recharge points.

Vegetation and Land Use Considerations: In addition to meander patterns and soil texture, the study considered the existing vegetation cover and land use in the identified zones. Natural vegetation can enhance recharge processes by reducing surface runoff and promoting infiltration. Areas with minimal urbanization and impermeable surfaces were prioritized to maximize recharge potential.

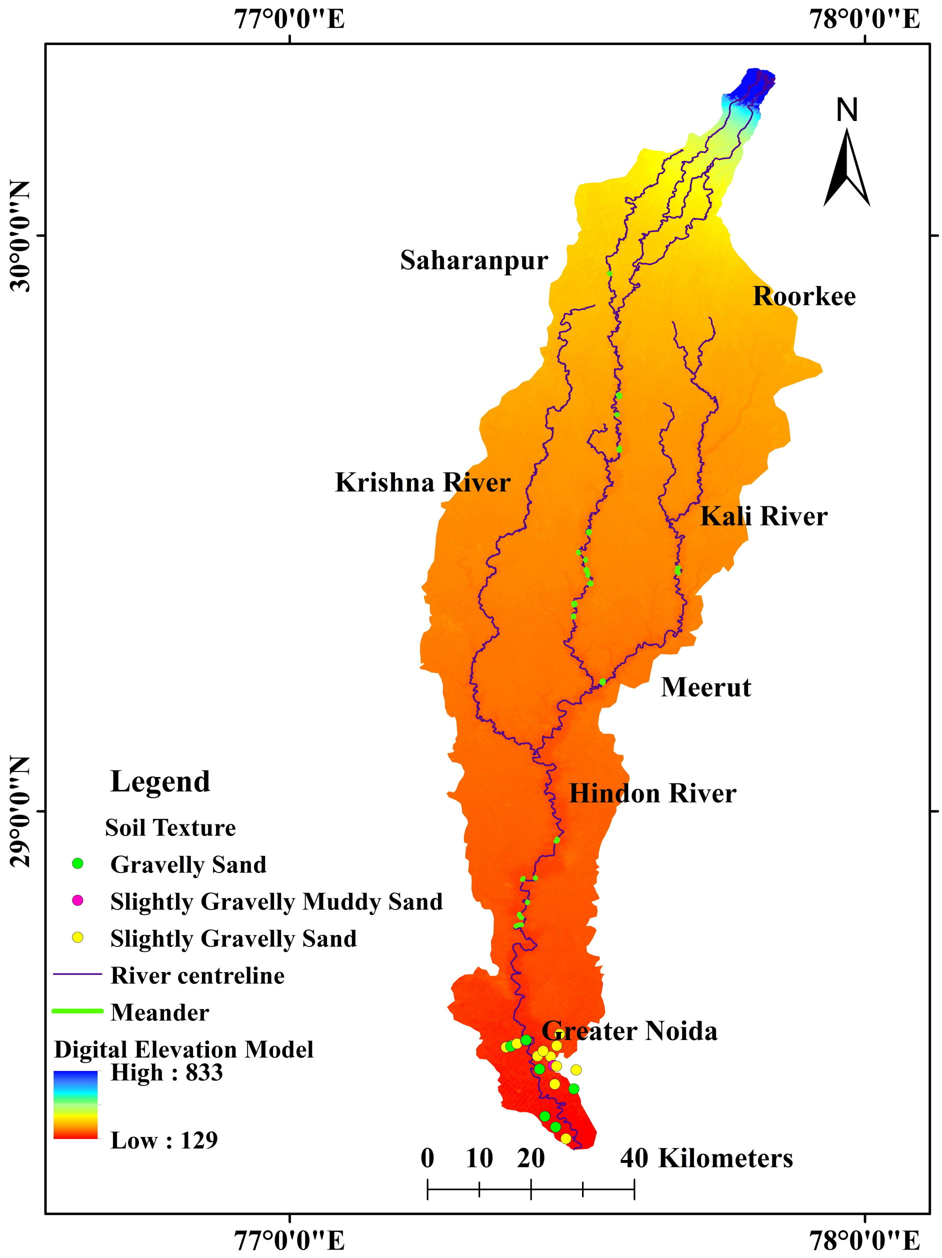


Fig1. Hindon river map with meandering and soil texture

3.Soil texture analysis

Soil obtained near to Hindon river were found Gravelly sand, slightly gravelly sand and slightly gravelly muddy sand.

Gravelly sand typically has high permeability and infiltration capacity due to the presence of coarse particles. This allows water to move through the sediment more easily, facilitating groundwater recharge. While gravelly sand promotes rapid infiltration, it may have a lower storage capacity compared to finer sediments.

Slightly Gravelly Sand:

The permeability of slightly gravelly sand is influenced by the proportion of gravel and sand. Higher gravel content generally leads to increased permeability, supporting efficient groundwater recharge. The presence of fine particles can influence water retention to some extent. Slightly gravelly sand with good connectivity can enhance groundwater recharge.

Slightly Gravelly Muddy Sand:

The presence of mud or silt in slightly gravelly muddy sand can reduce overall permeability compared to cleaner sands. Infiltration in slightly gravelly muddy sand may be slower compared to coarser sediments, but the mud content can contribute to prolonged recharge by retaining water. However, the mud content may enhance water retention. Contaminants may be filtered or attenuated as water moves through the sediment.

