

Pollution Control Board, Assam Conservation of River Kolong, Nagaon Preparation of Detailed Project Report City Sanitation Plan

December 2013





Joint Venture of THE Louis Berger Group, INC and DHI (India) Water & Environment Pvt. Ltd.



Photos on the front page are taken by the project field team in Nagaon town during visits in year 2013.

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LIST OF KEY ABBREVIATIONS

BOD	:	Biological Oxygen Demand
CDM	:	Clean Development Mechanism
COD	:	Chemical Oxygen Demand
CPCB	:	Central Pollution Control Board
CPHEEO	:	Central Public Health Environmental Engineering Organisation
CSP	:	City Sanitation Plan
CWC	:	Central Water Commission
DA	:	Drainage Area
DBO	:	Design, Build & Operate
DO	:	Dissolved Oxygen
DPR	:	Detailed Project Report
FR	:	Feasibility Report
GIS	:	Geographical Information System
GL	:	Ground Level
Gol	:	Government of India
ICT	:	Information and communications technology
IEC	:	Information, Education & Communication
JNNURM	:	Jawahar Lal Nehru National Urban Renewable Mission
LPD	:	Litres Per Day

:	Million Litres per Day
:	Ministry of Environment and Forests, Govt. of India
:	Municipal Solid Waste
:	National Ganga River Basin Authority
:	Nagaon Municipal Board
:	Nagaon Municipal Corporation
:	National River Conservation Directorate
:	National River Conservation Plan
:	Operation and Maintenance
:	Pollution Control Board, Assam
:	Project Feasibility Report
:	Public Health Engineering
:	Project Management Unit
:	Pumping Station
:	River Front Development
:	Sewage Pumping Station
:	Suspended Solids
:	Sewerage Treatment Plant
:	Solid Waste Management
:	Total Suspended Solids
:	Urban Local Bodies

Salient Features of the Project

Background and Objective

A study conducted by the Central Pollution Control Board (CPCB) identified the Kolong River (Kolong), a tributary of Brahmaputra River as one of 71 most polluted rivers in India. The Kolong originates from the Brahmaputra River in the Hatimura region of Jakhalabandha (Nagaon district, Assam), and after traversing approximately 250 kms through the districts of Nagaon, Morigaon and Kamrup, rejoins the Brahmaputra River at Kolongpar near Guwahati. The river flows through the heart of the Nagaon urban area and divides the town into two regions (Nagaon and Haiborgaon).

The Kolong River stretch which runs through the Nagaon town (Nagaon) is polluted resulting in environmental degradation and continues to impact the health/hygiene of the inhabitants in the surrounding area. Therefore, the Pollution Control Board of Assam (PCBA) has commissioned preparation of this Detailed Project Report (DPR) for Kolong in accordance with the Ministry of Environment and Forests (MoEF), National River Conservation Directorate (NRCD) guidelines (NRCD, 2010).

The NRCD had earlier prescribed specific guidelines for the preparation of the Project Feasibility Report (PFR) and DPR under the National River Conservation Plan. Subsequent developments including the formulation of the March 2001 resolution by the National River Conservation Authority, lead to the issuance of new guidelines for the preparation of the DPR under the consolidated National River Conservation Plan and the National Lake Conservation Plan. The overall objective of the DPR is formulating a comprehensive and integrated river restoration plan for the Kolong in accordance with the 2010 NRCD guidelines.

Scope of the Work

Per the NRCD (2010) guidelines, the DPR will be prepared in a three-stage process related to sewerage schemes, namely:

- City Sanitation Plan (CSP), which constitutes this report.
- Project Feasibility Report (PFR) for sewerage scheme.
- Detailed Project Report (DPR).

The DPR will possess the following salient features:

- Adopt a holistic approach and provide for an integrated sewer network up to houseproperty lines in place of drain interception and diversion to ensure full coverage of Nagaon town and thereby transport all sewage to treatment plants for optimal utilization.
- Incorporate dovetailing with projects under the JNNURM/UIDSSMT/State Plan to ensure optimal utilization of resources on a priority basis.
- Adopt the Design, Build & Operate model for efficient operation and maintenance of river conservation schemes.
- Incorporate a stakeholder focused consultative approach at the stage of formulation and implementation of the project, to ensure active involvement of various stakeholders and the civil society to generate support and encourage ownership.
- Apply cutting-edge information and communications technology (ICT) tools and software for project planning and design.
- Select the most innovative and best technology options for treatment of sewage. Selection and analysis of technical and financial sustainability of created assets created for this life cycle study along with detailed analysis of the performance metrics will be further considered at PFR stage.

Good Practices to be followed in the DPR:

- Incorporate rain water harvesting in community sanitation schemes.
- Promote solar energy for community sanitation schemes.
- Use of improved sanitation scheme based on higher user charges where applicable.
- Upgrade existing community sanitation and sewerage infrastructure.
- Consider innovative River Front Development Projects.
- Introduce "river festival" and "river runs" under the public participation, information, education, and communication activities.
- Consider design parameters of sewage treatment plants (STP) based on actual measurements and analyses, and on the scarcity of land.

Executive Summary

The Nagaon stretch of Kolong suffers from environmental degradation and continues to impact the health/hygiene of the inhabitants in the surrounding area. Therefore, PCBA has assigned its highest priority to restoring the Kolong in accordance with the NRCD guidelines by adopting a series of integrated conservation measures. These measures include among others; waste water management; solid waste management; water resources management for hydraulic improvement of the river channel; provision of civil amenities along the river and around the area of influence; and, formulation of an awareness program among the affected communities and stakeholders to refrain from activities that degrade the condition of the river in any manner. The conservation measures will be analysed and documented in a DPR following NRCD (2010) guidelines. The DPR will thereafter serve as the primary guidance document for future river restoration measures.

The overall aim of the project is to revitalize the Kolong within the context of the continued urbanization of Nagaon by restoring it to its natural state, while allowing the river system to continue to support flood management, landscape development and recreational activities. In its current degraded state, the Kolong serves as an extended sewer canal running through the densest populated areas within Nagaon. The water quality of the river will be restored per NRCD guidelines by: restricting inflows of raw sewerage from residential/commercial establishments; limiting direct discharge from storm water drains along roads adjacent to the river; and preventing unabated dumping of solid waste by communities residing along the river. Measures will be adopted to augment inflow of clean water to improve river hydraulics and flood management controls, and to develop an integrated water resource management system to sustain optimum water levels required in the river during the dry winter months. The revitalization efforts will incorporate riverfront development to encourage public participation and ownership of the river. It is noted that this DPR is one of the several initiatives currently underway by the Government of Assam to improve the living conditions in Nagaon.

The DPR is being prepared by an experienced team of Indian and international professionals with a wide range of expertise in river restoration and wastewater management controls. In addition to collecting data and reviewing reports and documents of relevant programmes, consultations have been carried out with relevant Government agencies, municipalities, community members and other stakeholders. The DPR will also address diverse yet related issues such as environmental sustainability and dependency of local communities. An action plan has been drawn up per contract provisions and includes data collection and field surveys, preparation of the City Sanitation Plan, assessment of the feasibility of the main components of the proposed pollution abatement and river conservation measures, and finally preparation of the DPR.

Check List for City Sanitation Plan

S No	NPCD Checklist Parameters*	Addressed		Reference in this CSP			
5. NO.	NRCD Checklist Parameters	Yes No					
1	Has the available data of the polluted stretch of the river basin been collected?	Yes		Chapter 1, Section 1.3.			
2	Have the maps of the river basin and the city been prepared?	Yes		Chapter 1, Section 1.3.1 and 1.3.6.			
1	Has the city been selected after studying the status of water quality of the river in the entire stretch in the state?	Yes		Town has been selected for most polluted stretch as per NRCD guidelines.			
2	Has the problem of pollution with its causes been identified?	Yes		Chapter 1, Section 1.3, Description of the project area.			
3	Have all the sources of pollution of river been identified?	Yes		Chapter1, Section 1.3, Description of the project area.			
4	Has the information of toilet facilities available in slums and elsewhere been collected?	Yes		Chapter 3, Section 3.1.			
5	Has the condition of ghats been ascertained?	Yes		Chapter 3, Section 3.3 and 3.4.			
6	Has the expected outcome of pollution abatement project been spelt out in terms of improvement of water quality and of environment in the city been spelt out?	Yes		And will be covered in details through numerical simulations in the Feasibility Report and the DPR.			
7	Has the present system of management of waste water and other works been studied	Yes		Chapter 2.			
8	Have areas requiring upgrading of existing system of waste water management been identified?	Yes		Chapter 6.			
	Have areas for sewer alignments been identified?	Yes		Chapter 6.			
	Have drainage areas and sewage districts been identified?	Yes					
	Has the need for following Schemes been exam	nined?					
	(i) Solid waste management	Yes		Chapter 4.			
	(ii) Community toilet	Yes		Chapter 3, Section 3.1.			
	(iii) River front development	Yes		Chapter 3, Section 3.3.			
	(iv) Other non-point sources of pollution	Yes					
	Have agencies that will be assigned the preparation of component schemes been identified?	Yes		Chapter 7.			
	Has Executive Summary been prepared?	Yes		At the front of the report			
NPCD (2010) Chapter 20. Executive Summary and Check Lists for City Sanitation Plan							

NRCD (2010), Chapter 20, Executive Summary and Check Lists for City Sanitation Plan

1 About the Project Area

1.1 Authority for Preparation of Project

The authority for preparation of the project is:

River and Lake Conservation Cell Pollution Control Board, Assam Bamunimaidam; Guwahati-21 Ph: +91-361-2652774 (O) +91-9435343530 (M) Fax: +91-361-2550259 Website: www.pcbassam.org

1.2 Composition of the Team for CSP

The project team for the CSP consists of The Louis Berger Group, Inc. in consortium with DHI (India) Water & Environment Pvt. Ltd.

1.3 Description of the Project Area

The Kolong River is a spill channel that diverts from the Brahmaputra River in the Hatimura region of Jakhalabandha (Nagaon district, Assam; Figure 1-1 and Figure 1-2).



Figure 1-1: Study area.



Figure 1-2: Kolong River basin. The polluted stretch in Nagaon town is marked.

The river is approximately 250 km long and flows through the Nagaon, Morigaon and Kamrup districts. It flows through the heart of the Nagaon urban area, where it divides the town into the two regions: Nagaon region and Haiborgaon region. The Kolong River re-joins the Brahmaputra River at Kolongpar near the town of Guwahati.

In 1962, the Kolong River was closed by a dike at its upstream point of diversion from the Brahmaputra River. The dike was constructed by the State Flood Control Department to reduce flooding along the river during peak flow events. With the inflow from the Brahmaputra River blocked, the current sources of flow in the Kolong River are as follows:

- Stormwater runoff from its catchment runoff;
- Baseflow from ground water seepage; and
- Waste water discharges from Nagaon town and various towns.

The main contributors of pollutions to the Kolong River are:

- Misa River that carries organic loads and urban sewage from the Misa Township and tea gardens.
- Diju River that carries organic loads from tea gardens.
- Nagaon town that discharges volumes of untreated sewage into the river.

The Haria and Gerua Rivers are tributaries that flow into the Kolong River. Since they carry a lower organic load, they reduce the contaminant concentrations in the Kolong River.

The dike along the Brahmaputra River has led to stagnation and degradation in the Kolong River in its upper catchment area (i.e., between the dike and the confluence with the Gerua River), a river stretch of nearly 197 km. In this stretch, the river is now choked with silt and water hyacinths, and its water is murky and polluted. The most polluted stretch of the river is located between its entrance into Nagaon town and its confluence with the Haria River.

1.3.1 Description of the Polluted Stretch

The Kolong River flows through the heart of the Nagaon, Morigaon and Kamrup districts and transverses through densely populated residential, industrial and commercial areas. It carries a portion of the municipal and other wastes from neighbouring communities and also serves as the natural drainage for storm water runoff.

The pollution caused by domestic and industrial waste poses a threat to the people along the river. The major focus of the restoration and conservation of the river is Nagaon town, the biggest polluter, and its immediate downstream stretch. Misa, Kaliabor, Puranigudam, Samaguri, Raha and Jamunamukh are also priority peripheral towns, where conservation works should to be taken up in the future.

1.3.2 Justification for selecting the Town for Project Formulation under NRCP/NGRBA

A study by the Central Pollution Control Board found that the Kolong River is among the most polluted rivers in India. Similarly, the NRCD (2010) guidelines identify the Kolong River as one of the rivers to consider for conservation.

There has furthermore been a strong and collective demand from the inhabitants of Nagaon town to clean up the river and bring it back to its past pristine status along with a healthy ecosystem in the river basin.

1.3.3 Brief History of the Town

The present Nagaon district was once known as Khagarijan with its headquarter at Paranigudam. At that time there was a canal in the heart of the district. This canal was covered by reeds which were locally known as Khagari (hence the name Khagarijan).

During the reign of the Ahom King Pratap Sinha (1603 -1641 AD) the Kacharis attacked his kingdom and advanced as far as to Kaliabor. The people in the area between Kaliabor and Raha fled in panic. After expulsion of the Kacharis from the Ahom Kingdom, the king deputed an officer named Momai Tamuli Brabarua to reconstruct the area. Brabarua established new villages for the repatriated fugitives. The new settlements were called Nagaon, which stands for 'new village settlement', a name later given to the district.

1.3.4 Geographical Location

The Nagaon district in Assam is situated on the south bank of the Brahmaputra River (between 25°45' and 26°45' North and 91°50' and 93°20' East). It is bounded by six other districts (Figure 1-1). The Nagaon district covers an area of 4,002 km² making it one of the largest district in Assam.

1.3.5 Climate

The climate of the Nagaon district has the following characteristics:

- *Winter:* Dry and cool winter months with little rain and moderate winds from the east and north-east (north-east monsoon). Fog is a predominant feature of the weather condition during this season.
- *Pre-monsoon season:* The winter period is followed by the pre-monsoon season with thunderstorms from March to May.
- *Monsoon season:* Humid and hot conditions in summer months with the south-west monsoon and abundant rains.
- Post-monsoon season: This season lasts from October to November.

