Detailed Project Report

Model Project on Decentralised Wastewater Treatment System (DWWTs) including local reuse, Children's Park, Bodhgaya

July, 2018

Prepared for

Bodhgaya Nagar Panchayat (BNP)

Bodhgaya, Bihar

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Executive summary

- With a population of 38,439, Bodhgaya Nagar Panchayat (BNP) is spread to 20.2 sq. km. and is administratively divided into 19 wards.
- Bodhgaya is an important tourism/ heritage city and houses UNESCO's world heritage site, 'Mahabodhi Temple'.
- City's water demand is currently met by ground water resources.
- In absence of operational sewerage network, all kinds of wastewater (grey water, effluent from excreta containment, storm water) flow in storm water drains
- Most of the storm water drains outfall into pynes (anthropogenic water channels traditionally used for conveying water for irrigation), which finally conveys the wastewater to low lying areas/ agriculture lands or into Niranjana River.
- By recognising the importance of decentralized and/or cluster-based approach for wastewater management as an alternative solution to achieve city-wide sanitation with optimum use of resources, Bodhgaya City Sanitation Task Force (CSTF) decided to implement a model project on Decentralised Waste Water Treatment (DWWT) with local reuse.
- In this regard, BNP requested Centre for Science and Environment (CSE, New Delhi) to carry out feasibility study and prepare a Detailed Project Report (DPR).
- After screening of potential sites, CSE selected children's park as the most suitable site for the proposed DWWTs of 10 Kilo Litre per Day (KLD) capacity.
- The total land area of the children's park is about 5,700 sq.m. The proposed DWWTs will cover land area of 175 sq.m (3% of the total park area) of which 29 sq.m would be under ground and could be implemented under paved areas/parking, while 146 sq.m will be incorporated within the landscaping area as green area and pond area that adds to the aesthetics.
- The proposed technology is completely based on gravity, uses no chemicals, and requires minimal energy. System components include Settler, Anaerobic Baffled Reactor (ABR), Planted Gravel Filter (PGF) bed, polishing pond and storage tank for treated waste water.
- The treated water will be used to maintain the green landscape of the park. The estimated green area of the park is 3,000 sq.m which can use up to 9,000 litres of treated water on daily basis. In addition, this, treated waste water may also be used for road washing during the tourist season to replace the current practice of road washing by fresh water.
- The CAPEX of this proposed project is estimated to INR 15.34 lakhs.

- The OPEX of the DWWTs including manpower, electricity, consumables and repair comes out to be INR. 2.07 lakhs per annum on an average.
- In addition to the OPEX, expenditure towards sensitizing the local communities through Information, Education & Communication (IEC) is about INR. 1.5 Lakhs for five years.
- The technical details provided in the DPR doesn't include the conveyance of the wastewater to the DWWTs from the point of generation i.e. public toilets located opposite to Kalchakra Maidan, toilets of Primary Health Care Centre (PHC) and Samanway Ashram.

1. Background and introduction

The conventional strategy for planning sewage management for any urban area focuses on conveyance of the sewage through sewer pipes to a common point for treatment. This type of approach for planning is generally referred to as a centralized sewage management (sewerage). For sewage to be treated at centralized sewage treatment system, it has to be conveyed to the sewage treatment plants through a drainage network (sewer line, generally underground drain). However, most cities in India do not have sewerage system to convey it to the treatment plants.[1] In addition, these conventional centralized sewerage systems require an elaborate infrastructure, energy for pumping and large volume of water to carry the wastes or excreta to treatment plants. Not only such systems require energy but also require skilled labour for its operation and maintenance. According to a survey of water – wastewater scenario of 71 cities published in CSE's publication 'Excreta Matters' (2012), Indian cities have a two-fold challenge:

1. Deficit in connectivity and repair which leads to a huge backlog for provision of household sewer connection. It is estimated that only 30% of the generated sewage could be treated in India in 2015.
2. Cities are ever expanding and growing in areas where the sewerage network doesn't exist. This leads to a constant increase of number of households without sewer connection. In this situation, sewage spills everywhere.

This two fold challenge creates a backlog-front log situation warranting huge financial and technical resources to meet the demand.

To address the above challenges, decentralized approach for sewage treatment has recently drawn worldwide attention as it offers an effective alternative for many urban, peri-urban areas and even for localities within various class-I and metro cities which are not connected with any conveyance. It deploys a combination of onsite and/or cluster systems that are designed to operate at smaller scales.[2] In this way, they, at one hand, reduce the effects on the environment & public health and financial resources required otherwise, but also increase the ultimate reuse of wastewater depending on the community type, land-use, technical options and local settings. Above all, such an approach allows flexibility in wastewater management, as there is an ease of decision making towards any simple or complex technology in consideration to local factors. Moreover, decentralized systems can be replicated

[1] Rohilla, S. et al., 2014. Decentralised wastewater treatment and reuse: Case studies of implementation on different scale – community, institutional and individual building, Centre for Science and Environment

2 Massoud, M.A., Tarhini, A. and Nasr, J.A., 2009. Decentralized approaches to wastewater treatment and management: applicability in developing countries. Journal of environmental management, 90(1), pp.652-659.

and installed on as needed basis, therefore evading the costly infrastructure that is implemented in advance anticipating future population growth and floating populations.

Table 1: Decentralised wastewater management approach

Approach	Suitability
Decentralized wastewater management approach – treatment and local reuse	• Areas where setting up of the sewerage connection becomes expensive to implement, operate and maintain: o Areas with low population densities and dispersed households o Unplanned and scattered communities • Sprawling population in the peri-urban areas where it is not very feasible to provide sewerage connection • Areas with demand for bulk water for non-potable purposes like horticulture, maintenance of green landscape, road washing etc. • Areas with congested and narrow roads where laying sewer connection is not feasible but a small-bore sewer is possible.

In 2015, Government of India launched a national flagship programme - Atal Mission for Rejuvenation and Urban Transformation (AMRUT) with a focus on providing funds for urban renewal projects for providing services to households and build amenities in cities which improve the quality of life for all, especially the poor and the disadvantaged. Under AMRUT, the thrust areas include sewerage and septage management which is inclusive of decentralized wastewater management. There are various other sources of funds that may be sought from the Government missions (e.g. Smart Cities Mission (SCM), Heritage City Development and Augmentation Yojana (HRIDAY), fourteenth finance commission) and private finance (that includes corporate social responsibility - CSR, microfinance, housing finance institutions, and commercial banks) to support effective wastewater management.

Table 2 illustrates various sources available through central government that may be explored for implementation of a decentralised wastewater management project.

Table 2: Opportunities for funding from central government

Program	Opportunity for funding in decentralized sanitation embedded in different program guidelines
AMRUT	Funds can be sought for creating "decentralized sewerage systems,.....recycling and reuse of wastewater"
HRIDAY	One of the key components that the program can fund includes "Provision of basic services…and its linkages with city infrastructure/ trunks for water and wastewater management and treatment"
Smart Cities Mission	Sanitation (particularly wastewater recycling and storm water reuse) is one of the core infrastructure elements included in the program
PMAY – Housing for All	Program guidelines mentions that "……if these are located in the peri-urban/ newly developed/ contact areas where trunk sewer is not available, then these toilets can be connected to on-site/ decentralized sanitation systems"
Swachh Bharat Mission (SBM)	Program guidelines mention that "….In the event that a sewerage system is not available within 30metres from the proposed household toilet, in addition to the construction of the toilet superstructure, an on-site treatment system……should also be constructed for the collection, treatment and/or disposal of sewage at, or near the point of generation'.
Namami Gange	Program guidelines refer to "….in-situ treatment in open drains"
Fourteenth Finance Commission (FFC)	The FFC recommends basic grants to ULBs "….with the purpose of providing unconditional support for delivery of basic services that includes water supply, sanitation including septage management, sewage and solid waste management…among other services assigned to them under relevant legislature."

Source: NIUA (2017) "Handbook on Decentralised wastewater treatment module, 2017" Delhi, India.

Currently in Bodhgaya, there is no operational sewerage system and all kind of wastewaters (grey water, effluent from excreta containment, storm water) flow in storm water drains which find their ways into pynes (anthropogenic water channels traditionally used for irrigation water) and finally to low lying areas/ agriculture lands or into Niranjana river. In view of this, the decentralized approach would be beneficial as it not only provides for a long-term solution for small communities but is more flexible which makes it affordable and reliable. While there are many impediments and challenges towards wastewater and faecal sludge management in Bodhgaya, these can be overcome by suitable sanitation planning and its implementation.

Centralized management of the decentralized wastewater treatment systems could be executed by the urban local body (ULB) to ensure that they are inspected and maintained regularly. However, management strategies should be site specific accounting for social, cultural, environmental and economic conditions in the target area.

1.1. Rationale for DPR preparation

Ministry of Housing and Urban Affairs, Government of India (MoHUA, GoI) identified CSE to support a total of 23 towns (including Bodhgaya) so that they become flagship towns in faecal sludge management (D.O. MD-SBM/AA/62/2016 dated 30th May 2016, Annexure 1). During the City Sanitation Task Force Meeting (CSTF) in Bodhgaya on 10th October, 2017, the importance of DWWTs as integral part of the solution to solve sanitation related issues was discussed. Following to this, CSE organized a technical training on planning and designing of decentralised wastewater treatment and faecal sludge treatment plant systems in Delhi during 10-13 Oct. 2017 where the engineer from BNP participated, and learned about the concept. As agreed by the CSTF, the Bodhgaya Nagar Panchayat requested CSE (dated December 1, 2017) for the technical support to implement a model project (See Annexure 2: Request letter from BNP for Pilot DWWTs). CSE agreed to carry out site assessment and prepare a detailed project report (DPR) for a high-impact and high-visibility model project on DWWTs for local reuse.

The project is aimed to:

- Showcase a good management practice through decentralized wastewater treatment and local reuse.
- Improve understanding on advantages and challenges of a decentralized approach in Bodhgaya through pilot model project.
- Sensitization through a high-visibility project and behavioral change for local reuse of the treated wastewater.
- Develop skills of the ULB staff for implementation, operations & maintenance and monitoring of a systems based on similar technologies.

CSE carried out the feasibility study along with the assessment of potential sites for DWWTs and presented to the Executive Officer (EO) and members of ULB in Bodhgaya on 10th January (Annexure 3: Minutes of the Meeting with EO, BNP dated January 3, 2018).Thus, this DPR is prepared against the above background and is being submitted to Bodhgaya Nagar Palika for their necessary action and perusal.

1.2. Scope of DPR

This DPR is prepared for a model project of decentralized wastewater management system of 10KLD capacity that is capable to treat and locally reuse the treated wastewater. The DPR attempts to offer the following:

i. Methodology to screen potential sites and select the most suitable site to house the proposed model project.
ii. Complete technical and financial (capital and O&M cost) details of a sustainable DWWTs including proposal for its local reuse

The technical details don't include the conveyance system from the point of generation till the inlet of the treatment system as it may vary as per site conditions. Separate DPR should be raised for the same by the ULB. However, this DPR does include brief analysis of the wastewater generation quantity and quality, its proximity to the model project location.

2. About Bodhgaya

Bodhgaya (Bodhgaya Nagar Panchayat, BNP) is a small town which is internationally renowned as the place where Lord Buddha attained enlightenment more than 2500 years ago. The Bodhi Tree under which Lord Buddha attained enlightenment is considered of importance by the followers of Buddhism across the world. There are numerous monasteries and temples reflecting diverse Buddhist lineages and communities of practice. There is a significant interest and investments from countries such as Japan, Korea, China, Thailand, Cambodia, Vietnam, Myanmar, and Sri Lanka. There exists multi-layered historical ethnography of Bodhgaya's modern rebirth as the place of Buddha's enlightenment and the spatial politics that underlie its designation as UNESCO's World heritage site in 2002. Located 13 km away from Gaya city (District Headquarters), Bodhgaya is directly linked by roads to the surrounding region. The town is linked by NH1 through NH83 (Gaya-Dhobi Road) connecting Delhi and Kolkata as well as Patna and Varanasi. Bodhgaya is also close to an international airport – 8 km from the town. The nearest railway station is in Gaya city. [3]

Presently, Bodhgaya is a Nagar Panchayat with an area of 20.2 sq.km which is administratively divided into 19 wards (Figure 1). Even though the residential population of Bodhgaya is not much (38,439 as per census 2011), there is a huge tourist influx that goes up to ten times of its native population for days at a stretch.[4] Approximately, 70% of total annual tourists visit Bodhgaya during months of Sept-March while only 30% of total tourists visit during months of April to August. The annual tourist footfall in 2017 was estimated to be around 19,64,680 which reflects that the average tourist population per day is 5,383.

In Bodhgaya, natural direction of drainage is from southwest to north and northeast, except at the Temple, which is at a lower elevation than the surrounding area. Numerous drainage channels that are part of the indigenous *Ahars* and Pynes irrigation system characterize the area. Historically, these pynes and *ahars* were used as irrigation canals. Now, most of the storm water from the city (sheet flow and from constructed drains) end up in three pynes namely Mocharim, Amwa and Rajapur.

The evolution of the town is concentrated around the Mahabodhi temple complex on East West and North-South Axis. City's development is centered along the two main axis, one along the river and the other along the central spine that connects the Temple to the Gaya Dhobi road. The river Niranjana forms the physical boundaries of the town on the eastern side. The present development pattern follows along the wards surrounding the temple complex namely 15, 16, 17, 18, 19 where in maximum number of monasteries and hotels are situated. Apart, there is an urbanization trend observed along North-South direction along the Niranjana River in the North and Magadh University in the South where government offices and private planned colonies are proposed. The town is surrounded by agricultural fields and small settlements of not

[3] City Development Plan, Bodhgaya
[4] Primary surveys (2017-18)

more than 5,000 population. Further, 60% of the total area of BNP is under agriculture and has high demand of water for irrigation. This causes increased pressure on the existing resources and infrastructure and pose a challenge to BNP to effectively offer municipal services. In the absence of a robust conveyance system for wastewater and any designated disposal/treatment site, wastewater (including effluent from OSS and grey water from bathrooms & kitchens) is either discharged in drains (kuccha/pucca) or water bodies. Drainage system in BNP conveys the wastewater to low-lying areas or pynes in the city without any treatment. Excreta of 99% population of BNP is unsafely managed, as shown in the excreta flow diagram (also known as Shit Flow Diagram, SFD) as elucidated in Figure 2. Unsafe management of excreta contaminates the environment either through wastewater (WW) or through faecal sludge & septage (FS&S). To achieve city wide sanitation, both WW and FS&S should be safely managed.

Under Bodhgaya Sewerage Scheme, 65.33 km long sewer network has been planned for BNP, out of which 60.4 km (92% of planned) has already been laid down. Sewage Treatment Plant (STP) of 10 MLD design capacity based on Extended Aeration technology, is also being constructed at Suryapura[5]. Initial quantity of sewage expected to reach the plant is 7.082 MLD with its design period being 30 years. The STP is expected to lower the Biochemical Oxygen Demand (BOD) of the inflow to 30mg/l and Total Suspended Solids (TSS) to 50mg/l. 25% of the treated water will be reused in horticulture/agriculture post chlorination and rest shall be discharged in nearby drain/river[6]. However due to delays, no individual connection has yet been provided. Such unaccounted delay is posing financial, health and environmental burden on the BNP as current mode of wastewater conveyance is detrimental to all as it exposes the population to severe health hazards, contamination of storm water cause value loss, while no treatment and inappropriate disposal lead to loss of economic value of land and possible re-use of by-products.

Decentralized wastewater/ sewage management system could be a viable solution as it may be less resource intensive in terms of overall implementation and maintenance cost. Also, such an approach provides for flexibility for improvisation as many parallel systems of suitable technologies may be commissioned as per requirement.

[5]NBCC, 2009. *Detailed Project Report for Bodhgaya Sewerage Scheme,* Bodhgaya: National Building Construction Corporation Ltd.