Location name	Lattitude	Longitude	Elevation (m	>=2.36mm	>=1.18mm	>=600 µm	300 µm	150 µm	63 µm	45 µm	<45 µm	Total weight (From 100g	Texture data
Jhatta	28.4697667	77.4435667	193	9.94	18.53	7.39	15.29	21.47	23.68	2.29	0.84	99.43	Gravelly Sand
Deri Kambakshpur	28.4512	77.46225	197	4.98	17.98	9.36	20.75	20.37	22.34	2.41	1.28	99.47	Gravelly Sand
Sec-150	28.4310833	77.4802167	180	0.09	3.69	8.25	30.03	26.32	28.66	1.95	0.42	99.41	Slightly Gravelly Sand
Suthiyana	28.5259833	77.4609333	198	2.56	14.32	8.65	20.09	10.58	35.68	5.85	1.55	99.28	Slightly Gravelly Sand
Brick Kiln	28.5739667	77.4534833	202	3.12	17.78	9.8	20.25	11.95	32.24	3.66	0.67	99.47	Slightly Gravelly Sand
Bisrakh	28.57475	77.4308333	209	1.66	8.71	5.04	10.92	7.22	56.79	6.03	3.18	99.55	Slightly Gravelly Sand
Patwari	28.5836333	77.4406167	195	0.43	8.72	9.66	34.77	33.55	12.01	0.32	0.14	99.6	Slightly Gravelly Sand
Brick Kiln (Roza Yakubp	28.6130833	77.4695667	198	3.93	7.68	5.59	15.03	22.73	39.96	3.45	1.09	99.46	Slightly Gravelly Sand
Brick Kiln (Roza Yakubp	28.6133333	77.4694167	199	1.27	11.09	7.92	14.79	14.16	43.49	5.05	1.54	99.31	Slightly Gravelly Sand
Milk Lachi	28.5926667	77.4642833	202	1.85	2.81	3.68	9.18	8.77	67.68	3.96	1.11	99.04	Slightly Gravelly Sand
Mamura	28.5902333	77.37635	198	1.45	6.97	5.39	13.07	8.82	51.32	10.2	2.15	99.36	Slightly Gravelly Sand
Basi	28.5936	77.38685	203	0.35	0.94	1.91	8.01	22.14	57.97	6.16	1.82	99.3	Slightly Gravelly Sand
Sarfabad	28.5916833	77.3844333	195	17.74	16.01	7.28	18.39	9.85	24.73	4.13	1.39	99.52	Gravelly Sand
Garhi Chaukhandi	28.5966	77.3951	196	1.83	15.02	10.39	19.18	20.62	28.87	2.75	0.61	99.27	Slightly Gravelly Sand
Hindon floodplain	28.6011333	77.4106833	190	0.2	2.3	3.96	11.5	9.86	60.78	8.09	2.26	98.95	Slightly Gravelly Muddy Sand
Partala	28.6027667	77.4111167	201	6.07	10.5	4.63	9.15	33.32	30.73	3.63	1.27	99.3	Gravelly Sand
Aminabad	28.5586	77.4583333	204	1.82	6.03	3.43	6.93	2.75	62.52	13.4	2.24	99.14	Slightly Gravelly Muddy Sand
Kheda Chauganpur	28.5573167	77.4637	198	1.43	15.84	12.71	23.37	10.65	28.98	4.91	1.49	99.38	Slightly Gravelly Sand
Surajpur	28.5507667	77.4979833	190	1.9	7.48	7.45	18.06	20.91	37.91	4.73	1.1	99.54	Slightly Gravelly Sand
Panchvihar	28.5174333	77.4939833	189	0.36	1.65	1.74	5.77	33.04	47.86	6.95	2.24	99.61	Gravelly Sand
Jalpura	28.55235	77.4342167	196	7.25	18.24	7.2	13.27	8.45	41.29	3.41	0.38	99.49	Gravelly Sand

Table1. Grain size analysis of Hindon river floodplain

4.Strategies:

Bank Stabilization

Use erosion control measures such as riprap, gabions, and revetments along the riverbanks to stabilize them and reduce the likelihood of erosion.

Vegetative Cover

Promote the growth of native vegetation along the riverbanks. The roots of plants help bind the soil, reducing erosion and providing natural stabilization.

Terracing

Construct terraces or step-like structures along the riverbanks to slow down water flow, reducing erosive force and promoting sediment deposition.

Check Dams

Install check dams or weirs strategically to control the flow of water and reduce its erosive power. These structures can also help trap sediment.

River Channelization

Design and implement controlled channelization to guide the river along a predetermined path. This involves modifying the course of the river to reduce erosion and stabilize the banks.

Erosion-Resistant Materials

Use erosion-resistant materials for construction in and around the river, such as concrete or reinforced structures, to minimize the impact of erosive forces.

Sediment Management

Implement sediment management practices to control the transport of sediments. This can involve dredging or sediment retention structures to maintain a stable riverbed.

Hydrological Management

Implement water flow management strategies to control the discharge and flow patterns of the river. This may involve regulating dam releases or controlling upstream development to minimize erosion.

Community Engagement

Involve local communities in the decision-making process to ensure that interventions align with their needs and the sustainable use of natural resources.

Adaptive Management

Implement adaptive management practices that allow for adjustments based on monitoring and assessment of the river's behavior and the effectiveness of interventions.