The average annual rainfall in the district was 1,788 mm between years 2000 and 2010 (Table 1-1; Figure 1-3). Annual rainfall in the district ranges from approximately 1,000 mm in the south to 2,000 mm in the north. About 68% of the annual rainfall amount falls in the period from June to September, with July being the rainiest month of the year. In the pre-monsoon months of April and May and the post-monsoon month of October, rainfall occurs mostly as thundershowers.

Year	Average Annual Rainfall (mm)
2000	2,381
2001	1,556
2002	1,865
2003	2,064
2004	2,060
2005	2,778
2006	645
2007	1,620
2008	1,457
2009	1,017
2010	2,221
Average (2000 to 2010)	1,788

Table 1-1: Average annual rainfall (mm) in Nagaon.

Source: Nagaon Water Resource Division, 2011



Figure 1-3: Average annual rainfall (mm) in the Nagaon district (data from Nagaon Water Resource Division, 2011).

Air temperatures are recorded at two meteorological observatories in the district, one at Lumding and the other at Chaparmukh. The record from Lumding covers a long period while that from Chapurmukh only covers a short period. In the five (5) years from 2009 to 2013, daily temperatures ranged from a maximum of 34°C in July-August to a minimum of 10°C in January (Table 1-2; Figure 1-4).

Month	Max Temperature (°C)	Min Temperature (°C)
January	23.2	10.3
February	27.7	13.6
March	30.8	16.8
April	31.0	20.3
May	32.7	22.8
June	33.5	25.3
July	33.6	25.6
August	33.6	25.5
September	33.5	24.8
October	32.5	21.9
November	28.6	16.7
December	25.3	13.3

Table 1-2: Maximum and minimum monthly temperatures in the Nagaon district.



Figure 1-4: Maximum and minimum monthly temperatures in the Nagaon district in 2010 (data from Nagaon Water Resource Division, 2011).

1.3.6 Topography

The catchment area is bordered by the Meghalaya Hills to the south and the Brahmaputra River to the north (Figure 1-5). Due to the downwards areal slope, storm water from the wet Meghalaya Hills flows towards the Brahmaputra River through numerous smaller rivers. However, much of the catchment area of the Kolong River in located in the low-gradient plain south of the Brahmaputra River in the northern part of Assam.



Figure 1-5: Topographic elevations (DEM) in the Kolong catchment area.

1.3.7 Drainage Channels

There is no well-connected drainage system in Nagaon town. Many of the open or closed-atsurface drains running along the side of the roads are either blocked or not linked up properly. That condition is one of the reasons for floods in the town particularly during the monsoon season. After heavy showers water-logged areas can be found in the town. The worst affected areas are:

- Part of Panigaon
- Hotelbari area
- Teliapatti
- Santipur
- Lakshminagar
- Islampatty
- Area opposite to Haibargaon railway station.

Table 1-3 lists the drains proposed to be improved by the State Government (PCBA, 2010).

Table	1-3:	Drains	to be	improved	(Source:	Data	from	PCBA.	2010).	
1 abio	. 0.	Diamo	10 00	mprovou	(000100.	Duiu	nom	1 00/ 3	2010).	

S.No.	Name of the drain	Length	Width	Drain
		(m)	(m)	type
1	NH-37	688	1.25	Iype -1
2	Namghar Road	785	1.25	Type -1
3	Radhika Sati Road	688	1.25	Type -1
4	Rudraram Bora Road	1,313	1.25	Type -1
5	NH-37 (Dhing chariali to Kolong River	938	1.25	Type -1
6	Tarunram Phukam Road	1,250	1.25	Type -1
7	Laokhowa Road	1,875	1.25	Type -1
8	Madhav Dev road	2,063	1.25	Type -1
9	Mohichandra Bora Road	850	1.25	Type -1
10	Gunabhira, Bora Road	1,250	1.25	Type -1
11	NH-37 to Jail Road(Bara Bazar)	1,250	1.25	Type -1
12	Gurudwara Road	1,188	1.25	Type -1
13	Bimala Bora Road	1,750	1.25	Type -1
14	Masjid Road	1,000	1.25	Type -1
15	Kirtanghar Road	1,000	1.25	Type -1
16	Motiram Bora Road	937	1.25	Type -1
17	Milanpur Road	1,125	1.25	Type -1
18	Abad Nagar area road	1,938	1.25	Type -1
19	ITI Road	1,000	1.25	Type -1
20	RK Mission Road	1,681	1.25	Type -1
21	ADP Road	1,375	1.25	Type -1
22	Basanti Bora Road	2,250	1.25	Type -1
23	Railway open drain	813	1.50	Type -3
24	NH-37 (from ADP Road to Nagaon College junction)	1.250	1.25	Type -1
25	NH-37 Via Ghanashyam Bezbarua Rd. Manik Bezbarua	1 750	1 50	
25	Road to Kolong	1,750	1.50	Type -3
26	Amolapatty Rd to Kolong via Girls College Road	1,500	1.25	Type -1
27	Amolapatty Rd. to NH-37 via Stadium Road	1,375	1.4	Type -2
28	Chay Ali to Kolong via Amolapatty Rd. and Shankar Mandir Road	1,400	1.4	Type -2
29	Polytechnic Road to Kolong via Chay Ali	2,938	1.25	Type -1
30	NH-37 from Polytechnis to Panigaon Chariali	2,250	1.25	Type -1
31	Park Road	1.188	1.25	Type -1
32	Bara Bazar crossing N. Ahmed Road Thana Road and Azad Road	3,125	1.4	Type -2
33	Drain from N Ahmed to Mori Kolong	2,250	1.4	Type -2

1.3.8 Administrative Divisions

Nagaon district has 3 civil subdivisions, namely Nagaon, Kaliabor and Hojai (Table 1-4). It is divided into 10 revenue circles and 18 development blocks. The biggest of the seven communities in the district is Nagaon town with 126,115 inhabitants. There are 240 Gram

Panchayats inhabited by 1,375 villages. There are 21 police stations. The national highways NH-36 and NH-37 cross the district.

Table 1-4: Administrative divisions in the Nagaon district.

Туре	Number
No. of Civil Subdivisions	3
No. of Towns/Cities	7
Revenue Circles	10
No. of Development Blocks	18
No. of Gram Panchayats	240
No. of inhabited Villages	1,375
No. of Community Information Centres	18
National highway passing through the district	NH-36 and NH-37

1.3.9 Commercial Aspects

Agriculture: Agriculture is the backbone of Assam's economy providing a livelihood to about 78% of its population. Agriculture is expected to remain the predominant economic activity for several decades to come. Due to the general characteristics of the soil, the district is best suited for cultivation of paddy rice. Besides paddy rice, maize, arahar, wheat, other cereals and small millets, rabi pulses, gram, jute, mesta, cotton, sugarcane, potato, sweet potato, banana etc. also grow in the district. Horticulture could be one of the strongest features of the economy of Nagaon district because of its congenial agro-climatic and soil conditions. The district has advantages in producing potato, banana, chillies, arecanut, coconut, etc.

Floods are a major impediment in the development of the agricultural sector. Credit flow has also been low. This aspect is now showing signs of improvement. Present marketing linkages in the sector are weak. The average land holding size is also low (0.9 hectare [ha]). Funding requirements need to be met under various governmental schemes and credit linkages from banks. An important component is the requirement of convergence of various agencies such the Irrigation Department, ASEB office, District Rural Development Agencies (DRDA), banks, etc.

Fisheries: Considering the fact that Assam gets a lot of rainfall and that fish is an integral part of the diet of the people of Assam, the state produces about 5.7% of the total freshwater fish production in India. The Nagaon district produces roughly 14,000 metric tons (MT) of fish in a year which is about 9% of the total production in the state. It is estimated that 95% of the population consumes fish; the total fish consumption is estimated to be about 23,000 MT in a year. Imported fish dominate the organised markets.

Nature has made the Nagaon district a congenial place for pisciculture. Beels, marshes, ponds, and around 150 natural fishes in the district paved the way for the pisciculture development. As the district also has an advantage of a high water table, it is not necessary to dig deep for water. There are a high number of unemployed youths in the district and it has been observed that most of them are active in fishery. In the past, fishing was not considered a respectable employment, but this perception has changed and the fishing sector is looked upon at as a decent livelihood option. However, absence of fishing on scientific/commercial principles is common, and the fishery sector in the district results only in low level of productivity. Concerted and coordinated efforts for organised pisciculture development would have a multiplying and accelerating effect not only in the district economy but the economy of the state as a whole.

1.3.10 Industrial Activities

Industry does not have a dominant role in the Nagaon district, which still depends mostly on agriculture. Existing industries include the following:

- Tea industry (largest industry)
- Handloom and handicrafts industries
- Forests and wood industry.

In addition, the following industrial projects are taken up in cooperative and state sectors:

- Assam Cooperative Jute Mill Ltd.
- Kampur Cooperative Sugar Mill
- Katimari Weaving Project
- Sack Craft paper project at Dhing.

These are all medium-scale industrial projects. Whereas the Jute Mill at Silghat is flourishing, the Kampur Sugar Mill has been struggling.

The handloom industry is the most important cottage industry in Assam with a glorious past. It is closely associated with art and culture of the society. Weaving is a traditional activity of the state. Weaving of fabrics is a way of livelihood for a large number of rural families and artisans. Looms are often found in rural households. However, weaving is only a part-time activity and not the primary bread-earning activity. As a result, the handloom industry has not yet been developed to its full potential. Jajori, located about 17 km from Nagaon town, is an important centre of handloom production. Famous for its Kacha pat products, there are approximately 6,705 weavers which include most of the local families. In addition, the government has established a handloom production centre at Jajori. The Nagaon district has a potential by way of organising, modernisation, training and providing adequate marketing linkages, and it is proposed to use the Self-Help Group (SHG) method to develop its potential more fully.

Handicraft is also an important cottage and household industry, providing self-employment opportunities for the inhabitants in rural areas to supplement their earnings. The most important handicraft are: 1) kuhila craft; 2) pottery and terracotta; 3) jute, cane and bamboo products; and 4) rantholi jewellery.

The Nagaon district has potential for agro-based industries, including pisciculture and sericulture. Identified limitations for such industries are power shortages, seasonal floods, shortage of industrial labour, and lack of practical entrepreneurial motivation or experience.

1.3.11 Educational Activities

Types of educational institutions in the Nagaon district (based on the District Report) are shown in Table 1-5.

Type of Institution	Government	Provincialized
Higher Secondary School	2	55
High School	1	139
Sanskrit Tol		5
Senior Madrassa		10
Title Madrassa		1
Junior College		1
College		15

Table 1-5: Types of Institutions in Nagaon District.

The baseline survey for the district report was carried out in 30 sample villages. The survey showed that educational and schooling facilities for girls are much less common compared to the boys. Primary and middle schools exist for 3% of the girls for both types of schools, and for 23% and 14% of the boys, respectively. The same tendency exists for high and higher secondary education.

The survey also reveals that in all 30 sample villages at least one primary school is found within the village. More than 93% of the primary schools are located within 2 km. Although the distribution of primary schools in the rural area is satisfactory, more than 75% of the schools do not have a pucca structure. About 10% of them are semi-pucca, while the remaining buildings are kutcha normally with mud flooring and thatched roof.

There are approximately 15 degree colleges and one junior college in Nagaon district. Main educational institutions in the Nagaon district are listed below:

- Assam Agricultural University
- Homeopathic Medical College, Nagaon
- A.D.P. College (named after Anandaram Dhekial Phukan)
- Khagorijan College (named after the old administrative headquarter of the Nowgong District)
- Nowgong Law College

1.3.12 Cultural Activities

The Nagaon district has a rich cultural heritage:

- Place Bordowa, where the great Vaishnavite Saith Mapurush Srimanta Shakardev was born, is situated just 18 km northwest from Nagaon town.
- There are two Satras (Vaishnavite monasteries) in Nagaon, one is Narowa Sattra and one is Salaguri Sattras.
- There is a mini museum in Narowa Sattras.
- There are numerous Namghars (worship places) but the main ones are Bharalli Namghar, situated in Hatbar. Subhagya Madhav, Dulal Madhav and Gopal Madhav are three ancient temples built during the reign of Ahom King Shiva Singh. People visit the Namghars regularly, particularly during the birth and death anniversaries of the Vainavite saints, and on occasions such as Janmastami, Bihu and Assamese New Year.

The colourful culture of Nagaon can be seen in its music and dance, art and craft forms, festivals, and food. Of the dances practised in Nagaon, Nagayan Ojhapali is most well-known.

Tourism attractions in the Nagaon district include the following:

- *Kaziranga National Park:* It is a world heritage site giving home to five big mammals: the great Indian one-horned rhinoceros, the royal Bengal tiger, the Asian elephant, the eastern swamp deer, and the Asiatic wild buffalo. Furthermore, it is the habitat of a sizeable population of other rare and endangered species. Every year thousands of tourists visit this park.
- Lowkhowa Avayaranya: The park is situated at Lowkhowa about 25 km from Nagaon town and covers an area of 70 km². The main attraction is its great Indian one-horned rhinoceros. Various species of birds and other animals like tiger, leopard, Asiatic buffalo, wild boar, civet cat, leopard cat, hog deer, are also found in Lawkhowa.
- Samaguri Bill (also known as Pokhi Tirtha): Situated about 16 km east of Nagaon town, the area has migrating birds from different places of the world in the winter season. The Rock Garden Amusement Park and Tanz Water Park, situated near Samaguri, are new attractions for the Nagaon public.
- Subdivision towns like Kaliabor (48 km east of Nagaon town) and Hojai (61 km from Nagaon town) are historic places. Hojai is renowned as the granary of Assam and the principal wholesale market for rice in Assam, though sugarcane, mustard, jute and vegetables are also grown in abundance. Hojai is also the centre of the Agar perfume industry.
- *Silghat:* Situated at almost 50 km from Nagaon is a vital and picturesque river port lying on the south bank of the Brahmaputra River. Pre-communication links of central Assam across the Brahmaputra River are maintained through this port town. Besides playing host to the Assam Cooperative Jute mill, Silghat also has several temples to enthral visitors. A big Samantagiri hillock draws big crowds from everywhere.