[6] KII with Ramky official

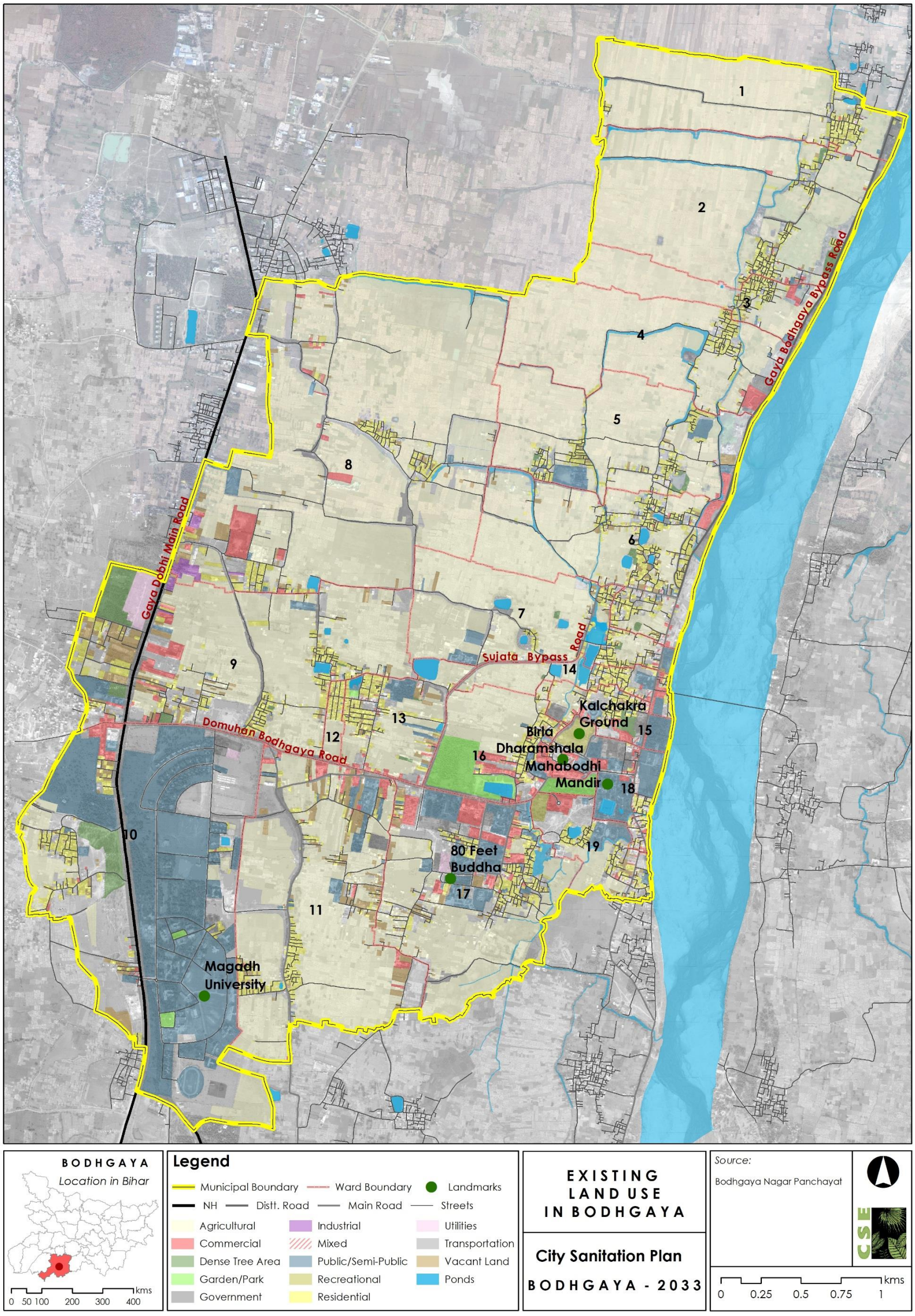


Figure 1: Administrative division and land use in Bodhgaya

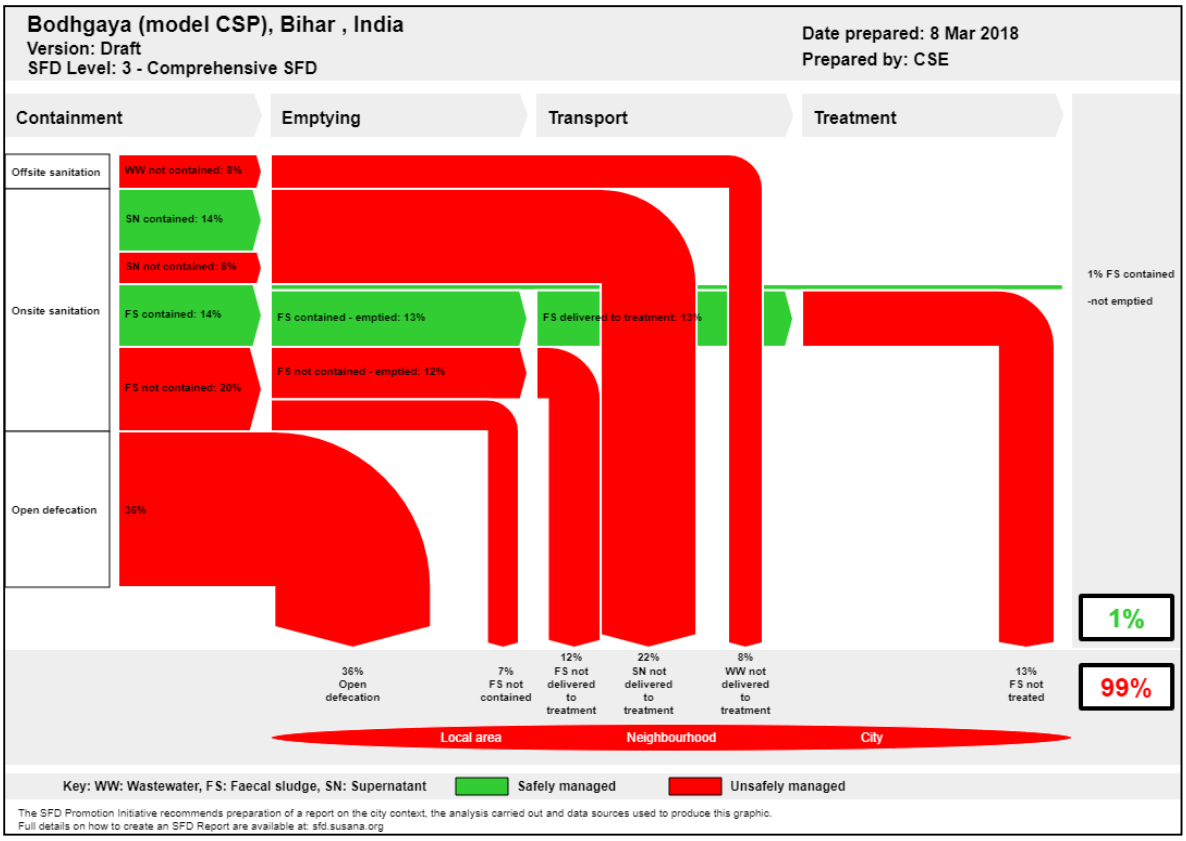


Figure 2: Excreta Flow diagram of Bodhgaya

As CSE is also preparing a model City Sanitation Plan (CSP) for the city of Bodhgaya, the projects indicated through action plan in Bodhgaya CSP would eventually determine future implementations towards a sustainable and sanitized Bodhgaya. The CSP would focus on suggesting solutions that are appropriate, innovative, sustainable and affordable for Bodhgaya.

3. Applicable rules and regulation

As per CPCB and the Gazette of India, Ministry of Environment, forest and climate change released a notification dated 13th October, 2017 where the standards that are to be achieved for safe disposal of treated water from any sewage treatment plant are suggested (Table 3).

Table 3: Effluent discharge standards vide Gazette notification dtd October 13, 2017

Parameters	**Location**	**Standards*** Concentration not to exceed
pH	Anywhere in the country	6.5-9.0
Bio-Chemical Oxygen Demand (BOD)	Metro Cities*, all State Capitals except in the State of Arunachal Pradesh, Assam, Manipur, Meghalaya Mizoram, Nagaland, Tripura Sikkim, Himachal Pradesh, Uttarakhand, Jammu and Kashmir, and Union territory of	20
	Andaman and Nicobar Islands, Dadar and Nagar Haveli Daman and Diu and Lakshadweep	
	Areas/regions other than mentioned above	30
Total Suspended Solids (TSS)	Metro Cities*, all State Capitals except in the State of Arunachal Pradesh, Assam, Manipur, Meghalaya Mizoram, Nagaland, Tripura Sikkim, Himachal Pradesh, Uttarakhand, Jammu and Kashmir and Union territory of Andaman and Nicobar Islands, Dadar and Nagar Haveli Daman and Diu and Lakshadweep	<50
	Areas/regions other than mentioned above	<100
Fecal Coliform (FC) (Most Probable Number per 100 milliliter, MPN/100ml	Anywhere in the country	<1000

*Effluent discharge standards (applicable to all mode of disposal)**

4. Site assessment criteria and matrix

The factors determining site selection include the technical feasibility and also aspects related to the ease of acquiring permission for implementation, land availability, it's potential to be a high impact site, social acceptance and local reuse of treated wastewater. Also, understanding the local context is crucial for technology selection and should be done only after conducting a comprehensive site evaluation. Table 4 lists the developed ten point scoring matrix and highlights the parameters that are taken into account for final site selection.

Table 4: Ten point scoring matrix for site selection

S No	Parameters	Maximum score	Scoring for DWWTs site
1	Ownership of land	10	• ULB owned land – 10 • State government land – 8 • Private land – 4 • Under any dispute - 0
2	Availability of land	10	• Immediately available – 10 • Available in 1-3 months - 6 points • Available in > 3 months - 3
3	Distance from Residential area/ Habitat	10	• Within 100 m - 500 m – 10 • Within 500 - 1km – 7 • > 1 km – 5 • 1-3 Km -3 • 3-5 km –2 • > 5 Km- 0
4	Approach road	5	• No approach road – 0 • Narrow road – 2 • Wide road - 5
5	Visibility and impact	15	• At prominent location and have viable re-use options - 15; At prominent location but not having viable re-use options - 10; No prominent location but having viable reuse possibilities- 5; Good location with reasonable impacts - 3; No impacts/ No visibility – 0
6	Operations, Maintenance and monitoring responsibility by any organization	15	• Direct under control of BNP - 15, Partial control/ stakeholder - 10; No control of BNP-5

7	Disposal of treated effluent under gravity or through pumping, disposal point	5	• Under gravity- 5; Partial under gravity and pumping - 3; Entire pumping - 0
8	Social acceptability. Is there any chance of problem for society?	10	• No probability - 10, May arise issues but involvement of them can address the issue - 5, Likely chances of dispute - 0
9	Chances of flood in the area	10	• No history of flood - 10; No Flood in recent years - 7; Occasionally flood - 5, Flood plain/prone –00
10	Is any water body adjacent to the site	10	• Nearby water body (within 200 m) -3, 100-200 m - 4; > 500 m- 1km - 10

Based on the above matrix, all identified sites were assessed and obtained scores were used to finalise the site for DWWTs.

5. Proposed sites for model DWWTs including local reuse

As indicated in section 1.2., this DPR consists of a detailed report for implementation of a model project based on decentralized approach of wastewater management. The sites proposed were visited by representatives from both BNP and CSE between September 2017 and January 2018. The initial criteria for proposal were on the basis of land availability at a high impact site that could have better prospects to achieve the required outcomes. Data from each site was collected during the visits and subsequent surveys were analyzed on the basis of a ten point scoring matrix developed. As shown in Figure 3, the screened sites included:

5.1. Meditation Park, Mahabodhi temple

The Mahabodhi temple is the center for development for Bodhgaya historically and follows a similar trend even presently. During the site survey in the month of October (2017), the meditation park was considered as a potential site due to its strength as a site of very high visibility. Subsequent interactions with the Chief Monk and his office during the field survey confirmed that the green area and the lined pond adjacent to the toilet complex's septic tanks could be utilized to upgrade present on-site treatment through the septic tank. The effluent from the septic tank presently flows out through a sewer or a pyne and eventually merges into the Mocharim Pyne. However, the final approval and funding for implementation lies with the Bodhgaya Temple Management Committee (BTMC) with no direct control of BNP. During the interactions in October 2017 and January 2018, an interest was expressed for consideration if a DPR for the project is submitted. With an approximate 11,300 sq.m of green area, the meditation park offers to have potential for reuse of 20-30KLD of treated waste water (See Figure 4).

5.2. BNP head office, Rajapur

BNP is all set to shift to its new office building, currently under construction in Rajapur. The construction is occurring in full swing within a premise of allocated land area of approximately 5,700 sq.m. The location is in close proximity to the floodplain and lies on Gaya-Bodhgaya bypass. Rajapur pyne flowing across the road parallel to the site carries storm water and sewage from its catchment area with a significant flow near to the site. Possible use of the treated water could be to develop and maintain green open areas within the upcoming campus (6-8KLD), road washing that is done through tankers by

BNP (as and when required) or for toilet flushing in the head office building (user dependent, would require dual piping to the toilets in the building). Figure 5 shows the location of this site.

5.3. Children's park

Bodhgaya Nagar Panchayat has proposed development of a children's park under AMRUT thrust area of upgrading green spaces, parks and recreation center. The proposed park site is located opposite to Samanway Ashram, in close proximity to the public toilets (Kalachakra Maidan) on one side and the public toilets (Primary Healthcare Centre) on the other side. As the Kalachakra Maidan becomes the center surrounded by bus stand, temporary health camps, shops and markets during the tourist season, this site promises high visibility. The approximate green area of the park would be 3,000 sq.m with a potential to reuse about 9 KLD of the treated water for horticulture. Alternately, the park being developed can have fountains with source of water being the treated water. Possible sources of wastewater could be either the public toilet (Primary Healthcare Centre) or the effluent of the septic tanks of Samanway Ashram. Figure 6 presents the site's overview.

Table 5 summarizes the scores obtained by each screened site based on the assessment criteria and matrix as discussed in section 4.

Figure 3: Location for shortlisted sites for DWWTs in Bodhgaya

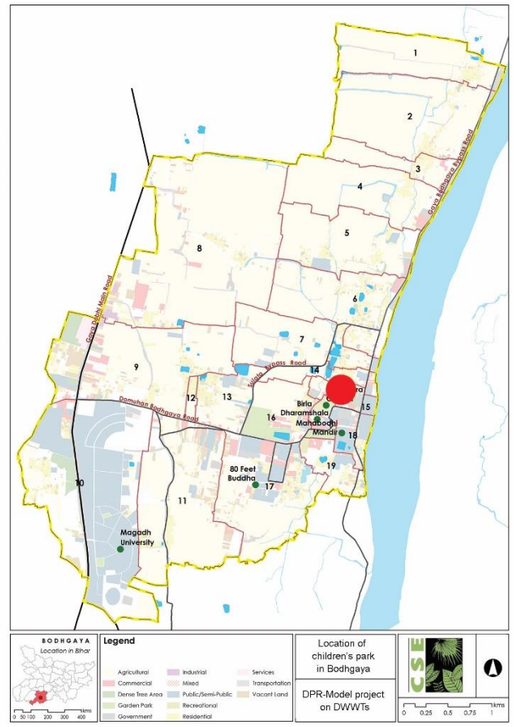
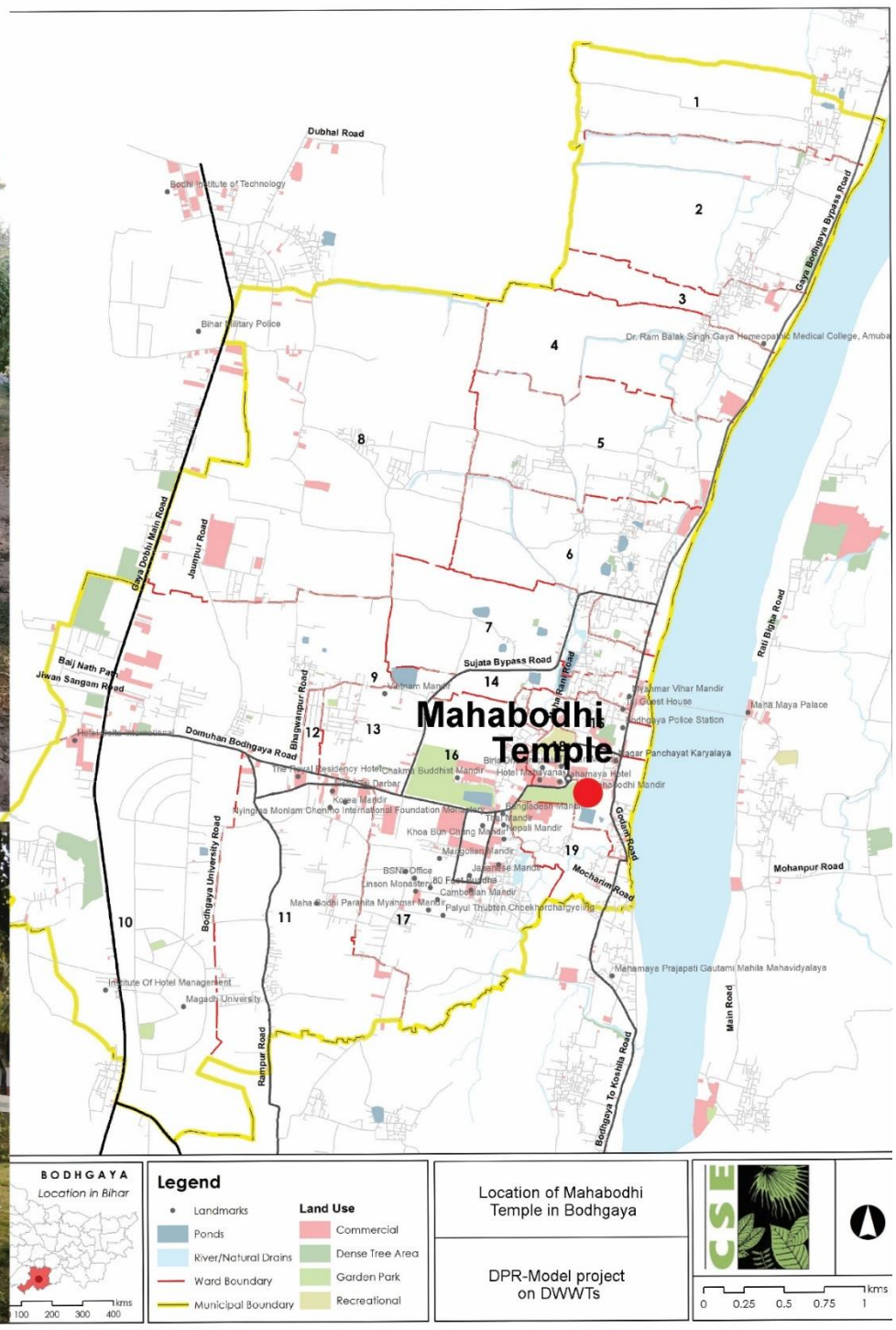