5. Objectives

- Mitigate river incision and stabilize riverbanks.
- Improve water quality and reduce pollution.
- Implement sustainable practices for long-term river health.
- Enhance ecosystem resilience and biodiversity.

6. Proposed Project Components

6.1 Bank Stabilization:

Location: Along the stretch at 15 points (refer to Table1 Hindon Migration Region)

Approach: Use riprap, gabions, and revetments to stabilize riverbanks and prevent erosion.

Image 1 Riprap

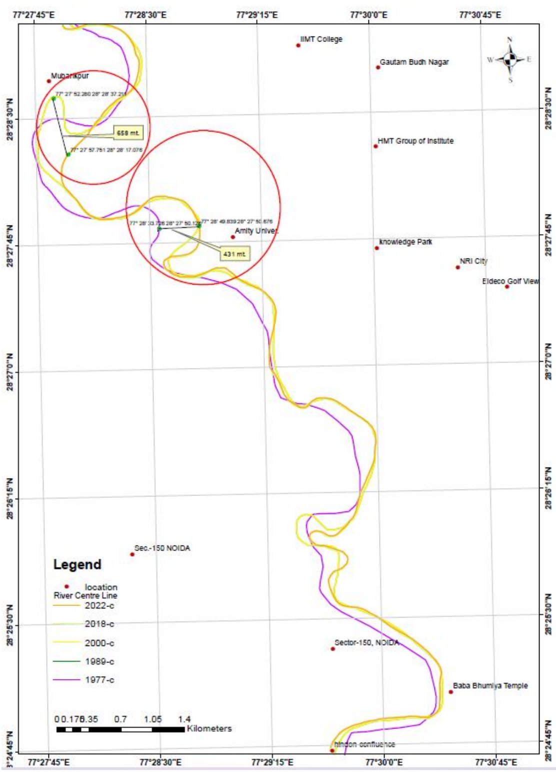
Image 2 Gabions

Image 3 Revetments

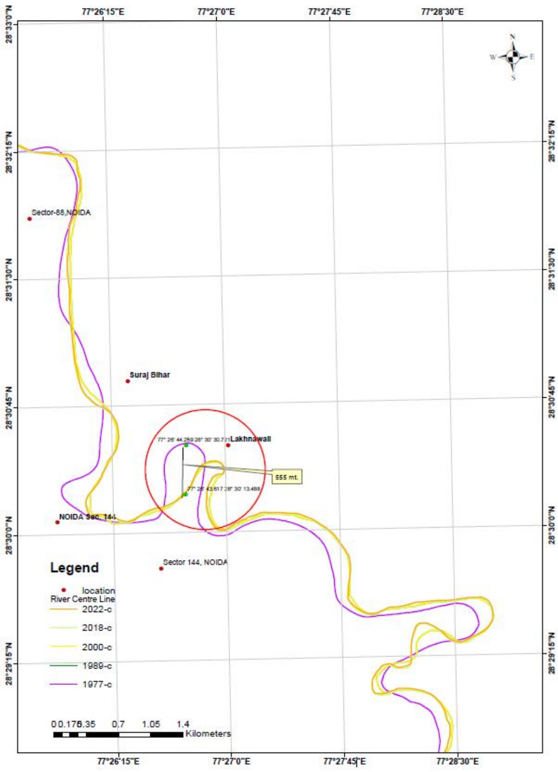
Hindon Migration region			
Sr No	Location	Lattitude	Longitude
1	Mubarakpur and Amity University	28°28'30"	77°27'52"
2	Laknawall	28°30'30"	77°26'44"
3	Sabbir Masjid	28°33'08"	77°25'33"
4	Behlolpur	28°37'25"	77°24'22"
5	Poddar international	28°43'11"	77°23'44"
6	Sirora	28°45'50"	77°24'20"
7	Suthari	28°50'56"	77°24'36"
8	Kunhalda	28°53'03"	77°25'08"
9	Harikhera	28°58'58"	77°26'05"
10	Mawl Kalan	29°01'30"	77°27'15"
11	Jauddinpur	28°53'06"	77°26'42"
12	Khaprana	29°09'31"	77°28'35"
13	Baparas	29°11'16"	77°29'56"
14	Chanderi	29°15'56"	77°30'05"
15	Bawana	29°19'01"	77°29'31"

Table2. Hindon river migration Region

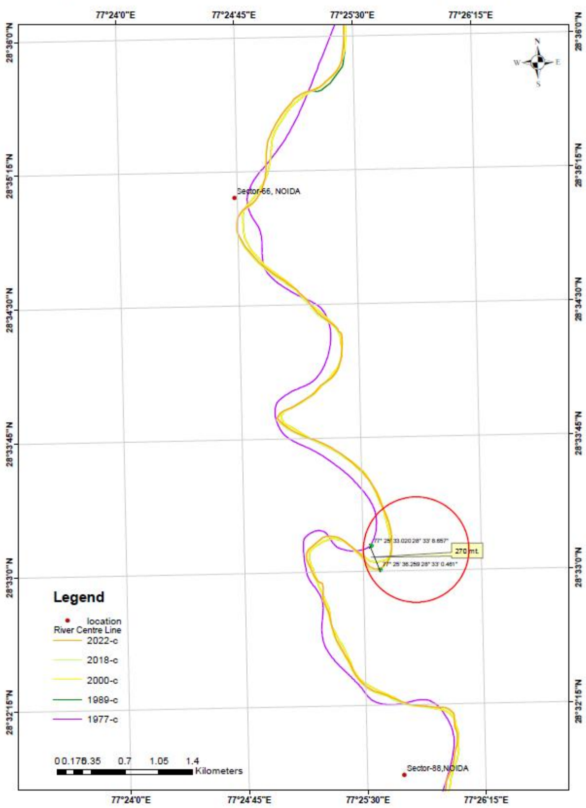
Migration of Hindon River (Location Specific) Part-1