- Jugijan: Situated at about 6 km from Hojai, it has become well-known after the recent discovery of remnants of a fort and three stone temples decorated with carvings and base-reliefs.
- *Kamakhya Temple:* The famous Kamakhya temple is situated in Silghat on the bank of Brahmaputra River. The Ashok Astami Melas is held every year at the Kamakhya temple.
- Waterfalls like Akashiganaga (located near Doboka, 34 km to the south-east of Nagaon town) and Champawati Kunda (located in Chapanala) are famous falls, and favourites for many picknickers.
- Other places like Ranthaliu village, located 4 km west of Nagaon town, is famous for its gold-plated traditional ornaments. Jamnunamukh, located 35 km from Nagaon town is also famous for its earthen wares.

1.3.13 Religious Activities

The population in the Nagaon district has the following religions, as per the District Report (2010) that was based on a total of 900 sample households in 30 villages:

- Muslim: 54.6%
- Hindu: 45.2%
- Christian: 0.2%

Of the total sample households, 11.8% were from Scheduled Caste (SC), 3.9% from Scheduled Tribe (ST), and 21.6% from Other Backward Caste (OBC). The Muslim and Christian households represent general caste.

1.3.14 Socio-Economic Status

As described in section 1.3.9, agriculture is the backbone of Nagaon's economy and more than 78% of its working population derives their livelihood from agriculture. Fishing is another common economic activity in the district.

People of Nagaon are in many ways still living the traditional Indian way. People help each other during the time of family function, family crisis and also during festivals, like bihu and puja. The community feeling is strong. In the namghars, most time of the year, people offer Prasad on the occasion of death anniversaries, birthdays and any other important dates of family members and also during Assamese New Year and during the month of Bhadra.

1.3.15 Town Management

The Nagaon Municipal Board is responsible for town management. The Chairman of the Nagaon Municipal Board (NMB) is the head of the town and District Magistrate has the full responsibility for the district. Disasters are managed by the district Disaster Management Authority (Table 1-6).

1.3.16 Land Cost in and around the Town

Land cost at Nagaon vary by location, but typical cost for 1 katta is from 6-7 lakhs INR and up to 1 crore INR (1 katta is equal to 2,880 square feet).

1.3.17 City Development Plan

A development plan for Nagaon town is not available.

Table 1-6: Disaster Management Authority.

S.No.	Designation	Status
1	Deputy Commissioner, Nagaon	Chairperson
2	Chairperson, Zilla Parishad, Nagaon	Co-chairperson
4	Superintendent of Police, Nagaon	Member
5	Jt. Director, Health Services, Nagaon	Member
6	Executive Engineer, PWD (R) Nagaon State Road Division, Nagaon	Member
7	Executive Engineer, PWD (R), Nagaon Rural Road Division, Nagaon	Member
8	Executive Engineer, Nagaon Water Resources Division, Nagaon	Member
9	Executive Engineer, Irrigation, Nagaon Division, Nagaon	Member
10	Executive Engineer, PWD (R), Building Division, Nagaon	Member
11	Executive Engineer, PHE, Dhing, Nagaon	Member
12	Executive Engineer, NH-37, Nagaon	Member
13	Executive Engineer, PHE, Nagaon	Member
14	Executive Engineer, (PWD) Electrical Division, Nagaon	Member
15	Executive Engineer PWD, Kaliabor Rural Road Division, Jakhalabandha, Nagaon	Member

1.4 Population within the Project Area

According to census data, the population of Nagaon town has grown by 30% in 20 years, from 93,350 in year 1991 to 1,21,628 in year 2011 (Table 1-7). The sex ratio between males and females is near even. The most recent literacy rate was recorded with 74%.

Area	Year	Population	Sex Ratio (females per 1000 males)	Literacy Rate (%)
	1991	93,350	929	55
Nagaon town	2001	1,07,667	944	62
	2011	1,21,628	962	74

Table 1-7: Demographic details of Nagaon town.

Source: Census of India

1.4.1 Ward Wise Population

The ward wise population of the Nagaon town is presented in Table 1-8. Population and number of households were obtained from census data of years 2001 and 2011.

The population in some of the wards increased in this time periods, while the population in other wards decreased. Wards 20, 23 and 27 are the most developed wards in the town.

1.4.2 Slum Wise Population of the last 5 Decades

As per the 2011 census, the total slum population in Nagaon town was 18,110 which decreased by almost 50% compared to the 2001 census data. One of the reasons for the decrease in the slum population may be economic growth of the people. Sanitation facilities in slum areas consist mostly of community toilets, which are connected to a septic tank and soak pit. The condition of these community toilets is bad.

	2001		2001 2011	
Ward No	Households	Total Population	Household	Total Population
1	350	2,085	350	1,705
2	838	4,591	974	4,587
3	686	3,143	1,035	4,151
4	497	2,728	510	2,725
5	922	4,351	1,038	4,456
6	1,331	6,704	1,565	6,873
7	679	2,931	748	3,022
8	829	3,811	970	3,858
9	565	2,565	583	2,429
10	389	1,883	449	1,831
11	1,009	5,109	1,108	4,989
12	926	4,963	1,138	4,991
13	373	2,118	487	2,327
14	654	3,311	706	3,117
15	451	3,489	567	2,641
16	757	3,417	861	3,563
17	938	4,690	1,013	4,583
18	1,000	5,262	1,199	5,414
19	581	2,751	815	3,377
20	2,513	12,524	3,221	15,240
21	407	2,196	561	2,564
22	930	4,504	1,200	5,149
23	918	4,201	1,753	7,308
24	1,010	5,605	1,335	6,485
25	677	3,643	1,207	5,336
26	962	5,092	1,090	5,001
27			608	2,917
28			229	989
Total	21,243	1,07,667	27,320	1,21,628

Table 1-8: Ward wise population of Nagaon Municipal area (Source: Census of India).

1.4.3 Population Projections as per the City Master Plan

Presently there is no City Master Plan for the Nagaon town. The base data used for population projection were obtained from the Census of India, with detailed summaries for urban area population and municipal ward for 2001 and the 2011. These data provided the numeric basis for benchmarking of the actual population and its decadal growth for the past decades.

Different population projection methods (i.e., arithmetic, incremental increase, geometric, and exponential methods) were used to calculate future population growth. As different methods result in different projections, the averages of all methods were considered for the CSP population projection. Projected populations by different methods are presented in Table 1-9 and Figure 1-6.

Veer	1971	1991	2001	2011	2014	2024	2034	2044
Tear	Past Census Data			Future projections				
Arithmetical					1,26,296	1,41,858	1,57,419	1,72,981
Geometric					1,23,930	1,29,471	1,37,819	1,46,705
Incremental	56,537	93,350	1,08,786	1,21,628	1,40,145	1,61,482	1,86,067	2,14,395
Exponential					1,29,679	1,60,566	1,98,810	2,46,163
Average					1,30,013	1,48,344	1,70,029	1,95,061

Table 1-9: Population Projection by Different Methods.

Population Projection



Figure 1-6: Population projection of Nagaon Town.

On average, the population is expected to grow from approximately 1,22,000 in year 2011 to 1,95,000 by year 2044, an increase by 60% over the next 33 years. These growth rates will form the basis of river restoration design efforts.

1.4.4 Cattle Population

The Nagaon district has a total 8,59,214 cattle, as per livestock report of 2007. A total of 8,07,937 animals are local breed; the remaining 51,277 animals are cross-breed. A total of 22,457 animals are male cross-breed and 28,820 are female cross-breed. Also according to the 2007 livestock report, the Nagaon district has a total Buffalo population of 14,087. Out of this, 8,552 are male buffalo and the remaining 5,535 are female buffalo.

The Nagaon district is yet not self-sufficient in the production of milk, meat and eggs.

2 Sewerage Work

2.1 Status of Water Supply

Water supply to Nagaon town is the responsibility of the Nagaon Municipal Corporation, but presently the responsibility is held by the Public Health Engineering Department. People of Nagaon get water through various sources, including piped water supply, dug wells, hand pumps, tube and bore wells, and springs.

The piped water supply scheme was initiated in 1981. At the completion of the scheme, 4,477 households were covered by a tap connection, and 16 community taps were installed in 26 wards of the town. Ground water is pumped from six Deep Tube Wells (DTW; extending to depth of 30 to 50 m) with the help of 12.5HP submersible pumps to a treatment plant. The treated water is then stored in three underground reservoirs with capacities of 2.25 million liters (ML), 1.75 ML and 1.25 ML. Water is then pumped to three Elevated Service Reservoirs (ESR) with capacities of 1.8 ML, 1.2 ML and 0.9 ML (Figure 2-1) from where the water is supplied to the consumers through the distribution network. Water is supplied for only one hour in the morning.



Figure 2-1: Elevated service reservoirs in Zones 1, 2 and 3.

Presently, only 20% of the population is supplied by treated water through the distribution network. The remaining 80% of the population uses different water sources (Figure 2-2) primarily from the ground. Most of the houses in the outskirts have either tube or bore wells. The health hazard of using ground water is high because of elevated arsenic concentration in several locations as well as contamination from overflowing septic tanks and soak pits. Some village households use ponds as well to meet certain types of water supply needs.



Figure 2-2: Example of water contamination by septic tank and water pump placed side by side by side.

2.1.1 Actual Water Supply from Different Sources

As stated above, Nagaon town gets its potable water almost exclusively from the ground. Details of the various sources are listed in Table 2-1 and Figure 2-3. About 77% of the household in Nagaon town use hand pumps, tube and bore wells as the ground water table is high (3 to 4 m below the surface).

S. No.	Source	No. of Households	Population	Percentage
1	Tap water	6,394	27,273	22.40
2	Wells (open + closed)	108	461	0.38
3	Hand pumps	19,153	81,695	67.20
4	Tube wells / Bore wells	2,778	11,849	9.70
5	Other (springs, etc.)	82	488	0.29
	Total	28,515	1,21,766	100.00

Table 2-1: Water Supply by Source.



Figure 2-3: Population coverage by source (Source: Census 2011).

2.1.2 Proposal for Augmentation of Water Supply System

Presently there are no proposals for the augmentation of the water supply for Nagaon town. As the town has a perennial source of water (the Kolong River) it is advisable to use the river for water supply to the extent possible rather than ground water. In addition, ground water contains elevated iron concentrations in most parts of the town and elevated arsenic concentrations in some parts of the town. It is also a prerequisite as per the Central Public Health and Environmental Engineering Organisation (CPHEEO) manual to have a piped water supply system before a separate sewerage system can be proposed for the whole town. It is proposed that a DPR should be prepared to implement a water supply scheme by the NMB.

2.2 Status of Existing Waste Water Disposal Works

2.2.1 Existing Work

Presently, there is no existing sewerage collection system or treatment plant in Nagaon town. As per the information received from Nagaon Municipal Board, 85-90% of the inhabitants use a septic tank with soak pits for the sewerage disposal. Water from the soak pits contaminates the ground water and creates human health problems. The remaining 10-15% of inhabitants discharge their sewage directly in the river as most of them reside along the river.



Figure 2-4: Sewerage discharges along Kolong River.

Waste water from kitchens and washrooms are discharged into open drains in front of the houses, which are directly discharged into the river without any treatment. These open drains are a major contributor to the pollution in the river. Some of the overflows of the septic tanks are also connected to these open drains, further contributing to the pollution of the river.

The river is also a significant cultural aspect to the town, and is used by the population for washing, bathing, and fishing. It is imperative that a method of sewage collection and treatment be implemented to reduce pollution and improve the water quality of the Kolong River and reduce existing health risks.

2.2.2 Work under Execution

The amount of water supplied to Nagaon residents is less than 135 lpcd, which is the standard prescribed in the Central Public Health and Environmental Engineering Organisation (CPHOO) manual. Considering that only 22% of the population of Nagaon receives 50-60 lpcd of piped water supply, there will not be sufficient sewage generation in the town for a sewage treatment plant (STP). Presently there are no works proposed for the sewerage system for the Nagaon town. As there is no existing sewerage system in place, new house construction plans require septic tanks within the premises of the house for construction approval. The size of the septic tank depends on the number of family members in the house.

2.2.3 Work Sanctioned but not yet started

As stated, there are no existing sewerage system works in the Nagaon town. However, a tender has been called for construction of road side drainage. As per the information provided by the NMB the process of awarding the drainage construction work is in progress. The work on open drains has been sanctioned but not yet started.

2.2.4 Total Waste Water Generation

The Kolong River carries part of the town's municipal and other wastes and also serves as the natural drainage for storm water runoff. Based on an inquiry during the reconnaissance survey, the average quantity of water used in the toilets is estimated as 30 lpcd at present. This is in line with estimates by Green Building Brain (Canada) and the Government of New South Wales which also suggest that the blackwater (sewage) percentage is 25-30% of total waste water generated.

Table 2-2: Waste water Generation in Nagaon town.

Total Households in the Town	Total Waste Water	Total Households	Total Waste Water
	Generated in the	Connected to Septic	Collected in the
	Town (m ³)	Tanks	Septic Tanks (m ³)
27,320	13,135 ¹	23,905	3,196 ²

Assumptions: (1) 80% of 135 lpcd supplied water; (2) 30 lpcd of waste water

When a water supply system is implemented the sewerage generation per capita will be:

Table 2-3: Calculation of per Capita Sewage Generation.

S. No.	Description	Demand (lpcd)
1	Net per capita water demand for Nagaon	135.00
2	Add 10% for ICI demand ¹ @ 10%	13.50
2	Add ground water infiltration @ 5%	6.75
	Sub Total	155.25
3	Considering 80% for sewage generation	124.20
	USE	125.00

As the town grows and develops, including the water supply system, the total waste water generation will increase.

Table 2-4: Projection for Total Waste Water Generation for Nagaon town (Population projection can be found in Table 1-9).