Figure 4: Location of proposed DWWTs site at Children's Park



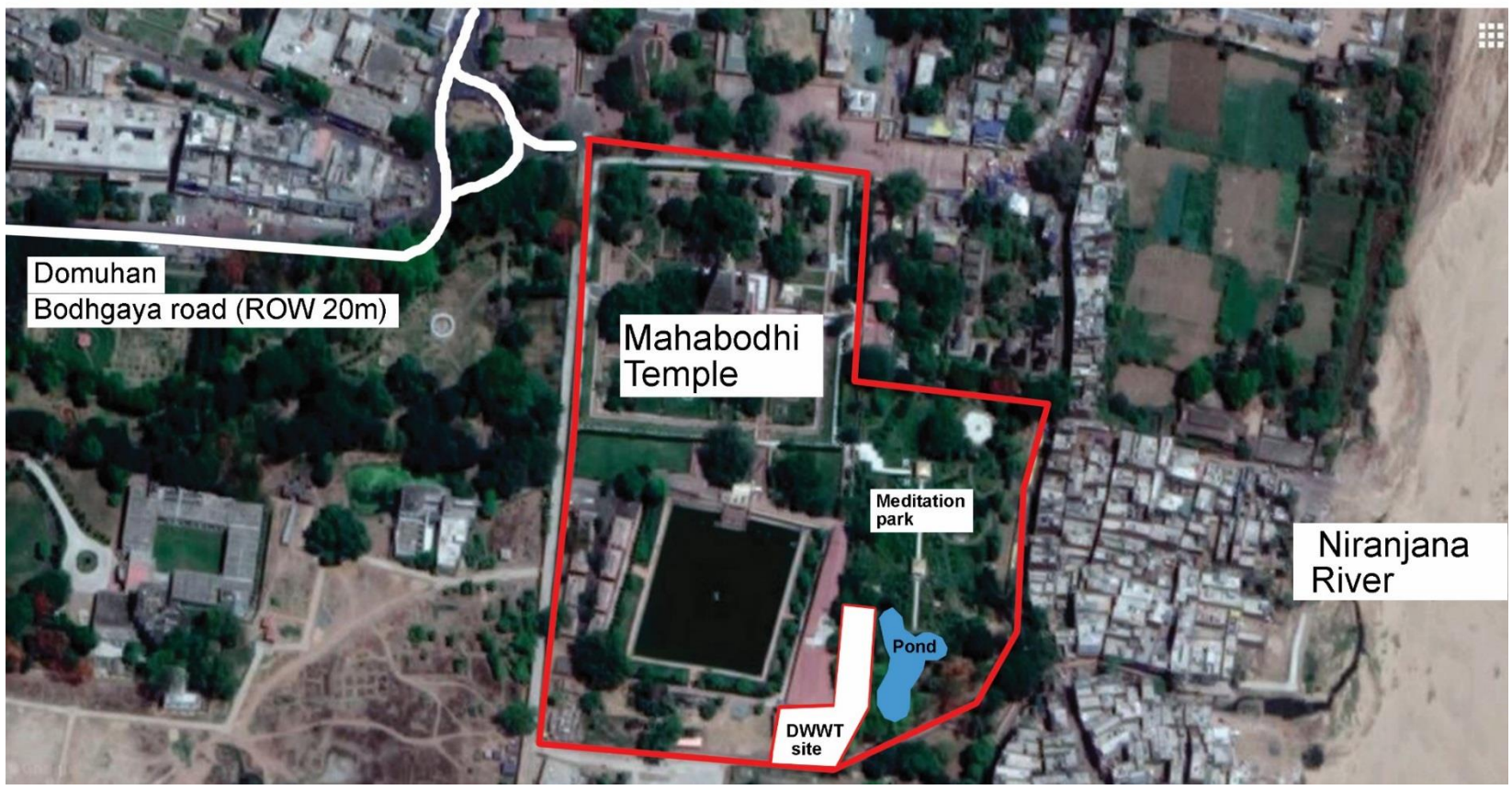


Figure 5: Location of proposed DWWTs at meditation Park, Mahabodhi Temple Complex

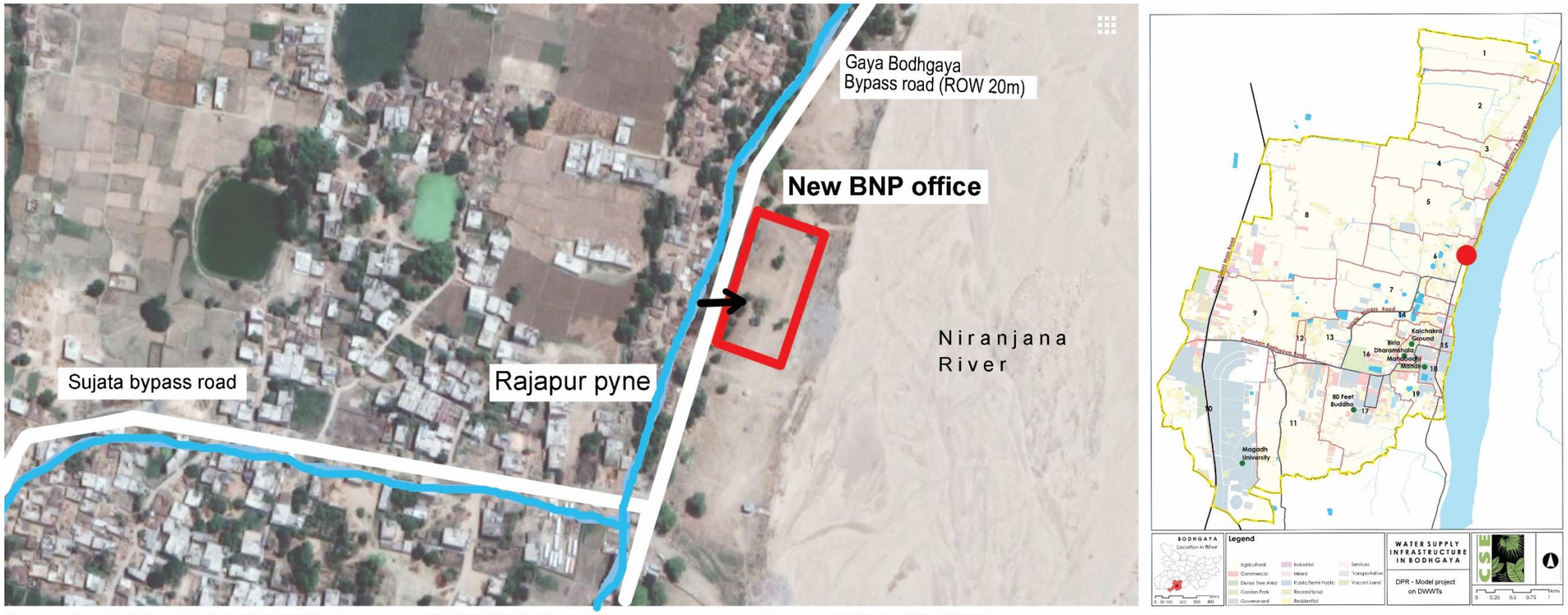


Figure 6: Location of proposed DWWTs site in BNP's new office

Table 5: Scoring matrix for proposed DWWTs sites

Site name	**Score (out of 100)**	**Proposed DWWTs capacity**	**Technical and social challenges**
Children's park	75	10KLD	• Inlet to be taken from across the road from Samanway Ashram, Public Toilet (PT) at Public Healthcare Centre (PHC) and/or PT opposite Kalchakra Maidan • Coordination with the Ashram/ Public Toilet's maintenance staff
BNP's Head office	73	10KLD	• Inlet from across the road through the pyne would require laying of pipe, pumping across the highway. This might require BNP's action and coordination with Public Works Department (PWD).
Mahabodhi Temple	65	30KLD (depending on re-use)	• BTMC to approve and sanction the project which could be time consuming process • Temple Protection Act, Archaeological Survey of India may object as the temple is a heritage site.

Based on the above scores, series of discussions and consultations with BNP, Children's park is finally selected to demonstrate the model DWWTs. This document provides for design of a 10KLD capacity decentralized wastewater treatment system at Children's park.

6. Survey and data collection for selected site (Children's park)

The selected site is to be developed as a park and recreation center especially for children. The park is located in close proximity to the Kalachakra Maidan which experiences gathering of people in huge numbers (up to 40,000 during teachings of Dalai Lama) during religious events in Bodhgaya. Samanway Ashram right opposite to the park houses a residential school for children, periodically organizes skill development courses and free of cost eye-health camps.

6.1. Wastewater sources

Public Toilets located in proximity to the park site offer to be a potential source of wastewater for the model DWWTs. These public toilets are abundantly occupied when any event is organized in Kalchakra Maidan. During other months, there is no significant wastewater generation. There are two Public toilets in proximity, one is located opposite to Kalchakra Maidan and another inside the premises of Primary Healthcare Centre.

Alternately, the wastewater generated from Samanway Ashram may be treated in the model DWWTs during non-peak seasons. The wastewater generated from the premises of the Ashram goes into a septic tank that exits at the site. The effluent from these septic tanks may be pumped into a collection tank inside the park.

6.2. Wastewater quality

Wastewater characteristic at the inlet is assumed to be similar to domestic sewage of any residential area. It is assumed that incoming wastewater will not contain any hazardous chemical or biomedical waste. The following input waste water quality parameters are considered as a reference of the input wastewater quality at Children's park DWWTs (Table 6).

Table 6: Assumed wastewater characteristics and discharge standards applicable for proposed site

Quality parameters	Assumed quality (general characteristics of sewage)	Discharge standards*
pH	7.5-8.5	6.5-9
BOD (mg/L)	200	30
COD (mg/L)	350	-
TSS (mg/L)	100	<100
Faecal Coliform (MPN/ 100ml)	In the range of 10^3 to 10^6	<1000

*Effluent discharge standards-Gazette of India, notification dated 13th October, 2017, Ministry of Environment, Forest and Climate Change**

6.3. Wastewater quantity

The data for quantity of wastewater generated is estimated on the basis of the survey and data collection. It is concluded that at any given time at least 6KLD of wastewater is available for treatment from Samanway Ashram. Hence a pipeline carrying the septic tank effluent of Samanway Ashram should be connected to the collection tank/ settler. Table 7 summarizes potential sources of wastewater along with a conservative estimate of the quantity of wastewater generated from each of these sources.

Table 7: Estimates on the wastewater quantity

Wastewater source	Population	Wastewater generation (KLD)
Public Toilet (Opposite Kalchakra Maidan)	100 users per day during tourist season; 15 users per day otherwise	1.5 KLD
Samanway Ashram (Septic tank effluent)	60 –children; 15 - temporary staff; During camps – 200 per day	6KLD + 3KLD (during eye camps)
Public Toilet (PHC)	20 users per day	0.3 KLD

Source: CSE estimates, 2018

6.4. Reuse of treated waste water

The estimated green area of the park is 3,000 sq.m which has a potential daily requirement of water in the range of 6,000 to 9,000 litres *(at a rate of 2-3 litres per sq.m to maintain greenery).* The rest of the treated water is expected to be re-used for aesthetics in a water fountain. The proposed DWWT system will treat 10 KL of waste water on daily basis. The treated waste water will be stored in a storage tank. It is suggested that the treated waste water is used in meeting only non-potable water demand. The park being developed can have fountains for aesthetics with source of water being the treated waste water. The treated waste water should pass through the polishing pond before it is pumped into fountain. Horticulture water requirements in the park can be met by the treated waste water. This treated waste water may also be filled up in tankers and used for road washing during the tourist season. This will help conserve groundwater that is presently extracted to meet road washing water requirements.

7. The proposed DWWTs

The proposed system ensembles a combination of various modules that enable the treatment and local reuse of the sewage or the effluent from prevailing on-site sanitation system. The technology selected would showcase the following:

- Minimum energy requirement for wastewater treatment
- No use of chemicals
- Maintenance that would not need highly skilled labor
- Optimum treatment for the proposed reuse

A combination of processes like sedimentation, naturally occurring biological processes (anaerobic biodegradation, respiration, photosynthesis), chemical processes (sorption, precipitation, and nitrification-denitrification), natural aeration and natural UV exposure are generally deployed for wastewater treatment through the combination of units proposed. Few of the important processes that contribute to the treatment of wastewater in the proposed DWWTs combination are explained below:

1. Sedimentation – Suspended solids settle out of the fluid and come to rest against a barrier if certain retention time is allowed. This is due to their motion through the fluid in response to the forces acting on these solids (based on Stokes' law). These forces can be due to gravity, centrifugal acceleration, or electromagnetism.
2. Anaerobic Biodegradation – This process is completed in three steps. The first step is achieved by fermentative bacteria, also called hydrolytic and fermentative stage. This group of bacteria hydrolyzes complex biopolymers into simpler organic acids, alcohols, and CO_2. The second group of bacteria is called acetogenic bacteria that act upon long chain fatty acids, alcohols and produce acetic acids, CO_2 and H_2. In the third and final stage the, methanogen utilise hydrogen produced by the earlier groups and convert acetate and CO_2 into methane. Some species even act upon acetate and form methane. It can be outlined as follows:

   Hydrolytic stage ------> Acetogenic stage ------> Methanogenic stage
   Organic matters ------> Organic acids ---> Acetic acid ---> Methane + CO_2
   CO_2, alcohols ------> H_2, CO2
3. Chemical processes - The most important naturally occurring chemical removal processes are sorption, precipitation and volatization.

   - Sorption – It describes a group of processes, which includes adsorption and precipitation reactions. Adsorption refers to the attachment of ions to filter media. This results in short-term retention or long-term immobilization of several classes of contaminants.

- Precipitation and Volatization – These processes allow for separation either as precipitates or escape as volatile gases. Volatization generally occurs when pH is more than 8.5.

This section includes description, design specifications and drawing of each component of the DWWTs combination that is proposed for the model project at children's park in Bodhgaya. Figure 7 provides a quick schematic of proposed DWWTs.

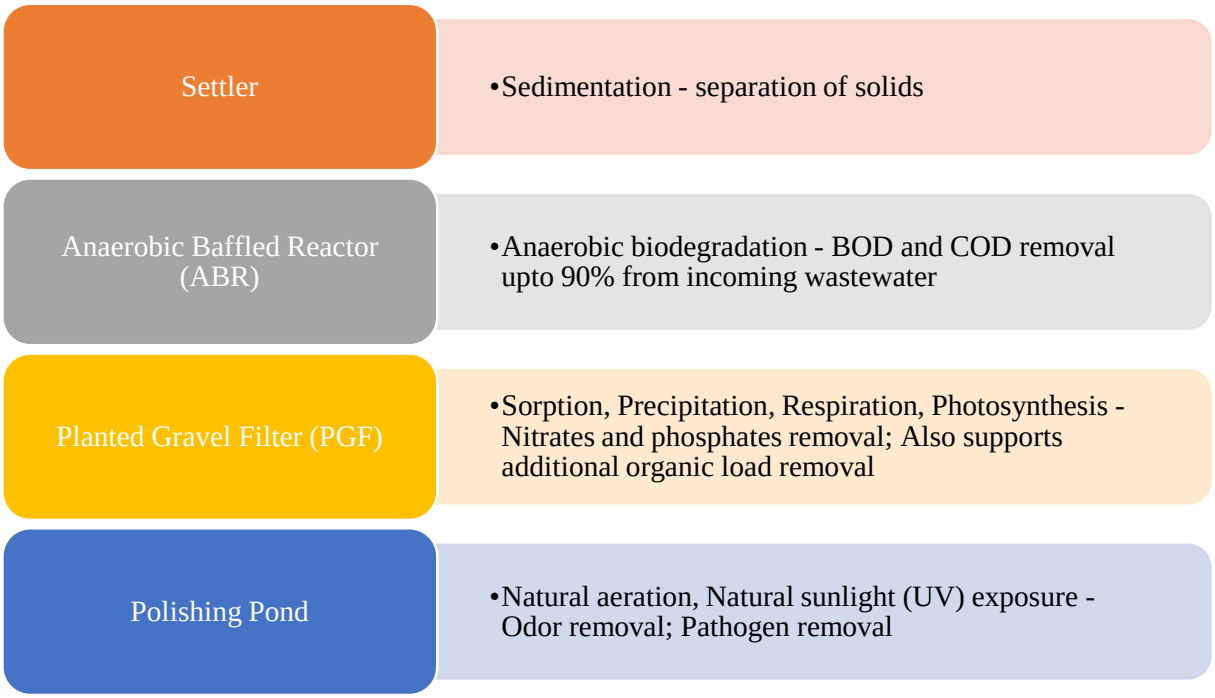


Figure 7: Summary of treatment process and DWWTs units

7.1. Settler

Suspended solid particles in the wastewater having specific gravity more than that of water settles down in this first chamber of DWWT system. Sufficient retention time ensures scum layer (lighter particles) separation on the top and the sludge layer formation at the bottom. Thus, relatively clearer water travels to the next unit i.e. Anaerobic Baffled Reactor (ABR). The settler at children's park will be two chambered. The first chamber is two third of the total length. This is an underground unit and has access covers on top of each chamber for maintenance purpose.

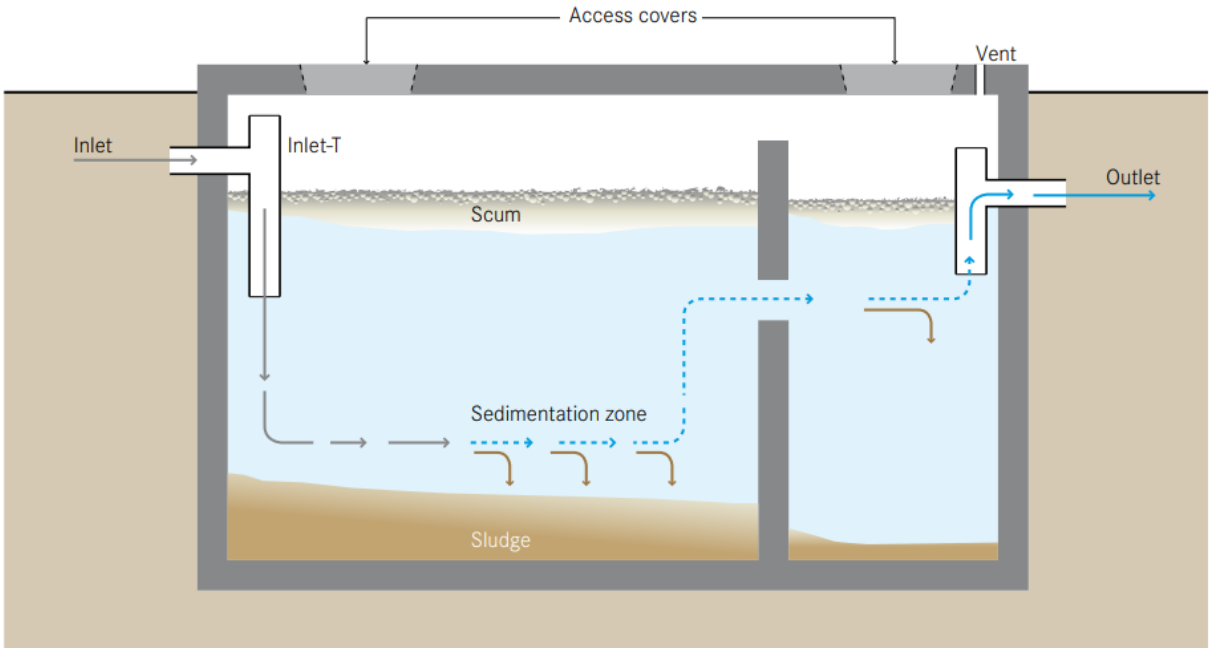


Figure 8: Conceptual section of a two chambered settler

Source: Compendium of Sanitation Technologies, 2nd Edition, Swiss Federal Institute of Aquatic Science and Technology (EAWAG), Switzerland

The settler is designed to retain waste water for three hours during peak flow time. This provides optimum retention time for the solids to settles down. Design specifications for the settler at Children's park are as given below:

- Two chambered settler with first chamber being of 2/3rd of the total length
- Length: Breadth ratio is maintained at 3:1
- Surface loading rate should not exceed 0.6 cum/sq.fm of wastewater peak hour flow

7.2. Anaerobic Baffled Reactor (ABR)

The ABR helps in degrading the organic fraction of dissolved solids in the wastewater and consequently reduces BOD and COD. The anaerobic filter chambers further helps in removing the retained sludge carried forward from the previous chambers. Considering the present waste water flow, six chambers are designed for ABR and the last two chambers are proposed to be filled with filter material. The recommended diameter of filter material (gravels) is 8-12 cm. ABR is placed after the settler and is also an underground module with manholes placed over it such that each chamber is accessible for cleaning. A gas vent is to be provided in the ABR for release of gases. The chambers are interconnected from the top for the free flow of the gases between chambers. The location for the vent can be decided during construction.