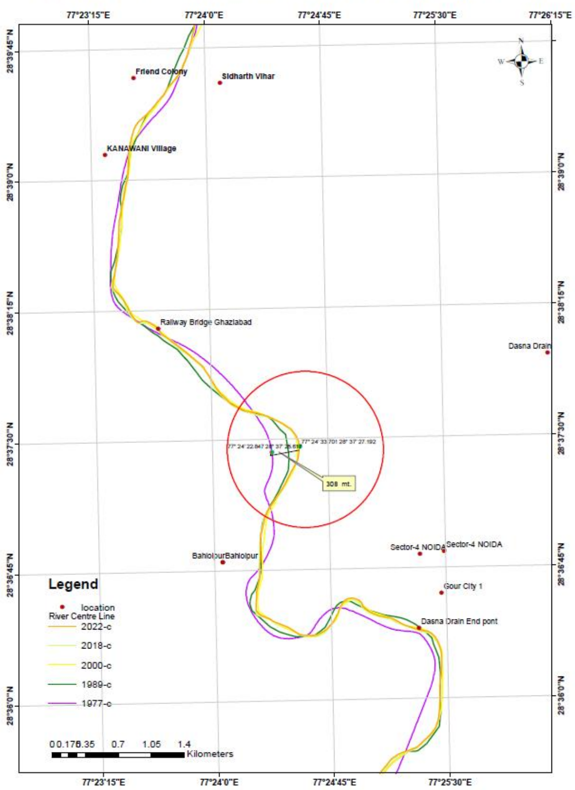
Migration of Hindon River (Location Specific) Part-2



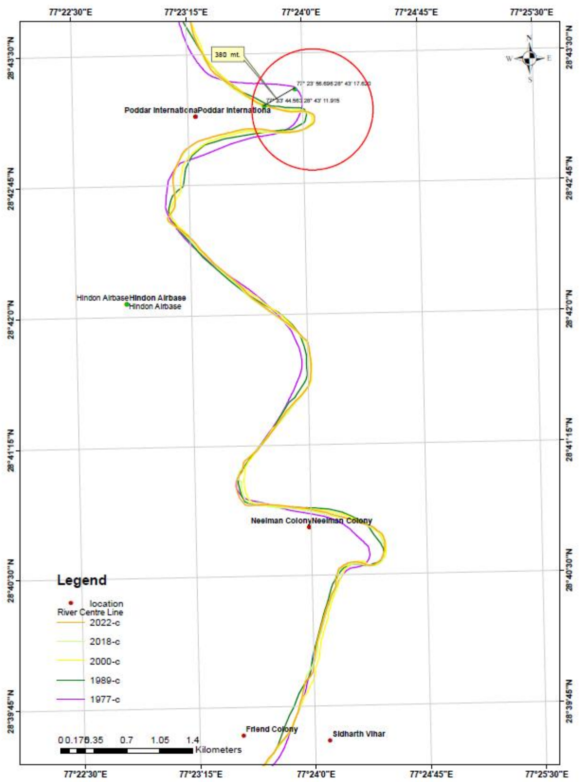
Migration of Hindon River (Location Specific) Part-3



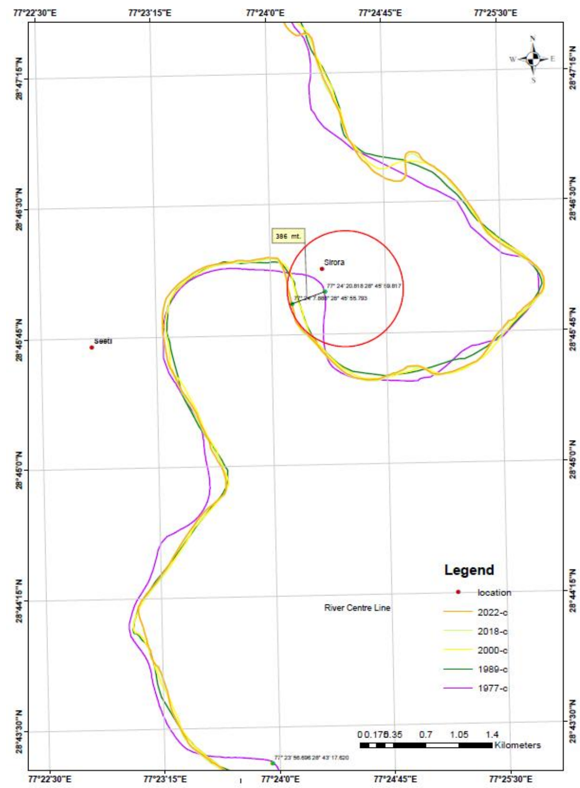
Migration of Hindon River (Location Specific) Part-4