Year	Population	Sewage Generation (MLD)
2024	1,48,344	18.543
2034	1,70,029	21.254
2044	1,95,061	24.383

2.2.5 Industrial Flow

There are no major industries located in the communities along the Kolong River, particularly in Nagaon town. There are only few car garages, which are contributing to the pollution of the river. These establishments produce waste products which are often dumped into the river. This type of indiscriminate dumping of establishment wastes have made the Kolong River water contaminated and unfit either for human consumption or for the fish population that used to be abundant in the river.

2.3 Status of Pollution of the River

2.3.1 Number and Details of Drainage Channel

There is no well-connected drainage system in Nagaon town, resulting in occasional flooding particularly in the monsoon season. Drains along the side of roads exist in some areas but may be blocked or not linked up properly. Flooding is of particular concern in the following areas:

- Part of Panigaon
- Hotelbar area
- Teliapatti
- Santipur
- Lakshminagar
- Islampatty
- Area opposite to the Haibargaon railway station.

In recent times, improvement schemes for the drains have been proposed by the state government with possible assistance from the Government of India. A road side drainage improvement project has been sanctioned by the NMB but has not yet started.

2.3.2 Waste Water Flow Carried by Drains

At present the Nagaon town does not have an integrated sewerage system. The only collection and treatment process being followed is the use of septic tanks. Therefore, part of the waste water generated in the town is being disposed off into the rivers without any treatment.

The waste water volume discharged into the Kolong River is based on the following assumptions:

- Estimated number of inhabitants contributing to waste water discharging into the river. The estimation is carried out as follows. On the basis of the town's topography a delineation of the town is made. On the basis of this delineation the areal percentage of each ward contributing to the discharge is determined. The number of people living in each ward is known. And hence the number of people in each ward contributing to the discharge in the Kolong River can be found simply by multiplying the percentage and the number of people in the ward.
- Daily contribution of 108 lcpd, calculated as follows: 0.8 x 135 lcpd.

Accordingly, the total waste water generation is as follows (see Figure 2-5):

- Point West Nagaon: 17,00,000 liters per day (I/d)
- Internal Ponds: 8,00,000 l/d
- Puta Kolong: 4,00,000 l/d
- Point East Nagaon: 17,50,000 l/d



Figure 2-5: Map showing the four (4) areas.

As the town along Kolong River grows and develops, including the water supply system, the water flow carried by drains to the Kolong River will increase (see Table 2-4).

2.3.3 Measurement of Flows in Drains along with Copies of Test Report

The drains inside Nagaon town discharging into the Kolong River were visited and inspected numerous times during the execution of the present project. During each visit the discharge from the drains were either measured by simple floater methods or estimated from the water depth. The estimates were used to evaluate the numbers provided in Section 2.3.2. The evaluation proved that the numbers presented in Section 2.3.2 are reasonable.

2.3.4 Waste Water Characteristics of Different Drains

The sources that have been identified include the following:

- Domestic sewage: Raw domestic sewage and partially treated sewerage in the form of septic tank effluent drains are directly connected to the storm water drainage system. The direct sewage discharges contribute heavy organic loads which affect water quality and include bacteria, viruses, and other pollutants which are harmful to human and ecological health. Similarly the septic tank effluent contributes organic loads but at a much lower magnitude.
- Municipal solid waste (MSW): MSW (i.e., garbage) is routinely dumped in town streets and along the banks of the Kolong River. At numerous locations along the river bank, MSW is strewn about in thin, non-contiguous layers, but in many locations, thicker, contiguous fills exist on the river banks and lie in contact with the flowing water. In many cases, metal, wood, and food wastes appear to be scavenged by local populations, dogs, and other animals, and the resulting mixture is dominated by plastic wastes. As these wastes slowly degrade, they release toxic pollution to the water.
- Storm water: Storm water is directly discharged to the Kolong River via the surface drainage system, and also as overland surface runoff. In both cases, this storm water carries solids and pollution from the town streets into the river, In addition to domestic sewage, this runoff likely includes particulates from combustion of diesel fuel and other petroleum fuels, pollution from MSW, oils and greases from pavement areas, abraded asphalt particulate, animal wastes, agricultural, and other pollution sources.
- Industrial pollution: Industrial pollution sources may include automotive maintenance areas, fuelling stations, and other industries indigenous to the area. These pollution sources can be directly discharged to the drainage system, can flow overland, or can infiltrate groundwater which ultimately discharges to the Kolong River.
- Atmospheric deposition: The air quality in Nagaon town is affected by sources such as the combustion of petrochemicals for transportation, energy, and industrial purpose and regional air quality pollution. Particulates which contains toxic combustion by-products and heavy metals such as mercury settle and dissolve into the town's waterways.

Due to the density of the residential population in Nagaon, it is believe that the most significant source of pollution to the Kolong River is the direct discharge of domestic sewage. Given the prevalence and magnitude of the problem, MSW dumping may also be a significant source. It is likely that the pollution loads from storm water, industry, and atmospheric deposition are less significant, but there has been little study done to confirm this assertion.

2.3.5 Measurement of Waste Water Characteristics along with Copies of Test Reports

The water quality measurements are collected and analysed by:

Environmental Research & Evaluation Centre (EREC) MPG Complex, R-2 Rupnagar, Guwahati Assam 781032 India Home-page: www.erec.in

EREC is a certified laboratory to collect and analyse water quality samples.

The water samples were collected at five locations on three consecutive days (Figure 2-6 and Figure 2-7):

- Upstream at the confluence with Misa River (river water)
- Upstream of Nagaon town (river water)
- Inside Nagaon town in the drain at the ATP bridge (drain water)
- Inside Nagaon town in the drain at the jail (drain water)
- Downstream of Nagaon town (river water).



Figure 2-6: Water sample collected from drain in Nagaon town.

NRCD water quality limits for effluent discharge into rivers are presented in Table 2-5.

Table 2-5: Effluent limits prescribed by NRCD (see Table 4.7 in NRCD).

Parameter	Unit	Limits
рН		From 5.5 to 9.0
BOD	mg/l	< 20
TSS	mg/l	< 30
Faecal coliform	MPN/100ml	Desirable – < 1,000 Permissible – < 10,000

As part of the present project, water samples were collected from two drains inside Nagaon town. The laboratory results are shown in Appendix A. The results confirm that the waste water characteristics correspond to domestic waste water with high pollution levels.

The waste water discharging from Nagaon town into the Kolong River does not adhere to present rules. The waste water is more polluted than allowed. Actions are required to lower the pollution of the Kolong River and improve the environmental conditions of the water body.



Figure 2-7: Locations of water samples.

2.3.6 Water Quality of the River U/S, D/S and at Outfall of Drain discharging into River

The following description is based on historical water quality measurements. Some of them can be found in Appendix C, D and E.

Based on the measurement in PCBA (1993) which has the most details inside the town it is found:

- The water quality levels do not vary much through the town (some more comments on this issue is given below).
- pH, BOD and DO levels are all higher during the pre-monsoon season than during the monsoon season as expected.
- Faecal coliform levels are generally lower during the pre-monsoon season than during the monsoon season.
- pH, BOD and DO levels satisfy the limits in NRCD guide (see section 2.3.9).
- Faecal coliform levels are higher than the desired limit and close to the permissible limit (see section 2.3.9).

The measurements show that the water quality levels do not change much throughout the town. Of course if and when samples are taken too close to the source the values can be high, but it is considered to be erroneous data (one such case is identified in the data). The downstream water quality samples should not be collected closer to the drain than about 10 times the width of the river to ensure that the sewerage is mixed over the river cross-section (else the data are meaningless as it will be an undefined mixture of drainage and river water).

No signs are found in the historical measurements that indicate that the water quality of the Kolong River has improved since the detailed measurements were collected in year 1993. On the other hand, it is found that the situation has most probably deteriorated and that the river today is more polluted than ever before.

The historical water quality data shows that the river is polluted with faecal coliform bacteria and does not adhere to the NRCD guideline. Actions are required to clean up the Kolong River for the benefit of the town's inhabitants and well as the ecosystems in the river.

2.3.7 Measurement of the Quality of River Water along with copies of Test Report

Details on water samples collected can be found in Section 2.3.5. The actual water quality data can be found in Appendix A.

Based on the collected and analysed water samples from the Kolong River and analysed as part of the present project it is found:

- pH and DO levels satisfy the limits in NRCD guide (see section 2.3.9).
- BOD levels do <u>not satisfy</u> the limit in the NRCD guideline and faecal coliform levels are higher than the desired limit and close to the permissible limit (see section 2.3.9).

The water quality data obtained in the present project shows that the Kolong River is polluted with faecal coliform bacteria inside Nagaon town and does not adhere to the NRCD rules.

2.3.8 Methodology followed for Flow Measurement and Quality Characteristics

The laboratory methodology is shown in Appendix B.

2.3.9 Water Quality Standards of River Water Quality

NRCD specifies the following limits for water quality for rivers if used for bathing:

Table 2-6: NRCD water quality limits for rivers (designated best use bathing) (see Tables 2.3 and 4.5 in NRCD).

Parameter	Unit	Limits
pН		From 6.5 to 8.5
BOD	mg/l	< 3
DO	mg/l	> 5
Faecal coliforms	MPN/100ml	Desirable – < 500 Permissible – < 2,500

For propagation of wildlife and fisheries, the following additional limits apply:

- DO > 4 mg/l
- Free ammonia (as N) < 1.2 mg/l.

2.4 Justification of the Project for Pollution abatement of the River

As stated in Section 1.3.2, the Central Pollution Control Board found that the Kolong River is among the most polluted rivers in India, and the NRCD (2010) guidelines considered the Kolong River as one of the rivers for conservation. The water quality measurement collected and analysed as part of the present project confirm the high degree of pollution. Hence, the pollution abatement is justified.

3 Non-Sewerage Work

3.1 Community Sanitation Scheme

Floating population: There are no data available on floating population for the 28 wards in the Nagaon town. However, data are available on permanent population for each ward (Table 3-1).

Level	Name	Area	No. of Household	Total Population
		Total	5,59,340	28,23,768
District	Nagaon	Rural	4,80,399	24,54,234
		Urban	78,941	3,69,534
Town	Nagaon (MB + OG)	Urban	27,320	1,21,628
TOWN	Nagaon (MB)	Urban	26,483	1,17,722
	Nagaon Municipal Board			
Ward	Ward No0001	Urban	350	1,705
Ward	Ward No0002	Urban	974	4,587
Ward	Ward No0003	Urban	1,035	4,151
Ward	Ward No0004	Urban	510	2,725
Ward	Ward No0005	Urban	1,038	4,456
Ward	Ward No0006	Urban	1,565	6,873
Ward	Ward No0007	Urban	748	3,022
Ward	Ward No0008	Urban	970	3,858
Ward	Ward No0009	Urban	583	2,429
Ward	Ward No0010	Urban	449	1,831
Ward	Ward No0011	Urban	1,108	4,989
Ward	Ward No0012	Urban	1,138	4,991
Ward	Ward No0013	Urban	487	2,327
Ward	Ward No0014	Urban	706	3,117
Ward	Ward No0015	Urban	567	2,641
Ward	Ward No0016	Urban	861	3,563
Ward	Ward No0017	Urban	1,013	4,583
Ward	Ward No0018	Urban	1,199	5,414
Ward	Ward No0019	Urban	815	3,377
Ward	Ward No0020	Urban	3,221	15,240
Ward	Ward No0021	Urban	561	2,564
Ward	Ward No0022	Urban	1,200	5,149
Ward	Ward No0023	Urban	1,753	7,308
Ward	Ward No0024	Urban	1,335	6,485
Ward	Ward No0025	Urban	1,207	5,336
Ward	Ward No0026	Urban	1,090	5,001
Ward	Kachalukhowa (Og) Ward No0027	Urban	608	2,917
Ward	Nartam Gaon (Og) Ward No0028	Urban	229	989

Table 3-1: Ward Population in the Nagaon District.

MB = Municipal Boundary

OG = Outgrowth

Source: Census of India 2011

Households without toilet: As per the information provided by the NMB, about 75% of all households in the Nagaon district have toilet facilities (or latrines; Table 3-2), using septic tanks and/or soak pits. New housing plans are not sanctioned by the NMB without having a toilet facility within the premises of the plot. About 25% of the population in the district do not use latrines. Within the Nagaon sub-district, 86% of all households have latrines. Within the urban Nagaon municipal boundary, 98% of the households have latrines.

Table 3-2: Household Data on Availability of Latrines.

Aroa Namo	Level	No. of House- holds	No. with Latrines	No. without Latrine	No without Latrine: Alternative Source	
Area Name					Public latrine	Open
	Total	5,60,857	4,22,431	1,38,426	7,580	1,30,846
District – Nagaon	Rural	4,80,208	3,45,629	1,34,579	6,721	1,27,858
-	Urban	80,649	76,802	3,847	859	2,988
Sub district	Total	88,217	75,805	12,412	1,372	11,040
Sud-district –	Rural	53,840	42,196	11,644	981	10,663
Nagaon	Urban	34,377	33,609	768	391	377
Nagaon (MB + OG)	Urban	28,515	27,973	542	373	169

Source: Census of India 2011

Slum wise population: Data on the slum population for each of the wards in the district are not available; however, data of the slum population in the Nagaon municipal area are available (Table 3-3). About 9% of the slum population of Assam is situated in the Nagaon municipal area. The slum population constitutes approximately 15% of the total population of Nagaon town.

Table 3-3: Slum Wise Population Data.

Name	Total no. of Household	Total population	Total Male	Total Female
India	1,39,20,191	6,54,94,604	3,39,68,203	3,15,26,401
Assam	42,533	197,266	101,424	95,842
Nagaon (MB + OG)	3,855	18,110	9,306	8,804

Source: Census of India 2011

Slum wise availability of public toilets: There are 13 slum pockets in Nagaon town and all households in slum pockets are provided with individual toilet facilities. In the past, all slum pockets had community toilet facilities, which have since been upgraded to individual toilet facilities using septic tanks.

Table 3-4: Number of Toilet Facilities.