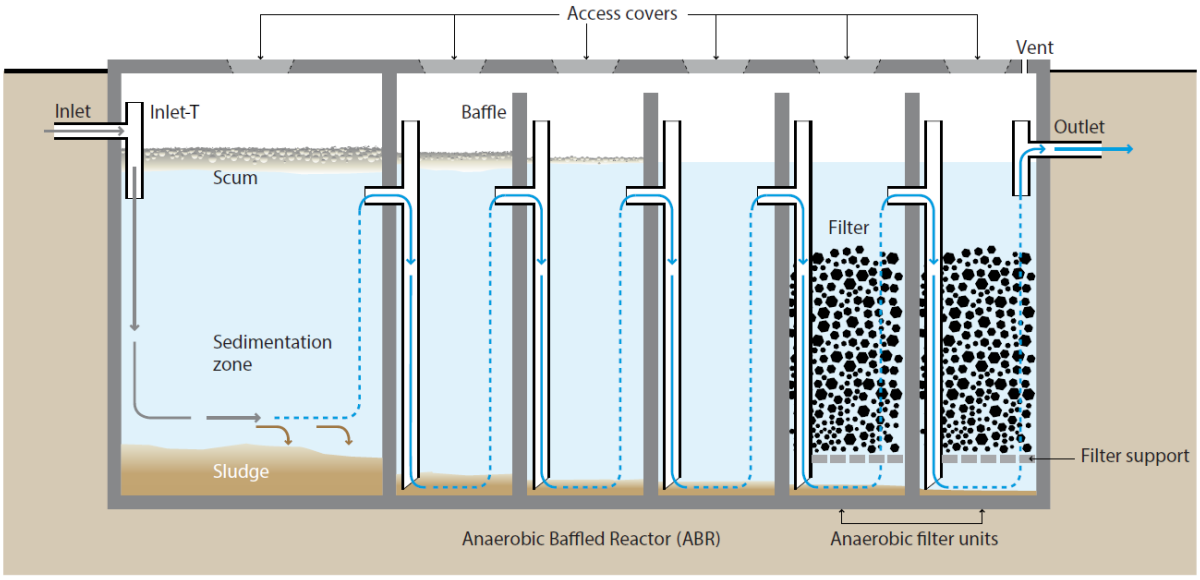


Figure 9: Conceptual section of an Anaerobic Baffled Reactor

Source: Compendium of Sanitation Technologies, 2nd Edition, Swiss Federal Institute of Aquatic Science and Technology (EAWAG), Switzerland

Design specifications for the designed ABR are as below:

- Upflow velocity to be maintained between 1.2 m/hr.
- Surface organic load is below 4 kg BOD/cu m per day
- The separation between the chambers can be given by a half brick wall. Each chamber should have a tee-bend pipe for the flow of water from one chamber to the other
- All chambers have space for gaseous movement and at-least one vent is to be provided for exhaust gasses.

7.3. Planted Gravel Filter (PGF) Bed

The main function of a horizontal PGF Bed is to remove excessive nitrates, ammonium and phosphates from the treated wastewater, provides aeration, and pathogen removal during by the filtration process. Horizontal sub-surface flow of wastewater through the root zones of wetland plants further aerates wastewater. Plantation of wetland plants in PGF should be done at some distance from the inlet and outlet points. At the same time, plantation needs to be done at equal distance within PGF for easy growth of roots. The inlet pipe should be placed in the middle of the filter bed wall (refer drawing), whereas the outlet gutter is placed at the bottom of the other end of PGF.

Design specifications:

- Filter Media - Bed is to be filled with 0.6m thick filter media (gravels/ screened rocks of size 2-5cm) that is locally available. Bigger crushed stones of size between 60-80mm to be kept at the bottom and at inlet and outlet for easy movement of treated waste water.
- Wetland plants - *Canna* and *Typha* are recommended. Local plant nursery can be contacted to supply these plants.
- The bottom slope of the PGF bed should maintained at 1% for maintaining gravity flow.

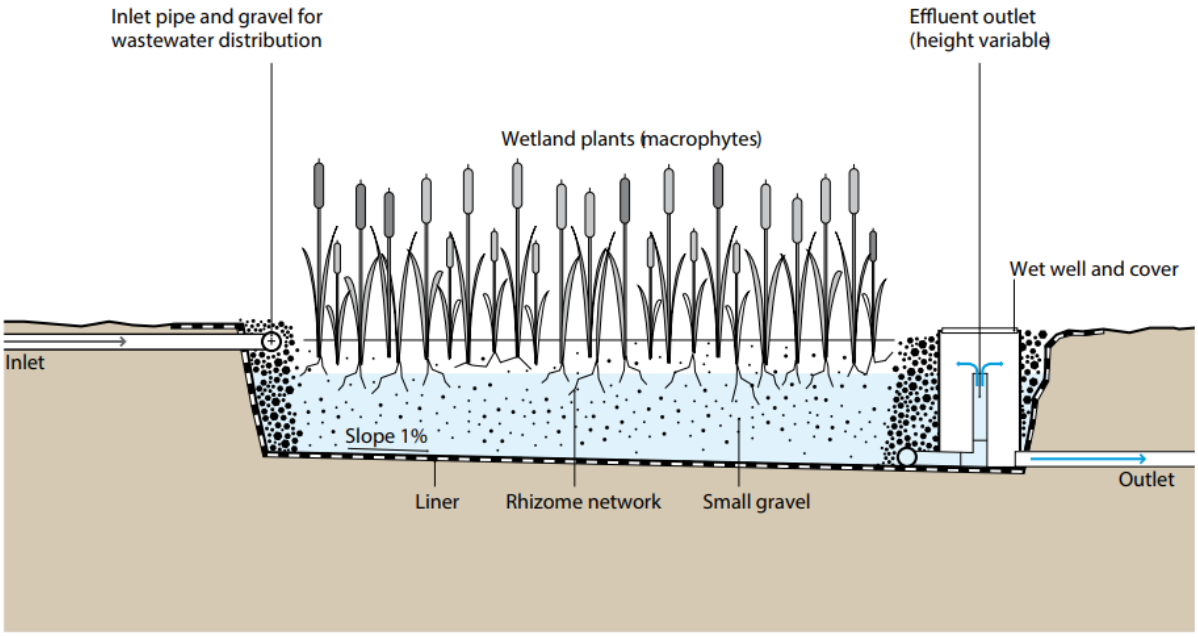


Figure 10: Section for a planted gravel filter bed

Source: Compendium of Sanitation Technologies, 2nd Edition, Swiss Federal Institute of Aquatic Science and Technology (EAWAG), Switzerland

7.4. Intercepting chamber and a storage tank

The intercepting chamber lies between PGF and the storage tank. It helps in maintaining optimum level of water flow inside the PGF bed. The level of the swivel pipe decides the water level inside the bed. Intercepting chamber also provides some aeration and access to collect sample of the treated waste water for quality analysis. The storage tank connected to this serves purpose of collection of treated waste water for end usage. The storage tank is designed to store water for 24 hours. Treated water should be used preferably on daily basis. In case the usage is not regular, the capacity of this storage tank needs to be increased as per the site conditions. Access cover, for ease of maintenance, is required for intercepting chamber and storage tank.

7.5. Polishing pond

The polishing pond is designed as an additional component which will receive water from the storage tank through a submersible pump. The pond provides for optimum surface area of treated waste water exposed to the atmosphere that enables gaseous exchange and exposure to natural sunlight. This supports in removal of both pathogen and odor.

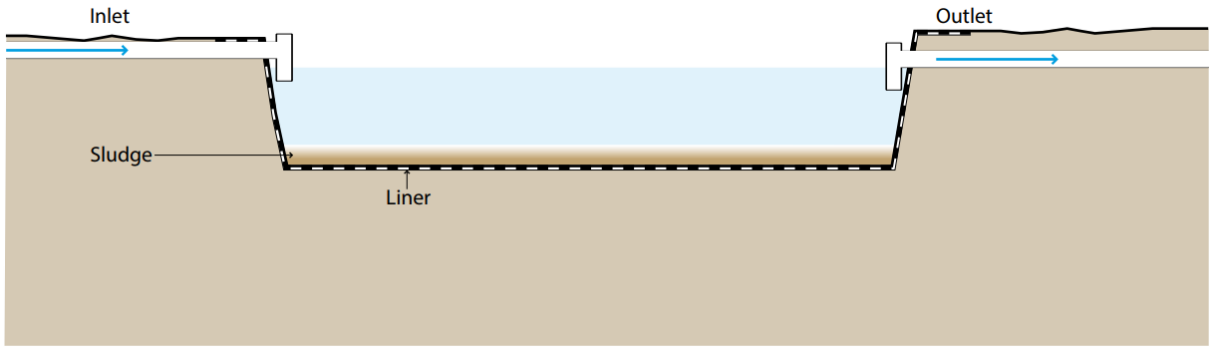


Figure 11: Conceptual section of a polishing pond

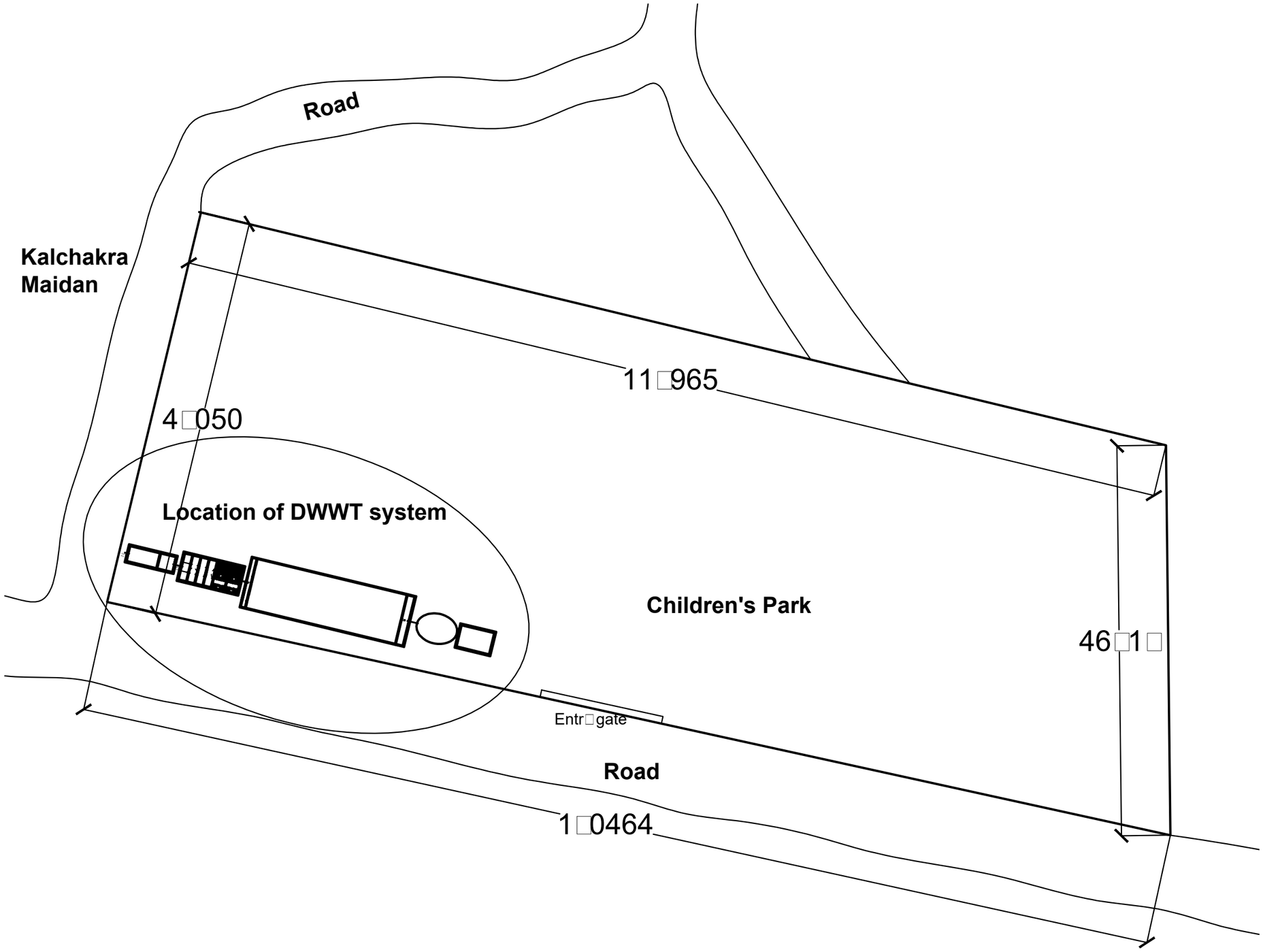
Source: Compendium of Sanitation Technologies, 2nd Edition, Swiss Federal Institute of Aquatic Science and Technology (EAWAG), Switzerland

Design specifications for the polishing pond are as below:

- Depth shouldn't be more than 1–1.5 m
- The outlet should have a valve which may be opened for flow into a fountain system.

8. Detailed drawings

Detail drawings of site plan and each of the units are attached with this document. Each of the drawing contains notes and recommendations which also includes recommendations regarding the materials to be used for construction.



PROJECT NAME:

MODEL PROJECT ON DWWT AND LOCAL REUSE, CHILDREN'S PARK, BODHGAYA

KEY MAP

N

NOTES:

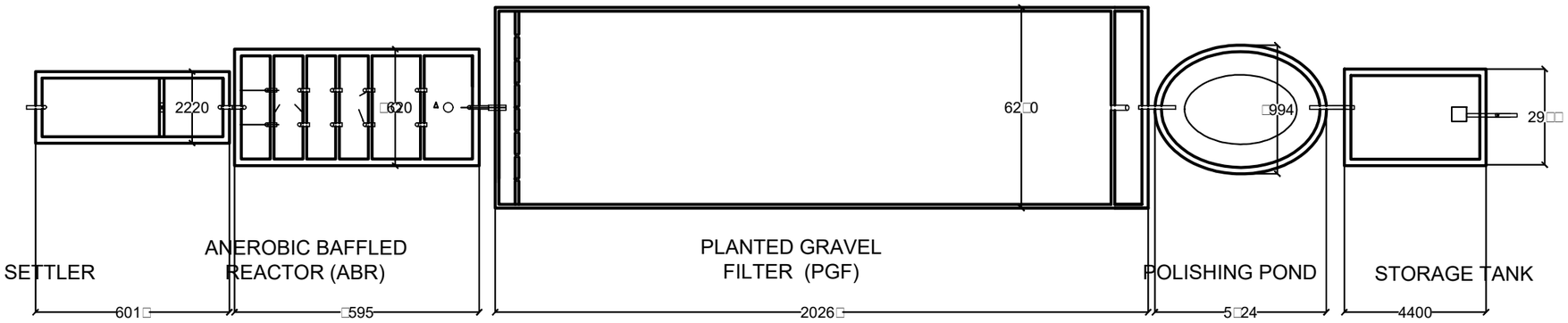
- THIS DRAWING SHOWS THE LOCATION OF PROPOSED DWWTs WITH REFERENCE TO CHILDREN'S PARK.
- ALL DIMENSIONS ARE IN MM, UNLESS MENTIONED OTHERWISE
- ALL INTERNAL DIMENSIONS SHOWN ARE CLEAR
- THIS DRAWING DOES NOT INDICATE ANY STRUCTURAL DETAILS.
- TOTAL CHILDREN'S PARK AREA: 5□24 s□□

TITLE:

SITE PLAN OF CHILDREN'S PARK

SHEET NO.	SCALE:	DATE:
1	1:500	JULY, 2018

CENTRE FOR SCIENCE AND ENVIRONMENT

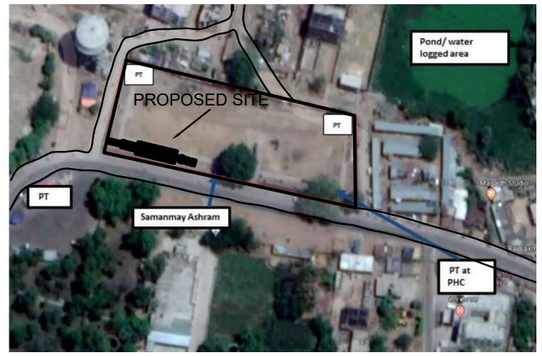


PLAN OF COMPLETE DWWT SYSTEM

SECTION OF COMPLETE DWWT SYSTEM

PROJECT NAME:

MODEL PROJECT ON DWWT AND LOCAL REUSE, CHILDREN'S PARK, BODHGAYA



SITE PLAN

N

NOTES:

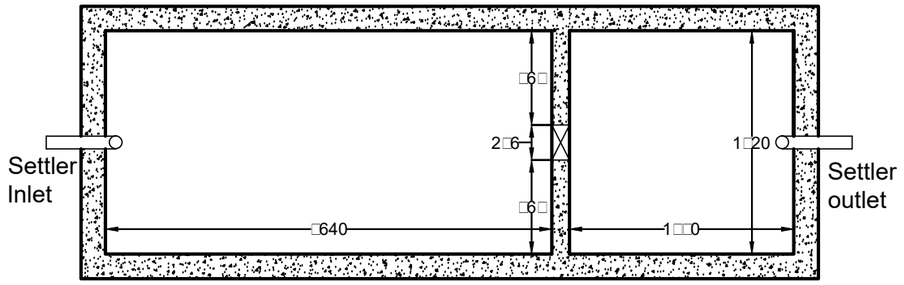
- ALL DIMENSIONS ARE IN MM, UNLESS MENTIONED OTHERWISE
- ALL INTERNAL DIMENSIONS SHOWN ARE CLEAR (E□CLUDING PLASTERING THICKNESS)
- THIS DRAWING DOES NOT INDICATE ANY STRUCTURAL DETAILS
-

TITLE:

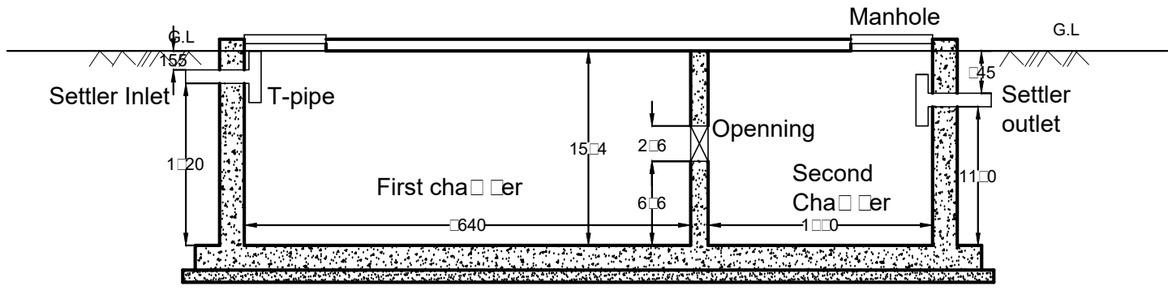
OVERVIEW OF COMPLETE DWWT SYSTEM

SHEET NO.	SCALE:	DATE:
2	1:170	JULY, 2018

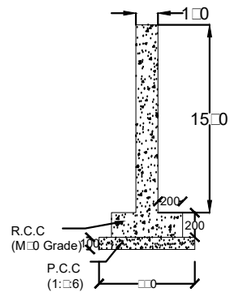
CENTRE FOR SCIENCE AND ENVIRONMENT



Settler Plan



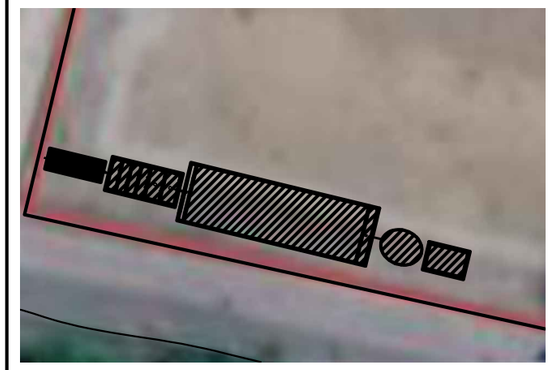
Settler Section



Section of footing

PROJECT NAME:

MODEL PROJECT ON DWWT AND LOCAL REUSE, CHILDREN'S PARK, BODHGAYA



N

SITE PLAN

NOTES:

- ALL DIMENSIONS ARE IN MM, UNLESS MENTIONED
- ALL INTERNAL DIMENSIONS SHOWN ARE CLEAR
- THIS DRAWING DOES NOT INDICATE ANY STRUCTURAL DETAILS
- THIS IS THE PROPERTY OF CSE AND SHOULD NOT BE COPIED OR PRODUCED ANYWHERE WITHOUT CSE'S PERMISSION

RECOMMENDATIONS:

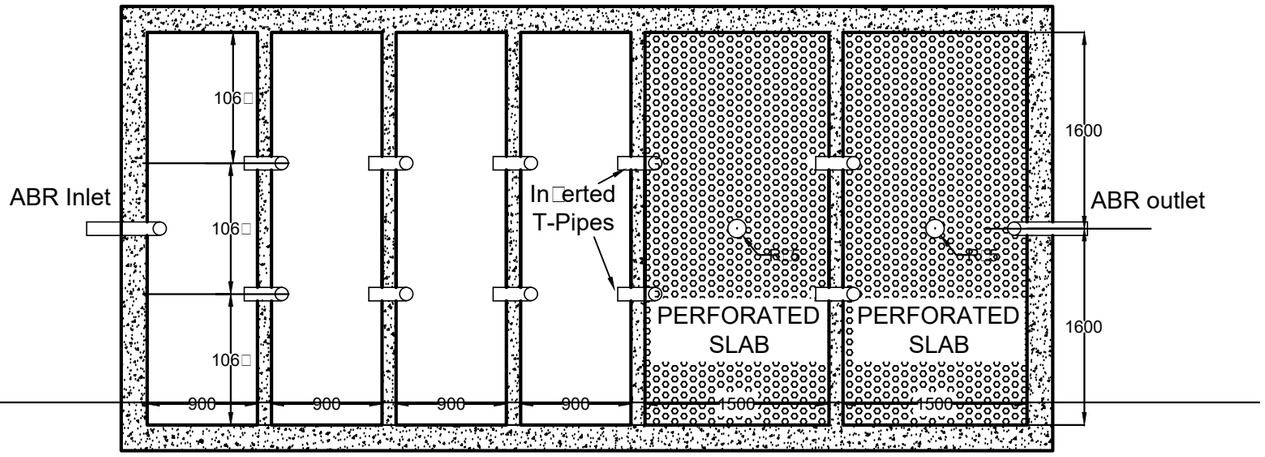
- WATERPROOFING OF ALL THE WALLS TO BE DONE
- ONE GAS VENT PIPE TO BE INSTALLED FOR SETTLER
- THE INLET PIPE FROM POINT OF GENERATION TO BE INSTALLED BY THE IMPLEMENTER
- MINIMUM DIAMETER OF PVC PIPES TO BE 110 MM
- MANHOLE: 50 MM THICK, THE LOCATION AND DIMENSIONS TO BE DECIDED ON SITE BY THE IMPLEMENTER AS PER IS: 4111
- PLASTERING OF 12MM THICKNESS TO BE PROVIDED FOR ALL BRICK MASONRY ON BOTH SIDES OF THE WALL WITH SPECIFIED WATER PROOFING AGENTS ADDED
- USE UPVC PIPES (100 MM-150 MM DIAMETER) WHICH CAN WITHSTAND PRESSURE UPTO 4 KG □CM2
- GRADE OF CONCRETE PROPOSED (M10 AND M□0) FOR ALL RCC ELEMENTS. IT IS RECOMMENDED TO USE SULPHATE RESISTANT CEMENT (SRC)

TITLE:

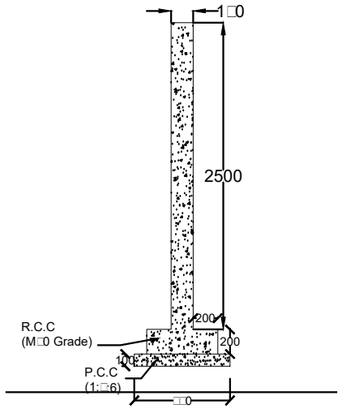
SETTLER

SHEET NO.	SCALE:	DATE:
3	**1:50**	**JULY, 2018**

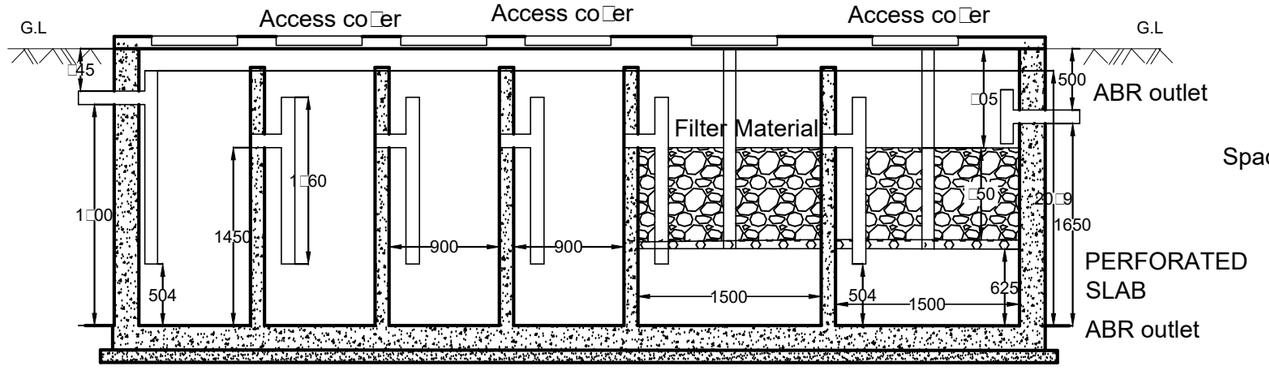
CENTRE FOR SCIENCE AND ENVIRONMENT

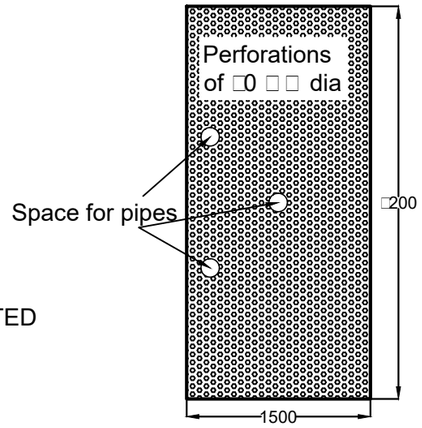


ABR Plan



Section of footing

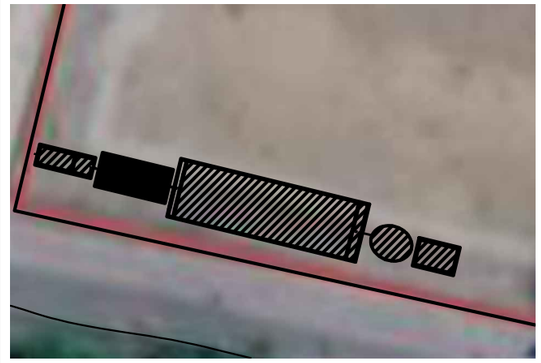




Plan for prefa□ricated sla□

PROJECT NAME:

MODEL PROJECT ON DWWT AND LOCAL REUSE, CHILDREN'S PARK, BODHGAYA



N

SITE PLAN

NOTES:

- ALL DIMENSIONS ARE IN MM, UNLESS MENTIONED
- ALL INTERNAL DIMENSIONS SHOWN ARE CLEAR
- THIS DRAWING DOES NOT INDICATE ANY STRUCTURAL DETAILS
- ABR: ANAEROBIC BAFFLED REACTOR
-

RECOMMENDATIONS:

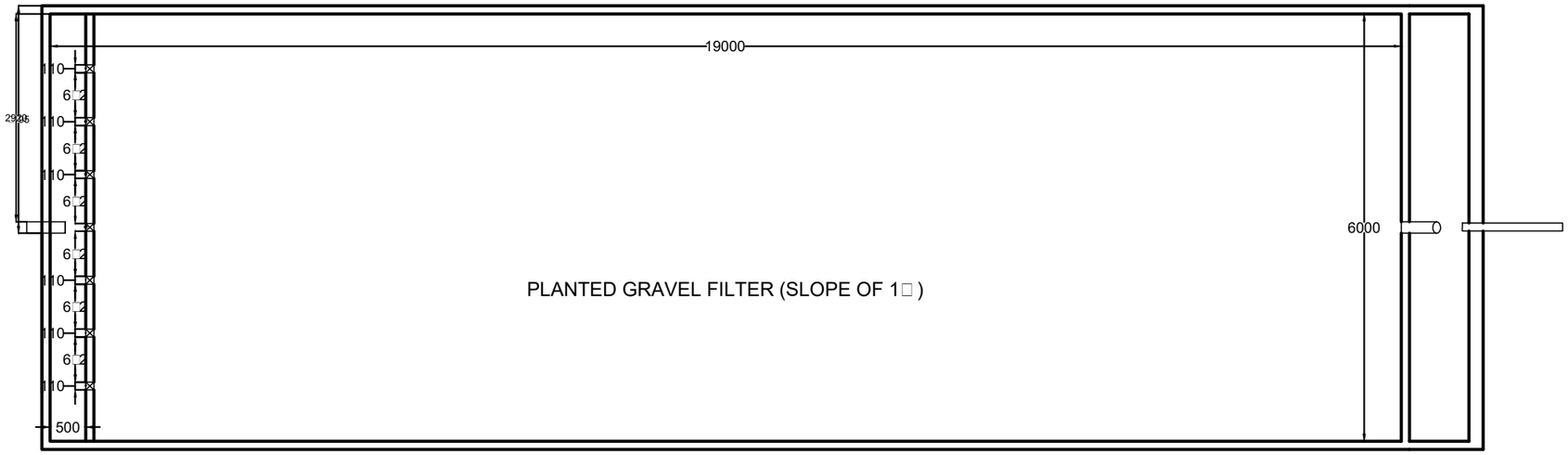
- WATERPROOFING OF ALL THE WALLS TO BE DONE
- ONE GAS VENT PIPE TO BE INSTALLED FOR ABR, THE LOCATION OF THE SAME TO BE DECIDED ON SITE BY THE IMPLEMENTER
- FILTER MATERIAL: BOULDERS 40- 60 MM
- MANHOLE: 50 MM THICK, THE LOCATION AND DIMENSIONS TO BE DECIDED ON SITE BY THE IMPLEMENTER AS PER IS: 4111
- PLACING OF PREFABRICATED SLAB TO BE DONE OVER A PROTRUDING DOWEL BAR
- PLASTERING OF 12MM THICKNESS TO BE PROVIDED FOR ALL BRICK MASONRY ON BOTH SIDES OF THE WALL WITH SPECIFIED WATER PROOFING AGENTS ADDED
- USE UPVC PIPES (100 MM-150 MM DIAMETER) WHICH CAN WITHSTAND PRESSURE UPTO 4 KG □CM2
- GRADE OF CONCRETE PROPOSED (M10 AND M□0) FOR ALL RCC ELEMENTS. IT IS RECOMMENDED TO USE SULPHATE RESISTANT CEMENT (SRC)

TITLE:

ANAEROBIC BAFFLED REACTOR

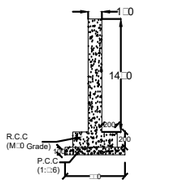
SHEET NO.	SCALE:	DATE:
4	**1:50**	**JULY, 2018**

CENTRE FOR SCIENCE AND ENVIRONMENT



PLAN

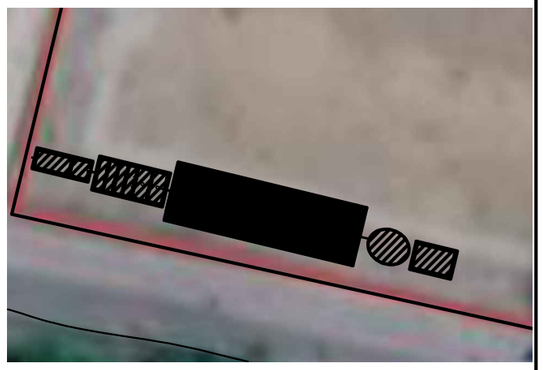
SECTION



Section of footing

PROJECT NAME:

MODEL PROJECT ON DWWT AND LOCAL REUSE, CHILDREN'S PARK, BODHGAYA



N

SITE PLAN

NOTES:

- ALL DIMENSIONS ARE IN MM, UNLESS MENTIONED
- ALL INTERNAL DIMENSIONS SHOWN ARE CLEAR
- THIS DRAWING DOES NOT INDICATE ANY STRUCTURAL DETAILS
- PGF: PLANTED GRAVEL FILTER
- SLOPE OF 1□ TO BE GIVEN TO THE BASE OF THE PGF BED FROM INLET TO THE OUTLET
-

RECOMMENDATIONS:

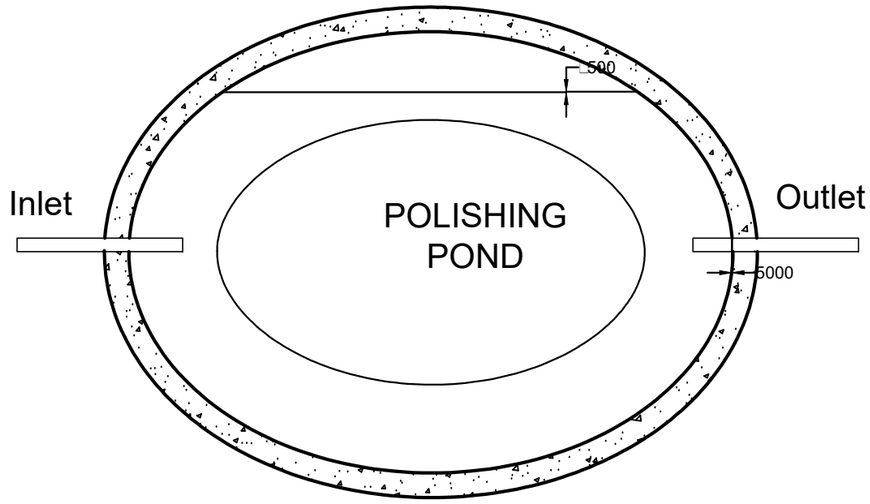
- PLANTS: TYPHA, CANNA OR PAPYRUS
- MINIMUM DISTANCE BETWEEN TWO PLANTS:150 - 200 MM
- MINIMUM WIDTH OF INTERNAL WALLS TO BE 115 MM, WHEREAS FOR E□TERNAL WALLS IT SHOULD BE 2□0 MM IF BRICK WALL, 150 -200 MM IF RCC WALL
- MANHOLES TO BE PLACED OVER INLET AND OUTLET CHAMBER OF THE PGF
- THE MANHOLE SI□E OVER THE INLET CHAMBER IS 450 □450 FOR THE INLET CHAMBER
- PLASTERING OF 12MM THICKNESS TO BE PROVIDED FOR ALL BRICK MASONRY ON BOTH SIDES OF THE WALL WITH SPECIFIED WATER PROOFING AGENTS ADDED
- USE UPVC PIPES (100 MM-150 MM DIAMETER) WHICH CAN WITHSTAND PRESSURE UPTO 4 KG □CM2
- GRADE OF CONCRETE PROPOSED (M10 AND M□0) FOR ALL RCC ELEMENTS. IT IS RECOMMENDED TO USE SULPHATE RESISTANT CEMENT (SRC)