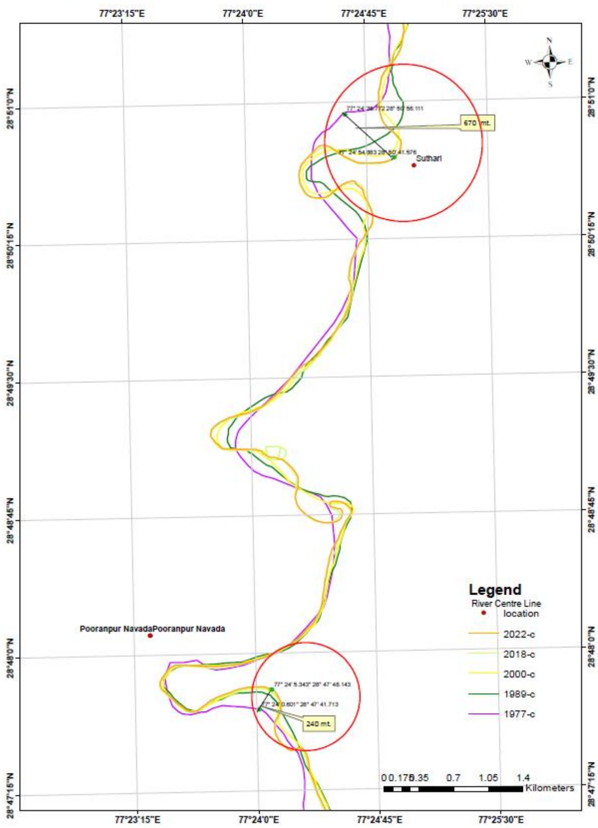
Migration of Hindon River (Location Specific) Part-5



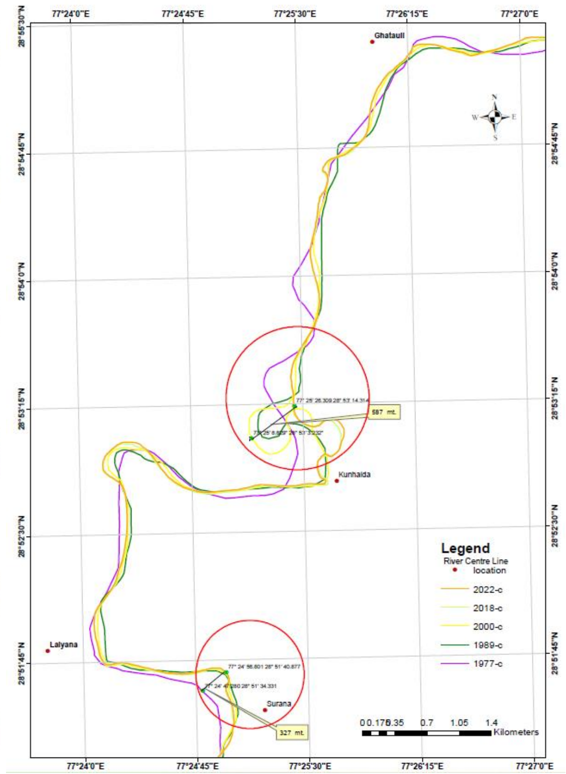
Migration of Hindon River (Location Specific) Part-6



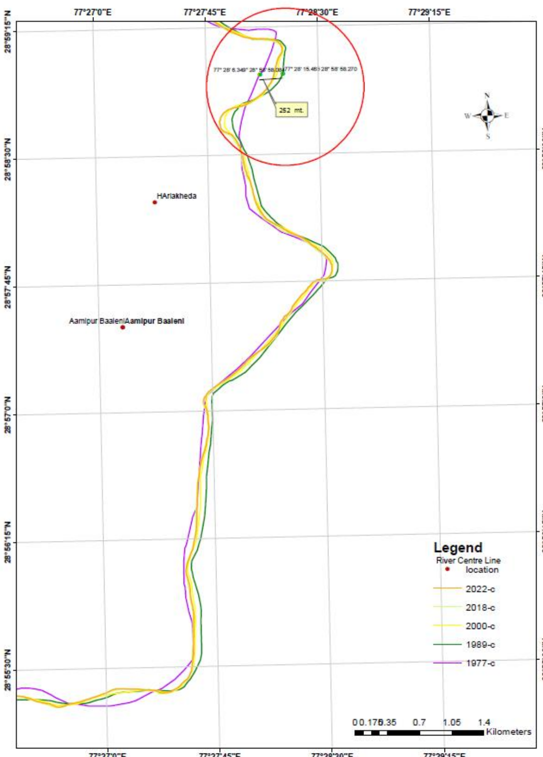
Migration of Hindon River (Location Specific) Part-7