Area Name	Total	Total Number of Households	Number of Households having Latrine Facilities within their Premises
District – Nagaon	Total	5,60,857	4,22,431
District – Nagaon	Rural	4,80,208	3,45,629
District – Nagaon	Urban	80,649	76,802
Sub-district – Nagaon	Total	88,217	75,805
Sub-district – Nagaon	Rural	53,840	42,196
Sub-district – Nagaon	Urban	34,377	33,609
Nagaon (MB + OG)	Urban	28,515	27,973

Slum rehabilitation: Presently there are no slum rehabilitation plans proposed for Nagaon town. The census data show a decrease in the slum population from 26% of the total population in 2001 to 15% in 2011. This decrease is mainly a result of higher income by slum dwellers during this period.

Identification of slums where Community Toilet Complexes (CTCs) are required: As stated above, each household in the 13 slum pockets of Nagaon town has separate toilet facilities. Therefore, there is no need for any CTCs.

Identification of public places where CTCs are required: CTCs are generally required at public places like bus stands, railway stations, gardens, etc. In Nagaon town, there are 11 bus stands where CTCs are present; these CTCs are in poor condition and require improvement. CTCs should also be provided for public places such as gardens and playgrounds.

3.2 Crematoria

Total population including floating population: The Nagaon district has a total population of approximately 2.82 million (Table 3-5). About 87% of the population is urban; the remaining 13% of the population is rural. Nagaon town has a total population of approximately 1,22,000 within its municipal boundary and its outgrowth area. There is no data available on floating population.

Level	Name	Total/Rural/Urban	No. of Households	Total Population
District	Nagaon	Total	5,59,340	28,23,768
		Rural	4,80,399	24,54,234
		Urban	78,941	3,69,534
Town	Nagaon (MB+OG)	Urban	27,320	1,21,628
	Nagaon (MB)	Urban	26,483	1,17,722

Table 3-5: Nagaon Population Data.

Source: Census of India 2011

Details of existing cremation ground, electrical, gas based, wood based (Conventional): There are total six cremation grounds in the Nagaon town. At four locations, Hindus are cremated and at the other two locations Muslims and Christian are cremated, respectively. The Hindu cremation grounds are located in Amallapatty, Haiborgaon chhanmari, Milanpur, and Madhupur. The Muslim ground is located in Haiborgaon south. Opposite from this site is the Christian burial ground.

As per the field investigations, there are no electric crematoria in and around Nagaon town. The existing cremation grounds are mainly conventional wood-burning facilities. Most cremations takes place along the river banks and often cremations are scattered over different ghats. No statistics are available on cremation activities and there are no plans for building a crematorium in the town.

Number of bodies cremated at each cremation ground: It is difficult to get the exact information on the number of bodies cremated at each cremation ground. Based on information obtained during the survey, roughly 10 to 15 bodies are cremated every month at all cremation grounds.

Wood consumption per cremation ground wise: Survey information indicates that the amount of wood consumed every month ranges from 300 to 500kg, depending on the number of bodies cremated and on weather conditions. The wood consumption is higher in winter and during the rainy season than during the summer.

3.3 River Front Development

Baseline for each ghat: There are no baseline data available for each ghat, although people utilise many of the river ghats for bathing. The use depends on need and on water depth. During the field visit, three structures were observed along the banks for general access (Figure 3-1).

Number of user-peak at any given time and average: Data on users of the ghats are not available.

Approximate dimensions of the ghat: Information on the dimensions of the ghats is not available. However, most of the ghats areas have stone steps, as observed during the field visit.
State of the ghats: There are no major ghats along the Kolong River. The existing ones are mainly used for puja and for bathing.

Improvement required: Improvement in terms of fencing off the ghats, putting railings along the steps of the ghats leading to river, and planting trees is required at most of the existing ghats.



Figure 3-1: Structures for access to the Kolong River in Nagaon.

3.4 Dhobi Ghat

Dhobi ghat information: As per field investigations, there are no specific organised Dhobi ghats along the river at present. People access the river at different points for washing. Dhobi ghats are based on convenience and shifts depending on the water level during the monsoon season and the non-monsoon seasons.

Specific location: There are no specific locations available for dhobi ghats. People access the river at different location depending on their needs and on available water depths.

Number of dhobis washing clothes: There is no information available on the number of Dhobi ghat. Therefore, the number of dhobis washing clothes could not be found out.

Alternative locations: Since there is no information available on the number of organised specific ghats location, it is difficult to identify if there is any alternative location suitable for a Dhobi ghat.

3.5 Carcass Disposal

Number of cattle that die in the town: There are no records available on the number of cattle that die in the town.

Existing arrangement for safe carcass disposal: As per the field investigations, there are no existing arrangements for safe disposal of carcasses. There are no systematic records on the number of carcasses disposed every day. No specific disposal location was reserved. Most of the dead bodies of animals are disposed in the river due to the lack of other disposal locations. Also, the Hindu population residing in villages near the banks of the river performs the last rites of the deceased along the river bank; burnt residues are dumped in the river.

Identification of the need for carcass disposal: The necessity for identifying a carcass disposal location should be assessed in more detail after obtaining reliable data on the number of dead animals requiring disposal. Thereafter, arrangements should be made to evaluate and

select suitable locations for the disposal of carcasses, in order to avoid the dumping of the carcasses in the river. This step is considered an important part of the river restoration effort.

3.6 Others (Waste Disposal from Dairies, Slaughter Houses, etc.)

As per the field investigations, there are no existing big dairy farms in and around the Nagaon area. The demand for domestic consumption of milk is made by the individual households rearing cows, buffaloes, or goat. No disposal location specifically for dumping of dairy waste could be identified during the site investigation. Most of the dairy waste products are utilised as manure or fuel, or are burned for household purposes. Cow dung cakes are used as fuel in poor households and as manure in vegetable gardens. Buffalo and goat waste are also used by the households as manure. Records on the number of the slaughter houses in Nagaon are not available. Therefore, details on the disposal of the waste generated from slaughtering are not available.

4 Solid Waste Management

Solid Waste Management (SWM) is a process of storage, collection and disposal of the waste generated from various sources like households, commercial, markets, etc. Improper disposal of Municipal Solid Waste (MSW) has a negative impact in terms of contamination of soil, surface water, ground water and generation of toxic and green-house gases. However, use of adequate information, resources, and efficient management practices could turn some of the solid waste into a useful resource.

The Ministry of Environment and Forests (MoEF), Government of India, published the "Municipal Solid Waste (Management and Handling) Rules" of 2000 (MSW Rules 2000). These rules were developed in compliance with Sections 3, 6, and 25 of the Environment Protection Act, 1986, and aim at standardization and enforcement of SWM practices in the urban sector. These rules dictate the following:

"Every municipal authority shall, within the territorial area of the municipality, be responsible for the implementation of the provisions of these rules, and for any infrastructure development for collection, storage segregation, transportation, processing and disposal of municipal solid wastes".

In addition, the rules state:

"The CPCB shall coordinate with the State Pollution Control Boards (SPCB) and the Pollution Control Committees in the matters of MSW disposal and its management and handling".

4.1 Baseline Information

According to the Municipal Solid Waste (Management and Handling) Rules, 2000, municipalities are responsible for municipal solid waste management and in Nagaon town; the NMB is doing the municipal solid waste management. The total waste generated per day in Nagaon town is approximately 30-32 metric tonnes (MT) from various sources like households, commercial establishments, hotels, market places, drain cleaning and street sweeping, construction waste etc. Out of the total generated waste about 22-23 MT are collected on the daily basis, which is about 70% only. As per the information provided by NMB staff, there are around 90-100 bins placed all over the town. The material of these bins is either fibre or cast iron. The condition of these bins is bad as can be seen from Figure 4-1.



Figure 4-1: Improper Waste disposal.

Solid waste collection is done on the daily basis from the collection points/ bins. Ten vehicles transport the waste to the landfill site, which is located 8 km away from the town in the Sialmari area. The landfill site is used on a rental basis as the NMB does not have any government land available for disposal of solid waste. Rent of Rs. 2000/- per month is paid to the owner of the land. Apart from the landfill site, the NMB has a solid waste incineration machine called "Swatch-Plasma system" with a capacity 500 kg per day. The system is the first initiative by the Pollution Control Board for scientific disposal of municipal solid waste.



Figure 4-2 : Swatch Plasma system Installed by Nagaon Municipal Board for Waste Disposal.

The total NMB staffs available are about 100 people, of which 51 are sweepers and remaining are labourers, drivers, tricycle pullers, etc. During the filed visit, it was observed that people threw garbage along the river side where there are no garbage bins, which is a cause of pollution for the river.

4.2 Category Wise Quantity of Solid Waste and its Characteristics

As stated above, the estimated waste generated across the town is 32 MT, which implies that the total waste generated per capita is approximately 0.2 kg/capita/day, considering an average family size of 5 persons. Official data on the category wise solid waste generated are not available. However, the general composition of the solid waste is as shown in Table 4-1 and Figure 4-3.

S. No.	Composition of waste	Percentage
1	Food and garden waste	40
2	Glass and ceramics	5
3	Paper	27
4	Metal	15
5	Inert	4
6	Plastic rubber	6
7	Textile	3
	Total	100

Table 4-1 : Composition of Solid Waste.



Figure 4-3 : Composition of Solid Waste.

4.3 Biodegradable and Non-Biodegradables Waste

Solid waste contains both biodegradable and non-biodegradable components. Based on the primary survey, it is estimated that 70% of the total waste is biodegradable and 30% is non-biodegradable. A major part of the waste is from households that generate a considerable part of biodegradable waste such as food, fruit, paper, etc. Increasingly, the use of plastic and packaged products contributes to non-biodegradable municipal waste.

4.4 Industrial Waste

There are no major industries in the Nagaon town, however there are some small rope-making enterprises which contribute to the solid waste. in addition, there are motor garages, wood furniture shops, etc. that contribute to the waste generation.

4.5 Bio-medical Waste

Bio-medical waste is generated by hospitals and other health services providers and consists of discharged drugs, waste shapes, microbiological and biotechnological waste, human anatomical waste, animal waste, etc.

There is no exclusive bio-medical waste management system for the Nagaon area.

According to the bio-medical waste (Management and Handling) Rules 1998, authorization by the State Pollution Control Board is mandatory for each medical service provider including research laboratories handling bio-medical waste. According to the Rules, the generator of the bio-medical waste is responsible for safe handling & management of the waste.

The Nagaon district has the following healthcare facilities:

- One (1) district hospital
- Eleven (11) child health clinics
- Seventy-one (71) public health clinics

• Thirty-three (33) nursing homes/private hospitals and diagnostic centres/laboratories.

All of the above are handling and producing bio-medical waste.

According to the District Authority and the Joint Director, Health Services (Jt. DHS), Nagaon does not have any information regarding authorization or a system for handling bio-medical waste. However, information furnished by the Jt. DHS revealed that no organisation has an incinerator for disposing bio-medical waste as per specified norms of the Board.

Thus, in absence of any mechanism for disposing bio-medical waste, its dumping in open spaces creates air pollution and health hazards. The survey team found that the private hospitals/nursing homes in the town are not segregating their waste and the bio-medical waste generated from these institutions is dumped along with the MSW. Dumped waste from a hospital was found on the river bank during the field visits (Figure 4-4).



Figure 4-4: Dumped waste from a hospital.

4.6 Segregation of the Solid Waste

In Nagaon town, there is no official process of the segregation of solid waste. Rag pickers collect some of the waste produced for their livelihood and as such that can be considered an unofficial segregation of the waste. But it is far from sufficient.

4.7 Collection and Storage System

The NMB is responsible for the collection, transport and disposal of municipal solid waste. For the collection of solid waste in Nagaon town there are:

- Ninety (90) to one-hundred (100) bins
- Six (6) or seven (7) mechanical dumper placers.

To carry out the collection work, the town employs:

- Fifty-one (51) sweepers
- Forty-seven (47) drivers, labourers, tricycle pullers, etc.

About 22-23 MT of the solid waste is collected through fiber and cast iron bins. The system is not sufficient and for that reason waste is also dumped at the following locations:

- Unauthorised/random sites in the town
- Open drains
- Along the Kolong River bank
- Directly into the Kolong River.

According to the field investigations conducted by team, there are more than 20 open dump sites which were identified along the Kolong River in Nagaon town.



Figure 4-5 : Dumping of waste along and into the Kolong River.

Rag pickers collect the recyclable fraction of the waste produced and sell those for their livelihood.

4.8 Transfer System

In some areas solid waste transportation vehicles come and collect the waste, but not in all areas. Solid waste is carried in open carts and trucks and dumped at the landfill site in the Sialmari area. There is no proper schedule or an integrated solid waste collection system present in Nagaon town.

For the collection and transportation of the solid waste the town has 10 vehicles:

- Five (5) tippers
- Four (4) tractors and six (6) trolleys
- One (1) TATA 407 truck.

For the collection of solid waste dumped on the ground the town has:

- One (1) excavator/loader
- One (1) loader skid.

In certain parts of the town the roads are narrow (the average road width is 3m). This restricts the movement of heavy vehicles. An example of the collection of waste is shown in Figure 4-6.



Figure 4-6: Solid waste transported by the Nagaon Municipal Board.

4.9 Garbage Dumping and Disposal Sites

The town has one location to dump garbage and one machine to burn garbage, as stated previously:

- The dumping location is located 8 km from the town at the Sialmari area. The rent for the area is 2000 INR/month. The location can only be sustained for about one more year.
- One (1) swatch machine behind Marar Park. It has a garbage burning capacity of 500 MT/day. The Pollution Control Board has installed it as an experiment for the disposal of solid waste.

4.10 Solid Waste converted to Compost - Composting Site and its Capacity

There are no composting sites and no official information on conversion of waste into compost in Nagaon town; although the options for the same can be worked out in the future for better management of solid waste. It is important to look at segregation of solid waste at the source so that it can be used for the compost.

4.11 Solid Waste Recycled

As there is no separation of waste at any level (neither at the household level or at the dumping ground level) it is difficult to recycle the waste. No organised official recycling process is done in Nagaon town. Rag pickers do collect recyclable waste from the waste dumping sites for their livelihood and hence some of the waste is recycled.