TITLE:

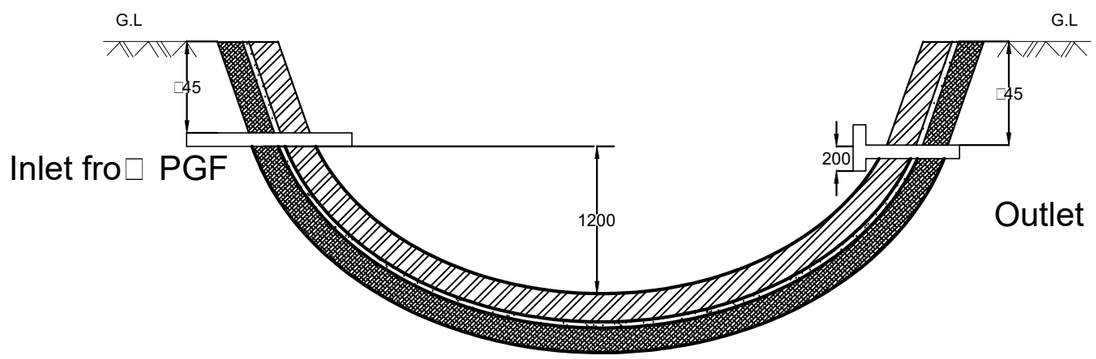
PLANTED GRAVEL FILTER BED

SHEET NO.	SCALE:	DATE:
5	1:80	JULY, 2018

CENTRE FOR SCIENCE AND ENVIRONMENT



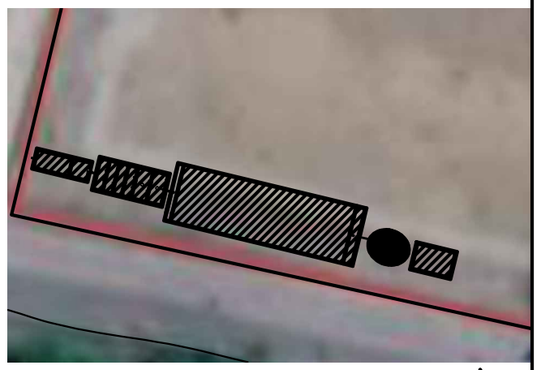
PLAN



POLISHING POND SECTION

PROJECT NAME:

MODEL PROJECT ON DWWT AND LOCAL REUSE, CHILDREN'S PARK, BODHGAYA



N

SITE PLAN

NOTES:

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- THIS DRAWING DOES NOT INDICATE ANY STRUCTURAL DETAILS
- THIS IS THE PROPERTY OF CSE AND SHOULD NOT BE COPIED OR PRODUCED ANYWHERE WITHOUT CSE'S PERMISSION

RECOMMENDATIONS:

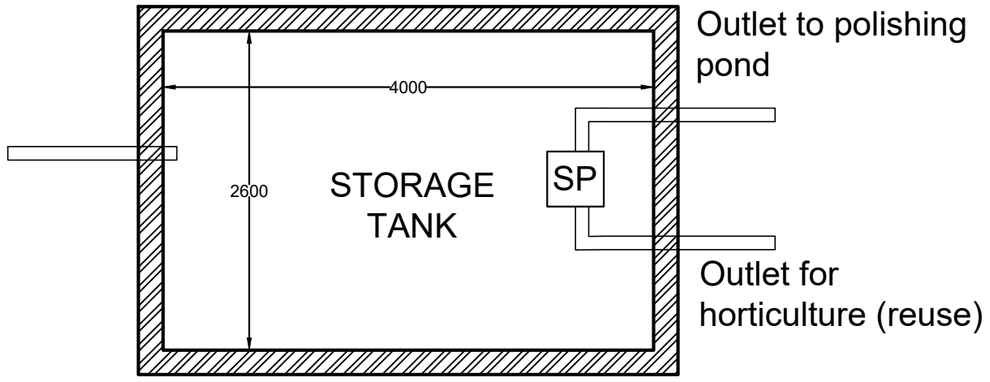
- MINIMUM DIAMETER OF PVC PIPES TO BE 110 MM
- POLISHING POND: FULLY LINED AND WATER PROOF
- WATER PROOFING - HDPE LINING OR TO BE DONE USING (I)CEMENT SLURRY MI□ED WITH WATER PROOFING COMPOUND (IS 2645) (II) 20 MM CEMENT PLASTER 1:□(1 CEMENT:□COARSE SAND)MI□ED WITH WATER PROOFING COMPOUND IN RECOMMENDED PROPORTION IN SECOND COURSE (III) 400 MICRON THICK PVC SHEET□HDPE
- BRICK WORK OVER WATER PROOFING
- USE UPVC PIPES (100 MM-150 MM DIAMETER) WHICH CAN WITHSTAND PRESSURE UPTO 4 KG □CM2

TITLE:

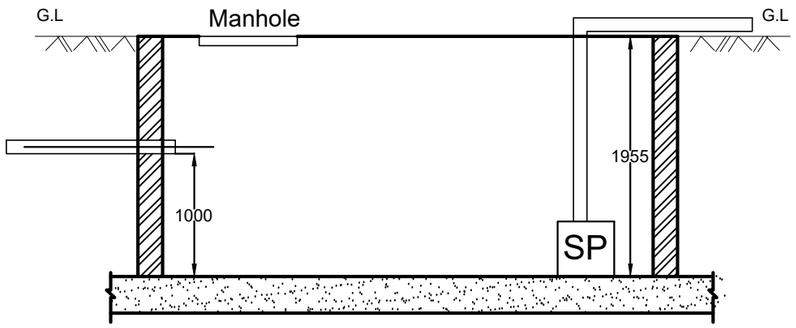
POLISHING POND

SHEET NO.	SCALE:	DATE:
6	**1:50**	**JULY, 2018**

CENTRE FOR SCIENCE AND ENVIRONMENT



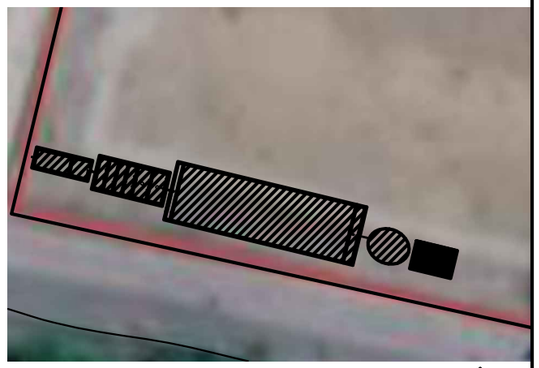
PLAN



STORAGE TANK SECTION

PROJECT NAME:

MODEL PROJECT ON DWWT AND LOCAL REUSE, CHILDREN'S PARK, BODHGAYA



N

SITE PLAN

NOTES:

- ALL DIMENSIONS ARE IN MM, UNLESS MENTIONED
- ALL INTERNAL DIMENSIONS SHOWN ARE CLEAR
- THIS DRAWING DOES NOT INDICATE ANY STRUCTURAL DETAILS

RECOMMENDATIONS:

- STORAGE TANK OF RCC IS PREFFERED
- MINIMUM DIAMETER OF PVC PIPES TO BE 110 MM
- MANHOLE: 50 MM THICK
- BEADING TO BE PROVIDED AT THE EDGES OF THE BASE OF POLISHING POND
- SUBMERSIBLE PUMP (SP) TO BE USED FOR CONVEYING WATER FROM STORAGE TANK TO POLISHING POND
- ENGLISH BOND BRICKWORK
- SUBMERSIBLE PUMP TO BE USED AS PER REUSE REQUIREMENTS - DETAILS NOT INCLUDED IN THE DPR
- CERAMIC TILES USED ON INSIDE SURFACE
-

TITLE:

STORAGE TANK

SHEET NO.	SCALE:	DATE:
7	**1:50**	**JULY, 2018**

CENTRE FOR SCIENCE AND ENVIRONMENT

9. Commissioning, operations and maintenance

The wastewater should be allowed to enter the system only after water leak tests, alignment test for pipings and plumbing. Initially, inoculum (sludge from an existing septic tank or fresh cow dung slurry) is to be added to the baffled reactor. Once operational, the system requires regular maintenance activities. This section contains suggestions and instructions for O&M of the DWWTs.

Table 8: Important O&M requirements

Settler	After two years of operation, enough sludge will be accumulated at bottom of first chamber of the settler that needs to be emptied (desludged) to maintain the efficiency of the settler. This can be done with the help of a vacuum pump.
Anaerobic Baffled Reactor	ABR needs commissioning by adding activated sludge (laden with bacteria) from STP or even cow dung slurry mixed in water can also be used to start decomposition of solids entering in ABR. ABR needs cleaning after 5-8 years. Complete removal of sludge during desludging is not recommended as it will again require commissioning of ABR to start decomposition process.
Planted Gravel Filter Bed	Plantation in the PGF bed is important and initially dense plantation is recommended. The dead leaves and plants need to be removed while maintaining PGF. Periodical harvesting is required to maintain the efficiency of the treatment system. For initial one to three months, the treated waste water needs to be monitored to observe the performance of the system.
Storage Tank and Reuse	The storage tank shouldn't keep stagnated treated waste water for long periods. It is suggested that the treated waste water from storage tank is reused on daily basis and the tanks are cleaned every quarter.

9.1. Do's and Don'ts for maintenance of DWWTs

DWWTs needs low maintenance cost in comparison to conventional treatment technologies as it doesn't require professionally skilled man-power nor does it require electricity for the treatment process. However, there are a few precautions to be taken during operations and maintenance that will ensure sustained operations. Table 9 summarises same.

Table 9: Do's and Don'ts for O&M of the DWWTs

	Do's	Don'ts
During commissioning	• Do frequent quality analysis of inlet and outlet wastewater. Once the system is up and running, wastewater quality testing should be done quarterly for the first year and then bi-annually. • Use personal protective equipment for personal safety while collecting samples for testing. • Standard operating procedures are to be used for collection and analysis of the collected samples.	• Don't let the wastewater enter the system without performing leakage test, level confirmation test, alignment test and flow test of the constructed system.
During O&M and monitoring (For information board – key information for anyone who comes in contact with the system as well as general public).	• Only domestic waste should enter the system. Chemicals, emulsions, paints & dyes should be avoided. • Use personal protective measures when reusing the treated water - wash hands post direct contact • The treated wastewater should be used for horticultural purpose only. • Do provide your feedback to the contact person mentioned on the information board if any positive or ill-effects of the wastewater treatment system, if observed.	• Do not throw litter on or around the system. • Non-biodegradable substances such as plastics, glass, metals, polythene, chemicals and large wood debris should not be allowed to enter inside the systems. These may choke pipes, pump or hinder the treatment process. • No flammable objects or activities should not be carried out near the vents. • Do not use the treated wastewater for portable purposes (e.g. drinking through sprinklers or taps around the green areas).

9.2. Operations and maintenance

Operation and maintenance activities mainly constitute of trimming of the plants of the planted filter bed, maintaining cleanliness of landscape around the system, and desludging of settler and anaerobic tank once in two-three years. Associated costs are estimated (Refer annexure 5: O&M and life cycle costing-DWWTs). Cost of operation and maintenance have been tabulated. The annual Operation and Maintenance cost [O and M] on an average is about ₹207, 600annually. This cost includes labor cost, energy cost for the electric pumps for re-use. In addition, information education and communication (IEC) activities are proposed such that it enables sensitization of all stakeholders involved and supports sustainability of the project. The recommendations for IEC activities in detail are provided in Annexure 7: Information, communication and education (IEC).

Initially, a close monitoring is required to set protocols for maintenance. For the same, maintenance of a log of activities is suggested. The checklist must be maintained for monitoring O&M activities and its documentation (See Table 10).

Table 10: Sample checklist for monitoring O&M activities

Activity	System component	Procedure	Frequency
Physical examination	1. Inlet chamber 2. PGF 3. Storage/Collection chamber for treated water	Visually observing the smooth flow of water. Report if any clogging or accumulation over the planted filter bed is observed.	Once a week
	Point of reuse	Visually observing the quality of the treated water. Report in case of noticeable/visible color, turbidity and odor variations.	Alternate day
Laboratory Analysis	1. Inlet chamber to settler 2. Inlet chamber to ABR 3. Inlet to PGF 4. Storage/Collection for treated water	Sample quality testing with all parameters – pH, TSS, TDS, BOD, COD, TKN, Total Phosphates, Faecal Coliform	On regular basis – Once in 3 months
Desludging	Settler and first two chambers of ABR	Removal of the settled sludge from settler and ABR. Note: The ABR should not be completely emptied	Every 3 years

Overall operation, maintenance and monitoring for the DWWTs doesn't demand skilled engineers at the site. However, semi-skilled or non-skilled personnel may be appointed and monitored through maintenance logs (See annexure 6: Sample format for maintenance log).

10.Estimated project cost

Detail Drawings and Bill of Quantity of a 10 KLD DWWTs are annexed (Annexure 4). Estimates based on Schedule of Rate of Bihar Government have been calculated. It comes to Rs 15, 34,200/-

Table 11: Summary of estimated cost of Implementation

S. No.	Description	No.	Amount (in INR)*
1	Site Preparation	Lump sum	25000
2	Settler	1	165000
3	Anaerobic Baffled Reactor (ABR)	1	384700
4	Planted Gravel Filter Bed	1	788300
5	Polishing Pond	1	29100
6	Storage Tank	1	69000
		Total	1461100
	Centage @4%		58444
	Contingencies @1%		14611
		Total Cost	**1534155**
		Round off figure	**1534200**

**Estimates are exclusive of all taxes*

The costs of the following items are not included and will cost extra.

i. Conveyance system from point of wastewater generation to DWWTs
ii. Landscaping including fencing/ hedging to avoid easy access of children into the facility
iii. Reuse mechanism/ Irrigation network

11.Time Line

Proposed timeline for the project implementation is as given below:

Phase I – DPR preparation and submission by July, 2018

Phase III – Tendering, appointment of construction & plumbing contractor and procurement of funds (Within 2 months)

Phase III – Construction and implementation (Within 6 months of the appointment of contractor)

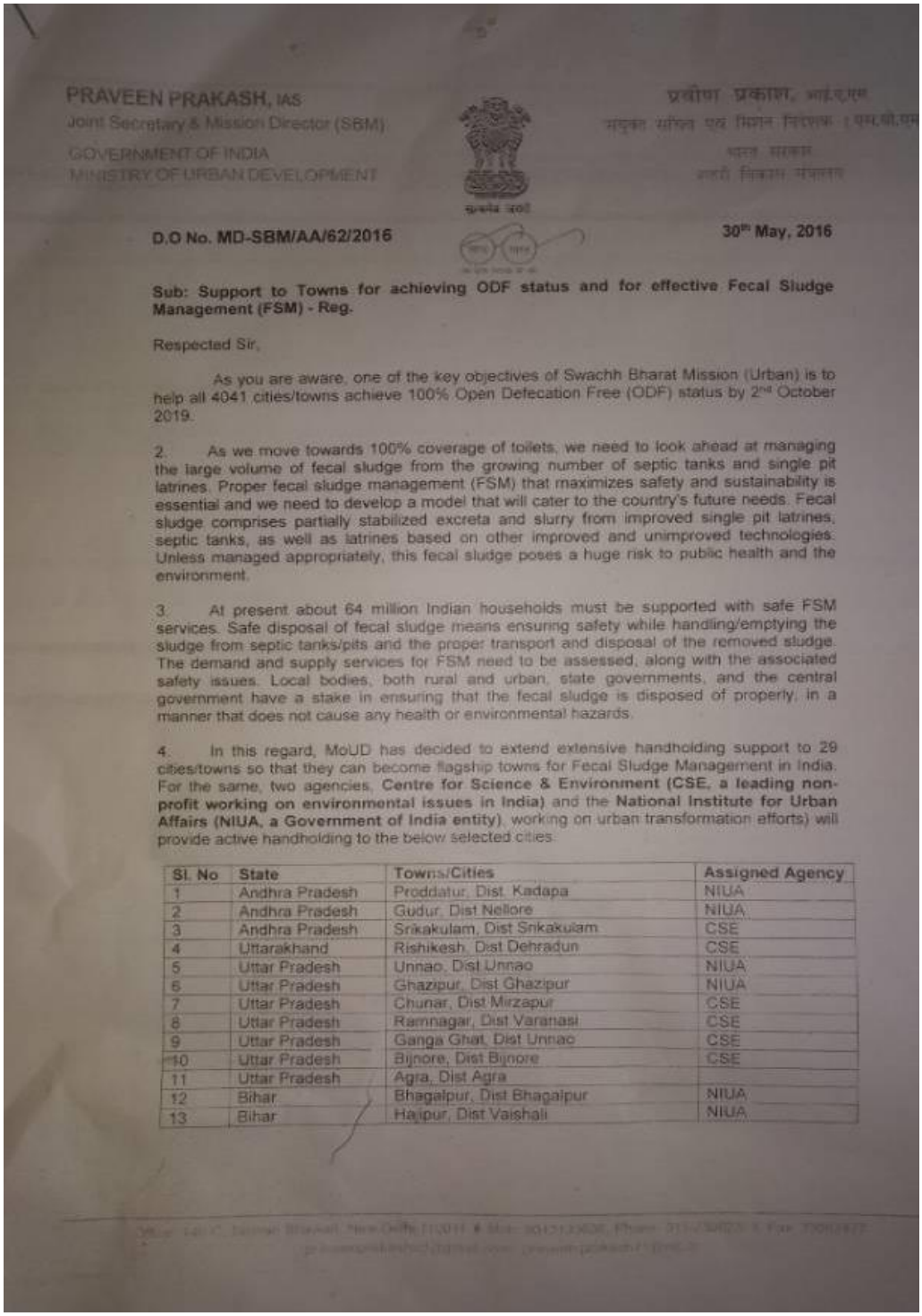
Phase IV – O&M and Monitoring (3 – 5 years from the date of completion)

Table 12: Timeline for implementation of model project

Activity	2018						2019														
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
DPR Submission																					
Tendering and appointment of construction & plumbing contractor																					
Excavation																					
Civil Work																					
Piping/ Plumbing																					
Post construction activities and start-up																					
Commissioning and stabilization																					
Landscaping																					
Sample Testing																					
O&M and monitoring												(Continuous process)…									

12. Annexure

Annexure 1: D.O. MD-SBM/AA/62/2016 dated 30th May 2016 (page ½)



PRAVEEN PRAKASH, IAS
Joint Secretary & Mission Director (SBM)
GOVERNMENT OF INDIA
MINISTRY OF URBAN DEVELOPMENT

D.O No. MD-SBM/AA/62/2016

30th May, 2016

Sub: Support to Towns for achieving ODF status and for effective Fecal Sludge Management (FSM) - Reg.