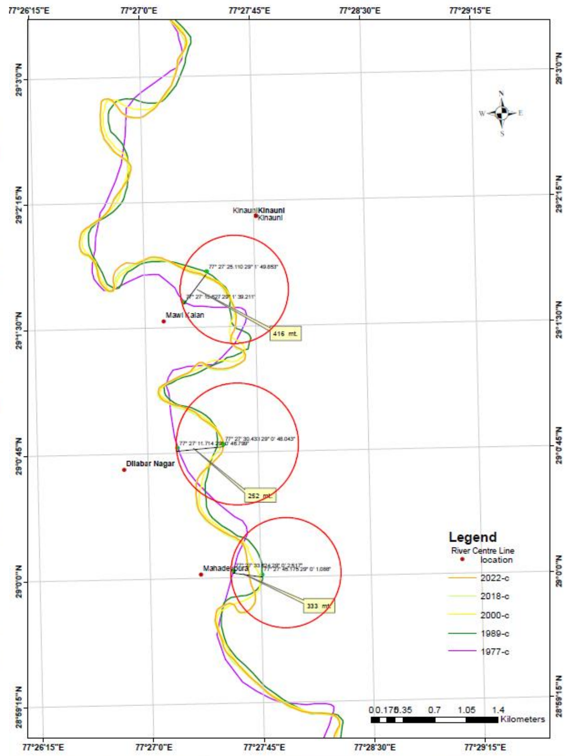
Migration of Hindon River (Location Specific) Part-8



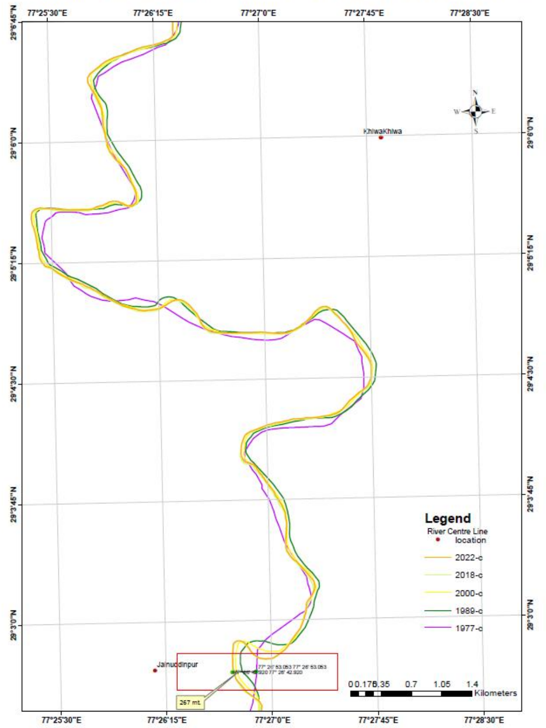
Migration of Hindon River (Location Specific) Part-9



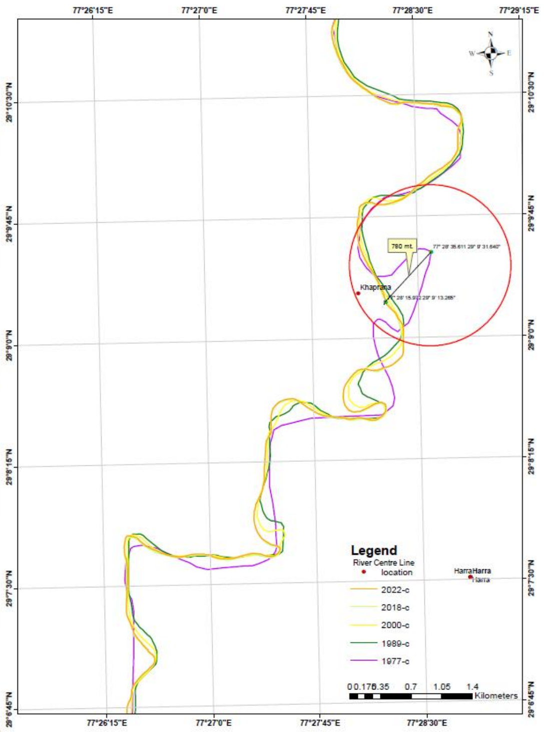
Migration of Hindon River (Location Specific) Part-10