4.12 Deficiencies in SWM System

From the information available and primary survey done in Nagaon town it can be observed that there are deficiencies in solid waste management, including the storage, collection, transportation and disposal of waste. In terms of storage facilities, the number of dust bins is small, and existing bins are not in good conditions especially along the Kolong River. Furthermore, the collection of the waste is a problem because the waste is not properly stored in the collection bins.

Although the NMB has some solid waste collection trucks and carts for the collection and transferring the solid waste, it is not sufficient for handling the waste generated from the entire town. On top of that, there is no proper disposal site since the existing site is not sustainable over long term.

4.13 Justification for Upgrading the Present System or a New System

In view of the existing waste generation and handling scenario and future growth potential of the Nagaon town, it is necessary to upgrade the existing solid waste management system (SWM) into an integrated management system to ensure proper management of disposal of solid waste.

The following key issues have been identified in Nagaon town:

- It is mandatory for all urban local bodies in India to comply the MSW (Management & Handling) Rules, 2000 of the Government of India. However, Nagaon town is well behind in regards to the compliance of this mandate primarily with regards to the MSW operational management aspect.
- Part of the uncollected solid waste is disposed into the water bodies of the town including the Kolong River. This results in the accumulation of solid waste and deposition of silt along certain stretches of the river. This in turn reduces the watercarrying capacity of the river besides polluting it and acting as a breeding ground of mosquitoes and other disease causing elements.
- Dumping of solid wastes in the open and leaving it for a longer period causes generation of leachate from such waste. There is a probability of contamination of ground water resource of the town basin and also deterioration of the river water quality due to seepage of such leachate.
- Stretches of the Kolong River flowing through the densely populated and developed areas of Nagaon town is susceptible for easy dumping due to lack of fencing or barricades by the residents and other establishments located adjoining the river. But only some limited stretches should be considered for fencing.
- Some storage containers and vats exist along the Kolong River but these are not properly designed to handle the volume of waste generated, are too few (i.e., widely spaced) and are usually uncovered. Wastes from many of these containers/vats spill over and provide easy access to stray animals. Part of such exposed waste thereafter finds its way to the Kolong River.

4.13.1 Proposed MSW Management System

To address the above mentioned issues and to safeguard the Kolong River from pollution, a set of measures are required in addition to the initiatives already taken up by the NMC for improvement of the existing SWM of the town. These measures are divided into the short (within next 5 years) and mid (next 5 to 10 years) terms. The short and medium terms investments required in the solid waste sector are as follows:

Short Term Measures:

- Fencing along limited selected stretches of the Kolong River within Nagaon.
- Public awareness program including banners/hoardings along the river stretch.

Mid Term Measures:

- Additional secondary storage containers and litter bins along the Kolong River, specifically in the densely populated area of Nagaon town. The provision for these additional storage facilities should be synchronized with the overall secondary storage facilities of Nagaon town.
- Procurement of additional collection and transport vehicles for removal of the waste stored in the proposed secondary storage facilities.

4.14 Consultation with Stakeholders

4.14.1 Resolution of ULB's for CSP Adoption

The Nagaon district has four municipal boards. They have all been contacted to obtain information and to be informed about the present project.

4.14.2 Consultation with Community

A number of habitants in Nagaon town have been interviewed about their experience with the solid water management system in the town and its impacts on their daily life.

The main objective of these interviews was to get first-hand information about the present waste management systems adopted by the town and identification of major problem areas.

The following are the major points identified through the interviews:

- The awareness regarding solid waste management is found to be low in the entire town.
- The inhabitants do not place waste into designated bins. However, the inhabitants
 defended themselves and claimed that since the waste management is not organised
 and scheduled they do also not need to act responsibly.
- Waste from the meat shops, etc. is mixed with the other solid waste from the town.

5 Consultation with Stakeholders

5.1 Resolution of ULB' for CSP Adoption

During the course of the study, the consultant involved stakeholders into the integrated management plan of the water bodies. The project components derived have been presented to relevant government officials and stakeholders (Table 5-1) to obtain feedback on the pros and cons of these options.

Table 5-1: List of Key Stakeholder.

S.No.	Department/Authority
1	State Administration
2	Department of Forest
3	Assam Disaster Management Authority
4	District Administration, Nagaon
5	District Administration, Morigaon
6	Nagaon Municipal Board
7	Public Health Engineering Department
8	Water Resource Department
9	Town and Country Planning
10	Fishery Department
11	Water Supply and Sewerage Board Assam
12	Central Water Commission
13	NRCD
14	Pollution Control Board, Assam
15	Public Work Department, Nagaon
16	National Highway Authority of India
17	Traffic Police
18	Local NGO's
19	Nagaon College
20	Ward members
21	Member Lok Sabha Assembly
22	Member of Parliament
23	Land and Revenue Department

Table 5-2 shows a partial list of officials and others consulted so far. Various community members, who are concerned with the conditions of the Kolong River, were consulted at different locations. They have been providing valuable suggestions on how the Kolong River should be restored. The consultation is an on-going process during the course of the study and therefore, the list will be updated later.

Table 5-2: Partial list of officials and others consulted so far.

S. No.	Name & Designation	Organisation
1	Mr. Gokul Bhuyan, Executive Engineer	Pollution Control Board, Assam
1	Mr. Banjit Talulshade, Executive Engineer	PHED
2	Mr. Rajesh Dash, Engineer	NMB
3	Mr. Praful Hazarika, Dy. Director	Town & Country Planning, Nagaon
4	Prof. Manik Kar	Nagaon College
5	Mr. Dilip Sarmah, Executive Engineer	WRD, Nagaon Division



Figure 5-1: Discussion with Nagaon Municipal Board members about solid waste.

After the submission of the inception report, a meeting with the Pollution Control Board Assam took place on the 4th of December, 2013. The meeting was headed by Mr. Dubey, Chairman, Pollution Control Board Assam.

S.No.	Name	Designation, Organisation			
1	Mr. R M Dubey	Chairman, Pollution Control Board			
2	Mr. R.M.Das	Consultant, GMDA			
3	Mr. Dutta	Consultant, PCBA			
4	Mr. Gokul Bhuyan	Executive officer, River and Lake conservation cell			
5	Prof Chandan Mahanta	Professor, IIT Guwahati			
6	Dr Guna Nidhi Paudyal	Managing Director, DHI (India)			
7	Mr. Subrata Mazumdar	Vice President, The Louis Berger Group (India)			
8	Dr Flemming Jakobsen	Technical Director, DHI (India)			
9	Mr. Louis Ragozzino	Waste Water Expert, The Louis Berger Group			
10	Mr. Harshad Dhande	Waste Water and Sewerage Expert, DHI (India)			
11	Mr. Rajiv Sinha	The Louis Berger Group, Inc.			
12	Mr. Lalit Mohan	Remote Sensing Expert, DHI(India) Water and Environment			
13	Mr. Rupesh Gupta	Project Coordinator, DHI(India) Water and Environment			
14	Prof. Tarun Acharya	Solid Waste Management, The Louis Berger Group			
15	Mr. Ayan Dey	Cost Estimation Expert, The Louis Berger Group			

The agenda of the meeting was the overall progress of the project, identification of pollution, and possible solutions to conserve the river as per NRCD guidelines. Comments were given on the following:

• All experts from PCBA mentioned that the opening of the mouth of the Kolong River along the Brahmaputra River is a good option, but needs detailed study and consideration of the flooding risks.

- The length of the river considered should only be the stretch inside the town for immediate steps (first 5-10 years), but a longer stretch be considered later (20-30 years).
- Nagaon town lacks power which should be considered in the planning.
- Rain causing flooding in Nagaon town is also important.

5.2 Consultation with Community

During the field visits to Nagaon town, and in areas along the Kolong River upstream from Nagaon town, the team interviewed and discussed with various local people the Kolong River water quality, sanitation, drinking water supply, and solid waste (Figure 5-2). Two examples are:

- Discussion with local people at the upstream mouth of the Kolong River.
- Discussion with local people at Misa. Most of the people have soak pits and are not discharging into the river. They use the Kolong River for bathing, washing, etc.



A group of local people near Nagaon are very keen to clean the river explained about sanitation issue at Nagaon.

Local boys are swimming in the Kolong river at Nagaon and they said if river will be more clean. It would be a hot spot.

Figure 5-2: Interaction with local people during field trips in the town.

6 Schemes for City Sanitation Plan

6.1 Key Elements

As stipulated in the NRCD guidelines (2010), the DPR must include a CSP and be consistent with the City Development Plan. As such, the following characteristics must be considered:

- Adopt a holistic approach and provide for an integrated sewer network up to houseproperty lines in place of drain interception and diversion to ensure full coverage of the town and thereby transportation of entire sewage to treatment plants for optimal utilization.
- Incorporate dovetailing with projects if any under JNNURM/UIDSSMT/ State Plan to ensure optimal utilization of resources on priority basis.
- Adopt the Design, Build & Operate (DBO) model for efficient operation and maintenance (O&M) of river conservation schemes.
- Adopt a stakeholder-focused consultative approach at the stage of formulation and implementation of the project, to ensure active involvement of various stakeholders and the civil society to generate support and encourage ownership.
- Use cutting-edge ICT tools and software for project planning and design.
- Adopt innovative and best technology options for treatment of sewage, including selection and analysis of technical and financial sustainability of created assets. For this, a life cycle study of technology options along with detailed analysis in respect of performance is mandatory at the FR stage.

6.2 Good Practices to be followed

In the development of the CSP, some good practices which should be followed include:

- Incorporate rainwater harvesting in community sanitation schemes.
- Promote solar energy for community sanitation schemes.
- Improve the sanitation scheme based on higher user charges where applicable.
- Upgrade the existing community sanitation and sewerage infrastructure.
- Consider innovative River Front Development (RFD) projects.
- Introduce "river festival" and "river runs" under the public participation, Information, Education & Communication (IEC) activities.
- Consider design parameters of STPs based on actual measurement and analysis, and also land requirements.

6.3 Proposed Actions

The restoration and conservation of the Kolong River is an important goal to Assam and the Nagaon town. To achieve this goal, in a sustainable manner, several actions are necessary. These actions focus on addressing pollution from the major sources – raw domestic sewage and MSW – and improving the hydraulic conditions. Actions are also proposed to provide human use benefits for the citizens of Nagaon. By providing these benefits, and connecting people to an improved waterway, the stewardship of the river can be shared by all and achieve lasting conservation success. The framework of the proposed restoration solution with specific action and target results is shown in Figure 6-1 and described further below.



Figure 6-1: Schematic of Conservation Framework.

6.3.1 Proposed Actions that Comprise the Restoration Solution

To remain consistent with the framework, the proposed actions which comprise the restoration of the Kolong River include:

- Sewage collection and treatment.
- Solid waste collection and management.
- Disposal location for animal carcasses.
- Removal of legacy pollution.
- Hydraulic improvement (including uptake of water from the Brahmaputra River to revive proper flow of Kolong River).
- Improving hygiene and sanitation conditions.
- Community access and benefits.
- Setting of monitoring system.

Each of these actions is described in more detail below:

- Sewerage collection and treatment: Presently there is no centralised sewerage collection and treatment facility in Nagaon largely because most households have either a septic tank or soak pit. A new sewage collection system is proposed to collect all sewage and transport it to a centralised place for treatment. The system, if properly implemented, will significantly reduce pollution loads to the river. Another option which may be considered is to have multiple decentralized STPs located at strategic locations throughout the catchment area. This option will be evaluated in the Feasibility Report.
- Solid waste collection and management: As the Nagaon town does not have any
 existing solid waste collection and management plan, it is proposed to have an
 Integrated Solid Waste Management Plan for the catchment area, which will also cover
 the entire town. As the town will implement a MSW collection and management system,
 waste will be collected from primary and secondary locations, and transported off-site to
 a disposal or reclamation facility. This system will require many years to become
 effective as the population learns to use and value the system over current litter and
 dumping practices.
- *Disposal location for animal carcasses:* Nagaon has a disposal site 8 km away from the Nagaon town which is presently used for the disposal of animal carcasses. During the primary survey, signs of disposal of carcasses in the Kolong River were not observed, but are known to take place.

- Removal of legacy pollution: Due to current practices, there is significant pollution in the Kolong River from sewage and MSW sources. Although this pollution could be allowed to naturally attenuate following sewage and MSW source control measures described above, the restoration of the river can be significantly accelerated by removing this legacy pollution. This action would involve dredging and bank clean-up to remove this legacy pollution.
- Hydraulic improvements: Regular flooding of the Nagaon town due to Kolong River in the past has resulted in closer connectivity of the Kolong River with the Brahmaputra River by the water resources department. This has resulted in less flow in the Kolong River, although the river is also connected to the Misa River and Diju River (Figure 1-2). The pollution in these rivers also contributes to the pollution of the upstream stretch of the Kolong River. A morphological study for the off-take at Brahmaputra River should be studied to find solutions for hydraulic improvement of Kolong River.
- *Improving hygiene and sanitation conditions:* A number of community toilet complexes are required in gardens and playground areas along the river. Solid waste collection bins and proper washing and bathing facilities are required at ghats along the river.
- Community access and benefits: One of the keys to river conservation success is to
 provide human connections to the waterway. When these connections are established,
 everyone becomes a steward of the river and the restoration will be more likely to
 succeed. Examples of community benefits include the establishment of greenways
 along the waterfront and points of interest to educate the community on conservation
 features and ecological resources.
- Setting of monitoring systems: An on-line system can be designed and proposed to be implemented to monitor the water flow as well as water quality of the Kolong River system. The on-line information will be used by decision makers to avoid flooding in the town.



Figure 6-2: Example of location where dredging is required.

6.4 Sewage Collection and Treatment Options

The most important aspect of preparation of the CSP is to concentrate on sanitation solutions which are required for the restoration of the Kolong River. In absence of a development plan for the Nagaon town, and in light of continuous contamination of the Kolong River, four potential options have been worked out.