Respected Sir,

As you are aware, one of the key objectives of Swachh Bharat Mission (Urban) is to help all 4041 cities/towns achieve 100% Open Defecation Free (ODF) status by 2nd October 2019.

2. As we move towards 100% coverage of toilets, we need to look ahead at managing the large volume of fecal sludge from the growing number of septic tanks and single pit latrines. Proper fecal sludge management (FSM) that maximizes safety and sustainability is essential and we need to develop a model that will cater to the country's future needs. Fecal sludge comprises partially stabilized excreta and slurry from improved single pit latrines, septic tanks, as well as latrines based on other improved and unimproved technologies. Unless managed appropriately, this fecal sludge poses a huge risk to public health and the environment.

3. At present about 64 million Indian households must be supported with safe FSM services. Safe disposal of fecal sludge means ensuring safety while handling/emptying the sludge from septic tanks/pits and the proper transport and disposal of the removed sludge. The demand and supply services for FSM need to be assessed, along with the associated safety issues. Local bodies, both rural and urban, state governments, and the central government have a stake in ensuring that the fecal sludge is disposed of properly, in a manner that does not cause any health or environmental hazards.

4. In this regard, MoUD has decided to extend extensive handholding support to 29 cities/towns so that they can become flagship towns for Fecal Sludge Management in India. For the same, two agencies, **Centre for Science & Environment (CSE, a leading non-profit working on environmental issues in India)** and the **National Institute for Urban Affairs (NIUA, a Government of India entity)**, working on urban transformation efforts) will provide active handholding to the below selected cities.

Sl. No	State	Towns/Cities	Assigned Agency
1	Andhra Pradesh	Proddatur, Dist. Kadapa	NIUA
2	Andhra Pradesh	Gudur, Dist Nellore	NIUA
3	Andhra Pradesh	Srikakulam, Dist Srikakulam	CSE
4	Uttarakhand	Rishikesh, Dist Dehradun	CSE
5	Uttar Pradesh	Unnao, Dist Unnao	NIUA
6	Uttar Pradesh	Ghazipur, Dist Ghazipur	NIUA
7	Uttar Pradesh	Chunar, Dist Mirzapur	CSE
8	Uttar Pradesh	Ramnagar, Dist Varanasi	CSE
9	Uttar Pradesh	Ganga Ghat, Dist Unnao	CSE
10	Uttar Pradesh	Bijnore, Dist Bijnore	CSE
11	Uttar Pradesh	Agra, Dist Agra	
12	Bihar	Bhagalpur, Dist Bhagalpur	NIUA
13	Bihar	Hajipur, Dist Vaishali	NIUA

Annexure 1: D.O. MD-SBM/AA/62/2016 dated 30th May 2016 (page 2/2)

Sl. No	State	Towns/Cities	Assigned Agency
14	Bihar	Muzaffarpur, Dist Muzaffarpur	CSE
15	Bihar	Katihar, Dist Katihar	CSE
16	Bihar	Buxar, Dist Buxar	CSE
17	Bihar	Bodh Gaya, Dist Gaya	CSE
18	West Bengal	Bansberia, Dist Hugli	CSE
19	West Bengal	Bongaon, Dist North 24 Parganas	CSE
20	West Bengal	Darjeeling, Dist Darjeeling	CSE
21	Tamil Nadu	Tiruchirapalli	CSE
22	Madhya Pradesh	Gwalior	CSE
23	Madhya Pradesh	Dewas	CSE
24	Mizoram	Aizawl	CSE
25	Rajasthan	Bikaner	CSE
26	Odisha	Cuttack	CSE
27	Karnataka	Tumkur	CSE
28	Delhi	Delhi	CSE
29	Maharashtra	Solapur	CSE

The key contact person for the respective agencies are:

a) **Centre for Science and Environment (CSE)**
Shri Suresh Rohilla
Programme Director, Water Management
Email: srohilla@cseindia.org
Mobile: 9910317904

b) **National Institute of Urban Affairs (NIUA)**
Ms Paramita Datta Dey
Senior Research Officer
Phone: +91-11-24617517, 24643284 (ext: 207)
Email: pdey@niua.org

5. The scope of work of CSE and NIUA would be to help the towns/cities in capacity building for FSM apart form support to identify the technology and need for FSM in their area, support in selection of consultant for preparation of DPR, and Transaction Advisory Support for selection of private partner to operate the FSM facility. They may also support the city in other FSM related aspects such as behaviour change, regulatory changes etc.

6. I request you to kindly issue instructions to the concerned officers/ municipal commissioners to get in touch with CSE/NIUA at the earliest, and to work closely with them in order to fully leverage their significant expertise in this area. They may reach out to me in case any clarifications are required.

In anticipation of your kind support.

With regards,

Yours sincerely,

(Praveen Prakash)

To,

Chief Secretaries of concerned states

Annexure 2: Request letter from BNP for a pilot DWWTs

कार्यालय नगर पंचायतबोधगया ,

दूरभाष नं.-0631-2200719, फैक्स नं०-0631-2200719, ई-मेल:-bodhgayamunicipal@gmail.com, website:-www.bodhgaya.biharurban.in

Letter No. 1198 Dated 01-12-17

To,

Dr. Suresh Kumar Rohilla
Program Director
Water Programme
Center for Science & Environment, New Delhi

Subject:- Request for Technical support for pilot project proposal on DWWTS and FSTP.

Dear Sir,

This is for the request for technical support to Bodhgaya Nagar Panchayat on preparing a proposal on Pilot Project on DWWTs and FSTP Reqarding this, the resolution has already been passed in third CSTF meeting. Bodhgaya Nagar Panchayat will be bearing whole cost by own financial resources. We request you to please provide the technical support for proposal on DWWTs and FSTP. The preliminary Survey has been done by CSE team on DWWTs in October2017. We are trying to implement a model pilot project in DWWTs and FSTP in this financial year. This will also help us to increase ranking in swachhatta survey 2018 as well as help us to achieve the goal of ODF++.

Bodhgaya Nagar Panchayat would like to thank you for selecting the Bodhgaya Nagar Panchayat for preparing a model CSP. We assure to CSE water team for required support from Bodhgaya Nagar Panchayat

Thanks & Regards

Executive Officer 01/12/17
Nagar Panchayat Bodhgaya

Annexure 3: Minutes of the Meeting with EO, BNP dated January 3, 2018

नगर पंचायत बोधगया के कार्यालय कक्ष में दिनांकः–3.1.2018 एवं दिनांकः–9.1.2018 को Centrer for Science & Environment के Water Programme, एवं नगर पंचायत बोधगया की बैठक की कार्यवाहीः–

- प्रथम बैठकः– दिनांक–3.1.2018 का विवरणः

दिनांक–3.1.2018 को Centre for Science & Environment, Water Programme के Programme Director, डा0 सुरेश कुमार रोहिल्ला, साथ–साथ उनकी टीम एवं नगर पंचायत बोधगया के कार्यपालक पदाधिकारी, श्री सुशील कुमार City Manager के बीच बैठक की गयी। जिसके मुख्य बिन्दुः–CSE Water Programme के द्वारा दिये जा रहे तकनीक सहयोग जिसमें:–

- Model CSP, बोधगया का निर्माण।
- Pilot Project, DWWTS के स्थल चयन एवं Proposal में मदद।
- भविष्य में FSM के ऊपर वृहत रूप से कार्य हेतु बोधगया नगर पंचायत में तकनीक सहयोग यूनिट (TCU)की स्थापना।

1. डा0 सुरेश कुमार रोहिल्ला, Programme Director, CSE ने, CSE की टीम के द्वारा किये गये सर्वे एवं Model CSP, बोधगया का निर्माण में तकनीक सहयोग देने की बात रखी एवं प्रारंभिक सर्वे का विवरण प्रस्तुत किया तथा साथ ही साथ CSE के Team के द्वारा किये गये Pilot Project DWWTS के स्थल चयन पर अपनी बात रखी तथा बताया की बोधगया नगर पंचायत में भरपूर संभालना है इसमें CSE Water Programme के द्वारा एक तकनीक सहायोग यूनिट (TCU) की स्थापना की जा सकती है। जिससे FSM में बोधगया नगर पंचायत को Model नगर निकाय के रूप में विकसित हो सके।

2. कार्यपालक पदाधिकारी, श्री सुशील कुमार के द्वारा CSE Water Programme के अभी तक दिये गये तकनीक सहयोग को संतोषप्रद बताया तथा भविष्य में नगर पंचायत बोधगया के द्वारा भरपूर सहयोग की वचनबद्धता दिया। जिसमें 1. Model CSP का निर्माण 2. Pilot DWWTS Project की स्थापना 3. तकनीक सहयोग यूनिट (TCU) का गठन में पूर्ण सहयोग देने की बात रखी तथा डा0 सुरेश कुमार रोहिल्ला,

Programme Director, CSE को धन्यवाद दिया, उन्होंने Model CSP निर्माण एवं तकनीक सहयोग यूनिट (TCU) के लिये बोधगया का चयन किया।

3. नगर प्रबंधक, श्री अमरेन्द्र कुमार ने भी प्रोग्राम निदेशक, CSE को धन्यवाद देते हुए आगे पूर्ण सहयोग देने की वचनबद्धता दिया।

- **द्वितीय बैठक:– दिनांक:–9.1.2018**

दिनांक:–9.1.2018 को CSE एवं नगर पंचायत के साथ आयोजित किया गया। इस बैठक की मूल उद्देश्य कार्यपालक पदाधिकारी, श्री सुशील कुमार, नगर प्रबंधक, कनीय अभियंता के समक्ष, CSE के टीम द्वारा किये गये Pilot Project, DWWTS के स्थल चयन की प्रारंभिक रिपोर्ट प्रस्तुत करना एवं संभावना को बताना था। CSE के वॉटर प्रोग्राम की तकनीक विशेषज्ञ एवं प्रोग्राम ऑफिसर सुश्री० छवि शारदा ने पूरी जानकारी प्रस्तुत की जिसमें Prospective Site के रूप में 1. Mahabodhi Temple premises, 2. Childern's Park (adjacent to Primary Health centre), 3. New NPP headoffice. सभी जानकारी लेने के बाद कार्यपालक पदाधिकारी, श्री सुशील कुमार ने Site No. 3. New NPP headoffice करे इस प्रोजेक्ट के लिए उपयुक्त बताया जहाँ अपशिष्ट जल का प्रवाह अधिक है वहाँ पर वैज्ञानिक रूप उपचारित अपशिष्ट जल को बेहतर तरीके कृषि में उपयोग लाया जा सकता है। यह क्षेत्र कृषि वाले क्षेत्र के नजदीक है एवं निरंजना नदी के पास भी है जिसे उपचारित अपशिष्ट जल को पूरी तरह स्वच्छ कर इसे नदी में प्रवाहित भी किया जा सकता है। इस बैठक में वॉटर प्रोग्राम के प्रोग्राम, डा० सुमित कुमार गौतम एवं डिप्टी प्रोग्रोम मैनेजर, बितुष लुथरा एवं नवीन कुमार (बिहार प्रोग्राम) एवं अनिल यादव, भौविक गुप्ता ने भाग लिया।

अन्त में धन्यवाद ज्ञापन के साथ बैठक की कार्यवाही समाप्त की गयी।

ह०/–
कार्यपालक पदाधिकारी,
श्री सुशील कुमार,
नगर पंचायत बोधगया।

Annexure 4: Bill of quantity

4.1 Cost estimate - Settler

S.N.	Description	Unit	No.	Quantity (in Cum)	Rate (`)*	Amount (`)	SOR Ref Code
1	Earth work in excavation in foundation, trenches etc. including dressing of sides and ramming of bottoms, including getting out the excavated material, refilling after laying pipe/ foundation and disposal of surplus excavated material at a lead upto 50m suitable site as per direction of Engineer for following depths, below natural ground / Road top level. In all types soils/ saturated soil such as moorum, sand, sandy silt, clay, black cotton soil, kankar, etc.						
1.1	from 0.0 to 1.5 mtr	cum	1	27.23			
1.2	from 1.6 to 3.0 mtr	cum	1	8.53			
				35.76	230.5	8243.19	2.8
2	Providing and laying in position cement concrete of specified grade excluding the cost of centring and shuttering - All work upto plinth level : 1:3:6 (1 Cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size).	cum	1	1.82	2775	5037.57	4.1.5
3	Reinforced cement concrete work in beams, suspended floors, roofs having slope upto 15° landings, balconies, shelves, chajjas, lintels, bands, plain window sills, staircases and spiral stair cases upto two stories excluding the cost of centring, shuttering, finishing and reinforcement: M30 Grade						
3.1	Raft	cum	1	3.63			
3.2	Walls	Cum	2	3.57			
		Cum	2	1.31			
		Cum		8.51	6618.3	56297.99	4.2.1

S.N.	Description	Unit	No.	Quantity (in Cum)	Rate (`)*	Amount (`)	SOR Ref Code
4	Reinforced cement concrete work in wall (any thickness), including attached pilasters, buttresses, plinth and string courses, fillets, columns, pillars, piers, abutments, posts and struts, etc. upto floor five level excluding cost of centring, shuttering, finishing and reinforcement: M20 Grade	Cum	1	0.33	5139.7	1703.09	5.2.2
5	Reinforcement for R.C.C. work at all levels including straightening, cutting, bending, placing in position and binding all complete. Thermo-Mechanically Treated bars	kg		1060.53	56	59389.83	5.22.7
6	Centring and shuttering upto two stories or height upto 7.5 metre above plinth level including strutting, propping etc. and removal of form for Foundations, footings, bases of columns, etc. for mass concrete. :						
6.1	Foundations, footings, bases of columns, etc. for mass concrete	sqm	2	2.61			
6.2	Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.	sqm	4	39.61			
		sqm	4	14.56			
		sqm	1	3.31			
		sqm		60.10	166.3	9994.70	4.3.1
7	Cutting holes up to 15x15 cm in R.C.C. floors and roofs for passing drain pipe etc. and repairing the hole after insertion of drain pipe etc. with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size), including finishing complete so as to make it leak proof.	No	5	5.00	138.5	692.50	18.77
8	U-PVC pipes (working pressure 4 kg/cm2) Rubber (Seal) Ring 100 mm dia.	metre	1	1.50	20.81	31.215	7191
9	UPVC single equal Tee (with door) 110x110x110 mm	No	2	2.00	187.3	374.6	7199
10	Circular shape 560 mm dia precast R.C.C. manhole cover with frame - H.D. – 35	No	2	2.00	1274.69	2549.38	7136

S.N.	Description	Unit	No.	Quantity (in Cum)	Rate (`)*	Amount (`)	SOR Ref Code
11	Providing and laying water proofing treatment to vertical and horizontal surfaces of depressed portions of W.C. kitchen and the like consisting of: (i) 1st course of applying cement slurry @ 4.4 kg/sqm mixed with water proofing compound conforming tc IS 2645 in recommended proportions. (ii) 11 nd course of 20 mm cement plaster 1:3 (1 cement:3coarse sand)mixed with water proofing compound in recommended proportion, (iii) Illrd course of applying blown or/residual bitumen applied hot at 1.7 kg. per sqm of area, (iv) IVth course of 400 micron thick PVC sheet.(Overlaps at joints of PVC sheet should be 100 mm wide and pasted to each other with bitumen @ 1.7 kg/sqnm).						
	Horizontal surfaces	sq.m	1	9.96			
	Vertical surfaces	sq.m	4	12.16			
			2	18.27			
				40.38	138.9	5609.17	22.3
					Total Cost	**149923.22**	
	Add 10% enhancement on SOR 2016 Items (Except Market Rate Item)					**14992.32**	
					Total Cost	**164915.55**	
					Round Off	**165000.00**	
	*All the above rates are as per Schedule of Rates Vol. 1, Eighth Edition, Published by - Building Construction Department, Patna, Bihar						

4.2 Cost estimate - Anaerobic Baffled Reactor (ABR)

S.N.	Description	Unit	No.	Quantity (in Cum)	Rate (in INR)*	Amount (in INR)	SOR Ref Code	Rate (in INR)*	Amount (in INR)	Reference (Code No.)
1	Earth work in excavation in foundation, trenches etc. including dressing of sides and ramming of bottoms, including getting out the excavated material, refilling after laying pipe/ foundation and disposal of surplus excavated material at a lead upto 50m suitable site as per direction of Engineer for following depths, below natural ground / Road top level. In all types soils/ saturated soil such as moorum, sand, sandy silt, clay, black cotton soil, kankar, etc.									
1.1	from 0.0 to 1.5 mtr	cum	1	8.06	4.16	1.5	50.2944			
1.2	from 1.6 to 3.0 mtr	cum	1	8.06	4.16	1	33.5296			
							83.824	230.5	19321.43	2.8
2	Providing and laying in position cement concrete of specified grade excluding the cost of centring and shuttering - All work upto plinth level : 1:3:6 (1 Cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size).	cum	1	8.06	4.16	0.1	3.35	3174.30	10643.30	4.1.5
3	Reinforced cement concrete work in beams, suspended floors, roofs having slope upto 15° landings, balconies, shelves, chajjas, lintels, bands, plain window sills, staircases and spiral stair cases upto two stories excluding the cost of centring, shuttering, finishing and reinforcement: M30 Grade									
3.1	Raft	cum	1	7.86	4.16	0.20	6.54			
3.2	Walls	cum	2	7.46	0.18	2.20	5.91			
		cum	2	3.56	0.18	2.20	2.82			
		cum					15.27	6618.3	101043.97	4.2.1