Migration of Hindon River (Location Specific) Part-11



Migration of Hindon River (Location Specific) Part-12



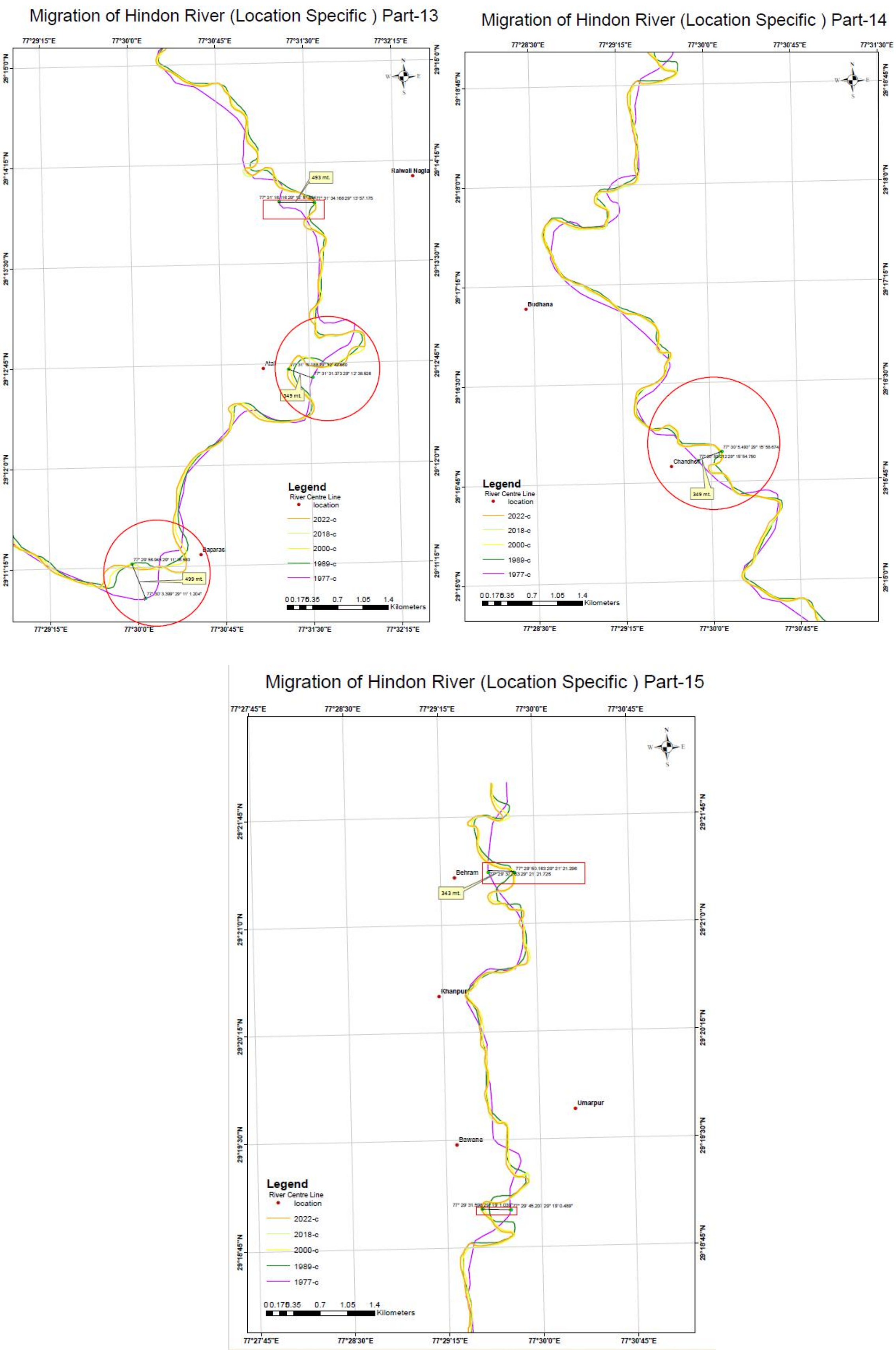


Fig. 3. Hindon river migration shown in part 1 to part 15

7. Technical Specifications

- Use erosion-resistant materials such as Riprap stones and concrete for bank stabilization.

Constructed against a bank/escarpment to protect it from erosion while absorbing wave and flow energy. Permanent ground cover structure made up of large loose angular stones.

7.1 Shear-stress method

• Shear-stress method

Effective rock size required for riverbank stabilization under applied shear stress is

estimated from Lanes relationship:

$$d_m = \frac{\tau_0}{\tau_{*c}\gamma(G-1)\left[\sqrt{1-\frac{\sin^2\phi_1}{\sin^2\phi}}\right]}$$

dm = effective rock size
$\tau 0$= applied shear stress
$\tau * c$ = critical Shield parameter
∅1 = side slope of bank
∅ = angle of repose of riprap rock
γ = unit weight of water
G= Specific weight of rock

7.2 Velocity method

Effective rock size required for riverbank stabilization under applied critical shear

Velocity

$$V_c = K_c\sqrt{2(G-1)gd_s}$$

$$K_c = \log\left(\frac{4h}{d_s}\right)\sqrt{\tan\phi}$$

Vc = critical mean flow velocity
ds = stone diameter
∅ = angle of repose of riprap rock
h= flow depth
h/ ds=relative submergence

7.3 RipRap Gradation

Size of representative of stability of riprap is determined by the larger size of rock as these are not transported under given flow condition. Riprap with angular stone is more stable. For poor gradation of riprap a filter is placed between riprap and bank material

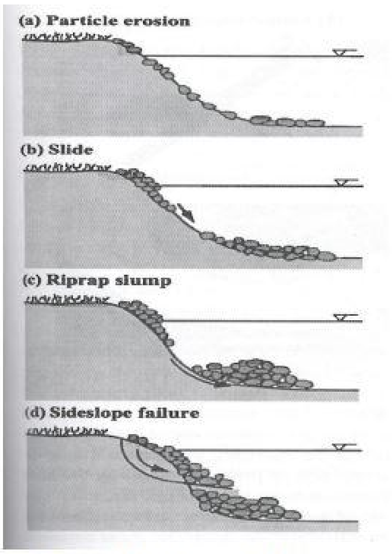
Table 8.2. *Suggested riprap size gradation*

Percent finer by weight	Sieve diameter ($\times d_{50}$)	Stone diameter ($\times d_{50}$)
0	0.25	—
10	0.35	0.28
20	0.50	0.43
30	0.65	0.57
40	0.80	0.72
50	1.00	0.90
60	1.20	1.10
70	1.60	1.50
90	1.80	1.70
100	2.00	1.90

From: Julien, 2002

Riprap can fail due to particle erosion, translational slides, slumps and side slope failure