Option 1 is full separation of the domestic waste in a separate sanitary sewer collection system that conveys the collected waste to a centralised sewerage treatment plant of 11 MLD capacity for the projected population of the catchment area. But as per the guidelines of CPHEEO "Manual on Sewerage and Sewage Treatment" second edition, one of the prerequisites is to have a piped water supply network in the town before proposing a separate sewerage system. This is a long-term solution for tapping the pollution of the Kolong River, which has to be implemented after having a piped water supply system for the whole town.

Option 2 is based on the same principle as Option 1 for having a separate sewerage collection system but instead of conveying the collected waste to a central STP, multiple decentralised STPs would be located throughout the town, along the river and possibly on government-owned land as availability of land along the river is scarce. If a minimum 1 MLD decentralised STP is considered, eight decentralised plants will be required to treat 11 MLD sewage generated from the projected population for the design year. This option should be used as immediate solution for prevention of direct pollution from the outfall drains along the Kolong River.

Option 3 consists of the collection of existing sewage and storm water drains in interceptor pipes which would run parallel on both sides of the Kolong River. Intercepted flow would be conveyed to an 11 MLD treatment plant, which should be constructed. The interceptor system would be sized to collect and convey the full capacity of a separated system, but would not be able to convey storm water drainage during wet weather, which would overflow into the Kolong River. This is a less desirable option as during wet weather; the combined sewage overflow would add diluted sewage to the river.

Option 4 also intercepts the sewage and storm drainage in interceptor sewers along the river but this flow would be treated at numerous decentralized STPs located throughout the town as indicated in Option 2. If a minimum 1 MLD decentralised STP is considered, eight decentralised plants will be required to treat 11 MLD sewage generated from the projected population for the design year.

The proposed sewerage system to be developed by the NMB should consist of a conventional sewerage system comprising of:

- Collection system with sewers (trunk mains, branch, and laterals) and sewer appurtenances.
- Conveyance system (pumping stations and rising/gravity main).
- STP(s) of sufficient capacity to cater the projected population of Nagaon town.
- The location of the treatment plant has to be finalized so that the treated effluent can be discharged to the water body.
- Any STP is generally located downstream of the intake point for water supply.
- Any STP is to be built at an elevation above the High Flood Level.

The treatment processes have to be selected based on raw sewage quality, techno-economic feasibility and suggestion from the approving authority. Selection is also based on availability of government-owned land. For the waste water collection system design, the parameters and guidelines of CPHEEO "Manual on Sewerage and Sewage Treatment" second edition have to be adopted. The sewerage system will be designed for the peak flow for design year. The present and projected population have to be considered with reference to the population projection and the same should be adopted for the design of the sewerage system.

The waste water collection system has been considered a "Separate System".

The waste water generated within the catchment area will be collected by means of trunk mains/sub mains. The trunk mains and laterals will preferably be laid along the side / centre the road and has to be routed based on the topographical data. Provisions are made for separate connection for each household which will be done under a separate project. Trunk mains have

to be designed to carry cumulative flows, i.e., the flow from the respective contributory areas as well as the flow contribution from the upstream and sub-trunk mains joining them. A properly designed trunk main sewer would carry the optimum discharge to transport solids such that the deposits are kept to a minimum. For this, it is desired to achieve self-cleaning velocity at least once a day during peak flows and also cater to expected fluctuations in discharge.

6.4.1 Kolong 5-year Plan

The approach for immediate restoration of the Kolong River is to prioritize the installation of a separate sanitary sewage collection system within the Kolong catchment area. The following actions will be required for the first five years for Kolong River restoration:

- Efforts initiated to generate awareness campaigns to promote better hygiene and sanitation practices.
- Restore flow regime in existing roadside drainage ditches.
- Implement a separate sewage collection system and sanitation plan on "priority areas" along the Kolong River by laying sewers and diverting the intercepted sewage flow to a proposed treatment facility or decentralized treatment plants spread throughout the catchment area.
- Aerate the internal drainage ponds for improving the quality of water.
- Increase the number of dust bins along the river for proper collection of solid waste.
- Promote 3R Principle Reduce, Reuse and Recycle for management of solid waste at household levels. Introduce a "No Plastic Bag" campaign.
- Clean the river bed of legacy pollution and restrict access to the river by introducing barriers for solid waste reduction.
- Define the extent of the river along its complete stretch and secure it against possible future encroachment.

6.4.2 Kolong 10-year Plan (after 5-year plan)

- Educate citizens about adopting better hygiene and sanitation practices.
- Make house connections for the collection of sewage from households in priority areas as water connections to all citizens with a 135 lpcd water supply is completed.
- Initiate and prioritise the Integrated Solid Waste Management plan for river basin area.
- Improve the drainage system to reduce flooding and water logging.
- Provide educational opportunities about river protection measures.
- Implement various river front developments works in collaboration with relevant authorities with a sustainable framework.

6.4.3 Kolong 15 to 30 year Plan (after 10-year plan)

- Ensure 100% of the households within the catchment area are connected to the sewers and serviced by treatment facility.
- Complete storm water and drainage system improvements with the Kolong catchment area.
- Perform periodic maintenance on river to ensure desilting and sediment deposition does not reduce the carrying capacity.
- Perform river front maintenance for public access to water.
- Operate and maintain separated system.

6.5 River Front Development

The success of the river front restoration scheme is dependent upon the acceptance and ownership of the project by authorities and the public. Currently the Kolong River is considered a resource to the citizens of Nagaon and has an economic value to the community, as many inhabitants are using the river for fisheries purpose. Some of the citizens are also using the river front for recreational activities although the river has the potential for a considerable aesthetic value. The Kolong river extends through the heart of the town and by improving the water quality of the river, removing the solid waste, providing adequate resources and collection point for waste deposit, removing the legacy contamination within the river, and restoring flow, the Kolong River has the potential to attract both commercial and residential development opportunities.



Figure 6-3: People using the river front for recreational activities.

As part of the river restoration scheme, the first step will be to define the extent of the river along its complete stretch and secure it against possible future encroachment, and prevent landslides along the river banks. The next step is to provide proper embankment/stone pitching, which the NMB has already started along the RKB bridge stretch of the Kolong River.



Figure 6-4: Stone pitching done along the RKB Bridge.

Some of the locations identified for the river front development are Nehru ground, Pranab Baruah Children Park and the Lord Shiva temple near the Haibargaon bazaar road. At Nehru ground an amphitheatre is proposed where social functions can be organised like music concerts, plays, etc. The proposed plan for the development of amphitheatre is as shown in Figure 6-5 and Figure 6-6. Cross section lines A-A and B-B in Figure 6-5 is presented in detail in Figure 6-7 and Figure 6-8.



Figure 6-5: Proposed location of Amphitheatre along Kolong River.











Figure 6-8: Section B-B of the Amphitheatre at Nehru ground.

Along the bank of the Kolong River is the existing Pranab Baruah Children Park, which will also be a part of river front development. Further proposed is a jogging track inside the park and proper plantings in the park and at other places along the Kolong River. The plantings will act as a buffer and will stop the erosion of soil. A conceptual sketch is shown in Figure 6-9 for the park and river front development. The park will be used by senior citizens for taking a walk and by children who can use the park and various play toys installed within it.



Figure 6-9: Conceptual sketch of plantings and jogging track in the Children Park.

Existing Ghats along the Kolong River are used for bathing and washing. Ghats on the temples are used for bathing and other Ghats are used for washing. Ghats along the temple areas should be properly fenced off.



Figure 6-10: Fencing of the Ghats at the temple area.

7 Financial Strategy for Executing the Different Components

The State Sanitation Strategy, like the National Urban Sanitation Policy developed at the national level, envisions making all cities sanitized and liveable. Implementing sanitation, being a state subject, has to be dealt with the utmost care. The state sanitation strategy supports the sanitation plans of the cities by duly acknowledging the financial constraints a ULB goes through. The state strategy urges the local government bodies to make the public aware of the financial constraints it goes through and helps in providing basic necessities in an appropriate way by making provisions for the timely payment of taxes. In addition, the government bodies should facilitate numerous IEC activities in the town, using audio-visuals and video documentaries, to promote awareness among the public towards a sanitized town.

Measures to strengthen the revenue streams include the following:

- E-Governance to be implemented and computerization of all systems and records.
- Surcharge on holdings totally / partially used for commercial purpose.
- Initiation of detailed survey to identify un-assessed and under-assessed properties.
- Strengthening of Assessment Department with adequate staffing.
- Lobbying with the State Government and Central Government (through the State Government) for settlement and subsequent regular payment of tax dues to Central and State Government agencies.
- Leverage on idle assets.
- Restructuring and re-evaluation of balance sheet.
- Valuation of assets under the corporation.
- Levy of reasonable tariffs and intense recovery.
- Increase water connections.
- A graded approach to revisions may have to be worked out so that cost recoveries increase over time.
- Change over the basis for property tax from annual rental value to an area-based system.
- Develop a system of tax assessment, reassessment, systems for serving demand notice, collection, developing information base.
- Encourage public private partnerships with part/full cost recovery principle, project structuring support for parking, terminals and solid waste management.
- Reform property tax system to firstly ensure total coverage of properties in the town.
- Shift from single entry system to double entry accrual based system.
- Provide training and capacity building measures in area of debt financing.

7.1 Planning

ULB level: CSPs need to be prepared in a participatory manner through consultations with urban citizens, especially the poor and women. The goal of making communities open

defecation free and moving towards a safe disposal system for sewage are the main thrust of a CSP. The phasing of the plan, its operational elements, choice of technology options and finances are included in the plan. This plan integrates the overall development plan of the ULB and is reviewed by the District Urban Sanitation Committee (DUSC) to dovetail it with other urban infrastructure development initiatives. CSPs need to be readied within a definite time frame.

State level: The State Sanitation Nodal Agency (SSNA) consolidates CSPs into a state level plan specifying the time frame, finances, operational components and guideline-sets for these components, to enable the state to earmark resources. The ULB aligns to the State plan. Special emphasis needs to be given to urban centres that attract floating populations seasonally (tourism) or sporadically (religious/cultural occasions) for planning. Also, appropriate environment-friendly solutions need to be incorporated for these locations.

7.2 Investment Requirements and Financing Options

A dedicated State Urban Sanitation Fund (SUSF) may be set up under the budget of the Housing and Urban Development Department with outlay from the state budget, supplemented by any provisions from Ministry of Urban Development (MoUD), Government of India (Gol). The proposed SUSF will be utilized for urban sanitation, and will focus on assisting the ULBs in the management (planning, communication, monitoring, etc.) of the sanitation programme. Guidelines for access and use of this fund will be framed and the State Urban Sanitation Committee (SUSC) will advise the department on the approval and sanction of ULB proposals. It will be mandatory for ULBs to commit to prepare the CSP for accessing this fund, and subsequent fund flows will be conditional with the implementation of the CSP.

The consolidation of ULB City Sanitation Plans at the state level will indicate financing requirements for implementing total sanitation in the urban areas of the state.

Scheme	Implementing Agency	Likely Funding	
Interception and diversion of waste water	PHED or any other agency implementing such projects in the State	NRCD	
Sewage treatment	Do	NRCD	
Community toilet complexes	ULB	NRCD	
Crematoria	ULB	NRCD	
Municipal solid waste directly polluting river water	ULB	NRCD	
Other municipal solid waste management	ULB	MoUD	
Dairies ULB		MoUD and MNRE (Energy Generation)	
Other non-point sources, e.g., washing vehicles, dhobi ghats, etc.	ULB	MoUD	
River front development Irrigation/water resources		NRCD	

Table 7-1: Schemes within the area of responsibility of government or public agencies.

A portfolio of funding sources (such as funds available through schemes like JnNURM, MoUD; funds committed through externally aided projects; PPP options with private or corporate sector) and potential partnerships with NGOs, the private sector, and other sanitation sector participants will be explored by the SSNA and guidelines will be issued to the ULB on the nature and modalities for accessing these.

7.3 Strategic Planning

The reconnaissance survey and baseline data indicate that the proportion of the population in Nagaon town fully served by adequate sanitation is relatively low, especially in poor urban areas in the river catchment. In addition, a relatively low portion of the town's population has access to municipal piped water supply, and access to door to door collection or municipal bins for solid waste disposal.

It has also been observed that the urban sewerage and drainage systems have inadequate coverage (where they exist), and are degraded. Mainly domestic waste water from houses is directly discharged to the open drains and then flows to the receiving river either directly or indirectly without any treatment. In consequence, the self-purification capacity of receiving water bodies is overloaded, causing surface and ground water pollution, significant health and economic risks, and reduced environmental quality.

This section on river restoration strategy takes a holistic approach to the pollution problem and looks beyond immediate concerns to consider the wider environmental impacts of proposed initiatives and activities and shall deal with sanitation problems in an integrated way rather than in isolation.

Schedule

The system shall be designed under the broad framework as per the guidelines for a design period of 30 years; however, the planning shall entail the implementation of the design in an organised and phased manner to meet the ultimate goals of this CSP. In this regard, the planning horizon has been taken with respect to the base year for which the Proposed Sewerage System Master Plan has been prepared for the entire Nagaon town to make this plan compatible with that project. The other phases of this project are proposed to be framed up to converge to an ultimate design year, again to be compatible with the Sewerage Plan.

Consultants have proposed a 3-phase approach to implement the plan proposed in this report, namely immediate, short-term, and long-term benefits to ameliorate the degrading river water quality and its restoration. Each term would be spread over a certain number of years to complete the targeted tasks. Under this, it has been adopted that financial approval of the scheme would probably be completed by year 2014 and construction tenders for implementation works would also be floated by 2014. This has been referred to as "immediate phase" having a projected time period of 5 years when the initial works are expected to be completed. The next phase of development over another 10 years from 2020 till 2030 is referred to as "short-term" and the remaining works to be taken up over the remaining 15 years is referred as "long-term". This phased approach aims to navigate through the challenges posed by the limitations in investments, existing administrative framework, institutional capacities, and community engagement in a proficient manner. The phases, corresponding timelines, and activities are defined in Table 7-2 and Table 7-3.