S.N.	Description	Unit	No.	Quantity (in Cum)	Rate (in INR)*	Amount (in INR)	SOR Ref Code	Rate (in INR)*	Amount (in INR)	Reference (Code No.)
4	Reinforced cement concrete work in wall (any thickness), including attached pilasters, buttresses, plinth and string courses, fillets, columns, pillars, piers, abutments, posts and struts, etc. upto floor five level excluding cost of centring, shuttering, finishing and reinforcement: M20 Grade	Cum	5	3.56	0.1	2.08	3.69	5139.7	18983.48	5.2.2
5	Reinforcement for R.C.C. Work at all levels including straightening, cutting, bending, placing in position and binding all complete. Thermo-Mechanically Treated bars	kg					2275.3032	56.00	127416.98	5.22.7
6	Centring and shuttering upto two stories or height upto 7.5 metre above plinth level including strutting, propping etc. and removal of form for Foundations, footings, bases of columns, etc. for mass concrete. :									
6.1	Foundations, footings, bases of columns, etc. for mass concrete	sqm	2	7.86		0.20	3.14			
6.2	Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.	sqm	4	7.46		2.20	65.65			
		sqm	4	3.56		2.20	31.33			
			10	3.56		2.08	73.87			
		sqm					173.99	166.30	28934.54	4.3.1
7	Supply of material									
	Boulder 50 mm to 200 mm	cum	2	3.20	1.50	0.72	6.91	364.2	2517.35	7753
8	U-PVC pipes (working pressure 4 kg/cm2) Rubber (Seal) Ring 100 mm dia.	metre	1	17.61			17.61	20.81	366.4641	7191

S.N.	Description	Unit	No.	Quantity (in Cum)	Rate (in INR)*	Amount (in INR)	SOR Ref Code	Rate (in INR)*	Amount (in INR)	Reference (Code No.)
9	Providing and fixing factory made precast RCC perforated slab, having concrete of strength not less than M-25, of size 1000x450x50 mm, reinforced with 8 mm dia four no's longitudinal & 9nos cross sectional T.M.T. hoop bars, including providing 50 mm dia perforations @ 100 to 125 mm c/c, including providing edge binding with M.S. flats of size 50 mm x 1.6 mm complete, all as per direction of Engineer-in-charge.	No	2	3.20	1.50		9.60	1007.5	9672	24.9
10	Circular shape 560 mm dia precast R.C.C. manhole cover with frame - H.D. – 35	No	6				6.00	1274.69	7648.14	7136
11	Cutting holes up to 15x15 cm in R.C.C. floors and roofs for passing drain pipe etc. and repairing the hole after insertion of drain pipe etc. with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size), including finishing complete so as to make it leak proof.	No	13				13.00	138.5	1800.50	18.77
12	UPVC single equal Tee (with door) 110x110x110 mm	each	11				11.00	187.3	2060.3	7199
13	Providing and laying water proofing treatment to vertical and horizontal surfaces of depressed portions of W.C. kitchen and the like consisting of: (i) 1st course of applying cement slurry @ 4.4 kg/sqm mixed with water proofing compound conforming tc IS 2645 in recommended proportions. (ii) 11 nd course of 20 mm cement plaster 1:3 (1 cement:3coarse sand)mixed with water proofing compound in recommended proportion, (iii) Illrd course of applying blown or/residual bitumen aplied hot at 1.7 kg. per sqm of area, (iv) IVth course of 400 micron thick PVC sheet. (Overlaps at joints of PVC sheet should be 100 mm wide and pasted to each other with bitumen @ 1.7 kg/sqm).									

S.N.	Description	Unit	No.	Quantity (in Cum)	Rate (in INR)*	Amount (in INR)	SOR Ref Code	Rate (in INR)*	Amount (in INR)	Reference (Code No.)
	Horizontal surfaces	sq.m	1	7.1	3.2		22.72			
	Vertical surfaces	sq.m	12	3.2		2.2	84.48			
		sq.m	2	7.1		2.2	31.24			
		sq.m					138.44	138.9	19229.32	22.3
								Total Cost	**349637.77**	
	Add 10% enhancement on SOR 2016 Items (Except Market Rate Item)								**34963.78**	
								Total Cost	**384601.55**	
								Round Off	**384700.00**	
	*All the above rates are as per Schedule of Rates Vol. 1, Eighth Edition, Published by - Building Construction Department, Patna, Bihar									

4.3 Cost estimate - Planted filter bed

S. No.	Description	Unit	No.	Quantity (in Cum)	Rate (`)*	Amount (`)	Reference
1	Earth work in excavation in foundation, trenches etc. including dressing of sides and ramming of bottoms, including getting out the excavated material, refilling after laying pipe/ foundation and disposal of surplus excavated material at a lead upto 50m suitable site as per direction of Engineer for following depths, below natural ground / Road top level. In all types soils/ saturated soil such as moorum, sand, sandy silt, clay, black cotton soil, kankar, etc.						
1.1	from 0.0 to 1.5 mtr	cum	1	217.152	230.5	50053.54	2.8
2	Providing and laying in position cement concrete of specified grade excluding the cost of centring and shuttering - All work upto plinth level : 1:3:6 (1 Cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size).	cum	1	14.48	3174.30	45953.71	4.1.5
3	Reinforced cement concrete work in beams, suspended floors, roofs having slope upto 15° landings, balconies, shelves, chajjas, lintels, bands, plain window sills, staircases and spiral stair cases upto two stories excluding the cost of centring, shuttering, finishing and reinforcement: M30 Grade						
3.1	Raft	cum	1	27.85			
3.3	Walls	Cum	2	8.90			
		Cum	2	2.92			
		Cum		39.67	6618.3	262552.73	4.2.1
4	Reinforced cement concrete work in wall (any thickness), including attached pilasters, buttresses, plinth and string courses, fillets, columns, pillars, piers, abutments, posts and struts, etc. upto floor five level excluding cost of centring, shuttering, finishing and reinforcement: M20 Grade	Cum	2	1.62	5139.7	8338.65	5.2.2
5	Reinforcement for R.C.C. work at all levels including straightening, cutting, bending, placing in position and binding all complete. Thermo-Mechanically Treated bars	kg		4955.1744	56.00	277489.77	5.22.7
6	Centring and shuttering upto two stories or height upto 7.5 metre above plinth level including strutting, propping etc. and removal of form for Foundations, footings, bases of columns, etc. for mass concrete. :						
6.1	Foundations, footings, bases of columns, etc. for mass concrete	sqm	2	8.24			

6.2	Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.	sqm	4	98.88			
		sqm	4	32.45			
		sqm	4	32.45			
		sqm		172.02	166.30	28606.26	4.3.1
7	Supply of material						
	Boulder 50 mm to 200 mm	cum	2	13.25	364.2	4824.92	7753
	Wetland plants	Lumpsum				10000.00	
8	U-PVC pipes (working pressure 4 kg/cm2) Rubber (Seal) Ring 100 mm dia.	metre	1	8.50	20.81	176.885	7191
9	UPVC bend 87.50 110 mm bend	each	1	1.00	98.85	98.85	7209
10	Cutting holes up to 15x15 cm in R.C.C. floors and roofs for passing drain pipe etc. and repairing the hole after insertion of drain pipe etc. with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size), including finishing complete so as to make it leak proof.	No	10	10.00	138.5	1385.00	18.77
11	Providing and laying water proofing treatment to vertical and horizontal surfaces of depressed portions of W.C. kitchen and the like consisting of: (i) 1st course of applying cement slurry @ 4.4 kg/sqm mixed with water proofing compound conforming tc IS 2645 in recommended proportions. (ii) 11 nd course of 20 mm cement plaster 1:3 (1 cement:3coarse sand)mixed with water proofing compound in recommended proportion, (iii) Illrd course of applying blown or/residual bitumen aplied hot at 1.7 kg. per sqm of area, (iv) IVth course of 400 micron thick PVC sheet. (Overlaps at joints of PVC sheet should be 100 mm wide and pasted to each other with bitumen @ 1.7 kg/sqm).						
	Horizontal surfaces	sq.m	1	119.04			
	Vertical surfaces	sq.m	4	28.8			
		sq.m	2	47.616			
		sq.m		195.456	138.9	27148.84	22.3
					Total Cost	**716629.14**	
	Add 10% enhancement on SOR 2016 Items (Except Market Rate Item)					**71662.91**	
					Total Cost	**788292.05**	
					Round Off	**788300.00**	
	*All the above rates are as per Schedule of Rates Vol. 1, Eighth Edition, Published by - Building Construction Department, Patna, Bihar						

4.4 Cost estimate - Polishing Pond

S.No.	Description	Unit	No.	Quantity (in Cum)	Rate (`)*	Amount (`)	Reference (Code No.)
1	Earth work in excavation in foundation, trenches etc. including dressing of sides and ramming of bottoms, including getting out the excavated material, refilling after laying pipe/ foundation and disposal of surplus excavated material at a lead upto 50m suitable site as per direction of Engineer for following depths, below natural ground / Road top level. In all types soils/ saturated soil such as moorum, sand, sandy silt, clay, black cotton soil, kankar, etc.	cum	1	19.24	230.5	4434.82	2.80
2	Providing and laying water proofing treatment to vertical and horizontal surfaces of depressed portions of W.C. kitchen and the like consisting of: (i) 1st course of applying cement slurry @ 4.4 kg/sqm mixed with water proofing compound conforming tc IS 2645 in recommended proportions. (ii) 11 nd course of 20 mm cement plaster 1:3 (1 cement:3 coarse sand)mixed with water proofing compound in recommended proportion, (iii) Illrd course of applying blown or/residual bitumen aplied hot at 1.7 kg. per sqm of area, (iv) IVth course of 400 micron thick PVC sheet.(Overlaps at joints of PVC sheet should be 100 mm wide and pasted to each other with bitumen @ 1.7 kg/sqm).	Sqm	1	19.24	389.10	7486.28	22.30
3	Half brick masonry with bricks of class designation 100A in foundations and plinth in : Cement mortar 1:3 (1 cement: 3 coarse sand)	Sqm	1	19.24	581.3	11184.21	6.18.3A
4	18 mm cement plaster in two coats under layer 12 mm thick cement plaster 1:5 (1 cement :5 coarse sand) and top layer 6 mm thick, cement plaster 1:3 (1 cement: 3 coarse sand) finished rough with sponge.	Sqm	1	19.24	170	3270.80	13.20
5	Making hole up to 20x20 cm and embedding pipes up to 150 mm diameter in masonry and filling with cement concrete 1:3:6 (1 cement : 3 coarse sand 6 graded stone aggregate 20 mm nominal size) including disposal of malba.	metre	2	0.23	95.2	21.90	18.79
6	U-PVC pipes (working pressure 4 kg/cm2) Rubber (Seal) Ring 100 mm dia.	metre	1	1.50	20.81	31.215	7191
					Total Cost	**26429.23**	

S.No.	Description	Unit	No.	Quantity (in Cum)	Rate (`)*	Amount (`)	Reference (Code No.)
	Add 10% enhancement on SOR 2016 Items (Except Market Rate Item)					**2642.92**	
					Total Cost	**29072.15**	
					Round Off	**29100.00**	
	*All the above rates are as per Schedule of Rates Vol. 1, Eighth Edition, Published by - Building Construction Department, Patna, Bihar						

4.5 Cost estimate - Storage Tank

S.N.	Description	Unit	No.	Quantity (in Cum)	Rate (`)*	Amount (`)	Reference (Code No.)
	Civil Works						
1	Earth work in excavation in foundation, trenches etc. including dressing of sides and ramming of bottoms, including getting out the excavated material, refilling after laying pipe/ foundation and disposal of surplus excavated material at a lead upto 50m suitable site as per direction of Engineer for following depths, below natural ground / Road top level. In all types soils/ saturated soil such as moorum, sand, sandy silt, clay, black cotton soil, kankar, etc.	cum	1	30.657545	230.5	7066.56	2.80
2	Providing and laying water proofing treatment to vertical and horizontal surfaces of depressed portions of W.C. kitchen and the like consisting of: (i) 1st course of applying cement slurry @ 4.4 kg/sqm mixed with water proofing compound conforming tc IS 2645 in recommended proportions. (ii) 11 nd course of 20 mm cement plaster 1:3 (1 cement:3 coarse sand)mixed with water proofing compound in recommended proportion, (iii) Illrd course of applying blown or/residual bitumen aplied hot at 1.7 kg. per sqm of area, (iv) IVth course of 400 micron thick PVC sheet. (Overlaps at joints of PVC sheet should be 100 mm wide and pasted to each other with bitumen @ 1.7 kg/sqnm).	Sqm	1	1.50	389.10	581.90	22.30
3	Brick masonry with bricks of class designation 100A in foundations and plinth in : Cement mortar 1:3 (1 cement: 3 coarse sand)						
3.1	Base Slab	Sqm	1	10.40			
3.2	Walls	Sqm	2	15.60			
		Sqm	2	10.14			
		Sqm		36.14	581.3	21008.18	6.18.3A
4	18 mm cement plaster in two coats under layer 12 mm thick cement plaster 1:5 (1 cement :5 coarse sand) and top layer 6 mm thick, cement plaster 1:3 (1 cement: 3 coarse sand) finished rough with sponge.						

S.N.	Description	Unit	No.	Quantity (in Cum)	Rate (`)*	Amount (`)	Reference (Code No.)
4.1	Base Slab	Sqm	1	10.40			
4.2	Walls	Sqm	2	15.60			
		Sqm	2	10.14			
		Sqm		36.14	170	6143.80	13.20
5	Providing and fixing 1st quality ceramic glazed wall tiles conforming to IS : 15622 (Thickness to be specified by the manufacture) of approved make in all colours, shades except burgundy , bottle green , black of any size as approved by Engineer-in-charge in skirting , risers of steps and dados over 12 mm thick bed of cement Motar 1:3(1 cement: 3 coarse sand) and jointing with grey cement slurry @ 3.3 kg per sqm including pointing in white cement mixed with pigment of matching shade complete.						
5.1	Base Slab	Sqm	1	10.40			
5.2	Walls	Sqm	2	15.60			
		Sqm	2	10.14			
		Sqm		36.14	766.3	27694.08	11.36
6	Making hole up to 20x20 cm and embedding pipes up to 150 mm diameter in masonry and filling with cement concrete 1:3:6 (1 cement : 3 coarse sand 6 graded stone aggregate 20 mm nominal size) including disposal of malba.	metre	1	0.12	95.2	10.95	18.79
7	U-PVC pipes (working pressure 4 kg/cm2) Rubber (Seal) Ring 100 mm dia.	m	1	1.50	20.81	31.215	7191
8	UPVC bend 87.50 110 mm bend	No	1	1.00	98.85	98.85	7209
					Total Cost	**62635.54**	
	Add 10% enhancement on SOR 2016 Items (Except Market Rate Item)					**6263.55**	
					Total Cost	**68899.09**	
					Round Off	**69000.00**	
	*All the above rates are as per Schedule of Rates Vol. 1, Eighth Edition, Published by - Building Construction Department, Patna, Bihar						

Annexure 5: O&M and Life Cycle Costing: DWWTs

	Year 1	Year 2	Year 3	Year 4	Year 5
OPEX - Line items	**Cost* (₹)**	**Cost* (₹)**	**Cost* (₹)**	**Cost* (₹)**	**Cost* (₹)**
Incentive for semi-skilled person	144,000	144,000	144,000	158,000	158,000
Labor/ Manpower	42,000	42,000	42,000	42,000	42,000
Electricity cost of pumping of pumping inlet and treated waste water depending on site condition will be required	5,000	5,000	5,000	5,000	6,000
Harvesting/ Trimming of plants and removal of its waste from the bed	1,000	1,000	1,000	1,000	1,000
Desludging and cleaning of settler/ ABR	NA	NA	4,000	NA	NA
Misc. including personal protective equipment like gloves, boots etc.	5,000	10,000	10,000	10,000	10,000
Total	**197,000**	**202,000**	**206,000**	**216,000**	**217,000**
Average					**207,600**

Annexure 6: Sample format for Maintenance Log

ACTIVITY- EVERYDAY **1.** Physical examination of inlet chamber **2.** Physical examination Planted filter bed **3.** Physical examination collection chamber for treated water					
Date/ Day	**Remarks** **ACTIVITY 1**	**Remarks** **ACTIVITY 2**	**Remarks** **ACTIVITY 3**	**Responsible person**	**Supervised by (Admin)**
MONDAY	ACTIVITY 1 and ACTIVITY 3 – Done. No variations reported. ACTIVITY 2 – Flowering of yellow canna flowers observed.			ABC	XYZ
WENESDAY					
FRIDAY					

Annexure 7: Information, Communication and Education

Description of IEC activity	Cost (in ₹)				
	Year 1	Year 2	Year 3	Year 4	Year 5
1. Trainings of engineers/officials on topics including: • Policies, programmes and guidelines for sewage, DWWTs and local reuse • Planning and Designing of Decentralised wastewater treatment systems and local reuse • Innovative approaches to involve and achieve stakeholder participation • Bulk reuse of treated wastewater in public spaces • Monitoring of the various decentralised wastewater treatment systems at various scales and its standard operating procedures • Setting up a call centre & MIS for better management • Engagement in model projects and showcasing successful implementations of the DWWTs 2. Training of DWWTs operators on topics including: • Understanding of the system and role of operators in DWWTs success • O&M activities to be undertaken for efficient and sustainable functioning of the system • Use of PPE • Awareness of labor laws, social welfare schemes • Data collection & system management including sampling process and protocols • Reporting process – observations relevant to system's efficiency, complaints, innovations 3. Provision of personal protective equipment for maintenance staff and training for its usage 4. Public participation and awareness on topics including: • Display boards with updated information on quality of treated water • Do's and Don'ts to be followed around the site and for treated water usage • Stencil signs at the site of reuse (Not for potable usage) • Information brochures distribution during exhibitions and cultural events on benefits of DWWTs	50,000	25,000	25,000	25,000	25,000
TOTAL	50,000	25,000	25,000	25,000	25,000