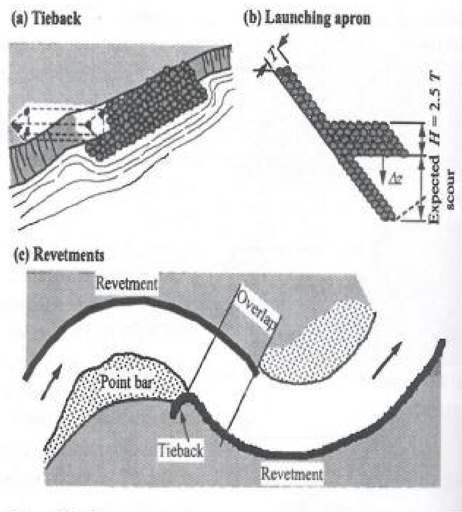
Riprap should not be used on slopes steeper than 1V:1.5H



Types of Riparian failure

Upstream and downstream ends of structure should be tied into stream banks

A launching apron is an effective revetment for riprap protection



Types of Riparian protection

Diagrams From: Julien, 2002

- Used under riprap revetment to allow water to drain easily from bank without carrying out soil particles
- Filter thickness should not be less than 6-9 in
- Opening of 25% to 30% is desirable to minimize clogging and reduce head loss
- Two types: Gravel filter and synthetic fabric filters

Suggested specification for gradation of filter material size

Julien, 2002

$$\frac{d_{50}(filter)}{d_{50}(base)} < 40$$

$$5 < \frac{d_{15}(filter)}{d_{15}(base)} < 40$$

$$\frac{d_{15}(filter)}{d_{85}(base)} < 5$$

- Select native plant species with strong root systems for vegetative cover.
- Construct check dams with appropriate height and spacing for effective water flow regulation.

7.4 Approaches for river bank stabilization

Strengthening the bank

– Hard Approaches : Riverbank Riprap & retaining walls

– Softer Approaches: Bioengineering and vegetation

Reducing Hydrodynamic force

– Flow control structures

7.4.1 Hard Approaches

- Riprap

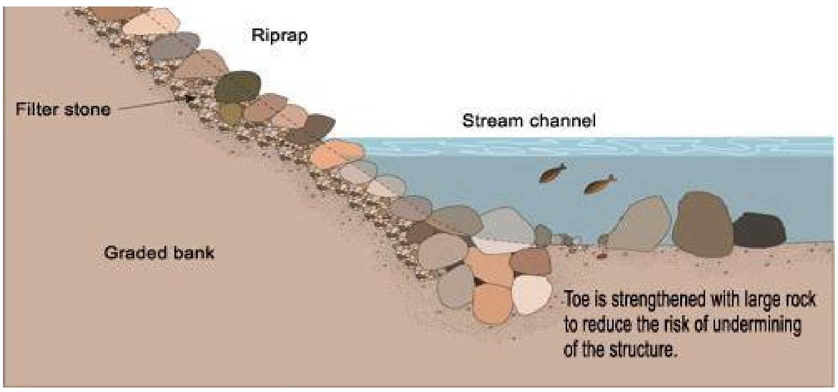


Image 1 Cross section of Riprap stream bank

Engineered Revetments

- Gabions and mattresses
- Sacks and blocks
- Concrete mattresses
- Soil cement

Retaining Walls

- Gravity walls
- Cantilever walls
- Sheet pilling

Flow Control Structures

- Reduce hydrodynamic forces against stream banks
- Control the direction, velocity, or depth of flowing water
- Reduce the possibility of bank degradation by diverting the flow
- These structures generally have certain degree of permeability

7.4.2 Soft Approaches (Bioengineering)

- Pole Plantings
- Coir Rolls
- Tree and Bush Revetment
- Brushwood bundles
- Woven stems
- Biodegradable geotextiles
- Brushwood layering
- Brushwood mattresses
- Green Toe protection
- Re-profiling
- Root wads

Comparing Hard And Soft Approaches

`	Hard, Engineering Approaches	Soft, Bioengineering Approaches
Advantages:	Durable, highly stable, can give rise to vegetation Local damages can be repaired easily	Long-term, re-generating protection Often less costly Potential for better environmental outcomes
Disadvantages:	Need construction practice and restricted to some design parameter Need manpower, materials, equipment Comparatively costly	May require time to establish Not always practical (requires, soil, water and mild slopes) Can cause damage later on via wind-throw of mature vegetation

6. Environmental Impact Assessment (EIA)

Conduct a comprehensive EIA to assess potential ecological impacts. Conduct thorough environmental impact assessments before implementing any intervention. This helps in understanding potential ecological consequences and guides decision-making.

Evaluate the proposed interventions' effects on biodiversity, aquatic life, and local ecosystems.

Implement mitigation measures identified in the EIA.

7. Project Timeline

Phase 1: Site assessment and Budget allocation

Phase 2: Site preparation along the bank (as per Table2. Hindon river migration Region)

Phase 3: Riprap, gabions and revetment construction

Phase 4: Monitoring and adaptive management

8. Monitoring and Evaluation

- Establish monitoring points at key locations.
- Regularly assess water quality, riverbank stability, and vegetation growth.
- Modify the project plan based on continuous monitoring and feedback.

9. Stakeholder Engagement

- Collaborate with local communities, environmental organizations, and government agencies.
- Conduct awareness programs to involve the community in the project.
- Seek approvals and support from relevant authorities.

10. Conclusion

The Hindon River Rejuvenation Project aims to address environmental challenges, enhance water quality, and contribute to sustainable water management. The comprehensive approach outlined in this DPR emphasizes the importance of balancing ecological conservation with the needs of local communities.