Phase	Year
Immediate	2014 – 2019
Short-Term	2020 – 2030
Long-Term	2031 – 2044

Table 7-2: Phased implementation of the CSP. The years shown are an example that may be changed during actual implementation.

Table 7-3: Strategic Planning Framework.

	Activity /				
	Infrastructure Facility	Immediate 2014 – 2019	Short-Term 2020 - 2030	Long-Term 2031 – 2044	
umptions	Education	Education Initiate Public outreach program to promote better sanitation practices.		Stakeholder involvement in river protection and general hygiene of the people.	
Ass			Efforts initiated to regularize the participatory planning and budgeting.		
	Sewerage and Sanitation	Implementation of the separated sewerage system and interceptor sewers to proposed scaled treatment facility. Aerate internal drainage ponds for better water quality.	Making the house connections for collection of sewage from households in priority areas as water connections to all citizens at 135 lpcd water supply is achieved. Collection of sewage from 80% households.	100% of the population in the town is connected to the sewers and serviced by treatment facility.	
Strategic Planning	Solid Waste Management	Add more dust bins along the Kolong River for better collection of solid waste. Initiate public awareness about the river restoration.	Prioritising SWM plan for the river basin area.	Implementation of town solid waste management plan.	
	Storm Water Drainage	Implementation of an organised storm water collection network in "priority areas" as per the original storm water management plan prepared for the town.	Extension of the storm water management plan to other areas of the town including other appurtenant works.	100% of the town is covered with storm water drainage system.	
	River Maintenance Works (De-silting, De-weeding, and De-sludging)	Initiate dredging of river bed for the legacy pollution and restricting access to river.	Implementation of river monitoring system for better flow and quality of water.	Only periodic river restoration works is undertaken to de-silt for natural siltation.	
	Hydraulic Improvement	Augmentation of River by diversion.	Flow augmentation from Brahmaputra river.	Regular maintenance of river flow control works.	
	River Front Development	Defining the extent of river along its complete stretch and securing it against any possible future encroachment.	Implementation of various river front developments works in collaboration with relevant authorities with a sustainable framework.	Regular maintenance of river from improvement works.	

8 Maps

Maps created for this CSP are summarized in Table 8-1.

Table 8-1: List of maps.

S.No.	Марѕ	Description
1	India	States of India, with Assam highlighted as the project location.
2	Assam	District map of Assam; it includes the Nagaon district where the Kolong River passes through and where the river is most polluted.
3	Map of Kolong River Basin	Kolong River and its tributaries. Also marks the location where the river flows through the Nagaon district.
4	Satellite image of the area	Satellite image (AWiFS) of the area.
5	Ward map of Nagaon	Municipal Wards, Slums and Roads
6	Digital Elevation Model	Digital Elevation Model(DEM) of Kolong river basin including Kopili, Digaru, Jamuna and Digaru rivers.
7	Sewerage Outfall Map	Municipal wards, sewerage outfall, water bodies.
8	Solid Waste Map	Municipal Wards, Soild Waste Dumping Sites and with water bodies in Nagaon town.
9	Bathing Ghat	Municipal Ward, Water Body with Bathing ghat in Nagaon Town.
10	Dredging Stretch	Municipal Ward, Kolong River with Dredging stretches
11	Sampling Location	Kolong river basin and Sapling location.
12	River Front Development	Map includes municipal wards and location of proposed river front development site.

9 References

- 1. Municipal Solid Waste (Management and Handling) Rules, 2000.
- 2. Census of India 1991 data.
- 3. Census of India 2001 data.
- 4. Census of India 2011 data.
- Ministry of Minority Affairs Government of India (20xx) "Baseline Survey of Minority Concentrated Districts, District Report, Nagaon", Prepared by Omeo Kumar Das Institute of Social Change and Development: Guwahati.
- 6. Department of Environment & Forest, Government of Assam (2012) "Assam State Plan on Climate Change, 2012-2017". 101 pages.
- Pollution Control Board, Assam (1993) "A report on Polluted river stretches in India: The Kalong system along Nagaon town, Assam. May – June, 1993", Prepared by Pollution Control Board Assam for Central Pollution Control Board, June 1993. 87 pages.
- Pollution Control Board, Assam (2010) "DPR for Restoration and Conservation of the Kolong River, Assam", Prepared by Centre for the Environment, Indian Institute of Technology, Guwahati, October 2010. 207 pages.
- 9. Pollution Control Board, Assam (2013) Personal communication, Water quality data for Kolong in the period 2008-2013.
- 10. Khan, I.I. and Arup, K.H. (2012) "Study of some water quality parameters of Kolong riverine system of Nagaon, India". The Clarion Volume 1 Number 2, pp 121-129.
- 11. Nagaon Official Website: http://nagaon.nic.in/econ.html.
- Department of Animal Husbandry and Veterinary, Nagaon official website: http://www.nagaonvety.org/.
- NRCD (Ministry of Environment & Forests, National River Conservation Directorate, New Delhi). 2010. Guidelines for Preparation of Project Reports under National River Conservation Plan and National Ganga River Basin Authority. Prepared by Alternate Hydro Energy Centre, Indian Institute of Technology (December 2010)

Appendix A: Water Quality Data (Present project)

City Sanitation Plan

Appendix B: Water Quality Methodology (Present project)

City Sanitation Plan

Appendix C: Water Quality Data (PCBA, 2013)

1

Parameters	Month & Year of collection					
	April, 08	April, 09	April, 10	April, 11	April, 12	April, 13
a. Physical Parameters:	r	1				
pН	7.6	7.5	6.8	7.2	6.5	7.4
Turbidity (NTU)	13.2	1.5	5.2	11.9	16	16.5
Conductance (µmho/cm)	106	101	84	94	116	134
b. Organic Parameters:						
DO (mg/L)	8.3	9.5	7.1	7.4	7.5	9.4
COD (mg/L)	16.5	6.3	3.3	9.4	4.6	5.9
BOD (mg/L)	3.3	1.1	1.0	2.2	1.2	2.3
c. Major Mineral Parameters:						
Chloride as CI (mg/L)	28	16	8	8	10	6
PO₄ as P (mg/L)	10	0.1	8.3	0.1	4.4	4.3
Sulphate as SO₄ (mg/L)	34	21.7	27	3.8	26.5	35.7
d. Other Inorganic parameters:					he	
T. ALKALINITY (mg/L)	42	48	38	48	32	40
T. Hard ness as CaCO ₃ (mg/L)	38	46	50	54	42	50
Calcium as CaCO ₃ (mg/L)	28	36	32	34	30	36
Magnesium as CaCO ₃ (mg/L)	10	10	18	20	12	14
NITRATE-N (mg/L)	0.2	0.1	0.1	0.1	0.1	0.44
Total Dissolved Solid (TDS) (mg/L)	76	74	62	48	82	92
Total Fixed Solid (TFS) (mg/L)	. 37	35	28	20	38	26
Total Suspended Solid (TSS) (mg/L)	29	12	13	34	10	12
Sodium (mg/L)	7.7	6.2	1.6	3.9	5.7	1.4
Potassium (mg/L)	1.7	2.5	1.3	1.6	2.6	0.6
Fluoride (mg/L)	0.57	0.55	0.53	0.32	0.41	0.34
e. Trace Metals:			I			
Zinc as Zn (μg/L)	51	86	324	27	390	46
Copper as Cu (µg/L)	3.9	6	27	1	13	BDL
Lead as Pb (µg/L)	1	10	15	1	10	BDL
Cadmium as Cd (µg/L)	3	3	BDL	1	3	BDL
Nickel as Ni (µg/L)	8	11.9	45	20	19	BDL
Chromium as Cr (T) (µg/L)	7.9	50	18	1	7	BDL
Arsenic as As (µg/L)	1.6	0.5	0.8	1	1.7	1.7
Mercury as Hg (µg/L)	BDL	BDL	BDL	BDL	BDL	BDL
Total Iron (µg/L)	180	80	1200	280	260	400
f. Bacteriological Parameters:						
Total Coliform (MPN/100ml)	700	910	360	Nil	360	1500
Faecal Coliform (MPN/100ml)	Nil	Nil	Nil	Nil	Nil	Nil

Table 3. Water Quality of Kolong river at Morigaon (During the period from 2008 to 2013)

Faecal Coliform (MPN/100ml) BDL : BELOW DETECTABLE LIMIT

Parameters	Month & Year of collection					
	April, 08	April, 09	April, 10	April, 11	April, 12	April, 13
a. Physical Parameters:						
рН	7.2	7.3	6.9	6.7	6.5	7.2
Turbidity (NTU)	5.8	8.1	110	8.6	6.2	3.8
Conductance (µmho/cm)	189	184	77	99	128	234
b. Organic Parameters:		· · · · · · · · · · · · · · · · · · ·			.	
DO (mg/L)	8	7.4	5.4	7.2	7.1	3.4
COD (mg/L)	9	14.6	10.4	4.6	3.1	11.8
BOD (mg/L)	2.6	3.5	2.7	1.9	0.9	3.2
c. Major Mineral Parameters:			I		1	
Chloride as CI (mg/L)	14	26	14	12	10	12
PO₄ as P (mg/L)	8.5	6.9	4.1	1.3	4.7	4.5
Sulphate as SO₄ (mg/L)	22.2	6.7	10.4	6.5	2.1	7.6
d. Other Inorganic parameters:						
T. ALKALINITY (mg/L)	76	96	42	58	2.2	122
T. Hard ness as CaCO ₃ (mg/L)	68	94	42	52	62	106
Calcium as CaCO ₃ (mg/L)	56	56	34	34	40	92
Magnesium as CaCO ₃ (mg/L)	. 12	38	8	18	22	14
NITRATE-N (mg/L)	0.1	0.1	0.1	0.1	0.1	0.96
Total Dissolved Solid (TDS) (mg/L)	132	128	48	66	88	156
Total Fixed Solid (TFS) (mg/L)	49	52	22	30	40	42
Total Suspended Solid(TSS) (mg/L)	24	18	11	23	14	16
Sodium (mg/L)	6.7	7.9	3.1	4.6	4.3	8.5
Potassium (mg/L)	1.6	2	2.5	2.6	2.9	0.7
Fluoride (mg/L)	0.63	0.83	0.73	0.53	0.41	0.38
e. Trace Metals:	1 <u>0</u> 00 000		r	1		1
Zinc as Zn (μg/L)	45.5	74	56	69	••	
Copper as Cu (µg/L)	3.9	13	37	150		
Lead as Pb (µg/L)	6	10	31	10		
Cadmium as Cd (µg/L)	3	2.6	1	2		
Nickel as Ni (µg/L)	9.4	9.2	54	20		
Chromium as Cr (T) (µg/L)	7.9	10.1	29	31		
Arsenic as As (µg/L)	5.3	3.9	2.2	3.2		
Mercury as Hg (µg/L)	BDL	BDL	BDL	BDL		
Total Iron (µg/L)	240	120	180	400		
f. Bacteriological Parameters:			1	I		
Total Coliform (MPN/100ml)	2200	700	910	360	910	1500
Faecal Coliform (MPN/100ml)	1100	300	Nil	Nil	300	Nil
Long and an a						

Table 4. Water Quality of Down stream of Kolong river at Anandaram Dhekial PhukanBridge, Nagaon (During the period from 2008 to 2013)

BDL : BELOW DETECTABLE LIMIT ... : Analysis Not Done.

Appendix D: Water Quality Data (Khan & Arup, 2012)
Parameters	Si	te-I	Site-II				
	Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon			
pН	7.9-8.2	7.1-8.0	8.2-8.6	6.5-7.1			
Total Suspended Solids (mg/L)	185-495	70-212	200-540	50-160			
Turbidity NTU	1.2-79.5	17.9-80.6	28.6-85.6	80.5-110.7			
Conductivity m.mhos.cm-1	426-449	412-429	496-546	479-531			
Total hardness (mg/l)	178-189	156-162	180-196	128-145			
D.O.(mg/l)	7.0-7.5	7.6-8.5	7.0-7.3	7.1-7.9			
B.O.D.(mg/l)	7.1-7.9	5.1-5.7	5.5-6.4	5.1-5.6			
C.O.D (mg/l)	431-450	412-429	509-541	490-506			
Chloride (mg/l)	150-161	178-187	180-214	206-213			

Table - 1 : Site wise observed values of different water quality parameters of Kolong River

Appendix E: Water Quality Data (PCBA, 2010)

River	Sampling	Temp ^r	pН	TDS	EC	DO	BOD ₅	Turbidity	Hardn	Cl	PO ₄
	point								ess		
Kolong	Kajalimukh										
	(Gobordhan)	28.9	7.4	90	97.30	6.6	1.1	284	44	7	0.125
Kolong	Boha	28.8	7.2	70	80.70	7.4	1.1	30	32	0.5	0.03
Kolong	Nagaon	29.4	7.4	110	119.40	6.8	1.4	25	64	15.5	0.053
Kolong	Dimoruguri	27.7	7.2	100	104.90	5.9	0.9	10	58	10	0.047
Kapili	Dharamtu1	27.4	7.5	80	84.70	7.4	1.5	8	38	1.5	0.032

Table 3-7 (a): Water quality data analysed in Kolong River

Table 3-8 (b): Water quality data analysed in Kolong River

River	Sampling	SiO ₂	Ca	Mg	Na	HCO ₃	NH ₃	SO4	K	NO ₃	Total	Free	Fe
	point										Chlorine	Chlorine	
Kolong	Kajalimukh	22.3	3.72	8.4	7.64	36	0.09	17.00	2.61	0.059	0.1	0.07	0.05
	(Gobordhan)												
Kolong	Boha	19.5	2.92	6.0	4.76	32	0.07	21.00	1.84	0.009	0.02	0.02	0.15
Kolong	Nagaon	31.6	3.91	13.2	6,51	66	0.06	10.00	2.37	0.103	0.06	0.04	0.15
Kolong	Dimoruguri	29.3	2,87	12.4	4.7	64	0.05	10.00	1.93	0.054	0.13	0.01	-
Kapili	Dharamtul	17.6	2,26	7.9	5.39	32	0.06	21.00	1.97	0.01	0.15	0.15	-